I Seminario Nazionale Rivelatori Innovativi

Monday 30 November 2009 - Friday 04 December 2009

INFN - Laboratori Nazionali di Frascati

Programme

Table of contents

Monday 30 November 2009

Micro-Pattern Gas Detectors - basic principles - Nuovo Centro Servizi (30 November 09:00-09:50)

Energy loss and ionization processes in matter by charged particles and photons; transport and collection of charges in gases; avalanche charge multiplication.

- Conveners: Prof. Sauli, Fabio

Nanotube Technology - Nuovo Centro Servizi (30 November 10:00-10:50)

- Conveners: Santucci, Sandro

Silicon Photomultipliers (SiPM) - Nuovo Centro Servizi (30 November 11:30-12:20)

Detection of photon is a base of many particle/radiation detectors. The development of novel photodetector opens up a new realm of application, and possibly leads to new discoveries. In the past few years, rapid progress was seen in the development of multi-pixel avalanche photodiodes (APDs) operated in the Geiger mode (commonly known as "silicon PM" devices, and have many different names depending on manufacturer). They consists of many (100 to >1000) small APD in a typical area of order 1 mm2. Each APD micropixel independently works as a photodetector operating in the Geiger mode, realizing large gain while keeping photon counting capability. The Geiger-mode APDs have many advantages as photon detector, such as high gain with low voltage and low power consumption, large photon detection efficiency, and immunity to magnetic fields and are expected to replace photomultiplier tubes in some of applications. In this lecture, I will start from explaining the basic operation principle of the multi-pixel Geiger mode APD. Then, I will introduce performance of currently available device, such as gain, dark noise rate, photodetection efficiency, and interpixel cross-talk, etc., with some emphasis on the relevance to the real application. The method to evaluate those key parameters will be also explained. Also discussed will be possibility of improvements of device performance, and applications to the high-energy physics, medicine, astro-particle physics and nuclear science instruments.

- Conveners: Yokoyama, Masashi

Photodetectors for Medical Imaging - Nuovo Centro Servizi (30 November 12:30-13:20)

- Conveners: Pani, Roberto

GEM - Bldg. 29 (30 November 14:30-17:30)

- Conveners: Bencivenni, G.

Medical Imaging - Bldg. 8 (30 November 14:30-17:30)

- Conveners: Pani, Roberto

Nanotube Technology Detectors - Nuovo Ed. Gran Sasso (30 November 14:30-17:30)

- Conveners: Ambrosio, Michelangelo

SiPM - Bldg. 29 (30 November 14:30-17:30)

- Conveners: Meddi, Franco; Calcaterra, Alessandro

THGEM for Single Photon Detection - Bldg. 28 (30 November 14:30-17:30)

- Conveners: Dalla Torre, Silvia; Tessarotto, Fulvio

Tuesday 01 December 2009

Micro-Pattern Gas Detectors - gaseous detectors - Nuovo Centro Servizi (01 December 09:00-09:50)

Classic proportional, multiwire and drift chamber detectors; microstrip gas chambers; micropattern gas detectors: gain characteristics, rate capability, discharge problems.

- Conveners: Prof. Sauli, Fabio

Nanotube Technology - Nuovo Centro Servizi (01 December 10:00-10:50)

- Conveners: Santucci, Sandro

Silicon Photomultipliers (SiPM) - Nuovo Centro Servizi (01 December 11:30-12:20)

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Wednesday 02 December 2009

Micro-Pattern Gas Detectors - MPGD applications - Nuovo Centro Servizi (02 December 09:00-09:50)

Use of micro-pattern detectors in physics: charged particle, neutron and photon detection; applications in medicine, biology, astrophysics.

- Conveners: Prof. Sauli, Fabio

Nanotube Technology - Nuovo Centro Servizi (02 December 10:00-10:50)

- Conveners: Santucci, Sandro

Silicon Photomultipliers (SiPM) - Nuovo Centro Servizi (02 December 11:30-12:20)

Detection of photon is a base of many particle/radiation detectors. The development of novel photodetector opens up a new realm of application, and possibly leads to new discoveries. In the past few years, rapid progress was seen in the development of multi-pixel avalanche photodiodes (APDs) operated in the Geiger mode (commonly known as "silicon PM" devices, and have many different names depending on manufacturer). They consists of many (100 to >1000) small APD in a typical area of order 1 mm2. Each APD micropixel independently works as a photodetector operating in the Geiger mode, realizing large gain while keeping photon counting capability. The Geiger-mode APDs have many advantages as photon detector, such as high gain with low voltage and low power consumption, large photon detection efficiency, and immunity to magnetic fields and are expected to replace photomultiplier tubes in some of applications. In this lecture, I will start from explaining the basic operation principle of the multi-pixel Geiger mode APD. Then, I will introduce performance of currently available device, such as gain, dark noise rate, photodetection efficiency, and interpixel cross-talk, etc., with some emphasis on the relevance to the real application. The method to evaluate those key parameters will be also explained. Also discussed will be possibility of improvements of device performance, and applications to the high-energy physics, medicine, astro-particle physics and nuclear science instruments.

- Conveners: Yokoyama, Masashi

Super-B Particle Identification System (PID) - basic design concepts - Nuovo Centro Servizi (02 December 12:30-13:20)

We will discuss principles of Cherenkov ring imaging using DIRC- like and Aerogel RICH detectors and compare them to TOF and dE/dx PID techniques. We will discuss various imaging concepts, including a pin hole and a focusing method. We discuss details of a photon propagation in the refractive media, such as quartz, including a calculation of the time-of-propagation (TOP) and its spread due to chromaticity. We then discuss expected No, and expected Cherenkov ring resolution and a final PID capability.

- Conveners: Prof. Va'vra, Jerry

GEM - Bldg. 29 (02 December 14:30-17:30)

- Conveners: Bencivenni, Giovanni

Medical Imaging - Bldg. 8 (02 December 14:30-17:30)

- Conveners: Pani, Roberto

Nanotube Technology Detectors - Nuovo Ed. Gran Sasso (02 December 14:30-17:30)

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- Conveners: Dalla Torre, Silvia; Tessarotto, Fulvio

Thursday 03 December 2009

SuperB Particle Identification system (PID) - Photodetectors - Nuovo Centro Servizi (03 December 09:00-09:50)

We discuss flat panel multi-anode PMTs, micro-channel PMTs, Geiger APDs (SiPMTs), APD and other types of photodetectors. We will discuss their performance but also problems including aging, and how to prevent it, their rate capability, and the effects of magnetic field. We discuss various readout schemes, including pixel or strip line readout methods, the pixel charge sharing concept and its utilization to improve the resolution. We discuss the detection efficiency, and new trends in the photocathode developments, and detector construction designs.

- Conveners: Prof. Va'vra, Jerry

Liquid Argon Detectors - Nuovo Centro Servizi (03 December 10:00-10:50)

- Conveners: Pietropaolo, F.

Monolithic pixels for innovative silicon trackers - Nuovo Centro Servizi (03 December 11:30-12:20)

Monolithic detectors integrating readout and detecting elements in the same piece of silicon offer significant advantages compared to hybrid solutions: detector assembly is greatly facilitated and production cost reduced, charge collection electrodes can be realized with very small capacitance values (down to a few fF!) yielding extremely favorable power-signal-to-noise performance. Such monolithic detectors have been implemented integrating CMOS on very high resistivity substrates (1E12 cm-3), and more recently using standard CMOS imaging technologies. Both approaches have been successful and have demonstrated this good power-S/N performance. However, the former are difficult to produce in volume, and the latter have sequential readout schemes often not compatible with time-stamping requirements of high energy physics experiments, and are often very sensitive to radiation damage. The presentation will concentrate on the design of the device and the readout circuitry of monolithic detectors, and on the perspectives of realizing such detectors in modern commercial CMOS technologies for use in future high energy physics tracking detectors. Charge collection, electric field and breakdown, the interaction between power and signal-to-noise in the analog part of the readout and issues with the digital circuitry and radiation tolerance will be covered.

- Conveners: Snoeys, Walter

Channeling radiation - Nuovo Centro Servizi (03 December 12:30-13:20)

- Conveners: Dabagov, Sultan

GEM - Bldg. 29 (03 December 14:30-17:30)

- Conveners: Bencivenni, Giovanni

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- Conveners: Pani, Roberto

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- Conveners: Dalla Torre, Silvia; Tessarotto, Fulvio

Friday 04 December 2009

Super-B Particle Identification System (PID) - Nuovo Centro Servizi (04 December 09:00-09:50)

We will compare proposed Focusing DIRC (FDIRC) detector concept for the SuperB with a similar TOP detector concept intended to be used at the Belle 2. This will include the present optics design features, mechanical designs, and electronics concepts. The comparison will also be done from point of view of expected pi/K separation as a function momentum, rate capability, types of photocathodes to be used, expected aging performance, etc. We then discuss a possible use of the Aerogel RICH or TOF methods in the forward direction, and judge if their performance is a good match to the expected momentum range and good enough to justify the effort given the solid angle of these regions, and compare them to a dE/dx performance of drift chamber.

- Conveners: Prof. Va'vra, Jerry

Liquid Argon Detectors - Nuovo Centro Servizi (04 December 10:20-10:50)

- Conveners: Pietropaolo, Francesco

Monolithic Pixels for Innovative Silicon Trackers - Nuovo Centro Servizi (04 December 11:30-12:20)

Monolithic detectors integrating readout and detecting elements in the same piece of silicon offer significant advantages compared to hybrid solutions: detector assembly is greatly facilitated and production cost reduced, charge collection electrodes can be realized with very small capacitance values (down to a few fF!) yielding extremely favorable power-signal-to-noise performance. Such monolithic detectors have been implemented integrating CMOS on very high resistivity substrates (1E12 cm-3), and more recently using standard CMOS imaging technologies. Both approaches have been successful and have demonstrated this good power-S/N performance. However, the former are difficult to produce in volume, and the latter have sequential readout schemes often not compatible with time-stamping requirements of high energy physics experiments, and are often very sensitive to radiation damage. The presentation will concentrate on the design of the device and the readout circuitry of monolithic detectors, and on the perspectives of realizing such detectors in modern commercial CMOS technologies for use in future high energy physics tracking detectors. Charge collection, electric field and breakdown, the interaction between power and signal-to-noise in the analog part of the readout and issues with the digital circuitry and radiation tolerance will be covered.

- Conveners: Snoeys, Walter

Particle Identification by means of Channeling Radiation in High Collimated Beams - Nuovo Centro Servizi (04 December 12:30-13:20)

Channeling radiation is emitted whenever a charged particle crosses a crystal along the direction of a major crystal axis or plane (axial and planar channeling respectively), with the incident angle less than the critical angle defined by Lindhard. The charged particle are trapped in the potential wells originated by the crystal lattice, resulting in a strong steering effect and in the emission of coherent radiation. The total emitted energy is proportional to $\gamma 2$, where γ is the Lorentz factor of the incident particle, while the average photon energy is proportional to $\gamma 3/2$. Due to its features, the channeling effect can be applied to discriminate in high energy unseparated beams between light radiating particles and heavy non radiating ones. Since a detectable channeling photon yield can be obtained from a reduced thickness crystal, the advantage of this particle identification technique is that small amounts of materials have to be disposed along the beam lines. On the other

hand, since the Lindhard angle is of the order of 100 μ-rad in the 1 - 10 GeV energy region, highly collimated beams are needed. To study this application of the channeling radiation, we have performed a beam test campaign at the CERN PS-T9 and SPS-H4 facilities using a 500μm thick <110> silicon crystal. A NaI calorimeter has been used to detect the channeling γ-rays produced in the crystal. The electron (positron) – pion identification performance has been studied. The preliminary results will be shown and the perspectives will be discussed.

- Conveners: Mazziotta, Mario Nicola

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- Conveners: Bencivenni, Giovanni

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- Conveners: Pani, Roberto

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- Conveners: Dalla Torre, Silvia; Tessarotto, Fulvio