Il Consiglio Direttivo dell’Istituto Nazionale di Fisica Nucleare, riunito in Roma il giorno 27 novembre 2015, alla presenza di n. 32 dei suoi componenti su un totale di n. 34;

- visto l’articolo 2 dello Statuto con cui l’Istituto Nazionale di Fisica Nucleare promuove, coordina ed effettua la ricerca scientifica nel campo della fisica nucleare, subnucleare, astroparticellare e delle interazioni fondamentali, nonché la ricerca e lo sviluppo tecnologico pertinenti all’attività in tali settori, e nello svolgimento della sua attività ha sviluppato competenze e conoscenze suscettibili di trovare applicazione in altri settori;

- vista la guida di supporto della Commissione Europea (CE) per il Programma Quadro Horizon 2020 (H2020) “H2020 Online Manual” e gli atti normativi di riferimento all’attività del Servizio Coordinamento Fondi Esterni dell’Amministrazione Centrale;

- ritenuto che è interesse dell’Istituto partecipare a bandi competitivi promossi e finanziati dalla CE e, in questo senso, il Servizio Coordinamento Fondi Esterni è deputato a supportare i ricercatori dell’Istituto che intendono proporre progetti nell’ambito di H2020;


- preso atto del Grant Agreement sottoscritto dalla Commissione il 21-05-2015 allegato alla presente deliberazione della quale costituisce parte integrante e sostanziale ;

- preso atto della sottoscrizione dell’ Accession Form for Beneficiaries da parte del Project Legal Signatory – PLSIGN (abbinato al suddetto progetto) come da pag. 288 del Grant Agreement ;

- considerato che la rilevazione contabile dell’entrata di bilancio e delle corrispondenti assegnazioni ai capitoli di spesa sarà oggetto di successiva delibera di variazione di bilancio;

- su proposta della Giunta Esecutiva;

- con n. 32 voti favorevoli;
Di ratificare la sottoscrizione dell’ Accession Form for Beneficiaries da parte del Project Legal Signatory – PLSIGN (abbinato al suddetto progetto) come da pag. 288 del Grant Agreement.
Subject: Invitation to grant preparation – from reserve list

Proposal: 654215 — AHEAD

Dear Luigi PIRO,

With reference to our previous notification on the outcome of the evaluations, we are pleased to inform you that the Commission is now in a position to proceed to the preparation of the Grant Agreement based on your proposal.

You will find the Evaluation Summary Report (ESR) for your proposal together with this letter in the "My Area" section of the Research Participant Portal. The ESR reflects the comments of the evaluators.

You will also find under chapter “Other Information” in this letter or available in the Participant Portal, the outcome of the Ethics Review (including the outcome of the Ethics screening/ Ethics Assessment), which may include elements to be taken into account during the grant preparation.

**Invitation to grant preparation**

With reference to the submitted proposal and its evaluation, the grant preparation shall be based on the following:

1. **Proposal No:** 654215 - AHEAD - RIA
2. **Topic:** INFRAIA-1-2014-2015 - Integrating and opening existing national and regional research infrastructures of European interest
3. **Project Officer:**
   - Ms Keji Alex ADUNMO
   - Keji-Alex.ADUNMO@ec.europa.eu
   - +32 22981363
   - Research infrastructure
4. **Maximum Grant Amount:**
   
   (4.1) EU contribution requested in Proposal: 4,982,477.00 EUR  
   (4.2) Maximum EU grant amount attributed to the Action following evaluation: 4,982,477.00 EUR

5. **Duration of the Action:** 42 Months

6. **Technical content:** The ‘Description of the Action’ (Annex 1 of the future Grant Agreement) and the ‘Estimated budget for the action’ (Annex 2 of the future Grant Agreement) shall be based on the proposal submitted.

   In the event that the ethics assessment and/or the security scrutiny identify substantive issues, these recommendations must be taken into account during grant preparation and reflected in the Description of the Action.

   Please note that, in principle, no changes in the consortium composition (including linked third parties) are possible during the grant preparation phase. Please inform your Project Officer (3) as soon as possible if an organisation from the proposal is no longer in a position to participate in the grant agreement for duly-justified reasons (e.g. due to bankruptcy).

7. **Timetable for grant preparation**

   7.1 **3 weeks after the date of this letter** is the deadline for the submission of the grant agreement data, including annexes. Following the assessment of the submitted version of the grant agreement data, you will have a two-week deadline to submit the final version taking into consideration all requirements highlighted by the Project Officer,

   7.2 **6 weeks after the date of this letter** is the deadline for the electronic signature of the participants’ declarations of honour.

   The Commission foresees proceeding with the signature of the grant agreement within **3 months** after the date of this letter.

   **Failure to respect the deadlines indicated above will be considered as a wish not to enter into, or continue with, the grant preparation and, therefore, to withdraw your proposal. In such a case, the Commission reserves the right to initiate the procedures to reject your proposal, unless alternative arrangements have been accepted by the Commission.**

   The entire grant preparation process, including communication with the Commission and the subsequent signature of the Grant Agreement, shall be carried out through the Research Participant Portal Grant Management Service (PP GMS). By logging into the ‘*My Area*’ section in the Participant Portal and selecting the project, each step of the grant preparation process can be followed, and all relevant documents consulted, at any time.

   The Grant Agreement preparation data provided through the Participant Portal (pre-filled with the information already available in the Beneficiary Register, and structured data from your proposal) are needed in order to prepare the grant agreement and provide programme-wide statistical information.

   Please note that some information related to the legal and financial status of participants is read-only and may only be updated by the Legal Entity Appointed Representative (LEAR) of the concerned
entity through the 'My Organisation(s)' page of the 'My Area' section in the Participant Portal. It is therefore important to ensure that all participants are aware of the need to appoint a LEAR with an extended mandate for Horizon 2020.

Furthermore, please be aware that linked third parties mentioned in your proposal also need to be registered and validated as legal entities. If necessary, please urge them to start the registration/validation process as quickly as possible.

Further information providing practical details on grant preparation (including how to transpose the information from your proposal to the grant agreement) as well as technical guidance, are available in the H2020 Online Manual on the Participant Portal.

This letter should not be regarded under any circumstances as a formal commitment by the Commission to provide financial support, as this depends on the satisfactory and timely conclusion of grant agreement preparation and on the internal completion of the formal selection process.

Please inform the other participants of the current situation.

Should you require further details concerning the granting process, you are invited to contact the officer in charge of your project (3).

Yours sincerely,

Antonio DI GIULIO

Enclosure(s):
Evaluation Summary Report
This Agreement (‘the Agreement’) is between the following parties:

on the one part,

the European Union (‘the EU’), represented by the European Commission (‘the Commission’),

represented for the purposes of signature of this Agreement by Head of Unit, DIRECTORATE-GENERAL FOR RESEARCH & INNOVATION, Innovation Union and European Research Area, Administration and finance, Pascale CID,

and

on the other part,

1. ‘the coordinator’:

ISTITUTO NAZIONALE DI ASTROFISICA (INAF), 97220210583, established in Viale del Parco Mellini 84, ROMA 00136, Italy, IT06895721006, represented for the purposes of signing the Agreement by Giovanni Fabrizio BIGNAMI

and the following other beneficiaries, if they sign their ‘Accession Form’ (see Annex 3 and Article 56):

2. UNIVERSITY OF LEICESTER (ULEIC) GB22, RC000659, established in UNIVERSITY ROAD, LEICESTER LE1 7RH, United Kingdom, GB916583894,

3. STICHTING SRON NETHERLANDS INSTITUTE FOR SPACE RESEARCH (STICHTING SRON) NL9, 41153005, established in SORBONNELAAN 2, UTRECHT 3584 CA, Netherlands, NL008952577B01,

4. MAX PLANCK GESELLSCHAFT ZUR FOERDERUNG DER WISSENSCHAFTEN E.V. (MPG) EV, VR13378B, established in Hofgartenstrasse 8, MUENCHEN 80539, Germany, DE129517720,

5. NATIONAL OBSERVATORY OF ATHENS (NOA), established in LOFOS NYMFON, ATHINA 11810, Greece, EL090050779,

6. THALES ALENIA SPACE ITALIA SPA (TAS Italia) SPA, 02101600480, established in Via Saccomuro 24, ROMA 00131, Italy, IT00991340969,

7. DANMARKS TEKNISKE UNIVERSITET (DTU), 30060946, established in Anker Engelundsvej 1, Bygnning 101, KONGENS LYNGBY 2800, Denmark, DK30060946,

8. CENTRUM ASTRONOMICZNE IM. MIKOLAJA KOPERNIKA POLSKIEJ AKADEMII NAUK (NCAC), RIN-III-250/98, established in Bartycka, 18, WARSZAWA 00716, Poland, PL5250008956,

9. UNIVERSITA DEGLI STUDI DI FERRARA (UNIFE), N/A, established in SAVONAROLA 9, FERRARA 44100, Italy, IT00434690384,

1 Text in italics shows the options of the Model Grant Agreement that are applicable to this Agreement.
10. UNIVERSITA DEGLI STUDI DI PERUGIA (UNIPG), DECRETO 2454 30/09/1996, established in PIAZZA DELL’ UNIVERSITA 1, PERUGIA 06123, Italy, IT448820548,

11. UNIVERSITE DE LIEGE (ULG), 325777171, established in PLACE DU 20 AOUT 7, LIEGE 4000, Belgium, BE0325777171,

12. UNIVERSITA DEGLI STUDI DI GENOVA (UNIGE), CF00754150100, established in VIA BALBI 5, GENOVA 16126, Italy, IT00754150100,

13. COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES (CEA) EPIC, 775685019, established in RUE LEIBLANC 25, PARIS 15 75015, France, FR43775685019,

14. Teknologian tutkimuskeskus VTT Oy (VTT) FI21, 26473754, established in VUORIMIEHENTIE 3, Espoo 02150, Finland, FI26473754,

15. LANCASTER UNIVERSITY (ULANC), RC000657, established in BAILRIGG, LANCASTER LAI 4YW, United Kingdom, GB604609849,

16. CESKE VYSOKE UCENI TECHNICKE V PRAZE (CESKE VYSOKE UCENI TECHNICE V PRAZE), 68407700, established in ZIKOVA 4, PRAHA 16636, Czech Republic, CZ68407700,

17. UNIVERSITY COLLEGE DUBLIN, NATIONAL UNIVERSITY OF IRELAND, DUBLIN (NUID UCD), established in BELFIELD, DUBLIN 4, Ireland, IE6517386K,

18. UNIVERSITA DEGLI STUDI DI PALERMO (UNIPA), CF80023730825, established in PIAZZA MARINA 61, PALERMO 90133, Italy, IT00605880822,

19. TARTU OBSERVATORY - ESTONIAN MINISTRY OF EDUCATION AND RESEARCH (TARTU OBSERVATORY ), 70003785, established in Toravere, TORAVERE 61602, Estonia, EE100285958 ,

20. UNIVERSIDAD DE ALICANTE (UNIVERSIDAD DE ALICANTE), established in CAMPUS DE SAN VICENTE RASPEIG, ALICANTE 03690, Spain, ESQ0332001G,

21. AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS (CSIC) ES8, established in CALLE SERRANO 117, MADRID 28006, Spain, ESQ2818002D,

22. EBERHARD KARLS UNIVERSITAET TUEBINGEN (EKUT), -, established in GESCHWISTER-SCHOLL-PLATZ, TUEBINGEN 72074, Germany, DE812383453,

23. LABORATORIO DE INSTRUMENTACAO E FISICA EXPERIMENTAL DE PARTICULAS (LIP), 273960916, established in RUA LARGA 4, UNIVERSIDADE DE COIMBRA, DEPARTAMENTO DE FISICA, COIMBRA 3004 516, Portugal, PT501694650,

24. CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE (CNRS), 180089013, established in Rue Michel -Ange 3, PARIS 75794, France, FR40180089013,

25. UNIVERSITE DE GENEVE (UNIVERSITE DE GENEVE), CHE110644228, established in RUE DU GENERAL DUFOUR 24, GENEVE 1211, Switzerland, CHE114927636TVA, as ‘beneficiary not receiving EU funding’ (see Article 9),

26. ISTITUTO NAZIONALE DI FISICA NUCLEARE (INFN), 976596, established in Via Enrico Fermi 40, FRASCATI 00044, Italy, IT04430461006,

Unless otherwise specified, references to ‘beneficiary’ or ‘beneficiaries’ include the coordinator.

The parties referred to above have agreed to enter into the Agreement under the terms and conditions below.
By signing the Agreement or the Accession Form, the beneficiaries accept the grant and agree to implement it under their own responsibility and in accordance with the Agreement, with all the obligations and conditions it sets out.

The Agreement is composed of:

Terms and Conditions

Annex 1  Description of the action
Annex 2  Estimated budget for the action
Annex 3  Accession Forms
Annex 4  Model for the financial statements
Annex 5  Model for the certificate on the financial statements
Annex 6  Model for the certificate on the methodology
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CHAPTER 2 ACTION

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The grant is awarded for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain — AHEAD’ (‘action’), as described in Annex 1.

ARTICLE 3 — DURATION AND STARTING DATE OF THE ACTION

The duration of the action will be 42 months as of 1 September 2015 (‘starting date of the action’).

ARTICLE 4 — ESTIMATED BUDGET AND BUDGET TRANSFERS

4.1 Estimated budget

The ‘estimated budget’ for the action is set out in Annex 2.

It contains the estimated eligible costs and the forms of costs, broken down by beneficiary and budget category (see Articles 5, 6). It also contains the estimated costs of the beneficiaries not receiving EU funding (see Article 9).

4.2 Budget transfers

The estimated budget breakdown indicated in Annex 2 may be adjusted by transfers of amounts between beneficiaries or between budget categories (or both). This does not require an amendment according to Article 55, if the action is implemented as described in Annex 1.

However, the beneficiaries may not add costs relating to subcontracts not provided for in Annex 1, unless such additional subcontracts are approved by an amendment or in accordance with Article 13.

CHAPTER 3 GRANT

ARTICLE 5 — GRANT AMOUNT, FORM OF GRANT, REIMBURSEMENT RATES AND FORMS OF COSTS

5.1 Maximum grant amount

The ‘maximum grant amount’ is EUR 4,982,477.00 (four million nine hundred and eighty two thousand four hundred and seventy seven EURO).
5.2 Form of grant, reimbursement rates and forms of costs

The grant reimburses **100% of the action's eligible costs** (see Article 6) (‘reimbursement of eligible costs grant’) (see Annex 2).

The estimated eligible costs of the action are EUR **5,085,247.00** (five million eighty five thousand two hundred and forty seven EURO).

Eligible costs (see Article 6) must be declared under the following forms (‘forms of costs’):

(a) for **direct personnel costs** (excluding direct personnel costs covered by the unit cost under Point (f)):

   - as actually incurred costs (‘actual costs’) or

   - on the basis of an amount per unit calculated by the beneficiary in accordance with its usual cost accounting practices (‘unit costs’).

Personnel costs for SME owners or beneficiaries that are natural persons not receiving a salary (see Article 6.2, Points A.4 and A.5) must be declared on the basis of the amount per unit set out in Annex 2 (unit costs);

(b) for **direct costs for subcontracting** (excluding subcontracting costs covered by the unit cost under Point (f)): as actually incurred costs (actual costs);

(c) for **direct costs of providing financial support to third parties** (excluding costs of financial support covered by the unit cost under Point (f)): not applicable;

(d) for **other direct costs** (excluding other direct costs covered by the unit cost under Point (f)): as actually incurred costs (actual costs);

(e) for **indirect costs** (excluding indirect costs covered by the unit cost under Point (f)): on the basis of a flat-rate applied as set out in Article 6.2, Point E (‘flat-rate costs’);

(f) for ‘Costs for providing trans-national access to research infrastructure’: on the basis of the amount(s) per unit set out in Annex 2 (unit costs).

5.3 Final grant amount — Calculation

The ‘**final grant amount**’ depends on the actual extent to which the action is implemented in accordance with the Agreement’s terms and conditions.

This amount is calculated by the **Commission** — when the payment of the balance is made (see Article 21.4) — in the following steps:

Step 1 – Application of the reimbursement rates to the eligible costs

Step 2 – Limit to the maximum grant amount

Step 3 – Reduction due to the no-profit rule

Step 4 – Reduction due to improper implementation or breach of other obligations
5.3.1 Step 1 — Application of the reimbursement rates to the eligible costs

The reimbursement rate(s) (see Article 5.2) are applied to the eligible costs (actual costs, unit costs and flat-rate costs; see Article 6) declared by the beneficiaries (see Article 20) and approved by the Commission (see Article 21).

5.3.2 Step 2 — Limit to the maximum grant amount

If the amount obtained following Step 1 is higher than the maximum grant amount set out in Article 5.1, it will be limited to the latter.

5.3.3 Step 3 — Reduction due to the no-profit rule

The grant must not produce a profit.

‘Profit’ means the surplus of the amount obtained following Steps 1 and 2 plus the action’s total receipts, over the action’s total eligible costs.

The ‘action’s total eligible costs’ are the consolidated total eligible costs approved by the Commission.

The ‘action’s total receipts’ are the consolidated total receipts generated during its duration (see Article 3).

The following are considered receipts:

(a) income generated by the action; if the income is generated from selling equipment or other assets purchased under the Agreement, the receipt is up to the amount declared as eligible under the Agreement;

(b) financial contributions given by third parties to the beneficiary specifically to be used for the action, and

(c) in-kind contributions provided by third parties free of charge and specifically to be used for the action, if they have been declared as eligible costs.

The following are however not considered receipts:

(a) income generated by exploiting the action’s results (see Article 28);

(b) financial contributions by third parties, if they may be used to cover costs other than the eligible costs (see Article 6);

(c) financial contributions by third parties with no obligation to repay any amount unused at the end of the period set out in Article 3.

If there is a profit, it will be deducted from the amount obtained following Steps 1 and 2.

5.3.4 Step 4 — Reduction due to improper implementation or breach of other obligations — Reduced grant amount — Calculation

If the grant is reduced (see Article 43), the Commission will calculate the reduced grant amount by deducting the amount of the reduction (calculated in proportion to the improper implementation of
the action or to the seriousness of the breach of obligations in accordance with Article 43.2) from the maximum grant amount set out in Article 5.1.

The final grant amount will be the lower of the following two:

- the amount obtained following Steps 1 to 3 or
- the reduced grant amount following Step 4.

5.4 Revised final grant amount — Calculation

If — after the payment of the balance (in particular, after checks, reviews, audits or investigations; see Article 22) — the Commission rejects costs (see Article 42) or reduces the grant (see Article 43), it will calculate the ‘revised final grant amount’ for the beneficiary concerned by the findings.

This amount is calculated by the Commission on the basis of the findings, as follows:

- in case of rejection of costs: by applying the reimbursement rate to the revised eligible costs approved by the Commission for the beneficiary concerned;
- in case of reduction of the grant: by calculating the concerned beneficiary’s share in the grant amount reduced in proportion to its improper implementation of the action or to the seriousness of its breach of obligations (see Article 43.2).

In case of rejection of costs and reduction of the grant, the revised final grant amount for the beneficiary concerned will be the lower of the two amounts above.

ARTICLE 6 — ELIGIBLE AND INELIGIBLE COSTS

6.1 General conditions for costs to be eligible

‘Eligible costs’ are costs that meet the following criteria:

(a) for actual costs:

(i) they must be actually incurred by the beneficiary;

(ii) they must be incurred in the period set out in Article 3, with the exception of costs relating to the submission of the periodic report for the last reporting period and the final report (see Article 20);

(iii) they must be indicated in the estimated budget set out in Annex 2;

(iv) they must be incurred in connection with the action as described in Annex 1 and necessary for its implementation;

(v) they must be identifiable and verifiable, in particular recorded in the beneficiary’s accounts in accordance with the accounting standards applicable in the country where the beneficiary is established and with the beneficiary’s usual cost accounting practices;

(vi) they must comply with the applicable national law on taxes, labour and social security, and
(vii) they must be reasonable, justified and must comply with the principle of sound financial management, in particular regarding economy and efficiency;

(b) for unit costs:

(i) they must be calculated as follows:

{amounts per unit set out in Annex 2 or calculated by the beneficiary in accordance with its usual cost accounting practices (see Article 6.2, Point A)

multiplied by

the number of actual units};

(ii) the number of actual units must comply with the following conditions:

- the units must be actually used or produced in the period set out in Article 3;
- the units must be necessary for implementing the action or produced by it, and
- the number of units must be identifiable and verifiable, in particular supported by records and documentation (see Article 18);

(c) for flat-rate costs:

(i) they must be calculated by applying the flat-rate set out in Annex 2, and

(ii) the costs (actual costs or unit costs) to which the flat-rate is applied must comply with the conditions for eligibility set out in this Article.

6.2 Specific conditions for costs to be eligible

Costs are eligible if they comply with the general conditions (see above) and the specific conditions set out below for each of the following budget categories:

A. direct personnel costs;
B. direct costs of subcontracting;
C. not applicable;
D. other direct costs;
E. indirect costs;
F. ‘Costs for providing trans-national access to research infrastructure’.

‘Direct costs’ are costs that are directly linked to the action implementation and can therefore be attributed to it directly. They must not include any indirect costs (see Point E below).

‘Indirect costs’ are costs that are not directly linked to the action implementation and therefore cannot be attributed directly to it.
A. Direct personnel costs (not covered by Point F)

Types of eligible personnel costs

A.1 Personnel costs are eligible, if they are related to personnel working for the beneficiary under an employment contract (or equivalent appointing act) and assigned to the action (‘costs for employees (or equivalent)’). They must be limited to salaries (including during parental leave), social security contributions, taxes and other costs included in the remuneration, if they arise from national law or the employment contract (or equivalent appointing act).

Beneficiaries that are non-profit legal entities² may also declare as personnel costs additional remuneration for personnel assigned to the action (including payments on the basis of supplementary contracts regardless of their nature), if:

(a) it is part of the beneficiary’s usual remuneration practices and is paid in a consistent manner whenever the same kind of work or expertise is required;

(b) the criteria used to calculate the supplementary payments are objective and generally applied by the beneficiary, regardless of the source of funding used.

Additional remuneration for personnel assigned to the action is eligible up to the following amount:

(a) if the person works full time and exclusively on the action during the full year: up to EUR 8 000;

(b) if the person works exclusively on the action but not full-time or not for the full year: up to the corresponding pro-rata amount of EUR 8 000, or

(c) if the person does not work exclusively on the action: up to a pro-rata amount calculated as follows:

\[
\text{EUR 8 000} \div \text{the number of annual productive hours (see below)} \times \text{the number of hours that the person has worked on the action during the year}. 
\]

A.2 The costs for natural persons working under a direct contract with the beneficiary other than an employment contract are eligible personnel costs, if:

(a) the person works under the beneficiary’s instructions and, unless otherwise agreed with the beneficiary, on the beneficiary’s premises;

² For the definition, see Article 2.1(14) of the Rules for Participation Regulation No 1290/2013: ‘non-profit legal entity’ means a legal entity which by its legal form is non-profit-making or which has a legal or statutory obligation not to distribute profits to its shareholders or individual members.
(b) the result of the work carried out belongs to the beneficiary, and

(c) the costs are not significantly different from those for personnel performing similar tasks under an employment contract with the beneficiary.

A.3 The **costs of personnel seconded by a third party against payment** are eligible personnel costs, if the conditions in Article 11.1 are met.

A.4 **Costs of owners** of beneficiaries that are small and medium-sized enterprises (‘SME owners’) who are working on the action and who do not receive a salary are eligible personnel costs, if they correspond to the amount per unit set out in Annex 2 multiplied by the number of actual hours worked on the action.

A.5 **Costs of ‘beneficiaries that are natural persons’** not receiving a salary are eligible personnel costs, if they correspond to the amount per unit set out in Annex 2 multiplied by the number of actual hours worked on the action.

A.6 **Personnel costs for providing trans-national access to research infrastructure** are eligible only if also the conditions set out in Article 16.1.1 are met.

**Calculation**

Personnel costs must be calculated by the beneficiaries as follows:

\[
\text{\{hourly rate} \\
\text{multiplied by} \\
\text{the number of actual hours worked on the action}, \\
\text{plus} \\
\text{for non-profit legal entities: additional remuneration to personnel assigned to the action under the conditions set out above (Point A.1)}.
\]

The number of actual hours declared for a person must be identifiable and verifiable (see Article 18).

The total number of hours declared in EU or Euratom grants, for a person for a year, cannot be higher than the annual productive hours used for the calculations of the hourly rate. Therefore, the maximum number of hours that can be declared for the grant is:

\[
\text{\{the number of annual productive hours for the year (see below)} \\
\text{minus} \\
\text{total number of hours declared by the beneficiary for that person in that year for other EU or Euratom grants}}.
\]

The ‘**hourly rate**’ is one of the following:

(a) for personnel costs declared as **actual costs**: the hourly rate is the amount calculated as follows:

\[
\text{\{actual annual personnel costs (excluding additional remuneration) for the person} \\
\text{divided by}
\]

(b) the result of the work carried out belongs to the beneficiary, and

(c) the costs are not significantly different from those for personnel performing similar tasks under an employment contract with the beneficiary.
number of annual productive hours\}. 

The beneficiaries must use the annual personnel costs and the number of annual productive hours for each financial year covered by the reporting period. If a financial year is not closed at the end of the reporting period, the beneficiaries must use the hourly rate of the last closed financial year available.

For the ‘number of annual productive hours’, the beneficiaries may choose one of the following:

(i) ‘fixed number of hours’: 1 720 hours for persons working full time (or corresponding prorata for persons not working full time);

(ii) ‘individual annual productive hours’: the total number of hours worked by the person in the year for the beneficiary, calculated as follows:

\{annual workable hours of the person (according to the employment contract, applicable collective labour agreement or national law) 
plus 
overtime worked 
minus 
absences (such as sick leave and special leave)\}.

‘Annual workable hours’ means the period during which the personnel must be working, at the employer’s disposal and carrying out his/her activity or duties under the employment contract, applicable collective labour agreement or national working time legislation.

If the contract (or applicable collective labour agreement or national working time legislation) does not allow to determine the annual workable hours, this option cannot be used;

(iii) ‘standard annual productive hours’: the ‘standard number of annual hours’ generally applied by the beneficiary for its personnel in accordance with its usual cost accounting practices. This number must be at least 90% of the ‘standard annual workable hours’.

If there is no applicable reference for the standard annual workable hours, this option cannot be used.

For all options, the actual time spent on parental leave by a person assigned to the action may be deducted from the number of annual productive hours;

(b) for personnel costs declared on the basis of unit costs: the hourly rate is one of the following:

(i) for SME owners or beneficiaries that are natural persons: the hourly rate set out in Annex 2 (see Points A.4 and A.5 above), or
(ii) for personnel costs declared on the basis of the beneficiary’s usual cost accounting practices: the hourly rate calculated by the beneficiary in accordance with its usual cost accounting practices, if:

- the cost accounting practices used are applied in a consistent manner, based on objective criteria, regardless of the source of funding;
- the hourly rate is calculated using the actual personnel costs recorded in the beneficiary’s accounts, excluding any ineligible cost or costs included in other budget categories.

The actual personnel costs may be adjusted by the beneficiary on the basis of budgeted or estimated elements. Those elements must be relevant for calculating the personnel costs, reasonable and correspond to objective and verifiable information;

and

- the hourly rate is calculated using the number of annual productive hours (see above).

B. Direct costs of subcontracting \((not \ covered \ by \ Point \ F)\) (including related duties, taxes and charges such as non-deductible value added tax (VAT) paid by the beneficiary) are eligible if the conditions in Article 13.1.1 are met.

Subcontracting costs for providing trans-national access to research infrastructure are eligible only if also the conditions set out in Article 16.1.1 are met.

C. Direct costs of providing financial support to third parties \((not \ covered \ by \ Point \ F)\) not applicable.

D. Other direct costs \((not \ covered \ by \ Point \ F)\)

D.1 Travel costs and related subsistence allowances (including related duties, taxes and charges such as non-deductible value added tax (VAT) paid by the beneficiary) are eligible if they are in line with the beneficiary’s usual practices on travel.

Travel costs for providing trans-national access to research infrastructure are eligible only if also the conditions set out in Article 16.1.1 are met.

D.2 The depreciation costs of equipment, infrastructure or other assets \((new \ or \ second-hand)\) as recorded in the beneficiary’s accounts are eligible, if they were purchased in accordance with Article 10.1.1 and written off in accordance with international accounting standards and the beneficiary’s usual accounting practices.

The costs of renting or leasing equipment, infrastructure or other assets (including related duties, taxes and charges such as non-deductible value added tax (VAT) paid by the beneficiary) are also eligible, if they do not exceed the depreciation costs of similar equipment, infrastructure or assets and do not include any financing fees.
The costs of equipment, infrastructure or other assets contributed in-kind against payment are eligible, if they do not exceed the depreciation costs of similar equipment, infrastructure or assets, do not include any financing fees and if the conditions in Article 11.1 are met.

The only portion of the costs that will be taken into account is that which corresponds to the duration of the action and rate of actual use for the purposes of the action.

As an exception, the beneficiaries must not declare such costs (i.e. costs of renting, leasing, purchasing depreciable equipment, infrastructure and other assets) for providing trans-national or virtual access to research infrastructure (see Article 16).

D.3 Costs of other goods and services (including related duties, taxes and charges such as non-deductible value added tax (VAT) paid by the beneficiary) are eligible, if they are:

(a) purchased specifically for the action and in accordance with Article 10.1.1 or

(b) contributed in kind against payment and in accordance with Article 11.1.

Such goods and services include, for instance, consumables and supplies, dissemination (including open access), protection of results, certificates on the financial statements (if they are required by the Agreement), certificates on the methodology, translations and publications.

Costs of other goods and services for providing trans-national access to research infrastructure are eligible only if also the conditions set out in Article 16.1.1 are met.

D.4 Capitalised and operating costs of ‘large research infrastructure’:\n
Indirect costs (not covered by Point F)

Indirect costs are eligible if they are declared on the basis of the flat-rate of 25% of the eligible direct costs (see Article 5.2 and Points A to D above), from which are excluded:

(a) costs of subcontracting and

(b) costs of in-kind contributions provided by third parties which are not used on the beneficiary’s premises;

(c) not applicable;

(d) unit costs under Articles 5.2(f) and 6.2.F.

3 ‘Large research infrastructure’ means research infrastructure of a total value of at least EUR 20 million, for a beneficiary, calculated as the sum of historical asset values of each individual research infrastructure of that beneficiary, as they appear in its last closed balance sheet before the date of the signature of the Agreement or as determined on the basis of the rental and leasing costs of the research infrastructure.
Beneficiaries receiving an operating grant\(^5\) financed by the EU or Euratom budget cannot declare indirect costs for the period covered by the operating grant.

**F. ‘Costs for providing trans-national access to research infrastructure’**

‘Costs for providing trans-national access to research infrastructure’ are eligible if they correspond to the amount per unit set out in Annex 2 multiplied by the number of actual units and if the conditions set out in Article 16.1 are met.

6.3 Conditions for costs of linked third parties to be eligible

*not applicable*

6.4 Conditions for in-kind contributions provided by third parties free of charge to be eligible

In-kind contributions provided free of charge are eligible direct costs (for the beneficiary), if the costs incurred by the third party fulfil — *mutatis mutandis* — the general and specific conditions for eligibility set out in this Article (Article 6.1 and 6.2) and Article 12.1.

6.5 Ineligible costs

‘Ineligible costs’ are:

(a) costs that do not comply with the conditions set out above (Article 6.1 to 6.4), in particular:

(i) costs related to return on capital;

(ii) debt and debt service charges;

(iii) provisions for future losses or debts;

(iv) interest owed;

(v) doubtful debts;

(vi) currency exchange losses;

(vii) bank costs charged by the beneficiary’s bank for transfers from the Commission;

(viii) excessive or reckless expenditure;

(ix) deductible VAT;

(x) costs incurred during suspension of the implementation of the action (see Article 49);

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\(^5\) For the definition, see Article 121(1)(b) of Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council of 25 October 2012 on the financial rules applicable to the general budget of the Union and repealing Council Regulation (EC, Euratom) No 1605/2002 (OJ L 218, 26.10.2012, p.1) (‘Financial Regulation No 966/2012’): ‘operating grant’ means direct financial contribution, by way of donation, from the budget in order to finance the functioning of a body which pursues an aim of general EU interest or has an objective forming part of and supporting an EU policy.
(b) costs declared under another EU or Euratom grant (including grants awarded by a Member State and financed by the EU or Euratom budget and grants awarded by bodies other than the Commission for the purpose of implementing the EU or Euratom budget); in particular, indirect costs if the beneficiary is already receiving an operating grant financed by the EU or Euratom budget in the same period.

6.6 Consequences of declaration of ineligible costs

Declared costs that are ineligible will be rejected (see Article 42).

This may also lead to any of the other measures described in Chapter 6.

CHAPTER 4 RIGHTS AND OBLIGATIONS OF THE PARTIES

SECTION 1 RIGHTS AND OBLIGATIONS RELATED TO IMPLEMENTING THE ACTION

ARTICLE 7 — GENERAL OBLIGATION TO PROPERLY IMPLEMENT THE ACTION

7.1 General obligation to properly implement the action

The beneficiaries must implement the action as described in Annex 1 and in compliance with the provisions of the Agreement and all legal obligations under applicable EU, international and national law.

7.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 8 — RESOURCES TO IMPLEMENT THE ACTION — THIRD PARTIES INVOLVED IN THE ACTION

The beneficiaries must have the appropriate resources to implement the action.

If it is necessary to implement the action, the beneficiaries may:

- purchase goods, works and services (see Article 10);
- use in-kind contributions provided by third parties against payment (see Article 11);
- use in-kind contributions provided by third parties free of charge (see Article 12);
- call upon subcontractors to implement action tasks described in Annex 1 (see Article 13);
- call upon linked third parties to implement action tasks described in Annex 1 (see Article 14).

In these cases, the beneficiaries retain sole responsibility towards the Commission and the other beneficiaries for implementing the action.
ARTICLE 9 — IMPLEMENTATION OF ACTION TASKS BY BENEFICIARIES NOT RECEIVING EU FUNDING

9.1 Rules for the implementation of action tasks by beneficiaries not receiving EU funding

Beneficiaries not receiving EU funding must implement the action tasks attributed to them in Annex 1 according to Article 7.1.

Their costs are estimated in Annex 2 but:

- will not be reimbursed and
- will not be taken into account for the calculation of the grant (see Articles 5.2, 5.3 and 5.4, and 21).

Chapter 3, Articles 10 to 15, 18.1.2, 20.3(b), 20.4(b), 20.6, 21, 23a, 26.4, 27.2, 28.1, 28.2, 30.3, 31.5, 40, 42, 43, 44, 47 and 48 do not apply to these beneficiaries.

The beneficiary will not be subject to financial checks, reviews and audits under Article 22.

Beneficiaries not receiving EU funding may provide in-kind contributions to another beneficiary. In this case, they will be considered as a third party for the purpose of Articles 11 and 12.

9.2 Consequences of non-compliance

If a beneficiary not receiving EU funding breaches any of its obligations under this Article, its participation of the Agreement may be terminated (see Article 50).

Such breaches may also lead to any of the other measures described in Chapter 6 that are applicable to it.

ARTICLE 10 — PURCHASE OF GOODS, WORKS OR SERVICES

10.1 Rules for purchasing goods, works or services

10.1.1 If necessary to implement the action, the beneficiaries may purchase goods, works or services.

The beneficiaries must make such purchases ensuring the best value for money or, if appropriate, the lowest price. In doing so, they must avoid any conflict of interests (see Article 35).

The beneficiaries must ensure that the Commission, the European Court of Auditors (ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 also towards their contractors.
10.1.2 Beneficiaries that are ‘contracting authorities’ within the meaning of Directive 2004/18/EC\(^6\) or ‘contracting entities’ within the meaning of Directive 2004/17/EC\(^7\) must comply with the applicable national law on public procurement.

**10.2 Consequences of non-compliance**

If a beneficiary breaches any of its obligations under Article 10.1.1, the costs related to the contract concerned will be ineligible (see Article 6) and will be rejected (see Article 42).

If a beneficiary breaches any of its obligations under Article 10.1.2, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

**ARTICLE 11 — USE OF IN-KIND CONTRIBUTIONS PROVIDED BY THIRD PARTIES AGAINST PAYMENT**

**11.1 Rules for the use of in-kind contributions against payment**

If necessary to implement the action, the beneficiaries may use in-kind contributions provided by third parties against payment.

The beneficiaries may declare costs related to the payment of in-kind contributions as eligible (see Article 6.1 and 6.2), up to the third parties’ costs for the seconded persons, contributed equipment, infrastructure or other assets or other contributed goods and services.

The third parties and their contributions must be set out in Annex 1. The Commission may however approve in-kind contributions not set out in Annex 1 without amendment (see Article 55), if:

- they are specifically justified in the periodic technical report and
- their use does not entail changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

The beneficiaries must ensure that the Commission, the European Court of Auditors (ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 also towards the third parties.

**11.2 Consequences of non-compliance**

If a beneficiary breaches any of its obligations under this Article, the costs related to the payment of the in-kind contribution will be ineligible (see Article 6) and will be rejected (see Article 42).

Such breaches may also lead to any of the other measures described in Chapter 6.


ARTICLE 12 — USE OF IN-KIND CONTRIBUTIONS PROVIDED BY THIRD PARTIES
FREE OF CHARGE

12.1 Rules for the use of in-kind contributions free of charge

If necessary to implement the action, the beneficiaries may use in-kind contributions provided by third parties free of charge.

The beneficiaries may declare costs incurred by the third parties for the seconded persons, contributed equipment, infrastructure or other assets or other contributed goods and services as eligible in accordance with Article 6.4.

The third parties and their contributions must be set out in Annex 1. The Commission may however approve in-kind contributions not set out in Annex 1 without amendment (see Article 55), if:
- they are specifically justified in the periodic technical report and
- their use does not entail changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

The beneficiaries must ensure that the Commission, the European Court of Auditors (ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 also towards the third parties.

12.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the costs incurred by the third parties related to the in-kind contribution will be ineligible (see Article 6) and will be rejected (see Article 42).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 13 — IMPLEMENTATION OF ACTION TASKS BY SUBCONTRACTORS

13.1 Rules for subcontracting action tasks

13.1.1 If necessary to implement the action, the beneficiaries may award subcontracts covering the implementation of certain action tasks described in Annex 1.

Subcontracting may cover only a limited part of the action.

The beneficiaries must award the subcontracts ensuring the best value for money or, if appropriate, the lowest price. In doing so, they must avoid any conflict of interests (see Article 35).

The tasks to be implemented and the estimated cost for each subcontract must be set out in Annex 1 and the total estimated costs of subcontracting per beneficiary must be set out in Annex 2. The Commission may however approve subcontracts not set out in Annex 1 and 2 without amendment (see Article 55), if:
- they are specifically justified in the periodic technical report and
- they do not entail changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.
The beneficiaries must ensure that the Commission, the European Court of Auditors (ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 also towards their subcontractors.

13.1.2 The beneficiaries must ensure that their obligations under Articles 35, 36, 38 and 46 also apply to the subcontractors.

Beneficiaries that are ‘contracting authorities’ within the meaning of Directive 2004/18/EC or ‘contracting entities’ within the meaning of Directive 2004/17/EC must comply with the applicable national law on public procurement.

13.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under Article 13.1.1, the costs related to the subcontract concerned will be ineligible (see Article 6) and will be rejected (see Article 42).

If a beneficiary breaches any of its obligations under Article 13.1.2, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 14 — IMPLEMENTATION OF ACTION TASKS BY LINKED THIRD PARTIES

Not applicable

ARTICLE 15 — FINANCIAL SUPPORT TO THIRD PARTIES

15.1 Rules for providing financial support to third parties

Not applicable

15.2 Financial support in the form of prizes

Not applicable

15.3 Consequences of non-compliance

Not applicable

ARTICLE 16 — PROVISION OF TRANS-NATIONAL OR VIRTUAL ACCESS TO RESEARCH INFRASTRUCTURE

16.1 Rules for providing trans-national access to research infrastructure

16.1.1 ‘Access providers’\(^{11}\) must provide access to research infrastructure or installations\(^{12}\) in accordance with the following conditions:

\(^{11}\) ‘Access provider’ means a beneficiary or third party (subcontractor or linked third party) that is in charge of providing access to one or more research infrastructure or installations, or part of them, as described in Annex 1.
(a) access which must be provided:

The access must be free of charge, trans-national access to research infrastructure or installations for selected user-groups.

This access must include the logistical, technological and scientific support and the specific training that is usually provided to external researchers using the infrastructure.

(b) categories of users that may have access:

Trans-national access must be provided to selected ‘user-groups’, i.e. teams of one or more researchers (users) led by a ‘user group leader’.

The user group leader and the majority of the users must work in a country other than the country(ies) where the installation is located.

This rule does not apply:

- if access is provided by an International organisation, the Joint Research Centre (JRC), an ERIC or similar legal entities;
- in case of remote access to a set of installations located in different countries offering the same type of service.

Only user groups that are allowed to disseminate the results they have generated under the action may benefit from the access, unless the users are working for SMEs.

Access for user groups with a majority of users not working in a EU or associated country is limited to 20% of the total amount of units of access provided under the grant, unless a higher percentage is foreseen in Annex 1;

(c) procedure and criteria for selecting user groups:

The user groups must request access by submitting (in writing) a description of the work that they wish to carry out and the names, nationalities and home institutions of the users.

The user groups must be selected by a selection panel set up by the access providers.

The selection panel must be composed of international experts in the field, at least half of them independent from the beneficiaries, unless otherwise specified in Annex 1.

The selection panel must assess all proposals received and recommend a short-list of the user groups that should benefit from access.

The selection panel must base its selection on scientific merit, taking into account that priority should be given to user groups composed of users who:

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12 ‘Installation’ means a part or a service of a research infrastructure that could be used independently from the rest. A research infrastructure consists of one or more installations.
have not previously used the installation and
- are working in countries where no equivalent research infrastructure exist.

It will apply the principles of transparency, fairness and impartiality.

(d) other conditions:

The access provider must request written approval from the Commission (see Article 52) for
the selection of user groups requiring visits to the installation(s) exceeding 3 months, unless
such visits are foreseen in Annex 1.

16.1.2 In addition, the access provider must:

- advertise widely, including on a dedicated website, the access offered under the Agreement;
- promote equal opportunities in advertising the access and take into account the gender
dimension when defining the support provided to users;
- ensure that users comply with the terms and conditions of this Agreement;
- ensure that his obligations under Articles 35, 36, 38 and 46 also apply to the users.

16.2 Rules for providing virtual access to research infrastructure

Not applicable

16.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under Articles 16.1.1 and 16.2, the costs of access will
be ineligible (see Article 6) and will be rejected (see Article 42).

If a beneficiary breaches any of its obligations under Articles 16.1.2, the grant may be reduced (see
Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

SECTION 2  RIGHTS AND OBLIGATIONS RELATED TO THE GRANT ADMINISTRATION

ARTICLE 17 — GENERAL OBLIGATION TO INFORM

17.1 General obligation to provide information upon request

The beneficiaries must provide — during implementation of the action or afterwards and in accordance
with Article 41.2 — any information requested in order to verify eligibility of the costs, proper
implementation of the action and compliance with any other obligation under the Agreement.
17.2 Obligation to keep information up to date and to inform about events and circumstances likely to affect the Agreement

Each beneficiary must keep information stored in the 'Beneficiary Register' (via the electronic exchange system; see Article 52) up to date, in particular, its name, address, legal representatives, legal form and organisation type.

Each beneficiary must immediately inform the coordinator — which must immediately inform the Commission and the other beneficiaries — of any of the following:

(a) events which are likely to affect significantly or delay the implementation of the action or the EU's financial interests, in particular:

(i) changes in its legal, financial, technical, organisational or ownership situation

(b) circumstances affecting:

(i) the decision to award the grant or

(ii) compliance with requirements under the Agreement.

17.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 18 — KEEPING RECORDS — SUPPORTING DOCUMENTATION

18.1 Obligation to keep records and other supporting documentation

The beneficiaries must — for a period of five years after the payment of the balance — keep records and other supporting documentation in order to prove the proper implementation of the action and the costs they declare as eligible.

They must make them available upon request (see Article 17) or in the context of checks, reviews, audits or investigations (see Article 22).

If there are on-going checks, reviews, audits, investigations, litigation or other pursuits of claims under the Agreement (including the extension of findings; see Articles 22), the beneficiaries must keep the records and other supporting documentation until the end of these procedures.

The beneficiaries must keep the original documents. Digital and digitalised documents are considered originals if they are authorised by the applicable national law. The Commission may accept non-original documents if it considers that they offer a comparable level of assurance.

18.1.1 Records and other supporting documentation on the scientific and technical implementation

The beneficiaries must keep records and other supporting documentation on scientific and technical implementation of the action in line with the accepted standards in the respective field.
18.1.2 Records and other documentation to support the costs declared

The beneficiaries must keep the records and documentation supporting the costs declared, in particular the following:

(a) for actual costs: adequate records and other supporting documentation to prove the costs declared, such as contracts, subcontracts, invoices and accounting records. In addition, the beneficiaries’ usual cost accounting practices and internal control procedures must enable direct reconciliation between the amounts declared, the amounts recorded in their accounts and the amounts stated in the supporting documentation;

(b) for unit costs: adequate records and other supporting documentation to prove the number of units declared. This documentation must include records of the names, nationalities, and home institutions of users, as well as the nature and quantity of access provided to them. Beneficiaries do not need to identify the actual eligible costs covered or to keep or provide supporting documentation (such as accounting statements) to prove the amount per unit.

In addition, for direct personnel costs declared as unit costs calculated in accordance with the beneficiary's usual cost accounting practices, the beneficiaries must keep adequate records and documentation to prove that the cost accounting practices used comply with the conditions set out in Article 6.2, Point A.

The beneficiaries may submit to the Commission, for approval, a certificate (drawn up in accordance with Annex 6) stating that their usual cost accounting practices comply with these conditions (‘certificate on the methodology’). If the certificate is approved, costs declared in line with this methodology will not be challenged subsequently, unless the beneficiaries have concealed information for the purpose of the approval.

(c) for flat-rate costs: adequate records and other supporting documentation to prove the eligibility of the costs to which the flat-rate is applied. The beneficiaries do not need to identify the costs covered or provide supporting documentation (such as accounting statements) to prove the amount declared at a flat-rate.

In addition, for personnel costs (declared as actual costs or on the basis of unit costs), the beneficiaries must keep time records for the number of hours declared. The time records must be in writing and approved by the persons working on the action and their supervisors, at least monthly. In the absence of reliable time records of the hours worked on the action, the Commission may accept alternative evidence supporting the number of hours declared, if it considers that it offers an adequate level of assurance.

As an exception, for persons working exclusively on the action, there is no need to keep time records, if the beneficiary signs a declaration confirming that the persons concerned have worked exclusively on the action.

18.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, costs insufficiently substantiated will be ineligible (see Article 6) and will be rejected (see Article 42), and the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.
ARTICLE 19 — SUBMISSION OF DELIVERABLES

19.1 Obligation to submit deliverables

The coordinator must submit the ‘deliverables’ identified in Annex 1, in accordance with the timing and conditions set out in it.

19.2 Consequences of non-compliance

If the coordinator breaches any of its obligations under this Article, the Commission may apply any of the measures described in Chapter 6.

ARTICLE 20 — REPORTING — PAYMENT REQUESTS

20.1 Obligation to submit reports

The coordinator must submit to the Commission (see Article 52) the technical and financial reports set out in this Article. These reports include the requests for payment and must be drawn up using the forms and templates provided in the electronic exchange system (see Article 52).

20.2 Reporting periods

The action is divided into the following ‘reporting periods’:

- RP1: from month 1 to month 18
- RP2: from month 19 to month 36
- RP3: from month 37 to month 42

20.3 Periodic reports — Requests for interim payments

The coordinator must submit a periodic report within 60 days following the end of each reporting period.

The periodic report must include the following:

(a) a ‘periodic technical report’ containing:

(i) an explanation of the work carried out by the beneficiaries;

(ii) an overview of the progress towards the objectives of the action, including milestones and deliverables identified in Annex 1.

This report must include explanations justifying the differences between work expected to be carried out in accordance with Annex 1 and that actually carried out.

The report must also detail the exploitation and dissemination of the results and — if required in Annex 1 — an updated ‘plan for the exploitation and dissemination of the results’;

The report must detail the access activity, indicating the members of the selection panel, the selection procedure, the exact amount of access provided to the user groups, the
description of their work, and information on the users (including names, nationality and home institutions).

(iii) a summary for publication by the Commission;

(iv) the answers to the ‘questionnaire’, covering issues related to the action implementation and the economic and societal impact, notably in the context of the Horizon 2020 key performance indicators and the Horizon 2020 monitoring requirements;

(b) a ‘periodic financial report’ containing:

(i) an ‘individual financial statement’ (see Annex 4) from each beneficiary, for the reporting period concerned.

The individual financial statement must detail the eligible costs (actual costs, unit costs and flat-rate costs; see Article 6) for each budget category (see Annex 2).

The beneficiaries must declare all eligible costs, even if — for actual costs, unit costs and flat-rate costs — they exceed the amounts indicated in the estimated budget (see Annex 2). Amounts which are not declared in the individual financial statement will not be taken into account by the Commission.

If an individual financial statement is not submitted for a reporting period, it may be included in the periodic financial report for the next reporting period.

The individual financial statements of the last reporting period must also detail the receipts of the action (see Article 5.3.3).

Each beneficiary must certify that:

- the information provided is full, reliable and true;

- the costs declared are eligible (see Article 6);

- the costs can be substantiated by adequate records and supporting documentation (see Article 18) that will be produced upon request (see Article 17) or in the context of checks, reviews, audits and investigations (see Article 22), and

- for the last reporting period: that all the receipts have been declared (see Article 5.3.3);

(ii) an explanation of the use of resources and the information on subcontracting (see Article 13) and in-kind contributions provided by third parties (see Articles 11 and 12) from each beneficiary, for the reporting period concerned;

(iii) not applicable;

(iv) a ‘periodic summary financial statement’ (see Annex 4), created automatically by the electronic exchange system, consolidating the individual financial statements for the
reporting period concerned and including — except for the last reporting period — the request for interim payment.

20.4 Final report — Request for payment of the balance

In addition to the periodic report for the last reporting period, the coordinator must submit the final report within 60 days following the end of the last reporting period.

The final report must include the following:

(a) a ‘final technical report’ with a summary for publication containing:

   (i) an overview of the results and their exploitation and dissemination;

   (ii) the conclusions on the action, and

   (iii) the socio-economic impact of the action;

(b) a ‘final financial report’ containing:

   (i) a ‘final summary financial statement’ (see Annex 4), created automatically by the electronic exchange system, consolidating the individual financial statements for all reporting periods and including the request for payment of the balance and

   (ii) a ‘certificate on the financial statements’ (drawn up in accordance with Annex 5) for each beneficiary, if it requests a total contribution of EUR 325 000 or more, as reimbursement of actual costs and unit costs calculated on the basis of its usual cost accounting practices (see Article 5.2 and Article 6.2, Point A).

20.5 Information on cumulative expenditure incurred

Not applicable

20.6 Currency for financial statements and conversion into euro

Financial statements must be drafted in euro.

Beneficiaries with accounting established in a currency other than the euro must convert the costs recorded in their accounts into euro, at the average of the daily exchange rates published in the C series of the Official Journal of the European Union, calculated over the corresponding reporting period.

If no daily euro exchange rate is published in the Official Journal of the European Union for the currency in question, they must be converted at the average of the monthly accounting rates published on the Commission’s website, calculated over the corresponding reporting period.

Beneficiaries with accounting established in euro must convert costs incurred in another currency into euro according to their usual accounting practices.

20.7 Language of reports

All reports (technical and financial reports, including financial statements) must be submitted in the language of the Agreement.
20.8 Consequences of non-compliance — Suspension of the payment deadline — Termination

If the reports submitted do not comply with this Article, the Commission may suspend the payment deadline (see Article 47) and apply any of the other measures described in Chapter 6. If the coordinator breaches its obligation to submit the reports and if it fails to comply with this obligation within 30 days following a written reminder sent by the Commission, the Agreement may be terminated (see Article 50).

ARTICLE 21 — PAYMENTS AND PAYMENT ARRANGEMENTS

21.1 Payments to be made

The following payments will be made to the coordinator:

- one pre-financing payment;

- one or more interim payments, on the basis of the request(s) for interim payment (see Article 20), and

- one payment of the balance, on the basis of the request for payment of the balance (see Article 20).

21.2 Pre-financing payment — Amount — Amount retained for the Guarantee Fund

The aim of the pre-financing is to provide the beneficiaries with a float. It remains the property of the EU until the payment of the balance.

The amount of the pre-financing payment will be EUR 2,135,489.64 (two million one hundred and thirty five thousand four hundred and eighty nine EURO and sixty four eurocents).

The Commission will — except if Article 48 applies — make the pre-financing payment to the coordinator within 30 days either from the entry into force of the Agreement (see Article 58) or from 10 days before the starting date of the action (see Article 3), whichever is the latest.

An amount of EUR 249,123.85 (two hundred and forty nine thousand one hundred and twenty three EURO and eighty five eurocents), corresponding to 5% of the maximum grant amount (see Article 5.1), is retained by the Commission from the pre-financing payment and transferred into the ‘Guarantee Fund’.

21.3 Interim payments — Amount — Calculation

Interim payments reimburse the eligible costs incurred for the implementation of the action during the corresponding reporting periods.

The Commission will pay to the coordinator the amount due as interim payment within 90 days from receiving the periodic report (see Article 20.3), except if Articles 47 or 48 apply.

Payment is subject to the approval of the periodic report. Its approval does not imply recognition of the compliance, authenticity, completeness or correctness of its content.
The **amount due as interim payment** is calculated by the *Commission* in the following steps:

1. **Step 1 – Application of the reimbursement rates**
2. **Step 2 – Limit to 90% of the maximum grant amount**

### 21.3.1 Step 1 — Application of the reimbursement rates

The reimbursement rate(s) (see Article 5.2) are applied to the eligible costs (actual costs, unit costs and flat-rate costs; see Article 6) declared by the beneficiaries (see Article 20) and approved by the *Commission* (see above) for the concerned reporting period.

### 21.3.2 Step 2 — Limit to 90% of the maximum grant amount

The total amount of pre-financing and interim payments must not exceed 90% of the maximum grant amount set out in Article 5.1. The maximum amount for the interim payment will be calculated as follows:

\[
\{90\% \text{ of the maximum grant amount (see Article 5.1)}\} - \{\text{pre-financing and previous interim payments}\}\}
\]

### 21.4 Payment of the balance — Amount — Calculation — Release of the amount retained for the Guarantee Fund

The payment of the balance reimburses the remaining part of the eligible costs incurred by the beneficiaries for the implementation of the action.

If the total amount of earlier payments is greater than the final grant amount (see Article 5.3), the payment of the balance takes the form of a recovery (see Article 44).

If the total amount of earlier payments is lower than the final grant amount, the *Commission* will pay the balance within 90 days from receiving the final report (see Article 20.4), except if Articles 47 or 48 apply.

Payment is subject to the approval of the final report. Its approval does not imply recognition of the compliance, authenticity, completeness or correctness of its content.

The **amount due as the balance** is calculated by the *Commission* by deducting the total amount of pre-financing and interim payments (if any) already made, from the final grant amount determined in accordance with Article 5.3:

\[
\{\text{final grant amount (see Article 5.3)}\} - \{\text{pre-financing and interim payments (if any) made}\}\}
\]

At the payment of the balance, the amount retained for the Guarantee Fund (see above) will be released and:
- if the balance is positive: the amount released will be paid in full to the coordinator together with the amount due as the balance;

- if the balance is negative (payment of the balance taking the form of recovery): it will be deducted from the amount released (see Article 44.1.2). If the resulting amount:
  - is positive, it will be paid to the coordinator
  - is negative, it will be recovered.

The amount to be paid may however be offset — without the beneficiary’s consent — against any other amount owed by the beneficiary to the Commission or an executive agency (under the EU or Euratom budget), up to the maximum EU contribution indicated, for that beneficiary, in the estimated budget (see Annex 2).

21.5 Notification of amounts due

When making payments, the Commission will formally notify to the coordinator the amount due, specifying whether it concerns an interim payment or the payment of the balance.

For the payment of the balance, the notification will also specify the final grant amount.

In the case of reduction of the grant or recovery of undue amounts, the notification will be preceded by the contradictory procedure set out in Articles 43 and 44.

21.6 Currency for payments

The Commission will make all payments in euro.

21.7 Payments to the coordinator — Distribution to the beneficiaries

Payments will be made to the coordinator.

Payments to the coordinator will discharge the Commission from its payment obligation.

The coordinator must distribute the payments between the beneficiaries without unjustified delay.

Pre-financing may however be distributed only:

(a) if the minimum number of beneficiaries set out in the call for proposals has acceded to the Agreement (see Article 56) and

(b) to beneficiaries that have acceded to the Agreement (see Article 56).

21.8 Bank account for payments

All payments will be made to the following bank account:
Name of bank: BANCA NAZIONALE DEL LAVORO S.P.A.
Address of branch: 15, VIA COSTANTINO NIGRA ROMA, Italy
Full name of the account holder: ISTITUTO NAZIONALE DI ASTROFISICA INFN
AMMINISTRAZIONE CENTRALE
Full account number (including bank codes):
IBAN code: IT69S0100503309000000218500

21.9 Costs of payment transfers

The cost of the payment transfers is borne as follows:

- the Commission bears the cost of transfers charged by its bank;
- the beneficiary bears the cost of transfers charged by its bank;
- the party causing a repetition of a transfer bears all costs of the repeated transfer.

21.10 Date of payment

Payments by the Commission are considered to have been carried out on the date when they are debited to its account.

21.11 Consequences of non-compliance

21.11.1 If the Commission does not pay within the payment deadlines (see above), the beneficiaries are entitled to late-payment interest at the rate applied by the European Central Bank (ECB) for its main refinancing operations in euros (‘reference rate’), plus three and a half points. The reference rate is the rate in force on the first day of the month in which the payment deadline expires, as published in the C series of the Official Journal of the European Union.

If the late-payment interest is lower than or equal to EUR 200, it will be paid to the coordinator only upon request submitted within two months of receiving the late payment.

Late-payment interest is not due if all beneficiaries are EU Member States (including regional and local government authorities or other public bodies acting on behalf of a Member State for the purpose of this Agreement).

Suspension of the payment deadline or payments (see Articles 47 and 48) will not be considered as late payment.

Late-payment interest covers the period running from the day following the due date for payment (see above), up to and including the date of payment.

Late-payment interest is not considered for the purposes of calculating the final grant amount.

21.11.2 If the coordinator breaches any of its obligations under this Article, the grant may be reduced (see Article 43) and the Agreement or the participation of the coordinator may be terminated (see Article 50).

Such breaches may also lead to any of the other measures described in Chapter 6.
ARTICLE 22 — CHECKS, REVIEWS, AUDITS AND INVESTIGATIONS — EXTENSION OF FINDINGS

22.1 Checks, reviews and audits by the Commission

22.1.1 Right to carry out checks

The Commission will — during the implementation of the action or afterwards — check the proper implementation of the action and compliance with the obligations under the Agreement, including assessing deliverables and reports.

For this purpose the Commission may be assisted by external persons or bodies.

The Commission may also request additional information in accordance with Article 17. The Commission may request beneficiaries to provide such information to it directly.

Information provided must be accurate, precise and complete and in the format requested, including electronic format.

22.1.2 Right to carry out reviews

The Commission may — during the implementation of the action or afterwards — carry out reviews on the proper implementation of the action (including assessment of deliverables and reports), compliance with the obligations under the Agreement and continued scientific or technological relevance of the action.

Reviews may be started **up to two years after the payment of the balance**. They will be formally notified to the coordinator or beneficiary concerned and will be considered to have started on the date of the formal notification.

If the review is carried out on a third party (see Articles 10 to 16), the beneficiary concerned must inform the third party.

The Commission may carry out reviews directly (using its own staff) or indirectly (using external persons or bodies appointed to do so). It will inform the coordinator or beneficiary concerned of the identity of the external persons or bodies. They have the right to object to the appointment on grounds of commercial confidentiality.

The coordinator or beneficiary concerned must provide — within the deadline requested — any information and data in addition to deliverables and reports already submitted (including information on the use of resources). The Commission may request beneficiaries to provide such information to it directly.

The coordinator or beneficiary concerned may be requested to participate in meetings, including with external experts.

For **on-the-spot** reviews, the beneficiaries must allow access to their sites and premises, including to external persons or bodies, and must ensure that information requested is readily available.

Information provided must be accurate, precise and complete and in the format requested, including electronic format.
On the basis of the review findings, a ‘review report’ will be drawn up.

The Commission will formally notify the review report to the coordinator or beneficiary concerned, which has 30 days to formally notify observations (‘contradictory review procedure’).

Reviews (including review reports) are in the language of the Agreement.

22.1.3 Right to carry out audits

The Commission may — during the implementation of the action or afterwards — carry out audits on the proper implementation of the action and compliance with the obligations under the Agreement.

Audits may be started up to two years after the payment of the balance. They will be formally notified to the coordinator or beneficiary concerned and will be considered to have started on the date of the formal notification.

If the audit is carried out on a third party (see Articles 10 to 16), the beneficiary concerned must inform the third party.

The Commission may carry out audits directly (using its own staff) or indirectly (using external persons or bodies appointed to do so). It will inform the coordinator or beneficiary concerned of the identity of the external persons or bodies. They have the right to object to the appointment on grounds of commercial confidentiality.

The coordinator or beneficiary concerned must provide — within the deadline requested — any information (including complete accounts, individual salary statements or other personal data) to verify compliance with the Agreement. The Commission may request beneficiaries to provide such information to it directly.

For on-the-spot audits, the beneficiaries must allow access to their sites and premises, including to external persons or bodies, and must ensure that information requested is readily available.

Information provided must be accurate, precise and complete and in the format requested, including electronic format.

On the basis of the audit findings, a ‘draft audit report’ will be drawn up.

The Commission will formally notify the draft audit report to the coordinator or beneficiary concerned, which has 30 days to formally notify observations (‘contradictory audit procedure’). This period may be extended by the Commission in justified cases.

The ‘final audit report’ will take into account observations by the coordinator or beneficiary concerned. The report will be formally notified to it.

Audits (including audit reports) are in the language of the Agreement.

The Commission may also access the beneficiaries’ statutory records for the periodical assessment of unit costs or flat-rate amounts.
22.2 Investigations by the European Anti-Fraud Office (OLAF)

Under Regulations No 883/2013\textsuperscript{15} and No 2185/96\textsuperscript{16} (and in accordance with their provisions and procedures) the European Anti-Fraud Office (OLAF) may — at any moment during implementation of the action or afterwards — carry out investigations, including on-the-spot checks and inspections, to establish whether there has been fraud, corruption or any other illegal activity affecting the financial interests of the EU.

22.3 Checks and audits by the European Court of Auditors (ECA)

Under Article 287 of the Treaty on the Functioning of the European Union (TFEU) and Article 161 of the Financial Regulation No 966/2012\textsuperscript{17}, the European Court of Auditors (ECA) may — at any moment during implementation of the action or afterwards — carry out audits.

The ECA has the right of access for the purpose of checks and audits.

22.4 Checks, reviews, audits and investigations for international organisations

\textit{Not applicable}

22.5 Consequences of findings in checks, reviews, audits and investigations — Extension of findings

22.5.1 Findings in this grant

Findings in checks, reviews, audits or investigations carried out in the context of this grant may lead to the rejection of ineligible costs (see Article 42), reduction of the grant (see Article 43), recovery of undue amounts (see Article 44) or to any of the other measures described in Chapter 6.

Rejection of costs or reduction of the grant after the payment of the balance will lead to a revised final grant amount (see Article 5.4).

Findings in checks, reviews, audits or investigations may lead to a request for amendment for the modification of Annex 1 (see Article 55).

Checks, reviews, audits or investigations that find systemic or recurrent errors, irregularities, fraud or breach of obligations may also lead to consequences in other EU or Euratom grants awarded under similar conditions (‘extension of findings from this grant to other grants’).

Moreover, findings arising from an OLAF investigation may lead to criminal prosecution under national law.


22.5.2 Findings in other grants

The Commission may extend findings from other grants to this grant (‘extension of findings from other grants to this grant’), if:

(a) the beneficiary concerned is found, in other EU or Euratom grants awarded under similar conditions, to have committed systemic or recurrent errors, irregularities, fraud or breach of obligations that have a material impact on this grant and

(b) those findings are formally notified to the beneficiary concerned — together with the list of grants affected by the findings — no later than two years after the payment of the balance of this grant.

The extension of findings may lead to the rejection of costs (see Article 42), reduction of the grant (see Article 43), recovery of undue amounts (see Article 44), suspension of payments (see Article 48), suspension of the action implementation (see Article 49) or termination (see Article 50).

22.5.3 Procedure

The Commission will formally notify the beneficiary concerned the systemic or recurrent errors and its intention to extend these audit findings, together with the list of grants affected.

22.5.3.1 If the findings concern eligibility of costs: the formal notification will include:

(a) an invitation to submit observations on the list of grants affected by the findings;

(b) the request to submit revised financial statements for all grants affected;

(c) the correction rate for extrapolation established by the Commission on the basis of the systemic or recurrent errors, to calculate the amounts to be rejected if the beneficiary concerned:

(i) considers that the submission of revised financial statements is not possible or practicable or

(ii) does not submit revised financial statements.

The beneficiary concerned has 90 days from receiving notification to submit observations, revised financial statements or to propose a duly substantiated alternative correction method. This period may be extended by the Commission in justified cases.

The amounts to be rejected will be determined on the basis of the revised financial statements, subject to their approval.

If the Commission does not receive any observations or revised financial statements, does not accept the observations or the proposed alternative correction method or does not approve the revised financial statements, it will formally notify the beneficiary concerned the application of the initially notified correction rate for extrapolation.

If the Commission accepts the alternative correction method proposed by the beneficiary concerned, it will formally notify the application of the accepted alternative correction method.
22.5.3.2 If the findings concern improper implementation or a breach of another obligation: the formal notification will include:

(a) an invitation to submit observations on the list of grants affected by the findings and

(b) the flat-rate the Commission intends to apply according to the principle of proportionality.

The beneficiary concerned has 90 days from receiving notification to submit observations or to propose a duly substantiated alternative flat-rate.

If the Commission does not receive any observations or does not accept the observations or the proposed alternative flat-rate, it will formally notify the beneficiary concerned the application of the initially notified flat-rate.

If the Commission accepts the alternative flat-rate proposed by the beneficiary concerned, it will formally notify the application of the accepted alternative flat-rate.

22.6 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, any insufficiently substantiated costs will be ineligible (see Article 6) and will be rejected (see Article 42).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 23 — EVALUATION OF THE IMPACT OF THE ACTION

23.1 Right to evaluate the impact of the action

The Commission may carry out interim and final evaluations of the impact of the action measured against the objective of the EU programme.

Evaluations may be started during implementation of the action and up to five years after the payment of the balance. The evaluation is considered to start on the date of the formal notification to the coordinator or beneficiaries.

The Commission may make these evaluations directly (using its own staff) or indirectly (using external bodies or persons it has authorised to do so).

The coordinator or beneficiaries must provide any information relevant to evaluate the impact of the action, including information in electronic format.

23.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the Commission may apply the measures described in Chapter 6.

SECTION 3 RIGHTS AND OBLIGATIONS RELATED TO BACKGROUND AND RESULTS
SUBSECTION 1  GENERAL

ARTICLE 23a — MANAGEMENT OF INTELLECTUAL PROPERTY

23a.1 Obligation to take measures to implement the Commission Recommendation on the management of intellectual property in knowledge transfer activities

Beneficiaries that are universities or other public research organisations must take measures to implement the principles set out in Points 1 and 2 of the Code of Practice annexed to the Commission Recommendation on the management of intellectual property in knowledge transfer activities18.

This does not change the obligations set out in Subsections 2 and 3 of this Section.

The beneficiaries must ensure that researchers and third parties involved in the action are aware of them.

23a.2 Consequences of non-compliance

If a beneficiary breaches its obligations under this Article, the Commission may apply any of the measures described in Chapter 6.

SUBSECTION 2  RIGHTS AND OBLIGATIONS RELATED TO BACKGROUND

ARTICLE 24 — AGREEMENT ON BACKGROUND

24.1 Agreement on background

The beneficiaries must identify and agree (in writing) on the background for the action (‘agreement on background’).

‘Background’ means any data, know-how or information — whatever its form or nature (tangible or intangible), including any rights such as intellectual property rights — that:

(a) is held by the beneficiaries before they acceded to the Agreement, and

(b) is needed to implement the action or exploit the results.

24.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

18 Commission Recommendation C (2008) 1329 of 10.4.2008 on the management of intellectual property in knowledge transfer activities and the Code of Practice for universities and other public research institutions attached to this recommendation.
ARTICLE 25 — ACCESS RIGHTS TO BACKGROUND

25.1 Exercise of access rights — Waiving of access rights — No sub-licensing

To exercise access rights, this must first be requested in writing (‘request for access’).

‘Access rights’ means rights to use results or background under the terms and conditions laid down in this Agreement.

Waivers of access rights are not valid unless in writing.

Unless agreed otherwise, access rights do not include the right to sub-license.

25.2 Access rights for other beneficiaries, for implementing their own tasks under the action

The beneficiaries must give each other access — on a royalty-free basis — to background needed to implement their own tasks under the action, unless the beneficiary that holds the background has — before acceding to the Agreement —:

(a) informed the other beneficiaries that access to its background is subject to legal restrictions or limits, including those imposed by the rights of third parties (including personnel), or

(b) agreed with the other beneficiaries that access would not be on a royalty-free basis.

25.3 Access rights for other beneficiaries, for exploiting their own results

The beneficiaries must give each other access — under fair and reasonable conditions — to background needed for exploiting their own results, unless the beneficiary that holds the background has — before acceding to the Agreement — informed the other beneficiaries that access to its background is subject to legal restrictions or limits, including those imposed by the rights of third parties (including personnel).

‘Fair and reasonable conditions’ means appropriate conditions, including possible financial terms or royalty-free conditions, taking into account the specific circumstances of the request for access, for example the actual or potential value of the results or background to which access is requested and/or the scope, duration or other characteristics of the exploitation envisaged.

Requests for access may be made — unless agreed otherwise — up to one year after the period set out in Article 3.

25.4 Access rights for affiliated entities

Unless otherwise agreed in the consortium agreement, access to background must also be given — under fair and reasonable conditions (see above; Article 25.3) and unless it is subject to legal restrictions or limits, including those imposed by the rights of third parties (including personnel) —
to affiliated entities\textsuperscript{19} established in an EU Member State or \textit{\textbf{associated country}}\textsuperscript{20}, if this is needed to exploit the results generated by the beneficiaries to which they are affiliated.

Unless agreed otherwise (see above; Article 25.1), the affiliated entity concerned must make the request directly to the beneficiary that holds the background.

Requests for access may be made — unless agreed otherwise — up to one year after the period set out in Article 3.

\textbf{25.5 Access rights for third parties}

\textit{The access provider must — unless it is subject to legal restrictions or limits, including those imposed by the rights of third parties (including personnel) — give users royalty-free access to background needed to implement the action.}

\textit{The access provider must inform the users as soon as possible of any restriction which might substantially affect the granting of access rights.}

\textbf{25.6 Consequences of non-compliance}

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

\textbf{SUBSECTION 3 RIGHTS AND OBLIGATIONS RELATED TO RESULTS}

\textbf{ARTICLE 26 — OWNERSHIP OF RESULTS}

\textbf{26.1 Ownership by the beneficiary that generates the results}

Results are owned by the beneficiary that generates them.

\textsuperscript{19} For the definition, see Article 2.1(2) of the Rules for Participation Regulation No 1290/2013: \textit{affiliated entity} means any legal entity that is under the direct or indirect control of a participant, or under the same direct or indirect control as the participant, or that is directly or indirectly controlling a participant. ‘Control’ may take any of the following forms:

(a) the direct or indirect holding of more than 50\% of the nominal value of the issued share capital in the legal entity concerned, or of a majority of the voting rights of the shareholders or associates of that entity;

(b) the direct or indirect holding, in fact or in law, of decision-making powers in the legal entity concerned.

However the following relationships between legal entities shall not in themselves be deemed to constitute controlling relationships:

(a) the same public investment corporation, institutional investor or venture-capital company has a direct or indirect holding of more than 50\% of the nominal value of the issued share capital or a majority of voting rights of the shareholders or associates;

(b) the legal entities concerned are owned or supervised by the same public body.

\textsuperscript{20} For the definition, see Article 2.1(3) of the Rules for Participation Regulation No 1290/2013: \textit{associated country} means a third country which is party to an international agreement with the Union, as identified in \textit{Article 7 of Horizon 2020 Framework Programme Regulation No 1291/2013. Article 7 sets out the conditions for association of non-EU countries to Horizon 2020.}
‘Results’ means any (tangible or intangible) output of the action such as data, knowledge or information — whatever its form or nature — whether it can be protected or not — that is generated in the action, as well as any rights attached to it, including intellectual property rights.

26.2 Joint ownership by several beneficiaries

Two or more beneficiaries own results jointly if:

(a) they have jointly generated them and

(b) it is not possible to:

(i) establish the respective contribution of each beneficiary, or

(ii) separate them for the purpose of applying for, obtaining or maintaining their protection (see Article 27).

The joint owners must agree (in writing) on the allocation and terms of exercise of their joint ownership (‘joint ownership agreement’), to ensure compliance with their obligations under this Agreement.

Unless otherwise agreed in the joint ownership agreement, each joint owner may grant non-exclusive licences to third parties to exploit jointly-owned results (without any right to sub-license), if the other joint owners are given:

(a) at least 45 days advance notice and

(b) fair and reasonable compensation.

Once the results have been generated, joint owners may agree (in writing) to apply another regime than joint ownership (such as, for instance, transfer to a single owner (see Article 30) with access rights for the others).

26.3 Rights of third parties (including personnel)

If third parties (including personnel) may claim rights to the results, the beneficiary concerned must ensure that it complies with its obligations under the Agreement.

If a third party generates results, the beneficiary concerned must obtain all necessary rights (transfer, licences or other) from the third party, in order to be able to respect its obligations as if those results were generated by the beneficiary itself.

If obtaining the rights is impossible, the beneficiary must refrain from using the third party to generate the results.

26.4 EU ownership, to protect results

26.4.1 The EU may — with the consent of the beneficiary concerned — assume ownership of results to protect them, if a beneficiary intends — up to four years after the period set out in Article 3 — to disseminate its results without protecting them, except in any of the following cases:

(a) the lack of protection is because protecting the results is not possible, reasonable or justified (given the circumstances);
(b) the lack of protection is because there is a lack of potential for commercial or industrial exploitation, or

c) the beneficiary intends to transfer the results to another beneficiary or third party established in an EU Member State or associated country, which will protect them.

Before the results are disseminated and unless any of the cases above under Points (a), (b) or (c) applies, the beneficiary must formally notify the Commission and at the same time inform it of any reasons for refusing consent. The beneficiary may refuse consent only if it can show that its legitimate interests would suffer significant harm.

If the Commission decides to assume ownership, it will formally notify the beneficiary concerned within 45 days of receiving notification.

No dissemination relating to these results may before the end of this period or, if the Commission takes a positive decision, until it has taken the necessary steps to protect the results.

26.4.2 The EU may — with the consent of the beneficiary concerned — assume ownership of results to protect them, if a beneficiary intends — up to four years after the period set out in Article 3 — to stop protecting them or not to seek an extension of protection, except in any of the following cases:

(a) the protection is stopped because of a lack of potential for commercial or industrial exploitation;

(b) an extension would not be justified given the circumstances.

A beneficiary that intends to stop protecting results or not seek an extension must — unless any of the cases above under Points (a) or (b) applies — formally notify the Commission at least 60 days before the protection lapses or its extension is no longer possible and at the same time inform it of any reasons for refusing consent. The beneficiary may refuse consent only if it can show that its legitimate interests would suffer significant harm.

If the Commission decides to assume ownership, it will formally notify the beneficiary concerned within 45 days of receiving notification.

26.5 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to the any of the other measures described in Chapter 6.

ARTICLE 27 — PROTECTION OF RESULTS — VISIBILITY OF EU FUNDING

27.1 Obligation to protect the results

Each beneficiary must examine the possibility of protecting its results and must adequately protect them — for an appropriate period and with appropriate territorial coverage — if:

(a) the results can reasonably be expected to be commercially or industrially exploited and

(b) protecting them is possible, reasonable and justified (given the circumstances).
When deciding on protection, the beneficiary must consider its own legitimate interests and the legitimate interests (especially commercial) of the other beneficiaries.

27.2 EU ownership, to protect the results

If a beneficiary intends not to protect its results, to stop protecting them or not seek an extension of protection, The EU may — under certain conditions (see Article 26.4) — assume ownership to ensure their (continued) protection.

27.3 Information on EU funding

Applications for protection of results (including patent applications) filed by or on behalf of a beneficiary must — unless the Commission requests or agrees otherwise or unless it is impossible — include the following:

“The project leading to this application has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 654215”.

27.4 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such a breach may also lead to any of the other measures described in Chapter 6.

ARTICLE 28 — EXPLOITATION OF RESULTS

28.1 Obligation to exploit the results

Each beneficiary must — up to four years after the period set out in Article 3 — take measures aiming to ensure ‘exploitation’ of its results (either directly or indirectly, in particular through transfer or licensing; see Article 30) by:

(a) using them in further research activities (outside the action);

(b) developing, creating or marketing a product or process;

(c) creating and providing a service, or

(d) using them in standardisation activities.

This does not change the security obligations in Article 37, which still apply.

28.2 Results that could contribute to European or international standards — Information on EU funding

If results are incorporated in a standard, the beneficiary concerned must — unless the Commission requests or agrees otherwise or unless it is impossible — ask the standardisation body to include the following statement in (information related to) the standard:

“Results incorporated in this standard received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 654215”.
28.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced in accordance with Article 43.

Such a breach may also lead to any of the other measures described in Chapter 6.

ARTICLE 29 — DISSEMINATION OF RESULTS — OPEN ACCESS — VISIBILITY OF EU FUNDING

29.1 Obligation to disseminate results

Unless it goes against their legitimate interests, each beneficiary must — as soon as possible — ‘disseminate’ its results by disclosing them to the public by appropriate means (other than those resulting from protecting or exploiting the results), including in scientific publications (in any medium).

This does not change the obligation to protect results in Article 27, the confidentiality obligations in Article 36, the security obligations in Article 37 or the obligations to protect personal data in Article 39, all of which still apply.

A beneficiary that intends to disseminate its results must give advance notice to the other beneficiaries of — unless agreed otherwise — at least 45 days, together with sufficient information on the results it will disseminate.

Any other beneficiary may object within — unless agreed otherwise — 30 days of receiving notification, if it can show that its legitimate interests in relation to the results or background would be significantly harmed. In such cases, the dissemination may not take place unless appropriate steps are taken to safeguard these legitimate interests.

If a beneficiary intends not to protect its results, it may — under certain conditions (see Article 26.4.1) — need to formally notify the Commission before dissemination takes place.

29.2 Open access to scientific publications

Each beneficiary must ensure open access (free of charge online access for any user) to all peer-reviewed scientific publications relating to its results.

In particular, it must:

(a) as soon as possible and at the latest on publication, deposit a machine-readable electronic copy of the published version or final peer-reviewed manuscript accepted for publication in a repository for scientific publications;

Moreover, the beneficiary must aim to deposit at the same time the research data needed to validate the results presented in the deposited scientific publications.

(b) ensure open access to the deposited publication — via the repository — at the latest:

(i) on publication, if an electronic version is available for free via the publisher, or
(ii) within six months of publication (twelve months for publications in the social sciences and humanities) in any other case.

(c) ensure open access — via the repository — to the bibliographic metadata that identify the deposited publication.

The bibliographic metadata must be in a standard format and must include all of the following:

- the terms “European Union (EU)” and “Horizon 2020”;
- the name of the action, acronym and grant number;
- the publication date, and length of embargo period if applicable, and
- a persistent identifier.

29.3 Open access to research data

Not applicable

29.4 Information on EU funding — Obligation and right to use the EU emblem

Unless the Commission requests or agrees otherwise or unless it is impossible, any dissemination of results (in any form, including electronic) must:

(a) display the EU emblem and

(b) include the following text:

“This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 654215”.

When displayed together with another logo, the EU emblem must have appropriate prominence.

For the purposes of their obligations under this Article, the beneficiaries may use the EU emblem without first obtaining approval from the Commission.

This does not however give them the right to exclusive use.

Moreover, they may not appropriate the EU emblem or any similar trademark or logo, either by registration or by any other means.

29.5 Disclaimer excluding Commission responsibility

Any dissemination of results must indicate that it reflects only the author’s view and that the Commission is not responsible for any use that may be made of the information it contains.

29.6 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).
Such a breach may also lead to any of the other measures described in Chapter 6.

ARTICLE 30 — TRANSFER AND/licensing of results

30.1 Transfer of ownership

Each beneficiary may transfer ownership of its results.

It must however ensure that its obligations under Articles 26.2, 26.4, 27, 28, 29, 30 and 31 also apply to the new owner and that this owner has the obligation to pass them on in any subsequent transfer.

This does not change the security obligations in Article 37, which still apply.

Unless agreed otherwise (in writing) for specifically-identified third parties or unless impossible under applicable EU and national laws on mergers and acquisitions, a beneficiary that intends to transfer ownership of results must give at least 45 days advance notice (or less if agreed in writing) to the other beneficiaries that still have (or still may request) access rights to the results. This notification must include sufficient information on the new owner to enable any beneficiary concerned to assess the effects on its access rights.

Unless agreed otherwise (in writing) for specifically-identified third parties, any other beneficiary may object within 30 days of receiving notification (or less if agreed in writing), if it can show that the transfer would adversely affect its access rights. In this case, the transfer may not take place until agreement has been reached between the beneficiaries concerned.

30.2 Granting licenses

Each beneficiary may grant licences to its results (or otherwise give the right to exploit them), if:

(a) this does not impede the rights under Article 31 and

(b) not applicable.

In addition to Points (a) and (b), exclusive licences for results may be granted only if all the other beneficiaries concerned have waived their access rights (see Article 31.1).

This does not change the dissemination obligations in Article 29 or security obligations in Article 37, which still apply.

30.3 Commission right to object to transfers or licensing

Not applicable

30.4 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such a breach may also lead to any of the other measures described in Chapter 6.
ARTICLE 31 — ACCESS RIGHTS TO RESULTS

31.1 Exercise of access rights — Waiving of access rights — No sub-licensing

The conditions set out in Article 25.1 apply.

The obligations set out in this Article do not change the security obligations in Article 37, which still apply.

31.2 Access rights for other beneficiaries, for implementing their own tasks under the action

The beneficiaries must give each other access — on a royalty-free basis — to results needed for implementing their own tasks under the action.

31.3 Access rights for other beneficiaries, for exploiting their own results

The beneficiaries must give each other — under fair and reasonable conditions (see Article 25.3) — access to results needed for exploiting their own results.

Requests for access may be made — unless agreed otherwise — up to one year after the period set out in Article 3.

31.4 Access rights of affiliated entities

Unless agreed otherwise in the consortium agreement, access to results must also be given — under fair and reasonable conditions (Article 25.3) — to affiliated entities established in an EU Member State or associated country, if this is needed for those entities to exploit the results generated by the beneficiaries to which they are affiliated.

Unless agreed otherwise (see above; Article 31.1), the affiliated entity concerned must make any such request directly to the beneficiary that owns the results.

Requests for access may be made — unless agreed otherwise — up to one year after the period set out in Article 3.

31.5 Access rights for the EU institutions, bodies, offices or agencies and EU Member States

The beneficiaries must give access to their results — on a royalty-free basis — to EU institutions, bodies, offices or agencies, for developing, implementing or monitoring EU policies or programmes.

Such access rights are limited to non-commercial and non-competitive use.

This does not change the right to use any material, document or information received from the beneficiaries for communication and publicising activities (see Article 38.2).

31.6 Access rights for third parties

The access provider must give the users royalty-free access to the results needed to implement the action.
31.7 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

SECTION 4 OTHER RIGHTS AND OBLIGATIONS

ARTICLE 32 — RECRUITMENT AND WORKING CONDITIONS FOR RESEARCHERS

32.1 Obligation to take measures to implement the European Charter for Researchers and Code of Conduct for the Recruitment of Researchers

The beneficiaries must take all measures to implement the principles set out in the Commission Recommendation on the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers\textsuperscript{22}, in particular regarding:

- working conditions;
- transparent recruitment processes based on merit, and
- career development.

The beneficiaries must ensure that researchers and third parties involved in the action are aware of them.

32.2 Consequences of non-compliance

If a beneficiary breaches its obligations under this Article, the Commission may apply any of the measures described in Chapter 6.

ARTICLE 33 — GENDER EQUALITY

33.1 Obligation to aim for gender equality

The beneficiaries must take all measures to promote equal opportunities between men and women in the implementation of the action. They must aim, to the extent possible, for a gender balance at all levels of personnel assigned to the action, including at supervisory and managerial level.

33.2 Consequences of non-compliance

If a beneficiary breaches its obligations under this Article, the Commission may apply any of the measures described in Chapter 6.

ARTICLE 34 — ETHICS

34.1 Obligation to comply with ethical principles

The beneficiaries must carry out the action in compliance with:

(a) ethical principles (including the highest standards of research integrity — as set out, for instance, in the European Code of Conduct for Research Integrity23 — and including, in particular, avoiding fabrication, falsification, plagiarism or other research misconduct) and

(b) applicable international, EU and national law.

Funding will not be granted for activities carried out outside the EU if they are prohibited in all Member States.

The beneficiaries must ensure that the activities under the action have an exclusive focus on civil applications.

The beneficiaries must ensure that the activities under the action do not:

(a) aim at human cloning for reproductive purposes;

(b) intend to modify the genetic heritage of human beings which could make such changes heritable (with the exception of research relating to cancer treatment of the gonads, which may be financed), or

(c) intend to create human embryos solely for the purpose of research or for the purpose of stem cell procurement, including by means of somatic cell nuclear transfer.

34.2 Activities raising ethical issues

Activities raising ethical issues must comply with the ‘ethics requirements’ set out in Annex 1.

Before the beginning of an activity raising an ethical issue, the coordinator must submit (see Article 52) to the Commission copy of:

(a) any ethics committee opinion required under national law and

(b) any notification or authorisation for activities raising ethical issues required under national law.

If these documents are not in English, the coordinator must also submit an English summary of the submitted opinions, notifications and authorisations (containing, if available, the conclusions of the committee or authority concerned).

If these documents are specifically requested for the action, the request must contain an explicit reference to the action title. The coordinator must submit a declaration by each beneficiary concerned that all the submitted documents cover the action tasks.

23 The European Code of Conduct for Research Integrity of ALLEA (All European Academies) and ESF (European Science Foundation) of March 2011. http://www.esf.org/fileadmin/Public_documents/Publications/Code_Conduct_ResearchIntegrity.pdf
34.3 Activities involving human embryos or human embryonic stem cells

Activities involving research on human embryos or human embryonic stem cells may be carried out only if:

- they are set out in Annex 1 or
- the coordinator has obtained explicit approval (in writing) from the *Commission* (see Article 52).

34.4 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43) and the Agreement or participation of the beneficiary may be terminated (see Article 50).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 35 — CONFLICT OF INTERESTS

35.1 Obligation to avoid a conflict of interests

The beneficiaries must take all measures to prevent any situation where the impartial and objective implementation of the action is compromised for reasons involving economic interest, political or national affinity, family or emotional ties or any other shared interest (‘conflict of interests’).

They must formally notify to the *Commission* without delay any situation constituting or likely to lead to a conflict of interests and immediately take all the necessary steps to rectify this situation.

The *Commission* may verify that the measures taken are appropriate and may require additional measures to be taken by a specified deadline.

35.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43) and the Agreement or participation of the beneficiary may be terminated (see Article 50).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 36 — CONFIDENTIALITY

36.1 General obligation to maintain confidentiality

During implementation of the action and for four years after the period set out in Article 3, the parties must keep confidential any data, documents or other material (in any form) that is identified as confidential at the time it is disclosed (‘confidential information’).

If a beneficiary requests, the *Commission* may agree to keep such information confidential for an additional period beyond the initial four years.

If information has been identified as confidential only orally, it will be considered to be confidential only if this is confirmed in writing within 15 days of the oral disclosure.
Unless otherwise agreed between the parties, they may use confidential information only to implement the Agreement.

The beneficiaries may disclose confidential information to their personnel or third parties involved in the action only if they:

(a) need to know to implement the Agreement and

(b) are bound by an obligation of confidentiality.

This does not change the security obligations in Article 37, which still apply.

The Commission may disclose confidential information to its staff, other EU institutions and bodies or third parties, if:

(a) this is necessary to implement the Agreement or safeguard the EU’s financial interests and

(b) the recipients of the information are bound by an obligation of confidentiality.

Under the conditions set out in Article 4 of the Rules for Participation Regulation No 1290/2013\(^{24}\), the Commission must moreover make available information on the results to other EU institutions, bodies, offices or agencies as well as Member States or associated countries.

The confidentiality obligations no longer apply if:

(a) the disclosing party agrees to release the other party;

(b) the information was already known by the recipient or is given to him without obligation of confidentiality by a third party that was not bound by any obligation of confidentiality;

(c) the recipient proves that the information was developed without the use of confidential information;

(d) the information becomes generally and publicly available, without breaching any confidentiality obligation, or

(e) the disclosure of the information is required by EU or national law.

36.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 37 — SECURITY-RELATED OBLIGATIONS

37.1 Results with a security recommendation

*Not applicable*

37.2 Classified results

*Not applicable*

37.3 Activities involving dual-use goods or dangerous materials and substances

*Not applicable*

37.4 Consequences of non-compliance

*Not applicable*

ARTICLE 38 — PROMOTING THE ACTION — VISIBILITY OF EU FUNDING

38.1 Communication activities by beneficiaries

38.1.1 Obligation to promote the action and its results

The beneficiaries must promote the action and its results, by providing targeted information to multiple audiences (including the media and the public) in a strategic and effective manner.

This does not change the dissemination obligations in Article 29, the confidentiality obligations in Article 36 or the security obligations in Article 37, all of which still apply.

Before engaging in a communication activity expected to have a major media impact, the beneficiaries must inform the *Commission* (see Article 52).

38.1.2 Information on EU funding — Obligation and right to use the EU emblem

Unless the *Commission* requests or agrees otherwise or unless it is impossible, any communication activity related to the action (including in electronic form, via social media, etc.) and any infrastructure, equipment and major results funded by the grant must:

(a) display the EU emblem and

(b) include the following text:

For communication activities: “This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654215”.

For infrastructure, equipment and major results: “This [infrastructure]/[equipment]/[insert type of result] is part of a project that has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654215”.

When displayed together with another logo, the EU emblem must have appropriate prominence.
For the purposes of their obligations under this Article, the beneficiaries may use the EU emblem without first obtaining approval from the Commission.

This does not, however, give them the right to exclusive use.

Moreover, they may not appropriate the EU emblem or any similar trademark or logo, either by registration or by any other means.

38.1.3 Disclaimer excluding the Commission responsibility

Any communication activity related to the action must indicate that it reflects only the author's view and that the Commission is not responsible for any use that may be made of the information it contains.

38.2 Communication activities by the Commission

38.2.1 Right to use beneficiaries’ materials, documents or information

The Commission may use, for its communication and publicising activities, information relating to the action, documents notably summaries for publication and public deliverables as well as any other material, such as pictures or audio-visual material that it receives from any beneficiary (including in electronic form).

This does not change the confidentiality obligations in Article 36 and the security obligations in Article 37, all of which still apply.

However, if the Commission’s use of these materials, documents or information would risk compromising legitimate interests, the beneficiary concerned may request the Commission not to use it (see Article 52).

The right to use a beneficiary’s materials, documents and information includes:

(a) use for its own purposes (in particular, making them available to persons working for the Commission or any other EU institution, body, office or agency or body or institutions in EU Member States; and copying or reproducing them in whole or in part, in unlimited numbers);

(b) distribution to the public (in particular, publication as hard copies and in electronic or digital format, publication on the internet, as a downloadable or non-downloadable file, broadcasting by any channel, public display or presentation, communicating through press information services, or inclusion in widely accessible databases or indexes);

(c) editing or redrafting for communication and publicising activities (including shortening, summarising, inserting other elements (such as meta-data, legends, other graphic, visual, audio or text elements), extracting parts (e.g. audio or video files), dividing into parts, use in a compilation);

(d) translation;

(e) giving access in response to individual requests under Regulation No 1049/2001, without the right to reproduce or exploit;

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(f) **storage** in paper, electronic or other form;

(g) **archiving**, in line with applicable document-management rules, and

(h) the right to authorise **third parties** to act on its behalf or sub-license the modes of use set out in Points (b),(c),(d) and (f) to third parties if needed for the communication and publicising activities of the **Commission**.

If the right of use is subject to rights of a third party (including personnel of the beneficiary), the beneficiary must ensure that it complies with its obligations under this Agreement (in particular, by obtaining the necessary approval from the third parties concerned).

Where applicable (and if provided by the beneficiaries), the **Commission** will insert the following information:

“© – [year] – [name of the copyright owner]. All rights reserved. Licensed to the **European Union (EU)** under conditions.”

### 38.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

**ARTICLE 39 — PROCESSING OF PERSONAL DATA**

#### 39.1 Processing of personal data by the Commission

Any personal data under the Agreement will be processed by the Commission under Regulation No 45/2001\(^{26}\) and according to the ‘notifications of the processing operations’ to the Data Protection Officer (DPO) of the Commission (publicly accessible in the DPO register).

Such data will be processed by the ‘**data controller**’ of the Commission for the purposes of implementing, managing and monitoring the Agreement or protecting the financial interests of the EU or Euratom (including checks, reviews, audits and investigations; see Article 22).

The persons whose personal data are processed have the right to access and correct their own personal data. For this purpose, they must send any queries about the processing of their personal data to the data controller, via the contact point indicated in the ‘service specific privacy statement(s) (SSPS)’ that are published on the Commission websites.

They also have the right to have recourse at any time to the European Data Protection Supervisor (EDPS).

\(^{26}\) Regulation (EC) No 45/2001 of the European Parliament and of the Council of 18 December 2000 on the protection of individuals with regard to the processing of personal data by the Community institutions and bodies and on the free movement of such data (OJ L 8, 12.01.2001, p. 1).
39.2 Processing of personal data by the beneficiaries

The beneficiaries must process personal data under the Agreement in compliance with applicable EU and national law on data protection (including authorisations or notification requirements).

The beneficiaries may grant their personnel access only to data that is strictly necessary for implementing, managing and monitoring the Agreement.

The beneficiaries must inform the personnel whose personal data are collected and processed by the Commission. For this purpose, they must provide them with the service specific privacy statement (SSPS) (see above), before transmitting their data to the Commission.

39.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under Article 39.2, the Commission may apply any of the measures described in Chapter 6.

ARTICLE 40 — ASSIGNMENTS OF CLAIMS FOR PAYMENT AGAINST THE COMMISSION

The beneficiaries may not assign any of their claims for payment against the Commission to any third party, except if approved by the Commission on the basis of a reasoned, written request by the coordinator (on behalf of the beneficiary concerned).

If the Commission has not accepted the assignment or the terms of it are not observed, the assignment will have no effect on it.

In no circumstances will an assignment release the beneficiaries from their obligations towards the Commission.

CHAPTER 5 DIVISION OF BENEFICIARIES’ ROLES AND RESPONSIBILITIES

ARTICLE 41 — DIVISION OF BENEFICIARIES’ ROLES AND RESPONSIBILITIES

41.1 Roles and responsibilities towards the Commission

The beneficiaries have full responsibility for implementing the action and complying with the Agreement.

The beneficiaries are jointly and severally liable for the technical implementation of the action as described in Annex 1. If a beneficiary fails to implement its part of the action, the other beneficiaries become responsible for implementing this part (without being entitled to any additional EU funding for doing so), unless the Commission expressly relieves them of this obligation.

The financial responsibility of each beneficiary is governed by Articles 44, 45 and 46.

41.2 Internal division of roles and responsibilities

The internal roles and responsibilities of the beneficiaries are divided as follows:

(a) Each beneficiary must:
(i) keep information stored in the 'Beneficiary Register' (via the electronic exchange system) up to date (see Article 17);

(ii) inform the coordinator immediately of any events or circumstances likely to affect significantly or delay the implementation of the action (see Article 17);

(iii) submit to the coordinator in good time:
  - individual financial statements for itself and, if required, certificates on the financial statements (see Article 20);
  - the data needed to draw up the technical reports (see Article 20);
  - ethics committee opinions and notifications or authorisations for activities raising ethical issues (see Article 34);
  - any other documents or information required by the Commission under the Agreement, unless the Agreement requires the beneficiary to submit this information directly to the Commission.

(b) The coordinator must:

(i) monitor that the action is implemented properly (see Article 7);

(ii) act as the intermediary for all communications between the beneficiaries and the Commission (in particular, providing the Commission with the information described in Article 17), unless the Agreement specifies otherwise;

(iii) request and review any documents or information required by the Commission and verify their completeness and correctness before passing them on to the Commission;

(iv) submit the deliverables and reports to the Commission (see Articles 19 and 20);

(v) ensure that all payments are made to the other beneficiaries without unjustified delay (see Article 21);

(vi) inform the Commission of the amounts paid to each beneficiary, when required under the Agreement (see Articles 44 and 50) or requested by the Commission.

The coordinator may not delegate the above-mentioned tasks to any other beneficiary or subcontract them to any third party.

41.3 Internal arrangements between beneficiaries — Consortium agreement

The beneficiaries must have internal arrangements regarding their operation and co-ordination to ensure that the action is implemented properly. These internal arrangements must be set out in a written ‘consortium agreement’ between the beneficiaries, which may cover:

- internal organisation of the consortium;
- management of access to the electronic exchange system;
- distribution of EU funding;
- additional rules on rights and obligations related to background and results (including whether access rights remain or not, if a beneficiary is in breach of its obligations) (see Section 3 of Chapter 4);
- settlement of internal disputes;
- liability, indemnification and confidentiality arrangements between the beneficiaries.

The consortium agreement must not contain any provision contrary to the Agreement.

41.4 Relationship with complementary beneficiaries — Collaboration agreement

Not applicable

41.5 Relationship with partners of a joint action — Coordination agreement

Not applicable

CHAPTER 6 REJECTION OF COSTS — REDUCTION OF THE GRANT — RECOVERY — PENALTIES — DAMAGES — SUSPENSION — TERMINATION — FORCE MAJEURE

SECTION 1 REJECTION OF COSTS — REDUCTION OF THE GRANT — RECOVERY — PENALTIES

ARTICLE 42 — REJECTION OF INELIGIBLE COSTS

42.1 Conditions

42.1.1 The Commission will — at the time of an interim payment, at the payment of the balance or afterwards — reject any costs which are ineligible (see Article 6), in particular following checks, reviews, audits or investigations (see Article 22).

42.1.2 The rejection may also be based on the extension of findings from other grants to this grant, under the conditions set out in Article 22.5.2.

42.2 Ineligible costs to be rejected — Calculation — Procedure

Ineligible costs will be rejected in full.

If the Commission rejects costs without reduction of the grant (see Article 43) or recovery of undue amounts (see Article 44), it will formally notify the coordinator or beneficiary concerned the rejection of costs, the amounts and the reasons why (if applicable, together with the notification of amounts due; see Article 21.5). The coordinator or beneficiary concerned may — within 30 days of receiving notification — formally notify the Commission of its disagreement and the reasons why.
If the *Commission* rejects costs with *reduction of the grant* or *recovery of undue amounts*, it will formally notify the rejection in the ‘*pre-information letter*’ on reduction or recovery set out in Articles 43 and 44.

### 42.3 Effects

If the *Commission* rejects costs at the time of an *interim payment* or *the payment of the balance*, it will deduct them from the total eligible costs declared, for the action, in the periodic or final summary financial statement (see Articles 20.3 and 20.4). It will then calculate the interim payment or payment of the balance as set out in Articles 21.3 or 21.4.

If the *Commission* — after an interim payment but before the payment of the balance — rejects costs declared in a periodic summary financial statement, it will deduct them from the total eligible costs declared, for the action, in the next periodic summary financial statement or in the final summary financial statement. It will then calculate the interim payment or payment of the balance as set out in Articles 21.3 or 21.4.

If the *Commission* rejects costs after the payment of the balance, it will deduct the amount rejected from the total eligible costs declared, by the beneficiary, in the final summary financial statement. It will then calculate the revised final grant amount as set out in Article 5.4.

### ARTICLE 43 — REDUCTION OF THE GRANT

#### 43.1 Conditions

43.1.1 The *Commission* may — at the payment of the balance or afterwards — reduce the maximum grant amount (see Article 5.1), if the action has not been implemented properly as described in Annex 1 or another obligation under the Agreement has been breached.

43.1.2 The *Commission* may also reduce the maximum grant amount on the basis of the *extension of findings from other grants to this grant*, under the conditions set out in Article 22.5.2.

#### 43.2 Amount to be reduced — Calculation — Procedure

The amount of the reduction will be proportionate to the improper implementation of the action or to the seriousness of the breach.

Before reduction of the grant, the *Commission* will formally notify a ‘*pre-information letter*’ to the coordinator or beneficiary concerned:

- informing it of its intention to reduce the grant, the amount it intends to reduce and the reasons why and
- inviting it to submit observations within 30 days of receiving notification

If the *Commission* does not receive any observations or decides to pursue reduction despite the observations it has received, it will formally notify *confirmation* of the reduction (if applicable, together with the notification of amounts due; see Article 21).
43.3 Effects

If the Commission reduces the grant at the time of the payment of the balance, it will calculate the reduced grant amount for the action and then determine the amount due as payment of the balance (see Articles 5.3.4 and 21.4).

If the Commission reduces the grant after the payment of the balance, it will calculate the revised final grant amount for the beneficiary concerned (see Article 5.4). If the revised final grant amount for the beneficiary concerned is lower than its share of the final grant amount, the Commission will recover the difference (see Article 44).

ARTICLE 44 — RECOVERY OF UNDUE AMOUNTS

44.1 Amount to be recovered — Calculation — Procedure

The Commission will — after termination of the participation of a beneficiary, at the payment of the balance or afterwards — claim back any amount that was paid but is not due under the Agreement.

Each beneficiary’s financial responsibility in case of recovery is limited to its own debt, except for the amount retained for the Guarantee Fund (see Article 21.4).

44.1.1 Recovery after termination of a beneficiary’s participation

If recovery takes place after termination of a beneficiary’s participation (including the coordinator), the Commission will claim back the undue amount from the beneficiary concerned, by formally notifying it a debit note (see Article 50.2 and 50.3). This note will specify the amount to be recovered, the terms and the date for payment.

If payment is not made by the date specified in the debit note, the Commission will recover the amount:

(a) by ‘offsetting’ it — without the beneficiary’s consent — against any amounts owed to the beneficiary concerned by the Commission or an executive agency (from the EU or Euratom budget).

In exceptional circumstances, to safeguard the EU’s financial interests, the Commission may offset before the payment date specified in the debit note;

(b) not applicable;

(c) by taking legal action (see Article 57) or by adopting an enforceable decision under Article 299 of the Treaty on the Functioning of the EU (TFEU) and Article 79(2) of the Financial regulation No 966/2012.

If payment is not made by the date specified in the debit note, the amount to be recovered (see above) will be increased by late-payment interest at the rate set out in Article 21.11, from the day following the payment date in the debit note, up to and including the date the Commission receives full payment of the amount.
Partial payments will be first credited against expenses, charges and late-payment interest and then against the principal.

Bank charges incurred in the recovery process will be borne by the beneficiary, unless Directive 2007/64/EC\textsuperscript{27} applies.

### 44.1.2 Recovery at payment of the balance

If the payment of the balance takes the form of a recovery (see Article 21.4), the Commission will formally notify a ‘pre-information letter’ to the coordinator:

- informing it of its intention to recover, the amount due as the balance and the reasons why;
- specifying that it intends to deduct the amount to be recovered from the amount retained for the Guarantee Fund;
- requesting the coordinator to submit a report on the distribution of payments to the beneficiaries within 30 days of receiving notification, and
- inviting the coordinator to submit observations within 30 days of receiving notification.

If no observations are submitted or the Commission decides to pursue recovery despite the observations it has received, it will confirm recovery (together with the notification of amounts due; see Article 21.5) and:

- pay the difference between the amount to be recovered and the amount retained for the Guarantee Fund, if the difference is positive or
- formally notify to the coordinator a debit note for the difference between the amount to be recovered and the amount retained for the Guarantee Fund, if the difference is negative. This note will also specify the terms and the date for payment.

If the coordinator does not repay the Commission by the date in the debit note and has not submitted the report on the distribution of payments: the Commission will recover the amount set out in the debit note from the coordinator (see below).

If the coordinator does not repay the Commission by the date in the debit note, but has submitted the report on the distribution of payments: the Commission will:

(a) identify the beneficiaries for which the amount calculated as follows is negative:

\[
\frac{\{\text{beneficiary’s costs declared in the final summary financial statement and approved by the Commission multiplied by the reimbursement rate set out in Article 5.2 for the beneficiary concerned}\}}{\text{the EU contribution for the action calculated according to Article 5.3.1}}
\]

multiplied by

the final grant amount (see Article 5.3),

minus

{pre-financing and interim payments received by the beneficiary}.

(b) formally notify to each beneficiary identified according to point (a) a debit note specifying the terms and date for payment. The amount of the debit note is calculated as follows:

\[
\text{amount calculated according to point (a) for the beneficiary concerned divided by the sum of the amounts calculated according to point (a) for all the beneficiaries identified according to point (a)} \times \text{amount set out in the debit note formally notified to the coordinator}.
\]

If payment is not made by the date specified in the debit note, the Commission will recover the amount:

(a) by ‘offsetting’ it — without the beneficiary’s consent — against any amounts owed to the beneficiary concerned by the Commission or an executive agency (from the EU or Euratom budget).

In exceptional circumstances, to safeguard the EU’s financial interests, the Commission may offset before the payment date specified in the debit note;

(b) by drawing on the Guarantee Fund. The Commission will formally notify the beneficiary concerned the debit note on behalf of the Guarantee Fund and recover the amount:

(i) not applicable;

(ii) by taking legal action (see Article 57) or by adopting an enforceable decision under Article 299 of the Treaty on the Functioning of the EU (TFEU) and Article 79(2) of the Financial Regulation No 966/2012.

If payment is not made by the date in the debit note, the amount to be recovered (see above) will be increased by late-payment interest at the rate set out in Article 21.11, from the day following the payment date in the debit note, up to and including the date the Commission receives full payment of the amount.

Partial payments will be first credited against expenses, charges and late-payment interest and then against the principal.

Bank charges incurred in the recovery process will be borne by the beneficiary, unless Directive 2007/64/EC applies.
44.1.3 Recovery of amounts after payment of the balance

If, for a beneficiary, the revised final grant amount (see Article 5.4) is lower than its share of the final grant amount, it must repay the difference to the Commission.

The beneficiary’s share of the final grant amount is calculated as follows:

\[
\frac{\text{beneficiary’s costs declared in the final summary financial statement and approved by the Commission multiplied by the reimbursement rate set out in Article 5.2 for the beneficiary concerned}}{\text{the EU contribution for the action calculated according to Article 5.3.1}} \times \text{the final grant amount (see Article 5.3)}.
\]

If the coordinator has not distributed amounts received (see Article 21.7), the Commission will also recover these amounts.

The Commission will formally notify a pre-information letter to the beneficiary concerned:

- informing it of its intention to recover, the due amount and the reasons why and
- inviting it to submit observations within 30 days of receiving notification.

If no observations are submitted or the Commission decides to pursue recovery despite the observations it has received, it will confirm the amount to be recovered and formally notify to the beneficiary concerned a debit note. This note will also specify the terms and the date for payment.

If payment is not made by the date specified in the debit note, the Commission will recover the amount:

(a) by ‘offsetting’ it — without the beneficiary’s consent — against any amounts owed to the beneficiary concerned by the Commission or an executive agency (from the EU or Euratom budget).

In exceptional circumstances, to safeguard the EU’s financial interests, the Commission may offset before the payment date specified in the debit note;

(b) by drawing on the Guarantee Fund. The Commission will formally notify the beneficiary concerned the debit note on behalf of the Guarantee Fund and recover the amount:

(i) not applicable;

(ii) by taking legal action (see Article 57) or by adopting an enforceable decision under Article 299 of the Treaty on the Functioning of the EU (TFEU) and Article 79(2) of the Financial Regulation No 966/2012.

If payment is not made by the date in the debit note, the amount to be recovered (see above) will be increased by late-payment interest at the rate set out in Article 21.11, from the day following the
date for payment in the debit note, up to and including the date the Commission receives full payment of the amount.

Partial payments will be first credited against expenses, charges and late-payment interest and then against the principal.

Bank charges incurred in the recovery process will be borne by the beneficiary, unless Directive 2007/64/EC applies.

ARTICLE 45 — ADMINISTRATIVE AND FINANCIAL PENALTIES

45.1 Conditions

Under Articles 109 and 131(4) of the Financial Regulation No 966/2012, the Commission may impose administrative and financial penalties if a beneficiary:

(a) has committed substantial errors, irregularities or fraud or is in serious breach of its obligations under the Agreement or

(b) has made false declarations about information required under the Agreement or for the submission of the proposal (or has not supplied such information).

Each beneficiary is responsible for paying the financial penalties imposed on it.

Under Article 109(3) of the Financial Regulation No 966/2012, the Commission may — under certain conditions and limits — publish decisions imposing administrative or financial penalties.

45.2 Duration — Amount of penalty — Calculation

Administrative penalties exclude the beneficiary from all contracts and grants financed from the EU or Euratom budget for a maximum of five years from the date the infringement is established by the Commission.

If the beneficiary commits another infringement within five years of the date the first infringement is established, the Commission may extend the exclusion period up to 10 years.

Financial penalties will be between 2% and 10% of the maximum EU contribution indicated, for the beneficiary concerned, in the estimated budget (see Annex 2).

If the beneficiary commits another infringement within five years of the date the first infringement is established, the Commission may increase the rate of financial penalties to between 4% and 20%.

45.3 Procedure

Before applying a penalty, the Commission will formally notify the beneficiary concerned:

- informing it of its intention to impose a penalty, its duration or amount and the reasons why and

- inviting it to submit observations within 30 days.

If the Commission does not receive any observations or decides to impose the penalty despite of observations it has received, it will formally notify confirmation of the penalty to the beneficiary.
concerned and — in case of financial penalties — deduct the penalty from the payment of the balance or formally notify a **debit note**, specifying the amount to be recovered, the terms and the date for payment.

If payment is not made by the date specified in the debit note, the Commission may **recover** the amount:

(a) by ‘**offsetting**’ it — without the beneficiary’s consent — against any amounts owed to the beneficiary concerned by the Commission or an executive agency (from the EU or Euratom budget).

In exceptional circumstances, to safeguard the EU’s financial interests, the **Commission** may offset before the payment date specified in the debit note;

(b) by **taking legal action** (see Article 57) or by **adopting an enforceable decision** under Article 299 of the Treaty on the Functioning of the EU (TFEU) and Article 79(2) of the Financial Regulation No 966/2012.

If payment is not made by the date in the debit note, the amount to be recovered (see above) will be increased by **late-payment interest** at the rate set out in Article 21.11, from the day following the payment date in the debit note, up to and including the date the Commission receives full payment of the amount.

Partial payments will be first credited against expenses, charges and late-payment interest and then against the principal.

Bank charges incurred in the recovery process will be borne by the beneficiary, unless Directive 2007/64/EC applies.

**SECTION 2   LIABILITY FOR DAMAGES**

**ARTICLE 46 — LIABILITY FOR DAMAGES**

46.1 **Liability of the Commission**

The **Commission** cannot be held liable for any damage caused to the beneficiaries or to third parties as a consequence of implementing the Agreement, including for gross negligence.

The **Commission** cannot be held liable for any damage caused by any of the beneficiaries or third parties involved in the action, as a consequence of implementing the Agreement.

46.2 **Liability of the beneficiaries**

46.2.1 **Conditions**

Except in case of force majeure (see Article 51), the beneficiaries must compensate the **Commission** for any damage it sustains as a result of the implementation of the action or because the action was not implemented in full compliance with the Agreement.

Each beneficiary is responsible for paying the damages claimed from it.
46.2.2 Amount of damages - Calculation

The amount the Commission can claim from a beneficiary will correspond to the damage caused by that beneficiary.

46.2.3 Procedure

Before claiming damages, the Commission will formally notify the beneficiary concerned:

- informing it of its intention to claim damages, the amount and the reasons why and
- inviting it to submit observations within 30 days.

If the Commission does not receive any observations or decides to claim damages despite the observations it has received, it will formally notify confirmation of the claim for damages and a debit note, specifying the amount to be recovered, the terms and the date for payment.

If payment is not made by the date specified in the debit note, the Commission may recover the amount:

(a) by ‘offsetting’ it — without the beneficiary’s consent — against any amounts owed to the beneficiary concerned by the Commission or an executive agency (from the EU or Euratom budget).

In exceptional circumstances, to safeguard the EU’s financial interests, the Commission may offset before the payment date specified in the debit note;

(b) by taking legal action (see Article 57) or by adopting an enforceable decision under Article 299 of the Treaty on the Functioning of the EU (TFEU) and Article 79(2) of the Financial Regulation No 966/2012.

If payment is not made by the date in the debit note, the amount to be recovered (see above) will be increased by late-payment interest at the rate set out in Article 21.11, from the day following the payment date in the debit note, up to and including the date the Commission receives full payment of the amount.

Partial payments will be first credited against expenses, charges and late-payment interest and then against the principal.

Bank charges incurred in the recovery process will be borne by the beneficiary, unless Directive 2007/64/EC applies.

SECTION 3   SUSPENSION AND TERMINATION

ARTICLE 47 — SUSPENSION OF PAYMENT DEADLINE

47.1 Conditions

The Commission may — at any moment — suspend the payment deadline (see Article 21.2 to 21.4) if a request for payment (see Article 20) cannot be approved because:

(a) it does not comply with the provisions of the Agreement (see Article 20);
(b) the technical reports or financial reports have not been submitted or are not complete or additional information is needed, or

(c) there is doubt about the eligibility of the costs declared in the financial statements and additional checks, reviews, audits or investigations are necessary.

47.2 Procedure

The Commission will formally notify the coordinator of the suspension and the reasons why.

The suspension will take effect the day notification is sent by the Commission (see Article 52).

If the conditions for suspending the payment deadline are no longer met, the suspension will be lifted — and the remaining period will resume.

If the suspension exceeds two months, the coordinator may request the Commission if the suspension will continue.

If the payment deadline has been suspended due to the non-compliance of the technical or financial reports (see Article 20) and the revised report or statement is not submitted or was submitted but is also rejected, the Commission may also terminate the Agreement or the participation of the beneficiary (see Article 50.3.1(l)).

ARTICLE 48 — SUSPENSION OF PAYMENTS

48.1 Conditions

The Commission may — at any moment — suspend, in whole or in part, the pre-financing payment and interim payments for one or more beneficiaries or the payment of the balance for all beneficiaries, if a beneficiary:

(a) has committed or is suspected of having committed substantial errors, irregularities, fraud or serious breach of obligations in the award procedure or under this Agreement or

(b) has committed — in other EU or Euratom grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (extension of findings from other grants to this grant; see Article 22.5.2).

48.2 Procedure

Before suspending payments, the Commission will formally notify the coordinator:

- informing it of its intention to suspend payments and the reasons why and

- inviting it to submit observations within 30 days of receiving notification.

If the Commission does not receive observations or decides to pursue the procedure despite the observations it has received, it will formally notify confirmation of the suspension. Otherwise, it will formally notify that the suspension procedure is not continued.

The suspension will take effect the day the confirmation notification is sent by the Commission.
If the conditions for resuming payments are met, the suspension will be lifted. The *Commission* will formally notify the coordinator.

During the suspension, the periodic report(s) (see Article 20.3) must not contain any individual financial statements from the beneficiary concerned. When the *Commission* resumes payments, the coordinator may include them in the next periodic report.

The beneficiaries may suspend implementation of the action (see Article 49.1) or terminate the Agreement or the participation of the beneficiary concerned (see Article 50.1 and 50.2).

**ARTICLE 49 — SUSPENSION OF THE ACTION IMPLEMENTATION**

**49.1 Suspension of the action implementation, by the beneficiaries**

**49.1.1 Conditions**

The beneficiaries may suspend implementation of the action or any part of it, if exceptional circumstances — in particular *force majeure* (see Article 51) — make implementation impossible or excessively difficult.

**49.1.2 Procedure**

The coordinator must immediately formally notify to the *Commission* the suspension (see Article 52), stating:

- the reasons why and
- the expected date of resumption.

The suspension will take effect the day this notification is received by the *Commission*.

Once circumstances allow for implementation to resume, the coordinator must immediately formally notify the *Commission* and request an amendment of the Agreement to set the date on which the action will be resumed, extend the duration of the action and make other changes necessary to adapt the action to the new situation (see Article 55) — unless the Agreement or the participation of a beneficiary has been terminated (see Article 50).

The suspension will be lifted with effect from the resumption date set out in the amendment. This date may be before the date on which the amendment enters into force.

Costs incurred during suspension of the action implementation are not eligible (see Article 6).

**49.2 Suspension of the action implementation, by the *Commission***

**49.2.1 Conditions**

The *Commission* may suspend implementation of the action or any part of it:

(a) if a beneficiary has committed or is suspected of having committed substantial errors, irregularities, fraud or serious breach of obligations in the award procedure or under this Agreement;
(b) if a beneficiary has committed — in other EU or Euratom grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (extension of findings from other grants to this grant; see Article 22.5.2), or

(c) if the action is suspected of having lost its scientific or technological relevance.

49.2.2 Procedure

Before suspending implementation of the action, the Commission will formally notify the coordinator:

- informing it of its intention to suspend the implementation and the reasons why and
- inviting it to submit observations within 30 days of receiving notification.

If the Commission does not receive observations or decides to pursue the procedure despite the observations it has received, it will formally notify confirmation of the suspension. Otherwise, it will formally notify that the procedure is not continued.

The suspension will take effect five days after confirmation notification is received by the coordinator (or on a later date specified in the notification).

It will be lifted if the conditions for resuming implementation of the action are met.

The coordinator will be formally notified of the lifting and the Agreement will be amended to set the date on which the action will be resumed, extend the duration of the action and make other changes necessary to adapt the action to the new situation (see Article 55) — unless the Agreement has already been terminated (see Article 50).

The suspension will be lifted with effect from the resumption date set out in the amendment. This date may be before the date on which the amendment enters into force.

Costs incurred during suspension are not eligible (see Article 6).

The beneficiaries may not claim damages due to suspension by the Commission (see Article 46).

Suspension of the action implementation does not affect the Commission’s right to terminate the Agreement or participation of a beneficiary (see Article 50), reduce the grant or recover amounts unduly paid (see Articles 43 and 44).

ARTICLE 50 — TERMINATION OF THE AGREEMENT OR OF THE PARTICIPATION OF ONE OR MORE BENEFICIARIES

50.1 Termination of the Agreement by the beneficiaries

50.1.1 Conditions and procedure

The beneficiaries may terminate the Agreement.

The coordinator must formally notify termination to the Commission (see Article 52), stating:
- the reasons why and
- the date the termination will take effect. This date must be after the notification.

If no reasons are given or if the Commission considers the reasons do not justify termination, the Agreement will be considered to have been ‘terminated improperly’.

The termination will take effect on the day specified in the notification.

50.1.2 Effects

The coordinator must — within 60 days from when termination takes effect — submit:

(i) a periodic report (for the open reporting period until termination; see Article 20.3) and

(ii) the final report (see Article 20.4).

If the Commission does not receive the reports within the deadline (see above), only costs which are included in an approved periodic report will be taken into account.

The Commission will calculate the final grant amount (see Article 5.3) and the balance (see Article 21.4) on the basis of the reports submitted. Only costs incurred until termination are eligible (see Article 6). Costs relating to contracts due for execution only after termination are not eligible.

Improper termination may lead to a reduction of the grant (see Article 43).

After termination, the beneficiaries’ obligations (in particular Articles 20, 22, 23, Section 3 of Chapter 4, 36, 37, 38 and 40) continue to apply.

50.2 Termination of the participation of one or more beneficiaries, by the beneficiaries

50.2.1 Conditions and procedure

The participation of one or more beneficiaries may be terminated by the coordinator, on request of the beneficiary concerned or on behalf of the other beneficiaries.

The coordinator must formally notify termination to the Commission (see Article 52) and inform the beneficiary concerned.

If the coordinator’s participation is terminated without its agreement, the formal notification must be done by another beneficiary (acting on behalf of the other beneficiaries).

The notification must include:

- the reasons why;

- the opinion of the beneficiary concerned (or proof that this opinion has been requested in writing);

- the date the termination takes effect. This date must be after the notification, and
- a request for amendment (see Article 55), with a proposal for reallocation of the tasks and the estimated budget of the beneficiary concerned (see Annexes 1 and 2) and, if necessary, the addition of one or more new beneficiaries (see Article 56). If termination takes effect after the period set out in Article 3, no request for amendment must be included unless the beneficiary concerned is the coordinator. In this case, the request for amendment must propose a new coordinator.

If this information is not given or if the Commission considers that the reasons do not justify termination, the participation will be considered to have been terminated improperly.

The termination will take effect on the day specified in the notification.

50.2.2 Effects

The coordinator must — within 30 days from when termination takes effect — submit:

(i) a report on the distribution of payments to the beneficiary concerned and

(ii) if termination takes effect during the period set out in Article 3, a ‘termination report’ from the beneficiary concerned, for the open reporting period until termination, containing an overview of the progress of the work, an overview of the use of resources, the individual financial statement and, if applicable, the certificate on the financial statement (see Articles 20.3 and 20.4).

The information in the termination report must also be included in the periodic report for the next reporting period (see Article 20.3).

If the request for amendment is rejected by the Commission, because it calls into question the decision awarding the grant or breaches the principle of equal treatment of applicants), the Agreement may be terminated according to Article 50.3.1(c).

If the request for amendment is accepted by the Commission, the Agreement is amended to introduce the necessary changes (see Article 55).

The Commission will calculate — on the basis of the periodic reports, the termination report and the report on the distribution of payments — if the (pre-financing and interim) payments received by the beneficiary concerned exceed the beneficiary’s EU contribution (calculated by applying the reimbursement rate(s) to the eligible costs declared by the beneficiary and approved by the Commission). Only costs incurred by the beneficiary concerned until termination takes effect are eligible (see Article 6). Costs relating to contracts due for execution only after termination are not eligible.

• If the payments received exceed the amounts due:

- if termination takes effect during the period set out in Article 3 and the request for amendment is accepted, the beneficiary concerned must repay to the coordinator the amount unduly received. The Commission will formally notify the amount unduly received and request the beneficiary concerned to repay it to the coordinator within 30 days of receiving notification. If it does not repay the coordinator, the Commission will draw upon the Guarantee Fund to pay the coordinator and then notify a debit note on behalf of the Guarantee Fund to the beneficiary concerned (see Article 44);
- in all other cases (in particular if termination takes effect after the period set out in Article 3), the Commission will formally notify a debit note to the beneficiary concerned. If payment is not made by the date in the debit note, the Guarantee Fund will pay to the Commission the amount due and the Commission will notify a debit note on behalf of the Guarantee Fund to the beneficiary concerned (see Article 44);

- if the beneficiary concerned is the former coordinator, it must repay the new coordinator according to the procedure above, unless:
  - termination is after an interim payment and
  - the former coordinator has not distributed amounts received as pre-financing or interim payments (see Article 21.7).

In this case, the Commission will formally notify a debit note to the former coordinator. If payment is not made by the date in the debit note, the Guarantee Fund will pay to the Commission the amount due. The Commission will then pay the new coordinator and notify a debit note on behalf of the Guarantee Fund to the former coordinator (see Article 44).

- If the payments received do not exceed the amounts due: amounts owed to the beneficiary concerned will be included in the next interim or final payment.

If the Commission does not receive the termination report within the deadline (see above), only costs included in an approved periodic report will be taken into account.

If the Commission does not receive the report on the distribution of payments within the deadline (see above), it will consider that:

- the coordinator did not distribute any payment to the beneficiary concerned and that
- the beneficiary concerned must not repay any amount to the coordinator.

Improper termination may lead to a reduction of the grant (see Article 43) or termination of the Agreement (see Article 50).

After termination, the concerned beneficiary’s obligations (in particular Articles 20, 22, 23, Section 3 of Chapter 4, 36, 37, 38 and 40) continue to apply.

**50.3 Termination of the Agreement or the participation of one or more beneficiaries, by the Commission**

**50.3.1 Conditions**

The Commission may terminate the Agreement or the participation of one or more beneficiaries, if:

(a) one or more beneficiaries do not accede to the Agreement (see Article 56);

(b) a change to their legal, financial, technical, organisational or ownership situation is likely to substantially affect or delay the implementation of the action or calls into question the decision to award the grant;
(c) following termination of participation for one or more beneficiaries (see above), the necessary changes to the Agreement would call into question the decision awarding the grant or breach the principle of equal treatment of applicants (see Article 55);

(d) implementation of the action is prevented by force majeure (see Article 51) or suspended by the coordinator (see Article 49.1) and either:

   (i) resumption is impossible, or

   (ii) the necessary changes to the Agreement would call into question the decision awarding the grant or breach the principle of equal treatment of applicants;

(e) a beneficiary is declared bankrupt, being wound up, having its affairs administered by the courts, has entered into an arrangement with creditors, has suspended business activities, or is subject to any other similar proceedings or procedures under national law;

(f) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has been found guilty of professional misconduct, proven by any means;

(g) a beneficiary does not comply with the applicable national law on taxes and social security;

(h) the action has lost scientific or technological relevance;

(i) not applicable;

(j) not applicable;

(k) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed fraud, corruption, or is involved in a criminal organisation, money laundering or any other illegal activity affecting the EU’s financial interests;

(l) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has — in the award procedure or under the Agreement — committed:

   (i) substantial errors, irregularities, fraud or

   (ii) serious breach of obligations, including improper implementation of the action, submission of false information, failure to provide required information, breach of ethical principles;

(m) a beneficiary has committed — in other EU or Euratom grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (‘extension of findings from other grants to this grant’).

50.3.2 Procedure

Before terminating the Agreement or participation of one or more beneficiaries, the Commission will formally notify the coordinator:

- informing it of its intention to terminate and the reasons why and
inviting it, within 30 days of receiving notification, to submit observations and — in case of Point (l.ii) above — to inform the Commission of the measures to ensure compliance with the obligations under the Agreement.

If the Commission does not receive observations or decides to pursue the procedure despite the observations it has received, it will formally notify to the coordinator confirmation of the termination and the date it will take effect. Otherwise, it will formally notify that the procedure is not continued.

The termination will take effect:

- for terminations under Points (b), (c), (e), (g), (h), (j), and (l.ii) above: on the day specified in the notification of the confirmation (see above);

- for terminations under Points (a), (d), (f), (i), (k), (l.i) and (m) above: on the day after the notification of the confirmation is received by the coordinator.

50.3.3 Effects

(a) for termination of the Agreement:

The coordinator must — within 60 days from when termination takes effect — submit:

(i) a periodic report (for the last open reporting period until termination; see Article 20.3) and

(ii) a final report (see Article 20.4).

If the Agreement is terminated for breach of the obligation to submit the reports (see Articles 20.8 and 50.3.1(l)), the coordinator may not submit any reports after termination.

If the Commission does not receive the reports within the deadline (see above), only costs which are included in an approved periodic report will be taken into account.

The Commission will calculate the final grant amount (see Article 5.3) and the balance (see Article 21.4) on the basis of the reports submitted. Only costs incurred until termination takes effect are eligible (see Article 6). Costs relating to contracts due for execution only after termination are not eligible.

This does not affect the Commission’s right to reduce the grant (see Article 43) or to impose administrative and financial penalties (Article 45).

The beneficiaries may not claim damages due to termination by the Commission (see Article 46).

After termination, the beneficiaries’ obligations (in particular Articles 20, 22, 23, Section 3 of Chapter 4, 36, 37, 38 and 40) continue to apply.

(b) for termination of the participation of one or more beneficiaries:

The coordinator must — within 60 days from when termination takes effect — submit:
(i) a report on the distribution of payments to the beneficiary concerned;

(ii) a request for amendment (see Article 55), with a proposal for reallocation of the tasks and estimated budget of the beneficiary concerned (see Annexes 1 and 2) and, if necessary, the addition of one or more new beneficiaries (see Article 56). If termination is notified after the period set out in Article 3, no request for amendment must be submitted unless the beneficiary concerned is the coordinator. In this case the request for amendment must propose a new coordinator, and

(iii) if termination takes effect during the period set out in Article 3, a termination report from the beneficiary concerned, for the open reporting period until termination, containing an overview of the progress of the work, an overview of the use of resources, the individual financial statement and, if applicable, the certificate on the financial statement (see Article 20).

The information in the termination report must also be included in the periodic report for the next reporting period (see Article 20.3).

If the request for amendment is rejected by the Commission (because it calls into question the decision awarding the grant or breaches the principle of equal treatment of applicants), the Agreement may be terminated according to Article 50.3.1(c).

If the request for amendment is accepted by the Commission, the Agreement is amended to introduce the necessary changes (see Article 55).

The Commission will calculate — on the basis of the periodic reports, the termination report and the report on the distribution of payments — if the (pre-financing and interim) payments received by the beneficiary concerned exceed the beneficiary’s EU contribution (calculated by applying the reimbursement rate(s) to the eligible costs declared by the beneficiary and approved by the Commission). Only costs incurred by the beneficiary concerned until termination takes effect are eligible (see Article 6). Costs relating to contracts due for execution only after termination are not eligible.

• If the payments received exceed the amounts due:

  - if termination takes effect during the period set out in Article 3 and the request for amendment is accepted, the beneficiary concerned must repay to the coordinator the amount unduly received. The Commission will formally notify the amount unduly received and request the beneficiary concerned to repay it to the coordinator within 30 days of receiving notification. If it does not repay the coordinator, the Commission will draw upon the Guarantee Fund to pay the coordinator and then notify a debit note on behalf of the Guarantee Fund to the beneficiary concerned (see Article 44);

  - in all other cases, in particular if termination takes effect after the period set out in Article 3, the Commission will formally notify a debit note to the beneficiary concerned. If payment is not made by the date in the debit note, the Guarantee Fund will pay to the Commission the amount due and the Commission will notify a debit note on behalf of the Guarantee Fund to the beneficiary concerned (see Article 44);
- if the beneficiary concerned is the former coordinator, it must repay the new coordinator the amount unduly received, unless:
  - termination takes effect after an interim payment and
  - the former coordinator has not distributed amounts received as pre-financing or interim payments (see Article 21.7)

In this case, the *Commission* will formally notify a *debit note* to the former coordinator. If payment is not made by the date in the debit note, the Guarantee Fund will pay to the *Commission* the amount due. The *Commission* will then pay the new coordinator and notify a debit note on behalf of the Guarantee Fund to the former coordinator (see Article 44).

• If the payments received do not exceed the amounts due: amounts owed to the beneficiary concerned will be included in the next interim or final payment.

If the *Commission* does not receive the termination report within the deadline (see above), only costs included in an approved periodic report will be taken into account.

If the *Commission* does not receive the report on the distribution of payments within the deadline (see above), it will consider that:
  - the coordinator did not distribute any payment to the beneficiary concerned, and that
  - the beneficiary concerned must not repay any amount to the coordinator.

After termination, the concerned beneficiary’s obligations (in particular Articles 20, 22, 23, Section 3 of Chapter 4, 36, 37, 38 and 40) continue to apply.

**SECTION 4  FORCE MAJEURE**

**ARTICLE 51 — FORCE MAJEURE**

‘Force majeure’ means any situation or event that:
  - prevents either party from fulfilling their obligations under the Agreement,
  - was unforeseeable, exceptional situation and beyond the parties’ control,
  - was not due to error or negligence on their part (or on the part of third parties involved in the action), and
  - proves to be inevitable in spite of exercising all due diligence.

The following cannot be invoked as force majeure:
  - any default of a service, defect in equipment or material or delays in making them available, unless they stem directly from a relevant case of force majeure,
Any situation constituting force majeure must be formally notified to the other party without delay, stating the nature, likely duration and foreseeable effects.

The parties must immediately take all the necessary steps to limit any damage due to force majeure and do their best to resume implementation of the action as soon as possible.

The party prevented by force majeure from fulfilling its obligations under the Agreement cannot be considered in breach of them.

CHAPTER 7 FINAL PROVISIONS

ARTICLE 52 — COMMUNICATION BETWEEN THE PARTIES

52.1 Form and means of communication

Communication under the Agreement (information, requests, submissions, ‘formal notifications’, etc.) must:

- be made in writing and
- bear the number of the Agreement.

Until the payment of the balance: all communication must be made through the electronic exchange system and using the forms and templates provided there.

After the payment of the balance: formal notifications must be made by registered post with proof of delivery (‘formal notification on paper’).

Communications in the electronic exchange system must be made by persons authorised according to the ‘Terms and Conditions of Use of the electronic exchange system’. For naming the authorised persons, each beneficiary must have designated — before the signature of this Agreement — a ‘Legal Entity Appointed Representative (LEAR)’. The role and tasks of the LEAR are stipulated in his/her appointment letter (see Terms and Conditions of Use of the electronic exchange system).

If the electronic exchange system is temporarily unavailable, instructions will be given on the Commission websites.

52.2 Date of communication

Communications are considered to have been made when they are sent by the sending party (i.e. on the date and time they are sent through the electronic exchange system).

Formal notifications through the electronic exchange system are considered to have been made when they are received by the receiving party (i.e. on the date and time of acceptance by the receiving party, as indicated by the time stamp). A formal notification that has not been accepted within 10 days after sending is considered to have been accepted.
Formal notifications on paper sent by registered post with proof of delivery (only after the payment of the balance) are considered to have been made on either:

- the delivery date registered by the postal service or
- the deadline for collection at the post office.

If the electronic exchange system is temporarily unavailable, the sending party cannot be considered in breach of its obligation to send a communication within a specified deadline.

52.3 Addresses for communication

The electronic exchange system must be accessed via the following URL:


The Commission will formally notify the coordinator and beneficiaries in advance any changes to this URL.

Formal notifications on paper (only after the payment of the balance) addressed to the Commission must be sent to the following address:

European Commission
DIRECTORATE-GENERAL FOR RESEARCH & INNOVATION
Research infrastructure
04/108
B-1049 Brussels Belgium

Formal notifications on paper (only after the payment of the balance) addressed to the beneficiaries must be sent to their legal address as specified in the 'Beneficiary Register'.

ARTICLE 53 — INTERPRETATION OF THE AGREEMENT

53.1 Precedence of the Terms and Conditions over the Annexes

The provisions in the Terms and Conditions of the Agreement take precedence over its Annexes.

Annex 2 takes precedence over Annex 1.

53.2 Privileges and immunities

Not applicable

ARTICLE 54 — CALCULATION OF PERIODS, DATES AND DEADLINES

In accordance with Regulation No 1182/7128, periods expressed in days, months or years are calculated from the moment the triggering event occurs.

The day during which that event occurs is not considered as falling within the period.

---

ARTICLE 55 — AMENDMENTS TO THE AGREEMENT

55.1 Conditions

The Agreement may be amended, unless the amendment entails changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

Amendments may be requested by any of the parties.

55.2 Procedure

The party requesting an amendment must submit a request for amendment signed in the electronic exchange system (see Article 52).

The coordinator submits and receives requests for amendment on behalf of the beneficiaries (see Annex 3).

If a change of coordinator is requested without its agreement, the submission must be done by another beneficiary (acting on behalf of the other beneficiaries).

The request for amendment must include:

- the reasons why;
- the appropriate supporting documents;  
- for a change of coordinator without its agreement: the opinion of the coordinator (or proof that this opinion has been requested in writing).

The Commission may request additional information.

If the party receiving the request agrees, it must sign the amendment in the electronic exchange system within 45 days of receiving notification (or any additional information the Commission has requested). If it does not agree, it must formally notify its disagreement within the same deadline. The deadline may be extended, if necessary for the assessment of the request. If no notification is received within the deadline, the request is considered to have been rejected.

An amendment enters into force on the day of the signature of the receiving party.

An amendment takes effect on the date agreed by the parties or, in the absence of such an agreement, on the date on which the amendment enters into force.

ARTICLE 56 — ACCESSION TO THE AGREEMENT

56.1 Accession of the beneficiaries mentioned in the Preamble

The other beneficiaries must accede to the Agreement by signing the Accession Form (see Annex 3) in the electronic exchange system (see Article 52) within 30 days after its entry into force (see Article 58).

They will assume the rights and obligations under the Agreement with effect from the date of its entry into force (see Article 58).
If a beneficiary does not accede to the Agreement within the above deadline, the coordinator must — within 30 days — request an amendment to make any changes necessary to ensure proper implementation of the action. This does not affect the Commission’s right to terminate the Agreement (see Article 50).

56.2 Addition of new beneficiaries

In justified cases, the beneficiaries may request the addition of a new beneficiary.

For this purpose, the coordinator must submit a request for amendment in accordance with Article 55. It must include an Accession Form (see Annex 3) signed by the new beneficiary in the electronic exchange system (see Article 52).

New beneficiaries must assume the rights and obligations under the Agreement with effect from the date of their accession specified in the Accession Form (see Annex 3).

ARTICLE 57 — APPLICABLE LAW AND SETTLEMENT OF DISPUTES

57.1 Applicable law

The Agreement is governed by the applicable EU law, supplemented if necessary by the law of Belgium.

57.2 Dispute settlement

If a dispute concerning the interpretation, application or validity of the Agreement cannot be settled amicably, the General Court — or, on appeal, the Court of Justice of the European Union — has sole jurisdiction. Such actions must be brought under Article 272 of the Treaty on the Functioning of the EU (TFEU).

As an exception, if such a dispute is between the Commission and UNIVERSITE DE GENEVE, the competent Belgian courts have sole jurisdiction.

If a dispute concerns administrative or financial penalties, offsetting or an enforceable decision under Article 299 TFEU (see Articles 44, 45 and 46), the beneficiaries must bring action before the General Court — or, on appeal, the Court of Justice of the European Union — under Article 263 TFEU.
ARTICLE 58 — ENTRY INTO FORCE OF THE AGREEMENT

The Agreement will enter into force on the day of signature by the Commission or the coordinator, depending on which is later.

SIGNATURES

For the coordinator

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Mon Jun 22 18:29:11 CEST 2015

For the Commission

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EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR RESEARCH & INNOVATION
Research infrastructure

ANNEX 1 (part A)

Research and Innovation action

NUMBER — 654215 — AHEAD
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1.1. The project summary

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One form per project

General information

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Abstract ⁷

We propose a set of integrated Activities in the High Energy Astrophysics Domain (AHEAD) in response to the INFRAIA-2014-2015 call Research Infrastructures for High Energy Astrophysics. The overall objective of AHEAD is to integrate national efforts in high-energy Astrophysics and to promote the domain at the European level, to keep its community at the cutting edge of science and technology in this competitive research area and ensure that space observatories for high-energy astrophysics are at the state of the art. AHEAD will integrate key research infrastructures for on-ground test and calibration of space-based sensors and electronics and promote their coordinated use. In parallel, the best facilities for data analysis of high-energy astrophysical observatories will be made available to the European community. The technological development will focus on the improvement of selected critical technologies, background modeling, cross calibration, and feasibility studies of space-based instrumentation for the benefit of future X-ray and gamma-ray missions, and the best exploitation of existing observatories. AHEAD will support the community via grants for collaborative studies, dissemination of results, and promotion of workshops. A strong public outreach package will ensure that the domain is well publicized at national, European and International level. The virtual circle infrastructure - networking - joint research activities, as devised in AHEAD, serves to establish strong connections between institutes and industry to create the basis for a more rapid advancement of high-energy astrophysical science, space-oriented instrumentation and cutting-edge sensor technology in Europe. This enables the development of new technologies and the associated growth of the European technology market, - with a dedicated technology innovation package - as well as the creation of a new generation of researchers.
## 1.2. List of Beneficiaries

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## 1.3. Workplan Tables - Detailed implementation

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1.3.3. WT3 Work package descriptions

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**Objectives**

This WP provides the project-wide management. It will ensure communication between WP leaders and the participants, and the precise, clear, timely, and open communication with the EC. It is a structure aimed to provide control and distribution of the EC financing during the project, monitoring activities and progress within the WPs (including milestones and relevant deadlines), and ensuring that the timeline of the deliverables and milestones is adhered to. Through its Project Office, it will provide support and expertise for issues related to contractual obligations, financial declarations and compliance with audit procedures. Furthermore, it will ensure the connection with the broad astrophysical community and the prompt and efficient dissemination of the results.

**Description of work and role of partners**

**WP1 - AHEAD Management** [Months: 1-42]

INAF

The management of AHEAD will be carried out under a set of coordinated activities under the supervision of the Project Office at INAF/IAPS. The overall Management structure will comprise the complementary structures described in Tasks 1.2 to 1.4.

**TASK 1.1 PROJECT OFFICE (INAF/IAPS)**

The Project Office (PO) activities are carried out by the Coordinator, the Project Scientist and the Project Officer, who will also act as Financial Assistant, and a Secretary. Only the Coordinator and Project Scientist will take active part in the Management Team meetings.

The PO will take care of the day-to-day activities for the management of the project. Furthermore, the Office will be responsible for the distribution of the EC funds to the partners and for the compilation of the financial and technical information from the WP leaders to prepare the reports to the EC. The Office will further provide support for the AHEAD Management and Consortium meetings. The Project Coordinator and Project Scientist will represent AHEAD at meetings and conferences.

The funding for the manpower under this task comprises 3 man-months/year of the Coordinator, 2 man-months/year of the Project Scientist, 2 man-months per year of the Project Officer and one full-time secretary starting at month 6 (total requested to EC: 280 k€). Audit certificate is 10 kEu. Funds for travel support are foreseen for the Coordinator to take part to meetings with the EC, and for the Coordinator and the Project Scientist for travels to participant’s premises as necessary to perform internal audits and ensure compliance with milestones (total 10 k€).

Budget for Task 1.1: 379 k€ (inc. overhead)

**TASK 1.2 CONSORTIUM BOARD (INAF/IAPS, ALL PARTICIPANTS)**

The board will be constituted of representatives from all legal entities participating in AHEAD and will deal with strategic decisions and with the oversight of the AHEAD project. The Board will meet at least three times in person during the project and use teleconferences as needed. At the start of the project a kick-off meeting will take place in which the financial distribution will be confirmed, and Work Package leaders and members of Review Panel Committees for NA and TA will be formally appointed.

Funds for travel support under this task are included for the Coordinator, for the Project Scientist, for the Project Officer and for the members of the Consortium Board.

Budget for Task 1.2: 72 k€ (inc. overhead)

**TASK 1.3 MANAGEMENT TEAM (INAF/IAPS AND WP LEADERS)**

The AHEAD Management Team is chaired by the AHEAD Coordinator and consists of all WP leaders, the Project Scientist and the Project Officer. The main task of this group is to perform the day-to-day execution of the project activities. The participation of the WP leaders is reflected in this participant’s table with the inclusion of their institutes. Personnel costs are not requested for WP leaders and, if any, are declared as management costs in the single WP tables. In some cases, their salary will be covered by their institutions. The Management Team will meet as required, but at
least four times during the project, i.e. at milestone review meetings before the time of each reporting period and for a mid-term review. Teleconferences of this team will be held every two months.

Funds for travel support under this task are included for the Coordinator and for the Project Scientist to attend 4 Management Team meetings, while travel costs for WP leaders are included in each WP.

Budget for Task 1.3: 6k€ (inc. overhead)

**TASK 1.4 SCIENCE ADVISORY COMMITTEE (Members of Astrophysical Community outside AHEAD)**

The Science Advisory Board will consist of a maximum of 8 representatives of the astrophysics community at large, including members of other astronomy-related EU-funded activities (e.g. ASTRONET, ASPERA, OPTICON, RADIONET), and with an equal share of gender representation. The role of this Committee will be to provide a strong connection between the AHEAD Consortium and the wider astrophysical community, so as to foster collaboration projects besides the AHEAD network and promote ideas for future astrophysics roadmaps. It will also serve as advisors to the Coordinator and to the members of the AHEAD Management Team, and as a pool of experts for the selection committees in Networking and Trans-National Access Activities. They will meet in person twice during the AHEAD project, at the same time as the AHEAD Management Team meetings.

Funds for travel support under this task are included for the members of the board who are not part of the Management Team.

Budget for Task 1.4: 12 k€

**TOTAL BUDGET FOR WP1: 469 K€**

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**Participation per Partner**

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<thead>
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**List of deliverables**

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<th>Deliverable Title</th>
<th>Lead beneficiary</th>
<th>Type</th>
<th>Dissemination level</th>
<th>Due Date (in months)</th>
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<tbody>
<tr>
<td>D1.1</td>
<td>Minutes of 1st Review meeting</td>
<td>1 - INAF</td>
<td>Report</td>
<td>Confidential, only for members of the consortium (including the Commission Services)</td>
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</tr>
<tr>
<td>D1.2</td>
<td>Minutes of mid-term review</td>
<td>1 - INAF</td>
<td>Report</td>
<td>Confidential, only for members of the consortium (including the Commission Services)</td>
<td>21</td>
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<tr>
<td>D1.3</td>
<td>Minutes of 2nd Review Meeting</td>
<td>1 - INAF</td>
<td>Report</td>
<td>Confidential, only for members of the consortium (including the Commission Services)</td>
<td>36</td>
</tr>
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<td>D1.4</td>
<td>Minutes of Final Review Meeting</td>
<td>1 - INAF</td>
<td>Report</td>
<td>Confidential, only for members of the consortium</td>
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### List of deliverables

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<tr>
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<td>(including the Commission Services)</td>
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</table>

### Description of deliverables

- **D1.1**: Minutes of 1st Review meeting [18]
  Report on the status/advancement of AHEAD activities and on the status of the documentation for the 1st reporting period.

- **D1.2**: Minutes of mid-term review [21]
  Report on the status/advancement of AHEAD activities

- **D1.3**: Minutes of 2nd Review Meeting [36]
  Report on the status/advancement of AHEAD activities and on the status of the documentation for the 2nd reporting period.

- **D1.4**: Minutes of Final Review Meeting [42]
  Report on the final outcome of AHEAD activities and on the status of the documentation for the last reporting period.

### Schedule of relevant Milestones

<table>
<thead>
<tr>
<th>Milestone number</th>
<th>Milestone title</th>
<th>Lead beneficiary</th>
<th>Due Date (in months)</th>
<th>Means of verification</th>
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<td>MS1</td>
<td>AHEAD Kickoff Meeting</td>
<td>1 - INAF</td>
<td>1</td>
<td>Kickoff Meeting report</td>
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<td>MS2</td>
<td>1st AHEAD review meeting</td>
<td>1 - INAF</td>
<td>18</td>
<td>Review Meeting Report</td>
</tr>
<tr>
<td>MS3</td>
<td>2nd AHEAD review meeting</td>
<td>1 - INAF</td>
<td>36</td>
<td>Review Meeting Report</td>
</tr>
<tr>
<td>MS4</td>
<td>Final AHEAD review meeting</td>
<td>1 - INAF</td>
<td>42</td>
<td>Review Meeting Report</td>
</tr>
</tbody>
</table>
Objectives

The objectives of this WP are: a) the organization of scientific Meetings and Workshops for young astronomers on topics relevant to High Energy Astrophysics, including instrumentation, cross-calibration and background modelling, b) foster working groups on specific science topics related to the Large X-ray Observatory theme through a visitor’s exchange programme, c) organising meetings of gamma-ray astronomers aimed at discussing science requirements and definition of instrumentation for a future gamma-ray observatory, d) releasing calls to the community, e) organising a peer-review system for the evaluation of grants for visits and workshops, g) handling a website and publicly available documentation.

Description of work and role of partners

UNIVERSIDAD DE ALICANTE, INAF, STICHTING SRON, MPG, DTU, NCAC, NUID UCD, CSIC

The general goal of WP2 is to enhance the collaboration (new or existing), capabilities, skills and performance among the scientific and technological groups in Europe involved, or willing to be involved, in High Energy Astrophysics. WP2 aims at preparing the community at large for the successful exploitation of the large high energy telescopes of the next decade. This goal will be achieved through the sponsorship of meetings, workshops, and an exchange visitor programme for scientists and engineers. WP2 will provide as well, training for young scientists on topics relevant to the current and future instrumentation, through the organization of 2 schools. Finally, it will support meetings and workshops of the gamma-ray community, through a dedicated sub-WP, in order to define the science requirements and the instrumentation for the next large gamma-ray telescope. The WP keeps a good balance between fixed specific activities and open calls. It also focuses strongly in mobility grants for the community.

TASK 2.1 MANAGEMENT (UA)
The general management of the WP2 will be done by the UA ensuring the coordination among participants. Tasks WP2.2 and WP2.3 will be under direct responsibility of the UA while Task WP2.4 will be under direct responsibility of IRAP which will report, in turn, to UA. The UA will maintain a Web site, linked to the general AHEAD site, where all the relevant information to the WP2 will be posted: release of public calls, rules and documents for applications, handling of proposals and the selection results. The site will be set up within 3 months since the start of the project to efficiently disseminate the information early to the community. A WP2 Selection Committee will be created to peer review the corresponding proposals for WP2.2 and WP2.3 as well as to advise in the organization of the schools. The members of this committee will be selected among the WP participants and the AHEAD Science Advisory Committee by the Consortium Board within the first month since the start of the project. Their names will be posted in the AHEAD website.

Budget for Task 2.1: The EU funding requested is 52 kEu for management services.

TASK 2.2 VISITOR PROGRAMME (UA)
The aim of this Task is to support research visits for scientists and engineers to foster new or strengthen existing collaborations of eligible candidates from astrophysics institutes in European countries, Associated Countries or candidate countries. The WP2 peer review committee will give particular attention to science and technology proposals related with the future Large X-ray Telescope, instrumentation, data exploitation and science. The duration of the visits will be between 1 week (minimum) and 3 weeks (maximum to be founded although the applicant can choose to extend the visit) that can be spent in 1 or more institutes in order to maximize the scientific return. To allow for maximum flexibility, we plan to release two open calls per year. These open calls will be strongly publicized through mass media channels (XMM-Newton and INTEGRAL Newsletters, National Astronomical Societies, the AHEAD portal, etc). A total of 6 calls will be released throughout the 3.5 year duration of the project in the months 3, 9, 15, 21, 27 and 33. The deadline will be set 1 month after the release while the visit should be performed within nine months after the deadline except for the last call that should be 6 months. Successful applicants will have to report to the WP2 management after the completion of the visits describing the scientific achievements.

Budget for Task 2.2: Assuming an average duration of the visits of two weeks at 1000 Eu per week (which will cover all travel costs and per diem), 8 available grants per call, the total amount requested is 120 kEu (with addition of overhead).

TASK 2.3 THE AHEAD MEETINGS AND WORKSHOPS (UA, NCAC, INAF)
This Task aims to partially support the organization of topic-oriented meetings relevant to the interest of the high energy astrophysics community in Europe. It also aims to encourage the widest possible dissemination of the results by supporting travels of young researchers to relevant meetings. Particular emphasis will be given to meetings that: a) strengthen the link between the high energy astrophysics community and other communities (such as the radio, infrared and optical), b) strengthen the synergy between the different current X-ray instruments (i.e. cross calibrations, background and instruments simulations).

For a small topic-oriented meeting of 40 participants at a cost of 350 Eu per participant (covering organizational support, wireless connections, local services, etc) the total cost would be 14kEu per meeting. We anticipate to organize 3 such meetings (once a year), at months 11, 23 and 37, with a total cost of 42 kEu. The exact topics will be decided by WP2 Selection Committee and announced in the AHEAD site at months 6, 17 and 29. This will allow to optimize the topic taking into account the status of other activities, hardware development and future missions. On the other hand we plan to support travel/subsistence costs for young researchers to attend the aforementioned meetings.

Budget for Task 2.3: We plan to provide 4 travel/subsistence grants per year to attend meetings per 3 years at 1500 Eu per grant. This amounts to a total of 18 kEu. Manpower is 8 kEu. Therefore the total EC funding requested for WP2.3 is 85 kEu. (incl. overhead)

TASK 2.4 THE AHEAD SCHOOLS (UA, CSIC3, SRON, MPG/MPE)
This sub-WP aims at providing training to young researchers in data reduction and analysis in techniques specifically related with the capabilities of the future instrumentation (i.e. high resolution spectroscopy). This will be accomplished through two AHEAD Schools for young astronomers. Particular emphasis will be given to the hands-on sessions where real data from current telescopes as well simulated data for the forthcoming instruments will be reduced and analyzed. This will constitute, as well, an excellent opportunity for the young researchers to exchange experiences with senior scientists helping to strengthen the ties inside the community. The first school will be devoted to high resolution spectroscopy, making special emphasis on the use of ASTRO-H data (Japanese/US mission expected to be launched by mid-2015, with significant European participation), enhancing the skills of young European astronomers to work with calorimeters. The School will be organized by UA, with the support of SRON and IFCA, at month 15. The second School will be devoted to X-ray surveys, making special emphasis on e-Rosita data (German/Russian mission, expected to be launched in 2016). This School will be organized by MPE, with the help of UA, at month 35.

Budget for Task 2.4: the estimated cost per student is estimated at 325 Eu. (covering organisational support, coffee breaks, wireless connection, local services, etc plus support to lecturers). We plan to organize 2 such Schools in Europe, for 40 participants. The total amount is 13 kEu per school per 2 schools = 26 kEu.

It is essential for this strategy to be successful to complement the previous schools with travel/subsistence grants for some of the applicants residing in less developed areas of the EU. We plan to support 20 students per school at 600 Eu per grant = 12 kEu per school per 2 schools = 24 kEu. Manpower is 14 kEu. The total amount requested to the EC for the WP2.4 is, therefore, 80 kEu (incl. overhead).

TASK 2.5 SUPPORTING THE GAMMA-RAY COMMUNITY (CNRS, UCD, CSIC2, CEA, INFN, LIP, UNIFE, DTU, MPG/MPE, INAF/IASF-BO)
This Task aims at providing the gamma ray community support to discuss the science requirements and definition of new instrumentation for the future gamma ray observatory and will be under direct responsibility of CNRS/IRAP. We plan to organize small topic-oriented meetings about twice per year (5 in total): Starting with the kickoff meeting (month 1), four progress meetings will take place during month 12, 18, 24, and 30. During these meetings a convergence towards the next generation of gamma ray telescope will be achieved. A large meeting at month 42 will allow to present the results of the previous meetings to the community at large and set up the preparation of the proposal for the most convenient Call for Missions.

Budget for Task 2.5: For the small topic-oriented meetings we expect 20 participants at a cost of 700 Eu per participant (including organizational aspects as well some travel or subsistence allowance) the total cost would be 14kEu per meeting per 5 meetings amounts to a total of 70 kEu. The funds for these status meetings are distributed to the different participants. For the large meeting we anticipate 100 participants. The cost of this meeting will be covered by the participant’s registration fee. We plan, however, to support 25 travel/subsistence grants for young researchers and researchers is less developed countries. At a cost of 1200 Eu per grant this amounts to 30 kEu. The symposium is organized by the WP9 leader. Manpower is 12 keuro. Therefore, the total amount requested for WP2.5 is 140 kEu (with the addition of overhead).
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<td>3 - STICHTING SRON</td>
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<td>4 - MPG</td>
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<tr>
<td>7 - DTU</td>
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<td>8 - NCAC</td>
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<td>17 - NUID UCD</td>
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<td>20 - UNIVERSIDAD DE ALICANTE</td>
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<td>21 - CSIC</td>
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### List of deliverables

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<td>20 - UNIVERSIDAD DE ALICANTE</td>
<td>Report</td>
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<tr>
<td>D2.2</td>
<td>2017 Meetings Report</td>
<td>20 - UNIVERSIDAD DE ALICANTE</td>
<td>Report</td>
<td>Public</td>
<td>28</td>
</tr>
<tr>
<td>D2.3</td>
<td>2018 Meetings Report</td>
<td>20 - UNIVERSIDAD DE ALICANTE</td>
<td>Report</td>
<td>Public</td>
<td>40</td>
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</table>

### Description of deliverables

Conference reports: the reports for the meetings corresponding to WP2.3 and WP2.5 will be published online each year (months 16, 28, 40).

- **D2.1 : 2016 Meetings report [16]**
  - Conference reports: the reports for the 2016 meetings corresponding to WP2.3 and WP2.5 (to be published online once per year)

- **D2.2 : 2017 Meetings Report [28]**
  - Conference reports: the reports for the 2017 meetings corresponding to WP2.3 and WP2.5 (to be published online once per year)

- **D2.3 : 2018 Meetings Report [40]**
  - Conference reports: the reports for the 2018 meetings corresponding to WP2.3 and WP2.5 (to be published online once per year)

### Schedule of relevant Milestones

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<td>MS5</td>
<td>Appointment of WP2 selection</td>
<td>20 - UNIVERSIDAD DE ALICANTE</td>
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### Schedule of relevant Milestones

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<td>MS6</td>
<td>Open web-site</td>
<td>20 - UNIVERSIDAD DE ALICANTE</td>
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<td>Web-page appearing on the internet</td>
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<td>MS7</td>
<td>First call for visitor grants</td>
<td>20 - UNIVERSIDAD DE ALICANTE</td>
<td>3</td>
<td>Web, mailing lists of selected proposals</td>
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<td>MS8</td>
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<td>20 - UNIVERSIDAD DE ALICANTE</td>
<td>9</td>
<td>Web, mailing lists of selected proposals</td>
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<td>20 - UNIVERSIDAD DE ALICANTE</td>
<td>15</td>
<td>Web, mailing lists of selected proposals</td>
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<td>Fourth call for visitor grants</td>
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<td>MS11</td>
<td>Fifth call for visitor grants</td>
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<td>27</td>
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<td>MS12</td>
<td>Six call for visitor grants</td>
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<td>33</td>
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</table>
Work package number | WP3 | Lead beneficiary | 5 - NOA
--- | --- | --- | ---
Work package title | NA2 – Public Outreach |  |
Start month | 1 | End month | 42

**Objectives**

The goal of this public outreach (PO) work-package is:
- to inform the general public, students and educators of the exciting discoveries in the area of high energy astrophysics.
- to inspire young people to follow careers in space astrophysics as well as in the relevant technology.

The main levels of public we aim to address are laymen with a basic background in sciences as well as high school students.

**Description of work and role of partners**

WP3 - NA2 – Public Outreach [Months: 1-42]

NOA, INAF, ULEIC

The above tasks will be achieved in a manifold of ways:
- a) a high energy astrophysics portal with news, videos, images, educational material as well as press related material.
- b) co-ordination of press releases across Europe and liaison with the press
- c) organisation of exhibitions in observatory and university visitor centers
- d) production of videos about the hot and violent universe and the missions that explore it.

The Public Outreach work-package will consist of the following task.

**TASK 3.1 MANAGEMENT (NOA)**

The management of this work-package will be led by NOA. There will be a scientific committee that takes the final decisions on the content of the public outreach material. This will consist of the representatives of the participating Institutes. For each task of the WP a responsible scientist will be appointed as Task leader; the Task leaders have been preliminarily identified and among these there are researchers with a well consolidated experience in the field of public relations and spread of knowledge actions.

The internal communication flows will be based on:
- weekly meeting between the WP leader and task leaders;
- monthly meetings between the WP leader and the Institution representatives involved;
- monthly meetings between the WP leader and the AHEAD project scientist and Coordinator

The communications will take place via phone/electronic mailing/skype/video conference.

There will also be extraordinary skype meetings before major events such as press-releases, exhibition setting up or the video production. Especially for the video production, we consider that a physical kick-off meeting will be necessary. A yearly physical meeting of the participating institutes in the WP3 is also foreseen.

The material for the exhibitions (e.g. stands) will be either transferred by surface mail or it will be produced electronically and then it will be printed locally in each country. The video production will be paid on an item basis (including narration or subtitles) and can be outsourced.

Budget for task 3.1: 15k (inc. overhead). The costs are for travel for the coordination of the activities (travels for 3 persons per year for 3 years at an estimated cost of about 1200 per person per year)

**TASK 3.2 WEB-PAGE. (NOA)**

A scientist will be employed at NOA who will be responsible for the update and maintenance of the web-page. This scientist should have a specialty in either science communication or astrophysics. He/she will be responsible for the prompt publication of the news items, the distribution of the press releases in all participating countries, the coordination of the necessary translations and the delivery of the exhibition items. The setting up and continuous updating of a public outreach portal is the main vehicle of this work-package as it will host the links to most of the other proposed outreach activities. The main topic of the portal will be high energy astrophysics news. Although there are many popular pages with astronomical news (e.g. http://media.inaf.it, http://hubblesite.org). Our proposed portal will be the only one specialised in high energy astrophysics around the world. NOA will lead the development and sustainment of this portal.

We anticipate that the page will be updated on a weekly basis. The portal will also contain some ‘static’ pages, which will include brief introductory papers on high energy astrophysics topics (e.g. X-ray binaries, detectors in X-ray Astronomy, accretion super-massive black holes, γ-ray emission from jets in AGN). Although we plan to write these papers involving
high energy astrophysicists, there will be links to already existing articles that appear in other reputable science portals (e.g. NASA, ESA). We expect that these short papers will have a long-standing impact even after the end of the project. The portal’s menu will appear apart from English in German, Italian, French and Spanish. The press releases, videos and educational material only, will be translated from English in these languages.

Budget for task 3.2: 116k The costs include 45 man-months for the web-page, plus 5k to a company for the creation of the web-page

TASK 5.3 VIDEOS (INAF, NOA, ULEIC).
We will produce a number of short (10-15 min) educational videos related to high energy astrophysics. The videos will be produced using the podcast method to keep the cost low and they will belong to four different categories:
5.3.1 First two videos. a) video to be used in visitors centers as the main introductory theme before the scientific talks or the telescope observations.
b) educational video aimed primarily at high school students (12-15yr)
5.3.2 Final two videos. c) video that will describe the institutes involved, containing interviews from important figures in high energy astrophysics.
d) special dome videos to be used by planetaria world-wide. According to our experience these dome videos have a very large publicity impact as they can be distributed freely in planetaria world-wide targeting a very wide audience.
The institutes involved in the PO work-package have extensive experience in astronomy video production (e.g. ULEIC, INAF/IASF-Bo). In particular, NOA has also extensive experience in the production of the more technically demanding dome-presentations (e.g. 3-d visual effects). An example of this work is given in https://www.youtube.com/watch?v=VHR2fBv+Hac&list=UUvdqK2Q4wLv90ZeoS-E2QUw
Budget for task 3.3. 50k (incl. overhead), at an average estimated cost per video of 10k including the narration and translation costs at different languages.

TASK 3.4 PRESS RELEASES (ULEIC).
A pivotal part of the public outreach is the issue of press releases. This ensures to maximize the visibility through the dissemination from the media. The text of the press releases will be issued by ULEIC/NOA in collaboration with the AHEAD coordinator. The dissemination to the media in each country will be done through a liaison point (the main AHEAD node in each country). These are the public outreach nodes (ULEIC, INAF/OAR, NOA) with the participation of MPE, CEA, Universidad Alicante and SRON. We anticipate a press release about 5-6 times a year. The press releases will be issued in English and then translated in some key European languages (German, French, Italian, Spanish). The translations will be carried out either directly from the public outreach nodes or from the public outreach offices of each country’s Astronomical Societies. For example MPE has a dedicated press release officer who will be responsible for the dissemination of the press releases in Germany. As such offices are not available in all countries, the translation could be carried out by a postdoctoral researcher in the main AHEAD node. In each country is expected that a postdoctoral researcher will devote 5% of his time on public outreach activities.
Budget for task 3.4. 12k.
This includes secretarial assistance for requesting material from scientists, providing advise on the length of the text, size of the images etc, the distribution of the press releases to press release officers abroad.

TASK 3.5 EXHIBITIONS (INAF)
INAF/OAR has a long-standing experience in the production of interactive and multi-media exhibit and will lead the efforts in this task. INAF/OAR organises 5-7 exhibitions per year including posters, multi-media and videos. High Energy astrophysics and its missions can be explained and presented to the public at large through public exhibitions. Depending on the availability of the public outreach nodes locations these could be permanent (in Observatory visitor centers and Universities) or temporary (e.g. during Open days in Universities, science days in museums and similar events). The exhibits will be divided mainly in two categories:
- static, using posters (paper or rolls). Based on previous experience, we envisage that 6-8 posters are sufficient
- dynamic using multi-media projections on monitors (playing from external media, e.g. usb stick).
The videos played during exhibitions will be the same produced in the framework of this program (task 5.3). Brochures will also be distributed.
Budget for task 3.5: 52k. This includes the design and preparation of the posters in PVC printing in individual countries or postage in case the material cannot be printed or purchased in each country.

TASK 3.6 EDUCATION (ULEIC).
Educational material. Most of the participating institutes devote significant manpower on education. These efforts concentrate on school visits at the visitor centers (e.g. NOA hosts two classes per day), as well as night time public observations. Our aim is to introduce the students to the basic elements of high energy astrophysics. The major means will be the produced videos which will be played during the visits. We will accompany these videos with a teacher’s booklet. The accompanying booklet will explain in detail the physical phenomena displayed in the video (e.g. a supernova explosion, or the accretion disk around a supermassive black hole) and the basic physics principles behind these phenomena. The booklet will also contain a few relevant exercises addressed to 13-15 year old students. These manuals will be originally written in English and they will be translated in the other languages. Both the videos and the booklet will be available for download from the AHEAD PO portal.

Additional Educational material. A variety of other educational booklets will be produced by ULEIC and will be posted on the web-page. The education section of our portal will also contain links to other educational material concerning high energy astrophysics on the web.

Budget for task 3.6: 56k The costs include contribution towards work months of a person to be based in ULEIC. Translation in another four European languages are included in the cost.

### Participation per Partner

<table>
<thead>
<tr>
<th>Partner number and short name</th>
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<tr>
<td>1 - INAF</td>
<td>19.00</td>
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<tr>
<td>2 - ULEIC</td>
<td>10.00</td>
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<tr>
<td>5 - NOA</td>
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<td><strong>Total</strong></td>
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### List of deliverables

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<th>Deliverable Number 14</th>
<th>Deliverable Title</th>
<th>Lead beneficiary</th>
<th>Type 15</th>
<th>Dissemination level 16</th>
<th>Due Date (in months) 17</th>
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<td>D3.1</td>
<td>Exhibitional Material</td>
<td>1 - INAF</td>
<td>Websites, patents filling, etc.</td>
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<td>D3.2</td>
<td>Videos Delivery (first two videos)</td>
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<td>Websites, patents filling, etc.</td>
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<td>D3.3</td>
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<td>Other</td>
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<td>D3.4</td>
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<td>Websites, patents filling, etc.</td>
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<td>D3.5</td>
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<td>Websites, patents filling, etc.</td>
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<td>D3.6</td>
<td>Final report</td>
<td>5 - NOA</td>
<td>Report  Confidential, only for members of the consortium (including the Commission Services)</td>
<td>42</td>
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Description of deliverables

Exhibitional materials; Videos; additional educational material; final report

D3.1 : Exhibitional Material [12]
Delivery of multimedia, poster and video materials for exhibition events in visitors centers and Universities

D3.2 : Videos Delivery (first two videos) [12]
Videos to be used in visitors centers as the main introductory theme before the scientific talks or the telescope observations (by INAF/OAR, ULEIC, NOA). Related to Task 3.3

D3.3 : Educational Material (accompanying the first videos) [12]
Explanatory material (e.g. booklet) accompanying the first videos in support of school visits at visitor's centres

D3.4 : Videos delivery [24]
Video with interviews, that will describe the institutes involved; special dome videos to be used by planetaria world-wide (INAF/OAR, ULEIC,NOA) Related to task 3.3

D3.5 : Additional Educational Material [30]
Other educational booklets; will be posted on the web-page Related to Task 3.6

D3.6 : Final report [42]
Activity report covering the full period

Schedule of relevant Milestones

<table>
<thead>
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<th>Milestone number</th>
<th>Milestone title</th>
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<td>MS13</td>
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<td>Web-page appearing on the internet</td>
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<td>MS14</td>
<td>Material delivered for</td>
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<td>News items in web-page advertising the exhibitions</td>
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<td>MS15</td>
<td>Completion of all videos</td>
<td>5 - NOA</td>
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<td>Appearance in AHEAD web-page (videos also in youtube)</td>
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<td>MS16</td>
<td>Educational Material</td>
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<td>Appearance in Web-page</td>
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**Objectives**

The TNA WP4 will give access to some of the best European ground test and calibration facilities relevant for high-energy astrophysics. Such facilities are used to test and/or calibrate new technology space hardware as well as hardware developed for specific space missions, but can be used in a wider context. Those facilities are currently only offered in the context of international and national collaborations or (rarely) via access costs at the expense of the external teams. With the implementation of a network of facilities in the AHEAD TNA, external team access costs will be covered with the support of the European Commission, strengthening scientific and technological exchanges among European and international teams. In particular, we foresee that such a novel facility network will enable access to teams in European and Associated Countries with no national access to ground facilities and, thus, to benefit from the Transnational Access in being able to test and calibrate their instruments with no strings attached. They will also be able to take advantage of high-level, already equipped and fully working facilities at no cost. The participation of the research facilities offering Transnational Access via AHEAD will increase the availability and access of these facilities at the European and international level, and will extend the services offered to the high-energy astrophysics scientific community as well as to a broader community.

Provision of access to the following infrastructures:
- INAF Distributed Calibration and Test Facility (IDCTF): 1 installation at INAF-OAPA and 3 installations at INAF-IAPS
- LARge Italian X-ray facility (LARIX): 2 installations at UNIFE
- University of Leicester Space Research Centre (ULSRC): 2 installations
- SPATIAL at LAM/CNRS and Aix-Marseille University: 1 installation
- Centre Spatial de Liège (CSL): 2 installations
- Space Test Laboratories (STL) at Università di Perugia: 2 installations

**Description of work and role of partners**

WP4 - TA1 – Access to facilities [Months: 1-42]

INAF, UNIFE, ULG

A list of common activities and procedures among the offered facilities is listed below, while in the following we provide a brief description of the infrastructures/installations and, where required, further additional TA information for each of the offered facilities and installations. The AHEAD Facility TA web page will be available within 4 months of the start of the EU funding period followed immediately by the first call for guest users. The first guest team will be hosted 6-12 month in the period. This will be followed by bi-annual calls up until six months from the end of the project.

The requested budget includes 4.5 man-months of effort over 3 years at INAF/OAPA to design, install and maintain the dedicated web page and to provide support activities for the selection panel.

- Synthetic description of the infrastructures participating in TA1

Description of the infrastructure:

Name of the infrastructure: IDCTF
Location (town, country): Palermo, Italy/Rome, Italy

Legal name of the organisation operating the infrastructure: INAF (XACT operated by INAF/OAPA; TVLAB, IPC, MEX operated by INAF/IAPS)
Localisation of organisation (town, country): Rome, Italy
Annual operating cost (excl. investment costs) of the infrastructure (€): 478.000 (including 25% overhead)

Description of the infrastructure:

The INAF Distributed Calibration and Test Facility (IDCTF) provides a wide range of services, from testing and calibration of X-ray optics instrumentation using X-ray beams, to equipments for space environment testing. The
The XACT facility has been designed to be versatile and easy to use both in the testing and calibration of instrumentation at the sub-system level (filters, detectors, optics) as well as in the calibration of fully integrated short focal length X-ray mirrors/telescopes. At the IAPS research centre in Rome Tor Vergata, a number of test equipments is available to support the development of hardware for space missions, mainly in the area of planetology (instruments on board Mars Express, Venus Express, ROSETTA, Cassini) and high energy astrophysics (INTEGRAL, AGILE). These equipments include a thermal-vacuum chamber, a plasma chamber, a device for spectroscopic measurements, plus several clean rooms and other related laboratory facilities.

Installation 1: XACT (X-ray Astronomy Calibration and Testing)
The XACT facility of the INAF - Osservatorio Astronomico di Palermo “G.S. Vaiana” (OAPA) was established in the early 1990s to participate in the development and calibration of the UV/Ion shields of the High Resolution Camera (HRC) of the, still operational, Chandra X-ray Observatory. Since then the facility has been actively used in several research projects including long-term monitoring of the XMM-Newton EPIC thin and medium filters, calibration of the JAXA/NASA Hinode filters, of the Chinese Chang’E-1 X-ray detector, of the Polish solar spectrograph SPHINX on-board the Russian mission CORONAS-Photon as well as supporting laboratory programmes in novel X-ray optics and detectors. The non-staff as well as specific costs of those activities have been funded by project grants and contracts to INAF/OAPA, while staff efforts and general costs are covered by INAF. Associated travel costs of visitors have been covered by the respective host institutes. The facility is operative for 220 working days per year, mostly for internal use. No formal record of accesses is available since it was not required by internal regulations. A recording scheme will be activated for dealing with proposed TNA.

The main components of the XACT facility include: 1) A 35-meter long vacuum beam-line including an X-ray source small chamber, a monochromator chamber 0.8-meter diameter and 1-meter height, a big chamber 3.5-meter long and 2-meter diameter to accommodate large size experiments, and a detector test chamber 1-meter long and 1-meter diameter opening inside a class 1000 clean-room. The diameter of the tubes increases from the source end (150 mm) to the telescope chamber to allow a full area illumination of 800 mm diameter, minimizing the volume and the internal surface of the pipe. The vacuum pumping system is entirely based on magnetic levitation turbo-molecular pumps, and on oil-free rotary pre-vacuum and back-up pumps. A minimum pressure of 5 x 10−8 mbar can be achieved, while normal operation is in the 10−7 mbar scale; 2) Three electron impact micro-focus X-ray sources, providing characteristic lines and bremsstrahlung continuum soft X-ray photons in the energy range 0.1-20 keV. The sources are very efficient, and depending on the anode material and operating parameters, they can produce X-ray fluxes in full illumination ranging between 100 and 50000 photons s−1 cm−2 at about 34 meters distance from the source; 3) X-ray detectors (proportional counters, MCP detectors, and solid state detectors) and monochromators (transmission grating, fixed exit double Bragg diffraction) covering the energy range 0.1-30 keV; 4) A large number of vacuum compatible micro-positioning systems including an alt-azimuth mount for testing grazing incidence X-ray optics. 5) A vacuum UV beam-line attached on a side port of the detector test chamber of the main beam-line, equipped with sources, monochromator and detectors operating in the wavelength range 10-3000 Å.

A suite of software applications, with user-friendly interfaces, based on the NI Labview™ software platform allows the full remote control of XACT operations. A well-equipped mechanical shop including a CNC lathe and milling machines, and support facilities such as a class 1000 clean room, class 100 clean benches, chemical hub, optical microscope, etc. are also available and will be part of the XACT/OAPA participation to the TNA offer.

Installation 2: TVLAB (Thermal Vacuum Chamber)
The TVLAB is a thermal-vacuum chamber used for qualification tests. Established since 1992 in the framework of the MARS96 project, it remained non-operative for several years due to difficulties following relocation. Afterwards, an appropriate location was found within the space assigned to the IAPS laboratories and the full equipment regenerated with the help of ASI funding assigned to different projects. The TVLAB is now placed inside a 100,000 class clean room and fully operative. The chamber features a volume of 1600 litres and a limit vacuum of 10-7 mbar (the primary vacuum is 10-2 mbar). The temperature range control is between -70 and +100 oC. The cycles can be handled in both automated or manual modalities. A data acquisition system (National Instruments cRIO9074 plus nominal and redundant workstations) allows for data recording and monitoring of 32 temperatures.

Installation 3: IPC (IAPS Plasma Chamber)
This installation is being used for simulation of space environment and includes a Sun Simulator, plus other planetary atmosphere environments. It features a Kaufman source and a 10,000 litres volume, and a vacuum of 10-7 mbar (vacuum with source: 7x10-6 mbar). The facility simulates the plasma flows at LEO altitude and has been used in the ‘80 to test the NASA-ASI Thetered satellite, successfully flown twice on board the Space Shuttle and in the ’90 to test the Low Energy Concentrator focal plane detector successfully flown on board the BeppoSAX Satellite.

Installation 4: MEX (class 10,000 clean room)
A 10,000 class clean room is available at IAPS, which has been mainly used for the assembly of the optics and electronic equipments of the PFS experiment on board the MARS and VENUS Express missions. The total surface of the room is 18.5 m². The room has a temperature and humidity control system and inside, an optical bench built from granite, a laminar flow blanket (class: 100) and dryers are available.

Services currently offered by the infrastructure: The facility has been already used in a number of research programs with other non-Italian groups on a scientific collaboration basis with no financial contribution from external users. The running and maintenance costs, as well as investments for the upgrade and development of the available instrumentation, have always been covered by institute funding and research and development programs of the research group responsible for the facility.

As of today the external teams have accessed the XACT facility on the basis of an exchange program based on mutual interest between the OAPA research and the external teams, with the external teams covering all their travel and living expenses and the facility team covering all the facility running costs, including those of the scientific and technical people involved. Moreover the XACT team have provided the support of the associate mechanical shop and electrical laboratory if some small specific mechanical or electrical interface was required. The testing facilities at IAPS have been already used in a number of research programs with both Italian and international teams, on a scientific collaboration basis with no financial contribution from external users. Together, these infrastructures can cover different applications relevant to high energy astrophysics (e.g. testing X-ray, gamma-ray instrumentation) as well as other space applications (e.g. planetology, infrared detectors, study of rocks/material composition).

Description of the infrastructure
Name of the infrastructure: LARIX
Location (town, country): Ferrara, Italy

Legal name of the organisation operating the infrastructure: UNIFE
Localisation of organisation (town, country): Ferrara, Italy
Annual operating cost (excl. investment costs) of the infrastructure (€): 651.000

Description of the infrastructure:
The LARIX (LARge Italian X-ray facility) laboratory is located in the Scientific-Technological Pole of the University of Ferrara in an underground building that includes a 100 m long tunnel with two large experimental rooms on each side. It hosts two hard X-ray installations, the 12 m long LARIX-A located in the experimental room A, and the 50 m long gamma-ray facility, LARIX-T, installed in the tunnel. LARIX A is ideal for performing linearity tests of hard X-ray detectors (e.g., Zavattini et al. 1997, NIM A 401, 206), for reflectivity measurements of X-ray reflector samples (e.g., Frontera et al. 1991, SPIE Procs. 1549, 113, Frontera et al. 2008, SPIE Procs. 7011, 52) and to perform ground calibration of entire hard X-ray experiments (e.g., Loffredo et al. 2003, A&A 411, L239–L242, about JEM-X calibration for INTEGRAL satellite). LARIX-T is suitable for testing gamma-ray reflectors (e.g., crystals) and low-weight gamma-ray detector prototypes. The normal manned operating hours of the test facilities are 08:00 to 19:00 Monday to Friday. It will not normally be possible for visitors to access the test facility out of these hours. It is not possible to control the facility using a remote connection, all measurement sequences have to be set up via local access.

Installation 1: LARIX-A
LARIX-A can be operated from about 10 keV to 140 keV. Its main components are described below.

X-ray Sources Two X--ray tubes, with different operational voltage, are mounted onto an optical table and powered by independent high voltage supplies. One tube is equipped with a Molybdenum anode, operating from 20 to 60 kV and current from 10 to 60 mA (Maximum operational power: 3.6 kW). The spot size is 0.5 x 0.5 mm2. The other tube is equipped with a Tungsten anode, operating from 40 to 140 kV and current from 0.1 to 5 mA (Maximum operational power: 70 W). The minimum spot size is 0.5 x 0.5 mm2. The output window of the first tube is equivalent to a 0.3 mm thick Beryllium foil, while that of the second tube is equivalent to a 1.5 mm thick aluminium foil. By means of remote controlled manipulators, both tubes can be moved up and down and translated along a direction perpendicular to the X--ray beam. Both X--ray tubes plus their translation stages are contained in a box made of a 5 mm thick Pb layer. Collimators and filters A set of two collimators limits the divergence of the X-ray beam. Filters are available for selecting the band of interest and related fluorescence lines. Filters include different thickness high purity Copper and Aluminium tails.

The Monochromator system The polychromatic source spectrum can be monochromatized with a double crystal diffractometer (Bragg-Bragg configuration) providing a fixed-exit beam independently of the selected photon energy. The monochromator is installed inside a sealed plexiglass box, where helium can be pumped. The box X--ray entrance and exit windows are made of polyethylene terephthalate (PET) 0.075 mm thick with a very high transparency at the operation energies. The output X--ray beam travels in evacuated tubes (10-3 mbar) up to the sample to be tested.
Sample holder and Manipulators The sample to be tested is positioned on a pedestal equipped with manipulators that allow to move the sample in three perpendicular directions (X,Y,Z) and rotate it around the vertical and the horizontal axes. An angular position accuracy of 3" can be achieved with a repeatability of 1".

X-ray detectors The available detectors include: 1) a large area (30 cm diameter) CsI X-ray imager, with pixel size of 300 µm; 2) a Nitrogen cooled spectrometer of high purity HPGe with a surface area of about 78 cm², a thickness of 13 mm and an X-ray entrance window of 0.254 mm Beryllium foil; 3) a NaI(Tl) scintillator detector of 42x42 mm² and 3 mm thickness, with imaging (a few mm) and spectral (resolution of 25% at 60 keV) capabilities. The detector holder can be moved in three perpendicular axes (X,Y,Z) and is equipped with a rotation stage (3.6° resolution) around the vertical. Other features and remote console Both the sample and detector pedestals can be translated along the X-ray beam direction on 6 m long rails. An overhead travelling crane (1000 kg weight-bearing, 20 m long) is installed parallel to the rails. A clean room of 100.000 class of 12 meters square hosts the sample; it can host also the detector when the distance between sample and detector is less than 2 m. The sample holder, the detector holder and the holder of the position gauge of the sample holder, can be moved on 10 m long rails. The control room, equipped with a PC-based interface running under LabView, is separated from LARIX A by means of a wall 2.1 m high, made of Al+Pb. It is possible to locate the X-ray beam, measuring its energy resolution.

Installation 2: LARIX-T
LARIX-T is installed in the 100 m tunnel with a controlled access. Its operational energy range is from 60 keV to 1 MeV. Safety doors separate the tunnel from the experimental room A where the console room is located. Its main components are described below.

Gamma-ray source A portable betatron (Vmax = 2.5 MV, Pmax = 310 W) or a gamma-ray generator (Vmax = 320 Volts, Pmax = 1800 W) are available. The gamma-ray generator is equipped with a tube with a Tungsten anode (fine focus of 0.3 mm diameter). For the current application (Laue lens development), the source adopted is the X-ray tube. A 20 mm thick Tungsten plate with a 3 mm diameter hole, followed by a 50 mm thick Lead shield with a 1 mm diameter hole limit the beam divergence. Either source can be translated in the plane Y-Z (X being the beam axis), and rotated around the Z and Y-axes.

Beamline The photons coming from the gamma-ray source enter through the initial collimator (X-ray entrance and exit windows of carbon fiber 3 mm thick) into a 21 m long beam-line under vacuum (of ≤1 mbar) made of stainless steel with an internal diameter of 60 cm. The beamline is planned to be extended up to 70 m. Final slit collimator A final slit collimator, mounted on a pedestal, can be translated in the Y-Z plane and rotated around the X, Y and Z axes, to get a gamma-ray pencil beam always parallel to itself and to a given direction. The slit aperture can be varied by means of four crossed and independent 20 mm thick blades of Tungsten Carbide.

Sample carriage and holder The sample to be tested is placed on a holder, that can be coarsely translated in the (X,Y) plane, and finely positioned and oriented by means of a 6-axis hexapod system. The hexapod allows uncertainties in the sample orientation of 1 arcsec and in the sample translation of 1 µm.

Detector system It includes two detectors (a gamma-ray imager and a solid-state spectrometer) placed on a carriage that can move back and forth on a 15 m long rail along the X-axis. The carriage allows also the translation of the detectors in the Y-Z plane with uncertainties of 0.5 mm in each direction. The gamma-ray imaging detector (CsI(Tl) scintillator viewed from an array of photodiodes) has a useful area 20 x 20 cm², with a spatial resolution 200 µm. The gamma-ray spectrometer is a cooled HPGe detector with 2.5 cm diameter with an energy resolution about 500 eV at 122 keV.

Clean room The final slit collimator, along with the sample holder, are located in a clean room (class better than 105, US FED STD 209E Cleanroom Standards) endowed with a thermal and hygrometric control (temperature within 1 C, relative humidity = 60% within 10%).

Gamma-ray beam monitor The beam intensity at the exit of the beamline is monitored using a calibrated NaI(Tl) scintillator integrated with a photomultiplier tube.

Console room All movements, except the detector translation along the gamma-ray beam direction, are motorized and remotely controlled, by a LabVIEW software interface.

Description of the infrastructure
Name of the infrastructure: University of Leicester Space Research Centre (ULSRC)
Location (town, country): Leicester, U.K.
Web site address: http://www2.le.ac.uk/departments/physics/research/src
Legal name of the organisation operating the infrastructure: University of Leicester
Localisation of organisation (town, country): Leicester, U.K.
Annual operating cost (excl. investment costs) of the infrastructure (€): 313.833 (including 25% overhead)
Installation 1: LLBTF

The Leicester Long Beam-line Test Facility (LLBTF) is a (nominally) 27.5m-length vacuum beam-line with an X-ray source enclosure at one end and an experimental chamber at the other. The experimental chamber opens into a class 1000 clean room to allow samples to be loaded and unloaded in a clean environment. The X-ray source chamber is pumped by a turbo-molecular pump and normally achieves pressures ~5×10^{-7} mbar. The source can be isolated from the beam-line so that either part can be vented independently. A number of different sources can be used: (1) low-voltage electron-bombardment source with Cu anode (various characteristic X-ray lines can be generated by coating the anode with other materials; maximum anode voltage approx 8kV); (2) 50kV 1mA sealed tubes with Mo target and Be window; (3) 100kV 3kW Philips tubes with Tungsten and Sc anodes; (4) Deuterium lamp and monochromator. Included in the chamber is a filter wheel for provision of transmission filters and or collimating apertures. A range of standard filters is available for C-K, Cu-L, Al-K and Si-K. Other energies can be produced. The Philips tube can also be configured to bombard a target to produce fluorescence X-rays. The X-ray source uses thin-film transmission filters only; no X-ray monochromator is available. The use of the 50kV or 100kV tubes needs to give due consideration to radiation safety at the experiment and must be discussed with ULEIC staff.

The beam-line has an experimental chamber located at the mid-way point, with a high-precision linear drive station (Newport M-MTM200PE.1V6 200mm travel 0.1μm resolution). This equipment is not integrated with the system control software. Four other (non-instrumented) access ports are available between the centre point and the experimental chamber, for user-provided equipment. The experimental tank consists of a main chamber which is 1.25m in diameter and 1.5m long. In addition there is a permanently attached extension chamber which is approximately 0.76m diameter by 0.7m long. The tank utilises a cryogenic pump and roughed out using a roots/rotary pump combination. The tank base pressure is < 2×10^{-6} mbar. Mounting and connection of the cryo pump are configured so as to avoid transfer of vibration to the chamber. All adjustments can be made while the system is under vacuum and operational using UHV-compatible vacuum stepper motors. The system is designed to uniformly illuminate optics up to 210mm diameter. A PN diode beam monitor allows the spatial and spectral variability of the beam to be mapped. The turret assembly is a high precision rotation stage which allows the items under test to be rotated in θ and φ. Nominal stability and repeatability of the rotation is better than 10 arc seconds. The system is also set up to rotate up to six samples into the beam one after the other by rotating a sample carrier about the X-ray beam (θ). The turret can be rotated through 180 degrees to allow easy loading of samples and can be used in the forward position or in the back position facing the detector. The nominal mounting area for items on the turret is 208mm (h) by 250mm (v), however it may be possible to accommodate larger items. The maximum mass that can be accommodated on the turret is about 5kg. The system includes a large active area, 90mm × 90mm, imaging MCP detector which is mounted on a three-axis movement. A set of IDL-based, image acquisition and control programs is used to adjust the position of the detector, turret and beam monitor and acquire image data from the detector. The system allows manual control but is also designed to automatically take multiple data sets under computer control. Image data from the MCP detector can be provided as either event lists or as linearised images. All data will be the property of the experimenter but ULEIC reserve the right to use the data to check on the operation and calibration of the facility. Normal control of the system is from a laboratory area outside the clean room. The normal manned operating hours of the test facility are 0800 to 1800 Monday to Friday but the test facility can acquire data 24 hours a day under computer control. It is not possible to control the facility using a remote connection, all measurement sequences have to be set up from the laboratory area. The operation of the facility will be done by ULEIC employees with the aim of carrying out the experimental plan for the tests in the most efficient way. All equipment to be tested under vacuum must be suitable for use in clean high vacuum. All user-supplied electrical equipment must have been tested for electrical safety within the last 12 months.

The long beam-line test facility is located in the basement of the Physics & Astronomy Building at the University of Leicester and is operated by staff from the Space Research Centre. The facility has been substantially refurbished over the last 10 years but has been in use since the mid-1970s and was used to calibrate detectors for Ariel5, Ariel 6, EXOSAT and Ginga missions. Currently the facility is being used to test and calibrate the MIXS optics for ESA's BepiColombo mission to Mercury as well as supporting laboratory programmes in X-ray Interferometry and Smart X-ray Optics.

Installation 2: Vacuum Bakeout Camera (VBC) - Instrumentation (optics, sensors etc) and other equipment (structural parts, electronics boards, mechanisms) to be placed in vacuum – either in on-ground test facilities or during flight in space - often requires ‘bakeout’ prior to vacuum exposure in order to remove potential contaminants such as hydrocarbons and water which could adversely affect the instrument under test or the environment (vacuum test chamber, spacecraft bus etc). The ULEIC Vacuum Bakeout Chamber (VBC) is sited within a clean (ISO6), AIV area in the Space Research Centre (SRC), permitting appropriate handling of contamination-sensitive equipment. The chamber has a capacity of ~0.6 m3 (0.8 m diameter x 1.2 m length), is equipped with two jacket heaters, a rotary-pump-backed turbomolecular pump, a Faraday mass spectrometer for residual gas analysis (RGA), a temperature controlled Quartz Crystal Microbalance (TQCM), vacuum gauges, feedthroughs for temperature-control instrumentation and a gaseous nitrogen backfill system for clean return to ambient pressure. The heater system can

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achieve a maximum chamber temperature of 125°C, and uses feedback from two PRTs to control the temperature of the baked items. A further ‘watchdog’ PRT is linked to a separate automatic heater shutdown to provide additional protection against exceeding temperature limits.

The VBC was commissioned in 2006 in conjunction with the JWST-MIRI project (for which ULEIC is the mechanical systems lead). It has been used to date for bakeout to ESA/NASA standards, for several JWST-MIRI subsystems and for BepiColombo-MIXS, including cases with sensitive optical surfaces, instances where the temperature limit had to be closely monitored and safeguarded, and contracted work for international partner organisations in Europe.

Services currently offered by the infrastructure:
The LLBTF is currently being used by ULEIC staff to test and calibrate the MIXS optics for ESA’s BepiColombo mission as well as supporting laboratory programmes in X-ray Interferometry and novel X-ray optics. The VBC is being used for bakeout to ESA/NASA standards, for several JWST-MIRI subsystems and for BepiColombo-MIXS. The JWST-MIRI work has included on-site visits by staff from European partner organisations. The costs of these LLBTF and VBC activities (ULEIC staff effort and non-staff costs) are funded by the respective project grants and contracts to ULEIC. Associated travel costs of visitors have been met by the respective host institutes.

Description of the infrastructure:
Name of the infrastructure: SPATIAL
Location (town, country): Marseille, France
Legal name of the organisation operating the infrastructure: CNRS and Aix-Marseille University
Localisation of organisation (town, country): Marseille, France
Annual operating cost (excl. investment costs) of the infrastructure (€): 1.378.000 (inc. 25% overhead)

Description of the infrastructure:

One of the main assets of LAM is the synergy from the collaboration in a same location of several research teams working in astrophysics, a research team in optics for astrophysics, and high-tech engineering teams specialized in optics and opto-mechanics equipped with major facilities for space and ground-based instruments at the best international standards with 1000 m2 (ISO5-ISO8) clean rooms.

These facilities have been organized in a technical platform open to external academic research or industrial partners, which includes a Space Qualification Center (SPATIAL) and a Robotized Polishing Center (POLARIS). The co-location of astrophysical research and engineering teams at LAM provides frequent and easy interactions, as well as a continuing optimization, an extremely favorable context for the emergence of new observational approaches, which are backed by an active R&D. It is on this basis that LAM prepares the future by designing, developing, testing and calibrating the innovative instruments for the next generation of space and ground-based observatories.

The SPATIAL technological facility at LAM is a space AIT/AIV center with a series of equipements dedicated to assembly, integration, tests and calibration of components and instruments with opto-mechanical core in space environment conditions (vibrations, vacuum et cryogenics chambers up to 80m3).

Their design has been made in anticipation of the next generation projects, particularly for the next space missions of ESA. These facilities have been conceived from the onset to be opened to LAM teams and partner institutes or agencies (CNES, ESA, ESO,…), as well as to any research institute or company requiring facilities of this kind.

This space AIT/AIV center provides the means for Assembly (mechnical tools, 3D metrology), Integration (clean room equipment, E.G.S.E), Tests/Qualification/Acceptance (optical metrology, transmission and reflexion measurements, vibration facility, vacuum/cryogenic chambers with stabilised optical bench) and Calibrations (optical benches of 0.8, 6 and 45 m3 with I.R. spectroscopy capabilities).

The SPATIAL technological facility can provide a set of 940 m² ISO5, ISO7 and ISO8 clean rooms, controlled according to the standard document ECSS-Q-70-ST-01-C "Cleanliness and Contamination control" with a temperature of 22°C +/- 3° and a humidity ratio of 60 % +/-10%. The floors of all the rooms are electrically conductive to allow for the flow of the electrostatic loads.

This facility also includes a set of thermal/vacuum chambers, in an ISO8 environment, with various performances:
- 250 litres cryostat (length 1.2m and 0.5m Ø), with 10-6 mbar vacuum and down to 5K temperature capability, 2.5m3 cryostat (length 1.4m and 1.0m Ø), with 10-6 mbar vacuum and 77K to 323K temperature capability, 45m3 cryostat (length 6.0m and 4.0m Ø), with 10-6 mbar vacuum and 77K to 323K temperature capability and vibration control at 10-7g level on the 5-100Hz range.

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This set of vacuum/thermal chambers is completed with vibration test equipment composed by a 3 axis 35KN air cooled shaker with a 600x600mm interface table and 22 channels for signal conditioning and accelerometers.

The LAM SPATIAL facility is already used in a number of research programs in the framework of international consortia (i.e NISP instrument for the Euclid ESA mission), on a scientific collaboration basis. In this case, the running and maintenance costs, as well as investments for the upgrade of the available instrumentation or development of a specific one, are covered by institutes funding (CNRS/AMU/CNES) and the associated research/scientific programs.
The facility is also offered to external academic or industrial teams in the basis of scientific/technical service for R&D, prototyping or qualification process of various opto-mechanical, mechanical or electronics systems or instruments. In this case external teams cover all their travel and living expenses and the facility running costs, including those of the LAM scientific and technical people involved. The LAM facility team provides scientific/technical assistance for the preparation of the measurements runs, conducts the measurements runs with the external teams, and delivers a final measurements analysis report. If necessary LAM provides a small mechanical support for interface design and realization.

Description of the infrastructure
Name of the infrastructure: CSL
Location (town, country): Liège, Belgium
Web site address: http://www.csl.ulg.ac.be

Legal name of the organisation operating the infrastructure: Centre Spatial de Liège (CSL)
Localisation of organisation (town, country): Liège, Belgium
Annual operating cost (excl. investment costs) of the infrastructure (€): 3,540,000 (incl. 25% overhead)

Description of the infrastructure:
The Centre Spatial de Liège (CSL) is part of the University of Liège and is specialised in the evaluation of optical payloads in simulated environment since the early 70's. Telescopes and space science instruments that have been tested at CSL cover the full electromagnetic spectrum, from X-rays to far infrared. Through every specific case, CSL team has gained unique experience and enlarged its testing capabilities to meet a wide range of test conditions and payload dimensions.

Installation 1: FOCAL2 - One thermal vacuum chamber is proposed in this project: FOCAL 2 (2m diameter). The chamber is located in a clean rooms whose cleanliness is permanently controlled to comply with an ISO-7 level (following ISO 14.644). Additionally, ISO-5 local areas can also be activated for specific applications via filtered laminar walls. The dimensions of the clean room are 27m L x 17.5m W x 10.5m H and cranes of 10T and 5T capacity are made available.

This vacuum chamber is equipped with built-in optical benches providing high mechanical isolation compatible with interferometric measurements. These benches lay on a heavy seismic concrete block, passively controlled. The thermal-vacuum chambers allow programmable temperature cycles in the range from -196°C to +120°C (LN2/GN2 mode). 5 thermal N2 channels are available on FOCAL 2.

Space Environmental Testing activities are performed according to ECSS standards and the clean rooms are controlled and monitored according to ECSS.Q.70.ST.01.C. The temperature and RH are permanently maintained respectively within 22°C+/- 3°C and 55%+/-10%.

Installation 2: Shaker 200 kN - For vibration testing, CSL proposes in this project a high capacity shaker operating in clean environment (from ISO7 to ISO5). It allows simulation of launch induced vibration, dynamical signature, interface force measurement and fatigue test. Its characteristics are listed hereafter:
• 3 axes
• 48 acquisition channels
• M+P control system with automatic notching
• Sine, random an shock inputs
• Slip table: 1500 x 1500 mm2
• Head expander: 1500 mm diameter
• Max sine force: 200 kN
• Max random force: 160 kN RMS
• Bandwith : 5 – 2000 Hz

For this project, CSL plans to provide to external teams technical support and access to facilities for the qualification of space hardware, in particular thermal vacuum and vibration tests.

Apart the travel and subsistence cost coverage as described in the general section, each approved qualification run at CSL facilities, will include:
- coverage of thermal vacuum facilities running cost, including man power cost for 24/24h monitoring, clean room access, turbomolecular pumping, thermal group with regulated LN2 line, access to control room and contamination monitoring;
- coverage of 200 kN shaker running cost, including clean room and control room access;

Over the full project duration, we offer a maximum of 8 days of FOCAL2, for experience in thermal vacuum. In the case of vibration tests, 2 days are offered.

Description of the infrastructure:
Name of the infrastructure: Space Test Laboratories
Location (town, country): Terni, Italy
Web site address: http://serms.unipg.it, http://laboratoriocem.tr.unipg.it/

Legal name of the organisation operating the infrastructure: Università di Perugia
Localisation of organisation (town, country): Perugia, Italy

Annual operating cost (excl. investment costs) of the infrastructure (€): 290.000 (SERMS)+65.000 (CEM) (incl. 25% overhead)

Description of the infrastructure:
The Space Test Laboratories of the Perugia University are located in the Polo Scientifico Didattico di Terni, in the premises of the faculty of Engineering. Two close installations, the SERMS and the CEM laboratories, provide coordinated services and qualification tests according to the required standards for instrumentation to be operated in space and/or hostile environment. All the instrumentation in the infrastructure is calibrated on a yearly basis by a certified procedure performed in agreement with the standard ISO 9001:2008. The infrastructure is operative for 220 working days per year.

Careful design and a detailed thermal and mechanical stress analysis of a device are among the key points to reach its full reliability. Extensive experimental campaigns are also usually applied to test the system functionality in the expected environmental conditions and to verify the mechanical/thermal behavior of the instrument and its electromagnetic interference with the surrounding equipment. In the Space Test Laboratories, mechanical/thermal and electronics design capabilities and the infrastructure for mechanical/thermal/thermo-vacuum/electromagnetic testing of payloads are integrated to provide a complete assistance in the field.

In the last two decades, collaboration with international research projects and industrial partners have been carried out continuatively in this infrastructure giving the opportunity to train highly qualified personnel, motivated in finding custom solutions to peculiar problems. The Fermi-LAT gamma-ray observatory and the AMS-02 cosmic ray telescope, successfully operating in orbit since 2008 and 2011 respectively, are the main scientific instruments which have been developed with the support of this infrastructure as in kind contribution to the international scientific collaborations. The mechanical design and qualification process of the silicon tracker for the DArk Matter Particle Explorer (DAMPE) is currently being carried in the Terni facilities as part of the scientific collaboration with Geneva University and the Chinese Academy of Science.

Qualification tests of the ASTRO-H SXS-filter wheel and POLAR electronics, due to be launched in 2015, have also been performed in the Space Test Laboratories as an external facility.

In fact, the infrastructure is also open to external access for scientific payloads and industrial applications with a detailed service pricelist. For the H2020 program we plan to offer the access to installations and the required assistance just on the basis of the overall running costs of the installations, which accounts for ≈30-50% of the standard pricelist cost for most of the offered services.

Installation 1: SERMS

The SERMS laboratory was established in 1995 by the university of Perugia in cooperation with the Istituto Nazionale di Fisica Nucleare (INFN) to provide engineering support to the design and test of the FERMI-LAT and AMS-02 scientific payloads developed in the astro-particle research teams of the University of Perugia and INFN. Based on a formal agreement with the University of Perugia, INFN personnel has access to the laboratory to develop its research programs and contributes to the facility infrastructure with its own equipment, shares the running costs of the facility and provides part of the personnel. An academic spinoff, the SERMS s.r.l., was established in 2004 and operates in the laboratory on the basis of legal agreements both with the University and INFN. In this framework, the SERMS s.r.l. acts as third party to the infrastructure, providing part of the personnel and equipment and participates to the running costs of the facility. The close contacts of this facility with major international industrial and research institutions during the AMS qualification process allowed a professional training of the personnel both in design and experimental testing with an objective driven / performance-based approach. Thanks to the partnership with the spinoff, the laboratory not only provides support to scientific research programs in space, but has extended its activities towards industry with design and qualification test for different applications.
On a surface of =500m², facilities for thermal, thermo-vacuum, pressure, salt and fog, drop and impact, vibrational and pyroshock tests are available to assess the behavior and resistance of devices to be used in hostile environments/space. The main facilities of the SERMS laboratory are:

- Clean rooms: one 4.9x9.30 M5.5 (class 1000) and one 4.99x9.30 m2 M6.5 (class 1000) clean rooms with ambient temperature (T=21±/− 2°C) and humidity (50+/− 10%) control

- Climatic test chambers:
  - Angelantoni Mod. CH500C-15ESS, Test Volume 0.85x0.572x0.892 m³, Temperature range: −70°C /+180°C, Heating – Cooling Speed: max 15 °C/min, Humidity Range: 10% / 98% U.R.
  - Angelantoni - Mod.EOS 1000 C, Test Volume 1x1x1 m³, Temperature range: −70°C /+180°C, Heating Speed: max 2 °C/min, Cooling Speed: max 1.5 °C/min, Humidity Range: 10% - 98% U.R.
  - TY2000WC, Test Volume : 2x1x1 m³, Temperature range: −70°C /+180°C, Heating Speed: max 2 °C/min, Cooling Speed: max 1.5 °C/min

- Thermovacuum chamber: Angelantoni Mod. HVT 2000 S/N 10107, Test Volume: cylindrical with 2m inner diameter x 2.1m length, Temperature Range: 70°C/+125°C, Temperature Gradient: 1°C/min, Vacuum Level: 1 x 10-5 mbar, Coolant fluid: Baysilone. The internal walls of the chamber are coated with a black paint to reproduce the black body optical properties (shroud) and Plates made of aluminium alloy are used for conductive coupling of the test item to the chamber (cold plates). Independent control for shroud and cold plates is available to reproduce different environmental conditions. ISO K (n.3) flanges and DN35CF (n.4) flanges are available with different feedthroughs (DB9, DB15, DB37, LEMO, HV pins) to operate devices under test.

- Pressure simulator: ECOVIDE Mod. VP600. Test Volume: cylindrical with 1.55 m inner diameter x 2.2 m length, max Altitude pressure: 4mBar; max Overpressure 1700 mBar; N° 3 DN200 ISO K flanges available for electrical connections, Fully compliant for Altitude, Overpressure tests according to: RTCA DE160E

- Vibration test systems: two independent shakers are installed in order to operate either independently or in conjunction to perform mechanical vibration in the 5-3000 Hz frequency range according to sine, noise and shock profiles in the horizontal or vertical directions for devices up to 1.6 Ton at the nominal force. Two slip tables (1x1 m², 2.1x2.1 m²) can be connected to the vibration systems to hold large/heavy devices in the test.

- PYROSHOCK SYSTEMS:
  - Pyroshock Simulator: developed at SERMS, this simulator reproduces pyroshock events with a great precision, repeatability and safety in accordance with the main space and aeronautics standards; among them: NASA-Standard-7003 Pyroshock test criteria; ESA Mechanical shock design and verification handbook; CSS-E-10-03A Space engineering – Testing; MIL-STD-810G method 517.

- Climatic test chambers:
  - TIRA GmbH S 59349/AIT – 440, A 2 11 3 090 Power Amplifier: Nominal force SINE/NOISE 49.5 kN, SHOCK 148.5 kN for a Max device weight of 910 kg.
  - Control/DAQ system: Spectral Dynamics Jaguar SD 2560 , 99 acquisition channels; Workstation: Sun Ultra 10, Software: Sine, Random JAGUAR 2570 ACP 99 channel-1 output system, Drive frequency up to 56kHz.
  - Pyroshock Simulator: developed at SERMS, this simulator reproduces pyroshock events with a great precision, repeatability and safety in accordance with the main space and aeronautics standards; among them: NASA-Standard-7003 Pyroshock test criteria; ESA Mechanical shock design and verification handbook; CSS-E-10-03A Space engineering – Testing; MIL-STD-810G method 517.

- Electrical power source, up to 600 kVA: Ling Electronics – PN.1212E, C335 Vibration Exciter-mod.2016: SINE 87.5 kN, NOISE 71kN, SHOCK 14. kN for a Max device weight of 700 kg.

- DAQ and probes: different DAQ systems (up to 40 channels, LMS SCADAS SCM05V, up to 32 channels SCXI - National Instruments, up to 60 channels Agilent TECHNOLOGIES 34972A) are available to register the readings from thermal sensors, accelerometers, strain gages, load cells, during the tests.

Installation 2: CEM

The CEM Laboratory was established in the 2001 as a facility designed to be versatile to use both in the research activities and testing for the assessment of electromagnetic compatibility for electrical devices used for several applications. Since then the facility has been actively used in several research projects and qualification sessions about EMC Test (Electromagnetic Compatibility Test). In particular EMC design and characterization of electric and electronic devices are performed by experimental tests and numerical simulations using the Finite Element Methods. Analysis and improvement of grounding, bonding, filters, and electromagnetic shields are developed. Electromagnetic compatibility testing and low voltage safety verifications are performed for mechanical and electrical devices used in the following environments: domestic, commercial, industrial, telecommunications, health, defense, avionic and aerospace. Pre-compliance and full-compliance qualifications are performed and realized. The main EMC standards are achievable by the facilities of the CEM Laboratory [MIL-STD-461C/D/E/F, RTCA-DO160 D/E/F/G, NASA-ESA EMC Standards, SSP 30237, SSP 30238, MIL-STD-285, IEEE STD 299 – 1997, European Directive 2004/18/EC, European Directive 1999/5/EC]. The main facilities of the CEM laboratory are:

- shielded and semi-anechoic chamber up to 18 GHz

- The dimensions of the shielded and semi-anechoic chamber are 8.20 m (length), 4.90 m (width), 5.50 m (height). The door dimensions are 2 m (width), 2.40 m (height), the turntable diameter is 2 m, the absorbing material is ferrite plates and cones. The anechoic frequency range is 30 MHz - 18 GHz, the shielding frequency range is 10 kHz - 18 GHz.
Outreach to new users:

• To cover the cost of 1.5 man month per year for a total of 4.5 man months to set up and maintain a web page and provide support for the selection panel.

• To support, in some exceptional case and with TNA Committee agreement, short visits for teams interested to apply for facility time and requiring a more direct contact with facility experts. The cost of those short visits shall be covered by the TA1 budget and has been estimated as 2% of the guest team travel and subsistence costs required for the actual TA measurements runs;

• To cover the travel and subsistence expenses of the peer-review selection committee. We envisage an initial face to face meeting of the independent selection panel members with the facility experts to be acquainted with the facility capability, followed by a first face to face selection meeting. To reduce running cost we foresee to hold most of the selection process by telematic means, however face to face meeting of the selection committee will be held in connection with the periodic intermediate report of the AHEAD program. Hence we have included in the budget the travel and subsistence costs for 3 face to face meetings of the selection committee;

• To cover the travel and subsistence expenses of team consisting of a maximum of two guest users. We assume a travel cost of 400 euros per person, and a daily subsistence cost of 130 euro per person. Visit length will depend on the required facility and planned testing and this information has been duly included in the evaluation of the requested budget; typical durations will range between 3 and 10 working days;

• To organize, in the case of complex facility and/or complex test run, short-term preparatory visits of (maximum) 2 people between the facility team and the selected external teams. The cost of those short visits shall be covered by the TA1 budget and has been estimated as 6% of the guest team travel and subsistence costs required for the actual TA measurements runs;

• ESD generators for electrostatic discharges up to 25 kV

Modality of access under this proposal: Time to be offered by peer-review selection following an open call for external team applications. We plan an open call about every six months. The selection committee will be constituted by five independent experts that will evaluate the proposed program.

Review procedure under this proposal: Users will submit an application via a web form on the dedicated web site which will permit a preference for a particular infrastructure/installation.

The proposal to access the offered facility time will be reviewed by an independent committee purposely appointed by AHEAD board that will comparatively evaluate the scientific and technological merit and relevance of the proposed program and will take advantage for its final evaluation of a technical report prepared by the facility experts that will verify the feasibility of proposed measurements vs. the characteristics of requested facility. In the selection process priority will be given to new users and user coming from countries where the requested facility and/or installation are not available.

Users will be expected to provide feedback on their visit and the selection panel will provide an annual report to the management board of AHEAD to maximize the quality and tailoring of the support through the lifetime of the project.

Support offered under this proposal: During the H2020 program we plan to offer to external visiting teams, in some cases at a reduced cost, a level of scientific and technical support equivalent to those usually offered to laboratory or industrial teams, with additional support to the selected external teams for travel and living expenses.

In particular with EU funds we plan:

• equipments for radiated and conducted emission tests up to 40 GHz: spectrum analyzers and receivers in the frequency range 30 Hz - 26.4 GHz, oscilloscopes, multimeters, LISNs (Line Impedance Stabilization Nets), inductive and capacitive probes, antennas (loop, rod, biconic, log-periodic, bilog, horn) for the frequency range 10 kHz - 40 GHz and electromagnetic field probes for broad band measurements in the frequency range 5 Hz - 40 GHz.

• equipments for radiated and conducted immunity tests up to 40 GHz: signal generators and power amplifiers in the frequency range 30 Hz - 40 GHz, pulse generators (burst, surge, damped sinusoid, pulses), inductive and capacitive injection probes, antennas (loop, square frame, bilog, horn) in the frequency range 10 kHz - 40 GHz, simulators (Lightning, NEMP, EMP and LEMP).

• ESD generators for electrostatic discharges up to 25 kV
possible number of users, we plan a specific section to be held at the COSPAR international meeting to be held in June 2016 in Istanbul. Typical attendance to the COSPAR meeting is world-wide with many thousands of participants from scientific institutes and industries from leading and emerging countries. We expect that such an action will succeed in increasing the number of interested guest users. Some of the offered facilities have been already open to users other than those of the given facility host country as part of collaborative research programs, and some have been already offered as a part of a specific contractual agreement. Since in emerging countries resources for an extensive stay at a facility will be limited we expect that the EU funding of external teams will boost the number of interested teams.

### Participation per Partner

<table>
<thead>
<tr>
<th>Partner number and short name</th>
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<tr>
<td>1 - INAF</td>
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### List of deliverables

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<th>Lead beneficiary</th>
<th>Type</th>
<th>Dissemination level</th>
<th>Due Date (in months)</th>
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<td>WP4 final activity report</td>
<td>1 - INAF</td>
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### Description of deliverables

- Activity reports at months 12, 24, 36, 42
- D4.1 : WP4 1st activity report [12]
- Activity report covering the 1st year (INAF/OAPA)
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<th>Milestone number</th>
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<td>Web-page appearing on the internet</td>
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Work package number | WP5 | Lead beneficiary | 2 - ULEIC
Work package title | TA2 - Access to X-ray data analysis
Start month | 1 | End month | 42

Objectives
The goal of this work package is to provide trans-national access (TA) to X-ray (and gamma-ray) data analysis methods including use of data tools, archives and space instruments via tutorials and mentoring by experienced scientists at the delivery institutes. The primary aim is to widen opportunities for scientists across Europe to exploit both European-funded and international X-ray astronomy facilities and X-ray data archives in order to enhance high-energy astrophysics science across Europe. The activities will be particularly designed to assist relatively inexperienced users in smaller institutes, but will be tailored to the needs of scientists with a wide range of experience. Following a selection process, to ensure suitability of the user, and an initial discussion of the user’s needs, to ensure the user’s activities will be productive and efficient, users will typically visit a delivery institute for a period of 5-10 working days. The delivery institute will provide the users with: a hands-on tutorial in the most up-to-date methods in X-ray data analysis (imaging, time series, spectroscopy); specific data analysis methods tailored to the users own research project(s); assistance with using software packages specific to European and international X-ray missions; given guidance in the exploitation of data archives located at the host institutions and elsewhere, including multi-waveband analysis; and mentoring in how to make use of the software and X-ray facilities when the user returns home, including a point of contact at the delivery institute for follow-up discussions. Thus a visit will be part of a process to enable science for the user rather than a single end point.

Provision of access to the following infrastructures:
• Department of Physics and Astronomy, University of Leicester
• SRON Netherlands Institute for Space Research
• ASTRO-H European Science Support Center, University of Geneva
• National Institute for Astrophysics, INAF
• Institute of Astronomy Astrophysics, Space Applications & Remote Sensing (IAASARS), National Observatory of Athens
• AIM / Service d’Astrophysique, CEA Saclay

Description of work and role of partners
WP5 - TA2 - Access to X-ray data analysis [Months: 1-42]
ULEIC, INAF, STICHTING SRON, NOA, CEA, UNIVERSITE DE GENEVE

Modality of access under this proposal:
Visiting users will be selected via a competitive process based on need and current access to X-ray facilities. The selection panel will consist of six scientists mainly comprising experts from outside the AHEAD consortium with some consortium representatives. If selected the user will be invited for a unit of time, typically 5 working days with a day of travel either side. Prior to the visit, there will be preliminary discussions with the user to ascertain their current experience and detailed requirements so the tutorial information can be best tailored to their needs. Additional support will be given after the visit ends to ensure the user obtains maximum benefit. We have budgeted for an average of 60 working days of user visit for each of the 8 installations or 12, 5-day visits. Adding 1 day subsistence per visit for travel time this gives 72 days of required subsistence plus 12 journeys.

The requested budget includes 3 man months of effort over 3 years at the University of Leicester to design, install and maintain the dedicated web page and to provide support activities for the selection panel.

Support offered under this proposal:
During the visit the user will be given space within an office in the host institute, access to the internet and assigned a contact scientist who be responsible for delivery of tutorial material and who will be available throughout the visit. The contact scientist will normally be a postdoctoral researcher, although more senior research staff will also be available for mentoring and scientific discussions on the use of methods for spectroscopic, time series and imaging data analysis using the most recent versions of high-energy astrophysics software. Software packages available include ftools, HEAsoft, XSELECT, XSTAR, mission specific software including those for XMM-Newton, Chandra and Swift as well as specialized software developed at the host institution. The user will be encouraged while present to join in
the usual research activities of the host institution (seminars, discussions of recent techniques and results, updates on current/future space missions and external training opportunities). The latter activities will be particularly important for users from small research centres to ensure they maintain contact with the subject once they return home. The user will be given practical help to arrange their visit (to arrange travel, accommodation and ensure prompt reimbursement of costs) as for current visitors to the host institution.

The requested EU funds will cover:

- The travel and subsistence costs of the users. We assume travel costs of 400 euros per person and subsistence costs of 130 euros per day for 6 days (allowing for travel time for a 5 working day visit).
- The costs of a support scientist for each working day of the user visit plus IT support. These costs are based on the relevant costs at each installation.
- The travel and subsistence costs of the selection panel for an initial meeting (travel of 250 euros and 3 days subsistence at 120 euros per day per person). Subsequent selection panels will meet via telcon.
- The costs of setting up and maintaining a web page and support for the selection panel costed at one man month per year totalling 3 man months, costed as for the support scientist time at Leicester.

Due to restrictions of funding for Switzerland at the time of writing, support for users visiting the ASTRO-H European Science Support Center, University of Geneva will be provided at no cost for this AHEAD proposal. Funding will be requested directly through the Swiss government.

Outreach to new users:
The availability of the X-ray data analysis scheme would be advertised via a dedicated web page maintained at the University of Leicester and by using existing astronomy networks including national societies (such as the Royal Astronomical Society, national institutions (such as INAF) and the European Astronomical Society. An indication of the level of demand for tutorials in X-ray data analysis is provided by the Swift tutorial system at the University of Leicester. This system is unfunded, and hence is limited by cost to the user and available institution staff time. Despite these limitations, the institution typically has 7 users per year. Broadening the scope, increasing the range of institutions and, most crucially, providing funding for users and staff should significantly increase the user base and enable a truly trans-national access activity. Europe has funded several X-ray facilities but currently there is no Europe-wide scheme for providing tuition and mentoring in X-ray data analysis.

Review procedure under this proposal:
Users will submit an application via a web form on the web site at Leicester which will permit a preference for a particular delivery institute (allowing for spoken language and detailed scientific requirements). The selection panel will consider proposals based on the following criteria: scientific excellence, previous experience, location and gender. The selection process will be biased towards users with a lack of suitable facilities for gaining training in their home country, to users outside the AHEAD institutes and to inexperienced users. The selection process will encourage users to obtain tutoring in facilities and methods outside of their previous experience so as to expand their future use of X-ray facilities, broaden their outlook and hence boost future employment prospects.

Users will be expected to provide feedback on their visit and the selection panel will provide an annual report to the management board of AHEAD to maximise the quality and tailoring of the support through the lifetime of the project. An annual report will be written on the activities of WP5 including a summary of visits made, feedback from users and comments from the selection panel.

- Synthetic description of the infrastructures participating in TA2

Description of the infrastructure:
Name of the infrastructure: Department of Physics and Astronomy, University of Leicester
Location (town, country): Leicester, United Kingdom
Web site address: http://www2.le.ac.uk/departments/physics
Legal name of the organisation operating the infrastructure: University of Leicester
Localisation of organisation (town, country): Leicester, United Kingdom
Annual operating cost (excl. investment costs) of the infrastructure (€): 96,000

Description of the infrastructure:
The Department of Physics and Astronomy at the University of Leicester is one the world’s premier institutions in the field of X-ray astronomy with an involvement in space missions for over 50 years. We have provided hardware and software for many of the premier facilities. Those currently in orbit include the ESA XMM-Newton satellite, the NASA Chandra satellite, the NASA/UK/Italy Swift satellite and we are providing hardware for the forthcoming India/Canada/UK Astrosat satellite due for launch in 2015. The Department hosts the UK Swift data centre, provides tutoring in the
use of Swift, hosts the LEDAS data archive for high-energy missions and hosts several supercomputer facilities. The Department houses some 150 scientists including groups dedicated to high-energy astrophysics and space technology. All major astrophysics software packages are available on the central computer servers, and the Department also houses a supercomputer system for more intensive computing needs. The many research and space project scientists at academic, postdoctoral, postgraduate and technical levels will provide the capability to meet the requirements for this data analysis work package.

Services currently offered by the infrastructure:
The Department hosts the largest high-energy astrophysics group in the UK encompassing hardware, software, observational astrophysics and theoretical astrophysics expertise. Examples of current astrophysics research include the areas of gamma-ray bursts, active galactic nuclei, galaxy clusters, accretion onto neutron stars and white dwarfs and charge-exchange processes in planetary ionospheres. The Department has recently led the production of the largest X-ray source catalogues for XMM-Newton and Swift which include multi-wavelength cross-correlation data. This will provide an ideal environment for a visiting scientists. We have extensive experience of providing support to visiting users as we currently provide a tutorial system for use of the Swift satellite, which has involved over 70 users in 9.5 years. The Department also hosts visiting scientists from other countries several times per month, and is currently involved in research and/or hardware collaborations with scientists in Germany, Italy, France, Holland, Denmark, Spain, Greece, Sweden, Ireland, USA, Canada, Chile, Israel, India, Australia, China and Japan. These projects involve in total involve many hundreds of scientists. The University of Leicester has a new conference facility (opened in 2014) which provides accommodation and meals. The facility is located close to the University. On site, the user will be located within the Department of Physics and Astronomy, which is itself located on the main University campus, close to the centre of the city of Leicester. The campus provides all the facilities expected of a University.

Description of the infrastructure
Name of the infrastructure: SRON Netherlands Institute for Space Research
Location (town, country): Utrecht, the Netherlands
Web site address: http://www.sron.nl
Legal name of the organisation operating the infrastructure: SRON Netherlands Institute for Space Research
Localisation of organisation (town, country): Utrecht, the Netherlands
Annual operating cost (excl. investment costs) of the infrastructure (€): 87.000

Description of the infrastructure:
SRON is the leading institute in Europe for the analysis of high-resolution X-ray spectra. The institute is Principal investigator on the two grating instruments currently operational in the soft X-ray band (the ESA mission XMM-Newton and the NASA mission Chandra). For the analysis of the collected spectra SRON developed dedicated analysis software which allows analysing high spectral data in a self-consistent way based on atomic transition probabilities. (SPEX, www.sron.nl/spex). Furthermore SRON is leading the European contribution to the Japanese satellite ASRO-H. This mission, while having its own unique science capability, can also be considered as a pathfinder for the X-ray Integral Field Unit on Athena.

Services offered by the infrastructure:
SRON Netherlands Institute for Space Research combines the development of new technology for space missions, the actual realization of instruments and the science analysis and its related tools. As such the institute combines detailed knowledge about the instrument performance and the physical interpretation of the collected data. The SRON science is strongly linked to this expertise and includes clusters of galaxies (the physical properties of the hot gas including the thermo dynamical conditions), properties of matter close to AGNs and the relevant feedback, properties of interstellar dust which can be uniquely probed in X-rays as well. This expertise, together with the dedicated software to analyse high spectral-resolution data are unique in the world. Already this is exploited by frequent visits (especially from Japan) where scientists are being educated in the interpretation of these data. As part of this TNA SRON will provide its facilities including expert knowledge for scientists in Europe, not yet expert on high spectral resolution data. Typical duration of these visits is from 1 to 2 weeks after which it is expected that the scientists will be able to continue their analysis at their home institute (also relying on the SPEX software which is freely available).

Description of the infrastructure
Name of the infrastructure: ASTRO-H European Science Support Center, University of Geneva
Location (town, country): Geneva, Switzerland
Web site address: http://astroh.unige.ch
Legal name of the organisation operating the infrastructure: University of Geneva
Localisation of organisation (town, country): Geneva, Switzerland
Annual operating cost (excl. investment costs) of the infrastructure (€): 192.000

Description of the infrastructure:
The European user support activities for the Japanese ASTRO-H mission (to be launched in late 2015) are spread across two centers: The Science Operations Centre (SOC), located at ESAC (Spain), and the European Science Support Center (ESSC), located at the Department of Astronomy of the University of Geneva (Switzerland). The tasks of the SOC are focussed on supporting the European user community in the use of the allocated time for ASTRO-H, through handling annual calls for observing proposals and related activities, while the tasks of the ESSC are focused on supporting the European scientific community with respect to the utilization of ASTRO-H.

The Department of Astronomy of the University of Geneva has a long experience in space missions, in particular with high-energy astrophysics missions. It hosts the Integral Science Data Center (ISDC) that provides archival access to the European INTEGRAL mission and user support (helpdesk) together with the integration and release of the INTEGRAL data analysis software (OSA). In addition, the Department of Astronomy is involved in ground segment activities for the ESA missions Gaia, Euclid, and Cheops. It further participates in activities related to the proposed ATHENA mission, and other space projects (e.g., LOFT, SPICA, JEM-EUSO, etc.). Scientific activities in high-energy astrophysics are strong with a focus around active galactic nuclei, X-ray binaries, galaxy clusters, and stars. The Department of Astronomy is member of the ASTRO-H consortium. It has led the development of the filter wheel mechanism and electronics for the Soft X-ray Spectrometer on board ASTRO-H. In addition, it hosts the ESSC in collaboration with ESA. The tasks of the ESSC are focused on supporting the European scientific community with the use of ASTRO-H:

• It provides expert knowledge about ASTRO-H,
• It trains European astronomers,
• It contributes to the validation of the scientific quality of the calibrations in the analysis software,
• It provides technical support to the ESA OTAC process.

The staff is involved in the ASTRO-H Science Working Group, contributes to the preparation of white papers on ASTRO-H performances, and to the definition of the target list to be proposed by the SWG for the performance verification phase. Finally, the ESSC/SOC staff shall contribute to the calibration effort of ASTRO-H. The activities of the ASTRO-H ESSC started in 2012. The ESSC has organized an ASTRO-H Special Session at the European Week of Astronomy and Space Science 2012 during which the mission and its science capabilities were presented. Further promotion activities are foreseen, including the presence at conferences and workshops. A user support/helpdesk interface has been developed in collaboration with the ESA ASTRO-H SOC; the ESSC staff focuses on providing support with technical information on instruments and data analysis software aspects.

Services currently offered by the infrastructure:

The INTEGRAL Science Data Centre already offers access to INTEGRAL data, and user support. The HEAVENS web interface hosted at the Department of Astronomy further provides access to several very high-energy astrophysics space data (e.g., FERMI, RXTE). The ASTRO-H ESSC has recently started its helpdesk interface. The ESSC staff, thus, are currently in a position to help European astronomers with the future use of ASTRO-H, albeit remotely. TNA access via AHEAD would be a valuable addition to the services provided by the ESSC and would further enhance the ESSC outreach to European astronomers by allowing them to visit the facility and receive data analysis tuition from ESSC staff.

Description of the infrastructure:

Name of the infrastructure: National Institute for Astrophysics, INAF
Location (town, country): Research Structures (i.e. Installations) at Bologna, Rome, Palermo (Italy): Bologna Observatory (OABO), Rome Observatory (OAR), Palermo Observatory (OAPA)
Web site address: http://www.inaf.it
Legal name of the organisation operating the infrastructure: Istituto Nazionale di Astrofisica
Localisation of organisation (town, country): Rome, Italy
Annual operating cost (excl. investment costs) of the infrastructure (€): 266.000

Description of the infrastructure:

INAF is the National Institute for research in astronomy in Italy. It coordinates and directly finances the astronomical research for the whole non-university based community, therefore more than 90% of the researchers in the field belong to the INAF (784 scientists and technical staff with a permanent position); furthermore, the large majority of the University professors are associated to INAF. The Italian national community is one of the world's premier in the field of High Energy Astrophysics: it has flown two national space missions, BeppoSax and AGILE, it has been deeply involved and/or has procured hardware for the NASA Chandra, ESA XMM-Newton, ESA-INTEGRAL, NASA SWIFT and NASA FERMI space observatories, it has key roles in the scientific operation of the NASA NuStar mission, as well as in the ESA ATHENA L2 mission study proposal and it is currently at the leading edge in exploiting the observational capabilities of the operating high energy observatories, also thanks to the many key/large projects with INAF scientists in PI or co-leading scientist role. INAF houses, mostly in the research structures at Milan, Bologna, Rome and Palermo, over 200 permanent and non-permanent scientists totally or partly dedicated to high energy astrophysics and space technology. All those research structures have adequate computer resources and often medium-size HPC facilities for
more intensive computing needs. All major astrophysics software packages are available on the computer servers. The many research and space project scientists at academic, postdoctoral, postgraduate and technical levels will provide the capability to meet the requirements for this data analysis work package.

Services currently offered by the infrastructure:
INAF hosts one of the largest high-energy astrophysics group in Europe and world-wide encompassing hardware, software, observational astrophysics and theoretical astrophysics expertise. Examples of current astrophysics research include the areas of gamma-ray bursts, active galactic nuclei, galaxy clusters, accretion onto neutron stars and white dwarfs, supernova remnants, cosmic ray acceleration, young stellar objects, star forming regions. The INAF involved research structures host numerous visiting scientists from other countries, and are currently involved in research and/or hardware collaborations with scientists in Germany, Italy, France, The Netherlands, Denmark, Spain, Greece, USA, Canada, China and Japan. These projects involve in total many hundreds of scientists.

Installation 1, Bologna: OABO, IASF-BO (in collaboration with Bologna University)
The Bologna high-energy group includes about a dozen of staff scientists and a similar number of Post-Docs and PhD Students from INAF-OABO, INAF-IASF/Bo and the Physics and Astronomy Department of the University of Bologna. The current research activity includes extra-galactic X-ray and multi-wavelength surveys, Active Galactic Nuclei, galaxy clusters, physics of accretion and ejection onto super-massive black holes, and background radiation. The team has a leading role in the scientific exploitation of high-energy data from previous and current X-ray missions. More specifically, the scientists of the Bologna node have developed significant expertise in the management of survey programs, in the production of science-validated catalogues and mission-oriented software for data reduction and analysis.

The Bologna GEant4 Multi-Mission Simulator (called BoGEMMS; see Bulgarelli, V. Fioretti; P. Malaguti, M. Trifoglio, F. Gianotti; Proc. SPIE 8453, High Energy, Optical, and Infrared Detectors for Astronomy V, 845335, 2012) is also available in Bologna and provides a tool to perform user-friendly GEant4 simulations of detectors/satellites backgrounds to any imprinting radiation/particle field, for variable and flexible geometries. Thanks to the close collaboration between the INAF institutes and the Department of Physics and Astronomy of Bologna University, a two-week tutorial on X-ray and Gamma-ray astronomy techniques and hand-on sessions for data reduction, analysis and interpretation has been active on a year basis at INAF-IASF since 2005. More than 200 under-graduate students have learnt the fundamentals of high-energy data analysis since then. The Bologna node environment offers a unique opportunity for the transfer of knowledge to visiting scientists.

Installation 2, Rome: OAR
The team at INAF-OAR have strong expertise in all the different aspects of high energy astrophysics. Researchers at OAR will make the best use of such skills to ensure that the visiting scientists will be able to acquire a wide range of expertise together with the motivation to successfully start their own research activity in this field. The research of the group focuses on galactic and extragalactic sources, as well as cosmology by means of current high energy missions (i.e. XMM-Newton, Chandra, Swift, Nustar). In particular, it involves the study of the following topics:

-Physics of Compact object: Timing and Spectroscopy of accreting compact objects, Magnetars, GRB afterglows;
-Physics of Active Galactic Nuclei: emitting/absorbing regions in the nuclear regions, AGN-driven outflows
-Cosmology: Extragalactic surveys, AGN cosmological evolution, Cosmic X-ray background and Warm-Hot Intergalactic Medium.

This extensive range of research activity within our team also demands sophisticated and high-level skills such as X-ray high-resolution spectroscopy, phase-coherent timing, phase and time resolved spectroscopy, and deep field imaging. The team at OAR includes scientists who served as support-scientists at operation-and-control centres of several X-ray missions (Chandra, XMM, BeppoSAX). Such a strong documented expertise in the field, guarantees the smooth development of the proposed project and the successful accomplishment of all its goals.

The visiting scientist will benefit of the long-standing collaborations between our team at INAF-OAR and other institutes in the area of Rome actively engaged in research on high energy astrophysics, i.e. a second INAF Institute - IAPS-Rome - , three Universities and the Science Data Centre of the Italian Space Agency, which ensures continuously updated databases and the development of mission-specific software. All OAR’s team members supervise regularly M.Sc./PhD students, and many of them also teach high-energy astrophysics courses at the three universities of Rome. OAR’s team members are also frequently involved in X-ray data analysis training courses and High Energy Astrophysics schools. Finally, INAF-OAR has a long tradition of hosting visiting scientists, as well as full scientific workshops, also thanks to the presence of an in-situ guesthouse.

Installation 3, Palermo: OAPA
The Palermo high-energy group includes about ten among staff scientists and Post-Docs and some PhD Students from INAF-OAPA, and the Physics and Chemistry Department of the University of Palermo. The current research activity includes galactic X-ray and multi-wavelength surveys with particular emphasis on the study of Star Forming Regions, physics of accretion and ejection onto pre-main sequence stars, physics of supernovae remnants, cosmic ray acceleration.
In those fields the team has a world-wide reputation in the scientific exploitation of high-energy data from previous and current X-ray missions. More specifically, the scientists of the Palermo node have developed since late ’90 novel detection algorithms for X-ray data based on wavelet transforms (Damiani et al 1997, ApJ 483, 350 & 370), have provided major contributions to 5 large-key Chandra and XMM-Newton past and current stellar survey (Orion, Taurus, rho Oph, NGC2264, NGC1893), to 3 large/key Chandra and XMM-Newton programs on SNRs (SN1006, W44, Vela PWN). As part of the latter activity scientists of the Palermo team have developed novel techniques for the analysis of X-ray images of extended sources. As part of the activity of an EU INT (Constellation) the Palermo team has organized in 2009 school with an extensive, and very successful, hand-on activity (http://www.astropa.unipa.it/ScuolaX2009/Practical.html) fully devoted to X-ray data analysis techniques for young astronomers coming from different expertise fields, hence Palermo involved scientists are able to pursue the mentoring activity planned in this WP.

Description of the infrastructure
Name of the infrastructure: Institute of Astronomy Astrophysics, Space Applications & Remote Sensing (IAASARS), National Observatory of Athens
Location (town, country): Athens, Greece
Web site address: www.astro.noa.gr
Legal name of the organisation operating the infrastructure: National Observatory of Athens
Localisation of organisation (town, country): Athens, Greece
Annual operating cost (excl. investment costs) of the infrastructure (€): 52.000

Description of the infrastructure:
IAASARS is a major Space Sciences Centre in South Eastern Europe. The Institute employs over 20 permanent members of staff and an equal number of postdoctoral research assistants. The Institute runs many ESA, EU and nationally funded projects ranging from Earth Observations to Space Astronomy. Regarding X-ray Astronomy the Institute has developed a strong expertise in bulk data analysis from X-ray surveys: automatic spectral extraction of XMM sources, automatic spectral fitting packages. In particular, the Institute runs the spectral fit database of the 3XMM sources (an ESA Prodex project). Automatic spectral extraction and fitting procedures have also been developed for the XMM-ATLAS survey and the 3Ms observation of the XMM-CDFS. Novel Bayesian analysis source detection techniques have also been developed for the XMM/SDSS 120 sq. degree survey. Identification of counterparts of X-ray sources, using maximum likelihood and Bayesian cross-correlation techniques are routinely developed. For aiding the above intensive computing analyses, the Institute hosts a 40-core cluster computer system.

Services currently offered by the infrastructure:
Based on the above expertise, the node in Athens will aid guest scientists in automated data analysis specifically tailored for X-ray surveys, where the typical number of sources is a few hundred or a few thousand source making impossible the reduction on a source by source basis. The support will include source detection using e.g. Bayesian techniques, cross-correlating X-ray with optical catalogs for the identification of counterparts and the automatic spectral extraction and spectral fitting of X-ray spectra.

Description of the infrastructure
Name of the infrastructure: AIM / Service d’Astrophysique, CEA Saclay
Location (town, country): Paris region, France
Web site address: http://irfa.cea.fr/Sap/
Legal name of the organisation operating the infrastructure: Commissariat à l’énergie atomique et aux energies alternatives
Localisation of organisation (town, country): Paris region, France
Annual operating cost (excl. investment costs) of the infrastructure (€): 93.000

Description of the infrastructure:
The astrophysics department at Saclay, which is situated 30 km south of Paris, is a major space astrophysics laboratory (about 70 scientists, as many engineers and as many postdocs or students) and is also involved in ground-based instrumentation. With respect to X-rays, our institute played a major role in the hardware development and calibration of the EPIC MOS cameras on XMM Newton and participates in the SSC consortium that is responsible for the catalogue of XMM-Newton sources. It is involved in the ASTRO-H Japanese mission to be launched in 2015, and in the future Athena large mission of ESA. About a dozen staff and postdocs work mostly on X-rays. They all have enough experience to meet the requirements for this data analysis work package. The major astrophysics software packages are available on the central computer servers, and a PC farm with 300 cores is available for the whole lab. The institute also has important contributions to the Integral, Fermi, Herschel, Planck, JWST and Euclid missions, as well as the HESS TeV instrument.

Services currently offered by the infrastructure:
The High-Energy group of the laboratory is involved in several fields of X-ray astronomy: black-hole X-ray binaries, the Galactic centre, magnetars and gamma-ray bursts, supernova remnants, clusters of galaxies, cosmological surveys. A particular strength of the group is its long experience with extended sources. Those require specific analysis methods (for background subtraction, mosaicking, spectro-imaging) which can be taught to visiting scientists. Another strength is the available multi-wavelength coverage. Specifically, the group can offer expertise in the whole range of gamma-ray astronomy, from MeV to TeV.

The laboratory is hosted at CEA Saclay, a large research facility of 5000 employees providing transportation and lunch on campus. Transportation from Paris is about 1 hour. Accommodation is also available more nearby in quiet Paris suburbs. The user will be given practical help to arrange their visit (to arrange travel, accommodation and ensure prompt reimbursement of costs) as ordinary visitors.

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List of deliverables

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<th>Dissemination level 16</th>
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### List of deliverables

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### Description of deliverables

Activity reports at months 12, 24, 36, 42  
D5.1 : WP5 1st activity report [12]  
Activity report covering the 1st year  
D5.2 : WP5 2nd activity report [24]  
Activity report covering the 2nd year  
D5.3 : WP5 3rd activity report [36]  
Activity report covering the 3rd year  
D5.4 : WP5 Final report [42]  
Detailed activity report covering the last semester and summary report of the the full period

### Schedule of relevant Milestones

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Athena will be the next observatory class X-ray facility for the study of the Hot and Energetic Universe with an expected launch date of 2028. In practice this implies that in 2018/2019 the technology for the payload has to be frozen considering the development time needed for space qualified instruments. The X-ray Integral Field Unit (X-IFU) is the most innovative instrument and will allow for the first time spatially resolved spectroscopy in the soft X-ray domain. The instrument is built around an imaging array of microcalorimeters based on pixels consisting of Transition Edge Sensors (TES) with absorbers operating at sub-K temperatures. The baseline X-IFU is based on technology that is currently under development in Europe. This technology will allow us to cover an energy range between 0.3 and 10 keV where an energy resolution of 2.5 eV is obtained, a field of view of 5 arcmin, sampled at 5 arcsec resolution and a count rate which is limited to a source strength of around 10 mCrab for which a good spectral resolution can be achieved. Clearly, pushing the limits of this technology will enable a significant improvement of the science return:

- A further reduction of the low energy threshold from 0.3 to 0.2 keV will push the redshift at which the most abundant emission/absorption line of baryons in cosmic filaments (O VIII line at 0.65 keV) can be detected from a redshift of 1.16 to 2.25. In addition a significant benefit to most science cases would come from an increase of the X-IFU effective area at low energies around and below 1 keV.
- The readout technology limits the number of pixels for cryogenic arrays to less than 4K pixels. The current pixel array design baseline is to cover the required field-of-view of the X-IFU (5 arcmin) with a uniform pixel size. This results in a sensor array with pixel dimensions which under-sample the angular resolution of the optics of Athena have a uniform count rate capability and single energy resolving power over the array. Within the readout constraints this array design can be further optimized by differentiation in different pixel types and sizes. An innovative detector design, in which multiple smaller absorbers with distinguishable time constants are connected to a single TES enables proper sampling of the angular resolution with a lower maximum countrate and a somewhat degraded energy resolution. To maintain the high count rate capability and the energy resolution at the centre part of the array, these central pixels will have the existing design with a single absorber.
- One of the factors that limits the number of readout channels and henceforth the number of pixels in the detector, is the thermal load of the harness between the cold stage at 50 mK and the next temperature shield (at 2 K). The channel capacity in the cold part of the readout can be increased by either increasing the number of pixels which are multiplexed in a single channel or by novel technology for the cryogenic harness, leading to a lower thermal load.
- Athena, with its large collecting area, is very well equipped to observe sources with low surface brightness. Especially characterizing gas in the outskirts of clusters of galaxies or in the Warm Hot Intergalactic Medium interconnecting the clusters can be done with greater sensitivity if the instrumental background can be reduced further. Using graded shielding or a larger anti-coincidence detector has the potential to reduce the background by a factor of 2, increasing the instrument sensitivity by the same factor.

Whereas there exists a well defined baseline for this instrument, pushing technology in the above areas will clearly enhance the capability of the X-IFU instrument on Athena and as such will have a major impact on the future of X-ray astronomy. This investment is needed over the next few years as after that period the time is needed to develop and realize the flight hardware. In this work package we will demonstrate the feasibility of these improvements by producing the relevant parts and by performing appropriate tests. We expect that at least a significant part of these improvements will be subsequently implemented in the X-IFU on Athena. By combining resources in different groups in Europe, we expect to be able to push these limits efficiently.
Following this realization the performance of these components will be tested and their relevance for Athena will be concluded. For ease of management the activities will be split in separate sub work packages but at the end a proper combination of these parts will result in a significantly better instrument.

Improved science performance of X-ray calorimeter

The micro calorimeter senses the heat pulses generated by X-ray photons when they are stopped and thermalized in the absorber. The temperature increases sharply after absorption of a photon and is measured by the change in the electrical resistance of a Transition Edge Sensor (TES), which must be cooled at temperatures less than 100 mK and biased in its transition between the super conducting and normal state. This is illustrated in the figure below, where at the left the transition is shown, in the middle the basic read-out scheme and at the right the thermal response of a pixel following the absorption of a photon. The TES is based on bi-layers of superconducting and normal metals (Ti/Au or Mo/Au). The absorber consists of 4 – 7 um Bi, which provides the photon stopping power while hardly contributing to the heat capacity, on thin Cu layer (~um), which promotes conduction of thermal energy from the absorber to the TES, but contributes to the heat capacity. While a good thermal conduction is crucial for a good count rate in combination with a good energy resolution, absorber heat capacity is a limiting factor for the count rate and energy resolution. The operational limit of the TES explored up till now has been that of low heat capacity and relatively low conductivity. A schematic view of the relevant components of the detector and its first stage read-out are shown in the figure on the right and includes the sensor array itself, with the first stage cold electronics (LC filters and SQUIDs) at 50 mK, cryogenic harness and electronics at 2 K (array SQUIDs, voltage divider and EMC filtering). In addition an anti-co detector is located just underneath the sensor itself. By recording the arrival time of charged particles, signals in the sensor due to these particles can be rejected. All these components are in an advanced state at the partner institutes for the baseline instrument.

WP 6.2 X-RAY SENSORS (SRON, CSIC, ULANC)

Currently the baseline array is foreseen to include 3840 separate pixels, consisting of a TES and an absorber. The size of the absorbers is limited by the heat capacity and thermal conductivity of the Cu layer to about 250 x 250 um2 to meet the energy resolution requirement This limitation, together with the maximum number of pixels which can be multiplexed in a single chain and the acceptable heatload on the cryogenic detector limits the Field of View to 5 arcmin and the maximum countrate to the equivalent of 10 mCrab (~50 counts/sec/pixel). If various sized absorbers can be implemented and multiple absorbers can be connected to a single TES, the limitations of the baseline array will be significantly relieved. It will allow a larger Field of View, combined with smaller pixels which do not undersample the mirror point spread function, have a better energy resolution and can sustain higher count rates without pile-up effects. In practice, not all these improvements will be achieved at the same time but a combination of different improvements is the likely outcome. The first part of this work package is to produce different absorbers/TES combinations and demonstrate their performance. Essentially, a number of parameters will be varied: the size of the absorber, the thickness of the Cu layer of the absorber and the thermal links from the absorber to the TES and from the TES to the bath. In addition different absorbers will be connected to a single TES using different thermal links. Using the shape difference in the pulses will allow us to identify the absorber which is hit by the photon. In this way the number of pixels can be increased by a factor 4 or more for the same thermal and readout conditions.

Another parameter that can be varied is the material of the bilayer in the TES. So far different bi-layers have been used for the TES (Ti/Au and Mo/Au) resulting in different results, but also tested in different test setups by different groups. Compared to Ti/Au, traditionally used by SRON, Mo/Au TESes have a higher volume which facilitates thermalization, and decreases the requirements on the Cu thermalization layer. These properties might allow for the design of larger pixels, without losing energy resolving power. Simultaneously, Mo/Au also has a higher heat capacity per unit of X-ray stopping power, which lowers the theoretical pixel size with respect to TiAu TESes. Manufacturing and material properties will ultimately determine what is the optimal combination, and both routes will be explored in this workpackage. The second part of this work package is to compare the performance and understand the underlying physics between these different sets of bilayers. The objective is to simulate thermodynamic and transport properties of proximised Ti/Au and Mo/Au bi-layers, better understanding of electrodynamics of weakly superconducting TESs under DC and AC bias and energy transport beyond discretised lumped element approach if necessary Based on this comparison the best possible TES can be designed and this will be a second route to optimize the detectors. For these steps we will use existing production facilities at SRON and in Spain for the production of the baseline sensors, and the theoretical expertise present in Lancaster to analyse the performance of the detectors and to explore new combinations of properties and physical processes to enhance performance.

WP 6.3: AC BIASED READOUT (VTT, SRON)

Different schemes can be used to multiplex a number of pixels in a single read-out channel (with its own data handling hardware). In Europe the main emphasis is on Frequency Domain Multiplexing where the pixels are AC biased (with frequencies between 1 and 6 MHz, separated by 125 KHz) and the signals for the separate pixels are identified based
on the frequency information. In the baseline design, we expect to be able to multiplex 40 pixels in one channel. In this design a first stage summing SQUID is operated at 50 mK and an array of SQUIDs is operated at a higher temperature (2K) as a second stage, providing the necessary signal to drive the lines to room temperature (where the digitization is done). The disadvantage of this approach is that the two SQUID amplifier stages are physically separated, resulting in additional interconnections which limit the bandwidth of the signals transmitted between the SQUIDs to about 6 MHz. Also the thermal load on the 50 mK is about a factor 2 larger than when the summing SQUIDs and array SQUIDs were to be operated both at 2K. This is caused by the need to bias the summing SQUIDs (and hence double the harness). Clearly, if both SQUID stages can be operated at 2 K a larger set of pixels can be operated for a given cooling power. As part of this work package we will provide a detailed assessment of combining the two SQUIDs at the 2K level (VTT) and the feasibility to have a corresponding cryo-harness with the appropriate characteristics (cross talk, inductance, bandwidth) to allow for this (SRON).

To further increase the multiplexing factor, it is essential to improve the dynamic range of the SQUID combination. SQUIDs with a larger dynamic range allow faster pixels that can handle higher count rates, and more electronic filtering in the readout lines, and it opens the possibility for a higher readout bandwidth and thus a higher multiplexing factor. The two possible routes to be explored here for dynamic range improvement are linearization of the SQUID response and the enhancement of power dissipation and critical current density in the second SQUID stage.

The Mo/Au route also requires modifications of the SQUID input circuit due to the lower specific resistance of Mo/Au, which could be combined in this part of the WP.

WP 6.4: ANTI-COINCIDENCE DETECTORS (AC) (UNIGE, INAF/IAPS and SRON)

Rejection of the in-orbit particle background by a factor of 100 or more is required to carry out measurements of faint or diffuse X-ray sources. This reduction can be achieved with an anticoincidence detector (AC) that needs to be close to the microcalorimeter, and therefore operated at similar low temperatures. The baseline AC detector is based on a Si absorber read-out by a distributed set TES sensors and its performance has been demonstrated (ref. 3). This concept has several advantages: a low energy threshold, the possibility to disentangle the thermal from a-thermal signal components, the same operating temperature and the SQUID readout similar to the main detector. This work package includes three relevant sub-workpackages:

a) optimization of size of the anti-co detector
b) application of additional anti-co detectors to cover the lateral sizes of the sensor
c) feasibility study of detection capability in the hard X-ray band

In the current design the size of the anti-co is 1 mm larger than the sensor (18 mm compared to 17 mm). Together with a typical distance of 1 mm this implies that on the outer pixels particles with an incident angles greater than 63° may be missed by the anti-co detector (depending on the direction of the particle). Clearly a larger anti-co will improve this and an increase of the anti-co size by 3 mm already improves this by a factor 2. As the first task we expect to demonstrate the feasibility of such devices. A further improvement can be obtained by adding a number of pixels covering the lateral edges of the detector. This requires optimized pixels for this purpose as well as a proper design of the focal plane assembly.

Another improvement of the anti-coincidence detector is its use as a hard X-ray detector (E>20 keV). This enables, in combination with the top-layer microcalorimeter array, the simultaneous measurement of X-ray spectral features over a broad energy range. There are numerous science goals that will benefit (e.g. the simultaneous study of the iron line and hard X-ray reprocessing component produced by an accretion disk around a black hole). In the first phase we will study the science requirements, in particular the energy band. This could require a detector design for achieving the selected stopping power. After a preliminary design phase, one or two geometries and materials could be investigated and tested at 50 mK prior to the fabrication and the test of a demonstrator. This study will give all the science and detector parameters for a design and fabrication of such detector in view of an application to space based observations. Based on these results a decision will be taken on the feasibility to include this additional feature in the X-IFU on Athena. This work has a strong link to WP 9 which will provide detailed estimates of the different background components (cosmic rays, particles with a solar origin, etc.) The devices will be produced in available production facilities at the University of Genova and tested at INAF/IAPS-Roma. The EU funding will allow us to demonstrate the improved performance.

WP 6.5: INTERCONNECTING HARNESS FOR CRYOGENIC DETECTORS (CEA-Saclay, SRON)

For large cryogenic detector arrays the electrical connections to higher temperature stages are critical for the required cooling power (and hence the detector size in number of pixels). We try to reduce the heatload per connection in this part. The electrical interconnections require low Ohmic impedance lines or coaxial cables with higher impedances. Within this work package we concentrate on the low Ohmic impedance lines. With current technology, a heatload of 14 nW/cm can be achieved for low Ohmic impedance lines from 0.1 up to the 2 K level (with an intermediate temperature at @ 0.3 K). As part of this activity we expect to improve this situation by a factor of at least 2 (allowing for larger
devices covering a larger part of the FOV while keeping power dissipation inside the same available cooling power budget and thus reducing the observation time for extended objects by the same factor). The focus of this work package is to improve the wiring integration (smaller pitch) in parallel with reducing the conductor cross section (possibly using superconducting material) in combination with the interconnections at the ends and assembly with connectors (with low sensitivity for EMI). We will also address the expected yield of this harness. We will use existing test facilities and the EU funding will allow us to produce the interconnecting harness and to test these (performance, environment). The harness will be produced in industry as specific facilities are required, and only industry will be able to mass produce these harnesses. In this context, subcontracting to industry is mandatory.

WP 6.6: OPTICAL BLOCKING FILTERS FOR CRYOGENIC DETECTORS (UNIPA)
Cryogenic detectors require thermal/optical blocking filters to thermally insulate the sensors, operating at sub-K level, from the satellite environment (typically at room temperature). As no filters exist which are thermally insulating and transparent at X-ray energies, these filters also reduce the effective area of the system. Baseline filters, using polyamide with a thin deposited Al layer and a stainless steel support grid are frequently used in these applications but have the disadvantage that below 0.3 keV the transmission for a typical set of filters drops below 50%. As part of this activity we will perform a detailed analysis of the minimal thickness required for the filters to withstand the launch conditions and still provide adequate thermal insulation, procure these filters and measure their thermal, optical and X-ray properties.

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List of deliverables

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<td>D6.6</td>
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Description of deliverables

Trade-off report for critical design steps: sensor array, read-out options and anti-co (Month 12) New set of SQUID for readout (Month 24) H/W components for optical filters (Month 30) Upgraded test facility for readout options (Month 36) H/W components for microcalorimeter, AC detectors, interconnecting harness (Month 36) Final report: testing of H/W components, system performance & additional recommendations (Month 42)

D6.1 : Design tradeoff report (X-ray sensors) [12]
Report of a study aimed at the design optimization of X-ray sensors (SRON, CSIC, ULANC)

D6.2 : Design tradeoff report (AC) [12]
Report of a study aimed at the design optimization of Anticoincidence Detectors (INAF/IAPS, SRON)

D6.3 : Design tradeoff report: AC biased readout [12]
Report of a study aimed at the design optimization of the readout for the Anticoincidence detectors (VTT, SRON)

D6.4 : New set of SQUIDs for readout [24]
production of new SQUIDs fro detector readout

D6.5 : Developed H/W components: X-ray microcalorimeter detector [36]
Delivery of optimized and tested detector prototypes (including measurements report)

D6.6 : Upgraded test facility for readout option [36]
Implemented upgrade on existing facility, for testing readout options

D6.7 : Developed H/W components: AC detector [36]
Delivery of optimized Anticoincidence detector prototype (including measurements report)

D6.8 : Developed H/W components: interconnecting harness [36]
Delivery of interconnecting harness for cryogenic detectors (including measurements report)

D6.9 : Developed H/W components: optical filters [30]
Delivery of optical blocking filters for cryogenic detectors, with measurement of thermal, optical and X-ray properties (including measurements report)

D6.10 : WP6 Final report [42]
Final report covering the full period, including testing H/W components, system performance and additional recommendations

Schedule of relevant Milestones

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<td>MS34</td>
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<td>System performance Report for WP 6.2, 6.3, 6.4, 6.5, 6.6</td>
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ATHENA will be the next ESA observatory Large-class mission to probe the high energy X-ray Universe. Due for launch in 2028 it will have a mirror with unprecedented collecting area (2 m² at 1 keV) and two instruments: the X-IFU (X-ray Integral Field Unit, TES-Transition Edge Sensor based detectors array), the WFI (Wide Field Imager, structured on active pixel sensors based on DePFET). The main difference between them is that the first one will produce high energy resolution spectra of images based on a small field of view, while the second one will produce images of a wide field of view featured by a reduced energy resolution spectra. So they are complementary. The satellite will be inserted into the L2 orbit.

From the scientific point of view two important points are both the instrumental sensitivity, which is connected to the residual particle background (BKG) around the detectors, and its calibration, related to in-depth knowledge of the spectral models of high energy standard candles. The understanding and the improvement of the sensitivity is important for probing faint and/or distant sources, so also going deep in terms of redshift, while the accurate calibration is necessary for providing measurements with high accuracy.

Since no X-ray instrument has ever flown in L2, the worldwide community has no knowledge about the energy spectrum of particles in such an orbit down to keV range that interact with the payload. Thus, it is necessary to continue the already started work to understand the residual BKG around the ATHENA detectors. Further, both Chandra and XMM satellites experienced on their detectors the phenomenon of soft proton focusing (i.e. up to some MeV): like the photons, also low energy protons by grazing incidence on the optics can be focused to the focal plane assembly (FPA), so increasing the local residual BKG.

To address this problem, so providing a very low residual BKG as result, it is necessary to adopt active anticoincidence detectors, and to perform simulation where the input particles, defined by some spectra (scaled by different orbits at L2), interact with the so-called mass model of the satellite/payload/FPA. Usually the tool GEANT4 is used as software since it takes into account all the involved physics, but also the ray tracing technique is used to probe the FPA by photons or protons.

To utilise the full potential of the large effective area provided by ATHENA its instruments should be accurately calibrated. Especially the knowledge of the energy dependence and normalisation of the effective area are very critical when deriving astrophysical results from observations. Thus, is mandatory to complement the on-ground calibration of the ATHENA instruments via in-flight cross-calibration with other high energy missions. We will develop the existing strategy, methodology and standard candle data base for in-flight cross-calibration between instruments onboard ATHENA and other high energy missions.

The main goal of this WP7 is the reduction of the ATHENA BKG, both for the X-IFU (Task 7.2) and the WFI (Task 7.4) instruments, with respect to their baseline level, so this work is addressed to an improvement and to share their common knowledge. Thanks to the drawings/mass model of the instruments for the X-IFU case (Task 7.2) we will also have, through the ray tracing (Task 7.5) the photon response instrument matrix. The minimized (at best) residual BKG and the response matrix is the natural bridge to insert the cross-calibration task (Task 7.3), so to have as conclusion of WP7 activities the best we can have as "calibrated" instruments inserted in the minimum residual BKG. The results from the Task 9.3 will be “disseminated” via a public tool for propagating the current knowledge of instrument calibration uncertainties into the scientific results.
TASK 7.2: X-IFU BKG (INAF/IAPS)
This simulation activities for X-IFU will be performed at the INAF/IAPS. The requirements phase and the instrument model generation will be contributed by scientists from INAF/IAPS and SRON will provide for the part concerning the X-IFU FPA drawings. At the beginning we will use the ATHENA baseline-drawings. This will also ensure a tight interaction with the activities of WP6 (Detectors for Athena: innovations beyond the baseline).

What we have understood during the study for the X-IFU is that the residual particle bkg is mainly composed by electrons, as secondary particles produced in the neighborhood of the TES-array detector: this is the contribution we have further to damp as improvement with respect to the ATHENA baseline.

At present we have in mind to deeply investigate two different solutions, by involving passive and active shields: 1) to study how a Kapton baffle surrounding the TES-array can reduce the flux of secondaries; 2) increase the number of the CryoAC pixels (the baseline foresees a planar structures divided on 4 pixels) in order to cover also the lateral edges of the TES-array to intercept slanted trajectories. This configuration its similar to a half box with 5 faces surrounding the TES-array. The outputs of this Task 7.2 are: a) the detailed mass model of the X-IFU FPA (GEANT4); b) the ultimate residual particles background from the adopted different solutions; c) the photon spectral instrument response matrix (from the filters to the TES array by GEANT4, coupled with the optics ray-tracing from Task 7.5); d) Possible input to FPA design from bkg improvement studies (linked to WP6)

TASK 7.3: CROSS-CALIBRATION (ULEIC, INAF/IAPS, TARTU OBSERVATORY)
Over the last decade a number of astrophysical sources have been identified by the community as standard candles in the high energy regime. They have the property of being stable (or near-stable) and are objects whose spectral properties have been analysed in detail in multi-mission cross-calibration observing campaigns by the current generation of X-ray and gamma-ray observatories such as XMM-Newton, Chandra, Suzaku, Swift and NuSTAR. They include isolated neutron stars, thermal and non thermal supernova remnants and galaxy clusters. This work package will a) develop the diagnostics tools used for estimating the calibration uncertainties between different high energy instruments, b) probe the effect on galaxy clusters properties of the uncertainties of different calibration components from different X-ray instruments, c) bring together the community effort into a single database of spectral models and their cross-calibration uncertainties, associated background and instrument responses into a common and accessible database and d) produce an astrophysical simulator which ties together the spectral models and their cross-calibration uncertainties with spatial information on the sources which are extended (the spatial information will be provided by Chandra which has the highest spatial resolution of existing missions). The simulator will produce spectrally encoded source images and will provide a natural input into Task 7.5 for simulations of the photon response of the ATHENA focal plane assembly.

Hence we foresee as output an Astrophysical "standard candle" source simulator, and as a deliverables, data repository (source and background data, instrument responses and associated cross-calibration uncertainties), spectral models, simulator software.

TASK 7.4: WFI BACKGROUND AND PROTON SCATTERING PROPERTIES OF IR COATED SURFACES (EKUT)
The activities of this task will focus on the particle background of the Wide Field Imager instrument. The goal is to further improve, or at least confirm, in the new configuration of the ATHENA-L2/WFI the background level previously predicted for the WFI in the old IXO/ATHENA-L1 configuration. The study will be based mainly on Geant4 simulations. Together with the optimization of the passive solutions (e.g. identification of the most appropriate materials and geometries in the WFI FPA configuration) useful to reduce the background as much as possible, an electromagnetic approach to prevent secondary electrons generated from the mass surrounding the WFI from reaching the detector will be investigated as well. The assessment of the background component that may result from soft protons funneled to the focal plane by the telescope will be pursued by means of a ray-tracing tool, such an activity is strongly linked with those of Task 7.2 to share the common knowledge, and Task 7.5.

As a specific contribution to the development and validation of the tool, we will provide a matrix energy-angle of experimental data of proton scattering on Iridium coated surfaces, using the setup already implemented for testing eROSITA mirror shell samples at the Van de Graaff accelerator in Tübingen. This activity is strongly connected to the Task 7.5. The activities of Task 7.4 will be developed in coordination and synergy with the activities of the other tasks of WP7, as well as with all other activities within the WFI consortium led by MPE.

TASK 7.5: OPTICS OF PROTON AND PHOTON FOCUSING (INAF/IASF Palermo)
Chandra and XMM-Newton missions showed that X-ray telescopes are able to focus soft protons (100 keV-1 MeV) with grazing incident angles as well as photons. This phenomenon need to be carefully considered in the design of the next generation of X-ray missions planned for working in the Lagrangian point L-2, as ATHENA. The available experimental data on the proton reflection form the optics together with reflectivity tables obtained with specific simulators (e.g. GEANT4, SRIM) can be introduced in a ray-tracing code to model the optics transmission of protons. The main objective of this task will require the following outputs: a) production of a ray-tracing code able to simulate the photon transmission
that will be validated reproducing the performances of working X-ray grazing incident telescopes (i.e. XMM-Newton, Swift). This code, together with the response matrices of the focal plane detectors, will allow us to simulate also the diffuse background; b) production of sets of mathematical functions or numerical tables to model the proton reflection efficiency and the scattering angles as function of the input energies and directions. This task will use the output of the Task 7.4 for the Ir coated surface; c) production of a ray-tracing code able to simulate the transmission at the focal plane of grazing incident photons. This task will join the two previous outputs replacing the models of the photon reflection with the proton one in the photon ray-tracing.

The photon ray-tracing can easily handle event photon list files of calibration sources produced by the Task 7.3. These files in fact are the natural input of the ray-tracing providing that the RA and DEC coordinate of the source (either point-like or diffuse) are converted to the correspondent angles in the telescope reference system.

### Participation per Partner

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### List of deliverables

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### Description of deliverables

Task 7.1 X-IFU mass model Task 7.2 WFI mass model+bkg reduction: Report on feasibility study Task 7.3: Data repository (source and background data, instrument responses), spectral models, simulator software (M42).

D7.1 : X-IFU mass model [18]
The detailed GEANT4 mass model developed for simulation of the X-IFU focal plane assembly (INAF/IAPS)
D7.2 : WFI mass model plus background reduction [18]
Report on feasibility study
D7.3 : Data repository [42]
Source and background data, instrument responses and associated calibration uncertainties, spectral models, simulator S/W.

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Work package number 9 | WP8 | Lead beneficiary 10 | 4 - MPG
---|---|---|---
Work package title | JRA3 – Development and characterization of optics for next generation X-ray telescopes | | |
Start month | 1 | End month | 42

**Objectives**

The goal of this work package is to further develop and characterise four key X-ray optics technologies for the next generation X-ray missions with a special emphasis on the ESA L-class mission Athena. 1) the Silicon Pore Optics (SPO) modules that will be used in the mirror system of Athena, which combines a large collecting area (2 m²), a high angular resolution (5 arcsec) and a large field of view (50 arc minutes diameter). 2) Slumped Glass Optics (SGO) as possible enhancement of the optics for Athena allowing for an increase in the hard X-ray response, dedicated hard X-ray telescopes and short focal length wide-field survey telescopes. 3) lobster eye micro-pore optics (MPO) for wide field X-ray imaging as needed for next generation transient explorers to enable detailed follow up by Athena, 4) Kirkpatrick Baez (KB) optics constructed from silicon plates or glass which represent an alternative for low cost wide field imaging experiments. The groups participating in the work package will be providing demonstrator optics for testing at the Max-Planck-Institute for extraterrestrial Physics PANTER X-ray test facility. In addition a high resolution SPO or SGO optical module (<5 arcsec HEW) will be calibrated in parallel beam configuration at PANTER. As an increasing number of these technologies are based on a modular design ad the large area cannot be achieved by a monolithic structure, there is a need for screening facilities on these modules (X-ray optic units or XOUs in short). A prototype BEaTriX (Beam Expander testing X-ray facility) for screening the XOUs will be setup, tested and verified by comparison with PANTER data. Metrology and simulations will be provided for ground-based test facility configurations and in orbit-like conditions. A common European position with respect to these different technologies will be boosted by detailed simulations of this technology in a common framework.

**Description of work and role of partners**


MPG, INAF, ULEIC, CESKE VYSOKE UCENI TECHNICKE V PRAZE

This work package will be divided into 4 parts:

WP8.0 MANAGEMENT

Management of this WP will be carried out by Max-Planck-Institute for extraterrestrial Physics (MPE, part of MPG), with no funding requested. This will be done in close cooperation with the three other three institutes involved in this WP. Whereas the development of the experimental activities will be centered at the relevant laboratory, there will be yearly meetings to coordinate activities.

WP8.1 SIMULATION AND TESTING OF PROTOTYPE X-RAY OPTICS (ULEIC/MPE/INAF-OAB/CTU)

Detailed simulations will done to predict the in-orbit and ground based (finite source distance or parallel beam) performance (i.e. the point spread function and efficiency) of existing prototype optics. These optics will be provided for tests at PANTER by the groups developing them. The following 4 key X-ray optics technologies will be studied (see Figure 1):

- Silicon Pore Optics (SPO) are currently investigated for the development of the ATHENA large collecting area optics. Both the Wolter-I and KB geometries will be investigated. - ESA/Cosine.
- Square pore micro-channel plates (MCP) will be investigated for the development of lobster eye modules for wide field x-ray imaging. - University of Leicester.
- Slumped Glass Optics (SGO) are currently investigated as an alternative to SPO for the development of the ATHENA large collecting area optics. Both the Wolter-I and KB geometries will be investigated. - INAF-OAB / MPE
- Silicon Wafer Optics (SWO) will be investigated for the development of KB geometry optics as an alternative to glass plates - CTU

The work will comprise studying, simulating and ray tracing the current optical designs possibilities for the all three X-ray optics geometries, Wolter-I, Kirkpatrick-Baez, Lobster Eye (see figure 2). An assessment and modelling of inherent aberrations and determining the error budget for the technologies with a detailed breakdown of all the contributions which limit the angular resolution, size of field of view and collecting area will be performed. From this a detailed simulation of instrument response for all cases will allow a prediction of the scientific performance. Also studies of different substrates Si vs. Glass for the KB modules will be carried out. For testing each of the four technologies at PANTER the setup will be optimised and simulated so that the measured results can be compared with the expectations.
in a consistent way for all technologies. For all the tests the setup geometry in PANTER will be optimised for each optic and the analysis software modified so that the results can be compared with the simulations.

Furthermore from the SPO and SGO optics that will be tested a good high resolution XOU (called ‘master’) will be selected and characterized in detail using the PANTER collimated X-ray beam. This XOU will then be used for a cross check of the BEaTriX test facility performance (see WP8.2).

WP8.2 SETUP AND VALIDATION OF A XOU SCREENING TEST FACILITY FOR ATHENA (OAB/MPE)

BEaTriX (Beam Expander Testing X-ray facility, see Figure 3) will be installed at INAF/OAB, Merate (Italy). It will be a facility to provide fast, full illumination, functional tests of X-ray mirror modules. The compact chamber size will allow a fast pump down (< 1 h) possible, providing feedback to the mirror manufacturing chain in a comparable time. The system relies on a double expansion of a monochromatic X-ray beam from a very small, isotropic source via a parabolic mirror and asymmetric diffraction from a large, monolithic crystal. The current design will allow the production of a parallel and collimated X-ray beam of about 200 mm x 60 mm, that is sufficient to fully illuminate the largest XOU's that will be produced for ATHENA. Once developed, such a facility can be setup at the industrial site where the mirror units will be produced. The validation of the facility will be performed using the “master” XOU characterised in the WP8.1. Apart of the use in the context of Athena, this facility has a wider usage for any future development of optics based on the modular approach. The following points will be addressed in this work package and the results presented in reports. These comprise a detailed performance simulation aimed at establishing the manufacturing tolerances, the manufacturing of the beam expanding elements and related mechanical parts, and following up the procurement of other beam line components and the assembly of BEaTRIX, finalising with an X-ray performance verification. All this work will be summarized in detailed reports that will be delivered.

WP8.3 IMPROVED PARALLEL X-RAY BEAM FOR STUDYING HIGH SPATIAL RESOLUTION ATHENA OPTICS (MPE/OAB/LU)

The characterisation of high resolution X-ray optics requires a beam divergence of less than 1 arcsec. To date all measurements of X-ray optics are performed at X-ray test facilities such as PANTER which provide slightly divergent beams. Large collimated X-ray beams are very difficult to generate. At PANTER this problem has been studied and with a prototype 5 cm diameter full Fresnel zone plate with a focal length of 120 m the quality of a collimated beam has been measured at 1.5keV and shows that the required divergence can be achieved. This has led to an initial design of a Fresnel zone plate sector which generates a 100 mm x 50 mm parallel beam which is currently being implemented at PANTER (see Figure 3 right). Further optimisation of material and geometry to improve the efficiency and the quality of the zone plate is required and will be studied in this work package.

In this package the tests setups will be designed and implemented so that the measurements can be taken in the optimum geometry. In addition custom written analysis software will be used to analyse this data so that it can then be compared to the simulations. These results will be presented in corresponding reports.
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List of deliverables

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<td>D8.11</td>
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Description of deliverables

1. Reporting Dates: 1) T0 + 10 months; 2) T0 + 28 months; 3) T0 + 40 months. WP8.1: Simulation, production and testing of prototypal X-ray optics (ULEIC/MPE/INAF-OAB/CTU): 1. - Comprehensive reports on optical design, error budget, scientific performance and analysis/calibration. 2. - Detailed trade-off of technologies to implement the optical design - Characterization of master high resolution XOU (HEW < 5") 3. - Report of the measurements of the different X-ray optics units compared with the simulations. - Report on software package used to support the optical design, error budget, simulation and calibration. WP8.2 Setup of the BEaTriX XOU screening test facility (INAF-OAB/MPE) 1. Final design report 2. Report on the technical assembly completion 3. Report of the X-ray test and performance verification WP8.3 Optimisation (materials and geometry) of a collimated beam using a zone plate sector approach (MPE) 1. Report on the design improvements to the collimated X-ray beam 2. Report on the implementation of the optimized the collimated X-ray beam 3. Report on the performance verification of the collimated X-ray beam

D8.1 : Prototype Design and Performance Report [10]
Report of optical design, error budget, scientific performance, analysis plus calibration. Related activity: simulation and testing of prototype X-ray optics (WP 8.1)
D8.2 : Screening test facility final design report [10]
Report on the final design of the BEaTriX XOU screening test facility. Activity related to WP 8.2. To be provided by INAF/OAB
D8.3 : Design report on the collimated X-ray beam [10]
Report on the design improvement of the collimated X-ray beam. Activity related to WP8.3
D8.4 : Optical design tradeoff report [28]
Detailed trade-off report of technologies to implement the optical design. Activity related to WP8.1
D8.5 : Report on the characterization of master high resolution XOU [28]
Report on the characterization of master high resolution X-ray optical unit, for tests performed at PANTER facility. Activity related to WP8.1
D8.6 : Screening facility technical assembly completion report [28]
Report on the technical assembly completion of the BEaTriX XOU screening test facility. Activity related to WP8.2. To be provided by INAF/OAB
D8.7 : Implementation report of the optimized collimated X-ray beam [28]
Report on the implementation of the improved parallel X-ray beam for testing high resolution optics. Activity related to WP8.3
D8.8 : Measurements vs theory report of the different X-ray optics units [40]
Report of the measurements of the different X-ray optics units compared with the simulations. Activity related to WP8.1

D8.9 : Report on software for optical design, theory and simulations [40]
Report on software package used to support the optical design, error budget, simulation and calibration. Activity related to WP8.1

D8.10 : X-ray test and performance verification report [40]
Report on the X-ray test and performance verification of the BEaTriX XOU screening test facility. Activity related to WP8.2. To be provided by INAF/OAB

D8.11 : Performance verification report for the collimated X-ray beam [40]
Report on the performance verification of the collimated X-ray beam for the testing of high resolution optics. Activity related to WP8.3

### Schedule of relevant Milestones

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<td>Meeting to present and review the activity on the: -WP8.1, detailed trade-off of technologies to implement the optical design (see deliverable D8.4) - WP8.2: technical assembly completion (see deliverable D8.6) - WP8.3: implementation of the optimized the collimated X-ray beam (see deliverable D8.7)</td>
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<td>-WP8.3: performance verification of the collimated X-ray beam (see deliverable 8.11)</td>
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Objectives

The European Gamma-Ray community has a long and successful record in designing, realizing and observing with space observatories. At present, a large number of laboratories prepare the future through ambitious R&D programs on the key technologies required for the next step in space. Given the limited number of flight opportunities, and the fierce competition to get selected by a space agency, it is important to present mature proposals in response to the rare calls of opportunity.

In order to improve the chances of a future gamma-ray astrophysics mission, WP9 will develop tools that enable performance evaluation, for the selection and further development of an instrument concept, based on state of the art technologies, to be proposed for the next generation of gamma-ray observatory.

The essence of WP9 is as a service to the gamma-ray community: the simulation of instrument concepts relevant for the present key science questions in the domain, providing a common denominator for selecting a future space mission.

Description of work and role of partners

WP9 - JRA4 – Assessment of gamma-ray experiments [Months: 1-42]
CNRS, UNIFE, CEA, CSIC, LIP, INFN

WP9 shall support activities like simulation, feasibility studies and assessment of instrumentation devoted to the hard X-ray to soft-medium gamma-ray range (0.1- >100 MeV)

Work method - achieving the objectives of WP9 will require six tasks:

a) prioritize gamma-ray science objectives
b) define mission requirements
c) design instrument concepts
d) select instrument concepts to be studied
e) simulate the selected instrument concepts
f) discuss and valorize the results

TASK WP9A : PRIORITIZATION OF GAMMA-RAY SCIENCE OBJECTIVES
The "Science Advisory Group" (SAG) will assess and prioritize the science program for the future mission(s), it defines scientific goals to be achieved by the instruments. Starting at the kick-off meeting of WP9, the SAG will work during the initial phase of AHEAD, producing a white paper of the science objectives (deliverable 1) for month 6. The white paper will be presented at a common SAG/IWG meeting (milestone 1) and serves as input for WP9b.

TASK WP9B : DEFINITION OF MISSION REQUIREMENTS
The scientific input defined by the SAG will serve as a basis for the "Instrument Working Group" (IWG) which will develop the science program into instrument performance requirements. This work starts at the milestone 1 meeting. After a duration of 3 months, the mission requirement document (milestone 2, deliverable 2) will be issued to the community.

TASK WP9C : DESIGN OF INSTRUMENT CONCEPTS
A call for instrument concepts will be issued to the larger gamma-ray community (AHEAD and beyond) following milestone 2. The responses shall satisfy the instrument performance requirements elaborated by the IWG and are due Month 12.

TASK WP9D : SELECTION OF INSTRUMENT CONCEPTS TO BE ASSESSED
The submitted proposals will be examined by a selection committee (milestone 3). Two or three mission proposals will be selected for detailed assessment in WP9d. The selection will be made public in a report (deliverable 3) containing the submitted proposals along with the analysis/decision of the selection committee.

TASK WP9E : SIMULATION OF RELEVANT INSTRUMENT CONCEPTS
The simulation of the selected instrument concepts is the central activity of WP9. It is provided by the Simulation Working Group (SWG): the assessment of the instrument concepts with the same tools will provide a common denominator for selecting a future space mission.

The performance parameters for each of these payloads is to be simulated: the main driver, sensitivity, critically depends on the effective area and background - and according to the science objectives on the angular and spectral resolution (which are simulation results by themselves). The detectors studied shall be derived from existing state of the art detectors - i.e. highly integrated, low noise, low power devices - such as the ones presently developed by several of the participating institutes. WP9e will also support the assessment and simulation of Focusing Optics (Multilayer telescope concepts, Laue lens telescope concepts). For each of the studied payloads, an accurate mass model that includes passive material in the detectors and their surroundings, realistic energy thresholds and energy and position measurement accuracy, and an approximate spacecraft bus mass and distribution are crucial to this modeling. Particular care will be taken to accurately include all passive materials close to the detector. The simulated background environment will include cosmic diffuse photons, cosmic-ray protons, electrons, and positrons, calculated using the MEGAlib environment tools.

The MEGAlib toolbox is ideally adapted for the task of the SWG: it consists of a set of software tools designed to simulate and analyze data of gamma-ray detectors, with a specialization on Compton telescopes. While it has been originally developed for the Compton scattering and pair creation telescope MEGA (MPE/A. Zoglauer), it also has been successfully applied to a wide variety of hard X-ray/gamma-ray telescopes in space and on ground, such as COMPTEL, NCT, ACT, NuSTAR. While MEGAlib is perfectly suited for the simulation of focal plane detectors, dedicated software is used for the simulation of the performance of multilayer mirrors (MCMC at DTU) and Laue lenses (LLL).

According to the instrument concepts selected (see WP9d), a number of post-docs/physicists will be hired by the board to work at the various institutes of the participants. The main objective shall be the simulation of the selected mission concepts, and the assessment of the respective performances in the light of the mission requirement document (milestone 2, see above). The contribution of the post-docs shall be a "service" to the entire AHEAD community - i.e. they shall simulate/optimize/assess the mission concepts proposed and make them evolve.

The main effort of WP9e will be provided by the member institutes of the SWG. Through regular meetings with all the WP9 partners, the concepts will go through iterations (including risk assessment, benefit- and cost-trade-off), and (hopefully) converge into a commonly accepted mission.

The progress meetings of the SWG will punctuate the simulation work in 6 month intervals.
- 1st SWG meeting - month 12: kickoff for the simulation activities with the SAG/IAG
- 2nd SWG progress meeting - month 21: progress meeting
- 3rd SWG progress meeting - month 27: progress meeting
- 4th SWG final meeting - month 36: simulation completed, presentation of results to SAG/IAG

The detailed report on the performance of the studied instrument concepts is deliverable 4 (month 36).

**TASK WP9F: DISCUSSION AND VALORIZATION OF THE RESULTS**
The main results obtained in WP9 shall be presented in an international symposium open to the larger astrophysics community; the Symposium will address the key science case(s) selected in WP9a. The Symposium is organized under the responsibility of the board of WP9 during the last months of AHEAD 1. The proceedings of the Symposium are deliverable 5 (month 42) - after refereeing, the papers will be published in a special issue of "Experimental Astronomy".

### Participation per Partner

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### List of deliverables

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<th>Type</th>
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<td>D9.5</td>
<td>Report on the Gamma-Ray Symposium</td>
<td>24 - CNRS</td>
<td>Report</td>
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### Description of deliverables

1. White Paper on scientific goals to be achieved by the instruments - SAG/IAP (Month 6) 2. Mission requirement document (AO for mission concepts) - IAG/IRAP (Month 9) 3. Short report on the mission selected for detailed assessment - IAG/IRAP (Month 12) 4. Detailed report on the performance of the studied instrument concepts - SWG/IRAP (Month 36) 5. Report on the Gamma-Ray Symposium - SAG/IAG/SWG (Month 42) Also, after refereeing, the papers will be published in a special issue of "Experimental Astronomy"

- **D9.1 : White paper [6]**
  Science paper describing the prioritization of gamma-ray science objectives. Activity related to WP9a. To be provided by CNRS/IRAP.

- **D9.2 : Mission Requirements Document [9]**
  Document issued by the Instrument Working Group, describing instrument performance requirements. Activity related to WP9b. To be provided by CNRS/IRAP

- **D9.3 : Report on the selected mission design [12]**
  Short report on the mission designs selected for study. Activity related to WP9d. Document issued by a WP9 selection committee. To be provided by CNRS/IRAP.

- **D9.4 : Detailed performance Report [36]**
  Detailed performance Report

- **D9.5 : Report on the Gamma-Ray Symposium [42]**
## Schedule of relevant Milestones

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<th>Milestone number</th>
<th>Milestone title</th>
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<th>Means of verification</th>
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<td>MS43</td>
<td>Common SAG/IWG meeting</td>
<td>24 - CNRS</td>
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<td>Science White Paper</td>
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<td>MS44</td>
<td>IAG issues AO</td>
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<td>Mission requirement document</td>
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<td>Simulations completed</td>
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<td>Full WP9 Report</td>
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<td>MS47</td>
<td>Gamma-Ray Symposium</td>
<td>24 - CNRS</td>
<td>42</td>
<td>SI in &quot;Experimental Astronomy&quot;</td>
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</table>
The goal of this Work Package is to kick-off the transition of the technologies pioneered by the AHEAD project from laboratory prototypes to a set of mature and well-engineered products that could be used as building blocks for future instruments for space missions as well as other applications.

The proposed work starts with an application survey (Task 10.2) analysis where the technologies developed in the frame of the other AHEAD WPs are analysed in terms of their possible use in the field of both space missions and non-spatial applications. The application survey of this WP includes an assessment of the overall characteristics and performances of the newly developed technologies and a set of study cases where these technologies are put at the core of future implementation. Example of study cases are (but not limited to) scientific space missions other than Astrophysics, like in the fields of geo-science, environmental and earth observation. In the field of non-spatial applications some important study cases will be introduced either to improve technological processes (e.g. non-invasive inspection in biology and materials characterization) or based on their potential benefit for society and mankind in general like medical diagnostic, diffuse radioprotection and landmines localization.

The most advanced technology developed within AHEAD will be further developed to the level of engineering studies down to the level equivalent to a phase B study in a space program (Task 10.3). This WP activity will start by a system engineering study for the realization of a complete micro-calorimeter system for use in space missions. The study will cover all the involved aspects of such development, including the procurement philosophy for critical components and materials and the use of test and calibration facilities as studied in the other WPs of the AHEAD project. Finally, on the basis of space application study results the most promising no-spatial application will be detailed. A cost evaluation at system component level will be performed in support of a possible development step.

### Description of work and role of partners

**WP10 - JRA5 - Technology Innovation** [Months: 1-42]

**TAS Italia**

The proposed work breakdown structure for WP10 is as follows:

- **WP10.1 PROJECT OFFICE AND MANAGEMENT (TAS-I)**
- **WP10.2 APPLICATION SURVEY (TAS-I)**

The main goal of this WP is to perform a broad survey on the possible application of the technologies developed within AHEAD for future space missions and for non-spatial applications. With regard to spatial applications, the survey will be aimed to analyse application beyond that for high energy astrophysics taking in account other fields e.g. observational cosmology, planetology, sun-science and earth applications like remote sensing, geo-science, atmospheric science. Survey of non-spatial applications will be targeted to the identification of possible spin-off in various fields with impact on the society. A possible important topic of this survey is the use of a combination of the technologies developed in AHEAD for landmines localization in the field. This challenging project would exploit the availability of well-engineered arrays of high sensitive and high resolution detectors (having both imaging and multi-spectral capability), together with specialized optics and ancillary HW and SW detector technologies, to pinpoint scattered and buried landmines. Locating these landmines would allow the clearing of many areas presently unusable for human sustaining as a follow up of regional wars e.g. in the Balkans or Mid-East and Far-East countries. Other topics of this survey will be in the medical diagnostics and material and biology science providing methods for less invasive measurement and analysis. A final task of this WP is the individuation and analysis of the detailed requirements set by the applications in all those fields. The task also aims to identify possible product lines to fulfil the most interesting needs which will be highlighted.

- **WP10.3 FEASIBILITY / SYSTEM ENGINEERING STUDY M-CALORIMETERS (TAS-I)**

The main task of this WP is the engineering study of a µ-calorimeter system for a space mission and its applicability to non-space technologies and usages. The requirements of the system to be engineered will be identified following the results of WP10.2: we can envisage it will be based on an array of TES detectors with spectroscopic and imaging capability, as those developed in WP6.
The engineering study will include all elements of a complete system, from the detector array, the thermo-mechanical design and the readout electronics and cooling system. The engineering study will also include the identification of the product development plan including the procurement strategy and use of test/calibration facilities. The engineering study will be carried out up to the level of a phase B (definition of all HW and SW interfaces, definition of functional block diagrams, definition of engineering budgets (mass, power, volume, data rate etc.), definition of costs). On the basis of engineering study results a non-space technology application case will be detailed.

### Participation per Partner

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<th>Partner number and short name</th>
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### Description of deliverables


Preliminary report on the technology transfer survey

D10.2 : Survey Report Final [41]
Final report of the results of the application survey. Related to WP10.2

D10.3 : Market Analysis [29]
Market analysis for the identified target applications. Related to WP10.2

D10.4 : System requirements study report [11]
Requirements document for the System Engineering Study of micro-calorimeters.

D10.5 : System engineering report issue 1 [29]
Report of system engineering study for microcalorimeters. Related to WP 10.3

D10.6 : System Engineering Report final [41]
System Engineering Report final issue, including engineering budgets and costs. Related to WP10.3

### Schedule of relevant Milestones

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<td>Test readiness review for</td>
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<td>Ultimate X-IFU bkg</td>
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<td>WP8</td>
<td>4 - MPG</td>
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<td>Common SAG/IWG meeting</td>
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<td>Science White Paper</td>
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### 1.3.5. WT5 Critical Implementation risks and mitigation actions

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<td>R1</td>
<td>Failure from a participant to accomplish a major task for the project.</td>
<td>WP1</td>
<td>The Board will reassign the required work, e.g., to another AHEAD participant with reallocation of funds, or will find a new participant, after formal agreement by the EC and signature of an accession to the Grant Agreement.</td>
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<td>R2</td>
<td>Delay in launch date of near-future missions (Astro-H, e-Rosita)</td>
<td>WP2</td>
<td>It is unlikely that both missions will be delayed and the topics and dates of the Meetings and Schools can easily be adjusted to take this into account.</td>
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<td>R3</td>
<td>Number of proposals for access to facilities is lower than expected requests.</td>
<td>WP4</td>
<td>We estimate that the risk is low as far as the project covers a time period of intense R&amp;D activity for Athena. Recovery actions include a) stronger communication to advertise the offer; b) a dedicated management team for in-depth analysis and solutions; c) reallocation of the funds within TNA.</td>
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<td>R4</td>
<td>Unavailability of research scientists to support user visit</td>
<td>WP5</td>
<td>Adopt a flexible approach to scheduling user visit</td>
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<td>R5</td>
<td>Web page not delivered on time</td>
<td>WP5</td>
<td>Will deploy additional programming effort at no cost</td>
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<td>R6</td>
<td>Proposed detector development turns out to be unrealistic</td>
<td>WP6</td>
<td>Following parallel routes we have reduced the risks and we plan to assess these risks after the trade-off review (month 12). If necessary we will reallocate the funding between the sub-tasks in WP6.</td>
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<td>R7</td>
<td>Science return from improved hard X-ray response of the anti-co detector is limited</td>
<td>WP6</td>
<td>(a) It is the purpose of this activity to define the added science return. Only in case of a major improvement this will be followed for Athena as the added complexity to the instrument is expected to be significant. (b) Development of the hard X-</td>
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<td>WP Number</td>
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<td>R8</td>
<td>Problem at the selected Proton beam facility to test scattering from Ir coated samples</td>
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<td>If the foreseen tests are not feasible at the EKUT accelerator, we will look for other similar facility available in the EU. If the latter is capable of carrying out the proposed measurements, this could be added as a new participant after formal agreement by the EC.</td>
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<td>R9</td>
<td>Unavailability of PANTER due to testing flight optics as well as upgrading the parallel beam.</td>
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<td>Adjust the testing schedule to accommodate the additional optics. The required testing level for this program is limited (several weeks) and in general this can be done in between calibration campaigns for flight optics</td>
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<td>Delay in realization of the BEATRIX test facility.</td>
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<td>As this is a new facility development long lead items could be a problem. This can be mitigated by early on identifying such components and ordering them early on. A delay in the optical qualification tests of the facility of up to 6 months could be accommodated.</td>
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### 1.3.6. WT6 Summary of project effort in person-months

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1.3.7. WT7 Tentative schedule of project reviews

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## 1.3.8. WT8 Summary of transnational / virtual access provision per installation

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1.4. Ethics Requirements

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<td>- The applicant must confirm that the ethical standards and guidelines of Horizon2020 will be rigorously applied, regardless of the country in which the research is carried out</td>
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1. Project number
The project number has been assigned by the Commission as the unique identifier for your project. It cannot be changed. The project number should appear on each page of the grant agreement preparation documents (part A and part B) to prevent errors during its handling.

2. Project acronym
Use the project acronym as given in the submitted proposal. It can generally not be changed. The same acronym should appear on each page of the grant agreement preparation documents (part A and part B) to prevent errors during its handling.

3. Project title
Use the title (preferably no longer than 200 characters) as indicated in the submitted proposal. Minor corrections are possible if agreed during the preparation of the grant agreement.

4. Starting date
Unless a specific (fixed) starting date is duly justified and agreed upon during the preparation of the Grant Agreement, the project will start on the first day of the month following the entry into force of the Grant Agreement (NB: entry into force = signature by the Commission). Please note that if a fixed starting date is used, you will be required to provide a written justification.

5. Duration
Insert the duration of the project in full months.

6. Call (part) identifier
The Call (part) identifier is the reference number given in the call or part of the call you were addressing, as indicated in the publication of the call in the Official Journal of the European Union. You have to use the identifier given by the Commission in the letter inviting to prepare the grant agreement.

7. Abstract

8. Project Entry Month
The month at which the participant joined the consortium, month 1 marking the start date of the project, and all other start dates being relative to this start date.

9. Work Package number
Work package number: WP1, WP2, WP3, ..., WPn

10. Lead beneficiary
This must be one of the beneficiaries in the grant (not a third party) - Number of the beneficiary leading the work in this work package

11. Person-months per work package
The total number of person-months allocated to each work package.

12. Start month
Relative start date for the work in the specific work packages, month 1 marking the start date of the project, and all other start dates being relative to this start date.

13. End month
Relative end date, month 1 marking the start date of the project, and all end dates being relative to this start date.

14. Deliverable number
Deliverable numbers: D1 - Dn

15. Type
Please indicate the type of the deliverable using one of the following codes:
- Document, report
- Demonstrator, pilot, prototype
- Websites, patent filings, videos, etc.
- OTHER

16. Dissemination level
Please indicate the dissemination level using one of the following codes:
- Public
17. Delivery date for Deliverable
Month in which the deliverables will be available, month 1 marking the start date of the project, and all delivery dates being relative to this start date.

18. Milestone number
Milestone number: MS1, MS2, ..., MSn

19. Review number
Review number: RV1, RV2, ..., RVn

20. Installation Number
Number progressively the installations of a same infrastructure. An installation is a part of an infrastructure that could be used independently from the rest.

21. Installation country
Code of the country where the installation is located or IO if the access provider (the beneficiary or linked third party) is an international organization, an ERIC or a similar legal entity.

22. Type of access
- VA if virtual access,
- TA-uc if trans-national access with access costs declared on the basis of unit cost,
- TA-ac if trans-national access with access costs declared as actual costs, and
- TA-cb if trans-national access with access costs declared as a combination of actual costs and costs on the basis of unit cost.

23. Access costs
Cost of the access provided under the project. For virtual access fill only the second column. For trans-national access fill one of the two columns or both according to the way access costs are declared. Trans-national access costs on the basis of unit cost will result from the unit cost by the quantity of access to be provided.
HISTORY OF CHANGES

First Submission (14/04/2015):
- PIC of participant VTT is changed;
- Budget info for “UNIVERSITE DE GENEVE” updated to account for the non-requested grant;
- Milestones & Reporting periods changed to months 18-18-6; updated description of WP1, task 1.3;
- Milestone & Deliverable dates updated to match with new reporting periods scheme;
- TNA access cost of CNRS, LAM facility “SPATIAL” changed from unit costs. N.of access for SPATIAL changed from 16 to 24. Updated in Table 3.2c;
- Table 3.1c - change N/A to ‘R’ for Minutes of Meetings;
- Deliverable 3.3 (booklet) changed to “OTHERS”;
- Deliv. 3.6 change “DEC” to “R”;
- Table 3.1a4 “WP4 description”. The sentence “In particular for each measurement run at SPATIAL facilities, we plan to cover 50% of the facility running cost, including FTE costs of the LAM facility team involved, with in-house funding, while the other 50% will be covered by EU” has been dropped;
- Table 3.4b: added access cost description for participants INAF, ULEIC, UNIPG to include access costs for installations using “unit cost” accounting method;
- Table 3.4b: added access cost description for participant CNRS;
- Removed tables in Sect 3.4 (Resources to be committed).

Second Submission (4/05/2015):
- Removed Tables from 3.1a1 to 3.1a10: Work package description and Synthetic description of the infrastructures participating in TA1 and TA2;
- Removed Table 3.2.C;
- Section 4.2, added information on SERMS srl (“The SERMS s.r.l. estimation of the costs budgeted for the in-kind contribution is € 5120, and will be regulated by article 12 of the General Model Grant Agreement”);
- Add details in TNA Table for UNIPG (installation CEM and SERMS), and for CNRS (installation SPATIAL);
- Page 20, Gannt chart updated for WP1 following change of schedule for reporting periods;
- Changed effort in WP9 for CNRS from 54,5 P/M to 38 P/M: 30P/M for post-doc and 8 P/M of senior scientists employed by CNRS;
- WP1,WP4, updated the deliverables for the Reporting Period in order to be congruous with the milestone;

[654215][AHEAD] – PART B
- WP2, removed the connection to D2.1
- WP9, Add deliverables 49 (relative number in wp D9.4) and 50 (relative number in wp D9.5);
- WP1-10, corrected the milestones wrongly listed,
- Improved description WP8_Milestone.

**Third Submission (6/05/2015):**
- Section 4 Members of Consortium, 4.1 Participants, added clarification for 3.SRON and 14.VTT;
- WP1, removed in “General Description of all Deliverables” item 2_SAC members list and item 3_Quality assurance procedures;
- Linked Milestones from M1 to M4 only to WP1.

**Fourth Submission (19/05/2015):**
- For the Beneficiary 5 deleted € 5.000 from column “Direct costs for subcontracting” and add € 4.000 to column “Other direct costs”, and recalculated 25% for indirect costs;
- Updated table 3.4b for Beneficiary 5, production of a web page for € 4.000;
- Updated table 3.4b for Beneficiary 13, deleted reference to subcontracting;
- Add information in section 4.2, for subcontracting under Beneficiary 13;
- Deleted sentence on subcontracting by Beneficiary 5, in section 3.4.
1. Excellence

**Biological and Medical Sciences - Starting Communities**
- Health information, clinical data, samples and medical images – support to population studies.
- New tools and resources for analysing and integrating genomic, epigenomic, proteomic, metabolomic and phenomic data.
- Plant and forestry material resources.
- European nanomedicine characterisation infrastructure.
- Research infrastructures supporting rare diseases research.

**Biological and Medical Sciences - Advanced Communities**
- High-containment biosafety facilities and virus collections including for high-risk animal/human pathogens.
- Vaccine infrastructures.
- Research infrastructures for translating research on biological structures into innovation in biomedicine.
- Research infrastructures in aquaculture.

**Energy - Starting Communities**
- European facilities for electrochemical energy storage testing.
- Testing of wind turbines, ocean energy converters and electrical subsystems for grid integration under laboratory conditions.

**Energy - Advanced Communities**
- European smart grids research infrastructure.

**Environmental and Earth Sciences - Starting Communities**
- Research infrastructures for hydrological/hydrobiological research.
- Research infrastructures for research on crustal fluids and geo-resources.
- Research infrastructures for long-term ecosystem and socio-ecological research.
- Research infrastructures for ocean drilling.

**Environmental and Earth Sciences - Advanced Communities**
- Aerosol, clouds, and trace gases research infrastructure.
- Research infrastructures for environmental hydraulic research.
- Research infrastructures for terrestrial research in the Arctic.
- Research infrastructures for forest ecosystem and resources research.
- Research Infrastructures for integrated and sustained coastal observation.

**Mathematics and ICT - Starting Communities**
- Distributed, multidisciplinary European infrastructure on Big Data and social data mining.

**Mathematics and ICT - Advanced Communities**
- Integrating activity for facilitating access to HPC (High Performance Computing) centers.

**Engineering, Material Sciences, and Analytical facilities - Starting Communities**
- Advanced frontier research in nanoelectronics.
Engineering, Material Sciences, and Analytical facilities - Advanced Communities
- Advanced nanofabrication.
- Advanced material research based on large-scale facilities.
- Leading-edge research based on advanced laser sources.
- Functional materials for special applications.
- Facilities for research on materials under extreme conditions.
- Large-scale testing facilities for engineering applications.

Physical Sciences - Starting Communities
- European laboratory astrophysics.
- Research infrastructures for high-energy astrophysics.
- Science at deep-underground laboratories.
- Integrating gravitational wave research.

Physical Sciences - Advanced Communities
- Detectors for future accelerators.
- Research infrastructures for nuclear physics.
- European planetary science.

Social Sciences and Humanities - Starting Communities
- Generations and gender: a cross-national longitudinal data infrastructure for research on social cohesion and social inclusion and for the study of inter-generational relations in an ageing society.
- Research infrastructures for studying the role of intangible investment for economic growth and for the study of cultural, historical and institutional innovation processes.

Social Sciences and Humanities - Advanced Communities
- Contemporary European history: European Holocaust research infrastructure.
- European research infrastructures for restoration and conservation of cultural heritage.
1.1 Objectives

High-Energy astrophysics is entering a new era with the selection by the European Space Agency of the Hot and Energetic Universe as science theme for the next large class mission with a launch in 2028. R ESA has recently selected the X-ray Observatory Athena (Advanced Telescope for High Energy) as the relevant mission. Although 2028 looks far ahead, it is now the critical point in time to prepare for this new facility. The technology should be ready in the next 4 years before the mission enters into the implementation phase and the community should be prepared and get trained. At higher energies the few opportunities that will be offered in the future require the build up of a community consensus on scientific and technological priorities. The exciting science and the cutting-edge technology that will be developed in the next years will be ripe for the benefit of the industrial market and the European society. For this reasons the AHEAD proposal is very timely and will address key objectives:

- Integrate and coordinate national efforts in high-energy astrophysics at a much higher level than is presently available within Europe. AHEAD involves 26 participants from 16 countries, including major European institutions in the field, and offers to users 21 facilities for instrument tests and data analysis. By a strong focus on networking, standardization and establishing common access procedures to facilities, AHEAD aims at bringing the high-energy astrophysical community to an advanced level of integration. Apart of this near term focus, AHEAD will also define the next science goals and enabling technology for high energy astrophysics after the Athena mission, such as a gamma-ray mission.

- Provide a network of ground based test facilities for developing, calibrating and testing both generic technologies as well as instruments developed for space missions in an environment representative of space conditions. This network will ensure that European scientists and engineers have many more opportunities to access some of the most advanced infrastructures for space environmental testing of components and instrument characterization. Access will provided in particular to scientists without national access to similar facilities. For this objective, AHEAD will offer 13 installation facilities that can accomodate 27 different projects, and can serve 54 users, offering a total access of 192 days.

- Push the limits of current technology needed for the optimal science return of new future facilities such as Athena beyond the state-of-the-art by focused development of technology for these missions (in the fields of X-ray collecting optics, development of the detector and handling the in orbit background). This will be realized by bringing scientists from 10 different countries together in a joint research program.

- Ensure maximal scientific return from present observing facilities in the field (XMM, INTEGRAL, Fermi, Chandra,..) by offering access to a network of expert research infrastructures in data analysis and their scientific exploitation. Access will be provided in particular to teams in Europe and Associated Countries who currently have no strong expertise in data analysis. For this objective, AHEAD offers access to 8 facilities that can accomodate 96 different projects, and can serve 96 users, offering a total access of 480 days.

- Promote high-energy astrophysics at various levels (e.g., regional, national, European, international) and in different communities (astrophysics, teachers, and public) and prepare communities in less experienced countries to participate in the science return from future high-energy facilities.

- Ensure maximal scientific return from new facilities under development in Europe such as the Spectrum RG all sky survey (together with Russia) and the dedicated high spectral resolution Japanese mission ASTRO-H to which the EU contributes, by training the next generation of young researchers in the field.

- Combine the knowledge of European scientists and leading European industrial partners enabling technological transfer for the development of innovative technologies for the benefit of the European society and the high-tech industrial market.

This work is also addressing the recommendations of the European Astronomical Society (EAS Working Group on the Future of Space Astronomy)\(^1\), and as such has strong support in our community.

1.2 Relation to the work programme

The AHEAD proposal relates to the topic “Research Infrastructure for High Energy Astrophysics” and is addressing the funding scheme of collaborative research programs, in the framework of Research and Innovation (RIA) action. The scope of the topic, as it reads from the call, is “opening up existing facilities for developing, calibrating and testing both generic technologies as well as instruments developed for space

\(^1\) http://eas.unige.ch/reports.jsp
missions in an environment representative of space conditions. Access should be provided in particular to scientists without national access to testing and calibration facilities, at the same time stimulating scientific and technological exchanges among European teams“.

The ambitious scope of the call will be pursued with a coherent plan including facilities, networking activities and joint research projects. AHEAD will integrate, on a European scale, key research infrastructures for on-ground test and calibration of sensors and electronics for high energy astrophysical space experiments, promote their coordinated use and provide the users with optimized access. Access to those facilities will be regulated by a peer-review committee with priority to users of nations without similar facilities. In a similar fashion, the best facilities and expertise for data analysis of space-base high energy observatories will be made available for the benefit of the astronomical European community, with particular regard to countries with a less advanced experience in the domain. Networking activities will foster a culture of cooperation and build a truly European high-energy community, tightening at the same time the ties with the society with a strong outreach program.

The technological development will focus on the improvement of selected critical technologies beyond the state-of-the-art, and feasibility studies of space-based instrumentation for the benefit of future X-ray and gamma-ray missions, and the best exploitation of existing facilities. The virtual circle infrastructure - networking - joint research activities, as devised in AHEAD (Fig.1), serves to establish strong connections between institutes and industry to create the basis for a more rapid advancement of high-energy astrophysical science, space-oriented instrumentation and cutting-edge sensor technology in Europe. This enables the development of new technologies and the associated growth of the European technology market, as well as the creation of a new generation of researchers. Overall these integrated activities will ensure that the European high-energy astrophysics community will stay at the forefront of this competitive research area and will be able to address fundamental topics in astrophysics encompassing matter under extreme conditions in the close vicinity of black holes, the formation and evolution of Galaxies and of large scale structures, and the life cycle of matter and energy.

Figure 1. Conceptual diagram showing the coherent links between different parts of the AHEAD project and their relationship with Science Community, Society and Industry, placed at the vertex of the two most relevant parts. All NA and TNA activities will have a strong impact on the Science Community, NA (in particular Outreach) and JRA (Innovation) on the Society while TNA (test facilities) and JRA (Innovation, X-ray detectors, Optics, Gamma-ray experiments) on European Industry.
1.3 Concept and approach

Astronomy is one of the most fundamental sciences that focuses on understanding the origin and the content of our Universe, of our Solar System, and Life on Earth. Observational techniques have significantly evolved in the last century, from optical ground telescopes to advanced observing facilities in space. In particular, the twentieth century has seen the opening up of many observing windows of the electromagnetic spectrum from radio to X- and gamma-rays, and more recently up to energies of TeV. Only recently have high-energy photons (of several hundreds to trillions of electronvolts) been detected from astrophysical sources: while the thick Earth atmosphere protects humanity from these energetic photons, it also prevented astronomers from detecting such photons. With the advent of rockets launched in the 1960s with high-energy detectors, high-energy astrophysics was born, starting with the detection of the Sun and many strong X-ray sources that turned out to be exotic astrophysical objects such as neutron stars and black holes. The field of high-energy astrophysics quickly entered main-stream astronomy, recognised by the award of the 2002 Nobel Prize to Prof. Riccardo Giacconi “for pioneering contributions to astrophysics, which have led to the discovery of cosmic X-ray sources”.

European astronomy has quickly integrated high-energy astrophysics and has been central in building and launching high-energy astrophysics missions in space: European nations have contributed actively to X- and γ-ray astrophysics early on (e.g., Copernicus, Astronomische Nederlandse Satelliet, Ariel-V), and have taken responsibility for several important national missions (e.g., BeppoSAX, ROSAT, AGILE). At the European level, the European Space Agency has been pivotal in the field, operating its own high-energy astrophysics missions (COS-B from 1975 to 1982, EXOSAT from 1983 to 1986, XMM-Newton since 1999, INTEGRAL since 2002). The future of European high-energy astrophysics, in particular X-ray astronomy, is now well established: the Athena X-ray Observatory is to be launched as the second ESA L-class missions some time around 2028. It will carry novel instruments and mirrors to resolve fundamental questions for Astrophysics and Cosmology like: how did ordinary matter assemble into the large scale structure we see today? How do black holes grow and shape the Universe? The science and mission concept are described in detail in the relevant ESA white paper². In Fig.2 we summarize the capability of this mission. With its wide field camera large areas of the sky will be mapped and the black hole evolution up to and including the re-ionisation age of the Universe will be determined, enlightening the role of these objects in shaping the formation and evolution of galaxies. With its high spectral resolution of the narrow field camera the metal enrichment and physical conditions of the major constituents of the hot universe, the cosmological filaments and galaxy groups and clusters, will be determined and tracked from their formation era. The frontier will be pushed into the highest redshift universe, to find the spectroscopic signatures imprinted in the spectrum by the explosions of primordial stars. With its unprecedented capabilities in the X-ray domain, Athena will join the large astronomical infrastructures at other wavelengths being built for the next decade and serve the whole astrophysical community.

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Whereas the future of X-ray astronomy in Europe is now well defined, this is less clear for the gamma-ray astronomy. Astronomy in the medium-energy gamma-ray band (0.1 – 100 MeV) holds a rich promise for elucidating many fundamental questions concerning, e.g., nucleosynthesis in stellar explosions (novae and supernovae), the origin of cosmic rays and particle acceleration, the physics of Gamma-Ray Bursts, neutron stars and black holes, celestial sources of positron annihilation, the active sun, or the origin of terrestrial gamma-ray flashes. In addition, this field of astronomy also contributes to the advancement of cosmology and fundamental physics. However, there is not any mission approved in this regime that may follow up INTEGRAL, that has now reached its 12th year of operation. There are ample margins to improve the capabilities in this energy range by e.g. implementing techniques of large sky survey, complemented with pointed observation with focusing devices. At higher energies (~ GeV), with the sensitivity catered by the LAT on Fermi and the Agile contribution, potential improvements may come in pushing the sensitivity and source identification by improving the angular resolution of the detectors. Given the limited number of flight opportunities, and the fierce competition to get selected by the European Space Agency, it is important to present mature proposals in response to the Calls of Opportunity. This requires a strong coordination of the relevant community.

Despite the good auspices for high-energy astrophysics in Europe, there is clearly a strong need to coordinate efforts at the European level. While the European astronomical community working at optical/infrared and millimeter wavelengths have their own Integrated Activities (OPTICON and RADIONET, respectively), the European high-energy astrophysics community does not yet benefit from such approach. In fact, this is even more compelling. In contrast with ground-based activities, access to space required by high energy astronomy, presents some special challenges. For ground-based astronomy there are many more opportunities to contribute to existing and forthcoming facilities. This does not apply to space missions, where there are far fewer missions to which the community can contribute, compounded by the fact that even relatively minor contributions to space projects require significant funding which can only be achieved with support of the national space agencies.

Technology, infrastructures in this field are becoming more complex and expensive, primarily due to the need to meet even more ambitious performance goals, an inexorable pressure that cannot be avoided if cutting-edge science is to be attained. Such demands cannot realistically be tackled by a single nation. Europe has a long history of developing, building and using high-energy space-based technology and the related infrastructures. While flight instruments for approved missions are typically supported by ESA and member state space agencies, the investment in infrastructures and R&D is decreasing rapidly. A related concern, noted in the European Astronomical Society report on the Future of Space Astronomy, is the size and preservability of technology development activities, particularly as the interval between space missions increases. The definition
of a roadmap and priorities allows to focus the resources to those strategic area where European leadership can be consolidated: the goals of this proposal is to keep the technology development capability and the related infrastructure at a sufficient size to maintain a world-leading role and to provide sufficient continuity so that knowledge and expertise can be passed on to each new generation. This calls for the European AHEAD initiative, to create an integrated approach for high energy astrophysics activities (similar to OPTICON), allowing our community to define an optimized strategy for scientific and technological activities and to support these choices, setting the international agenda.

An important step forward in this respect has been achieved by the European high energy community that has converged – through a crucial process of coordinated discussions - on a single mission concept for its next large X-ray observatory. This approach has been successfully rewarded: Athena has been recently approved by ESA as its second large mission for a launch in 2028. The high energy community is now rallying behind Athena, that thus represents the key asset for investments in the coming years, and a milestone for the next generation of young astronomers to be formed now. The next 4 years will be indeed crucial for the best preparation of this facility. The technology should be developed before the mission enters into the implementation phase, scheduled to start in 2019, and the community should be prepared and get trained. The AHEAD proposal that we are submitting in response to the call INFRAIA-2014-1015 is thus perfectly positioned in time and scope to successfully address such a unique opportunity for the high-energy astronomical community. We plan to build upon the first step achieved with the approval of Athena, by strengthening and broadening its context, in terms of infrastructures, networking and focused technological development and offering to the community at large access to related facilities. AHEAD also plans to provide the proper framework to extend such a successful approach for the benefit of the community more specialized in the gamma-ray regime, by strengthening the coordination and supporting the definition of a scientific and technological roadmap by feasibility studies. In addition to test facilities for space-based instrumentation, AHEAD will offer the possibility for scientists to visit major astrophysical institutes and data centers and perform data analysis by accessing data archives and software tools, for different broad and specialised topics.

The various types of activities in AHEAD (i.e. networking activities, trans-national and joint research activities) foresee a high degree of integration with one another (Figure 1). The facilities offered in TNA will take advantage of technological and methodological developments carried out in JRAs, (for example: Instrument background simulation & cross-calibration (JRA) => Access to Data Analysis (TNA)) and, in return, TNA will provide facilities to test and improve the cutting edge technologies and data analysis tools being developed in JRAs. Networking Activities will offer forums for presenting and discussing the methods and results obtained in all JRAs and TNAs, thus providing a valuable feedback for improvements. The outreach activities in NA will focus on AHEAD science and technology topics. A strong link ties various JRA activities. Instrument simulations will evaluate instrumental background and performances in various configurations and then used an input to guide the implementation solutions in the instrument development. Finally, the Innovation work-package will make use of technologies being developed in AHEAD JRA.

A stronger balance in gender is a natural evolution in the field. A considerable fraction of post-docs and over about half of the Ph.D students are women and this will allow us to increase their participation and active role in AHEAD at all levels. Gender balance will be one of the guidelines in the definition of the compositions of the AHEAD committees.

1.4 Ambition

The ambitious objective of AHEAD is to integrate national efforts in high-energy Astrophysics and to promote the domain at the European level, to keep the community at the cutting edge of science and technology, ensuring that space observatories for high-energy astrophysics are prepared beyond the present state of the art. This goal will be pursued with a coherent plan including facilities, networking activities and joint research projects. AHEAD will improve beyond the state of the art the access and the organization of existing infrastructure, by opening 21 ground test and data analysis facilities to 150 users. AHEAD will integrate, on a European scale, key research infrastructures for on-ground test and calibration of sensors and electronics for high energy astrophysical space experiments, promote their coordinated and optimized use, increasing substantially the number of users that do not have access to similar facilities at national level. Access will be not limited to users
in the field of high energy astrophysics but will encompass a much broader community developing technologies relevant to the European industrial market and society and that require environmental test under similar harsh conditions. In a similar fashion, the best facilities and expertise for data analysis of space-based high energy observatories will be made available for the benefit of the astronomical European community, with priority to users where national access to similar facilities is lacking. Networking activities will strongly enhance cooperation between the participants in the project and the scientific communities benefiting from the research infrastructures by supporting a total of 9 meetings, 2 schools and 8 grants for visitor programs. This will also provide a strong feedback to improve the services offered by AHEAD. The technological development will focus on the improvement of selected critical technologies beyond the state-of-the-art, background modelling, cross calibration, and feasibility studies of space-based instrumentation for the benefit of future X-ray (with particular regard to Athena) and gamma-ray missions, and the best exploitation of existing facilities. AHEAD will support members of the high-energy astrophysics community via grants for collaborative studies, dissemination of results, and promotion of workshops organized by the community. The virtual circle infrastructure - networking - joint research activities, as devised in AHEAD, serves to establish strong connections between institutes and industry to create the basis for a more rapid advancement of high-energy astrophysical science, space-oriented instrumentation and cutting-edge sensor technology in Europe. This enables the development of new technologies and the associated growth of the European technology market, with a dedicated technology innovation package - as well as the creation of a new generation of researchers. AHEAD includes a public outreach package to ensure that high-energy astrophysics is well publicized at national, European and International level. Overall these integrated activities will ensure that the European high-energy astrophysics community will stay at the forefront of this competitive research area and will be able to address fundamental topics in astrophysics encompassing matter under extreme conditions in the close vicinity of black holes, the formation and evolution of Galaxies and of large scale structures, and the life cycle of matter and energy.

Networking Activities
The AHEAD Networking Activities are designed to enhance the services provided by the participating research infrastructures and to foster a culture of cooperation between participants in the various activities of AHEAD. The AHEAD Networking Activities also include activities designed to increase interactions between the high-energy astrophysics community at large and participating institutes (e.g., science working groups, selection committees, science advisory committee), aimed to prepare the community for the next observatories that will operate in the field. Grant support to the community will provide a vital mechanism for fostering collaborations and disseminating astrophysical results. Meetings will be organized and visitor support provided that will bring together the high-energy astrophysics community and will promote links with other astrophysics communities. The AHEAD project furthermore includes a dedicated public outreach work package aimed at strengthening ties between the AHEAD project and the general public, school teachers, media, funding agencies, and the European astronomy community. The Networking Activities are also designed to have strong links with the Transnational Access and Joint Research Activities, to ensure a stronger and more coherent integration of the various activities. We summarize below the proposed activities in each Networking Activity (the Management Work Package is addressed elsewhere):

- **NA1 - General Networking, Support to Community (WP2).** The general goal of WP2 is to enhance the collaboration (new or existing), capabilities, skills and performance among the scientific and technological groups in Europe involved, or willing to be involved, in High Energy Astrophysics. WP2 aims at preparing the community at large for the successful exploitation of the high-energy telescopes of the next decade, with particular regard to Athena, but also facilities with European involvement closer to launch, such as ASTRO-H and E-Rosita (both in 2015). This goal will be achieved through the sponsorship of meetings, workshops, schools for young astronomers and an exchange visitor programme for scientists and engineers. Particular emphasis will be given to meetings that a) strengthen the link between the high energy astrophysics community and other communities (such as the radio, infrared and optical), b) strengthen the synergy between the different current X-ray instruments (i.e. cross calibrations, background and instruments simulations). Finally, it will support meetings and workshops of the gamma-ray community, through a dedicated sub-WP, in order to define the science requirements and the instrumentation for the next large gamma-ray telescope. The WP keeps a good balance between fixed specific activities and open calls.
• **NA2 - Outreach activities (WP3)** will strengthen ties between the AHEAD community and the general public, students and educators, and inspire young people to follow careers in space astrophysics as well as in the relevant technology. The WP will setup a dedicated AHEAD high energy astrophysics website portal dedicated to public outreach with online downloadable material such as videos, images, and press-related material. Educational material, including a number of short educational videos on high-energy astrophysics, will be directly produced by this WP. It will coordinate existing Visitor Centres and other publicly accessible astronomical facilities to provide information on activities in high-energy astrophysics, and will coordinate educational material for use at all levels, including organizing events for high-school students and teachers.

**Transnational Access Activities**

The Transnational Access of AHEAD will provide access to some of the best European facilities in the two key areas related to the space-based high energy astrophysics: ground test and calibration facilities for high-energy astrophysics and space instrumentation (WP4 – Access to Facilities); b) data analysis and exploitation facilities (WP5 – Access to Data analysis). All these facilities will be offered via a peer-review process, taking into account scientific excellence and ensuring priority to those users lacking access to the relevant facilities or expertise in their countries. Ground test facilities are used to develop, calibrate and test new space-based technology, as well as hardware developed for specific space missions, in a space-representative environment. The facilities offered by AHEAD represent the state-of-the-art in the field, covering a widespread range of energies and performances. General technologies that require test under similar conditions and that can have a significant impact on the European technological market will also be granted access to AHEAD facilities. With access to data analysis, AHEAD is aiming at opening access to state-of-the-art data analysis in high-energy astrophysics, including use of data tools, archives and space instruments via tutorials and mentoring by experienced scientists in some of the best institutes in Europe. This WP will also offer access to GEANT-based instrument simulations, that will complement therefore the h/w tests offered in WP4, thus allowing in particular the less experienced European groups to assess both science and technological performances. These facilities are currently only used in the context of existing collaborations. Through the support offered by AHEAD they will become available to the full European community. External team access costs will be covered with the support of the European Commission, strengthening scientific and technological exchanges among European teams. In particular, we foresee that such a novel facility network will facilitate access to teams in Europe and Associated Countries who currently have no national access to ground-based test facilities or a strong expertise in the data analysis and will thus benefit in being able to test and calibrate their instruments as well as to pursue their science goals and eventually gain adequate experience.

• **TA1 - Access to Facilities (WP4).** Two key areas are covered by the proposed research infrastructures: a) calibration of detectors and telescopes in X-ray and gamma-rays and particle beams. b) test of hardware for the space environment. X-ray and gamma-ray beam line facilities are needed to calibrate detectors over a wide energy band. An appropriate calibration of the telescope plus focal plane detector requires large facilities with long focal lengths. Crucial for the space qualification of the detectors are environmental tests in an environment representative of conditions in space. For instruments being developed for approved space missions, the norm is for private companies to carry out these tests once the detector development is consolidated. However, there is an increasing demand for these tests during the prototyping phase to reduce risks in later stages of flight projects. Existing research infrastructures used for recent and current missions and instruments will be made available to the scientific community as well as users aiming to test components in similar environment. In order to attract new potential users we plan to realize a dedicated web interface describing the offered facilities, to prepare, in due time, the call for proposals, to disseminate the availability of this opportunity within the High Energy community, as well as to other interested research communities and possibly users from SMEs

• **TA2 - Access to Data Analysis (WP5).** The goal of this work package is to provide trans-national access (TNA) to X-ray and gamma-ray data analysis methods including use of data tools, archives and space instruments via tutorials and mentoring by experienced scientists at the delivery institutes. The offered facilities provide expert access to a large number of high energy observatories (XMM, INTEGRAL,
The AHEAD project is designed to provide an ambitious and strong set of Joint Research Activities and Networking Activities, to ensure a stronger and more coherent integration of the various activities. The Joint Research Activities are also designed to have strong links with the Transnational Access and the application of state-of-the-art technologies for the benefit of the society and industrial innovation in Europe. The transfer of cutting-edge technologies to industry with a dedicated Innovation Package (WP10) that will explore the later phases of instrument development. With AHEAD we aim to enhance this approach, by maximizing the common practice in the field of space instrumentation for high-energy astrophysics to involve industry during the later phases of instrument development. It is already through assessment studies – the definition of science and technology priorities for gamma-ray experiments, improving the coordination and the strength of the community in the proposition of future missions. It is already common practice in the field of space instrumentation for high-energy astrophysics to involve industry during the later phases of instrument development. With AHEAD we aim to enhance this approach, by maximizing the transfer of cutting-edge technologies to industry with a dedicated Innovation Package (WP10) that will explore the application of state-of-the-art technologies for the benefit of the society and industrial innovation in Europe. The Joint Research Activities are also designed to have strong links with the Transnational Access and Networking Activities, to ensure a stronger and more coherent integration of the various activities.

- **JRA1 – Detectors for Athena: Innovations beyond the baseline** (WP6). Athena will be the next and only general purpose X-ray facility for the study of the Hot and Energetic Universe with an expected launch date of 2028. This WP will facilitate a European effort to significantly enhance the science return of Athena. By collaborative efforts between institutes over Europe the science return of this mission can be improved considerably but this needs further technology development prior to the adoption of the mission by ESA (early 2019). Promising technology has been identified and with support of the EU an efficient coordination of this development between institutes in different countries is foreseen. Considering the development time needed for space qualified instruments, the mission schedule requires that in 2018/2019 the technology for the payload has to be frozen. The X-ray Integral Field Unit (X-IFU) is the most innovative instrument and will allow for the first time spatially resolved spectroscopy in the soft X-ray domain. The instrument is built

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around an imaging array of microcalorimeters based on pixels consisting of Transition Edge Sensors (TES) with absorbers and a large area TES-based detector underneath to reduce particle background. This implies operations at sub-K temperatures. Whereas there exists a well defined baseline for this instrument, pushing technology in the area of imaging, spectral resolution and background reduction will clearly enhance the capability of the X-IFU instrument on Athena and as such will have a major impact on the future of X-ray astronomy. This investment is needed over the next few years, essentially in phase with this Infrastructure call, as after that period the time is needed to develop and realize the flight hardware. In this work package we will demonstrate the feasibility of these improvements by producing the relevant parts and by performing appropriate tests. We expect that at least a significant part of these improvements will be subsequently implemented in the X-IFU on Athena. By combining resources in different groups in Europe, we expect to be able to push these limits efficiently.

- **JRA2 - Background simulation and scientific calibration (WP7).** This WP will provide the link between the infrastructures and the development (detector and optics JRA1 and JRA3). It will also link the knowledge acquired with the current operating missions to the challenges of the new technology needed for the large Athena X-ray observatory, aiming primarily to reduce significantly the background of the instruments, thus improving the science performance especially for faint and diffuse sources. The background and instrument simulations, as well as (cross) calibration of high-energy instruments will be harmonised through the adoption of standards and commonly developed modelling techniques. This WP will comprise the provision of a central database of instrument calibrations and modelling, to be used in TA-2.

- **JRA3 - Optics for next generation X-ray observatories (WP8).** The goal of this work package is to study and develop in depth methods for characterising (by theory and by measurement) four key X-ray optics technologies. One of these technologies, the SPO (Silicon Pore Optics) modules will be used in the mirror system of the next generation ESA X-ray observatory – Athena - which combines a large collecting area (2 m² at 1 keV), a high angular resolution (5 arc sec) and a large field of view (50 arc minutes diameter). Also alternate optical designs such as the Slumped Glass Optics (SGO) and Kirk-Patrick Baez (KB) as well as the optimization of the fabrication of these backup optics for an ATHENA type observatory will be studied. The fourth technology is focused on complementary missions which will allow a sensitive all sky monitoring to detect transient events (Lobster micropore optics). The latter will provide a quantum leap in the sky monitoring, by enabling for the first time wide field (hundreds of square degrees) focussing optics, thus improving the sensitivity limit of current technology (coded mask) by orders of magnitude. Such a technique will also provide a strong scientific link between the X-ray domain and the gamma-ray domain, by allowing a transformational advance in the study common phenomena in the two regimes, such as Gamma-ray Bursts. In this work package a prototype setup BEaTriX (Beam Expander testing X-ray facility) for improving upon the screening of X-ray optics will be realized and tested. The groups participating in the work package will be providing demonstrator optics for testing at the PANTER X-ray test facility and a high resolution optical module (<5 arc secs) will be calibrated in the parallel beam at PANTER and used to verify the screening functionality of BEaTriX. All optical simulations will be provided for in orbit like and ground based test facility configurations.

- **JRA4 - Assessment of gamma-ray experiments (WP9).** Given the limited number of flight opportunities, and the fierce competition to get selected by the European Space Agency, it is important to present mature proposals in response to the calls of opportunity. In order to improve the chances of a future gamma-ray astrophysics missions, WP9 will develop tools that enable performance evaluation, the selection and further development of an instrument concept, to be proposed for the next generation of gamma-ray observatory. The essence of WP9 is as a service to the gamma-ray community, that will lead to a definition of the

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scientific and technological priorities in the field, providing a common denominator for selecting a future space mission.

- **JRA5 – Technology Innovation (WP10).** Development of cutting edge technologies is inherent to high-energy astrophysics, that involves space-based instrumentation aimed to extract the maximum information from extremely faint sources. It is crucial to transfer this enormously innovative potential to the society. With this package AHEAD aims at studying potential applications of the technologies studied in AHEAD JRA selected into the society. Key player will be a leading space industry that has already been involved in the development phase of these technologies. Significant focus will be given to the high resolution spectroscopy and imaging capabilities of the cryogenic microcalorimeters studied in WP6, that promise to provide a breakthrough device for the low-dose diagnosis and analysis of materials (including biological samples).

2. **Impact**

2.1 **Expected impact**

One of the main goals of the AHEAD project is to provide a pan-European, coordinated and structured approach to research and technological development in high-energy astrophysics. This goal is well matched to the key requirement of the call, that integrated activities are expected to have a structuring impact on the European Research Area. The expected impact includes the following:

- **AHEAD TNA facilities will provide researchers with a broader, simplified, and more efficient access to the best research infrastructures they require to conduct their research, irrespective of location, with a strong impact across-the-board. Space-based instrumentation encompasses the full range of wavelengths, thus AHEAD facilities for space environmental test will have impact well beyond high-energy astronomy.**

- **The strong coordination planned for AHEAD facilities will allow to develop synergies and complementary capabilities, leading to improved and harmonised services, optimization of operations and improved usage of resources.**

- **Particular care will be devoted in AHEAD to the growth of a new generation of researchers, to be prepared to exploit at the best tools and facilities in the field. This will be achieved by acting at various levels: opening access to facilities for data analysis (TNA), supporting visits to the best institute in the field with a vigorous grant programme and with advanced schools (NA), and by involving young excellent researchers in JRA projects.**

- **AHEAD activities will include a large number of scientists and are designed to facilitate cross-disciplinary fertilizations and a wider sharing of knowledge and technologies between academia and industry. The activities will also provide a direct link with optical/infrared and radio/millimeter European Integrated Activities represented in OPTICON and RADIONET, filling a current gap.**

- **Innovation will be fostered through a reinforced partnership of research organisations with industry, with a specific work package on innovation led by industry with a direct link to AHEAD technologies.**

- **Some of the JRA activities will have a direct impact in improving the services provided by the facilities, e.g. by providing an up-to-date database of cross-calibration of the major instruments in high energy astronomical satellites.**

- **From the scientific point of view, the AHEAD activities will have a clear impact on the study of the hot and extreme Universe by improving beyond the state-of-the-art the enabling technologies for Athena and high energy astronomical missions, by enhancing the theoretical background and improving the data-analysis techniques and optimizing the exploitation of present observational facilities and data sets in Europe.**

**Expected Impact of the Transnational Access.**

The coordination of ground research facilities provided by AHEAD, together with the offering of access to external teams will enhance the support offered to the community. The research facilities offered in AHEAD include top-class facilities that will be used by high-energy astrophysicists developing space-based instruments to test and calibrate them, but will be also open to other communities (e.g. they could be used for planetology, or geological studies of the composition of rocks). The foreseen coordination is expected to strengthen the
capacity of the high-energy astrophysics community to develop new technologies and hardware prototypes as well as to test flight hardware. AHEAD will increase the potential for innovation and technology transfer in the related research infrastructures, in particular by reinforcing the partnership with industry and the use of research infrastructures by industrial researchers. The provision of a network of institutes providing expert data analysis in different science topics of presently operated high energy missions will increase the impact of such observatories by involving a larger scientific community, including countries with less experience in the field, thus maximizing the scientific return in the European context. The capabilities offered by TNA will be largely complementary, leading to improved and harmonised services and a more efficient use of resources across Europe

**Expected Impact of Networking Activities.**

The Networking Activities in AHEAD will focus on improving the connections between the participants and the high-energy astrophysics community. AHEAD workshops/schools will provide the opportunity for the interaction between young researchers and more experienced astronomers, and are also expected to initiate and strengthen a Europe-wide approach to research and collaboration. Schools dedicated to high-energy missions close to launch will ensure that the scientific return is maximized and will form the new generation of young astronomers. Public outreach is a key element of AHEAD. Dedicated activities will enhance visibility of high-energy astrophysics in the community at large. This will happen at several levels: at the general public level through exhibits and talks on high-energy astrophysics; at the educational level by targeting high school students in order to enhance their interest in astronomy; and at the professional level by disseminating information on AHEAD activities to other astronomical institutes within Europe

**Expected impact from Joint Research Activities.**

The AHEAD activities will have a strong impact in the study of the hot and extreme Universe by improving beyond the state-of-the-art the enabling technologies, and by enhancing the understanding of key performance parameters of the instrument response in-orbit, such as the background and instrument calibrations. The activities foreseen in WP6 will be aimed at improving the parameters of the key instrument aboard of Athena, XIFU, in several areas crucial for the scientific performances, such as the spectral resolution, the bandpass, the imaging capabilities and the residual background. An improved spectral resolution will enhance the detection of weak lines, as those expected from cosmological filaments in the Warm Hot Intra-Galactic Medium, while extending spectral performances at higher count rate will allow to carry out high spectral resolution observations of bright sources, like transients and Gamma-Ray Bursts. Extending the field of view will allow a wider coverage of extended sources such as cluster of galaxies and supernova remnants. A strong impact on scientific performance has the residual particle background, with particular regard to diffuse and faint sources, such as the outskirts of clusters of galaxies. With AHEAD JRAs, we will carry out an improved study of background performances with simulations in WP7 and enhance the implementation of active and passive shielding in WP6. The study of instrument performances carried out in WP7, with particular regard to their calibrations, will improve the services offered by the TNA on data analysis, by providing an up-to-date cross-calibration data base of in-flight instruments. The mirror package (WP8) will be aimed to improve the mirror performances by studying various techniques that can enable a better angular resolution, both by studying different mirror technologies, but also improving upon the technical approach to assemble and align mirror elements needed to reach the large effective area and not degrading the angular resolution. This will have impact in several scientific areas like, e.g., pushing the threshold of sensitivity to more distant supermassive black holes in the high redshift Universe. The mirror WP will also include a study aimed at opening a new window in the field, that of high sensitivity X-ray sky monitoring with Lobster-type optics, in line with other wavelengths facilities such as Lofar, LSSST, etc. It will also strengthen the scientific link with WP9, with a strong impact in the study of phenomena common to both regimes, such as Gamma-Ray Bursts.

In the hard X-ray/γ-ray regime, from focusing hard X-ray optics (like the one implemented in NuSTAR) and up to energies where pair-tracking telescopes start to become efficient (e.g., instruments such as CGRO-EGRET, Fermi-LAT, Agile) we find a domain of relatively under-explored astronomy. Among the unique astrophysical potentials of this domain are relativistic particle acceleration leading to cosmic rays and positron annihilation in our Galaxy. After the current “golden age” of high energy observatories has ended, and entering the Athena era, it will be then important to pave the way to realize a dedicated mission covering this energy range. In this framework, AHEAD will strongly support the gamma-ray community to elaborate key instrument

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concepts that could fill this important gap by providing the necessary sensitivity, by developing a scientific and technological roadmap (WP9).

A specific AHEAD activity (WP10), led by Industry, will be dedicated to innovation, technology transfer and spin-off to industry, identifying the most promising sensor, electronics and space systems technologies suitable for industrial take-up. We recall that high-energy detectors for astrophysics are extremely sensitive, deliver high signal to noise, with excellent spectral resolution and imaging capabilities, qualifying them for non-destructive analysis of low-dose material and biological samples. These activities will focus primarily on two of the technologies covered in AHEAD that appear already to be extremely promising in their innovation potential, i.e. on cryogenic microcalorimeters for material-science diagnostics and gamma-ray detectors for radioactive environmental surveys.

In summary, the AHEAD project is expected to have a substantial impact on the high-energy astrophysics community, as the activities will cover different aspects from scientific research, technological development, industrial assessment, and public outreach. The project will significantly enhance the existing facilities and will help to develop a coordinated approach for high-energy astrophysics in the future.

We do not foresee any barriers or framework conditions that may determine whether and to what extent the expected impacts will be achieved.

2.2 Measures to maximise impact

a) Dissemination and exploitation of results

The dissemination of the AHEAD results is fully implemented along the project life by a coordination of the development and outreach activities, with an operative scheme involving the participation to large meetings which involve high energy astrophysics researchers and the astronomy community at large, other space science communities and industry, the general public, the students and their teachers, and the funding agencies. Participants in AHEAD will also be encouraged to present intermediate results at specialized conferences and meetings. The results of activities (e.g. corresponding to milestones of the project) will be published as soon as they will become available on specialised journals and the most important achievements will be advertised by press releases. Oral presentations, as well as publications or press releases centered on AHEAD results will specify that the project has received Community research funding and will be required to specify support by AHEAD and the EC. This requirement will be extended to teams and individuals selected for TA and for grant support.

The dissemination of AHEAD results will also be achieved by the Coordinator and Project Scientist who will present the AHEAD project and its results at meetings on behalf of the AHEAD participants. This will take fully into account the need to describe precisely, and with adequate detail, the innovation potential of the technology transfer studies performed in WP10, to a range of professionals including researchers from physical and social sciences, and eventually, complemented with information useful to financial and investment officers. In this respect the dissemination of the innovation potential of the technologies developed under AHEAD will take advantage of the network of companies and industries, mostly space-based, that are connected with AHEAD participating institutes. We plan to build up a directory of potentially interested companies and to disseminate our results by newsletters and dedicated meetings.

The publication of results achieved by the teams participating in AHEAD will be advertised to the full AHEAD Consortium well in advance and, when requested, followed out internally before submission (in agreement with Art. 29 of the GA) with modalities that will be specified in the Consortium Agreement. The scientific and technical papers, preprints and a selected amount of the data produced will be made available, free of charge and accessible on the internet using public repositories. For articles, we plan to use arXiv\(^7\) which is a renowned, world-class science subject repository widely used by the astronomical community, allowing a reader to immediately read, download, and print a publication. An article will appear in arXiv before, during or immediately after its acceptance by a journal Editor’s board. This is nowadays common practice and well accepted from all main journals in the field. If the publisher does not allow archiving of the article in a repository,

\(^7\) http://arxiv.org/
the author will contact the publisher and inform her/him of the EC Open Access requirements, asking for an exception to the publisher’s normal policy. An embargo period could be used when imposed by the publishers. Moreover, a gold open access approach will be followed for a subset of publications: e.g., publications of Science proceedings, immediately available online; or special issues of journals freely accessible on journal web-pages (as in the case for the Proceedings of the Gamma-ray Symposium). In addition, an up-to-date repository of all AHEAD related articles will be maintained and accessible on the AHEAD main web-page.

Disseminating the AHEAD results will have a high impact on the process of building the high energy community and the infrastructure around Athena. Starting from the initial Athena technology developments, the results obtained from the JRA WPs 6 and 8 will help feeding new ideas for optimizing/testing detector and optics components, with the conception of new standards for building and testing of fabricated components and modules. In the gamma-ray regime, WP9 will deliver a scientific and technological roadmap, providing a strong asset for a successful mission proposal. Moreover, the output of the WP5 and WP7 activities will stimulate the production of new standards for data analysis, calibration, and offer tools for efficient use of advanced simulation toolkits (e.g. GEANT4). They will at the same time make available the knowledge/expertise of the specialists to a wider range of users. The test and calibration facilities offered in WP4, currently mostly used by specialised teams which are tightly connected to the developments pursued by the facility owners, will be rejuvenated by the involvement of new user teams, also including specialists from fields other than astrophysics. This will stimulate new ideas to support facilities with user tools aimed at increasing the efficiency of use and easier interpretation of the results.

The AHEAD project will generate different types of data including: (a) output of the test and calibration activities performed in the TA and/or during the tests of detector and optics components at PANTER or other laboratory facilities; (b) instrument based archives with on-orbit or simulated data, background simulation data, results of spectra analysis for calibration targets, etc. (c) activity reports; (d) videos and other multimedia objects. The maintenance of the above data will be guaranteed throughout the project life. The data described in (b) will be made available for access on the public internet and will be re-usable; these data files will be based on the Flexible Image Transfer System (FITS) format and organised into local archives. For example, WP9 will generate a calibration data-repository, being publicly available from the AHEAD web site (the institute hosting the AHEAD site will cure/maintain the access to them). Conversely, only a small subset of the type (a) will be publicly available for access to other teams, e.g. some of the data generated by the AHEAD JRA workpackages (in particular WP 6,7,8) as well as the information for their further use and exploitation. The above data will as much as possible use public databases (e.g. OpenAire) and/or dedicated local archives with open internet access. However, the management of Intellectual Property Rights (IPR) is an important issue, particularly in the case of technology development for space-based instruments, which may have applications outside the academic world in which they are developed. The AHEAD Consortium will address the IPR issue in its foreseen Consortium Agreement to determine the level of access that can be given to disseminate the results of industrial relevance. In addition, the Project Office, in collaboration with the AHEAD Management Team, will develop and maintain an IPR register. The register will serve as a database to decide on ownership of IP, and on patents. In particular, the Consortium Agreement will cover the decision mechanism on ownership of IP, in particular to protect the foreground of the project that may have valuable industrial or commercial applications. The AHEAD Management Team will regularly address the IPR issue during its teleconferences and in-person yearly meetings. The Consortium Board will be regularly kept informed of any IP issue that may require a decision.

Much of the software needed to support both development, TA and networking activities will be based on standard software tools like Java, C++ and other graphic tools for user interface; data analysis will take advantage of the astronomy open source packages ftools, SAS, R and topcat, while WP7 will make use, in an inter-related way with WP6, of the CERN provided package GEANT.

b) Communication activities

The calls for TNA in WP4 and WP5, the calls for grant support in WP2 and, more in general, the activities and key results of the AHEAD project, will be advertised to the astrophysics community at various astrophysics meetings during the project such as the 2016 Committee on Space Research (COSPAR) meeting, at the International Astronomical Union (IAU) Symposia and Colloquia, etc., and through mailing lists that involve a
A broader community than that of high-energy astrophysics (e.g., European Astronomical Society, INTEGRAL Newsletter, XMM-Newton Newsletter, International Astronomical Union, National astronomy societies, etc. Teams that have benefited from TNA will be encouraged to publish their results. In a similar fashion, technical results arising from the JRAs will be published in engineering (e.g., SPIE, IEEE Transactions in Nuclear Science, Journal of Low Temperature Physics) and scientific journals (e.g., Astronomy & Astrophysics, Experimental Astronomy, Monthly Notices of the Royal Astronomical Society). Moreover, once a plan for WP10 is established and a particular engineering study started, appropriate strategies will be initiated to advertise the impact on those networks (both science and social) that are candidate potential targets of the particular innovation.

In addition to the above measures, the AHEAD project will engage the astronomical community at large in a more structured approach, by setting up a Science Advisory Committee composed of researchers external to the AHEAD community (see section 3.2). We anticipate a membership that will comprise representatives of similar initiatives supported by EC in the field of astronomy, with particular regard to complementary programs at other wavelengths such as OPTICON and RADIONET, and ASTRONET, that aims at establishing a strategic planning mechanism for all of European astronomy.

General public, students and educators will be engaged in AHEAD activities with a dedicated outreach package, that includes several means to address that audience (press-releases, videos, a dedicated web-portal with several on-line educational resources, and dedicated AHEAD material in existing Visitor Centers in astronomical institutes).

Communication about the innovation potential of the technologies developed under AHEAD will target industrial parties with interest in high-tech space based instrumentation and ground applications, aiming at engaging potential partners for future spin-off. A initial list will include the network companies and industries that are connected with AHEAD participating institutes, and will be increased and updated during the program.

All members of AHEAD who are involved in advertising and communicating the project aims and results will report to the Coordinator within their yearly or mid-term reports, about their actions taken and the feedback received by the relevant communities. If the Coordinator or Project scientist find that a particular aspect of the communication needs to be improved, they will inform the beneficiary, jointly study a solution of the problem and implement an appropriate correction measure.

3. Implementation

3.1 Work plan

3.1.1 Overall structure

All aspects of networking, development (JRA) and transnational access are covered in AHEAD, with a broad range of topics and applications based on a common framework, constituted by the new technologies and scientific themes related to the future European large X-ray observatory, Athena. The AHEAD project is composed by a total 10 workpackages, including 2 networking (NA) workpackages, 5 joint-research activities (JRA) workpackages and 2 workpackages devoted to transnational access (TA), plus the AHEAD management WP. The two main JRA activities concern the design, optimisation and development of key technology for cryogenic microcalorimeters detectors (WP6), optical design studies and updating the performance of test facilities for the development of new high performance optics (WP8). These WPs are complemented by design optimization including shielding from space background (GEANT4 simulations), and the study of new tools and estimation methods for response calculations (WP7); and by an articulated study of science requirements and instrument concepts for the gamma-ray domain, supported by simulation activities (WP9). The WP9 activities, organised in working groups supported by a related networking program, are aimed at preparing the high energy community towards a further upgrade for those astrophysical topics already addressed by Athena (e.g., black holes physics and role of SMBH in Galaxies formation and evolution; physics of GRBs); plus other important topics like SN explosion physics and nucleosynthesis, and the study of the Galactic Centre. This will end up with the selection of the best technologies for a future γ-ray (0.1-50 MeV) mission. Finally, WP10 (technology...
innovation) addresses the feasibility of transfer to the market for the detector technologies studied in AHEAD. This package has an industrial lead and comprises engineering studies for the microcalorimeters.

A general networking package (WP2) will deal with an important visiting scientist program and the organization of schools, aiming at fostering new collaborations and deepening the knowledge of the most appealing topics for the near future, like e.g. high resolution spectroscopy (ASTRO-H related) and X-ray surveys (eRosita related). A public outreach package (WP3) will provide the means to disseminate the most exciting results in the field of high energy astrophysics to different types of public, by providing Web portals, videos and other educational materials; plus organisation of exhibitions within visitor’s centres addressing both science and technology topics. Finally, WP1 will be devoted to the broad AHEAD management. This will make use of two major membership groups: the Consortium Board, constituted of the representatives of the all Legal entities participating to the AHEAD project; and the Management Team constituted by the Project Team and by the WP leaders. A committee representative of the broad community (Science Advisory Board) will support the scientific quality of the work within AHEAD by supplying expertise for the AHEAD review committees and providing the necessary link with scientists of other related astronomy fields.

A Gantt chart showing the timing of the activities in AHEAD is shown in the following pages.
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3.1.2 Organisation of the activities and inter-relation among components

The organisation of the AHEAD activities is outlined in the work breakdown structure described in Fig. 3.1.2.1, also showing the interrelation between components. The upper part of the figure panel, dealing with management activities will be described in Section 3.2.

The development activities (JRAs) in AHEAD cover a range of experimental techniques in the X-ray and gamma-ray domains, strongly linked to instrument modeling, background studies and shielding optimisation, and also addressing calibration methods and tools. While the activity in the X-ray domain is strongly tailored to improving the techniques chosen for Athena, the effort of the gamma-ray community is driven by a strong networking activity, aimed at producing a roadmap for the final assessment of mission concepts and the related simulation work.

The coordination of ground research infrastructures implemented in the two TA workpackages will enhance the support offered by these to the community. The experimental infrastructure TA1 is organised as a network of test and calibration facilities, strongly linked to the activities of detector and optics development. Most of these facilities will be used for the TA offered under this project, while the PANTER site will be the focus of the optics development activities. The realisation of a new facility to support the testing of optics modules at the production site will also be supported by AHEAD.

Fig. 3.1.2.1 AHEAD organisational structure an interrelation among components

The networking WPs in AHEAD (NA1, NA2) will promote a strong visiting scientist program and schools linked to the science themes of the forthcoming X-ray missions; and an efficient public outreach activity to reach audience at all levels. The AHEAD networking activities will help an efficient strengthening of the community and the strong motivation a young generation of high energy astronomers; this has a natural strong link with the TA service provided by the data analysis infrastructures.

These activities are naturally inter-related. In Figure 3.1.2.1 are represented the high level links between the different work-packages. At a more detailed level, some of these links are showed in the bottom part of the
The experimental infrastructure represented by the facilities offering trans-national access is naturally linked to the detector and optics technology JRAs, and to the modelling activities of JRA2: in particular JRA3 (optics) will benefit from the experimental activity on soft protons present in JRA2; and the design/tradeoff studies in JRA1 will take advantage of the results of simulations in JRA2, in particular for the background shielding of detectors and the assessment of the performance of the anticoincidence detector. On the other hand, the Innovation WP (JRA5) will be strongly based on the work based of JRA1. This scheme described how strongly the experimental activities in AHEAD are linked together, though maintaining a high level of autonomy.

The other important aspect of AHEAD is networking. The general networking WP will, besides organizing conferences, schools and visiting programs, will help to build a more effective collaboration scheme of the gamma-ray community, fostering working group meetings to prioritize future work. This will feed input to the strong simulation efforts that will be taken in JRA4 (gamma-rays). Moreover, the public calibration database to be produced in JRA2 will be available to the users of the data analysis transnational access.

### 3.2 Management structure and procedures

#### 3.2.1 The organizational structure

The AHEAD organizational structure and decision making mechanisms are adapted from those successfully implemented in integrated activities in the field of astronomy with a similar level of complexity and scale of the project such as RADIONET and OPTICON. It is based on a Consortium Board, a AHEAD Management Team, that includes the Coordinator with the associated Project Office, and a Scientific Advisory Committee. In AHEAD each activity has a designated project leader, responsible for its delivery to requirements and budget. All activities will be monitored regularly by a central project office. Nearly annual assessment of performance of projects is provided by detailed review of the EC reporting documents, and financial status information, by project office. A Consortium Board with representatives from all participants, and the wider community, and with all Work Package leaders present, will be the governing body of AHEAD. It will receive regular project presentations from the WP leaders, ensuring full project-wide communication. The AHEAD organization structure incorporates an effective innovation management. A Scientific Advisory Committee, external to the project, will provide feedback from the community at large and advice the AHEAD Management Team about strategic decisions and new ideas or improved services that may be implemented in the AHEAD work package structure. This item will be constantly present in the agenda of progress meetings.

The structure is described in more detail in Fig. 3.1.2.1:

**i. Consortium board**

The governing body of AHEAD will be the Consortium Board (hereafter "the Board"). It consists of a representative of each participating institute of AHEAD (often the institute director or a senior scientist). The Board will initially nominate a chairman within the Consortium. The AHEAD Coordinator will serve as deputy chairman during all the four funded years. The Board will meet at least three times in person during the project and use teleconferences as needed. At the kick-off meeting at the start of the AHEAD project the Board will approve the allocation and distribution of resources. Communication between the Coordinator and the Board will also be conducted by e-mail to ensure smooth information flow.

Board decisions will be made based on consensus. If the latter cannot be achieved, a decision will be passed by majority vote of a quorum. The quorum will be achieved if 2/3 of Board members are present. Work package leaders are normally invited to attend Board meetings to present an overview, status, and progress of the WP activities. However, they have no vote. Representatives from the community at large may be invited as observers by the Board Chairman.

The main responsibilities of the AHEAD Consortium Board will be to:

- Make strategic decisions for the AHEAD project
- Oversee AHEAD activities
• Ensure compliance with the regulations laid down in the contract with the EC and in the AHEAD Consortium Agreement
• Approve the allocation and distribution of resources
• Decide on the need to reallocate funds if required
• Appoint and confirm Work Package leaders
• Confirm membership of the Science Advisory Committee as proposed by the Project Coordinator in consultation with the AHEAD Management Team
• Resolve potential conflicts within the AHEAD project

ii. AHEAD Management Team

The AHEAD Management Team (hereafter "the AMT") is chaired by the AHEAD Coordinator. It will also include the Project Scientist who will serve as Deputy Chairman, and all AHEAD WP leaders. The Chairman has the final authority on the decisions taken by the AMT. The Project Financial Assistant will attend the meetings and take minutes. The AMT will meet at least 4 times in face-to-face meetings (at milestone review meetings of each reporting period). It will also hold teleconferences every two months in which WP leaders will report to the AMT on the status of their activities. The Management Team main responsibilities will be to:

• Oversee the day-to-day implementation of the AHEAD activities
• Monitor progress of activities
• Propose strategic modifications to the Board
• Propose a list of members of the SAC to the Board for confirmation
• Appoint members of the selection committees in WP2, WP4, and WP5

Project office

The Project Office consists of the following team:

• The Project Coordinator
• The Project Scientist
• The Project Officer
• The Administrative staff (secretary)

The Project Coordinator's duties are to:

• Monitor all activities of the project and ensure that the activities follow the plan agreed by the AMT and approved by the Board
• Ensure that reports and documentation provided by WP leaders are transmitted to the EC and the Board
• Report activities to the Board
• Act as contact point for the EC and be responsible for reporting to the EC
• Represent the AHEAD project at conferences, meetings, and other

The Project Scientist's duties include:

• Support the Project Coordinator by attending AHEAD-related meetings, reporting to the AHEAD Management Team and Consortium Board
• Represent AHEAD at scientific meetings and events
• Be responsible for the oversight and coordination of the Networking Activities, Transnational Access, and Joint Research Activities
• Support the activities in WP3 related to education, outreach, and the generation of publicity materials
• Provide oversight to the AHEAD website and its content

The Project Officer duties include:

• Support the Project Scientist in the administration of the financial issues and timeline for the deliverables
- Receive financial and progress reports from the WP leaders
- Assemble and prepare the yearly report to the EC in collaboration with the Project Scientist and submit to the AHEAD Coordinator for approval and submission
- Provide support for the AHEAD Consortium board and Management Team (i.e., prepare reports, organize meetings, take minutes, etc)
- Receive details of progress from each Work package and review them with the Project Scientist

Management of individual activities

Each WP has an identified, foreseen leader (see table below) and a deputy WP leader that can represent the WP leader should he/she be unavailable, e.g., in an AHEAD Management Team meeting or teleconference. The WP leader will act as point of contact of the WP participants with respect to the Project Office.

<table>
<thead>
<tr>
<th>WP number/description</th>
<th>WP leader</th>
<th>Participating Institute</th>
</tr>
</thead>
<tbody>
<tr>
<td>WP1- Management</td>
<td>Luigi Piro (coordinator)</td>
<td>INAF/Institute of Space Astrophysics and Planetology</td>
</tr>
<tr>
<td>WP2- General Networking</td>
<td>José Miguel Torrejon</td>
<td>University of Alicante</td>
</tr>
<tr>
<td>WP3- Public Outreach</td>
<td>Ioannis Georgantopoulos</td>
<td>National Observatory of Athens</td>
</tr>
<tr>
<td>WP4- Access to facilities</td>
<td>Salvatore Sciortino</td>
<td>INAF/Palermo Observatory</td>
</tr>
<tr>
<td>WP5- Access to data analysis</td>
<td>Paul `O Brien</td>
<td>Leicester University</td>
</tr>
<tr>
<td>WP6- Detectors</td>
<td>Jan-Willem den Herder</td>
<td>Space Research Organisation Netherlands</td>
</tr>
<tr>
<td>WP7- Background and calibrations</td>
<td>Claudio Macculi</td>
<td>INAF/Institute of Space Astrophysics and Planetology</td>
</tr>
<tr>
<td>WP8- Optics</td>
<td>Vadim Burwitz</td>
<td>MPG/Max Planck Institute for Extraterrestrial Physics</td>
</tr>
<tr>
<td>WP9- Gamma-rays</td>
<td>Peter von Ballmoos</td>
<td>Research Institute in Astrophysics and Planetology (participating as CNRS)</td>
</tr>
<tr>
<td>WP10- Innovation</td>
<td>Paolo Bastia</td>
<td>Thales Alenia Space Italia Spa</td>
</tr>
</tbody>
</table>

The main responsibilities of WP leaders will be to:
- Ensure that the agreed WP description is followed and that the dates of deliverables and milestones are adhered to
- Participate in teleconferences. A Deputy WP leader may replace the WP leader if he/she is unavailable
- Participate in the Management Team meetings. A Deputy WP leader may exceptionally replace the WP leader if he/she is unavailable
- Provide to the Project Office a comprehensive annual report, including scientific and technical reports, and in a timely fashion

iii. Science Advisory Committee

The Science Advisory Committee (hereafter the SAC) will consist of a pool of external advisors (i.e. not directly involved in the project) no larger than 8 members. The Advisors will be senior scientists representing the astrophysics community at large (from high-energy astrophysics but from other fields as well), with an equal share of gender representation. Astrophysicists from European countries or Associated Countries not represented in the AHEAD Board will be included. Members of other astronomy-related EU-funded activities (e.g. ASTRONET, ASPERA, OPTICON, RADIONET) will be invited to maximize interactions and optimize complementarities.
The Advisors will be proposed by the AHEAD Management Team and will be confirmed by the AHEAD Board. The SAC will meet twice during the AHEAD project. The meetings will take place at the same time and location of two of the AHEAD Management Team meetings. The Advisors will attend the Management Team meeting and provide feedback from the community at large and advice to the AHEAD Management Team about strategic decisions. Members of the SAC will also serve as a pool for which to choose members for the different selection committees of networking and trans-national activities. The Advisors will be selected on a case-by-case basis by the AHEAD Management Team for inclusion in the selection committees.

**Management of funds**

The coordinator at INAF/IAPS will receive EC funds for AHEAD and will distribute them in accordance with the plan agreed with the EC and the decisions taken by the Consortium Board. Thereafter, the participants' financial departments will deal with the funds in accordance to their financial policies and procedures. They will, then, be responsible for the delivery of the annual financial statements to the Project Office which will assemble and prepare the yearly report to the EC. Travel funds for the members of the SAC are reimbursed by INAF as they are not beneficiary of the project.

**Consortium Agreement**

A Consortium Agreement will be drafted after the submission of the AHEAD proposal and is expected to be signed before the signature of the Grant Agreement between the EC and the Coordinator. The Consortium Agreement is likely to be based on the DESCA (Development of a Simplified Consortium Agreement) 2020 model in view of the large number of universities and research centres representing the AHEAD participants. The Consortium Agreement will also take into account the presence of our industrial partner and will handle intellectual property rights and publication of results. The issue of dissemination of results and management of intellectual property is described in detail in Section 2.2.
3.2.2 Significant Risks and associated mitigation plans

The AHEAD proposal has gone through several steps toward a self-consistent, solid set of activities with as little risk as possible. Various options and activities for the high-energy astrophysics community were considered by a steering committee, which was set up for the preparation of the proposal and that comprised representatives of the major institutions in the field in Europe. The steering committee, that will end its role after the start of the project, preselected those activities that could potentially be included in AHEAD. For each of these, a leader and an initial set of participating institutes were defined. The steering committee worked actively with the work package leaders to produce a set of activities, meeting via teleconferences and in person to fit in the budgetary limit of 5 Me and in the time frame limit of 3.5 years. In addition, the steering committee restricted the JRAs to a limited set of well-defined technologies to better focus the technological development and improvement in AHEAD. Difficult decisions were met, but this process allowed us to present the current proposal which has, in our view, limited the number of risks. Below, we review those risks and address how such risks can be dealt with (summarized in tab. 3.2b)

Risks associated with the Networking Activities

Networking activities have inherently very few risks, as they consist mainly in meetings, workshops, support to the community, and public outreach. However, we address below specifically potential risks:

- **WP1: AHEAD Management**

  The Management side of AHEAD is built around the Project Office and the AHEAD Management Team. The Coordinator, the project scientist, the project officer and WP leaders are all senior, permanent staff members with experience in project management. Frequent interactions between the members of the Team will exist throughout the duration of the project, and in case of major issues, the Team will work together to propose a solution that would be submitted to the Consortium Board. In case of failure from a participant, the Board will reassign the required work, e.g., to another AHEAD participant with reallocation of funds, or will find a new participant, after formal agreement by the EC and signature of an accession to the Grant Agreement. We believe, however, that this worst-case scenario is unlikely, as careful planning of the activities was done for the submission of this proposal, with significant matching involvement by the participants.

- **WP2: Support to the community**

  The activities are related to both the organization of meetings, conferences, and workshops, and grant funding for the community. Both the AHEAD meetings and workshops/schools will be organized by members of the AHEAD consortium, most of which have experience in the organization of similar events. The grant funding activity carries, in our view, little risk, given the size, as well as the active presence of the high-energy astrophysics community in Europe. We anticipate that the response to the various calls for proposals associated with grants will be large. Two schools are devoted to training young researchers in techniques related with the capabilities of future missions, specifically high resolution X-ray spectroscopy, with special emphasis on ASTRO-H (launch in mid 2015), and X-ray surveys, with particular regard to E-Rosita (launch in 2016). The risk associated to this subWP is a delay on the launch date. However, it is unlikely that both missions will be delayed and the topics and the dates of the schools can be easily re-adjusted to take this into account.

- **WP3: Outreach activities**

  Significant risks with public outreach activities are limited. The activities are carried out at sites that have already a strong experience in the field, and have an on-going institutional outreach program.

Risks associated with the Transnational Access:

- **WP4: Access to Facilities**

  Theoretically, the main risk for the TA WP4 is the lack of proposals for access or a lower than expected request. However, we believe that in practice the risk for the AHEAD TA is low. The project period covers a time period of intensive R&D activity for Athena. In addition, in performing our inventory of the medium-size ground...
test and calibration facilities currently active in European countries in the field of high-energy astrophysics we have verified the interest of several research teams across Europe and Associated Countries to use the facilities via the TA program in order either to pursue specific research and technology development programs or to pursue calibration programs of specific space-related flight hardware. In order to attract new potential users we plan to realize/improve the current web pages describing the offered facilities, to prepare, in due time, the call for proposals, to disseminate the availability of this opportunity within the High Energy community, as well as to other, possibly interested, research communities and possibly users from SMEs. Therefore, we concluded that the risk that the TA facilities is actually low. Should there be any lower request than expected for the use of facilities, or an imbalanced request for access (i.e., one facility more than another), we will reallocate the funds associated with the TA program (within WP4 or moving resources to WP5), in agreement with the AHEAD Management Team, and formally approved by the Consortium Board. We estimate that the risk is low as far as the project covers a time period of intense R&D activity for Athena.\footnote{R&D at subsystem level related to the ATHENA phase A/B1 study. We expect that some of those subsystems will require access to testing facilities. Moreover, in performing our inventory of the medium-size ground test and calibration facilities currently active in European countries in the field of high-energy astrophysics we have verified the interest of several research teams across Europe and Associated Countries to use the facilities via the TA1 program in order either to pursue research and technology development programs or to pursue calibration programs of flight hardware in the development phase.} Recovery actions include a) stronger communication to advertise the offer; b) a dedicated management team for in-depth analysis and solutions; c) reallocation of the funds within TNA.

- **WP5: Access to Data Analysis**

Considering the large astrophysical community interested in exploiting data from high-energy astronomical facilities we anticipate a strong demand to the offered facilities. A minor risk related to this WP is a delay of the Web form for accepting applications from users. As recovery action, the participants will deploy additional programming effort at no cost. Another risk concerns the unavailability of research scientists to support users visits. In such a case, a flexible approach to schedule user visit will be adopted.

**Risks associated with the Joint Research Activities**

The risks associated with research and technological development at the edge of current technology, such as space-based instruments, are inherently larger than for NAs. Below we address specific issues for the JRAs:

- **WP6: Detectors for Athena: Innovation beyond the baseline**

The main goal of the WP6 is to enhance the performance of X-IFU, the detector for high spectral resolution imaging based on Transition Edge sensors (TES). We plan to follow different and parallel routes to improve the performances beyond the baseline, i.e: a) reducing the low-energy threshold by improving the cryogenic optical blocking filters; b) improving the imaging capabilities by: b1) readout of multiple pixels with distinguishable time constant; b2) increasing the number of pixels which are multiplexed in a single channel; b3) increasing the number of channels as a result of a lower thermal load that could be achieved with novel technology for cryo-harness; c) reducing the residual particle background by improving active and passive shielding techniques; d) enabling the anticoincidence detector to deliver hard X-ray response. By following parallel routes we will reduce the risks and we plan to assess these risks after the trade-off review (month 12). If necessary, we will reallocate the funding between the sub-tasks.

- **WP7: ATHENA background simulation and scientific calibration**

The WP ATHENA background simulation and scientific calibration is deemed to be at low risk since most of the activities here involved are already in-place. In fact, the core of the software structures to perform simulations is present, being related to the baseline activities for the ATHENA mission. Further, the people involved are not only experts in the fields of background simulation and cross-calibration, but also collaborate together on these fields, so the team here presented is robust. Hence, possible problems can appear for
unforeseen events along the running project. A possible risk is related to the testing of coated samples in a proton beam. As a recovery action we will look into other available facilities.

- **WP8: Development and characterization of optics for next generation X-ray observatories**

The goal of this work package is to develop and characterise four key X-ray optics technologies for the next generation X-ray missions beyond the state of the art. The groups involved have a long-standing experience in this field and are already acquainted to work together, in addition parallel development of different technologies will mitigate the risk overall. Some significant risk can be derive from the unavailability of PANTER due to testing flight optics as well as upgrading the parallel beam. This problem can be circumvented by adjusting the schedule to accommodate the additional optics. Because the required testing level for the AHEAD optics program is limited (several weeks), it can be allocated in between calibration campaigns for flight optics. Another significant risk is the delay in the realization of the BEATRIX facility. As this is a new facility development, long lead items could be a problem. This can be mitigated by early on identifying such components and ordering them early on. A delay in the optical qualification tests of the facility of up to 6 months could be accommodated.

- **WP9: Assessment of gamma-ray experiments**

This WP is deemed to be at low risk, being focused on scientific and technological assessment studies carried out by participants with strong experience in such activities.

- **WP10: Innovation technologies**

This WP is deemed to be at low risk as the company in charge of it has a long-standing experience in system design for space scientific instrumentation, also including cryogenic subsystems like e.g. for the Planck (ESA) mission. This heritage allows the core activity of the WP, the system design study, to start early in the AHEAD program thus contributing to the engineering requirements identification and providing an early evaluation of the design details influence on the instrument performances. As a result it will be possible to foresee a degree of flexibility for those few design parameters that will be identified as more critical w.r.t the performances, so allowing an easier adaptation to late trimming of requirements that could arise during the AHEAD program development.
3.3 Consortium as a whole

The AHEAD project includes 26 participating legal entities involved in 10 different Work-Packages. The participants in AHEAD are distributed all over Europe with a total representation of 16 countries: 15 Member States and 1 industrialised third country (Switzerland). Among these, are influential representatives of the so-called emerging countries. An aerospace industry leads the activities of JRA WP10. The competence of the participants covers all the fundamental aspects needed for a successful realization of the AHEAD project, in particular: i) fundamental research in high-energy astrophysics, ii) development of space-based X-ray and γ-ray instrumentation and related spin-off for applications, iii) operations of calibration and test facilities, iv) data analysis, and v) public outreach and education. The different and complementary expertise of the AHEAD participants is reflected in the various proposed activities in this proposal.

The AHEAD proposal includes participants that have a strong tradition in collaboration and work effectively together. This is indeed the case of the high-energy astrophysical community, where the development of space instrumentation requires collaborative efforts. AHEAD is aimed at better integrating and coordinating such research and technological efforts in Europe. The AHEAD Consortium is built around scientists with significant experience in managing large projects. Many AHEAD participants have strong previous involvement in space-based technological development and have led several large projects toward launching high-energy astrophysics missions in space. Several participants also have experience with EC projects (e.g., OPTICON, EURO-VO, RTN programs, etc). Participants in the outreach activities have further previous experience in public outreach on many scales (local, national, and European). The participants have also organized large conferences and meetings in high-energy astrophysics and are, therefore, familiar with the required financial and organizational needs. Each JRA WP is led by a particular institute and person with strong expertise and knowledge in the represented activities. Some of the participants operating the research infrastructures offered in the TA are further actively involved in both the NAs and JRAs of AHEAD for the benefit of the research infrastructures, but also for the high-energy astrophysics community. The latter will profit from the “free” access to such facilities via AHEAD.

In summary, the AHEAD Consortium was built to be as large as possible and aimed to represent as best as possible high-energy astrophysics efforts in Europe and Associated Countries. While it could not include all high-energy astrophysics institutes to achieve efficiency, the Consortium is constituted of the leading institutes with complementary and overlapping expertise. They will work together to achieve the goals of the AHEAD project and to complete the proposed activities and their associated deliverables.

Industrial Involvement

The Joint Research Activities in AHEAD focus on the development of prototypes and reports on the next generation of space-based instruments, in charge of research organizations, and their application to the society via a specific innovation package, that is in charge of an industry. In addition to the institutes for which fundamental research is their main goal, some large technology-focused institutes (VTT) participate. For them, participating in the development of cutting-edge technology is clearly of great interest. The major and immediate role of industry in AHEAD will be to complement the prototype developments and performance studies by feasibility/engineering studies mostly devoted to the transfer of the technologies addressed by the project to applications outside space, like e.g. medical diagnosis, studies of material composition, landmines localisation. These activities will be performed by an industrial partner (Thales Alenia Space) actively supporting the development of high tech detectors for space applications, including Athena. On the longer run, industrial involvement will be required for the implementation of some of the technologies developed in AHEAD for future missions, such as Athena or a gamma-ray astronomical satellite. So, this organizational scheme will naturally strengthen the already existing link between forefront research and technological development for high-energy astrophysics in universities and research organizations and industry. The industrial involvement in AHEAD is therefore a crucial component for the exploitation of the results of the development of cutting-edge technologies.
Other countries

All AHEAD participants requesting EU funds are eligible for such funding. Switzerland will participate with an in kind contribution as one of the provider of TA-2 (Data analysis) at no cost for EU. While the network of facilities offered by members eligible for funding covers the expected needs of the community, the addition of the Swiss contribution will further enlarge the offer to the community.

3.4 Resources to be committed

The total eligible costs of AHEAD amount to 5085 k€ with 4982 k€ of EC contribution for a total of 757.5 person-months. The AHEAD Consortium has deliberately focussed its budget on the JRAs, devoted the research and technological development for the next generation of space instruments (detectors and optics JRAs) with a total EU contribution of 3034 k€. This is fully justified by the link of these activities with the other JRAs and NAs (see Section 3.1 for details) and with experimental infrastructure (facilities). Nevertheless, the budget assigned for TA is significant (715 k€), corresponding to an excellent level of offer. The TA costs include both running costs of the facilities, manpower support from infrastructures as well as travel and subsistence for visiting users. The interactions between the AHEAD project and the community and general public will further be supported with a good portion of the AHEAD budget, with a total of 937 k€ for the general networking and public outreach activities (NA1 and NA2). The management costs foresee the support of the AHEAD Project Office, as well as the activities of the single WP leaders, with adequate manpower and travel funding.

The proposed EC contribution is, 61% for the JRAs, 15.5% for the NAs, 9.5% for the Management, and 14.5% for the TA. The amount of institutional funding for the Project is very low (~2.5% of the total), which ensures consistency and helps to ensure that activities are adequately funded. Personnel costs of senior scientists has been included only when a high level of expertise is required (e.g. Coordinator, WPL leaders, advanced technology development).

To estimate meeting attendance costs for management, we used a fixed value of 400 € for travel and 130 €/day for subsistence, yielding 530 € and 660 € per person for one-day and two-day long meetings, respectively. The same assumption has served as a basis to estimate travel/subsistence costs for TA for both test facility and data analysis WPs.

Management and Networking Activities

The financial plan for the Management and Networking Activities shows a strong component of travel (including subsistence) and other direct costs reflecting the needs to organize conferences and work-shops and to fund grant support (WP2), and to pay for public outreach material (WP3). In general, the personnel costs for NAs are low, except for WP3 due to the need to continuously update web-pages and produce new educational material.

The total EC requested amount for management are 390 k€ for the Project team (WP1), including 60 person-months for a total 350 k€, plus 40 k€ of travel costs. The above personnel costs are charged to the Coordinator (3 person-months/year), the Project scientist (3 person-months/year) and the Project Officer (2 person-months/year), plus a full-time secretary beginning 6 months after the start of the project. The travel costs also cover the coordination of the activities among participants, attendance of progress meetings and internal audits. Travel for the attendance of three Consortium meetings (including KO meeting) are assigned to each participant in WP1.

In WP2, there are organisation costs for 3 topical meetings and 2 schools which are covered by an EC funding of 67 k€. For the same events travel grants are foreseen. For the meetings, we plan to provide 4 grants/year for a total of 3 years on a cost basis of 1500€/grant, for a total of about 22.5k€ of requested EC contribution; while for the schools, we plan to support 20 students per school at 600 €/grant, for a total of 30k€ of EC contribution. The scientist visitor program in WP2 is organised in visits of two weeks and will be funded on a cost basis of 1000€/week, for a total EU contribution of 125k€. Finally, we plan to contribute to the Large Gamma-ray Symposium, foreseen to take place towards the end of the AHEAD project, by a program of 25 travel grants for young researchers with a cost basis of 1200€/grant (total of 37k€ of EU contribution). The management of WP2 requires 14 person-months for a total of 37k€ of EC contribution. We also added some manpower effort for the Organisers of meeting and schools (0.2 to about 0.5 person-months; 2 person-months for NCAC).
In AHEAD, there is no request for dissemination costs as the advertising of results to the science community will be mainly provided through publication in world-class journals free of cost (e.g. Astronomy & Astrophysics, Monthly Notices of the Royal Astronomical Society) and/or use of renowned public repositories (e.g. arXiv).

**Joint Research Activities**

The financial plan for the Joint Research Activities shows that the costs are dominated by personnel costs. This is also reflected by the large amount of person-months to be funded by the EC. Most of the personnel hired will be at the postdoc level (>90%). For the most challenging technology development WPs the share permanent vs. temporary positions can be slightly higher: for WP6 (detectors) the permanent staff contribution is expected as 35% of the total. While for WP8 (optics) the share is less than 10%. Travel costs for WP6 are relatively high, reflecting the need for regular work package team meetings for this hardware-oriented WP, as well as participation to measurement campaigns: two campaigns in a European laboratory (plus one test run and one visit to filter manufacturer) for WP6; pre/post test reviews and measurement campaigns at PANTER for WP8. Equipment costs for WP6 concern the acquisition of tools for machine shops, computers and software licenses (6.5k€ of EC contribution).

About 85% of manpower has a scientist-type profile. In WP9 (gamma-ray) and WP7 (background and calibrations), nearly 100% of the requested personnel costs are for post-doc level scientists. For WP8 (optics) it is about 90%. This share is lower in the detector technology development, i.e. about 60%; where significant engineering type staff and/or highly specialized expertise is required. Finally, in WP10 (innovation WP) all the manpower costs are for engineering personnel.

Subcontracting for 30k€ is foreseen in WP6 for the production and procurement of specialized harness for detectors.

**Transnational Access**

The TA Work packages WP4 and WP5 include provisions for the travel costs of users to the facilities and research centres, plus manpower and travel costs for selection panels of the TA calls (assuming a panel composition of 5 persons). User team visits for WP4 (access to facilities) are assumed to be based on groups of 2 persons and maximum access duration of 8 days. The total number of team visits provided is 27 for the access to 13 offered installations (WP4), for an overall EC contribution (including 25% overhead) of 270.1k€, of which, 137k€ for facilities which uses actual costs as accounting method; 133€ for facilities which using units costs. Moreover, 99.7k€ of EC contribution is foreseen for travel and subsistence of the teams. For WP5 (access to X-ray data analysis) we foresee team visits by a single user for a total number of 96 visits to 8 installations at 5 different infrastructures. The costs for TA of the infrastructure provided by the University of Geneva will be offered as institutional contribution, free-of-cost for EU, as Switzerland is not directly eligible for funding within this proposal. The total access cost of each infrastructure in WP5 is based solely on manpower for the support and scientific training of users. This amounts to 213.9k€ of EC contribution for access to X-ray data analysis in WP5 plus 134.29k€ of travel/subsistence costs for user teams.

The costs for management of TA are included in the corresponding WP budgets; these amount:

- 22k€ for INAF/OAPA corresponding 4.5 person-months personnel cost. Plus 9k€ of travel costs for the meeting of the selection panel (5 persons, 3 meetings foreseen).
- 22k€ for University of Leicester corresponding to 3 person-months personnel cost, plus 5k€ for travel costs of the selection panel.

No subcontracting costs are requested for the activities of transnational access.

The estimated spending profile for the different types of activities (Management+NA, JRA, TA) is shown in the figure below.
Table 3.4b: ‘Other direct cost’ items (travel, equipment, other goods and services, access costs)

A detailed breakdown is given below, for those participants providing transnational access and/or for which the sum of the costs for travel, equipment and goods and services exceed 15% of the personnel costs.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Cost (€)</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/INAF</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Travel</strong></td>
<td>81598</td>
<td>Travel for Project team to participate to 3 consortium, 4 management and advisory committee meetings, plus internal audits; for IAPS, travel grants for conference (WP2); for OAR, for meetings of WP3; for TA selection panel meetings (WP4); IAPS, meetings and participation to test runs in WP6; progress meetings of WP7. Includes 11k for supporting meeting of the SAC and 7.5k for selection panel of WP4.</td>
</tr>
<tr>
<td><strong>Equipment</strong></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Other goods and services</strong></td>
<td>33800</td>
<td>Audit certificate (10kEur); costs for organization of meeting (WP2), 14k</td>
</tr>
<tr>
<td><strong>Access costs (if applicable)</strong></td>
<td>11795</td>
<td>TA to facilities (excluding personnel costs): 1 installation at INAF/OAPA (4.8kEur) plus 3 installations at INAF/IAPS (7.0kEur)</td>
</tr>
<tr>
<td><strong>Travel and subsistence for trans-national access (if applicable)</strong></td>
<td>66636</td>
<td>29kEur for TA to facilities; 38kEur for TA to data analysis</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>189029</td>
<td></td>
</tr>
<tr>
<td>2/ULEIC</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Travel</strong></td>
<td>17024</td>
<td>WP3: for selection panel meeting attendance plus WP Leader attendance at Management meetings; participation to 3 consortium meetings; travel for meetings of WP8</td>
</tr>
<tr>
<td><strong>Equipment</strong></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Other goods and services</strong></td>
<td>2800</td>
<td>Audit costs</td>
</tr>
<tr>
<td><strong>Access costs (if applicable)</strong></td>
<td>0</td>
<td>(excluding direct personnel costs)</td>
</tr>
<tr>
<td><strong>Travel and subsistence for trans-national access (if applicable)</strong></td>
<td>26187</td>
<td>T&amp;S for users of facilities. WP5: 13.5k; WP4: 12.6k.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>46009</td>
<td></td>
</tr>
<tr>
<td>3/STICTING SRON</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Travel</strong></td>
<td>13570</td>
<td>Travel for coordination of the activities across team in 6 countries. Plus WP6 Leader attendance to MGT meetings: (2.1k)</td>
</tr>
<tr>
<td><strong>Equipment</strong></td>
<td>0</td>
<td></td>
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<td><strong>Other goods and services</strong></td>
<td>33000</td>
<td>Material and masks for production of sensors (WP6)</td>
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<td>(excluding direct personnel costs)</td>
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<td><strong>Travel and subsistence for trans-national access (if applicable)</strong></td>
<td>12600</td>
<td>T&amp;S for users of SRON installation (WP5)</td>
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<td><strong>Total</strong></td>
<td>59170</td>
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<tr>
<td>Participant 4/MPG</td>
<td>Cost (€)</td>
<td>Justification</td>
</tr>
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<tr>
<td><strong>Travel</strong></td>
<td>23080</td>
<td>Participation to Consortium meetings (2k€)Travel grants for School 2, WP2 (14.5k€) + travel for meetings of the gamma-ray community (4k€) in WP2.5, plus WP leader to attend management meetings and for coordination of activities (2.6k€)</td>
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<td><strong>Equipment</strong></td>
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<td>Other goods and services</td>
<td>7500</td>
<td>Cost for organisation of school 2 in WP2</td>
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<td><strong>Access costs (if applicable)</strong></td>
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<td><strong>Travel and subsistence for trans-national access (if applicable)</strong></td>
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<tr>
<td><strong>Travel</strong></td>
<td>8100</td>
<td>Travel for organisation of activities in WP3. Travel of WP leader to Management and Consortium meetings</td>
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<td><strong>Equipment</strong></td>
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<td>Other goods and services</td>
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<td><strong>Travel and subsistence for trans-national access (if applicable)</strong></td>
<td>12600</td>
<td>T&amp;S for users of IAASARS installation (WP5)</td>
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<td><strong>Total</strong></td>
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<td><strong>Travel</strong></td>
<td>5980</td>
<td>Participation to 3 consortium board meetings (2k); meetings of WP2.3 (4k)</td>
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<td><strong>Equipment</strong></td>
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<tr>
<td>Other goods and services</td>
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<td><strong>Access costs (if applicable)</strong></td>
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<td><strong>Travel and subsistence for trans-national access (if applicable)</strong></td>
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<th>Justification</th>
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<tr>
<td><strong>Travel</strong></td>
<td>7980</td>
<td>Travel grants for Meeting 2 (WP2.3)</td>
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<td><strong>Equipment</strong></td>
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<td>Other goods and services</td>
<td>10000</td>
<td>Organisation of Meeting 2 (WP2.3)</td>
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<td><strong>Access costs (if applicable)</strong></td>
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<tr>
<td><strong>Travel and subsistence for trans-national access (if applicable)</strong></td>
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<td><strong>Total</strong></td>
<td>17980</td>
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<td>Participant 9/UNIFE</td>
<td>Cost (€)</td>
<td>Justification</td>
</tr>
<tr>
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<td>---------------</td>
</tr>
<tr>
<td>Travel</td>
<td>5980</td>
<td>Participation to 3 consortium board meetings (2k); meetings of WP2.3 (4k)</td>
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<tr>
<td>Equipment</td>
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<td>Other goods and services</td>
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<td>Access costs (if applicable)</td>
<td>2032</td>
<td>TA to facilities (excluding direct personnel costs): 2 installations at UNIFE</td>
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<tr>
<td>Travel and subsistence for trans-national access (if applicable)</td>
<td>10174</td>
<td>T&amp;S for users of 2 UNIFE installations (WP4)</td>
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<td><strong>Total</strong></td>
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<tr>
<td>Travel</td>
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<td>Participation to 3 consortium board meetings (2k);</td>
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<td>Equipment</td>
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<tr>
<td>Other goods and services</td>
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<tr>
<td>Access costs (if applicable)</td>
<td>2582</td>
<td>TA to facilities (excluding personnel costs): 2 installations</td>
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<tr>
<td>Travel and subsistence for trans-national access (if applicable)</td>
<td>13565</td>
<td>T&amp;S for users of 2 UNIPG installations (WP4)</td>
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<td><strong>Total</strong></td>
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<tr>
<td>Travel</td>
<td>1980</td>
<td>Participation to 3 Cons. Board (incl KO)</td>
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<td>Equipment</td>
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<tr>
<td>Other goods and services</td>
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<tr>
<td>Access costs (if applicable)</td>
<td>53 920</td>
<td>(excluding direct personnel costs) Access cost for FOCAL2 and shaker facility at CSL</td>
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<tr>
<td>Travel and subsistence for trans-national access (if applicable)</td>
<td>6 840</td>
<td>T&amp;S for users of 2 CSL installations (WP4). Team of 2 guests, 400 euro for travel for each guest, 130 euro of daily subsistence for each guest. Visit duration typically 1 day longer than actual access duration</td>
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<td><strong>Total</strong></td>
<td><strong>62 740</strong></td>
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<tbody>
<tr>
<td>Travel</td>
<td>5980</td>
<td>Participation to 3 consortium meetings (2kEur) + meetings of the gamma-ray community (4kEur, WP2.5)</td>
</tr>
<tr>
<td>Equipment</td>
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<tr>
<td>Other goods and services</td>
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<td></td>
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<tr>
<td>Access costs (if applicable)</td>
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<td>(excluding direct personnel costs)</td>
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<td>Travel and subsistence for trans-national access (if applicable)</td>
<td>12600</td>
<td>T&amp;S cost for 60 days of visits (WP5)</td>
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<td><strong>Total</strong></td>
<td><strong>18580</strong></td>
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<td>Participant 14/VTT</td>
<td>Cost (€)</td>
<td>Justification</td>
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<tr>
<td>Travel</td>
<td>7980</td>
<td>Three consortium progress meetings, one per year in 2015, -16 and -17.</td>
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<tr>
<td></td>
<td></td>
<td>Two technical visits to SRON/Utrecht, foreseen in the year 2015.</td>
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<tr>
<td>Equipment</td>
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<tr>
<td>Other goods and services</td>
<td>4300</td>
<td>Electronic components for the cryogenic test system 1500.</td>
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<td></td>
<td></td>
<td>Mechanical parts 1300.</td>
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<tr>
<td></td>
<td></td>
<td>Liquid helium, to be used in testing the prototype 1500.</td>
</tr>
<tr>
<td>Access costs (if applicable)</td>
<td></td>
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<tr>
<td>Travel and subsistence for trans-national access (if applicable)</td>
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<tr>
<td>Travel</td>
<td>5980</td>
<td>Participation to 3 Consortium meetings (2kEur), plus meetings of the gamma-ray community (4kEur, WP2.5)</td>
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<tr>
<td>Equipment</td>
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<tr>
<td>Other goods and services</td>
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<tr>
<td>Access costs (if applicable)</td>
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<tr>
<td>Travel and subsistence for trans-national access (if applicable)</td>
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<td><strong>Total</strong></td>
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<tr>
<td>Travel</td>
<td>7980</td>
<td>Participation to 3 Consortium meetings (2k€), plus participation to 2 measurement campaigns in European laboratories (2k€). 1 visit to filter manufacturer in USA (2k€)</td>
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<tr>
<td>Equipment</td>
<td>6000</td>
<td>Tools for the machine shop, computers, technical software licences (WP6)</td>
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<tr>
<td>Other goods and services</td>
<td>20000</td>
<td>Procurement of filter samples according to new optimized design</td>
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<tr>
<td>Access costs (if applicable)</td>
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<tr>
<td>Travel and subsistence for trans-national access (if applicable)</td>
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### Participant 20/UNIVERSIDAD DE ALICANTE

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<tr>
<td><strong>Travel</strong></td>
<td>130100 Travel grants for: Visitor Programme (100000), Travel grants for Meeting 1 (6000; WP2.3) and for School 1 (20 students, 12000; 5 lecturers, 8000). Attendance to 4 AMT meetings of WP2 leader: 1590. Participation to 3 consortium meetings (2k)</td>
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<tr>
<td><strong>Equipment</strong></td>
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<tr>
<td><strong>Other goods and services</strong></td>
<td>22000 Organization of Meeting 1 (4k) and School 1 (18k)</td>
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<td><strong>Access costs (if applicable)</strong></td>
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<td><strong>Travel and subsistence for trans-national access (if applicable)</strong></td>
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### Participant 21/CSIC

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<tr>
<td><strong>Travel</strong></td>
<td>14630 Participation to 3 Consortium meetings (1.6k), Travel to SRON for coordination purposes, discussion of results and eventual tests. 3-4 trips, depending on duration (2.6k); meetings of CSIC participants of the gamma-ray community (10k)</td>
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<tr>
<td><strong>Equipment</strong></td>
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<tr>
<td><strong>Other goods and services</strong></td>
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<td><strong>Access costs (if applicable)</strong></td>
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<tr>
<td><strong>Travel and subsistence for trans-national access (if applicable)</strong></td>
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### Participant 23/LIP

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<tr>
<td><strong>Travel</strong></td>
<td>5980 Participation in scientific and consortium meetings in Europe</td>
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<td><strong>Equipment</strong></td>
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<td><strong>Other goods and services</strong></td>
<td>3000 Consumables</td>
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<td><strong>Access costs (if applicable)</strong></td>
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<td><strong>Travel and subsistence for trans-national access (if applicable)</strong></td>
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<td>Participant 24/CNRS</td>
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<td><strong>Travel</strong></td>
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<td><strong>Equipment</strong></td>
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<td><strong>Other goods and services</strong></td>
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<td><strong>Access costs (if applicable)</strong></td>
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<td><strong>Travel and subsistence for trans-national access (if applicable)</strong></td>
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<td><strong>Equipment</strong></td>
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<td><strong>Other goods and services</strong></td>
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<td><strong>Access costs (if applicable)</strong></td>
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<td>(excluding direct personnel costs)</td>
</tr>
<tr>
<td><strong>Travel and subsistence for trans-national access (if applicable)</strong></td>
<td>19200</td>
<td>Travel and subsistence for TN access (4 visits per year, each 5 days, at 220 EUR/day and 500 EUR travel per visit)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
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4. Members of the consortium

4.1. Participants (applicants)

[Participant 1: INAF]

The National Institute for Astrophysics (INAF) is the leading Italian Institute conducting research in astronomy and astrophysics. Researches performed by the scientific staff of the Institute go from the study of planets and minor bodies of the solar system up to extragalactic science and cosmology (e.g. large scale structure of the Universe). INAF promotes, develops and co-ordinates, as part of programs of the European Union and international organizations, research activities in collaboration with the Universities and with other public and private entities, national, international and foreign. It designs and develops innovative technologies and advanced instrumentation for the study and exploration of the cosmos. It promotes the dissemination of scientific culture through educational projects and dissemination of Astronomy addressed to schools and to the community.

This INAF mission fully matches not only the tasks inside this proposal, since it has the full expertise to get the results in terms of high energy astronomy knowledge, but also the H2020 aims. There are seven INAF research structures participating in this proposal:

1. IAPS:

The Institute for Space Astrophysics and Planetology in Rome (INAF/IAPS) was born on January 2012, when two historical Institutes were merged: IASF, Istituto di Astrofisica Spaziale e Fisica Cosmica and IFSI, Istituto di Fisica dello Spazio Interplanetario. The staff working in AHEAD were former researchers of IASF, that was established in the early sixties and whose primary mission has been to develop and fly space experiments for high-energy astrophysics, and to carry out data analysis and theoretical interpretation studies.
This High Energy section has the PI-ship in several experiments and missions, including BeppoSAX, INTEGRAL, Agile. Significant resources and facilities are devoted to space experiments, with facilities including clean rooms, thermal vacuum, cryogenic test, stratospheric balloon assembly, workshops.

**Role in AHEAD:** dr. L. Piro is the Coordinator of this AHEAD proposal and main contact of the INAF institute. He will be supported in this effort by permanent staff persons of the AHEAD Project Office: dr. L. Natalucci, the project scientist, will help the timely advancement of the project and the accomplishment of the research goals in consultation with the coordinator. He will also supervise the technical aspects of the activities, including the interpretation of results. He will also contribute to WP7. Dr. M. Rossi, Project Officer and Financial Assistant, will support to the Coordinator for legal, financial and administrative aspects, and for overall management activities.

IAPS has also a major role in the JRAs, leading WP9 by dr. C. Macculi. IAPS owns a significant background on simulation activities and experiences with the GEANT4 package. The institute will also participate to WP6, for which L. Piro and C. Macculi will work on the improvement of the performance of the anticoincidence detector.

**Relevant publications:**


**Relevant previous projects or activities:**

- ATHENA (Advanced Telescope for High Energy Astrophysics): national coordination
- Athena/X-IFU (X-ray Integral Field Unit): Co-PIship
- INTEGRAL (International Gamma-Ray Astrophysics Laboratory): PIship
- National coordinator for the project awarded 2002, “Descartes Prize of EC: solving the gamma-ray burst riddle: the Universe’s biggest explosions”
- Project Scientist office for BeppoSAX

2. **OAPA:**

The INAF Osservatorio Astronomico di Palermo (OAPA) was founded in 1790. Today at OAPA works 15 INAF scientists and 4 associated University professors, about 12 among post-docs and graduate students and 13 support staff persons. Since 2006 the OAPA technological premise has moved to a new building to host the renovated 34 meter-long XACT facility, the OAPA departmental parallel computer facility, an enlarged and improved set of laboratories as well as a renovated machine shop. This building is the working place of a dedicated team of OAPA researchers, university professors and PhD students. This team is working since many years in R&D activities in the field of focalization and detection of soft X-rays, and has established fruitful connections with local small enterprises in the area of high-vacuum systems, material treatments, microelectronics and laser writing technique. The OAPA group has taken part to the successful realization/calibration of the Chandra High Resolution Camera, of the XMM-Newton EPIC, of the Solar-B XRT.
as well as to other missions or technological programs funded by Chinese, Polish and Czech space agencies. A joint group from OAPA and UNIPA is currently deeply involved in the ESA L2 mission ATHENA with roles in both of the two planned focal plane instruments.

**Role in AHEAD:** The INAF-OAPA will participate to the AHEAD through its involvement in WP3. Prof. S. Sciortino will coordinate the effort to provide the transnational access. The OAPA will also provide an important installation for the TA, the Institute has a long experience in the calibration of hardware for X-ray missions. OAPA will also participate in WP4 as providing access to X-ray data analysis with special emphasis on:

- the analysis of high resolution spectra of stars and young stellar objects taken with Chandra LTGS and HTGS and XMM-Newton RGS,
- the analysis of spectral data of SNRs;
- the analysis of time-resolved spectral data of young stars taking also advantage of purposely software tools developed in house.

**Relevant publications:**


3. **OAB:**

The INAF Brera Astronomical Observatory (OAB) has developed an important know-how in the field of the design, development and calibrations of optics and instrumentation for space and ground-based telescopes. In the field of X-ray astronomy, taking the heritage of the technology set-up for the Beppo-SAX telescopes, OAB has been deeply involved in the implementation of the X-ray mirrors on board of the XMM (ESA) and Swift (NASA, ASI, PPARC) satellites. A number of developments were carried out as a contractor of ESA and the Italian Space Agency (ASI), including the development of the innovative thin glass optics produced by hot slumping or direct polishing, while now has a leadership role within the activities aiming at the implementation and calibrations of the optics for the ATHENA mission. In the field of optical/NIR ground, it assumed the leadership in the implementation of the X-SHOOTER VLT-ESO spectrograph and the REM robotics telescope. It is now covering a leadership role in the implementation of the Cherenkov Telescope Array Observatory, with the leadership in the ASTRI project. The technology activities are located in the Merate site Very important are the facilities used for the metrology applications (in part developed inside the Institute on original designs), the
technology of ion beam polishing and figuring, polishing of optical surfaces, soon to be greatly improved with the acquisition of a Jet and Bonnet polishing Zeeko-1200 machine and the technology of polymeric re-writable devices.

**Role in AHEAD:** OAB will be deeply involved in the activities of the WP7, devoted to the development and characterization of optics for next generation X-ray telescopes. Within AHEAD, dr. D. Spiga will lead the development and implementation of the BEaTriX (Beam Expander testing X-ray facility) facility, that will be installed at its lab site of Merate (Italy); he will also provide expertise in the interpretation of the calibration data. Dr. G. Pareschi, director of OAB, will act as supervisor of these activities; he is also development leader of the thin glass foil optics.

It already exists a long and very fruitful heritage of collaborations with the other partners (MPE, UL, CTU) and together with them OAB will carry out the activities concerning the design, development and calibrations of innovative segmented X-ray optics based on the Silicon Pore and glass slumping technologies, for which an important know-how is already existing. In particular, OAB developed ad hoc software for the design of X-ray optics and the interpretation via ray tracing and analytic approach of the calibration data. BEaTriX will consist of a facility able to provide fast, full illumination, functional tests of X-ray mirror modules, sufficient to fully illuminate the largest XOUs that will be produced e.g. for ATHENA (but also possible for other projects based on segmented optics). OAB will be in charge of the concept, design and implantation of the new calibration lab. At this regard, innovative optics for the collimation of the beam based on precisely polished parabolic mirrors and diffractive crystals will be realized and assembled in the facility, while a precise manipulator will be installed for allowing the alignment of the optics to be tested. Once the BEaTriX facility is developed, OAB will transfer the know-how to the industrial site where the mirror units of the ATHENA (or other telescopes) optics will be produced.

**Relevant publications:**


4. **OAR:**

The Osservatorio Astronomico di Roma (OAR) is one of the largest INAF institutes, including 37 permanent staff, 30 Post Docs and about 20 PhD and undergraduate students. OAR researchers are involved in all major fields of Astrophysics. The largest groups are on Stars and Stellar Populations, Galaxies and Cosmology and High Energy Astrophysics. OAR host a relatively small but very active technology group involved in activities for LBT and ESO VLT, E-ELT instruments.

OAR has a long standing close and fruitful collaboration with the three Universities of Roma (La Sapienza, Tor Vergata and Roma TRE). OAR researchers teach five undergrad and 2 PhD courses at these Universities, and train undergraduate and PhD students routinely.
Role in AHEAD: The AHEAD team at the Observatory of Rome has a well-established tradition of supporting student learning through research. All team members have been actively engaged in the supervision of undergraduate, postgraduate and PhD students and works closely with many post-doctoral research fellows in the field high energy astrophysics. Furthermore, many of them also teach high-energy astrophysics undergraduate courses and are involved in X-ray data analysis schools and "hands on" workshops. This teaching and supervision expertise will be pivotal in ensuring successful implementation of the activities foreseen in the AHEAD WP4 package by providing tutorials in X-ray data analysis and reduction. AHEAD members at OAR are deeply involved in cutting edge research in galactic and extra-galactic X-ray astronomy and cosmology using XMM, Chandra, Suzaku Swift and NuStar observations. Therefore, they can share their practical and theoretical know-how in a wide variety of subjects related to important and fast growing topics in X-ray astronomy. F. Fiore, the Director of OAR, has been playing a leading role in the exploitation of data from deep and wide-area X-ray surveys and their multiwavelength follow-up programs since late 90s. E. Piconcelli has an extensive experience in X-ray imaging and spectroscopy. The team of OAR, provides a strong and proven expertise in X-ray timing analysis techniques and some of these members are recognized experts in X-ray high-resolution spectroscopy and time-resolved spectroscopy. E. Piconcelli and F. Fiore also served as support-scientists at the operation-and-control center of XMM-Newton, Chandra and BeppoSAX, respectively.

Relevant publications:


Relevant previous projects or activities:

Concerning the AHEAD proposal, particularly relevant are the OAR programs on AGN and galaxy surveys at optical, infrared and X-ray wavelengths. OAR researchers are involved in the CANDELS, ASTRODEEP, VANDELS, COSMOS international projects (among others).

5. OABO:

The Bologna Astronomical Observatory (OABO) is one of the largest INAF institutes employing about 35 permanent staff members and about 20 Post Docs and PhD students. OABO has two major research areas: Stars and Stellar Populations and Galaxies and Cosmology and is also actively participating in the design and development of instrumentations for present and future ground based facilities (i.e. VLT and E-ELT). The most important research lines at OABO includes "Large scale surveys at optical and infrared wavelengths", "X-ray selected active galactic nuclei", "X-ray emitting gas in clusters of galaxies". The three research lines mutually reinforce each other and place OABO at the forefront of the European research in these fields. OABO has also a long standing close and fruitful collaboration with the University of Bologna Physics and Astronomy Department (DIFA) staff especially in terms of training undergraduate and graduate students and Post Doc. The OABO and DIFA scientific staff has matured a state of the art experience in the exploitation of data from several space mission such as ROSAT, ASCA, BeppoSAX, XMM, Chandra, Suzaku, NuSTAR, Spitzer and Herschel being also deeply involved in futur projects (eROSITA and ATHENA).

Role in AHEAD: The staff team in Bologna (Physics and Astronomy Department, DIFA, and Bologna observatory) has a long-dated teaching experience coupled with pronounced capability in working proficiently with under-graduate and PhD students, and postdoc researchers. The combined scientific and technical
expertises of all of the AHEAD team members in Bologna is well suited to offer, within the AHEAD WP4 package, tutorials in X-ray data analysis. Since 2005 the institution is deeply involved, in close collaboration with INAF-IASF in Bologna, in the organization of a two-week tutorial on X-ray data reduction, analysis and interpretation. The course, mostly focused on AGN science and intended for under-graduate students, aims at providing the most up-to-date techniques and key tools for a proper X-ray data handling and interpretation. Several science cases with associated X-ray datasets (mostly Chandra and XMM-Newton) are offered.

The staff provides also the needed expertise in the field of multi-wavelength AGN characterization, which is of paramount importance to understand the physical properties of AGN in e.g. X-ray surveys and has a world recognized expertise in the analysis and interpretation of X-ray observations of Cluster of Galaxies.

**A. Comastri** is world-wide expert in the field of X-ray background synthesis models and evolution of AGN across cosmic time.

**Relevant publications:**


2. Ettori, Stefano; Donnarumma, Annamaria; Pointecouteau, Etienne; Reiprich, Thomas H.; Giodini, Stefania; Lovisari, Lorenzo; Schmidt, R., *Mass Profiles of Galaxy Clusters from X-ray Analysis*, 2013, SSRv, 177, 119


6. IASF-BO:

The Istituto di Astrofisica Spaziale e Fisica Cosmica- Bologna specialises in space science, bringing together expertise in both technological and developmental research, and in astrophysics and cosmology. IASF-Bologna participates in national and international research programs, many of which are realized in collaboration with space agencies, universities and research institutions from Italy and abroad. IASF-Bologna’s staff have been, and still are, involved with a high level of responsibility, in a number of national (ASI), European (ESA – European Space Agency) and international scientific space and ground missions, like BeppoSAX, XMM-Newton, INTEGRAL, AGILE, Planck, ATHENA, Euclid, CTA, E-ELT.

**Role in AHEAD:**

Since year 2005, IASF-Bo has been deeply involved in the organization of the High Energy Laboratory Course of the Department of Astronomy of the University of Bologna addressed to the last year Astronomy students
and led first by Prof. G.G.C. Palumbo, and nowadays by Prof. B. Marano and Dr. C. Vignali of the DIFA. Laboratory courses and classes are held yearly for a two-weeks period in the IASF-Bo facilities, and have covered i) “hands-on” hardware specific activities (such as calibration facilities, detector characterization, etc.), ii) “hands-on” data analysis and interpretation activities (such as identification of an open scientific question, definition of an observation dataset to answer the question, data analysis, scientific interpretation, and presentation of final results) and iii) 10 to 20 hours of frontal lessons to introduce and prepare students to the activities i) and ii) listed above. The number of IASF-Bo staff persons involved (typically from 5 to 10) changes every year according also to the number of students (typically from 20 to 30) expected. Simulations of high energy satellites, and their interactions with surrounding particle environment are also envisaged in this TA using the BoGEMMS (Geant4-based) multi-mission simulator available at IASF-Bo. Finally, we note here the roles of A. Bulgarelli as world-wide expert in the simulation (using the BoGEMMS simulator, but not only) and analysis of data obtained from X-ray and Gamma-ray instruments. The Ahead team for IASF-BO has world-wide experts in the field of X-ray spectroscopy of Active Galactic Nuclei and experts of CZT detectors.

Relevant publications:

3. Dadina et al., "Ultraluminous X-ray source XMMUJ132218.3-164247 is in fact a type I Quasar", 2013, A&A, 559, 86

7. IASF-PA:

The Istituto di Astrofisica Spaziale e Fisica cosmica di Palermo (IASF-Pa) is a scientific structure of the INAF whose activities are mainly focused on X and gamma astronomy either with the design and realization of instrumentation for space missions and on ground-based and space-born very high-energy observatories as well as on the analysis and interpretation of scientific data. Scientists from IASF-Pa played a primary role in the design and calibration of two telescopes (HPGSPC and MECS) on board the BeppoSAX mission and the calibration of the X-ray telescope on board Swift. IASF-Pa scientists involved in AHEAD have experience in measurements and simulations of the noise background in X and Gamma rays instruments produced by the interaction with charged particles. They are involved in the design of the anticoincidence detector for the calorimeter foreseen on board the next missions IXO and XENIA.

Role in AHEAD: the IASF Palermo has a long experience in the production of a ray-tracing codes able to simulate the optics transmission either for input photons or protons in the X band. The software has already been used for the in-flight calibration of BeppoSAX-MECS and Swift-XRT effective area. It has also used to estimate the contribution of the stray-light and to design a baffle in new X-ray missions proposed to past ESA call. Moreover including in the code the reflection function of grazing incident protons, the software has been used to evaluate the contribution of focused protons. In fact, as Chandra and XMM-Newton missions experienced, X-ray telescopes are able to focus soft protons (100 keV-1 MeV) with grazing incident angles as well as photons reducing the telescope sensitivity. The main tasks of IASF Palermo researcher will then be:

- production of a ray-tracing code able to simulate the transmission at the focal plane of grazing incident photons.
- production of sets of mathematical functions or numerical tables to model the proton reflection efficiency and the scattering angles as function of the input energies and directions.

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• production of a ray-tracing code able to simulate the transmission of grazing incident protons at the focal plane in order to evaluate its contribution to the total background.

Relevant publications:


The key persons and their expertise relevant for the project are:

• Dr. Luigi Piro (gender: male).

Born in 1960. In 1985 research staff at Istituto Tecnologie e Studio Radiazioni Extraterrestri of C.N.R., Bologna. In 1988 he moved to Japan, at RIKEN institute. In 1990 in Istituto Astrofisica Spaziale, C.N.R., in Rome. Appointed Project Scientist of the BeppoSAX satellite by the Italian Space Agency (ASI) in 1992 and, following the launch on April 1996, director of scientific operations. In 1997 appointed Primo Ricercatore and, as of 2002, Director of Research at IAPS/INAF in Rome. His primary research activity is High Energy and Relativistic Astrophysics. PI of observational programmes on Gamma-Ray Bursts and on galaxies harbouring black holes. He is among the most cited authors in all science disciplines, as recognized by the Institute of Scientific Information (ISI). He has published 244 articles in refereed journals, 394 other scientific publications (proceedings, circulars,…), given 60 invited reviews in international conferences and organized 40 scientific international conferences in the field, including 10 COSPAR symposia. Member of several national and international boards (ASI, ESA, NASA, JAXA, IAU), referee of Nature, Science, Astronomy and Astrophysics, Astrophysical Journal, etc: book reviewer and column writer for Nature. As BeppoSAX Project scientist he has led the activities on GRB resulting in the discovery of the X-ray afterglow. He is involved in the development of experiments and space missions of ESA, ASI, JAXA and NASA. He is leading the development of cryogenic microcalorimeters in Italy and leading the Italian contribution to the Athena mission. Awards: In 1998 Bruno Rossi Prize of the American Astronomical Society for the discovery of the X-ray and optical afterglow of gamma-ray bursts, making possible the solution to the 30 year old problem of fixing the distances of gamma-ray bursts sources. This result was classified by the Science journal in the top 10 most important discoveries made in 1997. In 2002 Descartes Prize of the European Commission for Solving the Gamma-ray burst riddle: the Universe's biggest explosions.

• Dr. Lorenzo Natalucci (gender: male).

Staff researcher at IAPS. Born in Ancona, Italy, 1959. Expert in coded mask imaging, instrument calibration, simulations, and astrophysics of Galactic compact objects. He contributed to the development of the Science Ground Segment of the BeppoSAX mission; and to the design of the coded mask, passive shielding and operational modes of the INTEGRAL/IBIS imager. S/W Manager of IBIS and appointed member of ESA review panel for the INTEGRAL Science Ground Segment review; member of the INTEGRAL Operations Coordination Group led by ESA. As PI and Co-I of approved observation proposals for BeppoSAX,
INTEGRAL and Swift, and member of the INTEGRAL Survey group, he participated to the discovery observations and scientific interpretation of several Neutron Star X-ray Binaries. He participates to a multi-instrument campaign to monitor the Crab variability in hard X-rays. PI of ASI funded studies for the US led EXIST mission proposal. Member of the NuSTAR Science Team for the Galactic Binaries and Galactic Survey Working Groups. Member of Athena X-IFU team. He also leads the Non-Thermal SNR Working Group of the International Consortium for High Energy Calibration. Author of 85 refereed publications and other 122 non-refereed articles on astrophysics; plus a number of papers on physics journals.

- Prof. Salvatore Sciortino (gender: male).

Salvatore Sciortino is born in Palermo in 1955. Laurea cum laude in Physics in 1978. In 1979 he starts his research activity on Stellar Coronal Physics collaborating with the HEA group at CFA where he spend long research periods. Since 2001 he is Astronomo Ordinario (Research Professor) at Osservatorio Astronomico di Palermo (OAPA). He has been Co-I of XMM-Newton EPIC and member of the OAPA Chandra HRC team. He has co-led the HRC GTO program of stellar observations, and has been PI of national research programs, of tens of GO space programs, etc. Past Director of Osservatorio Astronomico di Palermo (1.1.2002-27.12.2011) and of Osservatorio Astrofisico di Catania (June-November 2012) he is the Head of the Science Coordination Unit of INAF. Past member of the XEUS Study Team, of the IXO SDT, of the ATHENA Study Team is member of the Athena XIFU team. He is author of more than 400 publications, more than 160 in international professional journals; his H-index is 44. His current main scientific interests concentrate on the high energy emission from young and pre-main sequence stars, and on next generation X-ray missions.

- Dr. C. Macculi (gender: male).

He is in charge of the laboratory testing activity about the cryogenic TES-microcalorimeters at INAF/IAPS, both in terms of sensors and electronics. Historically, his interest goes from cryogenics, to microwave polarimeters, to cryogenic X-ray detectors. He is responsible for the test of the cryogenic anticoincidence detector of the X-IFU ATHENA. For the WP6 he will deal with the tests of both the anticoincidence detector and the hard-X ray detector. For the WP9 he will manage the overall activity.

- Dr. Monia Rossi (gender: female)

She has a long experience as project management, and coordinates the activities of the IAPS INAF Project Management Office. She has participated as responsible for the project office of several instruments for ESA missions, and regarding the VI and VII Framework Programme she has been and is project manager for ARENA INAF and EUROPLANET INAF and CASSIS INAF, FISICA INAF, ASTROMAP INAF, STORM INAF, CROSSDRIVE INAF and VIALACTEA (INAF, coordinator organization) ensuring correct execution of the management activities and preparing all necessary reports and support documents for the INAF participation and coordination. Ahead Role: support to the Coordinator for legal, financial and administrative aspects, and for overall management activities.

- Dr. Enrico Piconcelli (gender: male)

Staff Researcher at the Osservatorio Astronomico di Roma (since December 2012). Support Scientist at the XMM-Newton User Support Group (ESAC/ESA) (2012); Post-Doc positions at the Osservatorio di Roma (2005-2011); ESA Internal Fellow (2003-2005) at the European Science Astronomy Centre; Phd in Astronomy at the University of Bologna (03/31/2003). Referee for Astronomy & Astrophysics, MNRAS and The Astrophysical Journal; Observation proposal reviewer for Chandra OTAC in 2006; Observation proposal reviewer for XMM-Newton OTAC in 2008 and 2009; Member of the PhD commitee, Universidad Complutense de Madrid (Jan. 2009). Science definition team member for ASI X-ray missions under development. Local Coordinator (OA-Roma) for the 3-yrs grant “Accretion Processes in nearby & distant radio quiet AGNs/QSOs” (ASI-INAF DA-033) Principal Investigator of 9 observing programs for different X-ray astronomical telescopes (total allocated time: ~1.2 Ms); and 1 observing program for Telescopio Nazionale Galileo (1.8 ks). Co-I of IRAM-PdBI millimeter interferometer observing programs aimed at the study of giant molecular outflows in quasars. My work has resulted in 57 papers in refereed scientific journals and many conference proceedings (H-index=19). Research activity: Physics of Active Galactic Nuclei (AGN).-Spectral and evolutionary properties of AGN in the X-ray band-X-ray background and X-ray surveys-Relativistic Fe lines in AGN-Nuclear
properties of AGN with fast outflows-Physical, temporal and geometrical properties of the nuclear obscuring matter. AGN and host-galaxy co-evolution.-AGN-driven feedback. AGN evolution & Demography: properties and dependence. Invited Speaker at International meetings and Faculty Colloquia.

- **Dr. Daniele Spiga** (gender: male)

Daniele Spiga graduated in Physics from the Milano University in 2000 with a thesis on the detection of the polarization component of the CMB. In 2005 he was awarded with the Ph.D in Astrophysics and Astronomy at the Milano-Bicocca University, after defending a technological thesis developed at INAF/OAB, devoted to the development of multilayer-coated mirrors for future X-ray telescopes. His Ph.D Thesis was awarded with the "P. Tacchini" prize in 2005 of the Italian astronomical society (SAIt). In 2007 he has been hired by INAF/OAB as staff researcher and is currently responsible for metrology labs at the same institute. He currently works in the X-ray optics group at INAF/OAB on the surface metrology of X-ray mirrors, multilayer characterizations and hard X-ray optic tests in X-ray full illumination and pencil beam; at this regard he led calibration experiments in international facilities like Panter/MPE and the Beijing Synchrotron Radiation Facility. His main interest is the development of software to consistently predict the imaging quality from metrology data and he’s author of many important papers in this fields. He took part in the NHXM, Simbol-X, WFXT, IXO development programs in collaboration with ASI and ESA. He’s currently lead a program funded by INAF devoted to the development of actively corrected mirrors for X-ray astronomy based on thin glass mirrors.

- **Dr. Andrea Comastri** (gender: male)


Most of the research activity is in the field of extragalactic X–ray astronomy (AGN physics and evolution; models for the X–ray background) and the multiwavelength characterization of the X–ray sources discovered in both deep and large area X–ray surveys. About 170 papers in referred journals (more than 6300 citations and H index of 42). Some 20 invited talks and reviews in the last 10 years.

- **Dr. Teresa Mineo** (gender: female)

After the degree, she started her scientific activity working on the on-ground calibration of the balloon borne Gamma-ray detector FIGARO II (0.2-4 MeV energy range) with the responsibility to implement the detector response matrix and the software to produce and deconvolve the observed spectrum. She partecipated to the on-ground and in-flight calibrations of the imaging focal plane detector MECS on board the BeppoSAX satellite and XRT on board Swift. She was involved in the simulations to evaluate the level of background in several mission proposed in the past ESA calls. She is at the moment part of the CTA team and is responsible for the calibration with muons of ASTRI SST-2M prototype. Moreover she is involved in the timing and spectral analysis and interpretation of high energy data from compact stars obtained from the working and past X-ray satellites (BeppoSAX, XMM, RXTE, INTEGRAL, Swift etc).

Her activity is documented by more than 300 publications at conferences and on international journals, and works as Researcher for the IASF-PA.
Dr. Andrea Bulgarelli (gender: male)

Degree in Computer Engineering with honors (University of Modena and Reggio Emilia) in 1999. PhD in Sciences and Space technologies (CISAS, University of Padua) in 2006. Research Fellowship from 2001 to 2004 and technologist since 2005 at the INAF/IASF Bologna. Since 2001 he is part of the AGILE Team and since 2007 he is the Software Manager and flare advocate of AGILE Team, publishing as first author 18 Astronomical Telegrams. He was professor of Databases Management Systems at the Faculty of Engineering of the University of Modena and Reggio Emilia from 2003 to 2012. He has participated or participates in important national and international programs such as AGILE, SIMBOL-X, NHXM, ATHENA, CTA and ASTRI. Since 2012 he coordinates the Real-Time Analysis of CTA, involving several Universities and Research Centers in Europe and the United States. His main field of research is related to analysis techniques for gamma-ray instruments and background rejection techniques for both X- and gamma-ray instruments. In this context has developed BoGEMMS with IASFBO colleagues, a multi-mission tool for the simulation of X- and gamma-ray telescopes. In the past three years has been the first author and co-author of over 40 publications in refereed international journals, mainly in the context of the AGILE and CTA missions and background simulations. Award: HEAD AAS Bruno Rossi Prize 2012 as a Member of the AGILE Team.

Participant 2: ULEIC

The University of Leicester has 23000 students, employs over 3000 people and has a turnover of around 300 million euros. The Department of Physics and Astronomy includes two leading research groups in high-energy energy astrophysics and space instrumentation: the X-ray and Observational Astronomy (XROA) and the Space Science and Instrumentation (SSI) groups. The XROA group, founded in 1960, has a distinguished record in high-energy astrophysics, having played a leading role in many X-ray observatories from Ariel-V to Swift. The group has a research programme encompassing a wide range of current astrophysics, was home to the XMM-Newton EPIC and Survey Science Centre teams, and is home to the UK Swift Science Data Centre. The group is involved in the infra-red sky survey UKIDSS, the CTA project and the NGTS exoplanet survey. The group had a strong involvement in the development of the Virtual Observatory through its role in the UK AstroGrid project and both VO-TECH and VO-DCA at the European level. The SSI group is part of the University's Space Research Centre (SRC), which has a broad space research programme. The Space Research Centre building provides laboratories, engineering support, clean rooms and test facilities for instrument development. The SRC also operates an extensive set of facilities for instrumentation calibration and test, including the Leicester Long Beamline Test Facility, a vacuum beamline primarily used for testing and calibration for X-ray instruments and optics. The SSI group focuses primarily on instrumentation and mission development for space astrophysics, and on instrumentation, mission development and data analysis and modelling for planetary science. The SRC also has an extensive portfolio of Knowledge Exchange/Technology transfer activities, including long-standing ones arising from its developments in X-ray detectors for space use.

Role in AHEAD: The University of Leicester will participate in WP3, WP4, WP5, WP7 and WP9. P. O’Brien will coordinate AHEAD activities at Leicester, will coordinate WP4 on trans-national access for data analysis and will be responsible for Leicester contributions to WP5. R. Willingale will have prime responsibility for the Leicester activities in WP7. J. Pye will have prime responsibility for the activities of WP3 at the University of Leicester. S. Sembay will be responsible for Leicester contributions to instrument characterisation and simulation for WP9.

Relevant publications:

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**Relevant previous projects or activities:**

Major past activities include optics and/or detector development for ROSAT, Jet-X, XMM-Newton and Swift, whilst current activities incorporate JWST (MIRI instrument), Astrosat, BepiColombo and mission studies for Athena, SVOM, and MagEX. Both the XROA and SSI groups are actively engaged in the Department's outreach activities, which are acknowledged to be amongst the strongest within the UK and benefit particularly from our very close links with the UK's National Space Centre, located in Leicester.

The **key persons** and their expertise relevant for the project are:

- **Paul O'Brien** (gender: male)

Professor of Astrophysics and Space Science at the University of Leicester and is a member of several ground-based and space-based facility teams, including LOFAR, CTA, Swift and Athena. His research is concentrated on the study of compact objects and in particular the high-energy emission from Active Galactic Nuclei and Gamma-Ray Bursts and he is an author on some 300 research papers. He is also Director of the University of Leicester Observatory and leads outreach activities to children and the general public.

- **Richard Willingale** (gender: male)

Professor of High Energy Astrophysics and a member of the Space Research Centre and the X-ray and Observational Astronomy research group at the University of Leicester. He is an expert in the design and testing of X-ray telescopes and X-ray optics and has a keen interest in the astrophysics of Gamma-Ray Bursts, Super Nova Remnants and the Interstellar Medium. He is a member of the ESA Athena Science Study Team.

- **John Pye** (gender: male)

Manager of the Space Research Centre at the University of Leicester, and is leading the University’s efforts on the James Webb Space Telescope (JWST). He is a Co-Investigator in the JWST Mid-InfraRed Instrument (MIRI) project and a Co-Investigator in the XMM-Newton Survey Science Centre. His research interests include magnetic activity and coronae in cool stars, and sky surveys (especially in the X-ray/EUV) and their statistical analysis. He has over 80 publications in refereed journals, and ~140 in total. He has more than 30 years of experience in the management and leadership of space projects, from instrument development to ground systems and data analysis, including JWST, XMM-Newton, ROSAT, Einstein Observatory and Ariel V. He is involved in public engagement activities, and initiated a display featuring JWST-MIRI at the UK’s National Space Centre in Leicester.

- **Steve Sembay** (gender: male)

Senior research fellow at the University of Leicester. He has extensive experience in space projects, most recently as lead of the XMM-Newton EPIC team at Leicester with responsibility for characterisation of the in-flight performance of the EPIC/MOS cameras. He is also involved with the development of micro-channel plate optics concepts for the study of the Earth-Sun solar wind interaction.
Participant 3: STICHTING SRON

SRON Netherlands Institute for Space Research is the national expertise center for scientific space research in the Netherlands. It has a staff of about 200 engineers and scientists covering the range of basic instrument related research, building instruments and scientific harvesting. SRON has a long standing and excellent track record in high-energy astrophysics and is the principle investigator institute for the high spectral resolution gratings on the ESA satellite XMM-Newton and the NASA satellite Chandra and it leads the European contribution to the Japanese ASTRO-H satellite. Over the past decade SRON has been developing TES based calorimeters to allow for spatial resolved spectroscopy and is leading this effort in Europe and will therefore lead the development of the detector for the next ESA mission Athena.

Role in AHEAD: The main personnel for this Project are dr. J.W. den Herder who is responsible for the high-energy missions in SRON and was also responsible for the Reflection Grating Spectrometer on XMM-Newton. He will be supported by dr. L. Gottardi and dr. R. den Hartog, both Instrument Scientists, experts on detector work and the read-out in SRON. The support of the data analysis activities will be led by prof. Dr. J. Kaastra (SRON and University of Leiden). He is one of the world experts on spectral analysis and his fields of interests include the chemical evolution, active galactic nuclei and supernova remnants.

Relevant publications:

Relevant projects or activities:
SRON has been leading as principle investigator a number of instruments in both the high-energy and low-energy domain. This includes the Reflection Grating Spectrometer on XMM-Newton (ESA), the Low-Energy Transmission Grating (NASA) and the HIFI instrument on Herschel (ESA). Currently SRON leads the European contribution to the Japanese-US satellite ASTRO-H (expected launch date 2015) which can be considered as precursor to Athena as the mission will also include a TES based calorimeter (although with less performance). SRON has invested significant resources over the last decade in the development of the new TES calorimeters to allow for spatial resolved spectroscopy. In addition to these astrophysics fields SRON has also an active program to study the earth climate (e.g. Schiamaci, Tropomi).

The key persons and their expertise relevant for the project are:

- Dr. J.W. den Herder (gender: male)

Ph.D 1986, University of Amsterdam and since then being employed by SRON. His current position is co-leading the Astrophysics group of SRON. Following his participation in the calibrations of the COMPTEL instrument on the NASA observatory Compton-GRO, he became responsible for the delivery and commissioning of the Reflection Grating Spectrometer onboard of XMM-Newton (launch in 1999). Since then he has been leading various proposals for space missions for which a cryogenic imaging detector has been
crucial. He is currently member of the ESA Athena Science Study Team and co-PI on the X-ray Integral Field Unit. He is also PI on the Japanese ASTRO-H satellite leading the European contribution to this mission.

- **Prof. Dr. Jelle S. Kaastra** (gender: male)

PhD 1985 Utrecht University, since then at SRON; leading senior scientist of the X-ray spectroscopy group at SRON; honorary professor High-Energy Astrophysics at Leiden University; expert in X-ray spectroscopy of active galactic nuclei and clusters of galaxies; main developer of the SPEX X-ray analysis package; more than 28 years of experience with X-ray spectroscopy; Principal Investigator of the RGS spectrometer on XMM-Newton and the LETGS spectrometer of Chandra; ESA member of the Science Advisory Committee of Astro-H; member and past member of many national and international review committees. He has supervised 8 masters students and 12 PhD students. 225 refereed publications, 10500 citations, Hirsch index 57.

**Participant 4: MPG**

The **Max Planck Society** (**Max-Planck-Gesellschaft**) is a registered association which is funded to a large extent by the German federal and state governments. Since its establishment in 1948, no fewer than 17 Nobel laureates have emerged from the ranks of its scientists. The research institutes of the Max Planck Society perform basic research in the interest of the general public in the natural sciences, life sciences, social sciences, and the humanities. In particular, the Max Planck Society takes up new and innovative research areas that German universities are not in a position to accommodate or deal with adequately. These interdisciplinary research areas often do not fit into the university organization, or they require more funds for personnel and equipment than those available at universities.

The **Max-Planck Institute for extraterrestrial Physics** (**MPE**) is the leading institute in Germany in the field of observational high-energy astrophysics. In this area, it has built or contributed X-ray optics and instrumentation for missions such as ROSAT, Chandra, XMM-Newton, Swift, INTEGRAL, Fermi. It is also actively participating in instrument calibration and data analysis for all these missions. MPE is also involved in the activities related to ESA's future X-ray (ATHENA) missions. Scientific activities cover a broad range of topics, and involve multi-wavelength data analysis as well as modeling of astrophysical conditions.

**Role in AHEAD: Dr. V. Burwitz** is in charge of the MPEs PANTER X-ray test facility and will coordinate the JRA activities for WP7 (optics). He has been deeply involved in the development and calibration of the X-ray mirrors for the eROSITA X-ray all-sky survey mission to be launched on Spektrum Roentgen-Gamma in 2016. He is also involved in the development of SPO and SGO XOUs for the IXO mission and the upcoming ESA mission ATHENA.

**Relevant publications:**


Relevant previous projects or activities:

- eROSITA Telescope testing and calibrating the x-ray mirror assemblies; see Burwitz et al., Proc SPIE 8861, 88610J (2013)
- X-ray optics developments at ESA; see Bavdaz et al., Proc. SPIE 8861, 88610L (2013)
- Direct hot slumping and accurate integration process to manufacture prototypal x-ray optical units made of glass, see Civitani et al., Proc. SPIE 8861, 886110 (2013)
- Thin glass shell oriented to wide field x-ray telescope, see Civitani et al., Proc. SPIE 8443, 84430Q (2012)
- Light-weight glass mirror systems for future x-ray telescopes, see Proc. SPIE 8861, 88610Q (2013)

The key persons and their expertise relevant for the project are:

- Dr. Vadim Burwitz (gender: male)

After completing School in Mallorca Spain in 1984 started to study Physics at the Freie Universität Berlin, Germany. In September 1991 Diploma Thesis on the topic “Albedo maps of Pluto and improved physical parameters of the Pluto-Charon system” was completed at the Department of Physics of the Freie Universität Berlin, Germany. In September 1997 Ph.D. Thesis on the topic “X-ray and optical properties of ROSAT discovered magnetic cataclysmic variables (mCVs)” successfully defended at the Department of Physics, of the Georg-August Universität Göttingen, Germany. Started work in December 1997 as a research Scientist at the Max-Planck-Institut für extraterrestrische Physik in Garching, Germany working on the ground and in-flight calibration of ROSAT, Chandra-LETGS, and XMM-Newton missions. Since 2009 involved in the development, production and calibration of the X-ray Mirrors for the upcoming eROSITA all-sky survey mission. And since 2011 in charge of running MPEs X-ray test facility PANTER as well as working on the development of new technology mirrors for the now adopted ESA mission ATHENA as part of the optics working group.

Participant 5: NOA

The Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing (IAASARS) is one of the three institutes of the National Observatory of Athens, the oldest research institution in Greece (Est. 1841). The main activities of the Institute involve basic and applied research in a number of topics in astrophysics, from distant galaxies to the solar neighborhood, as well as ground based and space-born remote sensing, earth observation and signal processing. IAASARS hosts a strong group in X-ray Astronomy consisting of 3 permanent staff and 5 postdoctoral research scientists. The group’s research interests revolve around X-ray surveys and Active Galactic nuclei utilising observations from XMM_Newton but also Chandra. The group is involved in support work for X-ray missions e.g. contributing to the development of software for the eROSITA mission and developing the spectral fit database for the 3XMM catalog.

The institute is also committed to outreach and science dissemination for the general public and runs a very comprehensive public outreach program. NOA has two visitor centers, one at the city center at the premises of the old observatory (1842) and one at the outskirts of Athens where its research center is situated. The visitors center at Penteli alone provides tours for two classes (60 students) on a daily basis. The Penteli center also provides a night tour per week for the audience which include a lecture, a video presentation as well as observations with its historic refractor Newall telescope. Night tours at the city center visitor center routinely organised together with day time visits at a small museum with astronomical instruments. IAASARS also organises for the past 20 years a three-day summer school addressed to excellent high school students who are interested to pursue Astronomy or Physics in their careers. The summer school includes lectures from the astronomers of IAASARS, hands-on astronomy exercises performed on the computer as well as night observations. Finally, IAASARS is prolific in the production of public outreach astronomy videos and especially 'dome' videos which are distributed to planetariums. IAASARS has been highly appraised for its public outreach program by international committees which assess every few years the institute's performance (mainly research but also educational and outreach programs).
Role in AHEAD: dr. I. Georgantopoulos is responsible for coordinating the activities of the Public Outreach package (WP5). He is also in charge of the NOA node for trans-national access of data analysis which specialises on analysis of data from X-ray surveys.

Relevant publications:


Relevant previous projects or activities:

Public outreach video productions (examples):
- https://www.youtube.com/watch?v=VHR2fBv-Hac&list=UUvdqK2Q4wLv90ZeoS-E2QUw
- https://www.youtube.com/watch?v=9FvNiqQzgV-w&list=UUvdqK2Q4wLv90ZeoS-E2QUw&index=4
- https://www.youtube.com/watch?v=BzKZvn-XYIw&list=UUvdqK2Q4wLv90ZeoS-E2QUw&index=5
- https://www.youtube.com/watch?v=n8anszJOc10&index=21&list=UUvdqK2Q4wLv90ZeoS-E2QUw

The key persons and their expertise relevant for the project are:

- Dr. Ioannis Georgantopoulos (gender: male)

Dr. Ioannis Georgantopoulos is Research Director at IAASARS/NOA. Co-authored 120 papers published in refereed astrophysics journals, of which 28 as the first author. The total number of citations to all his refereed papers is ~3000, with an h-index of 30 (source NASA Astrophysics Data System). He has obtained numerous research grants (ESA, EU and national funds) in the past five years totaling about 2ME. He was a member of ESA’s Advisory Structure. He was also a member of the science working group of the XEUS and NHXM ESA candidate missions. Regarding, public outreach he organises the ‘Astronomy Summer School’ addressed to high school students. He has also written many public outreach articles in newspapers and magazines.

Participant 6: THALES ALENIA SPACE ITALIA SPA

Thales Alenia Space Italia S.p.a. is the Italian branch of Thales Alenia Space (TAS), a joint subsidiary of Thales (67%) and Finmeccanica (33%), and a partner in the Space Alliance along with Telespazio. The company has over 7500 employees in France, Italy, Spain, Belgium, Germany, UK and USA, and posted total revenues of 2 billion euros in 2013.

Thales Alenia Space (TAS) has more than 40 years of experience in the design, integration, testing, operation and commissioning of innovative space systems. Featuring cutting-edge technologies, these systems meet the needs of commercial, government, scientific, defence and security customers from around the world.

Thales Alenia Space is also the space company leader in European scientific programs with a prime role in missions like GOCE, Herschel & Planck and ExoMars.
The Science products line, part of the Digital Products Development and Validation unit within the Centre for Competence Electronics (CCEL), is located in the TAS-Italia Milan plant which represents one of the leading centers in Italy in the space businesses since over 30 years and is fully committed to space activities operating in the European market of satellite electronic equipment. At the present time the TAS-Italia Milan site employs about 200 people, 80% of them being university graduated and degree technicians.

The Science products line department is specialized in the development of scientific instruments for space.

Role in AHEAD: Thales Alenia Space Italia Science products background experience in system design, including thermomechanical and electronics HW and SW development, will be brought to the project from the beginning. This will allow an early involvement of the industry to ease the transition of the technologies developed in AHEAD from laboratories to space or ground applications. Thales Alenia Space Italia is interested in maintaining an active role in both ESA and national scientific programs, and is currently involved in the preliminary studies for ATHENA.

The participation of TAS-Italia in the AHEAD project is the natural follow-up of studies in the field of cryogenic electronics for scientific instruments that TAS-Italia is pursuing since a few years through collaboration with national and international scientific institutes, including the preliminary design of some ATHENA subsystems and other possible missions using cryogenic detectors (e.g. SPICA for InfraRed astronomy or CorE for CMB). The participation in the AHEAD consortium will allow Thales Alenia Space Italia to share knowledge and expertise with the leading scientific community so to ease the transition of innovative concepts from laboratory prototypes to industrial-grade products, thus enhancing the European competitiveness in the high technologies market.

The coordinating person for the project activities is P. Bastia who will also act as leader of WP10, coordinating the management and engineering activities as well as the dissemination of the results. Dr. P. Attinà will also participate as the person in charge of coordinating the Thales Alenia activities in connection with the Athena project.

Relevant publications:

4. Paolo Bastia, Jens Michael Poulsen, Franco Monzani, Paolo Radaelli, Paolo Marchesi, Claudio Labanti Martino Marisaldi, Fabio Fuschino, Andrea Bulgarelli: “AGILE, the Mini-Calorimeter”, Paper presented at the 9th ICATPP, October 2005

Relevant previous projects or activities: (developed at the Milan site)

- The Payload Data Handling Electronics (PDHE) of EPIC, the main Payload of XMM ESA X-Astrophysics Mission
- The PICsIT Detector Modules and the Payload Electronic Boxes (PEB) of IBIS, a Gamma Ray Imager flown in the ESA Mission INTEGRAL
- The Science Data Processing SubSystem (SDPSS) of the instrument MERIS, an IR imaging spectrometer aboard of ENVISAT.
- The Digital Electronic Subsystem of MARSIS, the water searching radar of MARS EXPRESS ESA mission, and SHARADE (Shallow Subsurface Radar) on board NASA’s Mars Reconnaissance Orbiter (MRO).
- The AGILE Payload Data Handling Electronics (PDHE) performing the Instrument Control, Self Triggering and Data Reduction Unit for the Italian Gamma Ray and Gamma Ray Burst Mission AGILE.

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The PLANCK Low Frequency Instrument (LFI) Data Acquisition Electronics (DAE)

The key persons and their expertise relevant for the project are:

- **Paolo Bastia** (gender: *male*)
  M.Sc. Physics, working in the space industry since 1990 beginning within Laben S.p.A (R&D department) and then with Thales Alenia Space after the merging.
  Experienced in the field of readout electronics for spaceborne scientific instruments after many years of space-grade HW development, from phase-A studies to satellite-level integration. Contributing to some of the main scientific missions of the last years (BeppoSAX, XMM, INTEGRAL, PLANCK, AGILE, GAIA) and also to many technological development and R&D projects including design and test of cryogenic LNA prototypes and SQUID readout chains.
  Present position: system engineer / front-end electronics specialist for the Science products line.

- **Dr. Primo Attinà** (gender: *male*)
  Doctor in Physics. In TAS Italia - since 1986. From 1986 up to 1996 he was the payload system engineer of the payload (composed by six X-ray instruments) that flown on the BeppoSAX satellite and in 1996-99 he was the coordinator for the development of JEM-X collimator (the italian contribution to JEM-X/INTEGRAL experiment). He is directly involved in several projects in the for X-ray and gamma astronomy. Since 2005 he has participated in several ESA study for the definition of the future IXO/ATHENA ESA X-ray observatory. Previously responsible of the assessment study of LOFT satellite (for X-ray source emission timing measurement) he has the role of Program Manager.

**Participant 7: DTU**

**DTU-space is the Danish Center for space based research.** It covers both earth observation and Astronomy and Astrophysics and has a staff of roughly 100 engineers and scientists. The activities range from developing novel concepts and instruments, building instruments and the subsequent analysis of scientific data from space based scientific satellites. The institute has an excellent and long standing track record in the field of instrumentation for high energy astrophysics. Recent projects include being the lead institution for coating and calibration of the mirror modules for the NuSTAR mission. Another significant current project is the ASIM mission which aims at studying Sprite phenomena using X-ray detectors on the International space station. Likewise the institute is the lead institution within the ATHENA collaboration for the development of the flight mirror coatings. Examples of past developments of instruments are the detectors for the coded mask JEM-X telescope on INTEGRAL and the SODART telescopes and associated detectors which was to be flown on the first incarnation of the Russian SRG mission.

Role in AHEAD: The key personnel for this project will be **F. E. Christensen** (male) who is the lead scientist at DTU-space for the development of novel concepts and coating technologies for future focusing telescopes in the hard X-ray/Gamma ray band. He will be supported by Dr. **D.M. Ferreira** (female) who is an expert researcher for DTU on ray tracing and predicting performance of highly nested telescope geometries.

**Relevant publications:**

1. Ferreira, Desiree Della Monica; Christensen, Finn Erland; Pivovarov, Michael J.; Brejnholt, Nicolai; Fernandez-Perea, Monica; Westergaard, Niels Jørgen Stenfeldt; Jakobsen, Anders Clemen; Descalle, Marie-Anne; Soufl, Regina; Vogel, Julia K., *Hard X-ray/soft gamma-ray telescope designs for future astrophysics missions*. Proceedings of SPIE, the International Society for Optical Engineering, Vol. 8861, 886116, 2013.
2. Harrison, Fiona A.; Craig, William W.; Christensen, Finn Erland; Hailey, Charles J.; Zhang, William W.; Boggs, Steven E.; Stern, Daniel; Cook, W. Rick; Forster, Karl; Giommi, Paolo; Grefenstette, Brian
The nuclear spectroscopic telescope array (NuSTAR) high-energy X-ray mission.

3. Fernández-Perea, Mónica; Descalle, Marie-Anne; Soufli, Regina; Ziock, Klaus P.; Alameda, Jennifer; Baker, Sherry L.; McCarville, Tom J.; Honkimaki, Veijo; Ziegler, Eric; Jakobsen, Anders Clemen; Christensen, Finn Erland; Pivovaroff, Michael J., Physics of reflective optics for the soft gamma-ray photon energy range. Physical Review Letters, Vol. 111, No. 2, 027404, 2013.


5. Ferreira, Desiree Della Monica; Christensen, Finn Erland; Jakobsen, Anders Clemen; Westergaard, Niels Jørgen Stenfeldt; Shortt, Brian, ATHENA optimized coating design. Proceedings of SPIE, the International Society for Optical Engineering, Vol. 8443, 2012, p. 84435L.

The key persons and their expertise relevant for the project are:

- Dr. Finn Christensen (gender: male)

Born in 1954. In 1982 he achieved the Ph.D. at the Danish Technical University. In 1982-1984 he worked as Systems developer at Mathematical Statistical Dept. and since 1984 is Senior staff Scientist at the Danish Space Research Institute. He has been Visiting Scientist at the Harvard Smithsonian Center for Astrophysics in Cambridge (US) and at the California Institute of Technology, Pasadena (US). His responsibilities are the development of novel concepts and coating technologies for future space missions and teaching master level courses on advanced X-ray instrumentation for scientific space missions. He has 170 publications in refereed journals and conference proceedings.

Box Participant 8: NCAC

The Nicolaus Copernicus Astronomical Center of Polish Academy of Sciences is the largest astronomical institute in Poland. It employs over fifty scientists with PhD degree and it educates more than twenty PhD students. Research is carried out in stellar evolution, the theory of accretion, high energy astrophysics, the dynamics of stellar systems, cosmology, relativity theory, the astrophysics of neutron stars, numerical simulations and other fields, comprising over 40 programmes funded by the governmental Ministry of Science and Higher Education and several international projects. CAMK can confer PhD and doctor habilitatus degrees.
Role in AHEAD: Modelling of cosmic sources. Broad-band spectra and light curves of cosmic high-energy sources will be modelled in terms of accretion, jet and colliding-wind models. The resulting papers will be published in leading astrophysical journals. Organization of conferences.

Relevant publications:

3. Zdziarski, Andrzej A.; Mikolajewska, Joanna; Belczynski, Krzysztof, 2013, 429, L104, Cyg X-3: a low-mass black hole or a neutron star

The key persons and their expertise relevant for the project are:

- Prof. Andrzej A. Zdziarski (gender: male)

He is a Full Time Professor, participating in research in NCAC. PhD in astronomy from Harvard University in 1986. The Polish state title of professor in 1994. The author of 250 refereed publications, with 12800 citations (according to NASA ADS), the H index of 56. Main scientific interests: high-energy astrophysics, radiative processes in cosmic sources, X-ray binaries, active galactic nuclei. Since 1991 at the N. Copernicus Astronomical Center.

Participant 9: UNIFE

University of Ferrara (UNIFE) is one of Italy’s oldest universities. It was founded in 1391 and through its remarkable history has hosted illustrious personalities from the worlds of culture, arts and science (e.g., N. Copernicus). Scientific research is one of the essential functions of UNIFE as well as a strong commitment to teaching. In all recent Italian public rankings UNIFE has always figured in the top 10 Italian Universities for Scientific Research. The Physics Department in particular is ranked in the top three among the mid-size Italian Universities.

The High Energy Astrophysics (HEA) Group operates in the Department of Physics and Earth Science (new name) and has a strong track record in experimental, observational and theoretical astrophysics. The group had the PI-ship, through Prof. Filippo Frontera, of the High Energy Instrument PDS (Phoswich Detection System) and the GRBM (Gamma Ray Burst Monitor), both aboard the BeppoSAX Italian Satellite with Dutch participation. GRBM had a crucial role in the discovery of the Gamma Ray Burst (GRB) afterglow and thus of their extragalactic origin, a mystery lasted about 30 years. The HEA group had the Col-ship of the JEM-X mask telescope aboard the ESA gamma-ray mission INTEGRAL. It also had an active participation high-energy mission proposals, such as Gamma Ray Imager (GRI), proposed as ESA/M2; DUAL, proposed as ESA/M3; Wide Field X-ray Telescope (WFXT), proposed to NASA and ASI; MIRAX of the Brazilian Space Agency, proposed to ASI as opportunity mission; GAME, devoted to GRBs, proposed to ESA as a small mission, Hard X-ray Modulation Telescope mission of the Chinese Space Agency, proposed as mission of opportunity to ASI.

Observational activities of the HEA group includes a) analysis and theoretical interpretation of X-/gamma-ray observations, in particular compact sources in binary systems and GRBs; b) leadership on a number of forefront multi-wavelength observational studies carried out over the last 15 years on X-ray selected surveys of distant galaxy clusters and active galactic nuclei with all major ground-based and space observatories (HST, Chandra, XMM-Newton, Spitzer).
The HEA group also operates the LARIX (LARge Italian X-ray) facility on the UNIFE campus, which is being used to develop a prototype of a Laue lens for focusing high energy X-rays (60-600 keV) using diffraction from crystals. This transnational facility consists of a 12 m long line (LARIX-A) for detector calibration and testing, and a 50 m long tunnel (LARIX-T), extendable to 100 m, where a lens petal prototype with 20 m focal length is being assembled with a patent-pending technology.

**Role in AHEAD**: The activity of UNIFE in WP8 will be coordinated by Prof. **P. Rosati** who recently joined UNIFE as full professor, where he leads a wide range of observational activities in the area of extra-galactic surveys and cosmology. Within WP8, he will coordinate the transnational access to the LARIX facility, and the end-to-end simulation modeling of the focusing capabilities offered by the Laue lens. The goal is a comprehensive feasibility study of a focusing gamma-ray mission, linking the scientific requirements to the instrumental parameters. P. Rosati will be supported by the deputy coordinator Prof. **F. Frontera**, Researcher at the Physics Dept, who has a life-long experience in the development of instrumentation for X-ray/Gamma-ray missions. For his pioneering studies on the X-ray afterglow of GRBs, Prof. Frontera was awarded the Bruno Rossi Prize of the American Astronomical Society in 1998, the Descartes Prize 2002 for Science of the European Committee, the Enrico Fermi Prize 2010 of the Italian Physical Society, and the Marcel Grossmann Award 2012.

**Relevant publications:**


The **key persons** and their expertise relevant for the project are:

- Prof. **Piero Rosati** (gender: male)

He has led or co-led several deep and wide X-ray surveys, such as he ROSAT Deep Cluster Survey, the Chandra Deep Field South (CDFS), the Great Observatory Deep Survey (GOODS). The latter field has become the center of the most extensive multi-wavelength campaigns in the sky. He got his PhD at University of Rome in 1995, with a thesis on X-ray surveys of clusters largely carried out at the Johns Hopkins University. He served 16 years at the European Southern Observatory, as a postdoctoral fellow, then deputy VLT Programme Scientist, lead of the Advanced Data Product group and the Hubble Legacy Archive group, and as project scientists of ESO-VLT instruments. He has been European PI of the Wide Field X-ray Telescope, member of the E-ELT Science working group, the ESA/Euclid Science Study Team and the HST/ACS construction team. He is author and coauthors of 260 articles in refereed journals (H-index=76).

**Participant 10: UNIPG**

The University of Perugia is a modern, multi-campus educational institution enrolling ≈ 30000 students and ≈ 2000 employees. Programs of advanced scientific research are developed in its 16 Departments. A wide range of research activities are promoted in the department of Physics & Geology, particle physics and astrophysics being the research fields mainly connected to by this proposal. The astro-particle group, currently lead by Prof. Bruna Bertucci, has been settled in mid 90’s and has rapidly grown since then thanks to the strong collaboration
with the INFN (Italian National Institute for Nuclear Physics) and the continuous support from the Italian Space Agency (ASI). Laboratory infrastructures for R&D on solid state particle detectors and microelectronics have been developed within the framework of the large international efforts leading to the successful AMS and FERMI-LAT experiments, now operating in space since 2011 and 2008 respectively. While exploiting the wealth of data from these on-going experiments, new projects are being carried by the Perugia team as the DAMPE and CSES space experiments due to be launched in 2015/2016 in the Chinese National Space Administration (CNSA) program. In both projects, Perugia has a leading role in the silicon tracker construction and space qualification process of the payloads.

**Role in AHEAD:** Test facilities for the space qualification of scientific payloads following the standards required by international space agencies (NASA, ESA, CNSA) have been deployed in the Terni site of the University of Perugia. A large variety of devices, from electronics boards to large payloads, can be tested in the SERMS laboratory against mechanical and thermal stressess, at ambient pressure and in vacuum, to verify their performances in hostile environments and to validate their thermo-mechanical models with experimental data. Engineering support in structure design and in the acquired data analysis is also provided by the team operating the facility. Design and assessment of electromagnetic compatibility (EMC) for electrical devices to be used in space and in a large variety of application is insured by the CEM laboratory, which is part of the Engineering department of the Perugia University.

Jointly operated by the Perugia University, the INFN and a University spinoff company, the SERMS and CEM installations are open to transnational access in WP4 of this proposal under the coordination of Bruna Bertucci, responsible of the SERMS laboratory.

**Key persons** for the different activities will be: Dr. F. Ambroglini, Dr. M. Duranti, Dr. A. Faba, with the roles described hereafter:

In the SERMS facility, mechanical tests will be coordinated by Dr. F. Ambroglini and thermal/thermo-vacuum tests by Dr. M. Duranti.

Dr. A. Faba, responsible for the CEM facility, will coordinate activities regarding electromagnetic testing. The mechanical and electronics technicians from UNIPG, in total 6 units of personnel from the Physics & Geology Department and the Engineering Department, will run the tests, support the test setup according to its complexity and will provide the small mechanical/electronics adjustments of the hardware when needed.

Free access to the instrumentation owned by INFN and the spinoff company, SERMS s.r.l., will be granted as in-kind contribution within this project, according to the general agreement of cooperation between the University of Perugia and these entities.

- **Prof. Bruna Bertucci** (gender female)

  Bruna Bertucci was born in Rome in 1965. Laurea cum laude in Physics at the Sapienza University in Rome in 1989, PhD in Physics in 1993 at the University of Perugia and fellow of the European Organization for Nuclear Research (CERN) in 1994-1996. INFN researcher in 1996-1997 and then researcher of the University of Perugia. Since 2007 associate professor in physics at the University of Perugia.

  She started her research activity in particle physics within the L3 international collaboration operating at the LEP experiment at CERN (1990-1998). She then moved in the astro-particle research field, with the AMS project (AMS-01 1998-2000, AMS-02 2000-now) where she participated to the design and construction of the \( \approx 7 \text{m}^2 \) silicon tracker, coordinated the subdetectors/electronics space qualification tests and is now leading one of the analysis groups. As of today, she is the Italian coordinator of the AMS project with an annual budget of \( \approx 500 \text{k€} \) (not including personnel). She is research associate of INFN, coordinator of the INFN astro-particle group in Perugia and member of the INFN Astroparticle Scientific Committee (Commissione scientifica 2) since 2007. Since 2011 she is the INFN scientific responsible for the INFN-ASI agreement (\( \approx 1 \text{M€} \) budget over three years) for the exploitation of space science data in the ASI Science Data Center. Her current main scientific interests concentrate on the high energy astrophysics, studying charged cosmic rays and gammas, exploiting the data from AMS experiment as well as contributing to the development of new gamma telescopes in space (DAMPE) and on ground (CTA).

  Co-authored more than 300 papers published in refereed international journals.

Co-authored more than 300 papers published in refereed international journals.
• Publications


• Dr. Antonio Faba (gender male)
He is assistant professor at the University of Perugia. His main scientific interests concentrate on electromagnetism and its applications as modeling and experimental characterization of magnetic materials, non-invasive electromagnetic diagnostic and electromagnetic compatibility. Since 2002, he is responsible for the Electromagnetic Characterization Laboratory (CEM) of the Engineering department.

• Dr. Filippo Ambroglini (gender male)
He is assistant professor at the University of Perugia. He has extensive experience in particle detectors construction and operation. He was contributing to the CMS silicon tracker detector development and, most recently, he is the responsible for the silicon tracker construction and space qualification process in the Limadou detector on the CSES satellite, a joint project between Italy and China for the study of magnetosphere perturbations by means of different instruments, supported in Italy by INFN and ASI.

• Dr. Matteo Duranti (gender male)
He is assistant professor at the University of Perugia. He participated to the construction and the commissioning in orbit of the AMS silicon tracker and to the thermo-vacuum space qualification test of the whole AMS experiment. Most recently, he is supporting the operation of the detector on the ISS, monitoring the thermal conditions in orbit and studying their influence on the detector performances. His experience in data acquisition systems and data handling is an asset to setup any experimental test.

Participant 11: ULG

The University of Liege has a student body numbering of 20,000 and a staff of 4300 persons, 2800 of whom are teachers or researchers. Inside Liege University, the Research Department CSL (Liege Space Centre) has been at the origin of the development of space activities in Belgium since the early 1960’s and is therefore one of the oldest space science laboratory in Europe. CSL is located in the Liege Science Park in the vicinity of the Liege university campus, with a payroll of 94 employees (60% of engineers/physicists) and a yearly turnover about 10M€.

CSL activities are organized in three programs – i.e. “Tests”, “Space Systems”, and “Technology Partnerships” – interacting closely.
1) Test program: CSL is specialized in the evaluation of optical payloads in simulated environment since the early 70’s. Telescopes and space science instruments that have been tested at CSL cover the full electromagnetic spectrum, from X-rays to far infrared. Through every specific case, CSL team has gained unique experience and enlarged its testing capabilities to meet a wide range of test conditions and payload dimensions.
2) Space systems Program: The Space System Program covers the developments of space instruments, from feasibility study to on-ground qualification and delivery to S/C platform. Thanks to the Belgian participation to the PRODEX program, CSL has been involved in the development of a great number of nationally funded space instruments, starting with EIT (SOHO) developed in the early 90’s. From this date, CSL developed

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payload elements for major ESA missions (XMM-Newton, INTEGRAL, Herschel, JWST, PROBA-2) as well as for NASA (IMAGE, STEREO…) or other national agencies like CNES (COROT). CSL has now an important participation in two instruments of Solar Orbiter: EUI (Extreme Ultraviolet Imager), where CSL is the Principal Investigator (PI), and HI (Heliospheric Imager) developed with NRL.

3) Technology Program: Inside this program, CSL offers research & development support or trainings in the following fields: Optical Design & Metrology, Mechanical & Thermal Design, Electronics in space environment, Surfaces micro & nano engineering, Thermal vacuum facilities, Satellite SAR data processing.

**Role in AHEAD:** ULG will provide transnational access to the related facility described in WP3. **Mrs I. Tychon** will be the CSL contact point for the need of scientific teams for thermal vacuum tests using FOCAL2 facility or vibration tests. She will organize the setting of the facility and the team work for the different parameters to be monitored during the experiment. A report providing a summary of test configuration and performed activities will be delivered.

**Relevant publications:**


**Relevant previous projects or activities:**

- **August 2014:** TROPOMI.
  Tropomi (Tropospheric Monitoring Instrument) is a spectrometer to be integrated inside Sentinel 5 spacecraft. It covers 7 spectral ranges from UV (270 nm) to infrared (2385nm). CSL is in charge of the Optical Ground Support Equipment of this instrument and of the test campaign whose duration is about 5 months under vacuum.

- **July 2014:** EUCLID.
  Optical Performance tests at STM level of EUCLID NI DS (Near Infra-red Detector System) inside FOCAL3.

- **March 2014:** MSI Test campaign.
  The MSI instrument (Multi-Spectral Instrument) of the Sentinel-2 Mission (Copernicus) for the earth observation in the visible bands, NIR and SWIR has been validated inside FOCAL simuator 5 of CSL.

- **January 2014:** SOLAR ORBITER EUI STM:
  Thermal vacuum and vibration tests of the EUI (Extreme Ultraviolet Imager) STM. The Extreme Ultraviolet Imager is a suite of three EUV telescopes that will fly onboard the Solar Orbiter mission and will observe the Sun in four bandpasses. The suite is equipped with a single-band and a dual-band High Resolution Imager that will observe the Sun at high spatial resolution and cadence, along with a dual-band Full Sun Imager that will continuously monitor the Sun.
The key persons and their expertise relevant for the project are:

- Mrs Isabelle Tychon (gender: female)

Mrs Isabelle Tychon is presently responsible of CSL test laboratory. Born in 1966, she had a degree of industrial engineer in Nuclear Section of Liege Gramme Institute in 1988. She started her career at CSL from 1990 as an assistant in the CSL facilities department. The mission of the European Space Agency's (ESA) X-ray Multi-Mirror Mission (XMM-Newton) gave her the opportunity to act as project manager for the Cryo-Optical Testing facilities. Following this project, she has been in charge, as project manager, of development of facilities and tests for EADS ASTRIUM (now AIRBUS Defence and Space) in the frame of AEOLUS-ALADIN, ROCSAT, SEVIRI, THEOS and GAIA missions. She also managed the qualification tests of Space Bio Separation, IMAGE, EUROSTAR and ODL.

- Participant 12: UNIGE

The UNIGE is the University of Genova, located in Genova, Italy. The Physics Department has several activities ranging from particle physics, astroparticles, matter sciences e theoretical physics.

**Role in AHEAD:** The Low Temperature Group has been settled at the beginning of the '90 and is presently lead by Prof Dr. F. Gatti, Researcher for UNIGE. The personnel participating to WP6 is belonging to this group. The LTD group has a micro fabrication facility for TES micro calorimeters and bolometers and low temperature test facility with 3 dilution refrigerators and SQUID electronics for readout.

**Relevant publications:**


The key persons and their expertise relevant for the project are:

- Prof. Dr. Flavio Gatti (gender: male)

He has led project for neutrino mass measurement with 0.1K micro calorimeter, within the Italian National Institute for Nuclear Physics science program Terahertz FP6 project for homeland security, is involved in bolometer fabrication for CMB polarization measurement within the Italian Space Agency programs.
Participant 13: CEA

The government agency CEA (Commissariat à l’Energie Atomique et aux Energies Alternatives) is a major actor of French research with 16000 employees. It emphasizes applied research, but also has a strong fundamental research division based in Saclay (DSM: Direction des Sciences de la Matière with 2350 employees).

IRFU, Institute of Research into the Fundamental Laws of the Universe, is a basic research institute of DSM inside CEA. Its scientific activities cover the fields of astrophysics, nuclear physics, and particle physics. Inside IRFU, two services, the Service d’Astrophysique (SAp) and the Service d’Electronique des Détecteurs et d’Informatique (SEDI) collaborate for the realization of instruments for space missions. SAP itself is a joint laboratory with CNRS and Université Paris Diderot and hosts about 200 people, 110 staff and 90 temporary (postdocs, students, contractors). SAP has a long experience in building instruments onboard astronomy satellites, for example, EPIC on board XMM/Newton, IBIS on board INTEGRAL, and PACS on board HERSCHEL. The X-ray group at SAP has been working all along the EPIC CCD camera development and calibration. This camera is now operating since 1999 on board the XMM/Newton X-ray astronomy satellite. SAP benefits from its experience in the field of infrared μ-bolometers and also of millimetric bolometers for space applications (ESA-CNES program: PACS Herschel).

Role in AHEAD: P. Laurent is an engineer and researcher at the CEA Saclay, working in gamma-ray astrophysics and space instrumentatation. He will be the CEA main contact for the AHEAD activity. He is involved in the definition of the future gamma-ray telescope (WP8), taking also part in the development of the simulation activities for the background and response modeling of a high energy telescope. He will also, in collaboration with O. Limousin, who is an engineer of CEA Saclay specialized in space instrumentation.

C. Pigot, physicist, researcher for CEA who is the coordinator of the micro-calorimeter development project in the Service d’Astrophysique and is the contact person for the activities of WP6. He will manage the development of the interconnection harness task. X. de la Broïse is engineer in electronics who is in charge of the development of cryogenic electronics in SEDI. He will conceive the low heat conductance harness. A. Le Coguie is the engineer in SEDI who will be in charge of the realization and testing of the different harness prototypes. He will, also, be involved in managing subcontractors.

J. Ballet, astrophysicist, researcher for CEA is the contact person for WP4 (access to data analysis). He will organize the stays of people coming to learn X-ray data analysis, providing them with an office and a tutor. He is a senior researcher (H-index 40) with a main interest around supernova remnants and broad expertise in data analysis. He is a co-I of the XMM Survey Science Center (responsible for providing the EPIC-MOS software) and coordinates the production of the Fermi-LAT source catalogues. He teaches data analysis in astrophysics at master 2 level.

Relevant publications:

The **key persons** and their expertise relevant for the project are:

- **Dr. Philippe Laurent** (gender: male)

He is currently the head of the French contribution to the Japanese Astro-H X-ray space mission. He spent his thesis in 1992, by studying hard X data sent by the SIGMA telescope on board the Russian-French mission GRANAT. Then, he participated to the realization and calibration of the ISGRI CdTe camera aboard the satellite INTEGRAL. Since 2000, he is the INTEGRAL/IBIS telescope "Instrument Scientist". He has managed the IBIS simulation group, and organized the ground calibration of the complete satellite in ESA/ESTEC in 2001. In 2010, he co-leads the French participation to the Japan-French HXI instrument phase A studies for the IXO mission proposal. Since the launch of INTEGRAL, he studied the IBIS data from galactic black holes and neutron stars (such as Cygnus X-1, the Crab pulsar, and Gamma-Ray Bursts), with emphasis on the measure and analysis of the polarization of the gamma-ray light emitted by those sources.

**Participant 14: VTT**

**VTT Technical Research Centre** of Finland is a multi-disciplinary expert organization with 2800 employees, government-owned but gaining a significant fraction of its income from contract research for the private sector. The project will involve the VTT Sensors and Circuits team, located in the Micronova microfabrication centre (www.micronova.fi). The Sensors and Circuits team has been involved in design and development of numerous detectors and the associated electronics for both industrial and scientific use. These include MEMS-based accelerometers, gyros and frequency standards; long-range UHF RFID, remotely-powered biochemical and industrial sensors, and quantum-mechanical devices such as mesoscopic amplifiers, metrology standards and Superconducting Quantum Interference Devices (SQUIDs). The Micronova runs a large Clean Room facility, where available processes include the standard BiCMOS, MEMS and a superconductive Josephson junction fabrication as well as e-beam and nanostamping lithography. VTT has designed and produced since 1994 the SQUID magnetometer chips used by the major commercial manufacturer of Magnetoencephalography systems, Elekta-Neuromag, and has also been involved in development of the SQUID readout electronics.

**Role in AHEAD: dr. M. Kiviranta**, VTT Senior Researcher, will coordinate the design, building and testing of SQUID-based cryogenic readout electronics for the WP6. Use of previously fabricated SQUID devices is mainly foreseen, although new SQUID design is possible if shared fabrication opportunities (main funding from other projects) will occur within the project duration.

**Relevant publications:**

The **key persons**, and their expertise relevant to the project are:

- **Dr. Mikko Kiviranta** *(gender: male)*

He has been involved in design of MEG systems since late 80's and MEG-specific SQUID magnetometer designs since early 90's. More recently he has been involved with SQUID multiplexers for cryogenic photon detectors, including development of advanced thin-film fabrication processes, SQUID design, room-temperature electronics and system design aspects. A related interest is high-speed SQUID readout electronics having a high dynamic range.

- **Participant 15: ULANC**

**Lancaster University** research in condensed matter physics covers a wide variety of topical projects ranging from low temperature physics, through semiconductors and devices, to non-linear dynamics and chaos, and surface physics. In the area of low temperature physics, our research group has an international reputation, currently holding the world record for the lowest temperature achieved for cooling solids (5 millionths of a degree above absolute zero). Low temperature physics gives unique access to large-scale quantum phenomena. Lancaster Quantum Technology Centre (QTC) provides a focus for future quantum technologies and is based in Lancaster University’s Physics Department, a working community of 145 researchers and 80 students. Work is undertaken in an atmosphere of national and international cooperation. Lancaster University was previously involved in development of low temperature sensors through ESA contracts 11415/95/NL/SK, 15797/01/NL/SF, 3-12950/09/NL/A, EPSRC (UK) grant EP/K001507/1 also in collaboration with SRON on many aspects of low temperature detector modelling.

*Role in AHEAD*: this project will be undertaken by two experts, who are ideally qualified to carry out this project to a successful conclusion, **A.G. Kozorezov**, Senior Research Fellow is an expert in theoretical modelling of physical processes in low temperature detectors. He has published extensively on theoretical issues related to superconducting detectors, is widely known.

*Relevant publications:*

The key persons, and their expertise relevant to the project are:

- **A.G. Kozorezov (gender: male)**

Until 1993 – Leading Scientist in the Institute of Radioengineering and Electronics of Russian Academy of Sciences, D.Sci., Prof. Moscow Physico-Technical Institute, since 1994 is Senior Research Fellow at the Department of Physics Lancaster University with almost 100 publications in peer-reviewed journals. He is well-known for his work on theory of low temperature superconducting detectors. Main recent results obtained in the course of this work cover wide areas of physics of tunnel junctions and transition edge spectrometers, energy down-conversion and thermalization in normal metals and superconductors, stationary states in superconducting tunnel junctions far from equilibrium, strong fluctuations in radiation energy deposition in thin films and are published in high impact journals. Other recent results cover areas of new compound semiconductor detectors of hard x- and gamma rays, specific defects and polarisation effects in radiation detectors.

**Participant 16: CESKE VYSOKE UCENI TECHNICKE V PRAZE**

**Czech Technical University in Prague**, CTU (founded in 1707) is the leading technical university in the Czech Republic. In 1960, the Department of Electrical Engineering became an independent faculty. The Faculty of Electrical Engineering (FEE) offers first-class education in the fields of electrical engineering, telecommunications, automation, informatics and computer science and engineering. All study programmes are closely linked to research activities. The FEE alone ranks among the top 5 research institutions in the Czech Republic. It generates about 30% of the research output of the whole CTU.

The FEE has extensive research collaboration with top universities and research institutions worldwide. It offers innovative solutions to industrial partners, military and security institutions. It participates in space research programmes and work for governmental agencies. The faculty offers the following study programmes taught in English: Electrical Engineering, Power Engineering and Management (BSc and Ing.), Communications, Multimedia and Electronics (BSc and Ing.), Cybernetics and Robotics (BSc and Ing.), Open Informatics (BSc and Ing.), Biomedical Engineering and Informatics (Ing. only). The PhD programme is divided into 16 branches of study. The graduates find top jobs in industry, research institutions, and at universities in the Czech Republic and worldwide. The faculty is involved in numerous space projects and programs, including development of space X-ray optics, often in collaboration with other entities. The development of space X-ray optics in the past was performed in collaboration mainly with CTU Faculty of Nuclear Science, Institute of Chemical Technology, and Astronomical Institute of the Academy of Sciences of the Czech Republic, representing together with IEE a consortium for X-ray optics development.

**Role in AHEAD:** Dr. R. Hudec acts as coordinator of the Czech X-ray optics consortium. In the past, he was involved in several commissions related to international X-ray optics programs such as telescope working groups for XEUS and IXO projects. He is expected to lead the AHEAD activities in the Czech Republic.

**Relevant publications:**


Relevant previous projects or activities:


The key persons, and their expertise relevant to the project are:

- Dr. Rene Hudec (gender: male)

Assoc.Prof. RN Dr. René Hudec, CSc. Date of Birth: July 28, 1951. Present position: Senior Scientist, Astronomical Institute, Ondrejov, Head of High Energy Astrophysics Group. Associated Professor for Applied Physics, Czech Technical University, Prague. Research area: High energy astrophysics, both galactic and extragalactic sources. Designer of space and ground-based experiments in this area with emphasis on X-ray optics and X-ray telescopes. Development of novel technologies for space X-ray telescopes. Professional activities: Co-I and member of consortia ESA INTEGRAL OMC (Optical Monitoring Camera) and ESA INTEGRAL ISDC. Co-I and consortium member, LOFT proposal for ESA Cosmic Vision M3. ESA/NASA/JAXA IXO project, Member of IXO Telescope Working Group. ESA Gaia, Member of CU7 Coordination Unit. Educational activities: Supervisor of 14 Diploma Thesis and 6 PhD Dissertations. Publications: Author and co-author of 600 scientific publications (including 176 papers in refereed journals) listed in the NASA ADS system.

Participant 17: NUID UCD

University College Dublin (UCD) is the largest university in Ireland, with ~23,000 students, of whom ~1,500 are PhD students across all disciplines. The UCD School of Physics educates undergraduate students to accredited BSc degree level in Physics, Theoretical Physics and Physics with Astronomy & Space Science. It recently introduced a taught MSc programmes in Space Science & Technology. There are currently more than 60 PhD students and 23 faculty in the School whose research areas are in Nanoscience, Atomic and Molecular physics and Astrophysics/Space Science.

Role in AHEAD. The research interests of and the UCD Space Science group are gamma-ray bursts, blazars, terrestrial gamma-ray flashes and pulsars. The group was involved in the development of hardware and software for the ESA high energy astrophysics mission, INTEGRAL and is currently running an R&D programme with ESA on the development of novel scintillators with silicon photomultiplier readout for use in future MeV astrophysics satellite experiments. Prof. L. Hanlon will coordinate the experimental work and detector simulation using, for example, GEANT4, and will be supported by Dr. S. Mc Breen. This expertise is relevant to WP8.
Relevant publications:


Relevant previous projects or activities:

- R&D programme with ESA underway to formulate new scintillators that are more robust and cheaper to manufacture than the current state of the art materials such as the lanthanum halides.
- R&D programme with ESA to simulate and experimentally characterise the performance of a module composed of a LaBr3 scintillator crystal coupled to a silicon photomultiplier (SiPM) for possible use as a calorimeter element in a high energy astrophysics mission such as GRIPS.

The key persons, primarily responsible for carrying out the proposed research and/or innovation activities, are:

- **Prof. Lorraine Hanlon** (gender: female)
  
  She is Associate Professor of Astronomy in the UCD School of Physics. She completed her BSc in Experimental Physics 1987, an MSc on the subject of High Temperature Superconductors in 1990 and her PhD investigating the spectra of gamma-ray bursts in the keV-MeV range in 1996. During her PhD from 1991 to 1995 she worked as a member of the COMPTEL team at the European Space and Technology Research Centre (ESTEC). She became a member of staff in the School of Physics in 1996. She has extensive experience in the field of gamma-ray astronomy. She is programme director of the BSc (Physics with Astronomy & Space Science) degree and is significantly involved in Citizen Science and outreach through the FP7 GLORIA project.

- **Dr. Sheila McBreen** (gender: female)
  
  She has been a lecturer in the School of Physics in UCD since November 2008. She obtained her BSc Joint Honours in Experimental Physics and Computer Science in 2000. She continued her studies in UCD and graduated with her PhD in 2004. Subsequently she obtained a postdoctoral fellowship in the European Space Agency in The Netherlands. Following the fellowship in ESA, Sheila successfully applied for a Marie Curie Intra-European Fellowship in the Max Planck Institute for Extraterrestrial Physics (MPE) in Germany. She has wide of experience in the analysis of data across the wavelength spectrum.
Participant 18: UNIPA

The Dipartimento di Fisica e Chimica of Università degli Studi di Palermo (UNIPA) includes a teaching/research staff of about 50 people and a technical/administrative staff of about 15 people. The Department is organized into research groups spanning Theoretical Physics (Quantum Optics), Experimental Physics (Astrophysics, Biophysics, and Solid State Physics), inorganic chemistry, organic chemistry, physical chemistry. The research/teaching staff is also significantly involved in the academic activity both within the curricula in physics and chemistry and within all other science curricula offered by Università degli Studi di Palermo.

Role in AHEAD: Prof. Marco Barbera will lead the tasks under WP 6.6.

The research team at UNIPA and INAF/OAPA has gained, since the early nineties, a large expertise in the design, development and calibration of filters used to protect X-ray detectors from out of band radiation and low energy charged particles in Space. The group has played key roles in the development programs of the filters for the CHANDRA HRC, the XMM-Newton EPIC camera, the JET-X CCD detector, and the X-Ray Telescope on-board HINODE, as well as for the LAD detector on LOFT. The team led by Marco Barbera will be responsible for the design, development and calibration of the aperture cylinder thermal shields of the X-IFU detectors, as well as of the large area filters of the WFI detector on-board the ATHENA recently selected as the next large mission within the ESA Cosmic Vision program.

The main role of the UNIPA team in AHEAD will be related to optimizing the design of the X-IFU aperture cylinder thermal shields in order to increase the low energy response of the detector. Such effort, which can significantly improve the scientific return of the ATHENA mission, will be based both on modeling and experimental activities and will require a strong involvement of filter manufacturers with large expertise in similar development programs. This research activity will rely on the use of the X-ray Astronomy Calibration and Testing (XACT) facility at INAF/OAPA, and of other key instrumentation available at UNIPA or in the research network set-up within the AHEAD project, e.g. Atomic Force microscopy, Scanning electron microscopy, X-ray Photoelectron spectroscopy, Small Angle X-Ray Scattering, synchrotron beam-lines, acoustic and vibrational test benches.

Relevant publications:


The key persons relevant to the project are:

- Prof. Marco Barbera (gender: male)
MB is associate professor of Astronomy and Astrophysics at Dipartimento di Fisica e Chimica of Università degli Studi di Palermo, Italy (UNIPA), and is associated to INAF-Osservatorio Astronomico di Palermo. He participated since the beginning to the design, development and operation of the X-ray Astronomy Calibration and Testing (XACT) facility of INAF/OAPA. MB has actively participated in the development and calibration programs of the HRC on-board the NASA mission Chandra (launch July 1999), the EPIC camera on-board the ESA mission Newton-XMM (launch December 1999), the XRT on board the Japanese Hinode mission (launch September 2006), the Lunar Orbital X-ray Fluorescence Imaging Spectrometer (LOXIA) on-board the Chinese mission Chang’E-1 (Launch October 2007), the Sphinx camera on-board the Russian mission CORONAS-Photon (launch January 2009). MB has been responsible for the design and preliminary testing of the filters for the LAD experiment on board LOFT, and is responsible within the ATHENA program for the design, development and calibration of the X-IFU aperture cylinder thermal shields and of the WFI large area focal plane filters. MB is also active in R&D research activities for the development of X-Ray micro-calorimeter arrays and for this purpose has designed and built at the XACT facility an Adiabatic Demagnetization Refrigerator operating at temperatures below 50 mK.

Participant 19: TARTU OBSERVATORY

Tartu Observatory is a public research and development authority, administered by the Estonian Ministry of Education and Research operating under the Research and Development Act, other laws and international contracts. Tartu Observatory is a successor of the Tartu University Observatory, founded in 1808, the Estonian Meteorological Observatory, founded in 1865, and the Institute of Astrophysics and Atmospheric Physics in 1973.

The principal area of activity of Tartu Observatory is the research and experimental development on natural sciences to promote science in the fields of astronomy, remote sensing and space technology, provide research-based services in these areas, be a reliable partner in the international networks, and train young scientists. Here meet the high competence of internationally recognized senior researchers with splendid enthusiasm of young scientists to find solutions for new challenging research questions.

Tartu Observatory has been a recognized partner in an international research and technology development. Through our excellent scientific competence we promote education, support entrepreneurship, and raise awareness of scientific worldview in order to contribute to solving of the challenges faced by society. As a space research centre we realize an excellence in the space science in the interests of the development of Estonia.

Role in AHEAD: Relevant to WP9.3 activities, J. Nevalainen, Senior Researcher in the Tartu Observatory, has been participating on the scientific planning of Athena mission (Nevalainen 2013) and on the characterisation of the background emission of the XMM-Newton satellite (Nevalainen et al., 2005). He is maintaining the Galaxy Clusters Working Group page of the International Consortium for High Energy Calibration (IACHEC). The page contains relevant information of the cross-calibration results based on clusters of galaxies and the corresponding data base for public usage. Dr. A. Reinart, Director of the observatory, will help to support the activities of dr. Nevalainen.

Relevant publications:

The key persons relevant to the project are:

- **Anu Reinart** (gender: female)
  Tartu Observatory director and Senior Researcher. Member of Estonian Space Council and of Estonian Space Policy workgroup. EU Marie Curie Fellow in 2002-2005. Specialises in Biosciences and Environment, Research relating to the State of the Environment and to environmental protection. She is currently involved in the following projects: Global Lakes Sentinel Services (GLaSS); study of metrological factors limiting complex optical measurements in remote sensing and atmospheric research; quantitative remote sensing of vegetation covers.

- **Jukka Nevalainen** (gender: male)
  J. Nevalainen is a chairman of the Galaxy Clusters Working Group of the International Astronomical Consortium for High Energy Calibration IACHEC. IACHEC has been working for 9 years towards establishing standards for high energy calibration and supervising and performing cross calibration work between different high energy missions. J. Nevalainen has been leading several high energy cross-calibration projects of IACHEC based on clusters of galaxies. In particular, the work in Nevalainen et al., (2010) provided quantitative evidence for a problem with the effective area calibration of CHANDRA-ACIS instrument. This led to re-calibration of the hydrocarbon contaminate of CHANDRA mirrors and consequent agreement with the X-ray measurements between CHANDRA and XMM-Newton in the 2-7 keV band.

**Participant 20: UNIVERSIDAD DE ALICANTE**

The University of Alicante (UA) Institute for Physics Applied to Science and Technology (IUFACyT) is a research infrastructure employing more than 50 physicists and engineers. Was created in 2009 to promote interdisciplinary basic research and its application to engineering and health sciences. Researchers in UA-IUFACyT work in areas such as Optics, Materials Science, Acoustics, Astrophysics, Signal Theory and Systems and Telecommunications. The UA is one of the major Spanish universities hosting more than 30000 students with an increasing number of international applicants. Its International Relations Office has a long standing experience in organizing Meetings and Schools. The Astrophysics group at UA-IUFACyT has been doing in Space Astronomy since the IUE days. It has been involved in the hardware teams and science of high energy telescopes as LEGRI (Low Energy Gamma Ray Imager) on board Minisat 01 or ESA’s INTEGRAL (International Gamma Ray Observatory) where the group participated directly in the Spanish consortium that designed, built, tested and delivered the coded masks. The group is currently involved in stellar and high mass X-ray binaries research using the major current X-ray observatories.

**Role in AHEAD: J.M. Torrejón** will coordinate the WP2 on Network Activities and Support to the Community.

**Relevant publications:**

Relevant previous projects or activities:

The X-ray Astronomy group at UA has participated actively in the organizations of large conferences:

- Local Organizing Committee of the IAU Colloquium 175 “The Be phenomenon in Early Type stars”, June-July, Alicante.

The key persons relevant for this proposal are:

- José Miguel Torrejón (gender: male)

He is the head of the X-ray Astronomy Group at UA and has been PI of three large projects of the Spanish National Space Programme. He was actively involved in the construction and testing of the coded masks of the INTEGRAL satellite. His research is centred in High Mass X-ray Binaries and X-ray active stars using the current great X-ray observatories (ESA’s XMM-Newton and NASA’s Chandra) where he has been successful applicant several times. He has been organizing Astronomy Schools at the UA, as well as Outreach activities, on a yearly basis, during the past 15 years.

Participant 21: CSIC

CSIC (Spanish National Research Council) is the largest public institution dedicated to research in Spain. It has a staff complement of more than 13000 employees (among these 3300 permanent researchers), 125 research institutes distributed throughout Spain, out of which 54 are joint ventures with other Organisations. Its main objective is to develop and promote research that will help bringing about scientific and technological progress, and it is prepared to collaborate with Spanish and foreign entities in order to achieve this aim. According to its Statute (article 4), its mission is to foster, coordinate, develop and promote scientific and technological research, of a multidisciplinary nature, in order to contribute to advancing knowledge and economic, social and cultural development, as well as to train staff and advise public and private entities on this matter.

CSIC provides services to the entire scientific community through management of the Singular Scientific and Technological Infrastructures (ICTS) such as Calar Alto Astronomical Observatory, Doñana Biological Station, European Synchrotron Radiation Facility, Hesperides Ocean Research Vessel, Integrated Micro and Nanoelectronics Clean Room, Juan Carlos I Antarctic Base, Max Von Laue-Paul Langevin Institute and Sarmiento de Gamboa Ocean Research Vessel.

CSIC has considerable experience in both participating and managing R&D projects and training of research personnel. Under the EU 7th Framework Programme, CSIC has signed 724 actions (including 62 coordinated by CSIC and 45 ERC projects). Funding wise, CSIC is listed as the 6th organisation in Europe in the 7th Framework Programme. As to the number of projects signed by CSIC within each programme, the distribution is People 36,4%, Cooperation 32,1%, Capacities 25,2% and Ideas 6,3%. If we take into account funding, the ranking would be different: Cooperation 45%, IDEAS 28%, People 19%, Capacities 8%. In addition, CSIC has a large participation in other European programmes as LIFE+, INTERREG, EMRP, RFCS, ERANET, etc.

There are 5 CSIC institutes participating in this proposal, in three different activities, as follows:

CSIC1 (coordinator: Dr. L. Fàbrega) is integrated by three institutes: Institut de Ciència de Materials de Barcelona (ICMAB), Instituto de Cieina de Materiales de Aragón (ICMA) and Instituto de Microelectrónica de Madrid (IMM). The team is constituted by expert scientists in materials science, superconductivity, cryogenics, and scientific instrumentation. They started in 2004 a joint research program to develop cryogenic radiation detectors in Spain. This initiative, funded by national grants, led to set up the facilities to fabricate and characterize TES detectors in Spain; with them, the research team has produced and characterized high quality Mo thin films, Mo/Au bilayers and TES microcalorimeters. This work was done in parallel to the developments of former X-ray observatory-class mission proposals (XEUS, IXO, ATHENA-L1) all of which contemplated a cryogenic imaging spectrometer in the X-ray telescope focal plane. Close collaboration with the other European...
institutions working on these devices was established. Currently the group participates in the X-IFU proto-consortium, the high resolution imaging spectrometer for Athena-L2, its work being the development of Mo/Au-based TES detectors for the X-IFU array.

**Role in AHEAD:** CSIC1 will be involved in WP6. Its role is the production and characterization of Mo/Au TES, with the aim of comparing their manufacturing processes and performances with those of Ti/Au TES. The goal is to identify the most suitable material to constitute a high resolution detector array meeting X-IFU requirements.

**CSIC2** (coordinator: Prof. M. Hernanz) is the Institut de Ciències de l'Espai (ICE, Institute for Space Sciences). ICE has strong scientific groups involved in X-ray and gamma-ray astrophysics, mainly performing models and observations of multi-frequency emission during classical nova and thermonuclear supernova explosions, as well as studies of Galactic compact objects in general (white dwarfs, neutron stars). ICE-CSIC has been involved in proposals of gamma-ray missions, as GRI (Gamma-Ray Imager, ESA M1), DUAL (ESA M3) and ACT (Advanced Compton Telescope, NASA), and X-ray missions like LOFT (Large Observatory for X-ray Timing. ESA M3). CSIC2 (ICE) has participated in the feasibility study of LOFT, one of the four (out of about fifty) missions selected for assessment study by ESA after the M3 call. The Institute also participates in MAGIC, Fermi, and ESA missions EUCLID and LISA Path Finder. Its researchers use multi-frequency data from all high-energy missions (e.g., XMM-Newton, INTEGRAL, Chandra, Swift, Fermi).

**Role in AHEAD:** CSIC2 will be involved in WP8, based on its capability to model instrument responses with GEANT4, fully taking into account the background, and also to develop a prototype of a Compton camera based on a stack of Si and CdTe detectors.

**CSIC3** (coordinator: Prof. X. Barcons) is the Instituto de Física de Cantabria (IFCA). IFCA has a long experience and tradition in high-energy astrophysics, being one of the very first groups in Spain to be established over 20 years ago. Members of CSIC3 have been and are involved in ESA’s XMM-Newton mission since 1996, for example as co-Is of the Survey Science Centre and in the XMM-Newton Users Group. At the moment, the group is part of the EU-funded project ARCHES, to further the capabilities of the XMM-Newton X-ray source catalogue. The group had for 15 years and continues to have a leading role in promoting a large X-ray observatory (XEUS-ISS, XEUS, IXO, Athena-L1 and now Athena-L2); members of the group have served in all SAGs and SSTs appointed by ESA to oversee all mission and technology studies related to these mission proposals. The group is part of the X-IFU proto-consortium, where it develops software algorithms for the event. CSIC3 has a solid background on extragalactic X-ray astronomy, especially on AGN and surveys; in both areas cross-fertilisation with observations in the IR, optical and radio, on which there is strong local expertise, are proving extremely fruitful.

**Role in AHEAD:** CSIC3 will be involved in WP2, where owing to the large expertise and breadth of international contacts, it will be instrumental in organising schools to promote the use of novel X-ray observational techniques, in particular spatially resolved high-spectral resolution spectroscopy (3D mapping).

**Relevant publications:**


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Walton, D., Zdziarski, A. et al., "The Large Observatory for X-ray Timing (LOFT)", Experimental Astronomy, vol. 34, p. 415 (2012) (more than 73 citations)


Relevant previous projects or activities:

- “Spanish participation in X-ray astronomy missions of ESA: development of high resolution cryogenic detectors” (2006-09), funded by Spanish MCINN, 600k€. PI: Prof. X.Barcons (coordinator) / Dr. L.Fàbrega (PI detectors)
- “ATHENA (Advanced Telescope for High ENergy Astrophysics): Definition phase. Development of TES-based sensor arrays” (2013-14), funded by Spanish MINECO. PI: Prof. X.Barcons, 170k€
- "Astrophysics in the MeV range: a challenge for instrumentation and an essential window for nuclear astrophysics", funded by the Spanish MICINN, 490 k€ (plus overheads) for 3 years (2009-2011). PI: M. Hernanz
- "The MeV frontier: a challenge for instrumentation and an essential window for the study of stellar explosions", funded by the Spanish MICINN, 400 k€ (plus overheads) for 2.5 years (2012-mid 2014). PI: M. Hernanz

The key persons and their expertise relevant for the project are:

- Dr. Lourdes Fàbrega (gender: female)
  Staff scientist at ICMAB-CSIC1. Expert in superconductivity, thin film deposition and microstructural characterization of functional materials. She leads the TES development in Spain since 2004. Within the CSIC1 team, she is the responsible of correlation of functional and structural properties and fabrication process, and of TES design. She will act as CSIC contact for AHEAD.

- Prof. Margarita Hernanz (gender: female)
  Research Professor at ICE-CSIC2. Specialized in various topics related to late stages of stellar evolution, high-energy (gamma and X-ray) astrophysics theory and observations. She has extensive experience with the optimization of instrument concepts for future missions. She was the co-PI of the LOFT/WFM instrument and member of the ESA's LOFT Science Study Team.

- Prof. Xavier Barcons (gender: male)
  Research professor at IFCA-CSIC3. He conducts research in Astronomy, in particular in Active Galaxies and X-ray sky surveys. He currently serves in ESA’s Athena-L2 Science Study Team, chairs the Science Team of the X-IFU consortium and has a large experience in big international scientific projects (e.g., he chairs the XMM-Newton Users Group, is ESO Council President, serves in the ALMA Board, served in ESA’s AWG and SSAC, coordinated the Assessment Study Reports –Yellow Books- of IXO and Athena-L1 and chaired and/or served in the SOC of many international conferences).

- Dr. Augustin Camón (gender: male)
  Staff scientist at ICMA-CSIC1. Expert in cryogenics, quantum metrology, applied superconductivity and cryogenic scientific instrumentation. Since 2004 he participates in the spanish initiative to develop Mo/Au-
based radiation detectors. Within the CSIC1 team, he is the responsible of the cryogenic characterization of Mo/Au TES detectors.

- **Dr. Jose Luis Costa-Krämer** (gender: male)

Staff scientist at IMM-CSIC1. Expert in thin film deposition, lithography and microelectronics device fabrication. Since 2008 he participates in the spanish initiative to develop Mo/Au-based radiation detectors. Within the CSIC1 team, he is the responsible of fabrication of Mo/Au TES detectors.

- **Participant 22: EKUT**

The **Eberhard Karls Universität Tübingen** is one of Europe’s oldest universities. Today, within EKUT are some 28,500 German and international students. Some 450 professors and more than 4000 other academic staff teach at the University’s seven faculties. The University specializes in a number of innovative fields of research: Neuroscience, Clinical Imaging, Translational Immunology and Cancer Research, Microbiology and Infection Research, Molecular Biology of Plants, Environmental and Geoscience, Astro- and Elementary Particle Physics, Quantum Physics and Nanotechnology, Archaeology and Anthropology, Language and Cognition, Education and the Media. The University has partnerships with more than 150 educational institutions in 45 countries, particularly in North America, Asia and Latin America, as well as with all the countries in Europe. Some 12.6 percent of students in Tübingen come from abroad, and many of the University’s German students pursue part of their studies in another country.

The High-Energy Astrophysics (HEA) group at the **Institute für Astronomie und Astrophysik (IAAT)** of the University of Tübingen is involved in the exploration of the high-energy universe, from X-rays to very high-energy \( \gamma \)-rays (in the TeV regime) up to ultra-high-energy cosmic rays (\( \sim 10^{20} \) eV). Currently the group consists of more than 30 people, including diploma/Ph.D. students. The research fields of the HEA group range from the data analysis and interpretation of the underlying physical processes to the characterization and development of instruments for the observation of high-energy sources. The IAAT-HEA is member of space missions (XMM-Newton, INTEGRAL, eROSITA, ATHENA, LOFT, JEM-EUSO) and ground based projects (HESS, CTA).

**Role in AHEAD**: as a member of the German consortium for the Wide Field Instrument aboard ATHENA, the IAAT-HEA participates in the studies for the design and optimization of the WFI configuration. The contribution of IAAT-HEA in AHEAD will mainly focus on the assessment and reduction of the particle background for the WFI, through simulations with Geant4 and/or other appropriate tools, as well as on the investigation and characterization of the soft proton scattering properties of the ATHENA optics by means of laboratory tests at the Tübingen accelerator facility. These tests are expected to provide an input and validation for ray-tracing simulations aimed at estimating the rate of soft proton at the ATHENA focal plane.

Prof. Dr. **A. Santangelo** will coordinate the IAAT activities in AHEAD WP9. **Dr. E. Perinati** will perform the simulation/feasibility studies proposed in the framework of AHEAD WP9

**Relevant publications:**


The key persons, primarily responsible for carrying out the proposed research and/or innovation activities, are:

- **Prof. Dr. Andrea Santangelo** (gender: male)


- **Dr. Emanuele Perinati** (gender: male)

  He got his degree in Physics from the University of Milan in 1997. In 1998 he participated in the calibration campaigns of the XMM-EPIC camera at the IAS in Orsay. In 1999/2000 he visited (7 months) the cryogenic laboratory of Dr. E. Silver at the CfA in Cambridge, MA. He achieved his Ph. D. in Physics from the University of Palermo in 2002 with a thesis on the thermalization of the energy in superconducting absorbers for X-ray microcalorimeters. From 2002 to 2007 he was a postdoc fellow at the Osservatorio Astronomico di Palermo working on cryogenic microcalorimeters for application in X-ray astrophysics. From 2007 to 2010 he was at the Istituto di Astrofisica Spaziale e Fisica Cosmica di Palermo working on the assessment of the focal plane design and background studies for the XMS microcalorimeter instrument aboard the IXO mission. In 2010 he joined the HEA group at the IAAT institute of the University of Tübingen, working on background studies for the eROSITA and IXO/ATHENA L-1 missions, as well as on the assessment of radiation damage and hyper-velocity impact risk for the SDD detectors aboard LOFT.

- **Participant 23: LIP**

  The Laboratório de Instrumentação e Física Experimental de Partículas (LIP) was created in 1986 as the reference national laboratory for collaboration with CERN in the area of accelerator experiments for particle physics. Its activity in Particle and Astroparticle Physics is developed also within other European and international organizations and large research infrastructures like ESA, SNOLAB, GSI, NASA and the Pierre Auger Observatory. Being an Associated Laboratory since 2001, LIP was assessed as ‘Excellent’ in four successive evaluations by international panels. One of the main objectives of the overall activity is the continuous training of scientists and the integration of promising young scientists in our established and supported research program. Subjacent to all our activities there is an effort for establishing strong links between research and higher education. The participation in ambitious higher education programs received in 2010, with the creation of the IDPASC consortium, the adequate institutional infrastructure to become a reference for students and professors in the years to come.
With about 80 researchers with PhD and a total of roughly 200 collaborators (including technical staff), LIP’s scientific activity is oriented by four main lines: Experimental Particle Physics with Accelerators, Astroparticle Physics, Detector Physics and Medical Physics. Complementing these, we develop work on Associated Instrumentation and Advanced Computing Technologies, and on Education, Training and Outreach.

**Role in AHEAD:** WP8 mandate concerns "feasibility studies and assessment of instrumentation" for high energy astrophysics. Mass model simulation will be the central activity of WP8. For more than a decade we have been using GEANT4 toolkit on semiconductor focal planes, Laue lens and polarimeters analysis. GEANT4 simulation code has been extensively developed for these applications and validated by several experiments in laboratory and in the European Synchrotron Radiation Facility in Grenoble, in particular under polarized radiation beam for polarimetric focal plane optimization and design. Limited analyses using MEGALIB were also performed.

The contribution of the Laboratório de Instrumentação e Física Experimental de Partículas will address instrument performance analysis, in particular instrument continuum, line and polarimetric sensitivity. These simulations will include focusing optics (Multilayer or Laue lens) operating together with the focal plane, in particular focal plane optimization as a function of focusing optics PSF (point spread function) and of on- and off-axis source photons’ projection. A comparative study will be performed to determine the trade-off between a focusing optics instrument solution and a highly segmented detection plane without focusing optics. Simulation will include all passive materials close to the detector. With MEGAlib will be simulated the background environment (cosmic diffuse photons, cosmic-ray protons, electrons, and positrons).

Our laboratory facilities, in particular a laboratory precision table to test polarimeters with a partially polarized beam (up to ~80%) generated by crystal diffraction, semiconductor detectors (CdTe family and Ge) and gaseous detectors (Xe, Ar, etc.), covering an energy band from 5 keV to 1 MeV, will allow multiple testing in order to validate multiple simulations’ data and results.

**Relevant publications:**


**Relevant previous projects or activities:**

- CdTe focal plane for a Laue lens gamma-ray space telescope - 3 year project funded by Portuguese Ministry of Science, ref: PTDC/CTE-SPA/65803/2006. 2007 to 2010;
- Gamma-Ray Imager mission proposal to M class ESA Cosmic Vision call, 2007;
- A DUAL mission proposal to M class ESA Cosmic Vision call, 2010;
- XIPE: the X-ray Imaging Polarimetry Explorer mission proposal to S class ESA call, 2012;
- Solar Hard X-ray Polarimeter mission proposal to joint scientific space mission Chinese Academy of Sciences (CAS) - European Space Agency (ESA) future call, 2014.
The key persons, and their expertise relevant to the project are:

- Dr. Rui Curado da Silva (gender: male)


- Prof. Filomena Pintos dos Santos (gender: female)

Maria Filomena de Osório Pinto dos Santos was born in Coimbra, Portugal, in 1959. Graduation in Physics at the University of Coimbra, in 1982. Member of Staff of the Physics Department, University of Coimbra since 1983. PhD in Physics at the University of Coimbra in 1995. Professor Auxiliar at the Physics Department, University of Coimbra, since 2005. Research experience: 30 years. Teaching experience: 30 years. More than 60 publications in archival journals and more than 50 in other publications, such as conference proceedings. Principal research interests are study of gaseous detectors for X-rays, modelling of physical events in gaseous detectors and Monte Carlo simulation studies.

- Prof. Jorge Maia (gender: male)

Jorge Manuel Maia Pereira was born in 1970, Physics Engineering at the University of Coimbra, in 1994. Master in Technological Physics, University of Coimbra, in 1997. PhD in Physics at the University of Coimbra, in 2005. Lecturer, Physics, Faculty of Science, University of Beira-Interior, Covilhã, Portugal (1998-2005). Since 2005 is Assistant Professor in Physics, Faculty of Science, University of Beira- Interior. Visiting Researcher, Burnett School of Biomedical Sciences, University of Central Florida, Orlando, FL, USA (2012-2013). Participation in editorial boards of scientific journals such as International Journal of Nuclear Energy and Hindawi Publishing Corporation, New York, USA. Principal research interests are focal plane instrumentation for high-energy telescopes and polarimeters. Actually he is also, researcher at LIP-University of Coimbra.

- Participant 24: CNRS

The Centre National de la Recherche Scientifique (CNRS) is a government-funded research organization, under the administrative authority of France’s Ministry of Research. CNRS laboratories (or research units) are located throughout France. Seven Joint Research Units (JRU) participate in the project AHEAD. A CNRS unit may be solely established and managed by CNRS or together with one or more other legal entities. CNRS and the other partners pool financial, material and/or human resources on a specific field. Such a unit is hosted in the premises of one of the parent legal entities. Staff is assigned to it by the parent entities.

CNRS1: The ‘Institut de Recherche en Astrophysique et Planétologie (IRAP – UMR5277)’ in Toulouse is a new Joint research Unit (UMR 5277) of CNRS and UNIVERSITE TOULOUSE III which results from the gathering of the old laboratories LATT, CESR, from part of the DTP and from a few researchers and teachers-researchers of the LMTG (about 300 people in total). The scientific objectives of the IRAP are the study and
the understanding of the Universe and its content: the Earth as a planet, its ionized environment, the sun and its planets, the stars and their planetary systems, the galaxies, the very first stars and the primeval Big Bang.

Role in AHEAD: Three members of IRAP are involved in the project: Dr. Jürgen Knödlseder, who is CNRS staff researcher, and Drs Peter von Ballmoos and Pierre Jean, who are professors of the University Toulouse III.

CNRS1 will participate in AHEAD by coordinating the activities of the gamma-ray community (WPN9 and WP2.5). Peter von Ballmoos will also act as main coordinator of CNRS participation.

Relevant publications:


CNRS2: The ‘Centre de Sciences Nucléaires et de Sciences de la Matière (CSNSM – UMR8609)’ is a joint research laboratory of the nuclear and particle physics institute (IN2P3) of CNRS and the UNIVERSITE PARIS-SUD, located at Orsay. Its human potential consists of 80 permanent researchers, engineers and technicians and is organized in eight research teams working in the fields of solid-state physics, nuclear physics and astrophysics. The nuclear astrophysics group of the CSNSM, which is currently led by Dr. Vincent Tatischeff, has a long experience in nuclear physics measurements dedicated to astrophysics. The team has also been actively working for nearly two decades on X-ray and gamma-ray astronomy, both on theory, analysis of data from the INTEGRAL satellite, and the development of innovative gamma-ray detectors.

Role in AHEAD: Three members of the nuclear astrophysics group are involved in the project: Drs Jürgen Kiener and Vincent Tatischeff, who are CNRS staff researchers, and Dr. Clarisse Hamadache, who is an assistant professor of the University Paris Sud.

CNRS2 will be involved in all tasks of WP9. The CSNSM team members will participate in the prioritization of gamma-ray science objectives as experts of solar flares, cosmic rays, and gamma-ray novae. They will be involved in the selection of instrument concepts based on both their expertise in gamma-ray detection and their previous involvement in the gamma-ray mission proposals CAPSiTT (Compton And Pair Silicon Timing Tracker) and GRIPS (Gamma-Ray Imaging, Polarimetry and Spectroscopy). Last but not least, they will have a key role in the simulation of relevant instrument concepts, making use of their good knowledge of the MEGAlib software package and their expertise in the background environment for various orbits.

Relevant publications:


**Relevant projects or activities:**

- “Development of a Compton gamma-ray telescope”, R&D project, LabEx P2IO, 40 k€ for 3 years (2012 – 2014), PI: Dr. V. Tatischeff

**CNRS3**: The ‘Institut d’Astrophysique de Paris (IAP - UMR7095)’ in Paris is managed by CNRS together with UNIVERSITE PIERRE ET MARIE CURIE. It has also, internally to the UPMC, the status of an “Observatoire des Sciences de l’Univers (OSU)”. With 64 permanent scientists, it is one of the largest laboratories in Astrophysics in France. Research topics cover a large fraction of modern astrophysics, including: Exoplanets and Interstellar matter; Stellar and Planetary Physics and Extrasolar Planets; Origin and Evolution of Galaxies; Cosmology and High Energy Astrophysics; Large scale structures and the deep Universe; Gravitation and Cosmology. The activities at IAP range from observations with large ground based or space telescopes, interpretation and modeling, numerical simulations and theory. IAP is not directly involved in the development of the hardware of instruments for ground based or space observatories. The main goal of IAP as an Institute is to be a place to address the important astrophysical questions by bringing together state-of-the-art results in observations, modeling, numerical simulation results and in theory, in an environment of academic freedom, merging local staff, students and postdocs and a large number of foreign visitors. IAP aims to be an international forum for discussion, confrontation and emergence of new ideas.

**Role in AHEAD**: Nicolas Prantzos will coordinate the SAG working group and the activities for the prioritization of the gamma-ray science objectives (WPN9 and WP2.5).

**CNRS4**: The ‘AstroParticle et Cosmologie (APC - UMR 7164)’ in Paris is managed by CNRS together with UNIVERSITE PARIS DIDEROT, CEA and OBSERVATOIRE DE PARIS. It was designed to bring together the different communities (experimentalists, theorists and observers) involved in the field of astroparticle physics. It was created in 2005 with laboratories MPQ (Matériaux et Phénomènes Quantiques) and MSC (Matière et Systèmes Complexes). APC brings together 75 permanent researchers, and over sixty engineers, technicians and administrative staff. Including non-permanent staff (PhD students, postdoctoral fellows, visitors), there are some 200 people in this new structure.

**Role in AHEAD**: Volker Beckmann and Regis Terrier, who are CNRS staff researchers, will participate in the studies of Compton gamma-ray detectors together with the colleagues at CSNSM and at CEA/Saclay.

**Relevant publications:**


**Projects/activities:**

- “Data distribution, visualisation, and cloud computing”, R&D project, LabEx UnivEarthS, 400 k€ for 5 years (2011 – 2016), PI: Dr. V. Beckmann
CNRS5: The ‘Laboratoire Leprince-Ringuet (LLR - UMR7638)’ in Palaiseau is managed by CNRS together with ECOLE POLYTECHNIQUE. The research program of LLR concerns particle physics and astrophysics. Since 1990 an astrophysics program started, based on high-energy gamma-ray astronomy; at ground sites (Mont Whipple; Thémis on the Pyrénées; Namibia-HESS) and in space: (Fermi satellite).

Role in AHEAD: Denis Bernard, Berrie Giebels will contribute on WP9.

CNRS6: The ‘Laboratoire d’Etudes Spatiales et d’Instrumentation en Astrophysique (LESIA - UMR 8109) is managed by CNRS together with OBSERVATOIRE DE PARIS, UNIVERSITE PARIS DIDEROT, UNIVERSITE PARIS DIDEROT. LESIA is one of the largest French laboratories of research in astrophysics (approximately 12% of the discipline). In April 2014, the laboratory counted 253 staff including 134 permanent. The permanent staff is composed of 69 Researchers/Scientists plus 65 Engineers/Technicians/Administrators of CNRS or members of Universities.

Role in AHEAD: Nicole Vilmer will be to represent the topic of high energy solar physics in the science advisory group.

Relevant publications:


CNRS7: The Laboratoire d’Astrophysique de Marseille (LAM) is one of the most important public research institutes in Europe in the area of astrophysics. It associates fundamental research in astrophysics with technological research in instrumentation. It is one of the few laboratories in France to be qualified to develop instrumentation for space missions. The LAM is a joint research unit (UMR7326) of the French National Research Center (CNRS-INSU) and Aix-Marseille University (AMU). The LAM undertakes research in astrophysics, with about 55 researchers, 55 PhD students and post-docs and 90 engineers, technicians and administrative staff. LAM building includes 1,000m2 of ISO5,7 and 8 clean rooms, as well as thermal vacuum chambers within its space qualification and test facilities.

Role in AHEAD: LAM will be involved in WP3. LAM will provide transnational access to the SPATIAL ground test facility. Marc Ferrari and David Le Mignant are the key persons involved in the AHEAD activities, at a managerial level. Dr Marc Ferrari is a Senior Astronomer. Dr Ferrari is LAM deputy-Director for Research & Technology and Knowledge Transfer. He is the scientific lead for the LAM Technology Facility. Dr Le Mignant is LAM Technical Director, responsible for the Ground-based and Space Instrumentation Department (DISS). The DISS includes 4 technical departments, and operates the Technology Facilities used for Space Qualification and Testing.
The **key persons**, and their expertise relevant to the project are:

- **Prof. Peter von Ballmoos** (gender: male)

  Peter von Ballmoos is with the Institut de Recherche en Astrophysique et Planétologie, he is professor of physics at UNIVERSITE TOULOUSE III. His main research interests are the observation, the analysis and interpretation of nuclear gamma-ray lines using various balloon and satellite instruments (Co-I of the ESA project INTEGRAL/SP; PI of CLAIRE, the “first gamma-ray lens” (Laue diffraction lens) for the French Space Agency CNES). At present, Peter von Ballmoos serves as PI of EUSO-BALLOON, a pathfinder for the JEM-EUSO mission concept which is devoted to the investigation of cosmic rays of extreme energy (E>5×10^{19} eV), using the Earth’s atmosphere as a giant detector. In the context of AHEAD, he brings in 30 years of experience in designing, building and operating instruments for high-energy astronomy. Together with Co-PI Vincent Tatischeff, Peter von Ballmoos is leading the AstroMeV Consortium (over 200 scientists from 18 countries) which is proposing the next medium energy gamma-ray mission in response to ESA's M4 call.

- **Dr. Vincent Tatischeff** (gender: male)

  Tenured scientist at CSNSM. Leader of the nuclear astrophysics group of CSNSM since 2011, he studied for about 18 years the acceleration and interactions of energetic particles in various astrophysical sites, including supernovae, novae, the interstellar medium and the active sun. His research regularly uses X-ray observations with XMM-Newton and gamma-ray observations with the INTEGRAL spectrometer SPI. Since 2012, he runs an R&D program aimed at the development of a new type of gamma-ray telescope combining a scintillator-based calorimeter and a stack of double-sided silicon strip detectors.

- **Dr. Volker Beckmann** (gender: male).

  He is a tenured research engineer and scientifically responsible for the François Arago Centre, a data analysis and computing centre for ground and space-based experiments in astroparticle physics at the APC. He has been working for scientific data centres in Switzerland, where he has been project manager at the INTEGRAL Science Data Centre in Geneva, and in the USA at NASA’s Goddard Space Flight Center where he worked as the head of the guest observer facility for the INTEGRAL gamma-ray space observatory. Beckmann is an expert on data processing for space missions, on high-energy astrophysics and on supermassive black holes. At the APC he is the project manager for the activities on ESA’s Euclid mission and he is the project scientist for the data processing centre of ESA’s eLISA gravitational wave space observatory. He is also involved in the mission preparation of the French-Chinese SVOM satellite that is going to study Gamma-Ray Bursts, and for the ground-based Cherenkov Telescope Array (CTA).

- **Dr. Denis Bernard** (gender: male)

  Head of the gamma astronomy group at LLR. Head of the HARPO Collaboration and of the LLR group of HARPO which is part of the gamma astronomy group at LLR. Director of research at CNRS, experience in detector design for particle physics experiments and science analysis. Author or co-author of ~570 peer reviewed papers.

- **Dr. Nicole Vilmer** (tenured scientist at LESIA; gender: female)

  She is director of research at CNRS. She has expertise in the field of solar physics mainly on X-ray/gamma-ray and radio diagnostics of energetic particles in the solar atmosphere. She is a Co-I on the RHESSI (Ramaty High Energy Solar Spectroscopic Imager) mission and a Co-I on STIX (X-ray imager) onboard Solar Orbiter. She was a member of the ESA working group on the payload definition team for in situ measurements on Solar Orbiter. She has also taken part in the analysis of gamma-ray solar observations of several US missions and was part of a close collaboration with the French team at CESR (Toulouse) (now IRAP) responsible for the PHEBUS experiment aboard GRANAT (solar bursts in the 100 keV-100 MeV energy range). She is the author
or co-author of ~70 peer reviewed papers in solar physics. She has been involved in several FP7 projects (HESPE, SEPServer) and has been supervising several PhD students and post-docs.

- **Dr. Marc Ferrari** (tenured scientist at LAM; gender: male)

Dr Marc Ferrari is a Senior Astronomer and LAM deputy-Director for Research & Technology and Knowledge Transfer. He is the scientific lead for the LAM Technology Facility and he’s an expert in optics and instrumentation (active optics, smart optics, optical fabrication and telescope). Since 2000 he has participated in several FP5 to FP7 projects for optical astronomy (OPTICON, ELT Preparatory Study) and in various projects for ground and space astronomy.

- **Dr. Berrie Giebels** (gender: male)

Head of the gamma-ray astronomy group at LLR. Member of the Fermi-LAT and HESS collaborations; the CTA consortium. Director of research at CNRS. His main research topics are on variable high-energy and very-high energy gamma-ray emission of active galaxies.

**Participant 25: UNIVERSITE DE GENEVE**

The **University of Geneva** is an institution devoted to research, teaching and dialogue. The Academy of Geneva was created in 1559 by Jean Calvin. With the creation of the Faculty of Medicine in 1873, the institution acquired the status of University. Since then, the UNIGE has continued to embrace new disciplines in order to remain responsive to new needs in education and research. UNIGE has a student body of 13,300 students. Renowned for its high level of excellence, the University offers a wide spectrum of academic courses in diverse fields of study such as the exact and natural sciences, medicine, social sciences and the arts. The UNIGE also shares the international calling of its host city, Geneva, a centre of international and multicultural activities with a venerable cosmopolitan tradition.

The Department of Astronomy of the University of Geneva has a long experience in space missions, in particular with high-energy astrophysics missions. It hosts the Integral Science Data Center (ISDC) that provides archival access to the European INTEGRAL mission and user support (helpdesk) together with the integration and release of the INTEGRAL data analysis software (OSA). In addition, the Department of Astronomy is involved in ground segment activities for the ESA missions Gaia, Euclid, and Cheops. It further participates in activities related to the proposed ATHENA mission, and other space projects (e.g., LOFT, SPICA, JEM-EUSO, etc).

Scientific activities in high-energy astrophysics are strong with a focus around active galactic nuclei, X-ray binaries, galaxy clusters, and stars.

The Department of Astronomy is member of the ASTRO-H consortium. It has led the development of the filter wheel mechanism and electronics for the Soft X-ray Spectrometer onboard ASTRO-H. In addition, it hosts the **European Science Support Centre** (ESSC), in collaboration with ESA. The tasks of the ESSC are focused on supporting the European scientific community with the use of ASTRO-H. The ESSC staff is involved in the ASTRO-H Science Working Group (SWG), contributes to the preparation of white papers on ASTRO-H performances, and to the definition of the target list to be proposed by the SWG for the performance verification phase. Finally, the ESSC/SOC staff shall contribute to the calibration effort of ASTRO-H. Dr. Audard has published more than 80 refereed articles in professional journals, and is PI and CoI of more than 140 successful observing proposals at wavelengths from radio to X-rays.

**Role in AHEAD**: Dr. M. Audard will lead the effort for the TA activity at UNIGE proposed in WP4.

**Relevant publications**:


The **key persons** relevant for this proposal are:

- **Dr. Marc Audard** (gender: male)

Dr. Audard is a staff member of the ASTRO-H European Science Support Centre located at UNIGE. He is an expert in stellar astronomy, namely star and planet formation through multi-wavelength observations, and in particular X-rays. He is member of the ASTRO-H Science Working Group that will reduce and analyze early ASTRO-H data. As ESSC staff member, he will also provide support to the European astronomers interested in the use of ASTRO-H data and analysis software.

### Participant 26: INFN

The **National Institute for Nuclear Physics (INFN)** is the leading Italian Institute conducting research in particle, astroparticle and fundamental physics. INFN promotes, develops and co-ordinates, as part of programs of the European Union and international organizations, research activities in collaboration with the Universities and with other public and private entities, national, international and foreign. It designs and develops innovative technologies and advanced instrumentation for the study and exploration of the fundamental laws of nature. It promotes the dissemination of scientific culture through educational projects addressed to schools and to the community.

**Role in AHEAD: Dr. A. Morselli** will coordinate the activities of INFN Roma for WPN9. The contribution of INFN Roma Tor Vergata will address instrument performance analysis, in particular the optimization of a detector that will increase significantly the sensitivity in the energy range between 10 and 50 MeV that is an experimentally very difficult range.

**Relevant publications:**


Relevant previous projects or activities:

- Participation in the design and construction of the Nina experiment
- Participation in the design and construction of the Pamela experiment
- Participation in the design and construction of the Agile experiment
- Participation in the design and construction of the Fermi-LAT experiment
- Participation in the design of the Gamma-Light experiment

The key persons relevant to the project are:

- Dr. Aldo Morselli (gender: male)

He is is First Researcher of the INFN Section at the University of Roma "Tor Vergata" and he is the Coordinator of the AGILE and Fermi experiments in the same Section. He is an author of over 360 publications on refereed international journals with an h-index of 88 and 25000 citation (google scholar).

He was Co-Investigator in all the balloon flight campaign of the WiZard collaboration: MASS, MASS91, TS93 and Caprice and he was involved in the design and construction of four satellite experiments: NINA, PAMELA AGILE and GLAST (now Fermi). He won with the Fermi Collaboration the 2011 Bruno Rossi Prize of the High Energy Astrophysics Division of the American Astronomical Society for enabling, through the development of the Large Area Telescope, new insights into neutron stars, supernova remnants, cosmic rays, binary systems, active galactic nuclei, and gamma-ray bursts and the 2012 Bruno Rossi Prize with the AGILE Team for the discovery of transient gamma-ray emission from the Crab Nebula. More information on the scientific activity and the complete list of publications with the link to the published papers can be found in the web page http://people.roma2.infn.it/~morselli/

Regarding, public outreach, he started and he is in the board of the Ricap and Shineghe conference series and in the board of ARAP, an association that promote fellowships for deserving students.

4.2. Third parties involved in the project (including use of third party resources)

Only participant 10 (UNIPG) has third parties involved in AHEAD. For participant 13 (CEA), one sub-contract is foreseen. Hereafter is the relevant information:

Participant 10: UNIPG

<table>
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<tr>
<th>Question</th>
<th>Answer</th>
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<tbody>
<tr>
<td>Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)?</td>
<td>N</td>
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<tr>
<td>Does the participant envisage that part of its work is performed by linked third parties(^9)?</td>
<td>N</td>
</tr>
<tr>
<td>Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)?</td>
<td>Y</td>
</tr>
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</table>

\(^9\) A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the Model Grant Agreement).
The SERMS laboratory is jointly operated by Perugia University, INFN and a private company, the SERMS s.r.l., born in 2004 as academic spinoff of the University of Perugia. The SERMS s.r.l. has granted access to the laboratory and all the equipment based on a research agreement with the Perugia University and, separately, with the INFN. At the same time, SERMS s.r.l. contributes to the installation with its own equipment, personnel and shares part of the running costs. Depending on the specific tests that will be required to the facility during the project, the SERMS s.r.l. personnel could be eventually needed in the design of the test setup (e.g. mechanical interfaces to the equipment) or it may happen that SERMS s.r.l. equipment could be used. This will be provided and operated by SERMS s.r.l. personnel as an in kind contribution as foreseen in the research agreement of cooperation between SERMS s.r.l. and the University of Perugia. The SERMS s.r.l. estimation of the costs budgeted for the in-kind contribution is € 5120, and will be regulated by article 12 of the General Model Grant Agreement.

Participant 13: CEA

<table>
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<th>Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)?</th>
<th>Y</th>
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<tr>
<td>Sub-contract for 30k€ for the production and procurement of specialized harness for cryogenic detectors under CEA supervision (WP6). The production process makes use of specific facilities only available in industry.</td>
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<tr>
<td>Does the participant envisage that part of its work is performed by linked third parties¹⁰?</td>
<td>N</td>
</tr>
<tr>
<td>Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)?</td>
<td>N</td>
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¹⁰ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the Model Grant Agreement).
5. Ethics and Security

5.1 Ethics

There are no known ethical issues in this proposal (see also Table in the administrative proposal forms). All integrated activities do not pertain to research on embryos, humans, or animals. Similarly, there are no known issues related to privacy, research involving developing countries, or dual use.

We confirm that the ethical standards and guidelines of Horizon2020 will be rigorously applied in the framework of the AHEAD project, regardless of the country in which the research is carried out.

5.2 Security

Please indicate if your project will involve:

- activities or results raising security issues: NO
- 'EU-classified information' as background or results: NO
<table>
<thead>
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<th>Form of costs</th>
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<td>No hours</td>
<td>Total(c)</td>
<td></td>
<td></td>
<td>Q(i)+x[(a)+(b)+(c)]+[(d)+(e)+(f)+(h1)]+[(g)]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total(h1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100.00</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>112059.00</td>
<td></td>
</tr>
<tr>
<td>A. Direct personnel costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>163769.00</td>
<td></td>
</tr>
<tr>
<td>A.1 Employees (or equivalent)</td>
<td></td>
<td>102475.00</td>
<td>0.00</td>
<td>99967.80</td>
<td>15980.00</td>
<td>0.00</td>
<td>100.00</td>
<td>163769.00</td>
</tr>
<tr>
<td>A.2 Natural persons under direct contract</td>
<td></td>
<td>102475.00</td>
<td>0.00</td>
<td>99967.80</td>
<td>15980.00</td>
<td>0.00</td>
<td>100.00</td>
<td>163769.00</td>
</tr>
<tr>
<td>A.3 Seconded persons</td>
<td></td>
<td>102475.00</td>
<td>0.00</td>
<td>99967.80</td>
<td>15980.00</td>
<td>0.00</td>
<td>100.00</td>
<td>163769.00</td>
</tr>
<tr>
<td>A.4 SME owners without salary</td>
<td></td>
<td>102475.00</td>
<td>0.00</td>
<td>99967.80</td>
<td>15980.00</td>
<td>0.00</td>
<td>100.00</td>
<td>163769.00</td>
</tr>
<tr>
<td>A.5 Beneficiaries that are natural persons without salary</td>
<td></td>
<td>102475.00</td>
<td>0.00</td>
<td>99967.80</td>
<td>15980.00</td>
<td>0.00</td>
<td>100.00</td>
<td>163769.00</td>
</tr>
</tbody>
</table>

**Estimated Costs**

- **Estimated eligible costs**
- **Maximum EU grant amount**
- **Maximum EU contribution**
- **Reimbursement rate %**
- **Information for indirect costs**
- **Information for auditors**
- **Other information**

**Grant Agreement number:** 654215 — AHEAD —

- **CNRS**
- **LIP**
- **EKUT**
- **Observatory**

**Information for**

- **Maximum costs of in-kind contributions not used on premises**
- **Point D.4 parties not receiving EU funding**

**Declaration of costs under**

- **Yes/No**
### ESTIMATED BUDGET FOR THE ACTION (page 2 of 3)

<table>
<thead>
<tr>
<th>Form of costs</th>
<th>Actual</th>
<th>Unit 1</th>
<th>Unit 2</th>
<th>Actual</th>
<th>Actual</th>
<th>Actual</th>
<th>Flat-rate</th>
<th>Unit 11</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Total (b) No hours Total (c) (d) (e) (f) (g) = 0.25 x ((a) + (b) + (c) + (d) + (e) + (f) + (h1) + (h2) - (m)) Total (h1) (i) = (a) + (b) + (c) + (d) + (e) + (f) + (g) + (h1) + (h2) + (h3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>25. UNIVERSITE DE GENEVE</strong></td>
<td>78800.00</td>
<td>0.00</td>
<td>0.00</td>
<td>78800.00</td>
<td>12895.80</td>
<td>4975.00</td>
<td>100.00</td>
<td>No</td>
</tr>
<tr>
<td><strong>26. INFN</strong></td>
<td>46000.00</td>
<td>0.00</td>
<td>0.00</td>
<td>46000.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>No</td>
</tr>
<tr>
<td><strong>Total consortium</strong></td>
<td>1247159.00</td>
<td>1247159.00</td>
<td>1247159.00</td>
<td>1247159.00</td>
<td>1247159.00</td>
<td>1247159.00</td>
<td>1247159.00</td>
<td>1247159.00</td>
</tr>
</tbody>
</table>
(1) See Article 6 for the eligibility conditions.

(2) The indirect costs covered by the operating grant (received under any EU or Euratom funding programme; see Article 6.5(b)) are ineligible under the GA. Therefore, a beneficiary that receives an operating grant during the action’s duration cannot declare indirect costs for the year(s)/reporting period(s) covered by the operating grant (see Article 6.3.E).

(3) This is the theoretical amount of EU contribution that the system calculates automatically (by multiplying all the budgeted costs by the reimbursement rate). This theoretical amount is capped by the ‘maximum grant amount’ (that the Commission/Agency decided to grant for the action) (see Article 5.1).

(4) The ‘maximum grant amount’ is the maximum grant amount decided by the Commission/Agency. It normally corresponds to the requested grant, but may be lower.

(5) Depending on its type, this specific cost category will or will not cover indirect costs. Specific unit costs that include indirect costs are: costs for energy efficiency measures in buildings, access costs for providing trans-national access to research infrastructure and costs for clinical studies.

(6) See Article 5 for the forms of costs.

(7) Unit: hours worked on the action; costs per unit (hourly rate): calculated according to beneficiary's usual accounting practice.

(8) See Annex 2a 'Additional information on the estimated budget' for the details (costs per hour (hourly rate)).

(9) Flat rate: 25% of eligible direct costs, from which are excluded: direct costs of financial support, and unit costs declared under budget category F if they include indirect costs.

(10) See Annex 2a 'Additional information on the estimated budget' for the details (units, costs per unit).

(11) See Annex 2a 'Additional information on the estimated budget' for the details (units, costs per unit, estimated number of units, etc).

(12) Only specific unit costs that do not include indirect costs.

(13) See Article 9 for beneficiaries not receiving EU funding.

(14) Only for linked third parties that receive EU funding.
### ADDITIONAL INFORMATION ON THE ESTIMATED BUDGET

**Research infrastructure unit cost**

6. Access costs for providing trans-national access to research infrastructure

- **Units**: see (for each access provider and installation) the ‘unit cost table’ attached
- **Amount per unit**: see (for each access provider and installation) the ‘unit cost table’ attached

* Amount calculated as follows:
  - average annual total access cost to the installation (over past two years)  
  - average annual total quantity of access to the installation (over past two years)

**Estimated number of units**: see (for each access provider and installation) the ‘unit cost table’ attached

Unit cost table (access to research infrastructure unit cost)

<table>
<thead>
<tr>
<th>Short name access provider</th>
<th>Short name infrastructure</th>
<th>Installation</th>
<th>Unit of access</th>
<th>Amount per unit</th>
<th>Estimated No of units</th>
<th>Total unit cost (cost per unit x estimated no of units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INAF</td>
<td>IDCTF</td>
<td>1 XACT</td>
<td>DAY</td>
<td>1030</td>
<td>24</td>
<td>24720</td>
</tr>
<tr>
<td>ULEIC</td>
<td>ULSRC</td>
<td>1 LLBTF</td>
<td>DAY</td>
<td>1020</td>
<td>24</td>
<td>24479</td>
</tr>
<tr>
<td>ULEIC</td>
<td>ULSRC</td>
<td>2 VBC</td>
<td>DAY</td>
<td>407</td>
<td>20</td>
<td>8132</td>
</tr>
<tr>
<td>UNIPG</td>
<td>STL</td>
<td>1 SERMS</td>
<td>DAY</td>
<td>1306</td>
<td>16</td>
<td>20907</td>
</tr>
<tr>
<td>UNIPG</td>
<td>STL</td>
<td>2 CEM</td>
<td>DAY</td>
<td>295</td>
<td>16</td>
<td>4721</td>
</tr>
</tbody>
</table>

---

1. Unit of access (e.g. beam hours, weeks of access, sample analysis) fixed by the access provider in proposal.
2. In exceptional and duly justified cases, the Commission/Agency may agree to a different reference period.
3. In exceptional and duly justified cases, the Commission/Agency may agree to a different reference period.
4. Data will be taken from the ‘table on estimated costs/quantity of access to be provided’ that is part of the proposal and Annex 1.
ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

UNIVERSITY OF LEICESTER (ULEIC) GB22, RC000659, established in UNIVERSITY ROAD, LEICESTER LE1 7RH, United Kingdom, GB916583894, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary (‘2’) in Grant Agreement No 654215 (‘the Agreement’)

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union (‘the EU’), represented by the European Commission (‘the Commission’), for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

BRIAN BERRY with ECAS id nbertrin signed in the Participant Portal on 12/06/2015 at 14:13:02 (transaction id BF061331)

Associated with document Ref. Ares(2015)2134334 - 21/05/2015
ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

STICHTING SRON NETHERLANDS INSTITUTE FOR SPACE RESEARCH (STICHTING SRON) NL9, 41153005, established in SORBONNELAAN 2, UTRECHT 3584 CA, Netherlands, NL008952577B01, (‘the beneficiary’), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary (‘3’)

in Grant Agreement No 654215 (‘the Agreement’)

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union (‘the EU’), represented by the European Commission (‘the Commission’),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

[Signature]

Associated with document Ref. Ares(2015)2134334 - 21/05/2015
ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

MAX PLANCK GESELLSCHAFT ZUR FOERDERUNG DER WISSENSCHAFTEN E.V. (MPG) EV, VR13378B, established in Hofgartenstrasse 8, MUENCHEN 80539, Germany, DE129517720, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary ('4')

in Grant Agreement No 654215 ('the Agreement')

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union ('the EU'), represented by the European Commission ('the Commission'),

for the action entitled 'Integrated Activities for the High Energy Astrophysics Domain (AHEAD)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Kypal NANDRA with ECAS id manduki signed in the Participant Portal on 07/07/2015 at 13:38:38 (transaction id Sigga=496. N82kKXKXwvop/8qDu2QNi7/QmG2f2wetfz2jBjDiI8ymYzgdoCSehGzG 6l9HOfO3nHieP93To6L30L1x0xZ3Ku66+1Yt9J0Uv3XKvD9hQZzg6VU0- 3TXc2KBeV2Q2gPzqAPGHsFUBVsylhnQMVZJjQzN9n3Sm). Timestamp by third party at
Tue Jul 07 14:36:52 CEST 2015
ACCESSION FORM FOR BENEFICIARIES

NATIONAL OBSERVATORY OF ATHENS (NOA), established in LOFOS NYMFON, ATHINA 11810, Greece, EL090050779, (‘the beneficiary’), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary (‘5’)

in Grant Agreement No 654215 (‘the Agreement’)

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union (‘the EU’), represented by the European Commission (‘the Commission’),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary
ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

THALES ALENIA SPACE ITALIA SPA (TAS Italia) SPA, 02101600480, established in Via Saccomuro 24, ROMA 00131, Italy, IT00991340969, (‘the beneficiary’), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

1. to become beneficiary (‘6’)

2. in Grant Agreement No 654215 (‘the Agreement’)

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union (‘the EU’), represented by the European Commission (‘the Commission’),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Luigi Maria QUAGLINO with ECAS id nquaagli signed in the Participant Portal on 19/07/2015 at 09:14:38 (transaction id Sigd:297-e3k0c7980c8oWf6L6-1lOHZ9at3Z/Ao57h4E5lqsdEMVCSa7e3mg2IUz4D-PAKc6lULXKkiD365V+27j/e3z7r6yft8fPGZ8Nu6b-035/w8Y2Ph516nXVe922/1fSUZjNLjU9$a9W8H1Ch). Timestamp by third party at Mon Jul 13 10:14:37 CEST 2015
ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

DANMARKS TEKNISKE UNIVERSITET (DTU), 30060946, established in Anker Engelundsvej 1, Bygning 101, KONGENS LYNGBY 2800, Denmark, DK30060946, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary (‘7’) in Grant Agreement No 654215 ('the Agreement') between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union ('the EU'), represented by the European Commission ('the Commission'),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Jakob FRITZ HANSEN with ECAS id nfrjjas signed in the Participant Portal on 20/06/2015 at 08:13:38 (transaction id Sgld-244-ov2zZvZrswz7pq7BqBi9t2fZwWflsSoXlsSdS1U9tCypAzuZrEcL0tJvQMC5fE9GRqPlMLRnQo-0-PH6iJVMVSYYCY23QabczaTzwbfl6GsmrCz2owRF2nAw6eBwzP8R4aJoAA4s+jGyBunWxWJ).
Timestamp by third party at Mon Jun 29 09:13:43 CEST 2015
ACCESSION FORM FOR BENEFICIARIES

CENTRUM ASTRONOMICZNE IM. MIKOLAJOA KOPERNIKA POLSKIEJ AKADEMII NAUK (NCAC), RIN-III-250/98, established in Bartycka, 18, WARSZAWA 00716, Poland, PL5250008956, (‘the beneficiary’), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary (‘8’)
in Grant Agreement No 654215 (‘the Agreement’)

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union (‘the EU’), represented by the European Commission (‘the Commission’),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary
ACCESSION FORM FOR BENEFICIARIES

UNIVERSITA DEGLI STUDI DI FERRARA (UNIFE), N/A, established in SAVONAROLA 9, FERRARA 44100, Italy, IT00434690384, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary (‘9’)

in Grant Agreement No 654215 (‘the Agreement’)

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union (‘the EU’), represented by the European Commission (‘the Commission’),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary
ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

UNIVERSITA DEGLI STUDI DI PERUGIA (UNIPG), DECRETO 2454 30/09/1996, established in PIAZZA DELL' UNIVERSITA 1, PERUGIA 06123, Italy, IT448820548, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary ('10')

in Grant Agreement No 654215 ('the Agreement')

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union ('the EU'), represented by the European Commission ('the Commission'),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Caterina PETRILLO with ECAS d'impresa signed in the Participant Portal on 29/06/2015 at 19:10:40 (transaction id 3g6i-739b-rQoQoOoEi6-x6kQWfGC+5J3ZLoLimsnV90GlEPfq/MGFX2ob0o0H2ng7/4/7v92/0P2e4AMs2aZ1vBA1/27/0Y5lPb5hjU9VMBXY70Zolu/g0T9w8eG5FtZhzw3x3N3FwRzXW/nMV3LAD8bK2pV633JX/aF37Wm), 1st request by third party at

Mon Jun 29 20:20:36 CEST 2015
ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

UNIVERSITE DE LIEGE (ULG), 325777171, established in PLACE DU 20 AOUT 7, LIEGE 4000, Belgium, BE0325777171, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary ('11')

in Grant Agreement No 654215 ('the Agreement')

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union ('the EU'), represented by the European Commission ('the Commission'),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary
ACCESSION FORM FOR BENEFICIARIES

UNIVERSITA DEGLI STUDI DI GENOVA (UNIGE), CF00754150100, established in VIA BALBI 5, GENOVA 16126, Italy, IT00754150100, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary (‘12’)

in Grant Agreement No 654215 (‘the Agreement’)

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union (‘the EU’), represented by the European Commission (‘the Commission’),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary
ACCESSION FORM FOR BENEFICIARIES

COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES (CEA) EPIC, 775685019, established in RUE LEBLANC 25, PARIS 15 75015, France, FR43775685019, (the beneficiary’), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary (‘13’)

in Grant Agreement No 654215 (‘the Agreement’)

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union (‘the EU’), represented by the European Commission (‘the Commission’),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Geoffie DECROS with ECAS id noecroga signed in the Participant Portal on 26/06/2015 at 12.01.21 (translation to Signd 496: D8kdiMiBj4tC5QwqBuYWuF3lBlIVDclhleDUZCe4kqV2dpYhawkvWPrem 3bUc4lWdHy58lzBYMoUez6bGh3uwUinboD-J7ZxYzKw3yrGJ1y兮PM8TmW-6M2zNhBFdpo3hLJtIAzn0y0DXCzoon4lAtw8dO4cQGrm). Timestamp by third party at Fri Jun 26 14:01:26 CEST 2015
ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

Teknologian tutkimuskeskus VTT Oy (VTT) FI21, 26473754, established in VUORIMIEHENTIE 3, Espoo 02150, Finland, FI26473754, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary ('14')

in Grant Agreement No 654215 ('the Agreement')

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union ('the EU'), represented by the European Commission ('the Commission'),

for the action entitled 'Integrated Activities for the High Energy Astrophysics Domain (AHEAD)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

[Signature]

Janne AIKIO with ECAS id raiioja signed in the Participant Portal on
25/06/2015 at 09:19:56 (transaction id SigId-134-
8278cYNoK9n1x0zHm595zOThzlel2zv4sUv7w56FfJH-Lf51GQ2zSY5e-
Lg0IFbBwthz=EdctkuDEJXVo7QsM54+P44slMVMVXYCHysey98/2sfr-
7f54rQo9XyjSS6twjwqaw678WhemGSGKCh842DCFhNf. Timestamp
by third party at
Thu Jun 25 10:20:03 CEST 2015
ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

LANCASTER UNIVERSITY (ULANC), RC000657, established in BAILRIGG, LANCASTER LA1 4YW, United Kingdom, GB604609849, (‘the beneficiary’), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary (‘15’)
in Grant Agreement No 654215 (‘the Agreement’)

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union (‘the EU’), represented by the European Commission (‘the Commission’),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Sarah RANDALL-PALEY with ECAS id mandarin signed in the Participant Portal on 28/08/2015 at 12:42:50 (transaction id SgJd-473-"DQD3b5GWU83dcCjuUGRUAZGwewXxYr7z3GvQH4iswJF4jE2jpx-AZSg2fzpwz6c0C0KYaPTFh2zc9Smj-71txVbymQkLjPZ6Mu-SOBPcV) with the signature: 09yqTUN84W1Uy. Timestamp by third party at Fri Jun 26 13:43:03 CEST 2015
ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

CESKE VYSOKE UCENI TECHNICKE V PRAZE (CESKE VYSOKE UCENI TECHNICKE V PRAZE), 68407700, established in ZIKOVA 4, PRAHA 16636, Czech Republic, CZ68407700, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary ('16')

in Grant Agreement No 654215 ('the Agreement')

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union ('the EU'), represented by the European Commission ('the Commission'),

for the action entitled 'Integrated Activities for the High Energy Astrophysics Domain (AHEAD)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Petr KONVALINKA with ECAS id nkonvalink signed in the Participant Portal on 11/07/2015 at 08:03:09 (transcription id Sgld50-48-YeOGzogSFpLzXn5DpsJql29KzazWAL3WY4MMPF8ye6YyczoL5GlHn7Z89G
HDVqKc6y9tboxZn2Zwm5huYAfLJ71x7x8y8m51PG7Nu0a-CHodScS5f5jULh5v10zHARhEmMg3CNXTIU6XUT).
Timestamp by third party at Sat Jul 11 09:04:16 CEST 2015
ACCESSION FORM FOR BENEFICIARIES

UNIVERSITY COLLEGE DUBLIN, NATIONAL UNIVERSITY OF IRELAND, DUBLIN (NUID UCD), established in BELFIELD, DUBLIN 4, Ireland, IE6517386K, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary (‘17’)

in Grant Agreement No 654215 (‘the Agreement’)

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union (‘the EU’), represented by the European Commission (‘the Commission’),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary
ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

UNIVERSITA DEGLI STUDI DI PALERMO (UNIPA), CF80023730825, established in PIAZZA MARINA 61, PALERMO 90133, Italy, IT00605880822, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary (‘18’)
in Grant Agreement No 654215 (‘the Agreement’)

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union (‘the EU’),
represented by the European Commission (‘the Commission’),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary
ACCESSION FORM FOR BENEFICIARIES

TARTU OBSERVATORY - ESTONIAN MINISTRY OF EDUCATION AND RESEARCH (TARTU OBSERVATORY), 70003785, established in Toravere, TORAVERE 61602, Estonia, EE100285958, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary ('19')

in Grant Agreement No 654215 ('the Agreement')

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union ('the EU'), represented by the European Commission ('the Commission'),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary
ACCESSION FORM FOR BENEFICIARIES

UNIVERSIDAD DE ALICANTE (UNIVERSIDAD DE ALICANTE), established in CAMPUS DE SAN VICENTE RASPEIG, ALICANTE 03690, Spain, ESQ0332001G, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary ('20')

in Grant Agreement No 654215 ('the Agreement')

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union ('the EU'), represented by the European Commission ('the Commission'),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

AMPARO NAVARRO FAURE with ECAS id navaro signed in the Participant Portal on 29/06/2015 at 16:54:29 [transaction id Sigb712-equKxvDz/RhPnKX/Emy/sR2VXzgT7Z2q2MsaKh36E7/hpSLADtsJQjumRsRsPdPdDnW/ZFb/aPPhoUMV5XYC2oCw5zTwMsgyG- wod/qKqKg/Q9ySbyW7f1y/oJWxp5nUcK6XnQcY1X6G]. Timestamp by third party at Mon Jun 29 17:54:40 CEST 2015
ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS (CSIC) ES8, established in CALLE SERRANO 117, MADRID 28006, Spain, ESQ2818002D, (‘the beneficiary’), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary (‘21’)

in Grant Agreement No 654215 (‘the Agreement’)

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union (‘the EU’), represented by the European Commission (‘the Commission’),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Alicia CASTRO with EDAS id infelton signed in the Participant Portal on 02/07/2016 at 11:44:56 (transaction id 5gl2t251-hpwyk1LJQd2SxKq5gEnYHe1BqG2SaM1R00000G+HYxK8yB6AVZymQ4AAW stsgTYHjHPMs3KgQm1A3j3g2yOc-FH8j1JuxSYXOYq17r2ZyMrBlm-G1QGe5D8AXr44cE6NNDMc39Sg544g9sp85E1xaj). Timestamp by third party at Thu Jul 02 12:40:24 CEST 2015
ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

EBERHARD KARLS UNIVERSITAET TUEBINGEN (EKUT), -, established in GESCHWISTER-SCHOLL-PLATZ, TUEBINGEN 72074, Germany, DE812383453, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary ('22')

in Grant Agreement No 654215 ('the Agreement')

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union ('the EU'), represented by the European Commission ('the Commission'),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Elisabeth BAIER with ECAS id mfranked signed in the Participant Portal on 29/06/2015 at 16:14:20 (transaction id S1pIG292, jBUy9z7AZw0wQzZq3tZcEzJtEoIE0Lg052ExThi23qKl initiativeAEYMYzDCQDF qnOOGSw7zWzYtd8qXaoyCQ030CMkdfidFHeiHvX3YcN1hj5EVE8bcR d2RCx708W8LA25F4gFj PVzgK9I1p6N1isDErLm5h). Timestmp by third party at Thu Jun 25 17:14:25 CEST 2015
ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

LABORATORIO DE INSTRUMENTACAO E FISICA EXPERIMENTAL DE PARTICULAS (LIP), 273960916, established in RUA LARGA 4, UNIVERSIDADE DE COIMBRA, DEPARTAMENTO DE FISICA, COIMBRA 3004 516, Portugal, PT501694650, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary (‘23’)

in Grant Agreement No 654215 (‘the Agreement’)

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union (‘the EU’), represented by the European Commission (‘the Commission’),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’. 

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Paulo Jorge RIBEIRO DA FONTE with ECSAS.id nitpqlc signed in the Participant Portal on 25/04/2015 at 09:52:28 (transaction id Spid-144-
04QqQgppzczwYPA333v7yUz07zPM1/TacHGBW3jphCh18FmJWFHkY5Y
CoVi4lC7v2/2aC5apJD4EO/kaN5WVM/PHB3tJUWNYXYCHx2/VE6bzwf+
LBz06zvzUU/jQ312Z9/SOLubFho6ap7ClpY2zdm). Timestamp by third party at
Thu Jun 25 10:33:33 CEST 2015

COPA CONFORME

2:
ACCESSION FORM FOR BENEFICIARIES

CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE (CNRS), 180089013, established in Rue Michel -Ange 3, PARIS 75794, France, FR40180089013, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary (‘24’)

in Grant Agreement No 654215 (‘the Agreement’)

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union (‘the EU’), represented by the European Commission (‘the Commission’),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Jean-Paul SWERTS with ECAS id nserje signed in the Participant Portal on 26/06/2015 at 10:20:39 (transaction id SigId-273-2a913b94b20e3d522f744f3b7904e3c7b1d40d781d8c22b3e2765dd656
d8573f2b6975c9f585b4a173c9e35d5a8c74b3d5c959f9738987a5b2e2c3d5d9

Associated with document Ref. Ares(2015)2134334 - 21/05/2015
ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

UNIVERSITE DE GENEVE (UNIVERSITE DE GENEVE), CHE110644228, established in RUE DU GENERAL DUFOUR 24, GENEVE 1211, Switzerland, CHE114927636TV A, (‘the beneficiary’), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary (‘25’)

in Grant Agreement No 654215 (‘the Agreement’)

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union (‘the EU’), represented by the European Commission (‘the Commission’),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)’.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Alex WAEBRY with ECAS id nwaehax signed in the Participant Portal on 01/02/2015 at 14:30:09 (transaction id Big)d-555-85u4sG1aG31q8QJPSVPReor0JqeqPoAtuO3nqUBKXQoB9qyV9Cj
Jk5JfJvPz2BF7hcKjLJzhMRF60Y6pLEU5-J71zX6Y8y1vGL1DZ7zmP-
JzrZIeobLi77SqdAeMvqy5AAXxAJCoxjWh7Hvd4YT2). Timestamp by third party at Wed Jul 01 15:30:31 CEST 2015
ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

ISTITUTO NAZIONALE DI FISICA NUCLEARE (INFN), 976596, established in Via Enrico Fermi 40, FRASCATI 00044, Italy, IT04430461006, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary ('26')

in Grant Agreement No 654215 ('the Agreement')

between ISTITUTO NAZIONALE DI ASTROFISICA and the European Union ('the EU'), represented by the European Commission ('the Commission'),

for the action entitled ‘Integrated Activities for the High Energy Astrophysics Domain (AHEAD)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any amendments to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement the grant in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Francesco FUGITO with ECAS id nfruciof signed in the Participant Portal on 29/06/2015 at 14:14:03 (transaction id Sgld-S81-RQodKbbp0lBPrvaWiVgqntHxK14jLZeS6T1zhJAsJY95cJXzA2Qp 7zJwpv8q3DfSfuK7j6ZuzVeReagbCMr-PiHzdUMVSYXChpEV685bhW Y-TamjteW1V0e2v9g7FT000f7io00LeGtb2LvXTrWc), Timestamp by third party at Thu Jun 25 15:14:17 CEST 2015
## MODEL ANNEX 4 FOR H2020 GENERAL MGA — MULTI

### FINANCIAL STATEMENT FOR [BENEFICIARY [name]/ LINKED THIRD PARTY [name]] FOR REPORTING PERIOD [reporting period]

<table>
<thead>
<tr>
<th>A. Direct personnel costs</th>
<th>Eligible(^1) costs (per budget category)</th>
<th>B. Direct costs of subcontracting</th>
<th>C. Direct costs of fn. support</th>
<th>D. Other direct costs</th>
<th>E. Indirect costs(^2)</th>
<th>[F. Costs of ... ]</th>
<th>Total costs</th>
<th>Receipts</th>
<th>Reimbursement rate %</th>
<th>Maximum EU contribution(^3)</th>
<th>Requested EU contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.1 Employees (or equivalent)</td>
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<td>A.2 Natural persons under direct contract</td>
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<td>A.3 Seconded persons</td>
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<td>A.6 Personnel for providing access to research infrastructure</td>
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<td>B. Direct costs of subcontracting</td>
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<tr>
<td>C. Direct costs of fn. support</td>
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<td>D. Other direct costs</td>
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<td>E. Indirect costs(^2)</td>
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<td>[F. Costs of ... ]</td>
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<td>Total costs</td>
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<td>Receipts</td>
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</tbody>
</table>

### Additional Information

<table>
<thead>
<tr>
<th>Information for indirect costs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs of in-kind contributions not used on premises</td>
</tr>
</tbody>
</table>

### Form of costs\(^4\)

<table>
<thead>
<tr>
<th>Actual</th>
<th>Unit</th>
<th>Unit</th>
<th>Actual</th>
<th>Actual</th>
<th>Actual</th>
<th>Flat-rate(^5)</th>
<th>Unit</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>a</td>
<td>Total b</td>
<td>No hours</td>
<td>Total c</td>
<td>d</td>
<td>[e]</td>
<td>f</td>
<td>[g]</td>
<td>[i1]</td>
</tr>
</tbody>
</table>

The beneficiary/linked third party hereby confirms that:

The information provided is complete, reliable and true.

The costs declared are eligible (see Article 6).

The costs can be substantiated by adequate records and supporting documentation that will be produced upon request or in the context of checks, reviews, audits and investigations (see Articles 17, 18 and 22).

For the last reporting period: that all the receipts have been declared (see Article 5.3.3).

\(^1\) See Article 6 for the eligibility conditions

\(^2\) The indirect costs claimed must be free of any amounts covered by an operating grant (received under any EU or Euratom funding programme; see Article 6.2.E). If you have received an operating grant during this reporting period, you cannot claim any indirect costs.

\(^3\) This is the theoretical amount of EU contribution that the system calculates automatically (by multiplying the reimbursement rate by the total costs declared). The amount you request (in the column 'requested EU contribution') may have to be less (e.g. if you and the other beneficiaries are above budget, if the 90% limit (see Article 21) is reached, etc).

\(^4\) See Article 5 for the form of costs

\(^5\) Flat rate: 25% of eligible direct costs, from which are excluded: direct costs of subcontracting, costs of in-kind contributions not used on premises, direct costs of financial support, and unit costs declared under budget category F if they include indirect costs (see Article 6.2.E)

\(^6\) Only specific unit costs that do not include indirect costs
ANNEX 5

MODEL FOR THE CERTIFICATE ON THE FINANCIAL STATEMENTS

- For options [in italics in square brackets]: choose the applicable option. Options not chosen should be deleted.
- For fields in [grey in square brackets]: enter the appropriate data

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TERMS OF REFERENCE FOR AN INDEPENDENT REPORT OF FACTUAL FINDINGS ON COSTS DECLARED UNDER A GRANT AGREEMENT FINANCED UNDER THE HORIZON 2020 RESEARCH FRAMEWORK PROGRAMME................................................................. 2

INDEPENDENT REPORT OF FACTUAL FINDINGS ON COSTS DECLARED UNDER A GRANT AGREEMENT FINANCED UNDER THE HORIZON 2020 RESEARCH FRAMEWORK PROGRAMME .................................................................................................................................................. 7
Terms of Reference for an Independent Report of Factual Findings on costs declared under a Grant Agreement financed under the Horizon 2020 Research and Innovation Framework Programme

This document sets out the ‘Terms of Reference (ToR)’ under which

[OPTION 1: [insert name of the beneficiary] (‘the Beneficiary’)]  [OPTION 2: [insert name of the linked third party] (‘the Linked Third Party’), third party linked to the Beneficiary [insert name of the beneficiary] (‘the Beneficiary’)]

agrees to engage

[insert legal name of the auditor] (‘the Auditor’)

to produce an independent report of factual findings (‘the Report’) concerning the Financial Statement(s) drawn up by the [Beneficiary] [Linked Third Party] for the Horizon 2020 grant agreement [insert number of the grant agreement, title of the action, acronym and duration from/to] (‘the Agreement’), and

to issue a Certificate on the Financial Statements’ (‘CFS’) referred to in Article 20.4 of the Agreement based on the compulsory reporting template stipulated by the Commission.

The Agreement has been concluded under the Horizon 2020 Research and Innovation Framework Programme (H2020) between the Beneficiary and [OPTION 1: the European Union, represented by the European Commission (‘the Commission’)] [OPTION 2: the European Atomic Energy Community (Euratom,) represented by the European Commission (‘the Commission’)][OPTION 3: the [Research Executive Agency (REA)] [European Research Council Executive Agency (ERCEA)] [Innovation and Networks Executive Agency (INEA)] [Executive Agency for Small and Medium-sized Enterprises (EASME)] (‘the Agency’), under the powers delegated by the European Commission (‘the Commission’).]

By which costs under the Agreement are declared (see template ‘Model Financial Statements’ in Annex 4 to the Grant Agreement).
The [Commission] [Agency] is mentioned as a signatory of the Agreement with the Beneficiary only. The [European Union][Euratom][Agency] is not a party to this engagement.

1.1 Subject of the engagement

The coordinator must submit to the [Commission][Agency] the final report within 60 days following the end of the last reporting period which should include, amongst other documents, a CFS for each beneficiary and for each linked third party that requests a total contribution of EUR 325 000 or more, as reimbursement of actual costs and unit costs calculated on the basis of its usual cost accounting practices (see Article 20.4 of the Agreement). The CFS must cover all reporting periods of the beneficiary or linked third party indicated above.

The Beneficiary must submit to the coordinator the CFS for itself and for its linked third party(ies), if the CFS must be included in the final report according to Article 20.4 of the Agreement.

The CFS is composed of two separate documents:

- The Terms of Reference (‘the ToR’) to be signed by the [Beneficiary] [Linked Third Party] and the Auditor;
- The Auditor’s Independent Report of Factual Findings (‘the Report’) to be issued on the Auditor’s letterhead, dated, stamped and signed by the Auditor (or the competent public officer) which includes the agreed-upon procedures (‘the Procedures’) to be performed by the Auditor, and the standard factual findings (‘the Findings’) to be confirmed by the Auditor.

If the CFS must be included in the final report according to Article 20.4 of the Agreement, the request for payment of the balance relating to the Agreement cannot be made without the CFS. However, the payment for reimbursement of costs covered by the CFS does not preclude the [Commission][Agency] the European Anti-Fraud Office and the European Court of Auditors from carrying out checks, reviews, audits and investigations in accordance with Article 22 of the Agreement.

1.2 Responsibilities

The [Beneficiary] [Linked Third Party]:
must draw up the Financial Statement(s) for the action financed by the Agreement in compliance with the obligations under the Agreement. The Financial Statement(s) must be drawn up according to the [Beneficiary’s] [Linked Third Party’s] accounting and book-keeping system and the underlying accounts and records;

- must send the Financial Statement(s) to the Auditor;
- is responsible and liable for the accuracy of the Financial Statement(s);
- is responsible for the completeness and accuracy of the information provided to enable the Auditor to carry out the Procedures. It must provide the Auditor with a written representation letter supporting these statements. The written representation letter must state the period covered by the statements and must be dated;
- accepts that the Auditor cannot carry out the Procedures unless it is given full access to the [Beneficiary’s] [Linked Third Party’s] staff and accounting as well as any other relevant records and documentation.

The Auditor:

- [Option 2 if the Beneficiary or Linked Third Party has an independent Public Officer: is a competent and independent Public Officer for which the relevant national authorities have established the legal capacity to audit the Beneficiary].
- [Option 3 if the Beneficiary or Linked Third Party is an international organisation: is an [internal] [external] auditor in accordance with the internal financial regulations and procedures of the international organisation].

The Auditor:

- must be independent from the Beneficiary [and the Linked Third Party], in particular, it must not have been involved in preparing the [Beneficiary’s] [Linked Third Party’s] Financial Statement(s);
- must plan work so that the Procedures may be carried out and the Findings may be assessed;
- must adhere to the Procedures laid down and the compulsory report format;
- must carry out the engagement in accordance with this ToR;
- must document matters which are important to support the Report;
- must base its Report on the evidence gathered;
- must submit the Report to the [Beneficiary] [Linked Third Party].

The Commission sets out the Procedures to be carried out by the Auditor. The Auditor is not responsible for their suitability or pertinence. As this engagement is not an assurance engagement, the Auditor does not provide an audit opinion or a statement of assurance.

1.3 Applicable Standards
The Auditor must comply with these Terms of Reference and with:

- the International Standard on Related Services (‘ISRS’) 4400 *Engagements to perform Agreed-upon Procedures regarding Financial Information* as issued by the International Auditing and Assurance Standards Board (IAASB);
- the *Code of Ethics for Professional Accountants* issued by the International Ethics Standards Board for Accountants (IESBA). Although ISRS 4400 states that independence is not a requirement for engagements to carry out agreed-upon procedures, the [Commission][Agency] requires that the Auditor also complies with the Code’s independence requirements.

The Auditor’s Report must state that there is no conflict of interests in establishing this Report between the Auditor and the Beneficiary *[and the Linked Third Party]*, and must specify - if the service is invoiced - the total fee paid to the Auditor for providing the Report.

### 1.4 Reporting

The Report must be written in the language of the Agreement (see Article 20.7).

Under Article 22 of the Agreement, the [Commission][Agency], the European Anti-Fraud Office and the Court of Auditors have the right to audit any work that is carried out under the action and for which costs are declared from [the European Union][Euratom] budget. This includes work related to this engagement. The Auditor must provide access to all working papers (e.g. recalculation of hourly rates, verification of the time declared for the action) related to this assignment if the [Commission][Agency], the European Anti-Fraud Office or the European Court of Auditors requests them.

### 1.5 Timing

The Report must be provided by *(dd Month yyyy)*.

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2 Supreme Audit Institutions applying INTOSAI-standards may carry out the Procedures according to the corresponding International Standards of Supreme Audit Institutions and code of ethics issued by INTOSAI instead of the International Standard on Related Services (‘ISRS’) 4400 and the Code of Ethics for Professional Accountants issued by the IAASB and the IESBA.
1.6 Other terms

[The [Beneficiary] [Linked Third Party] and the Auditor can use this section to agree other specific terms, such as the Auditor’s fees, liability, applicable law, etc. Those specific terms must not contradict the terms specified above.]

[legal name of the Auditor] [legal name of the [Beneficiary][Linked Third Party]]

[name & function of authorised representative] [name & function of authorised representative]

[dd Month yyyy] [dd Month yyyy]

Signature of the Auditor Signature of the [Beneficiary][Linked Third Party]
Independent Report of Factual Findings on costs declared under Horizon 2020 Research and Innovation Framework Programme

(To be printed on the Auditor’s letterhead)

To

[ name of contact person(s)], [Position]

[ Beneficiary’s] [Linked Third Party’s] name

Address

[ dd Month yyyy]

Dear [Name of contact person(s)],

As agreed under the terms of reference dated [dd Month yyyy]

with [OPTION 1: [insert name of the beneficiary] (‘the Beneficiary’)] [OPTION 2: [insert name of the linked third party] (‘the Linked Third Party’), third party linked to the Beneficiary [insert name of the beneficiary] (‘the Beneficiary’)],

we

[ name of the auditor] (‘the Auditor’),

established at

[full address/city/state/province/country],

represented by

[ name and function of an authorised representative],
have carried out the procedures agreed with you regarding the costs declared in the Financial Statement(s)\(^3\) of the [Beneficiary] [Linked Third Party] concerning the grant agreement [insert grant agreement reference: number, title of the action and acronym] (‘the Agreement’),

with a total cost declared of [total amount] EUR,

and a total of actual costs and ‘direct personnel costs declared as unit costs calculated in accordance with the [Beneficiary’s] [Linked Third Party’s] usual cost accounting practices’ declared of [sum of total actual costs and total direct personnel costs declared as unit costs calculated in accordance with the [Beneficiary’s] [Linked Third Party’s] usual cost accounting practices] EUR

and hereby provide our Independent Report of Factual Findings (‘the Report’) using the compulsory report format agreed with you.

**The Report**

Our engagement was carried out in accordance with the terms of reference (‘the ToR’) appended to this Report. The Report includes the agreed-upon procedures (‘the Procedures’) carried out and the standard factual findings (‘the Findings’) examined.

The Procedures were carried out solely to assist the [Commission] [Agency] in evaluating whether the [Beneficiary’s] [Linked Third Party’s] costs in the accompanying Financial Statement(s) were declared in accordance with the Agreement. The [Commission] [Agency] draws its own conclusions from the Report and any additional information it may require.

---

\(^3\) By which the Beneficiary declares costs under the Agreement (see template ‘Model Financial Statement’ in Annex 4 to the Agreement).
The scope of the Procedures was defined by the Commission. Therefore, the Auditor is not responsible for their suitability or pertinence. Since the Procedures carried out constitute neither an audit nor a review made in accordance with International Standards on Auditing or International Standards on Review Engagements, the Auditor does not give a statement of assurance on the Financial Statements.

Had the Auditor carried out additional procedures or an audit of the [Beneficiary’s] [Linked Third Party’s] Financial Statements in accordance with International Standards on Auditing or International Standards on Review Engagements, other matters might have come to its attention and would have been included in the Report.

Not applicable Findings

We examined the Financial Statement(s) stated above and considered the following Findings not applicable:

Explanation (to be removed from the Report):

If a Finding was not applicable, it must be marked as ‘N.A.’ (‘Not applicable’) in the corresponding row on the right-hand column of the table and means that the Finding did not have to be corroborated by the Auditor and the related Procedure(s) did not have to be carried out.

The reasons of the non-application of a certain Finding must be obvious i.e.

i) if no cost was declared under a certain category then the related Finding(s) and Procedure(s) are not applicable;

ii) if the condition set to apply certain Procedure(s) are not met the related Finding(s) and those Procedure(s) are not applicable. For instance, for ‘beneficiaries with accounts established in a currency other than euro’ the Procedure and Finding related to ‘beneficiaries with accounts established in euro’ are not applicable. Similarly, if no additional remuneration is paid, the related Finding(s) and Procedure(s) for additional remuneration are not applicable.

List here all Findings considered not applicable for the present engagement and explain the reasons of the non-applicability.

....

Exceptions

Apart from the exceptions listed below, the [Beneficiary] [Linked Third Party] provided the Auditor all the documentation and accounting information needed by the Auditor to carry out the requested Procedures and evaluate the Findings.
Explanation (to be removed from the Report):

- If the Auditor was not able to successfully complete a procedure requested, it must be marked as ‘E’ (‘Exception’) in the corresponding row on the right-hand column of the table. The reason such as the inability to reconcile key information or the unavailability of data that prevents the Auditor from carrying out the Procedure must be indicated below.
- If the Auditor cannot corroborate a standard finding after having carried out the corresponding procedure, it must also be marked as ‘E’ (‘Exception’) and, where possible, the reasons why the Finding was not fulfilled and its possible impact must be explained here below.

List here any exceptions and add any information on the cause and possible consequences of each exception, if known. If the exception is quantifiable, include the corresponding amount.

Example (to be removed from the Report):

1. The Beneficiary was unable to substantiate the Finding number 1 on ... because ....
2. Finding number 30 was not fulfilled because the methodology used by the Beneficiary to calculate unit costs was different from the one approved by the Commission. The differences were as follows: ...
3. After carrying out the agreed procedures to confirm the Finding number 31, the Auditor found a difference of _____________ EUR. The difference can be explained by ...

Further Remarks

In addition to reporting on the results of the specific procedures carried out, the Auditor would like to make the following general remarks:

Example (to be removed from the Report):

1. Regarding Finding number 8 the conditions for additional remuneration were considered as fulfilled because ...
2. In order to be able to confirm the Finding number 15 we carried out the following additional procedures: ....

Use of this Report

This Report may be used only for the purpose described in the above objective. It was prepared solely for the confidential use of the [Beneficiary] [Linked Third Party] and the [Commission] [Agency], and only to be submitted to the [Commission] [Agency] in connection with the requirements set out in Article 20.4 of the Agreement. The Report may not be used by the [Beneficiary] [Linked Third Party] or by the [Commission] [Agency] for any other purpose, nor may it
be distributed to any other parties. The [Commission] [Agency] may only disclose the Report to authorised parties, in particular to the European Anti-Fraud Office (OLAF) and the European Court of Auditors.

This Report relates only to the Financial Statement(s) submitted to the [Commission] [Agency] by the [Beneficiary] [Linked Third Party] for the Agreement. Therefore, it does not extend to any other of the [Beneficiary’s] [Linked Third Party’s] Financial Statement(s).

There was no conflict of interest\(^4\) between the Auditor and the Beneficiary [and Linked Third Party] in establishing this Report. The total fee paid to the Auditor for providing the Report was EUR \(______\) (including EUR \(______\) of deductible VAT).

We look forward to discussing our Report with you and would be pleased to provide any further information or assistance.

[legal name of the Auditor]

[name and function of an authorised representative]

[dd Month yyyy]

Signature of the Auditor

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\(^4\) A conflict of interest arises when the Auditor’s objectivity to establish the certificate is compromised in fact or in appearance when the Auditor for instance:
- was involved in the preparation of the Financial Statements;
- stands to benefit directly should the certificate be accepted;
- has a close relationship with any person representing the beneficiary;
- is a director, trustee or partner of the beneficiary; or
- is in any other situation that compromises his or her independence or ability to establish the certificate impartially.
Agreed-upon procedures to be performed and standard factual findings to be confirmed by the Auditor

The European Commission reserves the right to i) provide the auditor with additional guidance regarding the procedures to be followed or the facts to be ascertained and the way in which to present them (this may include sample coverage and findings) or to ii) change the procedures, by notifying the Beneficiary in writing. The procedures carried out by the auditor to confirm the standard factual finding are listed in the table below.

If this certificate relates to a Linked Third Party, any reference here below to ‘the Beneficiary’ is to be considered as a reference to ‘the Linked Third Party’.

The ‘result’ column has three different options: ‘C’, ‘E’ and ‘N.A.’:

- ‘C’ stands for ‘confirmed’ and means that the auditor can confirm the ‘standard factual finding’ and, therefore, there is no exception to be reported.
- ‘E’ stands for ‘exception’ and means that the Auditor carried out the procedures but cannot confirm the ‘standard factual finding’, or that the Auditor was not able to carry out a specific procedure (e.g. because it was impossible to reconcile key information or data were unavailable),
- ‘N.A.’ stands for ‘not applicable’ and means that the Finding did not have to be examined by the Auditor and the related Procedure(s) did not have to be carried out. The reasons of the non-application of a certain Finding must be obvious i.e. i) if no cost was declared under a certain category then the related Finding(s) and Procedure(s) are not applicable; ii) if the condition set to apply certain Procedure(s) are not met then the related Finding(s) and Procedure(s) are not applicable. For instance, for ‘beneficiaries with accounts established in a currency other than the euro’ the Procedure related to ‘beneficiaries with accounts established in euro’ is not applicable. Similarly, if no additional remuneration is paid, the related Finding(s) and Procedure(s) for additional remuneration are not applicable.

<table>
<thead>
<tr>
<th>Ref</th>
<th>Procedures</th>
<th>Standard factual finding</th>
<th>Result (C / E / N.A.)</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>ACTUAL PERSONNEL COSTS AND UNIT COSTS CALCULATED BY THE BENEFICIARY IN ACCORDANCE WITH ITS USUAL COST ACCOUNTING PRACTICE</td>
<td></td>
<td></td>
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</table>
The Auditor draws a sample of persons whose costs were declared in the Financial Statement(s) to carry out the procedures indicated in the consecutive points of this section A.

(The sample should be selected randomly so that it is representative. Full coverage is required if there are fewer than 10 people (including employees, natural persons working under a direct contract and personnel seconded by a third party), otherwise the sample should have a minimum of 10 people, or 10% of the total, whichever number is the highest)

The Auditor sampled ____ people out of the total of ____ people.

### A.1 PERSONNEL COSTS

For the persons included in the sample and working under an employment contract or equivalent act (general procedures for individual actual personnel costs and personnel costs declared as unit costs)

To confirm standard factual findings 1-5 listed in the next column, the Auditor reviewed following information/documents provided by the Beneficiary:

- a list of the persons included in the sample indicating the period(s) during which they worked for the action, their position (classification or category) and type of contract;
- the payslips of the employees included in the sample;
- reconciliation of the personnel costs declared in the Financial Statement(s) with the accounting system (project accounting and general ledger) and payroll system;
- information concerning the employment status and employment conditions of personnel included in the sample, in particular their employment contracts or equivalent;

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<tbody>
<tr>
<td>A.1</td>
<td>For the persons included in the sample and working under an employment contract or equivalent act (general procedures for individual actual personnel costs and personnel costs declared as unit costs) To confirm standard factual findings 1-5 listed in the next column, the Auditor reviewed following information/documents provided by the Beneficiary:</td>
<td>1) The employees were i) directly hired by the Beneficiary in accordance with its national legislation, ii) under the Beneficiary’s sole technical supervision and responsibility and iii) remunerated in accordance with the Beneficiary’s usual practices. 2) Personnel costs were recorded in the Beneficiary’s accounts/payroll system. 3) Costs were adequately supported and reconciled with the accounts and payroll system.</td>
<td></td>
</tr>
</tbody>
</table>

13
The Auditor also verified the eligibility of all components of the retribution (see Article 6 GA) and recalculated the personnel costs for employees included in the sample.

**Further procedures if ‘additional remuneration’ is paid**

To confirm standard factual findings 6-9 listed in the next column, the Auditor:

- reviewed relevant documents provided by the Beneficiary (legal form, legal/statutory obligations, the Beneficiary’s usual policy on additional remuneration, criteria used for its calculation...);
- recalculated the amount of additional remuneration eligible for the action based on the supporting documents received (full-time or part-time work, exclusive or non-exclusive dedication to the action, etc.) to arrive at the applicable FTE/year and pro-rata rate (see data collected in the course of carrying out the procedures under A.2 ‘Productive hours’ and A.4 ‘Time recording system’).

<table>
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<tr>
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<td>o the Beneficiary’s usual policy regarding payroll matters (e.g. salary policy, overtime policy, variable pay); o applicable national law on taxes, labour and social security and o any other document that supports the personnel costs declared.</td>
<td>records.</td>
<td>4) Personnel costs did not contain any ineligible elements.</td>
</tr>
<tr>
<td></td>
<td>The Auditor also verified the eligibility of all components of the retribution (see Article 6 GA) and recalculated the personnel costs for employees included in the sample.</td>
<td></td>
<td>5) There were no discrepancies between the personnel costs charged to the action and the costs recalculated by the Auditor.</td>
</tr>
<tr>
<td>6)</td>
<td>The Beneficiary paying “additional remuneration” was a non-profit legal entity.</td>
<td>6) The Beneficiary paying “additional remuneration” was a non-profit legal entity.</td>
<td></td>
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<tr>
<td>7)</td>
<td>The amount of additional remuneration paid corresponded to the Beneficiary’s usual remuneration practices and was consistently paid whenever the same kind of work or expertise was required.</td>
<td>7) The amount of additional remuneration paid corresponded to the Beneficiary’s usual remuneration practices and was consistently paid whenever the same kind of work or expertise was required.</td>
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</tbody>
</table>
**Ref** | **Procedures** | **Standard factual finding** | **Result (C / E / N.A.)**
--- | --- | --- | ---

**I**f **any part of the remuneration paid to the employee is not mandatory according to the national law or the employment contract ("additional remuneration") and is eligible under the provisions of Article 6.2.A.1, this can be charged as eligible cost to the action up to the following amount:

1. **(A)** If the person works full time and exclusively on the action during the full year: up to EUR 8,000/year;
2. **(B)** If the person works exclusively on the action but not full-time or not for the full year: up to the corresponding pro-rata amount of EUR 8,000, or
3. **(C)** If the person does not work exclusively on the action: up to a pro-rata amount calculated in accordance to Article 6.2.A.1.

8) The criteria used to calculate the additional remuneration were objective and generally applied by the Beneficiary regardless of the source of funding used.

9) The amount of additional remuneration included in the personnel costs charged to the action was capped at EUR 8,000 per FTE/year (up to the equivalent pro-rata amount if the person did not work on the action full-time during the year or did not work exclusively on the action).

**Additional procedures in case “unit costs calculated by the Beneficiary in accordance with its usual cost accounting practices” is applied:**

Apart from carrying out the procedures indicated above to confirm standard factual findings 1-5 and, if applicable, also 6-9, the Auditor carried out following procedures to confirm standard factual findings 10-13 listed in the next column:

10) The personnel costs included in the Financial Statement were calculated in accordance with the Beneficiary's usual cost accounting practice. This methodology was consistently used in all H2020 actions.
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</table>
|     | o obtained a description of the Beneficiary's usual cost accounting practice to calculate unit costs;  
| 11  |               | 11) The employees were charged under the correct category. |                     |
|     | o reviewed whether the Beneficiary's usual cost accounting practice was applied for the Financial Statements subject of the present CFS;  
| 12  |               | 12) Total personnel costs used in calculating the unit costs were consistent with the expenses recorded in the statutory accounts. |                     |
|     | o verified the employees included in the sample were charged under the correct category (in accordance with the criteria used by the Beneficiary to establish personnel categories) by reviewing the contract/HR-record or analytical accounting records;  
| 13  |               | 13) Any estimated or budgeted element used by the Beneficiary in its unit-cost calculation were relevant for calculating personnel costs and corresponded to objective and verifiable information. |                     |
|     | o verified that there is no difference between the total amount of personnel costs used in calculating the cost per unit and the total amount of personnel costs recorded in the statutory accounts;  
|     |               | 14) The natural persons reported to the Beneficiary (worked under the Beneficiary’s instructions). |                     |
|     | o verified whether actual personnel costs were adjusted on the basis of budgeted or estimated elements and, if so, verified whether those elements used are actually relevant for the calculation, objective and supported by documents. | 15) They worked on the Beneficiary’s premises (unless otherwise agreed with the Beneficiary). |                     |

For natural persons included in the sample and working with the Beneficiary under a direct contract other than an employment contract, such as consultants (no subcontractors).

To confirm standard factual findings 14-18 listed in the next column the Auditor reviewed following information/documents provided by the Beneficiary:

- the contracts, especially the cost, contract duration, work description, place of work, ownership of the results and reporting obligations to the Beneficiary;
<table>
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<tbody>
<tr>
<td>o</td>
<td>the employment conditions of staff in the same category to compare costs and;</td>
<td>16) The results of work carried out belong to the Beneficiary.</td>
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<tr>
<td>o</td>
<td>any other document that supports the costs declared and its registration (e.g. invoices, accounting records, etc.).</td>
<td>17) Their costs were not significantly different from those for staff who performed similar tasks under an employment contract with the Beneficiary.</td>
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<td></td>
<td>18) The costs were supported by audit evidence and registered in the accounts.</td>
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<td></td>
<td>For personnel seconded by a third party and included in the sample (not subcontractors)</td>
<td>19) Seconded personnel reported to the Beneficiary and worked on the Beneficiary’s premises (unless otherwise agreed with the Beneficiary).</td>
<td></td>
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<tr>
<td></td>
<td>To confirm standard factual findings 19-22 listed in the next column, the Auditor reviewed following information/documents provided by the Beneficiary:</td>
<td>20) The results of work carried out belong to the Beneficiary.</td>
<td></td>
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<tr>
<td></td>
<td>o their secondment contract(s) notably regarding costs, duration, work description, place of work and ownership of the results;</td>
<td>If personnel is seconded against payment:</td>
<td></td>
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<tr>
<td></td>
<td>o if there is reimbursement by the Beneficiary to the third party for the resource made available (in-kind contribution against payment): any documentation that supports the costs declared (e.g. contract, invoice, bank payment, and proof of registration in its accounting/payroll, etc.) and reconciliation of the Financial Statement(s) with the accounting system (project accounting and general ledger) as well as any proof that the amount invoiced by the third party did not include any profit;</td>
<td>21) The costs declared were supported with documentation and recorded in the</td>
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<tr>
<td>Ref</td>
<td>Procedures</td>
<td>Standard factual finding</td>
<td>Result (C / E / N.A.)</td>
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</table>
|     | o if there is no reimbursement by the Beneficiary to the third party for the resource made available (in-kind contribution free of charge): a proof of the actual cost borne by the Third Party for the resource made available free of charge to the Beneficiary such as a statement of costs incurred by the Third Party and proof of the registration in the Third Party's accounting/payroll;  
 o any other document that supports the costs declared (e.g. invoices, etc.). | Beneficiary’s accounts. The third party did not include any profit. | If personnel is seconded free of charge:  
22) The costs declared did not exceed the third party’s cost as recorded in the accounts of the third party and were supported with documentation. |
|     | A.2 PRODUCTIVE HOURS | | |
|     | To confirm standard factual findings 23-28 listed in the next column, the Auditor reviewed relevant documents, especially national legislation, labour agreements and contracts and time records of the persons included in the sample, to verify that:  
 o the annual productive hours applied were calculated in accordance with one of the methods described below,  
 o the full-time equivalent (FTEs) ratios for employees not working full-time were correctly calculated. | 23) The Beneficiary applied method [choose one option and delete the others]  
[A: 1720 hours]  
[B: the ‘total number of hours worked’]  
[C: ‘annual productive hours’ used correspond to usual accounting practices] | |
H2020 Model Grant Agreements: H2020 General MGA — Multi: September 2014

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</table>
|     | If the Beneficiary applied method B, the auditor verified that the correctness in which the total number of hours worked was calculated and that the contracts specified the annual workable hours. If the Beneficiary applied method C, the auditor verified that the ‘annual productive hours’ applied when calculating the hourly rate were equivalent to at least 90% of the ‘standard annual workable hours’. The Auditor can only do this if the calculation of the standard annual workable hours can be supported by records, such as national legislation, labour agreements, and contracts. **Beneficiary’s productive hours** for persons working full time shall be one of the following methods:  
A. 1720 annual productive hours (pro-rata for persons not working full-time)  
B. the total number of hours worked by the person for the Beneficiary in the year (this method is also referred to as ‘total number of hours worked’ in the next column). The calculation of the total number of hours worked was done as follows: annual workable hours of the person according to the employment contract, applicable labour agreement or national law plus overtime worked minus absences (such as sick leave or special leave). | 24) Productive hours were calculated annually.  
25) For employees not working full-time the full-time equivalent (FTE) ratio was correctly applied. | |
|     | If the Beneficiary applied method B.  
26) The calculation of the number of ‘annual workable hours’, overtime and absences was verifiable based on the documents provided by the Beneficiary. |  | |
|     | If the Beneficiary applied method C.  
27) The calculation of the number of ‘standard annual workable hours’ was verifiable based on the documents provided by the Beneficiary. |  | |
### C. The Standard Number of Annual Hours Generally Applied by the Beneficiary for its Personnel in Accordance with its Usual Cost Accounting Practices

This method is also referred to as ‘Total Annual Productive Hours’ in the next column. This number must be at least 90% of the standard annual workable hours.

‘Annual workable hours’ means the period during which the personnel must be working, at the employer’s disposal and carrying out his/her activity or duties under the employment contract, applicable collective labour agreement or national working time legislation.

### A.3 Hourly Personnel Rates

I) For unit costs calculated in accordance to the Beneficiary’s usual cost accounting practice (unit costs):

If the Beneficiary has a "Certificate on Methodology to calculate unit costs " (CoMUC) approved by the Commission, the Beneficiary provides the Auditor with a description of the approved methodology and the Commission’s letter of acceptance. The Auditor verified that the Beneficiary has indeed used the methodology approved. If so, no further verification is necessary.

If the Beneficiary does not have a "Certificate on Methodology" (CoMUC) approved by the Commission:

- **Option I:** “Unit costs (hourly rates) were calculated in accordance with the Beneficiary’s usual cost accounting practices”
- **Option II:** Individual hourly rates were applied
<table>
<thead>
<tr>
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</table>
|     | **Commission, or if the methodology approved was not applied, then the Auditor:**  
|     | o reviewed the documentation provided by the Beneficiary, including manuals and internal guidelines that explain how to calculate hourly rates;  
|     | o recalculated the unit costs (hourly rates) of staff included in the sample following the results of the procedures carried out in A.1 and A.2.  
|     | **II) For individual hourly rates:**  
|     | The Auditor:  
|     | o reviewed the documentation provided by the Beneficiary, including manuals and internal guidelines that explain how to calculate hourly rates;  
|     | o recalculated the hourly rates of staff included in the sample following the results of the procedures carried out in A.1 and A.2.  
|     | **“UNIT COSTS CALCULATED BY THE BENEFICIARY IN ACCORDANCE WITH ITS USUAL COST ACCOUNTING PRACTICES”:**  
|     | **IT IS CALCULATED BY DIVIDING THE TOTAL AMOUNT OF PERSONNEL COSTS OF THE CATEGORY TO WHICH THE EMPLOYEE BELONGS VERIFIED IN LINE WITH PROCEDURE A.1 BY THE NUMBER OF FTE AND THE ANNUAL TOTAL PRODUCTIVE HOURS OF THE SAME CATEGORY CALCULATED BY THE BENEFICIARY IN ACCORDANCE WITH PROCEDURE A.2.**  
|     | **HOURLY RATE FOR INDIVIDUAL ACTUAL PERSONAL COSTS:**  
|     | **IT IS CALCULATED BY DIVIDING THE TOTAL AMOUNT OF PERSONNEL COSTS OF AN EMPLOYEE VERIFIED IN LINE WITH**  
|     | **For option I concerning unit costs and if the Beneficiary applies the methodology approved by the Commission (CoMUC):**  
|     | 30) The Beneficiary used the Commission-approved methodology to calculate hourly rates. It corresponded to the organisation's usual cost accounting practices and was applied consistently for all activities irrespective of the source of funding.  
|     | **For option I concerning unit costs and if the Beneficiary applies a methodology not approved by the Commission:**  
|     | 31) The unit costs re-calculated by the Auditor were the same as the rates applied by the Beneficiary.  
|     | **For option II concerning individual hourly rates:**  

Associated with document Ref. Ares(2015)2134334 - 21/05/2015
**Procedures**

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<tbody>
<tr>
<td></td>
<td><strong>PROCEDURE A.1 BY THE NUMBER OF ANNUAL PRODUCTIVE HOURS VERIFIED IN LINE WITH PROCEDURE A.2.</strong></td>
<td>32) The individual rates re-calculated by the Auditor were the same as the rates applied by the Beneficiary.</td>
<td></td>
</tr>
<tr>
<td>A.4</td>
<td><strong>TIME RECORDING SYSTEM</strong></td>
<td>33) All persons recorded their time dedicated to the action on a daily/ weekly/ monthly basis using a paper/computer-based system. (delete the answers that are not applicable)</td>
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<td></td>
<td>To verify that the time recording system ensures the fulfilment of all minimum requirements and that the hours declared for the action were correct, accurate and properly authorised and supported by documentation, the Auditor made the following checks for the persons included in the sample that declare time as worked for the action on the basis of time records:</td>
<td></td>
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<td></td>
<td>o description of the time recording system provided by the Beneficiary (registration, authorisation, processing in the HR-system);</td>
<td>34) Their time-records were authorised at least monthly by the project manager or other superior.</td>
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<td></td>
<td>o its actual implementation;</td>
<td>35) Hours declared were worked within the project period and were consistent with the presences/absences recorded in HR-records.</td>
<td></td>
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<td></td>
<td>o time records were signed at least monthly by the employees (on paper or electronically) and authorised by the project manager or another manager;</td>
<td></td>
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<tr>
<td></td>
<td>o the hours declared were worked within the project period;</td>
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<tr>
<td></td>
<td>o there were no hours declared as worked for the action if HR-records showed absence due to holidays or sickness (further cross-checks with travels are carried out in B.1 below);</td>
<td></td>
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</table>
### Ref

<table>
<thead>
<tr>
<th>Procedures</th>
<th>Standard factual finding</th>
<th>Result (C / E / N.A.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>o  the hours charged to the action matched those in the time recording system.</td>
<td>36) There were no discrepancies between the number of hours charged to the action and the number of hours recorded.</td>
<td></td>
</tr>
<tr>
<td><strong>ONLY THE HOURS WORKED ON THE ACTION CAN BE CHARGED. ALL WORKING TIME TO BE CHARGED SHOULD BE</strong> <strong>RECORDED THROUGHOUT THE DURATION OF THE PROJECT, ADEQUATELY SUPPORTED BY EVIDENCE OF THEIR REALITY AND RELIABILITY (SEE SPECIFIC PROVISIONS BELOW FOR PERSONS WORKING EXCLUSIVELY FOR THE ACTION WITHOUT TIME RECORDS).</strong></td>
<td><strong>37) The exclusive dedication is supported by a declaration signed by the Beneficiary's and by any other evidence gathered.</strong></td>
<td></td>
</tr>
</tbody>
</table>

If the persons are working exclusively for the action and without time records

For the persons selected that worked exclusively for the action without time records, the Auditor verified evidence available demonstrating that they were in reality exclusively dedicated to the action and that the Beneficiary signed a declaration confirming that they have worked exclusively for the action.

### B  COSTS OF SUBCONTRACTING

**B.1** The Auditor obtained the detail/breakdown of subcontracting costs and sampled [10] cost items selected randomly (full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest).

To confirm standard factual findings 38-42 listed in the next column, the Auditor reviewed the

38) The use of claimed subcontracting costs was foreseen in Annex 1 and costs were declared in the Financial Statements under the subcontracting category.
Following for the items included in the sample:

- the use of subcontractors was foreseen in Annex 1;
- subcontracting costs were declared in the subcontracting category of the Financial Statement;
- supporting documents on the selection and award procedure were followed;
- the Beneficiary ensured best value for money (key elements to appreciate the respect of this principle are the award of the subcontract to the bid offering best price-quality ratio, under conditions of transparency and equal treatment. In case an existing framework contract was used the Beneficiary ensured it was established on the basis of the principle of best value for money under conditions of transparency and equal treatment).

In particular,

i. if the Beneficiary acted as a contracting authority within the meaning of Directive 2004/18/EC or of Directive 2004/17/EC, the Auditor verified that the applicable national law on public procurement was followed and that the subcontracting complied with the Terms and Conditions of the Agreement.

ii. if the Beneficiary did not fall under the above-mentioned category the Auditor verified that the Beneficiary followed their usual procurement rules and respected the Terms and Conditions of the Agreement.

For the items included in the sample the Auditor also verified that:

- the subcontracts were not awarded to other Beneficiaries in the consortium;

<table>
<thead>
<tr>
<th>Ref</th>
<th>Procedures</th>
<th>Standard factual finding</th>
<th>Result (C / E / N.A.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>following for the items included in the sample:</td>
<td>39) There were documents of requests to different providers, different offers and assessment of the offers before selection of the provider in line with internal procedures and procurement rules. Subcontracts were awarded in accordance with the principle of best value for money. (When different offers were not collected the Auditor explains the reasons provided by the Beneficiary under the caption “Exceptions” of the Report. The Commission will analyse this information to evaluate whether these costs might be accepted as eligible)</td>
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<tr>
<td></td>
<td>o the use of subcontractors was foreseen in Annex 1;</td>
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<tr>
<td></td>
<td>o subcontracting costs were declared in the subcontracting category of the Financial Statement;</td>
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<tr>
<td></td>
<td>o supporting documents on the selection and award procedure were followed;</td>
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<tr>
<td></td>
<td>o the Beneficiary ensured best value for money (key elements to appreciate the respect of this principle are the award of the subcontract to the bid offering best price-quality ratio, under conditions of transparency and equal treatment. In case an existing framework contract was used the Beneficiary ensured it was established on the basis of the principle of best value for money under conditions of transparency and equal treatment).</td>
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<td></td>
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<tr>
<td></td>
<td>In particular,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i. if the Beneficiary acted as a contracting authority within the meaning of Directive 2004/18/EC or of Directive 2004/17/EC, the Auditor verified that the applicable national law on public procurement was followed and that the subcontracting complied with the Terms and Conditions of the Agreement.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ii. if the Beneficiary did not fall under the above-mentioned category the Auditor verified that the Beneficiary followed their usual procurement rules and respected the Terms and Conditions of the Agreement.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>For the items included in the sample the Auditor also verified that:</td>
<td>40) The subcontracts were not awarded to other Beneficiaries of the consortium.</td>
<td></td>
</tr>
</tbody>
</table>
### Costs of Providing Financial Support to Third Parties

**C.1** The Auditor obtained the detail/breakdown of the costs of providing financial support to third parties and sampled [ ] cost items selected randomly (full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest).

The Auditor verified that the following minimum conditions were met:

a) the maximum amount of financial support for each third party did not exceed EUR 60 000, unless explicitly mentioned in Annex 1;

b) the financial support to third parties was agreed in Annex 1 of the Agreement and the other provisions on financial support to third parties included in Annex 1 were

<table>
<thead>
<tr>
<th>Ref</th>
<th>Procedures</th>
<th>Standard factual finding</th>
<th>Result (C / E / N.A.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>o there were signed agreements between the Beneficiary and the subcontractor; o there was evidence that the services were provided by subcontractor;</td>
<td>41) All subcontracts were supported by signed agreements between the Beneficiary and the subcontractor.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>42) There was evidence that the services were provided by the subcontractors.</td>
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</tr>
<tr>
<td>C</td>
<td>COSTS OF PROVIDING FINANCIAL SUPPORT TO THIRD PARTIES</td>
<td></td>
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<tr>
<td></td>
<td>The Auditor obtained the detail/breakdown of the costs of providing financial support to third parties and sampled [ ] cost items selected randomly (full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest).</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The Auditor verified that the following minimum conditions were met: a) the maximum amount of financial support for each third party did not exceed EUR 60 000, unless explicitly mentioned in Annex 1; b) the financial support to third parties was agreed in Annex 1 of the Agreement and the other provisions on financial support to third parties included in Annex 1 were</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>43) All minimum conditions were met</td>
<td></td>
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<tr>
<td>Ref</td>
<td>Procedures</td>
<td>Standard factual finding</td>
<td>Result (C / E / N.A.)</td>
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<td></td>
<td>respected.</td>
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</tbody>
</table>
### D. OTHER ACTUAL DIRECT COSTS

#### D.1 COSTS OF TRAVEL AND RELATED SUBSISTENCE ALLOWANCES

The Auditor sampled ______ cost items selected randomly *(full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is the highest).*

The Auditor inspected the sample and verified that:

- travel and subsistence costs were consistent with the Beneficiary's usual policy for travel. In this context, the Beneficiary provided evidence of its normal policy for travel costs (e.g. use of first class tickets, reimbursement by the Beneficiary on the basis of actual costs, a lump sum or per diem) to enable the Auditor to compare the travel costs charged with this policy;
- travel costs are correctly identified and allocated to the action (e.g. trips are directly linked to the action) by reviewing relevant supporting documents such as minutes of meetings, workshops or conferences, their registration in the correct project account, their consistency with time records or with the dates/duration of the workshop/conference;
- no ineligible costs or excessive or reckless expenditure was declared.

44) Costs were incurred, approved and reimbursed in line with the Beneficiary’s usual policy for travels.

45) There was a link between the trip and the action.

46) The supporting documents were consistent with each other regarding subject of the trip, dates, duration and reconciled with time records and accounting.

47) No ineligible costs or excessive or reckless expenditure was declared.

#### D.2 DEPRECIATION COSTS FOR EQUIPMENT, INFRASTRUCTURE OR OTHER ASSETS

The Auditor sampled ______ cost items selected randomly *(full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is the highest).*

For “equipment, infrastructure or other assets” [from now on called “asset(s)”] selected in the

48) Procurement rules, principles and guides were followed.

49) There was a link between the grant agreement and the asset charged to the action.
Sample the Auditor verified that:

- the assets were acquired in conformity with the Beneficiary's internal guidelines and procedures;
- they were correctly allocated to the action (with supporting documents such as delivery note invoice or any other proof demonstrating the link to the action);
- they were entered in the accounting system;
- the extent to which the assets were used for the action (as a percentage) was supported by reliable documentation (e.g. usage overview table);

The Auditor recalculated the depreciation costs and verified that they were in line with the applicable rules in the Beneficiary's country and with the Beneficiary's usual accounting policy (e.g. depreciation calculated on the acquisition value).

The Auditor verified that no ineligible costs such as deductible VAT, exchange rate losses, excessive or reckless expenditure were declared (see Article 6.5 GA).

### D.3 COSTS OF OTHER GOODS AND SERVICES

The Auditor sampled [ ] cost items selected randomly (full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest).

For the purchase of goods, works or services included in the sample the Auditor verified that:

- the contracts did not cover tasks described in Annex 1;

50) The asset charged to the action was traceable to the accounting records and the underlying documents.

51) The depreciation method used to charge the asset to the action was in line with the applicable rules of the Beneficiary's country and the Beneficiary's usual accounting policy.

52) The amount charged corresponded to the actual usage for the action.

53) No ineligible costs or excessive or reckless expenditure were declared.

54) Contracts for works or services did not cover tasks described in Annex 1.

55) Costs were allocated to the correct action and the goods were not placed in the inventory of durable equipment.
o they were correctly identified, allocated to the proper action, entered in the accounting system (traceable to underlying documents such as purchase orders, invoices and accounting);

o the goods were not placed in the inventory of durable equipment;

o the costs charged to the action were accounted in line with the Beneficiary's usual accounting practices;

o no ineligible costs or excessive or reckless expenditure were declared (see Article 6 GA).

In addition, the Auditor verified that these goods and services were acquired in conformity with the Beneficiary's internal guidelines and procedures, in particular:

o if Beneficiary acted as a contracting authority within the meaning of Directive 2004/18/EC or of Directive 2004/17/EC, the Auditor verified that the applicable national law on public procurement was followed and that the procurement contract complied with the Terms and Conditions of the Agreement.

o if the Beneficiary did not fall into the category above, the Auditor verified that the Beneficiary followed their usual procurement rules and respected the Terms and Conditions of the Agreement.

For the items included in the sample the Auditor also verified that:

o the Beneficiary ensured best value for money (key elements to appreciate the respect of this principle are the award of the contract to the bid offering best price-quality ratio, under conditions of transparency and equal treatment. In case an existing framework contract was used the Auditor also verified that the Beneficiary ensured it was established on the basis of the principle of best value for money under conditions of transparency and equal treatment);

\textbf{Such goods and services include, for instance, consumables and supplies, dissemination (including open access), protection of results, specific evaluation of the action if it is required by the}...
**Agreement, certificates on the financial statements if they are required by the agreement and certificates on the methodology, translations, reproduction.**

**D.4 Aggregated capitalised and operating costs of research infrastructure**

The Auditor ensured the existence of a positive ex-ante assessment (issued by the EC Services) of the cost accounting methodology of the Beneficiary allowing it to apply the guidelines on direct costing for large research infrastructures in Horizon 2020.

*In the cases that a positive ex-ante assessment has been issued* (see the standard factual findings 59-60 on the next column),

The Auditor ensured that the beneficiary has applied consistently the methodology that is explained and approved in the positive ex ante assessment;

*In the cases that a positive ex-ante assessment has NOT been issued* (see the standard factual findings 61 on the next column),

The Auditor verified that no costs of Large Research Infrastructure have been charged as direct costs in any costs category;

<table>
<thead>
<tr>
<th>59) The costs declared as direct costs for Large Research Infrastructures (in the appropriate line of the Financial Statement) comply with the methodology described in the positive ex-ante assessment report.</th>
</tr>
</thead>
<tbody>
<tr>
<td>60) Any difference between the methodology applied and the one positively assessed was extensively described and adjusted accordingly.</td>
</tr>
<tr>
<td>61) The direct costs declared were free from any indirect costs items related to the Large Research Infrastructure.</td>
</tr>
</tbody>
</table>
In the cases that a draft ex-ante assessment report has been issued with recommendation for further changes (see the standard factual findings 61 on the next column),

- The Auditor followed the same procedure as above (when a positive ex-ante assessment has NOT yet been issued) and paid particular attention (testing reinforced) to the cost items for which the draft ex-ante assessment either rejected the inclusion as direct costs for Large Research Infrastructures or issued recommendations.

<table>
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<tr>
<th>E</th>
<th>USE OF EXCHANGE RATES</th>
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<tbody>
<tr>
<td>E.1</td>
<td>a) For Beneficiaries with accounts established in a currency other than euros</td>
</tr>
</tbody>
</table>

The Auditor sampled _____ cost items selected randomly and verified that the exchange rates used for converting other currencies into euros were in accordance with the following rules established in the Agreement (full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 items, or 10% of the total, whichever number is highest):

**Costs incurred in another currency shall be converted into Euro at the average of the daily exchange rates published in the C series of Official Journal of the European Union (https://www.ecb.int/stats/exchange/eurofxref/html/index.en.html), determined over the corresponding reporting period.**

**If no daily Euro exchange rate is published in the Official Journal of the European Union for the currency in question, conversion shall be made at the average of the monthly accounting rates established by the Commission and published on its website (http://ec.europa.eu/budget/contracts_grants/info_contracts/infomac/infomac_en.cfm),**

62) The exchange rates used to convert other currencies into Euros were in accordance with the rules established of the Grant Agreement and there was no difference in the final figures.
<table>
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<tr>
<th>DETERMINED OVER THE CORRESPONDING REPORTING PERIOD.</th>
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<tbody>
<tr>
<td>b) For Beneficiaries with accounts established in euros</td>
<td>63) The Beneficiary applied its usual accounting practices.</td>
</tr>
<tr>
<td>The Auditor sampled _____ cost items selected randomly and verified that the exchange rates used for converting other currencies into euros were in accordance with the following rules established in the Agreement (full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 items, or 10% of the total, whichever number is highest):</td>
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<tr>
<td>COSTS INCURRED IN ANOTHER CURRENCY SHALL BE CONVERTED INTO EURO BY APPLYING THE BENEFICIARY’S USUAL ACCOUNTING PRACTICES.</td>
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</table>

[legal name of the audit firm]

[name and function of an authorised representative]

[dd Month yyyy]

<Signature of the Auditor>
ANNEX 6

MODEL FOR THE CERTIFICATE ON THE METHODOLOGY

- For options [*italics in square brackets*]: choose the applicable option. Options not chosen should be deleted.
- For fields in [*grey in square brackets*]: enter the appropriate data.

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TERMS OF REFERENCE FOR AN AUDIT ENGAGEMENT FOR A METHODOLOGY CERTIFICATE IN CONNECTION WITH ONE OR MORE GRANT AGREEMENTS FINANCED UNDER THE HORIZON 2020 RESEARCH AND INNOVATION FRAMEWORK PROGRAMME........................................................................................................................................2

INDEPENDENT REPORT OF FACTUAL FINDINGS ON THE METHODOLOGY CONCERNING GRANT AGREEMENTS FINANCED UNDER THE HORIZON 2020 RESEARCH AND INNOVATION FRAMEWORK PROGRAMME ........................................................................................................................................7
Terms of reference for an audit engagement for a methodology certificate in connection with one or more grant agreements financed under the Horizon 2020 Research and Innovation Framework Programme

This document sets out the 'Terms of Reference (ToR)' under which

[OPTION 1: [insert name of the beneficiary] ('the Beneficiary')] [OPTION 2: [insert name of the linked third party] ('the Linked Third Party'), third party linked to the Beneficiary [insert name of the beneficiary] ('the Beneficiary')]

agrees to engage

[insert legal name of the auditor] ('the Auditor')

to produce an independent report of factual findings ('the Report') concerning the [Beneficiary's] [Linked Third Party's] usual accounting practices for calculating and claiming direct personnel costs declared as unit costs ('the Methodology') in connection with grant agreements financed under the Horizon 2020 Research and Innovation Framework Programme.

The procedures to be carried out for the assessment of the methodology will be based on the grant agreement(s) detailed below:

[title and number of the grant agreement(s)] ('the Agreement(s)')

The Agreement(s) has(have) been concluded between the Beneficiary and [OPTION 1: the European Union, represented by the European Commission ('the Commission')] [OPTION 2: the European Atomic Energy Community (Euratom,) represented by the European Commission ('the Commission')] [OPTION 3: the [Research Executive Agency (REA)] [European Research Council Executive Agency (ERCEA)] [Innovation and Networks Executive Agency (INEA)] [Executive Agency for Small and Medium-sized Enterprises (EASME)] ('the Agency'), under the powers delegated by the European Commission ('the Commission').]
The [Commission] [Agency] is mentioned as a signatory of the Agreement with the Beneficiary only. The [European Union] [Euratom] [Agency] is not a party to this engagement.

1.1 Subject of the engagement

According to Article 18.1.2 of the Agreement, beneficiaries [and linked third parties] that declare direct personnel costs as unit costs calculated in accordance with their usual cost accounting practices may submit to the [Commission] [Agency], for approval, a certificate on the methodology (‘CoMUC’) stating that there are adequate records and documentation to prove that their cost accounting practices used comply with the conditions set out in Point A of Article 6.2.

The subject of this engagement is the CoMUC which is composed of two separate documents:

- the Terms of Reference (‘the ToR’) to be signed by the [Beneficiary] [Linked Third Party] and the Auditor;

- the Auditor’s Independent Report of Factual Findings (‘the Report’) issued on the Auditor’s letterhead, dated, stamped and signed by the Auditor which includes; the standard statements (‘the Statements’) evaluated and signed by the [Beneficiary] [Linked Third Party], the agreed-upon procedures (‘the Procedures’) performed by the Auditor and the standard factual findings (‘the Findings’) assessed by the Auditor. The Statements, Procedures and Findings are summarised in the table that forms part of the Report.

The information provided through the Statements, the Procedures and the Findings will enable the Commission to draw conclusions regarding the existence of the [Beneficiary’s] [Linked Third Party’s] usual cost accounting practice and its suitability to ensure that direct personnel costs claimed on that basis comply with the provisions of the Agreement. The Commission draws its own conclusions from the Report and any additional information it may require.

1.2 Responsibilities

The parties to this agreement are the [Beneficiary] [Linked Third Party] and the Auditor.
is responsible for preparing financial statements for the Agreement(s) (‘the Financial Statements’) in compliance with those Agreements;

is responsible for providing the Financial Statement(s) to the Auditor and enabling the Auditor to reconcile them with the [Beneficiary’s] [Linked Third Party’s] accounting and bookkeeping system and the underlying accounts and records. The Financial Statement(s) will be used as a basis for the procedures which the Auditor will carry out under this ToR;

is responsible for its Methodology and liable for the accuracy of the Financial Statement(s);

is responsible for endorsing or refuting the Statements indicated under the heading ‘Statements to be made by the Beneficiary/Linked Third Party’ in the first column of the table that forms part of the Report;

must provide the Auditor with a signed and dated representation letter;

accepts that the ability of the Auditor to carry out the Procedures effectively depends upon the [Beneficiary] [Linked Third Party] providing full and free access to the [Beneficiary’s] [Linked Third Party’s] staff and to its accounting and other relevant records.

The Auditor:


- [Option 2 if the Beneficiary or Linked Third Party has an independent Public Officer: is a competent and independent Public Officer for which the relevant national authorities have established the legal capacity to audit the Beneficiary].

- [Option 3 if the Beneficiary or Linked Third Party is an international organisation: is an [internal] [external] auditor in accordance with the internal financial regulations and procedures of the international organisation].

The Auditor:

- must be independent from the Beneficiary [and the Linked Third Party], in particular, it must not have been involved in preparing the Beneficiary’s [and Linked Third Party’s] Financial Statement(s);

- must plan work so that the Procedures may be carried out and the Findings may be assessed;

- must adhere to the Procedures laid down and the compulsory report format;

- must carry out the engagement in accordance with these ToR;

- must document matters which are important to support the Report;

- must base its Report on the evidence gathered;

- must submit the Report to the [Beneficiary] [Linked Third Party].

The Commission sets out the Procedures to be carried out and the Findings to be endorsed by the Auditor. The Auditor is not responsible for their suitability or pertinence. As this engagement is not an assurance engagement the Auditor does not provide an audit opinion or a statement of assurance.
1.3 Applicable Standards

The Auditor must comply with these Terms of Reference and with¹:

- the International Standard on Related Services (‘ISRS’) 4400 Engagements to perform Agreed-upon Procedures regarding Financial Information as issued by the International Auditing and Assurance Standards Board (IAASB);
- the Code of Ethics for Professional Accountants issued by the International Ethics Standards Board for Accountants (IESBA). Although ISRS 4400 states that independence is not a requirement for engagements to carry out agreed-upon procedures, the Commission requires that the Auditor also complies with the Code’s independence requirements.

The Auditor’s Report must state that there was no conflict of interests in establishing this Report between the Auditor and the Beneficiary [and the Linked Third Party] that could have a bearing on the Report, and must specify – if the service is invoiced - the total fee paid to the Auditor for providing the Report.

1.4 Reporting

The Report must be written in the language of the Agreement (see Article 20.7 of the Agreement).

Under Article 22 of the Agreement, the Commission, [the Agency], the European Anti-Fraud Office and the Court of Auditors have the right to audit any work that is carried out under the action and for which costs are claimed from [the European Union] [Euratom] budget. This includes work related to this engagement. The Auditor must provide access to all working papers related to this assignment if the Commission, [the Agency], the European Anti-Fraud Office or the European Court of Auditors requests them.

1.5 Timing

The Report must be provided by [dd Month yyyy].

¹ Supreme Audit Institutions applying INTOSAI-standards may carry out the Procedures according to the corresponding International Standards of Supreme Audit Institutions and code of ethics issued by INTOSAI instead of the International Standard on Related Services (‘ISRS’) 4400 and the Code of Ethics for Professional Accountants issued by the IAASB and the IESBA.
1.6 Other Terms

[The [Beneficiary] [Linked Third Party] and the Auditor can use this section to agree other specific terms, such as the Auditor’s fees, liability, applicable law, etc. Those specific terms must not contradict the terms specified above.]

[legal name of the Auditor] [legal name of the [Beneficiary] [Linked Third Party]]
[name & title of authorised representative] [name & title of authorised representative]
[dd Month yyyy] [dd Month yyyy]
Signature of the Auditor Signature Signature of the [Beneficiary] [Linked Third Party]
Independent report of factual findings on the methodology concerning grant agreements financed under the Horizon 2020 Research and Innovation Framework Programme

(To be printed on letterhead paper of the auditor)

To

[Name of contact person(s)], [Position]

[[Beneficiary’s] [Linked Third Party’s] name]

[Address]

[dd Month yyyy]

Dear [Name of contact person(s)],

As agreed under the terms of reference dated [dd Month yyyy]

with [OPTION 1: [insert name of the beneficiary] (‘the Beneficiary’)] [OPTION 2: [insert name of the linked third party] (‘the Linked Third Party’), third party linked to the Beneficiary [insert name of the beneficiary] (‘the Beneficiary’),

we

[insert name of the auditor] (‘the Auditor’),

established at

[full address/city/state/province/country],

represented by

[name and function of an authorised representative],
H2020 Model Grant Agreements: H2020 General MGA — Multi: September 2014

have carried out the agreed-upon procedures (‘the Procedures’) and provide hereby our Independent Report of Factual Findings (‘the Report’), concerning the [Beneficiary’s] [Linked Third Party’s] usual accounting practices for calculating and declaring direct personnel costs declared as unit costs (‘the Methodology’).

You requested certain procedures to be carried out in connection with the grant(s)

[title and number of the grant agreement(s)] (‘the Agreement(s)’).

The Report

Our engagement was carried out in accordance with the terms of reference (‘the ToR’) appended to this Report. The Report includes: the standard statements (‘the Statements’) made by the [Beneficiary] [Linked Third Party], the agreed-upon procedures (‘the Procedures’) carried out and the standard factual findings (‘the Findings’) confirmed by us.

The engagement involved carrying out the Procedures and assessing the Findings and the documentation requested appended to this Report, the results of which the Commission uses to draw conclusions regarding the acceptability of the Methodology applied by the [Beneficiary] [Linked Third Party].

The Report covers the methodology used from [dd Month yyyy]. In the event that the [Beneficiary] [Linked Third Party] changes this methodology, the Report will not be applicable to any Financial Statement submitted thereafter.

The scope of the Procedures and the definition of the standard statements and findings were determined solely by the Commission. Therefore, the Auditor is not responsible for their suitability or pertinence.

Since the Procedures carried out constitute neither an audit nor a review made in accordance with International Standards on Auditing or International Standards on Review Engagements, we do not

2 Financial Statement in this context refers solely to Annex 4 of the Agreement by which the Beneficiary declares costs under the Agreement.
give a statement of assurance on the costs declared on the basis of the [Beneficiary’s] [Linked Third Party’s] Methodology. Had we carried out additional procedures or had we performed an audit or review in accordance with these standards, other matters might have come to its attention and would have been included in the Report.

Exceptions

Apart from the exceptions listed below, the [Beneficiary] [Linked Third Party] agreed with the standard Statements and provided the Auditor all the documentation and accounting information needed by the Auditor to carry out the requested Procedures and corroborate the standard Findings.

List here any exception and add any information on the cause and possible consequences of each exception, if known. If the exception is quantifiable, also indicate the corresponding amount.

......

Explanation of possible exceptions in the form of examples (to be removed from the Report):

i. the [Beneficiary] [Linked Third Party] did not agree with the standard Statement number ... because...;

ii. the Auditor could not carry out the procedure ... established because .... (e.g. due to the inability to reconcile key information or the unavailability or inconsistency of data);

iii. the Auditor could not confirm or corroborate the standard Finding number ... because ....

Remarks

We would like to add the following remarks relevant for the proper understanding of the Methodology applied by the [Beneficiary] [Linked Third Party] or the results reported:

Example (to be removed from the Report):

Regarding the methodology applied to calculate hourly rates ...

Regarding standard Finding 15 it has to be noted that ...

The [ Beneficiary] [Linked Third Party] explained the deviation from the benchmark statement XXIV concerning time recording for personnel with no exclusive dedication to the action in the following manner:

...
Please provide the following documents to the auditor and annex them to the report when submitting this CoMUC to the Commission:

1. Brief description of the methodology for calculating personnel costs, productive hours and hourly rates;
2. Brief description of the time recording system in place;
3. An example of the time records used by the [Beneficiary] [Linked Third Party];
4. Description of any budgeted or estimated elements applied, together with an explanation as to why they are relevant for calculating the personnel costs and how they are based on objective and verifiable information;
5. A summary sheet with the hourly rate for direct personnel declared by the [Beneficiary] [Linked Third Party] and recalculated by the Auditor for each staff member included in the sample (the names do not need to be reported);
6. A comparative table summarising for each person selected in the sample a) the time claimed by the [Beneficiary] [Linked Third Party] in the Financial Statement(s) and b) the time according to the time record verified by the Auditor;
7. A copy of the letter of representation provided to the Auditor.

Use of this Report

This Report has been drawn up solely for the purpose given under Point 1.1 Reasons for the engagement.

The Report:

- is confidential and is intended to be submitted to the Commission by the [Beneficiary] [Linked Third Party] in connection with Article 18.1.2 of the Agreement;
- may not be used by the [Beneficiary] [Linked Third Party] or by the Commission for any other purpose, nor distributed to any other parties;
- may be disclosed by the Commission only to authorised parties, in particular the European Anti-Fraud Office (OLAF) and the European Court of Auditors.
- relates only to the usual cost accounting practices specified above and does not constitute a report on the Financial Statements of the [Beneficiary] [Linked Third Party].

No conflict of interest exists between the Auditor and the Beneficiary [and the Linked Third Party] that could have a bearing on the Report. The total fee paid to the Auditor for producing the Report was EUR [ ] (including EUR [ ] of deductible VAT).

---

3 A conflict of interest arises when the Auditor’s objectivity to establish the certificate is compromised in fact or in appearance when the Auditor for instance:

- was involved in the preparation of the Financial Statements;
We look forward to discussing our Report with you and would be pleased to provide any further information or assistance which may be required.

Yours sincerely

[legal name of the Auditor]

[name and title of the authorised representative]

[dd Month yyyy]

Signature of the Auditor

- stands to benefit directly should the certificate be accepted;
- has a close relationship with any person representing the beneficiary;
- is a director, trustee or partner of the beneficiary; or
- is in any other situation that compromises his or her independence or ability to establish the certificate impartially.
Statements to be made by the Beneficiary/Linked Third Party (‘the Statements’) and Procedures to be carried out by the Auditor (‘the Procedures’) and standard factual findings (‘the Findings’) to be confirmed by the Auditor

The Commission reserves the right to provide the auditor with guidance regarding the Statements to be made, the Procedures to be carried out or the Findings to be ascertained and the way in which to present them. The Commission reserves the right to vary the Statements, Procedures or Findings by written notification to the Beneficiary/Linked Third Party to adapt the procedures to changes in the grant agreement(s) or to any other circumstances.

If this methodology certificate relates to the Linked Third Party’s usual accounting practices for calculating and claiming direct personnel costs declared as unit costs any reference here below to ‘the Beneficiary’ is to be considered as a reference to ‘the Linked Third Party’.

Please explain any discrepancies in the body of the Report.

<table>
<thead>
<tr>
<th>Statements to be made by Beneficiary</th>
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<tbody>
<tr>
<td><strong>A. Use of the Methodology</strong></td>
<td><strong>B. Description of the Methodology</strong></td>
</tr>
<tr>
<td>I. The cost accounting practice described below has been in use since (dd \text{ Month yyyy}).</td>
<td>III. The methodology to calculate unit costs is being used in a consistent manner and is reflected in the relevant procedures.</td>
</tr>
<tr>
<td>II. The next planned alteration to the methodology used by the Beneficiary will be from (dd \text{ Month yyyy}).</td>
<td>[Please describe the methodology your entity uses to calculate personnel costs, productive hours and hourly rates, present your description to the Auditor and annex it to this certificate]</td>
</tr>
<tr>
<td>Procedure:</td>
<td>Procedure:</td>
</tr>
<tr>
<td>✓ The Auditor checked these dates against the documentation the Beneficiary has provided.</td>
<td>✓ The Auditor reviewed the description, the relevant manuals and/or internal guidance documents describing the methodology.</td>
</tr>
<tr>
<td>Factual finding:</td>
<td>Factual finding:</td>
</tr>
<tr>
<td>1. The dates provided by the Beneficiary were consistent with the documentation.</td>
<td>2. The brief description was consistent with the relevant manuals, internal guidance and/or other documentary evidence the Auditor has reviewed.</td>
</tr>
<tr>
<td>3. The methodology was generally applied by the Beneficiary as part of its usual costs accounting practices.</td>
<td></td>
</tr>
</tbody>
</table>
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<td><strong>Factual Findings:</strong></td>
<td></td>
</tr>
<tr>
<td>- ...</td>
<td></td>
</tr>
<tr>
<td><strong>C. Personnel costs</strong></td>
<td></td>
</tr>
<tr>
<td><strong>General</strong></td>
<td></td>
</tr>
<tr>
<td>IV. The unit costs (hourly rates) are limited to salaries including during parental leave, social security contributions, taxes and other costs included in the remuneration required under national law and the employment contract or equivalent appointing act;</td>
<td>Procedure: The Auditor draws a sample of employees to carry out the procedures indicated in this section C and the following sections D to F.</td>
</tr>
<tr>
<td>V. Employees are hired directly by the Beneficiary in accordance with national law, and work under its sole supervision and responsibility;</td>
<td>[The Auditor has drawn a random sample of 10 full-time equivalents made up of employees assigned to the action(s). If fewer than 10 full-time equivalents are assigned to the action(s), the Auditor has selected a sample of 10 full-time equivalents consisting of all employees assigned to the action(s), complemented by other employees irrespective of their assignments.]. For this sample:</td>
</tr>
<tr>
<td>VI. The Beneficiary remunerates its employees in accordance with its usual practices. This means that personnel costs are charged in line with the Beneficiary’s usual payroll policy (e.g. salary policy, overtime policy, variable pay) and no special conditions exist for employees assigned to tasks relating to the European Union or Euratom, unless explicitly provided for in the grant agreement(s);</td>
<td>✓ the Auditor reviewed all documents relating to personnel costs such as employment contracts, payslips, payroll policy (e.g. salary policy, overtime policy, variable pay policy), accounting and payroll records, applicable national tax, labour and social security law and any other documents corroborating the personnel costs claimed;</td>
</tr>
<tr>
<td>VII. The Beneficiary allocates its employees to the relevant group/category/cost centre for the purpose of the unit cost calculation in line with the usual cost accounting practice;</td>
<td>in particular, the Auditor reviewed the employment contracts of the employees in the sample to verify that:</td>
</tr>
<tr>
<td>VIII. Personnel costs are based on the payroll system and accounting system.</td>
<td></td>
</tr>
</tbody>
</table>

- i. they were employed directly by the Beneficiary in accordance with applicable national legislation;  
- ii. they were working under the sole technical supervision and responsibility of the latter;  
- iii. they were remunerated in accordance with the Beneficiary’s usual practices;  
- iv. they were allocated to the correct group/category/cost centre for the purposes of calculating the unit cost in line with the Beneficiary’s usual cost accounting practices; |
| IX. Any exceptional adjustments of actual personnel costs resulted from relevant budgeted or estimated elements and were based on objective and verifiable information. [Please describe the ‘budgeted or estimated elements’ and their relevance to personnel costs, and explain how they were reasonable and based on objective and verifiable information, present your explanation to the Auditor and annex it to this certificate]. | ✓ the Auditor verified that any ineligible items or any costs claimed under other costs categories or costs covered by other types of grant or by other grants financed from the European Union budget have not been taken |
**Please explain any discrepancies in the body of the Report.**

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<tr>
<td>or debts; interest owed; doubtful debts; currency exchange losses; bank costs charged by the Beneficiary's bank for transfers from the Commission/Agency; excessive or reckless expenditure; deductible VAT or costs incurred during suspension of the implementation of the action. XI. Personnel costs were not declared under another EU or Euratom grant (including grants awarded by a Member State and financed by the EU budget and grants awarded by bodies other than the Commission/Agency for the purpose of implementing the EU budget).</td>
<td>into account when calculating the personnel costs; ✓ the Auditor numerically reconciled the total amount of personnel costs used to calculate the unit cost with the total amount of personnel costs recorded in the statutory accounts and the payroll system. ✓ to the extent that actual personnel costs were adjusted on the basis of budgeted or estimated elements, the Auditor carefully examined those elements and checked the information source to confirm that they correspond to objective and verifiable information; ✓ if additional remuneration has been claimed, the Auditor verified that the Beneficiary was a non-profit legal entity, that the amount was capped at EUR 8,000 per full-time equivalent and that it was reduced proportionately for employees not assigned exclusively to the action(s). ✓ the Auditor recalculated the personnel costs for the employees in the sample.</td>
</tr>
</tbody>
</table>

If additional remuneration as referred to in the grant agreement(s) is paid

XII. The Beneficiary is a non-profit legal entity; XIII. The additional remuneration is part of the beneficiary's usual remuneration practices and paid consistently whenever the relevant work or expertise is required; XIV. The criteria used to calculate the additional remuneration are objective and generally applied regardless of the source of funding; XV. The additional remuneration included in the personnel costs used to calculate the hourly rates for the grant agreement(s) is capped at EUR 8,000 per full-time equivalent (reduced proportionately if the employee is not assigned exclusively to the action).

**Factual finding:**

4. All the components of the remuneration that have been claimed as personnel costs are supported by underlying documentation.
5. The employees in the sample were employed directly by the Beneficiary in accordance with applicable national law and were working under its sole supervision and responsibility.
6. Their employment contracts were in line with the Beneficiary's usual policy;
7. Personnel costs were duly documented and consisted solely of salaries, social security contributions (pension contributions, health insurance, unemployment fund contributions, etc.), taxes and other statutory costs included in the remuneration (holiday pay, thirteenth month's pay, etc.);
8. The totals used to calculate the personnel unit costs are consistent with those registered in the payroll and accounting records;
9. To the extent that actual personnel costs were adjusted on the basis of budgeted or estimated elements, those elements were...
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<tr>
<td><strong>Factual Findings:</strong></td>
<td>relevant for calculating the personnel costs and correspond to objective and verifiable information. The budgeted or estimated elements used are: — (indicate the elements and their values).</td>
</tr>
<tr>
<td>1.</td>
<td>10. Personnel costs contained no ineligible elements;</td>
</tr>
<tr>
<td>11. Specific conditions for eligibility were fulfilled when additional remuneration was paid: a) the Beneficiary is registered in the grant agreements as a non-profit legal entity; b) it was paid according to objective criteria generally applied regardless of the source of funding used and c) remuneration was capped at EUR 8,000 per full-time equivalent (or up to up to the equivalent pro-rata amount if the person did not work on the action full-time during the year or did not work exclusively on the action).</td>
<td></td>
</tr>
</tbody>
</table>

**D. Productive hours**

XVI. The number of productive hours per full-time employee applied is [delete as appropriate]:

- A. 1720 productive hours per year for a person working full-time (corresponding pro-rata for persons not working full time).
- B. the total number of hours worked in the year by a person for the Beneficiary
- C. the standard number of annual hours generally applied by the Beneficiary for its personnel in accordance with its usual cost accounting practices. This number must be at least 90% of the standard annual workable hours.

If method B is applied

XVII. The calculation of the total number of hours worked was done as follows: annual workable hours of the person according to the employment contract, applicable labour agreement or national law plus overtime worked minus absences (such as sick leave and special leave).

XVIII. ‘Annual workable hours’ are hours relevant for calculating the personnel costs and correspond to objective and verifiable information. The budgeted or estimated elements used are: — (indicate the elements and their values).
Please explain any discrepancies in the body of the Report.

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<tr>
<td>during which the personnel must be working, at the employer’s disposal and carrying out his/her activity or duties under the employment contract, applicable collective labour agreement or national working time legislation.</td>
<td><strong>Factual finding:</strong></td>
</tr>
<tr>
<td>XIX. The contract (applicable collective labour agreement or national working time legislation) do specify the working time enabling to calculate the annual workable hours. If method C is applied</td>
<td>General</td>
</tr>
<tr>
<td></td>
<td>12. The Beneficiary applied a number of productive hours consistent with method A, B or C detailed in the left-hand column.</td>
</tr>
<tr>
<td></td>
<td>13. The number of productive hours per year per full-time employee was accurate and was proportionately reduced for employees not working full-time or exclusively for the action.</td>
</tr>
<tr>
<td></td>
<td>14. The number of ‘annual workable hours’, overtime and absences was verifiable based on the documents provided by the Beneficiary and the calculation of the total number of hours worked was accurate.</td>
</tr>
<tr>
<td></td>
<td>15. The contract specified the working time enabling to calculate the annual workable hours. If method C is applied</td>
</tr>
<tr>
<td></td>
<td>16. The calculation of the number of productive hours per year corresponded to the usual costs accounting practice of the Beneficiary.</td>
</tr>
<tr>
<td></td>
<td>17. The calculation of the standard number of workable (working) hours per year was corroborated by the documents presented by the Beneficiary.</td>
</tr>
<tr>
<td></td>
<td>18. The number of productive hours per year used for the calculation of the hourly rate was at least 90% of the number of workable (working) hours per year.</td>
</tr>
<tr>
<td><strong>E. Hourly rates</strong></td>
<td><strong>Procedure</strong></td>
</tr>
<tr>
<td>The hourly rates are correct because:</td>
<td>✓ The Auditor has obtained a list of all personnel rates calculated by the Beneficiary in accordance with the methodology used.</td>
</tr>
<tr>
<td>XXIII. Hourly rates are correctly calculated since they result from dividing annual personnel</td>
<td>✓ The Auditor has obtained a list of all the relevant employees, based on which the</td>
</tr>
</tbody>
</table>

*If certain statement(s) of section “D. Productive hours” cannot be endorsed by the Beneficiary they should be listed here below and reported as exception by the Auditor.*

- …
**Please explain any discrepancies in the body of the Report.**

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<td>costs by the productive hours of a given year and group (e.g. staff category or department or cost centre depending on the methodology applied) and they are in line with the statements made in section C. and D. above.</td>
<td>personnel rate(s) are calculated.</td>
</tr>
</tbody>
</table>

If the statement of section ‘E. Hourly rates’ cannot be endorsed by the Beneficiary they should be listed here below and reported as exception by the Auditor:

- ...

**F. Time recording**

XXIV. Time recording is in place for all persons with no exclusive dedication to one Horizon 2020 action. At least all hours worked in connection with the grant agreement(s) are registered on a daily/weekly/monthly basis [delete as appropriate] using a paper/computer-based system [delete as appropriate];

XXV. For persons exclusively assigned to one Horizon 2020 activity the Beneficiary has either signed a declaration to that effect or has put arrangements in place to record their working time;

XXVI. Records of time worked have been signed by the person concerned (on paper or electronically) and approved by the action manager or line manager at least monthly;

XXVII. Measures are in place to prevent staff from:

i. recording the same hours twice,

ii. recording working hours during absence periods (e.g. holidays, sick leave),

iii. recording more than the number of productive hours per year used to calculate the hourly rates, and

Procedure

- The Auditor reviewed the brief description, all relevant manuals and/or internal guidance describing the methodology used to record time.

The Auditor reviewed the time records of the random sample of 10 full-time equivalents referred to under Section C: Personnel costs, and verified in particular:

- that time records were available for all persons with not exclusive assignment to the action;

- that time records were available for persons working exclusively for a Horizon 2020 action, or, alternatively, that a declaration signed by the Beneficiary was available for them certifying that they were working exclusively for a Horizon 2020 action;

- that time records were signed and approved in due time and that all minimum requirements were fulfilled;

- that the persons worked for the action in the periods claimed;

- that no more hours were claimed than the productive hours used to calculate the hourly
Please explain any discrepancies in the body of the Report.

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<tr>
<td>iv. recording hours worked outside the action period.</td>
<td>personnel rates;</td>
</tr>
<tr>
<td>XXVIII. No working time was recorded outside the action period;</td>
<td>✓ that internal controls were in place to prevent that time is recorded twice, during absences for holidays or sick leave; that more hours are claimed per person per year for Horizon 2020 actions than the number of productive hours per year used to calculate the hourly rates; that working time is recorded outside the action period;</td>
</tr>
<tr>
<td>XXIX. No more hours were claimed than the productive hours used to calculate the hourly personnel rates.</td>
<td>✓ the Auditor cross-checked the information with human-resources records to verify consistency and to ensure that the internal controls have been effective. In addition, the Auditor has verified that no more hours were charged to Horizon 2020 actions per person per year than the number of productive hours per year used to calculate the hourly rates, and verified that no time worked outside the action period was charged to the action.</td>
</tr>
</tbody>
</table>

[Please provide a brief description of the time recording system in place together with the measures applied to ensure its reliability to the Auditor and annex it to the present certificate].

[If certain statement(s) of section “F. Time recording” cannot be endorsed by the Beneficiary they should be listed here below and reported as exception by the Auditor:]

---

Factual finding:

20. The brief description, manuals and/or internal guidance on time recording provided by the Beneficiary were consistent with management reports/records and other documents reviewed and were generally applied by the Beneficiary to produce the financial statements.

21. For the random sample time was recorded or, in the case of employees working exclusively for the action, either a signed declaration or time records were available;

22. For the random sample the time records were signed by the employee and the action manager/line manager, at least monthly.

23. Working time claimed for the action occurred in the periods claimed;

24. No more hours were claimed than the number productive hours used to calculate the hourly personnel rates.

---

4 The description of the time recording system must state among others information on the content of the time records, its coverage (full or action time-recording, for all personnel or only for personnel involved in H2020 actions), its degree of detail (whether there is a reference to the particular tasks accomplished), its form, periodicity of the time registration and authorisation (paper or a computer-based system; on a daily, weekly or monthly basis; signed and countersigned by whom), controls applied to prevent double-charging of time or ensure consistency with HR-records such as absences and travels as well as it information flow up to its use for the preparation of the Financial Statements.
**Please explain any discrepancies in the body of the Report.**

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<tr>
<td>25. There is proof that the Beneficiary has checked that working time has not been claimed twice, that it is consistent with absence records and the number of productive hours per year, and that no working time has been claimed outside the action period.</td>
<td></td>
</tr>
<tr>
<td>26. Working time claimed is consistent with that on record at the human-resources department.</td>
<td></td>
</tr>
</tbody>
</table>

[official name of the Beneficiary] [Linked Third Party]

[official name of the Auditor]

[name and title of authorised representative]

[name and title of authorised representative]

[dd Month yyyy]

[dd Month yyyy]

<Signature of the Beneficiary> [Linked Third Party]>

<Signature of the Auditor>
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