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

- atteso che la Giunta Esecutiva ha ritenuto di assumere alcune decisioni per le ragioni di urgenza indicate nelle delibere stesse, avvalendosi delle facoltà di cui all’art. 14, comma 5, lettera b) dello Statuto dell’INFN;

- esaminate e discusse le delibere che la Giunta Esecutiva sottopone alla ratifica del Consiglio Direttivo;

- riconosciuti i motivi di urgenza come sintetizzati nelle delibere stesse, che hanno determinato la Giunta ad adottare le deliberazioni sottoposte a ratifica;

- con voti n. 32 a favore;

- visto il risultato della votazione

DELIBERA

di ratificare la seguente allegata deliberazione che è parte integrante e sostanziale:

n. 10899 9 novembre 2015 - approvazione “Specific Scientific Collaboration Agreement n. 2 between SESAME and INFN”
La Giunta Esecutiva dell’Istituto Nazionale di Fisica Nucleare, riunita a Roma in data 9 novembre 2015;

- premesso che il Consiglio Direttivo dell’Istituto ha approvato con deliberazione n. 13230 del 12 maggio 2014 lo “Specific Scientific Collaboration Agreement between Elettra-Sincrotrone Trieste, SESAME and INFN” con il quale l’INFN ha trasferito ad Elettra, per la progettazione, costruzione e test di quattro cavità a radiofrequenza per lo storage ring del sincrotrone SESAME, l’importo di Euro 1.000.000,00 a valere sul “Fondo Ordinario degli Enti e delle Istituzioni di Ricerca (FOE) per l’anno 2013” approvato con D.M. 2 luglio 2013 n. 591 cap. 7236 della previsione di spesa;

- preso atto che il “Fondo Ordinario degli Enti e delle Istituzioni di Ricerca (FOE) per l’anno 2014” del MIUR approvato con D.M. 24 novembre 2014 n. 851 cap. 7236, ha assegnato all’INFN un importo di Euro 852.469,00 per la fornitura a SESAME di ulteriori componenti per la costruzione dell’acceleratore e di supporto tecnico di personale qualificato;

- vista la deliberazione del Consiglio Direttivo n. adottata in pari data con la quale è stato approvato l’“Addendum I to the Specific Scientific Collaboration Agreement between Elettra, SESAME and INFN” per il rimborso a SESAME di Euro 250.000,00 per la progettazione e costruzione di quattro cavità a radiofrequenza per lo storage ring;

- considerato che le Parti intendono utilizzare l’importo residuo di Euro 602.489,00 per la progettazione e costruzione di due “silicon drift X-Ray detectors” per la linea di fascio XAFS/XRF di SESAME;

- visto lo schema di “Specific Scientific Collaboration Agreement n. 2 between SESAME and INFN”, allegato alla presente deliberazione e di essa parte integrante;

- considerato che il 21 novembre p.v. il Presidente INFN parteciperà alla riunione del Council di SESAME e che, in tale occasione, tale Accordo verrà formalizzato ufficialmente tra le Parti;

- ravvisata l’urgenza, in forza dei poteri conferitile dall’art. 14, comma 5, lett. b), del vigente Statuto;

DELIBERA

1) Di autorizzare il Presidente alla firma dello “Specific Scientific Collaboration Agreement n. 2 between SESAME and INFN”, allegato alla presente deliberazione e di essa facente parte integrante.
2) La presente deliberazione è sottoposta alla ratificazione del Consiglio Direttivo, ai sensi dell’art. art. 14, comma 5, lett. b), del vigente Statuto, nella prima riunione possibile.

3) Gli oneri finanziari derivanti dall’attuazione del predetto Accordo, pari a Euro 602.489,00, trovano copertura con gli stanziamenti FOE 2014 assegnati dal MIUR, e indicati in premessa, con vincolo di destinazione all’iniziativa specifica.
SPECIFIC SCIENTIFIC COLLABORATION AGREEMENT N. 2

between

The International Center for Synchrotron-light for Experimental Science and Applications in the Middle East, hereinafter referred to as “SESAME”, located at Next to Princess Rahma University College, Al-Salt Greater Municipality, P.O. Box 7, Allan 19252, Jordan, represented by Prof. Khaled Toukan, Director, whose elected domicile is SESAME, Next to Princess Rahma University College, Al-Salt Greater Municipality, P.O. Box 7, Allan 19252, Jordan

and

Istituto Nazionale di Fisica Nucleare, hereinafter referred to as “INFN”, located at Frascati (Italy), via Enrico Fermi 40, Tax Code 84001850589, represented by Prof. Prof. Fernando Ferroni, President,

hereinafter collectively referred to as the “Parties” and individually as “Party”,

whereas

• SESAME is a scientific and technological international centre of excellence set up under the auspices of UNESCO pursuing the construction of a third generation storage ring with the help of UNESCO, IAEA and the international community. The SESAME advanced synchrotron light source will be operated by the Members of SESAME and will be open to all qualified scientists worldwide.

• INFN is an Italian public research body under the supervision of the Ministry of Education Universities and Research (MIUR) dedicated to the study of fundamental constituents of matter and the laws that govern them and the conducting of theoretical and experimental research in the fields of subnuclear, nuclear and astroparticle physics.

• SESAME and INFN on November 26, 2013 have signed a "Framework Agreement of Scientific Cooperation", which foresees, among others, provision of new equipment.

• The Italian Ministry of Education, University and Research (hereinafter “MIUR”) has attributed to INFN through the “Decreto ministeriale per il riparto del Fondo ordinario per gli enti e le istituzioni di ricerca per l’anno 2014” (Ministerial Decree for budget allocation to research entities and institutions for the year 2014), the amount of € 852,489,00 (Euro eight-hundred-fifty-two-thousand-four-hundred-eighty-nine/00) for the SESAME project for the purpose of supporting the construction and the commissioning of the SESAME synchrotron, in the Kingdom of Jordan, in particular by providing components, mostly by in kind contributions and by technical support of qualified personnel.

• Based on the long standing commitment of INFN in supporting and collaborating at international level with international organisations active in the field of basic and applied research and studies in physics and material science, such as the International Atomic Energy Agency, the Abdus Salam International Center for Theoretical Physics, INFN and SESAME have entered into a Technical-Scientific Collaboration Agreement (hereinafter...
2.2 The terms of this Agreement shall be effective as of the date on which it is signed by the last of the Parties thereto. The Agreement is valid until the completion of the collaboration described in Annex 1.

**ARTICLE 3 - Conditions of the collaboration**

3.1 **Contributions**

The contribution equal to **€ 602.489,00 (Euro Six-hundred-two-thousand-four-hundred-eighty-nine)** provided by MIUR to INFN for the SESAME project will be the base for financial costs of all needs for the realization referred in Annex 1 including material and development.

INFN will be in charge of the development, design, materials procurement, fabrication and test of the X-Ray detectors, as listed in Annex 1.

SESAME will be in charge of the development, design, materials procurement, fabrication and test of the X-Ray detectors as listed in Annex 2.

SESAME will bear all the costs for the packing, shipment, installation and commissioning of the detector and all related equipment at its premises and of all the materials to be sent from SESAME to Elettra for the realisation of the collaboration.

Travel and lodging expenses of the personnel and collaborators of one of the Parties visiting the facilities of the other Party under the present collaboration will be covered by the sending Party.

3.2 **Ownership**

The X-Ray Detectors realised under the present Agreement will ultimately be owned by SESAME.

Individual components produced upon INFN specification in order that the final performance of the 2 X-Ray detectors be compliant with the contents of the technical annex to fulfil the requirement of the SESAME XAFS/XRF beamline will be supplied by companies with proven specific experience.

3.3 **Training**

In the framework of this collaboration SESAME personnel will be trained to measure, test and operate the equipment at the INFN premise or at other third Parties’ premises collaborating with INFN or SESAME. The estimate training time span will range from one month (minimum) to four months (maximum).

3.4 **Disclaimer**

Considering that all work results provided by the Parties under this Agreement are of experimental and development nature, the Parties offer no warranty, either expressed or implied, for the work results, including but not limited to the warranties of merchantability or the fitness of the product for any specific purpose.
the “Collaboration Agreement”) decision of the INFN Board of Directors n. 13230 of 12 May 2014, of approval for the Specific Scientific Collaboration Agreement between Elettra, SESAME e INFN.

• Considering that in the same agreement (art 4.2) it is foreseen that an addendum would be signed in the event of further MIUR contribution to cover the amount of € 250000 (Euro Two hundred and fifty thousand), which leaves the amount of € 602489 (Euro Six-hundred-two-thousand-four-hundred-eighty-nine) available for other joint scientific-technical initiatives.

• INFN has been developing for years within a wide collaboration including Elettra Trieste FBK Trento and Milano Politecnico front edge detection systems for high resolution X-rays imaging, and is currently developing detection systems to be applied at advanced light sources;

• SESAME has identified as one of its highest priorities the installation of an X-Ray Absorption and Fluorescence (XAFS/XRF) beam-line based on donated optical and mechanical components

• In line with its institutional mission, with the aim of promoting basic and applied research and programs at the international level in the field of detectors development, INFN intends to collaborate in the implementation of the strategic objectives pursued by MIUR in the construction and commissioning of SESAME;

The Parties hereby agree as follows:

ARTICLE 1 - Subject of the Agreement
1.1 INFN and SESAME in mutual understanding shall undertake a scientific and technological collaboration aimed at the development, design and construction of 2 novel Silicon Drift X-Ray detectors for the XAFS/XRF beam-line at SESAME.

1.2 The activities to be undertaken under this Specific Scientific Collaboration Agreement (hereinafter “Agreement”), the tasks, responsibilities and the terms of the collaboration between the Parties are outlined in the body text of this Agreement, in the document “INFN-SESAME Collaboration Description of the Technical Items to be provided by INFN” (hereinafter referred to as “Annex 1”) and in the document “INFN-SESAME Collaboration Description of the Technical Items to be provided by SESAME” (hereinafter referred to as “Annex 2”).

1.3 INFN and SESAME agree to perform the work under this Agreement on a best effort and best practice basis.

ARTICLE 2 - Duration
2.1 The estimated period of performance for completion of the collaboration described in the Annex 1 is 24 (twenty-four) months from the signing of the present Agreement. INFN and SESAME will inform each other without any delay of any incidents bearing the risk that the planned schedule cannot be achieved. In case the planned time schedule cannot be met, the INFN and SESAME shall decide jointly on a new time planning.
ARTICLE 4 - Location

4.1 The collaboration under this Agreement shall be carried out both at the INFN premises and at the SESAME premises and at other third Parties’ premises when deemed necessary.

ARTICLE 5 - Intellectual Property Rights

5.1 To the extent they are able to do so, and taking into account any confidentiality clauses or other restrictions, each Party agrees to communicate free of charge to the other Party any technical or scientific knowledge, whether patented or not, useful or necessary for the execution of the collaboration.

5.2 Intellectual property rights, hereinafter referred to as “IPRs”, owned or acquired by one of the Parties prior to, or independently from the execution of this Agreement will remain the property of such Party.

5.3 IPRs concerning the results of the collaboration will be agreed upon on a case-by-case basis by the Parties. However, each Party will be free to use them for its own research purposes.

5.4 Inventions, improvements and discoveries conceived or made solely by one of the Parties shall belong to the Party that has conceived or made them.

5.5 Parties agree that this Agreement is not intended to alter the ownership rights in any intellectual property or assets of the Parties.

ARTICLE 6 - Publications

6.1 Any publication arising from results obtained from this collaboration shall be disseminated under written consent of both Parties as is customary and appropriate. Publications shall be submitted to the other Party at least thirty (30) days prior to submission for publication, for review and comment. The other Party will answer within thirty days. Should the other Party not reply within that period, this shall be considered as tacit consent and acceptance for publication as proposed.

ARTICLE 7 – Personnel and collaborators

7.1 Personnel and collaborators of one of the Parties visiting other Parties’ facility in order to participate in or observe the research and development to be performed under this Agreement shall not be considered employees of the receiving Party for any purpose. As provided by art. 3.1, the sending Party shall bear any and all costs and expenses, including health insurance and general liability insurance, with regard to its personnel and collaborators visiting the receiving Party’s facilities.

7.2 Personnel and collaborators of one of the Parties visiting the facilities of the other Parties according to point 7.1 of this Article 7 must comply with the security regulations in force at the facility of the hosting Party, be professionally competent, informed about the risk of the job, of sound health, well-equipped with personal safety equipment, and covered by insurance for personal accident, injury of other persons and damage of property. The hosting Party shall have the right to exercise routine administrative and technical supervisory control of the occupational activities of such personnel and
collaborators during their visits and shall have the right to approve their visit and to later request their removal by the sending Party.

7.3 In relation to the performance of the collaboration under this Agreement and to the respective interests of the Parties, each of the Parties may second its personnel to the other Party. Each secondment shall be regulated by a separate agreement.

ARTICLE 8 – Liability, Insurance

8.1 Staff injury
Each Party shall be liable for its own staff and collaborators involved in the execution of the present Agreement and shall fulfil all the necessary legal obligations in the following areas:
- the legislation applicable to the employer covering Social Security and similar employment obligations,
- accidents in the work place and professional illnesses.
Each employer continues to be liable for any injuries or accident suffered by their own staff due to or during the execution of the present Agreement.

8.2 Damage to goods
Each Party shall be liable without any claim against the other Party, except in cases of gross negligence or intentional damage, for the damage of any nature suffered by its own property, wherever located, due to or during the execution of the present Agreement.

ARTICLE 9 - Non Disclosure

9.1 Each Party commits itself and its employees and its collaborators to treat confidentially the information received from the other Party under this Agreement. The confidential information shall not be disclosed, revealed, or given to anyone except employees and collaborators of either Party, in connection with their professional tasks under this Agreement.

9.2 Any disclosure of information to a third party shall be made only after receipt of written authorization by the disclosing Party, and after the third party has given its written agreement to maintain confidential such a disclosure, and not to use it outside the scope of this Agreement.

9.3 The receiving Party agrees that it will not use the confidential information for commercial purposes or attempt to commercialize it, its derivatives, or products, unless upon a written agreement with the disclosing Party.

9.4 The obligations under point 9.1 to 9.3 of the present Article 9 shall not extend to any part of the confidential information:
- a) that becomes part of the public domain or publicly known by publication or otherwise, not due to any unauthorised act by the other Party, or it subsidiaries or
- b) is already known by the Party at the time of its receipt from the other Party, or
- c) is or becomes publicly available without breach of this Agreement, or
- d) is made available to a third party by the Party without restriction on disclosure, or
- e) is rightfully received by the Party from a third party without restriction and without breach of this Agreement, or
- f) is disclosed with the written consent of the other Party, or
g) is required to be disclosed by the order of a governmental agency or legislative body or a court of competent jurisdiction.

9.5 Each Party acknowledges that any documents are delivered on an “as-is” basis for their consideration and evaluation. Each Party does not provide express or implied warranties concerning the know-how, including but not limited to, non-infringement rights of third parties, merchantability or fitness for a particular purpose.

9.6 Each Party shall take all necessary measures to prevent any infringement of the terms of this Agreement. Each Party shall be liable for any infringement and shall hold the other Party free and harmless against any and all claims or lawsuits or otherwise cost or damage, which may result thereof.

ARTICLE 10 - Project managers and Contact persons

10.1 The Project Managers of the present Agreement are Dr. Andrea Vacchi for INFN and Dr. Giorgio Paolucci for SESAME respectively. The Parties agree that a Project Committee with a maximum of three members (including the Project Managers) per Party will be formed. Each Party shall communicate the members of such committee to the other Parties by letter as well as any modification to its composition.

10.2 All correspondence relative to the Agreement shall be addressed to:

For INFN

Scientific and Technical matters: Prof. Andrea Vacchi INFN- Sezione di Trieste/Univ. of Udine

Administrative matters: Dr. Simona Fiori INFN-Amministrazione Centrale

Trieste Via E. Fermi, 40

Ph: + 39 040 3756233 I-00044 Frascati, Italy

E-mail: andrea.vacchi@trieste.infn.it Ph. +39-06-94032462

E-mail: simona.fiori@lnf.infn.it

For SESAME

Scientific and technical matters: Dr. Giorgio Paolucci SESAME

Administrative matters: Dr. Mohamed Yasser KHALIL Next to Princess Rahma University College

Al-Salt Greater Municipality P.O. Box 7, Allan 19252, Jordan

Tel: (+962-5) 351.13.48 Ext. 204 Tel: (+962-5) 351.13.48 Ext. 225

Fax: (+962-5) 351.14.23 Fax: (+962-5) 351.14.23

Email: giorgio.paolucci@sesame.org.jo E-mail: yasser.khalil@sesame.org.jo

Successors may be designated by exchange of letters between the Parties.

ARTICLE 11 - Final provisions
11.1 This Agreement consists of this body text, the Annex 1 “*INFN-SESAME Collaboration Description of the Technical Items to be provided by INFN*”, the Annex 2 “*INFN-SESAME Collaboration Description of the Technical Items to be provided by SESAME*”

11.2 All documents relating to this Agreement shall be written in English.

**ARTICLE 12 - Applicable law and Jurisdiction**

12.1 The present Agreement is subject to Italian law.

12.2 In the event of conflict, the Parties shall make every effort to reach an amicable settlement. Should the Parties fail to reach an amicable settlement within reasonable time, all disputes due to, arising from or in connection with the present Agreement, shall be referred to the sole competence of the ordinary Courts of Rome.

Allan, 21st November, 2015

For Istituto Nazionale di Fisica Nucleare

________________________

Prof. Fernando Ferroni  
President

For the International Center for Synchrotron-light for Experimental Science and Applications in the Middle East

________________________

Prof. Khaled Toukan,  
Director
ANNEX 1

SESAME – INFN Collaboration
Description of the Technical Items
to be provided by INFN

Authors: S. Ciano\textsuperscript{a}, S. Fabiani\textsuperscript{a}, A. Rachevski\textsuperscript{a}, I. Rashevskai\textsuperscript{b}, A. Vacchi\textsuperscript{a}, G. Zampa\textsuperscript{a}, N. Zampa\textsuperscript{a}

\textsuperscript{a} Istituto Nazionale di Fisica Nazionale (INFN) – Sezione di Trieste
\textsuperscript{b} INFN - Trento Institute for Fundamental Physics and Applications

Rev: October, 2015
1. Scope
Scope of this document is to describe the development, construction and test of the X-ray detector for the Sesame X-Ray Absorption and Fluorescence (XAFS/XRF) beamline in charge of INFN in the framework of the collaboration between SESAME and INFN. The work outlined here will be carried out within the frames of the collaboration that is actively developing X-ray detectors, based on silicon drift sensors, within an R&D project of INFN National Scientific Committee 5.

2. General Condition
All the items for the SESAME XAFS/XRF beamline shall match the high quality standard and the best performances required for the photon factories detection systems.

2.1. Documentation
Together with the equipment to be built, some appropriate documentation will be provided:
- the complete set of the final mechanical drawings
- the X-ray detector technical description and operating user guide
- detailed unloading/unpacking instructions
This documentation will be available in digital form, either CD or DVD.

3. Items list
The collaboration aims to develop, manufacture and commissioning the following items:

<table>
<thead>
<tr>
<th>Item/process</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Detection heads</td>
<td>8 + 1 spare</td>
</tr>
<tr>
<td>2. Back-end electronics board</td>
<td>8 + 1 spare</td>
</tr>
<tr>
<td>3. Back-end mechanical box with</td>
<td>1</td>
</tr>
<tr>
<td>electrical interfaces</td>
<td></td>
</tr>
<tr>
<td>4. Power supply system</td>
<td>1</td>
</tr>
<tr>
<td>5. Acquisition software based on</td>
<td>✓</td>
</tr>
<tr>
<td>the LabVIEW platform</td>
<td></td>
</tr>
<tr>
<td>6. Detector calibration and test</td>
<td>✓</td>
</tr>
</tbody>
</table>

1. Detection heads
The X-ray detector is composed of 8 (eight) independent detection heads each containing one Silicon Drift Detector Array (SDDA) and the frontend electronics. The detection heads are encapsulated in an aluminum box including an X-ray entrance window made of aluminated Mylar foils (used to provide a dark environment to the sensor) and gas inlet and outlet to allow flushing.

The SDDA comprises 8 (eight) sensor cells of 9 (nine) mm² sensitive area arranged in a linear array and sharing a single shallow p⁺ implant that constitute the sensor entrance window. This implant is fabricated to provide an efficiency of 30% at 4 keV to satisfy the requirement of the XAFS/XRF beamline.
The cells of the SDDA are read out by low-noise preamplifiers/pre-shapers providing an output pulse with peaking time $\leq 1$ $\mu$s, which will then be sampled and digitally filtered by the back-end electronics to sustain an event rate of 50 kcps/cell with an energy resolution $\leq 150$ eV at 5.9 keV when the sensor temperature is 0 °C, as per requirement of the XAFS/XRF beamline. To guarantee the energy resolution specification, the SDDA will be moderately cooled through a dedicated thermal interface on the detection head. The required external chiller equipment will be provided by SESAME.

![Figure 1: photo of the 8 channel SDDA anode (top) and entrance window (bottom) sides](image)

2. **Back-end electronics board**
   Each detection head is connected to a backend electronics (BE) board that provides digitization of the output signals of the sensor, digital processing, spectra acquisition, frontend configuration and testing, and data/slow-control communication with a host computer. The board comprises a 12-bit, 8-channel ADC and a FPGA (with configuration device), RAM memory, and an Ethernet interface.
The BE board will provide a range of pulse processing characteristic time in order to maximize the spectroscopic performance of the detection head as function of the input count rate. The system will have various operating modes to allow: calibration and diagnostics of the cells, noise filtering optimization, raw sample data acquisition, histogram acquisition with customizable ROIs, fixed time acquisitions started by a synchronization signal. These operating modes and their configuration will be set up by means of dedicated software running on a LabVIEW environment. Moreover a complete set of commands will be provided that will allow complete detector control and data acquisition by means of standard Socket TCP IP communication.

3. **Back-end mechanical box with electric interfaces**
   The detection heads and the corresponding back-end boards will be assembled in an aluminium mechanical box sealing the whole instrument. This box will provide connectors for all the electric interfaces required to power the system and to communicate with it, and mechanical interfaces (threaded holes) to allow mounting the instrument in suitable stands on the beamline.

4. **Power supply system**
   The X-ray detector requires an adequate power supply system to bias the sensors and the associated electronics. A low-noise power system will be delivered that will allow to adjust the SDDA bias.

5. **Acquisition software based on the LabVIEW platform**
   The X-ray detector is a complex instrumentation that requires calibration, configuration, and possibly diagnostic tests. All the functionalities of the system will be accessible by means of dedicated software based on the National Instruments LabVIEW platform,
which will be delivered within the CD/DVD containing the technical documentation of
the instrument, and it will consist of one or more “.vi” files. Moreover a complete set of
commands will be provided that will allow complete detector control and data
acquisition by means of standard Socket TCP IP communication.

6. **Detector calibration and test**
The following complete tests will be performed on the X-ray detector before delivery:

Measurements in air with electronic pulser and suitable X-ray sources:
- initial calibration of the energy-to-ADC gain for each cell
- determination of the energy resolution and dead time at several count rates up
to 50 kcps/cell
- measurement of the detection efficiency from 4 to 20 keV (2 keV steps) by
  comparison with a calibrated X-ray detector

The tests will be carried out at INFN premises and/or at other suitable X-ray facilities
such as Elettra Sincrotrone Trieste S.C.p.A.. The acceptance test certification
document will be delivered together with the instrumentation.
ANNEX 2

SESAME – Elettra Collaboration
Description of the Technical Items
to be provided by SESAME

Author: Cristina Pasotti
Rev: May, 2014
1. Scope
Scope of this document is to describe the development, construction and test of the RF cavities for the Sesame ring in charge of SESAME in the framework of the collaboration between SESAME and Elettra Sincrotrone Trieste

2. General Condition
All the items for the SESAME storage ring shall match the high quality standard and the best performances required for the photon factories.

2.1. Documentation
Sesame will edit all the appropriate information on the SESAME machine to develop the RF cavities and will give all the support required to complete the collaboration in due time.

3. Items list
The collaboration aims to arrange all the staff so that the RF cavities, listed in Annex I, are ready to be installed and commissioned in the Sesame storage ring.

<table>
<thead>
<tr>
<th>Item/process</th>
<th>Cavity #1</th>
<th>Cavity #2</th>
<th>Cavity #3</th>
<th>Cavity #4</th>
</tr>
</thead>
<tbody>
<tr>
<td>15. Tuning cage shipment</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>16. RF bellows</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>17. Vacuum equipment</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>18. Tapers and vacuum chambers</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>19. LL RF design</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>20. RF Power plant</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>21. Cooling water and electrical grid</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>22. Radioprotection shielding and safety rules</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>23. Commissioning</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

15. Tuning cage shipment
One (1) tuning cage required for the last resonant cell.

An old tuning cage will be refitted to host the new resonant cell. This cage is required at the resonant cell manufacturer premise in Italy.

16. RF Bellows
Eight (8) RF shielded bellows will be developed and built
The RF cavities needs two bellows on each beam port to allow the cavity tuning. The bellows shall be designed to operate in UHV environment. The bellows are required at SESAME laboratory.

*The bellows features are:*
- Nominal length: 150 mm
- Extension range: +5 mm
- Compression range: -15 mm
- Transverse offset: ± 0.5 mm
- Diameter: 100 mm
- Flanges: CF 160, swivel

17. Vacuum equipment

Each cavity shall be equipped with vacuum ion pump and a vacuum gauge to reach the ultimate vacuum pressure and to monitor the vacuum level. The vacuum level shall be used also to interlock the RF power in case of pressure bump.

A pre-vacuum equipment, usually diaphragm pump turbo molecular pump, shall be designed to start the gas evacuation process for each cavity. This equipment is to be used during the bake-out procedure.

All this equipment shall be ready at the Sesame laboratory.

18. RF tapers and chambers

Tapers, vacuum chambers and vacuum valve to connect the cavities to the storage ring

According to the final lay-out of the storage ring and the cavity locations, junction vacuum chambers, tapers and vacuum valve shall be ready and tested to install the cavities.

19. LL RF design

Four (4) LL RF electronics

The Low Level Electronic to monitor and control the amplitude and phase of the RF signal of each cavity shall be designed. The RF distribution of the main RF signal (machine clock) to the four RF plants shall be developed.

All this equipment shall be ready at the Sesame laboratory.

20. RF Power Plant

Four (4) RF Power Plants developed and installed

Each cavity will be fed by an RF Transmitter. The RF power capability shall be larger than 100 kW in continuous wave at 500 MHz, band-with larger than 2 MHz with low harmonic contents. Each transmitter will be commissioned on well matched power load (50 Ω).

All this equipment shall be ready at the Sesame laboratory.

21. Cooling Water and electrical grid

Four (4) cooling water and electrical grid connection
Connection to the cooling water and electrical grid for the cavities will be arranged at SESAME.

22. Radioprotection shielding and safety rules

The RF power conditioning of the cavities process causes non-ionizing radiation. A dedicated radiation shielded hutch shall be arranged to enclose one or all at the cavities to allow a safety operation with RF power. A written safety procedure shall be written and a robust interlock system will be developed and installed at SESAME.

23. Commissioning

RF power conditioning on one resonant cell and cooling rack commissioning

The RF power conditioning process performed at Elettra shall be repeated at least on one cavity to test its performances and to assess the RF power conditioning procedure. The cooling rack shall be commissioned too with RF power.