1 MPGD for Breast cancer prevention: a high resolution and low dose radiation medical imaging

Oral

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Abstract

Detection of small calcifications (1 micrometer = 10^{-6} m), is considered the best preventive tool of breast cancer [1]. However, digital mammography with low radiation skin exposure and generally accessible technology may have a resolution of 10 to 50 micrometer, insufficient for small calcification detection. MPGD and associated technologies, increasingly allow unprecedented sources of new information for medical imaging. In this work we combine and develop new advances to obtain accessible high resolution digital mammography images for early detection of micro-calcifications. We foresee and develop new applications for the versatility and diversity of information that could be obtained with the compact MPGD camera (high quality GEM developed at KEK), with resolutions below 50 micrometer [2], and new super-resolutions digital image compressed sensing methods [3], to transform diverse medium resolution images into one high resolution image.

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2 Origin and simulation of sparks in MPGD

Oral

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Abstract

The development of MPGD for high luminosity experiments requires a better understanding of the origin of the sparks in these detectors. Assuming a spark occurs whenever the electron number reaches the well known Raether limit, Geant4 simulations quantitatively reproduced the spark rate measured in Micromegas with high energy hadron beams. Large release of energies are provided by fragments from nuclear interactions between the beam and the detector's material. In order to further check the validity of our simulation, beam tests have been performed last year at the CERN/PS with low momentum hadrons on Micromegas. Large variations of the spark rate have been observed in positively charged hadron beams below 1 GeV/c, which are well described by the simulation. The role of the transverse diffusion has also been investigated with a Micromegas-GEM, and during another beam test inside a 5 T magnet at JLab. The simulation is now able to quantitatively explain the role of a GEM foil in the spark rate reduction.

3 GEM-based beam profile monitors for the antiproton decelerator

Oral

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Abstract

The new beam profile measurement for the Antiproton Decelerator (AD) at CERN is based on a single GEM with a very thin cathode and a 2D readout structure. This detector is very light, ~0.25 X0, as required by the low energy of the antiprotons, 5.3 MeV. This overcomes the problems previously encountered with multi-wire proportional chambers (MWPCs) for the same purpose, where beam interactions with the detector severely affect the obtained profiles.

A prototype was installed and successfully tested in late 2010, with another 5 detectors now installed in the beam lines of the ASACUSA and AEGIS experiments. We will provide a detailed description of the detector and discuss the results obtained.

The success of these detectors in the AD makes them likely candidates for upgrade of the beam profile monitors in all experimental areas at CERN. The various types of MWPC currently in use are aging and becoming increasingly difficult to maintain.

4 Advances in GEM-based cryogenic avalanche detectors

Oral

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Abstract

Cryogenic avalanche detectors combine dense noble gas media at cryogenic temperatures with Gas Electron Multipliers (GEMs) or thick GEMs (THGEMs). Such detectors are relevant in the field of rare-event experiments, such as those of coherent neutrino-nucleus scattering, dark matter search and solar neutrino detection, and in the medical imaging field. We summarize the recent progress made in cryogenic Ar and Xe avalanche detectors. In particular, we consider the THGEM multiplier performance in two-phase Xe, the optical readout of THGEM multipliers in the Near Infrared (NIR) in Ar and Xe using Geiger-mode APDs (G-APDs), the measurement of the primary and secondary NIR-scintillation yields in gaseous and liquid Ar at cryogenic temperatures. We also discuss the physical processes governing the performance of cryogenic two-phase avalanche detectors, their possible applications and those of the NIR scintillations.

5 Development of Epithermal Neutron Camera based on resonant energy-filtered imaging with GEM

Poster

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Abstract

Boron neutron capture therapy (BNCT) is a promising radiotherapy for malignant brain or skin cancers using 10B(n,α)7Li reaction. To enhance the curative effect on BNCT, epithermal neutron source is suitable because thermal neutrons become dominant around the tumor cells effectively after moderation of epithermal neutrons in the tissue. Spatial distribution of neutrons in epithermal energy region is, therefore, quite important for planning the patient radiation dose in the treatments. We propose an epithermal neutron camera combining a gas electron multiplier (GEM) with resonant filters in the epithermal energy region. We have considered the detailed design of a proto-type camera made of the GEM with a neutron-to-charged particle converter of 10B and Ag resonance filter through model calculation. We have made a preliminary performance check on the proto-type camera response with a pulsed neutron source at Kyoto University Research Reactor Institute - Linear Accelerator (KURRI-Linac). The results were in good agreement between the experiment and the model calculation. It is, therefore, concluded that the present epithermal neutron camera concept could be successfully demonstrated.

6 Withdrawal

7 Design and Construction of a Cylindrical GEM Detector as Inner Tracker Device at KLOE-2

Oral

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Abstract

We report on the design and construction of a triple-GEM detector as a new Inner

Tracker (IT) for the KLOE-2 experiment at the Frascati Phi-factory. The IT is composed of four tracking layers, each providing an independent 2-dimensional space point. Each layer is a fully cylindrical triple-GEM detector.

The front-end electronics is based on the GASTONE ASIC, specifically developed for this detector, a charge amplifier with digital output integrating 64 channels in one single chip.

After three years of R&D the construction of the first layer has started, with the aim of completing the detector by middle of 2012.

We report on the R&D achievements, including the construction process, the results of two beam-tests with prototype detectors, and the present realization status of the final detector and electronics.

8 GEM-based detectors for SR imaging and particle tracking.

Oral

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Abstract

Status of several projects under development in Budker INP with GEM-based detectors for SR imaging and particle tracking will be reviewed. These are namely: the detector for imaging of explosions(DIMEX) at SR beam, the detector for WAXS studies at SR beam (OD4), the triple-GEM detectors for the tagging system of KEDR experiment at VEPP-4M collider and the triple-GEM detectors for the tagging system of Deuteron experiment at VEPP-3 storage ring.

DIMEX is developed for imaging of synchrotron radiation from separate bunches in the storage ring and thus allows to view evolution of very fast processes. GEM serves as a screening mesh (Frisch-grid) with adjustable transparency in this detector. Last results with reduced GEM transparency will be demonstrated that allowed to improve dynamic range of the detector by a factor of 2.

OD-4 is arc-shaped detector with 350 mm focus distance based on GEM cascade. Readout PCB has 2048 30 mm long radial strips at a pitch of 0.2 mm at inner side. The detector is planed for operation in counting mode with single discriminator threshold. The first full-size prototype partly equipped with electronics demonstrated good spatial resolution of ∼0.5 mm (FWHM) as well as high rate capability of ∼150 kHz/channel with 8 keV photons and Ar-25%CO2 gas mixture at 1 atm.After these measurements the detector concept was significantly reconsidered and new electronics is now being developed.

The tagging system of KEDR detector is a two-shoulder magnetic spectrometer that was designed to measure precisely the momenta of electron and positron that lost their energy through two-photon interaction. 8 triple-GEM detectors with small-angle sterero readout are operating in this system. The first experience after operation during the season 2010-2011 will be reported.

The tagging system of Dueteron experiment is a new project that started last year. This will be also a magnetic spectrometer that will measure precisely the momentum of electrons or positrons in the range of 0.1-1 GeV. The detectors should contain as low amount of material as possible in order to reduce multiple scattering.

9 Development of gaseous photomutipliers with Micro Pattern Gas Detectors

Oral

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Abstract

In the last few years, considerable effort has been devoted to the development of gaseous photomultiplier tubes (PMTs) with micro-pattern gas detectors (MPGD) which are sensitive to visible light. The potential advantage of such a gaseous PMT is that it can achieve a very large effective area with moderate position and timing resolutions. Besides it can be easily operated under a very high magnetic field (∼1.5 Tesla).

Since photon and ion feedbacks cause faster degradation for the bi-alkali photocathode, the maximum achievable gain might be limited at a level 100. Several recent developments, however, have successfully achieved a long term high sensitivity for a photon detection by using hole-type MPGDs such as a gas electron multiplier (GEM) and a glass capillary plate (CP).

We constructed a double Micromegas detector with a bi-alkali photocathode. The gain of this device was studied by measuring the signal currents at the anode, first mesh, second mesh and the photocathode while varying the applied voltage of the first and second meshes. The gain reached 2×10^3 without a large deviation from the exponential curve. However, at a gain above 2×10^3 we observed a rapid gain rise due to secondary effects. In order to develop a gaseous PMT having no substantial secondary effects up to 10^5 with a bi-alkali photocathode we tried some combinations of a hole-type MPGD and a Micromegas.

We developed a hole-type MPGD with Pyrex glass by using a micro-blasting method, which allows the problem-free production of bi-alkali photocathode while a kapton GEM reacts with the photocathode materials. Basic performance tests of the Pyrex CP gas detector were carried out with a gas mixture of Ne (90%) + CF4 (10%) at 1 atm. We successfully obtained a gain of up to 1.5×10^4 and an energy resolution of 23% for 5. 9 keV X-rays.

In the development of gaseous PMTs with less ion-feedbacks we made simulation studies by using Garfield and Maxwell 3D, which can simulates the motion of electrons and ions in MPGDs.

We will present a current status of the development of gaseous PMTs and simulation results.

10 A very-low-threshold & ultra-low-background microbulk Micromegas detector for solar axion and dark matter searches.

Oral

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Abstract

Microbulk is a new Micromegas manufacturing technique, based on kapton etching technology, which has resulted to further improvement of the characteristics of the detector, such as uniformity, energy resolution and stability. These improvements in combination with the high radiopurity of the construction materials are the main reasons for achieving very low background level in the energy region ¡ 10 keV. A microbulk Micromegas optimized for the CAST experiment has shown a background at the surface that is compared with the achieved levels in the Canfranc underground laboratory.

The optimization of the gas mixture composition allows to reach high gain of the ordes105, leading thus to the reduction of the threshold towards the level of 100 eV. Such a low threshold in combination with the observed ultra-low-background opens new opportunities on the solar axion and other dark matter or dark energy searches.

11 A New Gamma Camera with a Gas Electron Multiplier

Poster

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Abstract

We have developed a prototype gaseous gamma camera with a Gas Electron Multiplier (GEM) for biomolecular analysis and medical applications. The system consists of three devices: a detector, an Ethernet hub, and a PC. The detector consists of a GEM-chamber and integrated readout electronics. The GEM-chamber consists of three parts: the gamma-ray conversion and amplification layers consisting of GEM foils, and a readout component. To increase gamma-ray-detection efficiency, we constructed a new type of GEM foil. The gamma-ray conversion layers are plated with gold 3 μ m thick on both surfaces. In order to test the performance of the prototype camera, several measurements were performed with a phantom filled with 99mTc (141 keV) as the radioactive source, and two-dimensional (2D) images were obtained using a pinhole collimator. The camera showed good capability to resolve objects of a few mm2. We believe that this system will offer new knowledge in biomolecular analysis and medical applications.

12 Neutron Imaging Detector Based on the μPIC Micro-Pixel Gaseous Chamber

Oral

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Abstract

A new detector employing the micro-pixel gaseous chamber (μPIC) and an FPGA (Field Programmable Gate Array)-based data acquisition system has been developed as a thermal-neutron imaging detector for small-angle neutron scattering and neutron radiography [1-3]. A small amount of He-3 added to the gas mixture is used as the neutron absorber, giving a detection efficiency for thermal neutrons of up to 30% for a gas mixture containing 30% He-3 at a total pressure of 2 atm. An improved FPGA program permits the simultaneous measurement of the track length and energy deposition for the resulting proton-triton tracks, allowing the separation of the proton and triton for improved position resolution. The detector features good time (¡1 μs) and spatial ($\sim$120 μm) resolutions and a high rate capability over a large active area (currently up to 40 cm $\times$ 40 cm with no dead space). We also found that the detector was able to be operated after more than 1 year on the same gas filling with no detectable degradation in imaging performance. By annealing the vessel and μPIC to reduce outgassing and utilizing a gas filtration system to remove the impurities that build up over time, the operation time of the gas could be extended even further, thereby drastically reducing the amount of He-3 required for the long-term operation of the detector. The basic operating characteristics of the prototype detector were demonstrated previously in two test experiments performed at the J-PARC Spallation Neutron Source in Tokai, Japan in 2009 and 2010 [3]. In this presentation, we will present preliminary results from a third test experiment carried out at J-PARC in February 2011, including neutron imaging, resonance absorption, and Bragg-edge transmission measurements. Through recent advancements in the analysis, we were able to achieve a position resolution of 118.4 $\pm$ 0.2 μm (preliminary), representing an improvement of more than a factor of 2 over our previous result. A quantitative analysis of neutron absorption peaks in various metals and a determination of internal strain from Bragg-edge transmission spectra of metallic rods under tensile load will also be presented.

References:

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13 MPGD based detectors and R&D work at BNL towards eRHIC and EIC

Poster

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Abstract

At Brookhaven National Laboratory (BNL) in Upton NY, R&D has begun towards tracking improvements for the existing detectors at the Relativistic Heavy Ion Collider (RHIC), existing detectors at the Relativistic Heavy Ion Collider (RHIC) and new detectors for an electron-ion collider (EIC) which may also be located at BNL (eRHIC).

Minimizing the detector material leads us towards GEM tracker layers or a fast central TPC as well as particle identification using Cerenkov counters with CsI based GEM readouts as used recently in the Hadron Blind Detector (HBD) in PHENIX.

The presentation plans to cover these ongoing R&D programs at BNL.

14 Spark-resistant large-area micromegas for the ATLAS upgrade

Oral

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Abstract

Large-area particle detectors based on the bulk-micromegas technology are an attractive choice for the upgrade of LHC detectors and/or detectors for the ILC or other experiments. In the context of the R&D for the ATLAS Muon System upgrade, we have built detectors of order 1 m^2. In order to overcome the spark problem in micromegas a novel protection scheme using resistive strips above the readout electrode has been developed. This technology has undergone extensive tests with hadron beams at the CERN-SPS, X-rays in the lab, as well as in a neutron beam. In addition a set of prototype chambers have been installed in the ATLAS cavern and are taking data in real LHC conditions. We will discuss the underlying design of the chambers and present results on the performance of these chambers.

15 Study of Resistive Micromegas in a Mixed Neutron and Photon Radiation Field

Poster

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Abstract

The luminosity upgrade of the Large Hadron Collider at CERN (sLHC) foresees a luminosity increase by a factor five compared to the LHC. To cope with the corresponding increase in background rates, the Muon System of the ATLAS experiment at CERN will need major changes in the very forward/backward region. The MAMMA R&D activity is focused on the development of large-area muon detectors based on the bulk-micromegas technology as candidates for such an upgrade. In order to overcome the spark problem a novel protection scheme using resistive strips above the readout electrode has been developed.

The response and sparking properties of resistive micromegas detectors in a mixed (neutron and gamma) high radiation field have been measured. The results of this study will be presented and compared to Monte-Carlo simulations of 5.5 MeV neutrons impinging on micromegas detectors.

16 Status of 2D GEM Detector with Strip Readout

Poster

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Abstract

The developed two-dimensional GEM (Gas Electron Multiplier) is the triple GEM detector, which is constructed from CERN standard GEM foils with an effective area of 200mm×200mm. The gaps between GEM foils, and between the last GEM and the readout board are set to 1mm, the gap between drift plane and the first GEM foil is set to 14mm. All the gaps can be changed easily later for performance optimization. High voltage is applied by CAEN modules and Ar:CO2(90:10) is used as working gas.

The electrons from the GEM detector are collected and read out through strips on the PCB board. Considering of the size of strip and engineering problem, big size or small size will make a bad spatial resolution of a center-of-gravity method yields. X direction strips (0.46mm×200mm) and Y direction strips (0.72mm×200mm) had been designed. Connectors of high density and high speed (QTE/QSE-020-01-L-D) from SAMTEC are used to connect the readout pitch with the front-end VME electronics. The detector was studied with the ^{55}Fe and synchrotron X-ray radiation source, the good position resolution and the sharp two-dimensional diffraction image were achieved. In the X direction, from four to five strips have the signal and the FWHM is about 0.2mm, and in the Y direction, from three to four strips have the signal and the FWHM is 0.174mm.

17 Performance of resistive-strip micromegas detectors with two-dimensional readout

Poster

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Abstract

Micromegas detectors show very good performance for charged particle tracking in high rate environments as for example at the LHC. In principle two coordinates can be extracted from the signals in these detectors. Several Micromegas chambers with spark protection by resistive strips and two-dimensional readout have been tested in the context of the R&D work for the ATLAS Muon System upgrade. The chambers have been studied in a X-ray test facility, in hadron beams, and in the ATLAS cavern. The poster will describe and discuss the layout of the 2D chambers and their performance, with special focus on the charge-up behavior of the chambers under high particle fluxes.

18 A Micromegas-based detector as a candidate for the ATLAS Muon upgrade

Poster

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Abstract

The planned luminosity upgrade of the Large Hadron Collider at CERN will present significant challenges to most of the detectors of the LHC experiments. The performance of the muon chambers of the first measurement station of the ATLAS endcaps is expected to be marginal even at the design luminosity. Analysis of data already obtained dictates, in addition, modifications to the Level 1 muon trigger to include information from the first measurement station in order to reduce the rate of fake triggers already evident at current luminosity. ATLAS is planning to replace these stations in both endcaps with higher performing detectors. One of the detector options considered will use resistive micromegas detectors currently under development and described in a companion contribution to this conference. In this paper the implementation of such a system will be described. Preliminary ideas of a detector layout consistent with the expected properties of large ($\sim$1.5 m^2) detectors will be presented. Progress on the development of a custom front end integrated circuit will also be presented, and a complete conceptual design of the entire electronics readout chain for both trigger and data acquisition will be discussed.

19 Study on thinner-THGEM and some applications

Oral

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Abstract

18 kinds of THGEM (THick Gas Electron Multiplier) with different thickness and hole diameter-pitches have been studied. Especially, thinner-THGEM with the thickness of 200um and small rim of 5-10μm with the hole diameter of 0.2mm and pitch of 0.5mm is emphasized. Some performance have been studied and the working conditions have been tested and selected. In Ne mixture, the gain of over 3×10^3 under relatively low working voltage, energy resolution of 15.9% with 5.9 keV x-rays and good gain stability are obtained. The associated Monte Carlo calculation of energy resolution dependence on drift electric field and induction field has been compared with the experimental results. Some results of recent investigations of the THGEM with CsI reflective photo-cathode has been tested for possible use as Cherenkov UV photon detection and increasing X-ray efficiency.

A THGEM with electrodes by 20μm thick resistive Kapton foils(RETGEM) performs week streamer discharge, satisfied energy resolution of 27%, with high effective gas gain and long-term stability.

A thinner-THGEM detector of 5×5 cm2 sensitive area with 16 channel direct current readout mode has been used for measuring the absolute intensity and two dimensional distribution from the Mo target 17KeV X-ray tube. In addition, a up-down double THGEM detector system with 32 channel readout used for cosmic-ray muon hodoscope was established for PhD students experiment.

A curved one dimensional (16 cm long) thinner-THGEM has been assembled and 64 channel direct current mode readout has been finished to be used for diffraction study on synchrotron radiation beam.

20 An online proton beam monitor for cancer therapy based on ionization chambers with micro pattern read-out

Oral

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Abstract

A unique compact LINAC accelerator for proton therapy is under development in Italy within the TOP-IMPLART project.. The proton beam will reach the kinetic energy of 230 MeV, it will have a widely variable current intensity (average of 10 nA) associated with a high pulse repetition frequency (10 μs long pulses at 200-400 Hz). The TOP-IMPLART system will provide a fully active 3+1D dose delivery, that is longitudinal (energy modulation), transversal active spot scanning, and current intensity modulation. These accelerator features will permit a highly conformational dose distribution, which therefore requires an effective, online, beam monitor system with wide dynamic range, good sensitivity, adequate spatial resolution and rapid response.

In order to fulfill these requisites a new device is under development for the monitoring of the beam intensity profile, its centroid and direction; it is based on transmission, segmented, ionization chambers with typical active area of 100x100 mm^2. Micro pattern x/y pad like design has been used for the readout plane in order to maximize the field uniformity, reduce the chamber thickness and obtain both beam coordinates on a single chamber. Alternate pads (with lozenge shape) form x (or y) strips with 0.875 mm pitch; half of them are therefore connected through vias to strips on the external side of the anode readout foil.

The chamber prototype operates in ionization region to minimize saturation and discharge effects.

Simulations (based on FLUKA) have been carried on to study the perturbation of the chamber on the beam parameters and the effects on the delivered dose (on a water phantom).

The charge collected in each channel is integrated by dedicated auto-ranging readout electronics: an original scheme has been developed in order to have an input dynamic range greater than 10^4 with sensitivity better than 3%. This is achieved by a dynamical adjustment of the integrating capacitance to the signal intensity. The charge collected on each channel is read out by a multiplexed ADC, managed by an external logic which is currently based on standard VME boards. A modular acquisition software controls the data acquisition.

In the conference, the beam monitor system will be discussed in more details and the status of the current development will be presented.

21 Development of two-dimensional imaging neutron detectors with a GEM

Poster

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Abstract

Materials and Life Science Facility (MLF) at J-PARC is one of the world 's highest intensity pulsed neutron sources. In December 2010, the proton beam power at J-PARC became 210 kW and is expected to reach 1 MW in the future. The neutron detector for MLF must also be able to achieve a high count rate.

We have developed a two-dimensional imaging neutron detector with a gas electron multiplier (GEM) for a neutron detector used in MLF. Since a GEM has a high count rate capability, the GEM-based detector is expected to work robustly under a high neutron intensity environment such as MLF. A 10B coated cathode plane in the GEM-based detector is used for neutron detection. Neutrons are caught by detecting charged particles emitted from a 10B(n, α) reaction. The neutron detection efficiency is optimized by coordinating the thickness of the 10B layer.

Neutron events are selected in a Field Programmable Gate Array (FPGA) mounted on the onboard electronics. The event selection algorithm in the FPGA is one of the key elements for high speed data-taking. In order to evaluate the validity of the event selection algorithm, a beam test was performed at the MLF neutron beam line. In addition, new algorithm for the FPGA was developed with feedback from the beam test results. The new algorithm is expected to improve the sampling rate and the position resolution.

This presentation describes the results of the beam test, and also reports the status of the FPGA firmware development for the new event selection algorithm.

22 MICROROC: MICROMEsh GAseous Structure Read-Out Chip

Poster

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Abstract

MICRO MEsh GAseous Structure (MICROMEGAS) and Gas Electron Multipliers (GEM) detectors are two candidates for the active part of a Digital Hadronic CALorimeter (DHCAL) as part of a high energy physics experiment at the International Linear Collider. Physics requirements lead to a highly granular hadronic calorimeter with up to thirty million channels with probably only hit information (digital calorimeter).

To validate the concept of digital hadronic calorimetry, a cubic meter technological prototype, made of 40 planes of one squared meter each, is compulsory. Such a technological prototype involves not less than 400 000 electronic channels, thus requiring the development of ASIC.

Based on the experience of previous ASICs (DIRAC and HARDROC) and on multiple testbeam results, a new ASIC, called MICROROC (MICRO mesh gaseous structure Read-Out Chip), is currently beeing jointly developped at IN2P3 by OMEGA/LAL and LAPP microelectronics goups. It should be submitted to foundry in june 2010, and prototypes are expected to be delivred at the beginning of september.

MICROROC is a 64 channel mixed-signal integrated circuit based on HARDROC manufactured in AMS 350 nm SiGe technology. Analog blocks and the whole digital part are reused from HARDROC, but the very front end* part, ie the preamplifier and shapers, has been especially re-designed for one square meter MICROMEGAS detectors, which require HV sparks robustness for the electronics and also very low noise performance to detect signals down to 2fC with an anode capacitance of. Each channel of the MICROROC chip is made of a fixed gain charge preamplifier, two different adjustable shapers, three comparators and a random access memory used as a digital buffer. Other blocks, like 12-bit DAC, configuration registers, bandgap voltage reference and LVDS receiver are included. All these blocks are power-pulsed, thus reaching a power consumption equal to zero in standby mode.

After characterisation of the MPW prototypes, a low volume production has been packaged in TQFP160 with the same pinout as the HARDROC. Therefore bulk MICROMEGAS detectors with embedded MICROROC have been straightforward built, using HARDROC previously designed PCBs and the same data acquisition system. First detector caracterisation with cosmic is currently on-going and the testbeam of suqre-meter prototypes is scheduled in summer 2011.

23 Study of Resistive Micromegas in a Mixed Neutron and Photon Radiation Field

Poster

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Abstract

The luminosity upgrade of the Large Hadron Collider at CERN (sLHC) foresees a luminosity increase by a factor five compared to the LHC. To cope with the corresponding increase in background rates, the Muon System of the ATLAS experiment at CERN will need major changes in the very forward/backward region. The MAMMA R&D activity is focused on the development of large-area muon detectors based on the bulk-Micromegas technology as candidates for such an upgrade. In order to overcome the spark problem a novel protection scheme using resistive strips above the readout electrode has been developed.

A study of the response and sparking properties of resistive micromegas detectors in a mixed (neutron and gamma) high radiation field has been performed. The neutrons are supplied by the Tandem accelerator, at the N.C.S.R. "Demokritos" in Athens. The results of this study will be presented. Monte-Carlo studies have been employed in the present work in order to study the effect of 5.5 MeV neutrons impinging on micromegas detectors. The response of the micromegas detectors on the photons originating from the inevitable neutron inelastic scattering on the surrounding materials of the experimental facility was also studied, and the simulation results were validated through comparisons with experimental data.

24 GEM-MSTPC: An active-target type detector in low-pressure He/CO2 mixed gas

Oral

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Abstract

Helium capture reactions such as (alpha, n) and (alpha, p) on proton- and neutron-rich radioactive nuclei are considered to play important roles to produce heavy elements in rapid proton- and neutron-capture process in astrophysical nucleosynthesis. For numerical evaluation of element abundances in the universe, those nuclear reaction rates are necessary, which can be obtained from the reaction cross sections in the energy region of astrophysical interest. If we go to measure those cross sections, we face technical difficulties that the intensity of radioactive nuclear beam (RNB) is limited and helium cannot be prepared as a solid target at room temperature. To overcome those difficulties, a gas counter as an active target operating in helium based mixed-gas is a powerful tool, which works not only as a charged particle detector but also as a gas target, leading to high efficient counting of reaction products. We have developed this type of gas counter, named as GEM-MSTPC, multi-sampling and tracking proportional chamber with 400 μm thick gas electron multipliers (THGEM), which has been selected for high beam injection rate capability. The operating gas and typical gas pressure are He/CO2 (10 %) and 120 Torr, respectively.

At various injection rates up to 10^5 pps, we examined the gas gain stability using alpha rays and low-energy C-12 beam. Large gas gain instability was observed on an originally developed THGEM even at low rate (a few pps) due to charge up of the insulator in the THGEM. By modifications of the THGEM, the gas gain stability has been improved to be within 2 % at the C-12 injection rate of 10^5 pps.

Moreover, as a general problem in a use of GEM, it is known that the vertical position of a particle track is distorted since the electron drift time is disturbed due to the electric field induced by numerous ions drift-backing from GEM into the drift space, which is called as ion feedback. We experimentally investigated the influence of ion feedback using alpha rays and low-energy C-12 beam. By optimization of electric fields and GEM configuration, the position distortion induced by the ion feedback has been suppressed within 1.5 mm at the C-12 injection rate of 10^5 pps. Those values satisfy experimental requirements.

In this presentation, we will present those developments and experimental results. In addition, GEM-MSTPC has been successfully applied to the measurement of 8Li(α, n)11B reaction cross sections. We will touch the measurement.

25 GEM tracker for high luminosity experiments at the JLab Hall A

Oral

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Abstract

A new large-area, lightweight tracker based on the GEM technology is under development for the upcoming experiments at the Hall A of the Jefferson Lab, where a longitudinally polarized electron beam of 11 GeV will be available in late 2013. This beam, combined with innovative polarized targets, will provide luminosity up to 10^{39} /(s.cm^2) opening exciting opportunities to investigate unexplored aspects of the inner structure of the nucleon and the dynamics of its constituents.

The tracker consists of 18 40x50 cm2 GEM modules that form larger chambers (up to 0.6 m^2) with adaptable active area depending on the experimental needs. The modules are largely independent, characterized by their own readout, high voltage supply and gas inlet/outlet as well as front-end electronics. The single GEM module is made by 3 GEM foils and double layers, 2D strip plane with 0.400 mm pitch. The strips are readout through properly designed ZIF terminals that will guarantee the optimal weight balance and at the same time avoid soldering. Finite Element Analysis has been used to minimize the mechanical supports (and therefore the dead area) and maximize uniformity of the gas flow.

Compactness, simplicity and versatility have driven the design of the readout electronics based on the 128 channel APV25 ASIC. The electronics consists of two active components: the front-end cards, directly connected to the detector strips and hosting the APV25, and a multi-purpose digitizer board (MPD).

One MPD handles up to 16 front-end cards (for a total of 2048 channels) and can be used in VME environments (also VME64x or VXS). It is managed by an ALTERA Arria GX FPGA and it includes sixteen 12 bits A/D converters synchronously running at 40 MHz, and ancillary electronics for driving the I2C protocol used to configure the APV25, as well as Ethernet 10-100, USB and SFP Optical transceiver, for system diagnostics and future extension; 2x64 Mbyte SDRAM is used to buffer the data and 8 front panel coaxial I/O connectors are provided to interface external control signals.

The FPGA performs several real-time tasks that maximize the data transfer rate: common noise and pedestal subtraction, sparse readout, out of time hits suppression (based on the multi sample capability of the APV25), event building.

The prototype system, under final revision, has been tested in the past months; results will be presented at the conference.

26 Direction-snesitive dark matter search with MPGD

Oral

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Abstract

NEWAGE is a direction-sensitive dark matter search experiment using a gaseous three-dimensional tracking device μ-TPC. We use μ-PIC, which is a type of MPGDs, as the two-dimensional read-out of our μ-TPC. Owing to the motion of the solar system with respect to the galactic halo, the direction-distribution of the WIMP (one of the candidate of dark matter) velocity that we observe at the earth is expected to show an asymmetry. Gaseous detector can detect this asymmetry by measuring the angular distribution of the nuclear tracks recoiled by WIMPs. After our first underground measurement at Kamioka (PLB686(2010)11), we made several detector updates to improve the sensitivities.

One of the main improvements was lowering the energy threshold from 100keV to 50keV by decreasing the gas pressure from 152 torr to 76 torr. Lower threshold is expected to improve the sensitivities, because the shape of expected energy spectrum is like exponential. Energy threshold of a direction-sensitive gaseous detector is limited by the track length. With lower pressure gas, track length will be longer and energy threshold will be lower. We optimized the detector operation with CF4 gas at 76 torr and measured the detector performance focusing on two parameters, detection efficiency and angular resolution. We irradiated the detector with fast neutrons from 252Cf and detected elastic-scattered nuclei. We evaluated the detection efficiency and angular resolution comparing the measured data with simulation data.

We will present the overview of NEWAGE as one of the MPGD applications, detector performance with low pressure gas, and improved sensitivities to dark matter.

27 Characterizing discharge protection and improving drift time resolution for Gridpix

Oral

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Abstract

A GridPix detector is a gaseous detector capable of detecting individual single primary electrons from ionizing particles. Such a detector consists of a pixel chip as active anode covered with a thin layer of silicon rich silicon nitride (SiRN), for protection against discharges, an integrated grid (InGrid), applied on top of the chip by wafer post processing techniques and a cathode. The drift region is between the grid and cathode and the gas gain occurs between the chip and the grid.

A layer of 8 μm SiRN, and according recent tests even 4 μm, is sufficient to protect against discharges. The effect of an 8 µ m SiRN layer on the operation of a detector has been determined. For high rates a potential drop across the SiRN layer decreases the gas gain. This effect can be quantified and can be used to determine the specific resistance of the SiRN layer. The resistance of the SiRN can be tuned by adjusting the amount of silicon during deposition.

False hits, pixels that fire because of charge arriving at adjacent pixels, cause an error in the amount of detected primary ionizations. Measurements have been performed to determine the chance of inducing a false hit as function of the charge on adjacent pixels.

Time walk effects due to pixel electronics response time and gas gain statistics cause errors in drift time measurements, worsening the resolution in the drift direction. Simulations and measurements have been performed to determine how much time walk can be compensated for. The measurements to verify the simulations have been performed on the gossipo3 chip. The Gossipo3 chip contains one pixel with new designed circuitry that simultaneously measures drift time with 1.6 ns bins and the time over threshold. For gas gains in the order of 2000 the time resolution can be improved by more than a factor of 5, down to 2.5 ns.

28 Ageing studies of Micromegas prototypes for the HL-LHC

Poster

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Abstract

Micromegas technology is a promising candidate to replace the forward muon chambers for the luminosity upgrade of the ATLAS. The LHC accelerator luminosity will be five times the nominal one, increasing background and pile-up event probability. This requires detector performances which are currently under study in intensive R&D activities.

Ageing is one of the key issues for a high-luminosity LHC application. For this reason, we study the properties of resistive Micromegas detectors under intense X-ray radiation (∼8 keV) and under thermal neutrons in different CEA-Saclay facilities. This study is complementary to those already performed using fast neutrons.

29 A prototype GEM-TPC for PANDA

Oral

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Abstract

The Anti-Proton Anniliation at Darmstadt (PANDA) fixed-target experiment planned at the future international Facility for Antiproton and Ion Research (FAIR) in Darmstadt, Germany, will investigate fundamental questions in non-perturbative Quantum Chromodynamics (QCD). It features a cooled antiproton beam with momenta from 1.5 to 15 GeV/c and will reach luminosities of up to 2 x 10^{32} cm^2/s corresponding to antiproton-proton-annihilation rate of 2×10^7 s^{-1}

One option for the central tracker of the target spectrometer is a cylindrical, ungated, continuously running Time Projection Chamber (TPC) with Gas Electron Multiplier (GEM)-based amplification stage surrounding the interaction point. The chamber is designed to be 150 cm long with an inner (outer) radius of 15.5 cm (41.5 cm). It will be read out by an array of 100000 hexagonal pickup electrodes.

To show the feasibility of such a detector, a prototype with a drift length of 72.5 cm and an inner (outer) radius of 5.25 cm (15.0 cm) was built. The pad plane of the detector has 10254 hexagonal pickup electrodes which are read out using 42 front-end cards, each equipped with four AFTER chips, originally developed for the T2K experiment.

The prototype was installed and tested in the FOPI spectrometer at GSI (Darmstadt, Germany). The central drift chamber and the RPC-TOF system of FOPI give excellent reference for momentum and energy loss measurements with the TPC. A superconducting solenoid magnet creates a magnetic field of 0.6 T. Gas mixtures of Ar/CO2 (90/10) and Ne/CO2 (90/10) were used with different drift fields ranging from 150 to 360V/cm. A Kr-83m source was used for gain calibration. Measurements were done using cosmic rays and different ion beams and targets. A 2% λ Al foil served as target for heavy ion beams of Kr-84 (1.2AGeV), Au-197 (1.0AGeV), Ne-22 (1.7AGeV) and N-14 (2.0AGeV).

The GEM-TPC will significantly improve the vertex resolution and secondary-vertex detection of the FOPI spectrometer, where it will be used in a three-week physics campaign with a π- beam in 2011. A detailed overview of the detector hardware will be presented together with first results from the test beams.

30 Development of wide dynamic readout for Time Projection Chamber

Poster

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Abstract

RIKEN Radio Isotope Beam Facility. It accelerates proton to Uranium up to 400MeV/u. The TPC will be used for identifying the nucleus as well as measuring the 3-D momentum in the magnetic field. Since number of ions by the incident charged particle is proportional to the square of its charge. So the TPC should have wide dynamic range readout in order to identify particles from Z=1 to 10. The TPC is divided into a drift region, gas amplification region and readout pad. In general, the drift and gas amplification part have good linearity and small crosstalk. However, a readout pad part may have large crosstalk, and then the next of the pad with larger signal induced by a higher Z particle may get a fake signal. Therefore we started to develop a low crosstalk readout pad design by an electromagnetic simulator and radio frequency instruments. The development requirement is the crosstalk level on an adjacent transmission line should be less than 0.5%. It is realized by putting a ground plane on the upper, lower side and the surrounding of a signal line. We would like to talk about the development of a wide dynamic range TPC pad.

31 Operation of the T2K Time Projection Chambers

Oral

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Abstract

T2K is a long baseline neutrino oscillation experiment in Japan, which was commissioned and started collecting data in 2009. The neutrino beam produced at the J-PARC facility is characterized, before oscillation, by a near detector ND280, located 280 m downstream of the target. In order to track and identify charged particles, ND280 relies on three Time Projection Chambers (TPCs) read out with Micromegas detectors for a total active surface of about 9 m2. The TPCs have been operated successfully during the physics runs that took place in 2010 and 2011. We will present the performance achieved by the T2K TPCs in the course of their first years of operation.

32 Detection of single photons with ThickGEM-based counters

Oral

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Abstract

The photon detectors based on MPGD (MicroPattern Gaseous Detector) represent the new generation ofgaseous photon detectors.

We report about an R&D programme dedicated to study both the principles and the engineering aspects of photon detectors based on Thick GEMs (THGEM), electron multipliers derived from the GEM ones and obtained making use of the PCB technology.

The photon detector consists in a THGEM multilayer architecture; a photoconverting coating (CsI) is applied onto the external surface of the first THGEM layer. The goal is the development of a gaseous detector of single UV photons, able to stably operate at high gain and high rate, to provide good time resolution and insensitive to magnetic field.

The most obvious field of application of these new devices are imaging Cherenkov counters used in nuclear and subnuclear physics for effective particle identification at high energies. Of course, as it is the case for all the photon detectors developed so far, different applications both in the field of ionizing particle detectors and outside the world of fundamental research can be envisaged.

All the principle aspects of the detector principle and architecture have been studied and validated; in particular, we discuss the time stability of the multiplier response and the criteria for an optimal choice of the electrical and operational parameters.

A second crucial phase has been started: the detailed investigation of all the relevant parameters.

This exploration is essential in view of engineering the detectors to build large size, robust devices adequate for the use in experiments. Features and limitation of the industrial production of large size PCBs have to be taken into account, so to optimize the choice of the detector geometrical parameter also in view of the industrial production. Status and perspectives of the engineering process are given.

33 Performances and sparking rate of anode-resistive Micromegas for HL-LHC environment

Oral

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Abstract

Micromegas technology is a promising candidate to replace ATLAS forward muon chambers -tracking and trigger- for future HL-LHC upgrade of the experiment. The LHC accelerator luminosity will be ten times the nominal one, increasing background and pile-up event probability in the same proportion. This requires detector performances which are currently under studies in intensive R&D activities.

We studied performances of four different resistive Micromegas detectors -0.3 to 2 M Ω/* and with different read-out strips pitch. These chambers have been tested using ~120 GeV momentum pions with rates from to 25 up to 250 kHz/cm2, at H6 CERN-SPS beam line in autumn 2010. The external reference was given by a telescope consisting of six non-resistive Micromegas, triggered by scintillators. Different gas mixtures were used for the resistive detectors (Ar + 2% C4H10 + 3% CF4) and for the telescope (Ar + 2% C4H10). All detectors were readout with analog GASSIPLEX chips with an integrating time constant of the order of ~1 μ sec then digitized by C-RAM CAEN modules.

We will present test beam data analysis focusing on the study of spatial resolution and efficiency of these new resistive detectors (with different beam intensity, HV conditions, orientation w.r.t. the beam, etc.). We will also present associated sparking results.

34 Digital Hadron Calorimetry for the International Linear Collider using GEM technologies

Oral

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Abstract

The physics of the ILC requires jet energy resolution significantly better than so far achieved. The combination of small (1cm x 1cm) cell size and a particle flow algorithm has been shown to be a strong contender for ILC calorimetry. Implementation of this calorimetry in GEM technology is an attractive solution, and will be described in this talk. Details will be given of work on GEM prototype active calorimeter layers, the associated analog and digital readout electronics, design of large GEM foils and chambers, and plans for future beam tests.

35 An overview on the design, construction and performance of large area triple- GEM prototypes for future upgrades of the CMS forward muon system

Oral

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Abstract

GEM detectors are used in high energy physics experiments given their good spatial resolution, high rate capability, and radiation hardness. An international collaboration is investigating the possibility of covering the 1.6¡—eta—¡2.4 region of the CMS muon endcaps with large-area triple-GEM detectors. In fact the CMS high-eta area is actually not instrumented and presents an opportunity for a detector technology able to cope with the hard environment. These micro-pattern gas detectors are an appealing option for simultaneously enhancing muon tracking and triggering capabilities in a future upgrade of the CMS detector. A general overview of this feasibility study will be presented. Design and construction of small (10cm × 10cm) and full-size trapezoidal (1m × 0.5m) triple-GEM prototypes will be described. Results from measurements with x-rays and from test beam campaigns at the CERN SPS will be shown for the small and large prototypes. Preliminary simulation studies on the expected muon reconstruction and trigger performances of this proposed upgraded muon system will be reported.

36 Withdrawal

37 Wafer-based production of integrated pixel-gas-detectors

Oral

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K. Desch (University of Bonn) (presenter)

Abstract

Gas amplification structures can be built up on top of CMOS pixel readout chips via modern post-processing techniques (InGrid, GEMGrid). InGrids developed by NIKHEF and Twente University based on the Timepix chip have been shown to work excellently and bear potential for numerous applications.

So far, the post-processing has to be done on single chips or small chip-squares which is prohibitive for the construction of larger area detectors. In the talk, I will report on the production of InGrid and GEMGrid

structures on 8 ´´ wafers at IZM Berlin as well as on their characterization and first test results.

38 Optical Scanning System for Quality Control of GEM-foils

Poster

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Abstract

An optical scanning system was commissioned and further developed in the Detector Laboratory of Helsinki Institute of Physics and University of Helsinki. It was designed to automatically scan, perform on-line analysis and to classify the overall quality of GEM-foils especially of the GEM-TPC detectors for Super-FRS at FAIR.

The optical scanning system consists of precision positioning table, lighting, optics and operating system with analysis software. It has active scanning area of 95 cm $\times$ 95 cm and it can study this area with the minimum resolution of 128 lp/mm.

We will present the performance of the system and show some of the results we obtained from the GEM-foil uniformity and quality analysis.

39 GEM spectrometer for J-PARC E16 experiment

Poster

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Abstract

J-PARC E16 experiment measures mass modification of ϕ meson in dense nuclear matter with high intensity proton beam. ϕ meson is produced in p+A collision and decay into electron-positron pairs and its invariant mass in nuclear matter is reconstructed from the momenta of electron and positron.

Spectrometer of E16 experiment is mainly composed of tracking detector and Cherenkov counter for electron identification. Gas Electron Multiplier (GEM) is applied to both detectors for electron amplification to cope with high rate environment at J-PARC.

GEM tracker consists of three layers of GEM detectors and sizes of GEM detectors are 10 × 10 cm2, 20 × 20 cm2 and 30 × 30 cm2. Each detector measures position of charged particles in magnetic field. Read out configuration is 2-dimensional strips. Strip pitch is 350 μ m for top side and 1400 μ m for bottom side. Required position resolution is 100 μ m for top side. Each size of GEM foil is manufactured and position resolution is evaluated.

GEM foils are manufactured with wet etching method by a Japanese company. But size of holes and flabbiness of foil need to be improved for 30 × 30 cm2 GEM. Size of holes become small using newly developed mask and the flabbiness is fixed by a jig which adds tension to GEM foil. Developed 30 × 30 cm2 GEM achieves gain of 104. Position resolution and efficiency are tested with positron beam at ELPH, Tohoku Univ. Position resolution becomes worse for angled particle tracks, but it is improved by using arrival timing information of ionized electrons. Position resolution is evaluated for 0 °, 15 °and 30 °angled tracks and 100 μ m is achieved up to 15 °.

Our Cherenkov counter is called the Hadron Blind Detector (HBD). The HBD is a mirrorless, windowless Cherenkov counter with a stack of GEM. CsI is evaporated on GEM surface as a photo-cathode. CF4 gas fills the whole detector volume and acts both as amplification gas and Cherenkov radiator. Cherenkov lights from electrons knock out photoelectrons from CsI. Photoelectrons are collected and amplified by GEM. Ionized electrons by hadrons drift to mesh cathode and not detected. CsI is evaporated by hand in our laboratory. Photoelectrons by Cherenkov light is measured with positron beam at ELPH, Tohoku Univ. and ∼10 photoelectrons are obtained.

Details of the development of spectrometer are reported in this talk.

40 Performances of Micromegas detectors with discharge reduction technologies for high hadron flux environments.

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Abstract

R&D on Micromegas detectors for high hadron flux environments is ongoing at CEA Saclay within the COMPASS and the CLAS12 groups. The goal of the studies is to reduce the discharge rate by a factor of 10 to 100 compared to the present COMPASS Micromegas detectors, in view of the future physics programs where hadron flux of 5×10^7 hadrons/sec are expected.

Two approaches have been followed, one based on a pre-amplification stage with a GEM foil and the other on resistive board technologies. To study and evaluate these solutions, small prototypes featuring an additional preamplifying GEM foil as well as prototypes using resistive layers like buried resistor scheme proposed by R. de Olivera et al, where the anode plane is made of resistive pads connected to the strips through resistors, were built and tested. The reduction of the discharge rate as well as the full performance of the prototypes have been measured using low energy (0.3 to 3 GeV) pion beam from the CERN PS, and high energy (150 GeV) muon beam from the SPS, within the RD51 test beam period. Promising results were obtained with the two approaches, both in term of discharge rate reduction and in term detection performances.

I will report on the full characterization of the prototypes in term of discharge probability, gain, efficiency, spatial and time resolutions, for the different operating regimes. A comparison between the different solutions of discharge rate reduction and the main performances will be given.

41 New flexible resistive GEM foil without metal

Oral

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Abstract

The GEM foils less material are desired to minimize the multiple scattering. Thinner copper layer in the normal GEM foils and aluminum electrode are tried so far. A new approach with resistive polymer is considered. It can provide higher effective gas gain without serious large discharges. In the present stage, we have developed new GEM foils with one copper electrode for one surface and one resistive polymer electrode for other surface. The GEM holes are made in the laser etching. The diameter and pitch are around 70um and 140um, respectively. One such foil is stacked in a chamber together with two normal GEM foils to test initial performance. It worked fine and could measure the effective gas gain. We will stack three new resistive foils in the chamber and more results will be present in the conference.

42 Gadolinium Coated Capillary Plate Detector for Neutron Imaging

Poster

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Abstract

Gd2O3 was successfully coated on the inner surface of capillary plate (CP), which makes it possible to detect thermal neutrons in event counting mode. Monte Carlo simulation has shown that quantum efficiency as high as 33% is obtainable for 25.3 meV thermal neutrons using one single coated CP with careful selection of the parameters. The imaging detector prototype was fabricated, the essential part of which is a two stage amplifying structure. The original signal is first amplified through gas avalanche within the micro channel. The small gap between the CP and the readout anode is the second stage. There is a wedge and strip pattern to locate the central position of the avalanche cluster. Some preliminary results are presented in the paper.

43 Development of GEM-TPC with gating grid for J-PARC hadron experiment.

Poster

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Abstract

Exotic hadrons such as tetraquark, pentaquark and dibaryon have recently attracted much attention. Recent lattice QCD calculation claimed there is no repulsive core in the S=-2 baryon-baryon interaction in I=J=0 channel, and suggested a possible existence of the H-dibaryon near lambda-lambda threshold. A peak structure was observed in the lambda-lambda mass spectra in the experiments at KEK-PS. However, it was not concluded as a resonance because of poor statistics. It is therefore important to study the lambda-lambda mass spectrum with much higher statistics at J-PARC.

For this purpose, we are now developing a new Time Projection Chamber surrounding a target to measure the emitted particles of short flight lengths under a high beam rate.The prototype of TPC with GEM readout has been developed. The effective area is about 100mm x 100mm x 300mm (drift direction) and beam particles go through the TPC perpendicular to the drift direction. A signal is amplified with three layers of GEM sheet and read out with anode pads of various size for the study of the TPC properties.

The goal of particle rate at the TPC is over 10^7Hz. In order to operate under such high counting rate, we adopted a gating grid opened by an appropriate trigger. We have tested the TPC by using an electron beam at the Reserch Center for Electron Photon Science, Tohoku university.

We report the results of the test experiment.

44 Study of effects of variation in GEM hole size distribution

Poster

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Abstract

Standard GEM-foil has bi-conical holes with outer diameter of 70 µm and inner diameter of 50 µm. Though the uniformity of the GEM-foils is generally good, sometimes faults in the manufacturing processes may produce foils that have inhomogeneous distribution of in the sizes of the holes. Depending on the working phase that induced the error the differences can be in the sizes of inner or outer holes.

By using optical scanning system we have mapped the uniformity of standard 10 cm × 10 cm GEM-foils. The areas with different holes were irradiated with X-rays from 55Fe source and the gain and resolution were compared. We will present the results of these measurements of the effects of variation in GEM hole diameter to the overall performance of the detector.

45 SMILE-II: Balloon-borne Experiment for Astronomical Observation Using an Electron-Tracking Compton Camera Based on a Gaseous Time Projection Chamber and a Position Sensitive Scintillation Camera

Poster

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Abstract

We have been developing an Electron-Tracking Compton Camera (ETCC) as an MeV gamma-ray telescope in the next generation, which consists of a gaseous time projection chamber (TPC) and a position sensitive scintillation camera.

Conventional Compton cameras like COMPTEL aboard Compton Gamma-Ray Observatory, can only measure the absorption point and the energy of the Compton-recoil electron and therefore the direction of the incident gamma ray is known to lie on the edge of the cone.

The ETCC, in contrast, can also measure the fine three dimensional track of the Compton-recoil electron with the gas chamber based on a micro pixel chamber (μ-PIC) and a gas electron multiplier (GEM), which enables us to fully reconstruct the direction of the incident gamma ray to a reduced arc on the Compton circle event by event.

The μ-PIC is a kind of a micro pattern gas detector manufactured with printed circuit board technology, which has a pixel pitch of 400 μ m with strip readout and a stable gas gain of $\sum$ 3000 to 6000.

We already had the balloon-borne experiment with the prototype ETCC consisting of the TPC with a volume of 14 x 10 x 10 cm cubed in 2006 and successfully observed diffuse cosmic and atmospheric gamma rays. For the next flight to observe the Crab Nebula from balloon altitudes, it is necessary to upgrade the ETCC to have higher sensitivity. Thus we are developing both a large ETCC with the 30 cm cubed TPC and a new data acquisition system (DAQ).

The new DAQ takes the rising time and duration of the pulse of each strip to get the information of the track and the energy deposition, while the previous one only took the data of the rising time. The information about the energy deposition of the recoil electron is the key to the determination of the precise position of the interaction point and the direction of the track, leading to improve the detection efficiency and the angular resolution of the ETCC.

We report the overview of our balloon-borne experiment and the improve points of the large ETCC.

46 High-angular-precision gamma-ray astronomy and polarimetry above the pair-creation threshold.

Oral

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Abstract

Making sensitive spectral measurements over the complete gamma-ray energy range is becoming more and more important to understand the emission mechanisms at work in cosmic sources such as pulsars, AGN and GRB. Closing the sensitivity gap between the Compton-based and the pair-production telescopes, which are most sensitive in the [10 - 1000] keV and [0.1 - 1000] GeV ranges, respectively, is a major issue. For the pair-production technique, the main path towards lower energy is through improving the detector characteristics that would result in a better angular resolution, and therefore an easier background rejection and a larger reconstruction efficiency at low energy. In addition, the measurement of the linear polarization fraction of the radiation as a diagnostic of the emission mechanism is badly missing at present.

I will present the performance, estimated from simulation, of a time projection chamber (TPC) used as the converter of a telescope with an angular resolution improved by one order of magnitude with respect to Fermi-LAT. This telescope has polarization sensitivity over the full energy range, with a similar effective area per unit mass as Fermi-LAT.

A demonstrator, consisting of a cubic TPC using a 5 bar Argon-based mixture, is being constructed at LLR. Amplification is provided by a bulk micromegas micromesh, and the signal is collected by a pair of crossed strips layers.

47 Test Beam Performance of Triple-GEM Prototypes for the Upgrade of the CMS Muon System in the Forward Region

Poster

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Michael Tytgat, on behalf of the GEMs for CMS Collaboration

Abstract

An international collaboration is investigating the possibility of instrumenting the forward region, 1.6¡—eta—¡2.4, of the muon system of the CMS detector at the LHC with large-area triple-GEM detectors. Such micro-pattern gas detectors are able to cope with the extreme particle rates expected at the LHC in that region and they would allow to combine precision muon tracking and fast triggering capabilities in one single subsystem. During the course of this feasibility study, several small (10cm x 10cm) and large, CMS-size (1m x 0.5m) triple-GEM prototypes have been designed and constructed. Measurements on these detector were performed with soft x-rays and with pion/muon beams at the CERN SPS during several test beam campaigns. In this paper, we will focus on these measurements and detail the obtained detector resolution and efficiencies, the effect of different configurations of the inter-electrode gaps and different gas mixtures on the timing performance, and we will discuss the performance of these detectors inside a strong magnetic field. Furthermore, we will present preliminary results of simulation studies using ANSYS and GARFIELD on the effect of various electric field configurations and gas mixtures and the presence of a strong magnetic field on the performance of such detectors.

48 Micromegas & Wire Chambers at Low Pressure for Beam Tracking

Poster

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Abstract

New facilities like FAIR at GSI or SPIRAL2 at GANIL, will provide radioactive ions beams at low energy (¡10MeV/n). Such beams have generally a large emittance, which requires the use of beam tracking detectors to reconstruct the trajectories. Due to their thickness, classical tracking detectors in beam would generate a lot of angular and energy straggling. One solution could be the use of Se-D (Secondary electron Detection). It consists in a thin emissive foil in beam with a low pressure gaseous detector off-beam to detect the secondary electrons ejected from the foil.

Different low pressure gaseous detectors (wire chamber or micromegas) have been constructed and tested since 2008. The performances achievable at low pressure are similar or even better than at atmospheric pressure. The fast charge collection leads to excellent timing properties as well as high counting rate capabilities. In-beam tests have been realized in 2010 at GANIL with micromegas and wire chamber prototypes, the time and spatial resolution have been measured as well as the influence of the counting rateo on the performances. These measurements have permitted to design new bigger prototypes to be tested fall of 2011.

49 Development of sealed gaseous PMT with Micro Pattern Gas Detector

Poster

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Abstract

We have advanced the development of sealed gaseous photomultiplier tubes (PMTs) composed by photocathode and MicroPattern Gas Detector (MPGD). The advantage of the gaseous PMT is that it can achieve a very large effective area with good spatial and temporal resolution. In addition, it can be possible to improve output uniformity and lower price compared with conventional PMTs. Due to demands of the manufacturing process of photocathode, the material of MPGDs should be well suited to the high level of cleanliness and chemical condition. To fulfill those require, A micro blasting technique was employed for the production of a new type MPGD with similar materials as those used in conventional PMTs. A basic performance test of the MPGD was carried out with a gas mixture of Ne (90%) + i-C4H10 (10%). We successfully obtained a gain of over 1×10^4 and an energy resolution of 16% for 5.9 keV X-rays. We observed an initial fluctuation of the gain over a few minutes, but confirmed to be improved by changing the substrate resistance. We constructed gaseous PMTs with bialkali photocathode, and obtained a gain over 100 for a visible light operation.

50 Developments of X-ray detector with a Gas Electron Multiplier

Poster

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Abstract

A Gas radiation detector using gas electron multiplier (GEM) has a number of advantages over wire chambers, e.g., higher amplification, larger and better spatial resolution. Therefore, GEM is expected for many applications such as medical instruments, space observations, structure analysis of materials etc. However, a radiation detector using GEM cannot detect high energy radiation due to the small scattering cross section of the gas.

We have developed X-ray detector with GEM for medical applications and space observations. To detect higher energy X-ray, we have developed GEM of a new concept coating Au (Au-GEM). Because Au has large amount of substance, hard X-ray is absorbed by gas than by Au. Thus, we are going to use Au-GEM as the hard X-ray detector. The photoelectrons which released from Au-GEM are amplified by general GEM (Standard-GEM) which set below Au-GEM.

At first, we are evaluating Au-GEM performance against soft X-ray. In our experiments, we set drift plane, Au-GEM, Standard-GEM (with 10cm × 10cm) and readout pad (with 3cm × 3cm) in the chamber. Before this experiments, we flowed a mixture gas (argon/methane = 90%/10%) through the chamber. We irradiated with 5.9keV X-ray from 55Fe radioactive source.

A performance which we evaluated is two of the following.

Photoelectric effects occur on either surface or bottom of Au-GEM. When Au-GEM performs electron multiplier, a number of photoelectrons released from surface are amplified by Au-GEM. However, if photoelectrons released from bottom, a number of it doesn 't change. Thus, although Au-GEM detects the same energy X-ray, spectrum represents as if Au-GEM detect a different energy X-ray. Therefore,we study operation voltage under conditions, which a number of electrons passed through Au-GEM is equal to a number of electrons released from bottom.

Au-GEM must not prevent X-ray which can detect with gas. Therefore, we study gain curve and spectrum with or without Au-GEM.

We will report status at conference.

51 Cern Photolithography workshop leader

Oral

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Abstract

Cern Photolithography workshop is involved since more than a decade in the devellopement and production of MPGDs. In this presentation, our last productions of large GEMs , large Micromegas with resistive protections and also large Thick GEMs or LEMs will be described. Since last year many new equipments for large size production have been introduced in our production line. The new possibilities given by these machines will be presented also.

52 Development of Resistive Electrode Gas Electron Multipliers (RE-GEM)

Oral

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Abstract

To multiply electrons charges, we have developed Gas Electron Multipliers (GEM), applying voltage between copper electrodes in an appropriate gas. However, the discharges between at the electrodes may cause short circuit between GEM electrodes. Among many solutions introduced so far, one of the solution is to increase the resistivity of the electrodes on GEM. Based on the idea, two type of this Resistive-GEM have already been proposed; Resistive Electrode Thick GEM[1][2] and Resistive Mesh GEM[3]. However, due to the difficulty on creating the holes on the GEM, it was hard to realize both of fine structure and high gain.

To overcome the difficulty, we then challenged to produce a new Resistive Electrode GEM (RE-GEM), applying resistive material, resistive-Kapton instead of coppers, to GEM with laser etching technique [4]. As a result, we succeeded on obtaining both of fine pitch and (moderately) high gain. More specifically, we used the resistive material as Resistive-Kapton with a resistance of 2 M Ohm/cm. A hole diameter, a pitch, and the thickness of the RE-GEM are 70 um, 140um, and 170um, respectively. The RE-GEM consists of three materials: 25 um thickness Resistive-Kapton as electrode, two 35um thickness Bonding Sheets, and 50um thickness Liquid Crystal Polymer as insulator.

With these configuration, we measured the gain curve of RE-GEM using an iron 55 active radio source as X-ray Source (5.9keV) in the gas mixture of Ar 70% and CO2 30% flowed at atmospheric pressure. As a result, we have successfully obtained the signals from the RE-GEM at 680V for the first time. Then, when increasing the voltage up to 740V, we have measured the maximum gain of about 300.

Thus, Our RE-GEM have functioned in the same way as the widely-used GEM, in terms of electron multiplication, though we need to more effort on increasing its gain for a given high voltage. In the presentation, we will report the details of the progression on our RE-GEM.

Reference:

[1] A. Di Mauro, et al., arXiv:0706.0102, 2007
[2] R. Akimoto, et al., Journal. Instrum 5 P03002, 2010
[3] R, Oliveira, et al., arXiv: 1002.1415, 2010.
[4] T. Tamagawa, et al., Nucl. Instr. and Meth. A 386(1997)531

53 Measuring the temporal behaviors of charges fed into cathodes, anodes, read-out pads in GEM.

Poster

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Abstract

We have developed various gas electron multipliers (GEMs) with a laser etching technique, changing geometry (pitch, hole diameter and thickness) and the materials of insulator layer from polyimide (PI) to liquid crystal polymer (LCP) [1] [2].

Now, we name the GEM of LCP insulator LCP-GEM.

In the photoelectric X-ray polarimeter, we will use LCP-GEM in the dimethyl ether (DME) gas at 190 Torr, for the NASA satellite project which is the Gravity and Extreme Magnetism Small Explorer (GEMS).

GEMS will be the first satellite to systematically measure the polarization of cosmic X-ray sources.

It is necessary to grasp charge amplified by LCP -GEM for the X-ray polarimater.

However, it has not been measured charge amplified by LCP-GEM at each electrode: drift plane, GEM cathode and GEM anode.

Then, we studied the dependence of charge collection efficiency at these electrodes on the external fields in gas or GEM thickness at each event.

We report the two results which show you how electrons and ionized gasses move in the amplification process.

First, we measured charges collected by each electrode as a function of drift field or induction field. We performed experiments in two kinds of gasses: the sealed 190 Torr DME and flowed Ar-CO2 (70%-30%).

The results in Ar-CO2 (70%-30%) gas show that as the electrical filed strength for the induction region increases from 4 kV/cm to 12 kV/cm, the efficiency of charge collections of the cathode and the read-out pad also increase 18 % and 246 % .

On the other hand, the more strong induction field, the more electrons collected by GEM anode decreased 53 %.

Second, we will also report about the difference of the charges collected between 50µm thickness LCP-GEM and 100µm thickness LCP-GEM in flowed Ar-CO2 (70%-30%).

We understood the efficiency of charge collected in LCP-GEM as function of electric filed and thickness.

Reference:

[1]T. Tamagawa, et al, Nucl. Instr. and Meth. A560 (2006) 418

[2]T. Tamagawa, et al, Nucl. Instr. and Meth. A608 (2009) 390

54 R&D of MPGD-readout TPC for the International Linear Collider experiment

Oral

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Abstract

A Time Projection Chamber (TPC) is specified for the central tracker of the ILD detector, one of two detector concepts planned for the International Linear Collider (ILC). Physics goals at the ILC will require a TPC with a position resolution of 100 microns and superior track separation, which are not achievable with a conventional Multi-Wire Proportional Chamber readout. A MPGD readout offers improved position resolution and track separation due to measuring the signal at the anode and minimization of the ExB effect. For several years, the LC TPC collaboration has been developing a MPGD readout using various small TPC prototypes and the Large Prototype TPC that is operated in a beam test at DESY. The MPGD technologies being tested are GEM and Micromegas with resistive charge broadening, with both traditional pad and CMOS pixel readout. We will report on the recent R&D toward the ILD TPC. Readout modules with both GEM and Micromegas gas amplification have achieved a position resolution on the order of 60 microns. R&Ds for second generation modules and compact readout electronics will be also discussed.

55 Development of a fast-neutron directional detector with a μ-PIC for homeland security

Poster

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Abstract

We have been developing a fast-neutron directional detector with the micro-pixel gas chamber (u-PIC). The u-PIC is a MPGD fabricated by printed circuit board technology and has been used as an imaging device in MeV gamma-ray astronomy and, by introducing He-3 as a converter, in radiography and scattering experiments using thermal neutrons. Anode and cathode strips in the u-PIC are formed orthogonally on either side of a polyimide substrate with a 400um pitch. Pixel anodes are formed at the center of cathode holes through the 100um thick substrate. The fast-neutron directional detector consists of a time projection chamber (TPC) with the 100mm x100mm u-PIC, a gas vessel with a 50mm drift cage, and analog (amplifier-shaper-discriminator) and digital(encoder) circuits .

Fast-neutron imaging based on MPGDs is a technique for detecting heavily shielded special nuclear material (Pu) in cargo containers or vehicles. Heavily shielded neutron sources emit mostly fast neutrons. Neutron background rate from cosmic-ray-produced secondaries is also very low. Our method uses elastic scattering of neutrons with atomic nuclei in an Ar/CH4 gas mixture within the vessel. By measuring the 3D-track of recoil protons in the TPC, we can determine the direction of incident neutrons, and achieve good background gamma-ray rejection. Fast-neutron imaging tests have been carried out in which fast neutrons emitted by a Cf-252 source were detected by measuring recoil protons. In this report, we propose the fast-neutron imaging method with the u-PIC as an alternative to He-3 detectors for homeland security.

56 Electro conductive polymer complex PEDOT/PSS to be coated on film for R E-GEM

Poster

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Abstract

Electro conductive polymer complex PEDOT/PSS is expected to be a good conductive coat for GEM electrodes. PSS in the form of colloidal particle makes the coated wet surface stable against water. When the PEDOT/PSS complex is included in the coated layer, however, the some of sulfo groups in a PSS absorbs many water molecules from atmosphere or water for rinsing. Also PEDOT/PSS colloidal particles on the surface would very slowly flow because there is not a thing to pin them. In this way the sheet resistance of the coated film becomes unstable and then deteriorated. A poor resistance of PEDOT/PSS coated film to water becomes fatal when a usual wet etching process is executed for GEM production.

PEDOT/PSS is actively researched in the industries aiming at practical use, and lots of patent documents which relate to PEDOT/PSS are published. Those documents suggest us that retaining the PEDOT/PSS complex with the binder is effective to improve the resistance to water. Especially, the melamine resin compound can be a good binder for a practical use because ionic bond of the negative sulfonic ion in PSS molecule and the cationic imino ion in melamine resin is expected to prevent from infiltration of water molecules. Our verification experiment actually confirmed that melamine resin system has a sufficient resistance to water and that the sheet resistance of the coated film is 1.0e+03 to 1.0e+08 ohm / sq according to the amount of the melamine resin compound.

57 Withdrawal

58 Development of a TGEM-TPC for the J-PARC E15 experiment

Poster

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Abstract

A Time Projection Chamber (TPC) with Thick Gas Electron Multipliers(TGEMs) has been developed for an inner tracker of the J-PARC E15 experiment, a deeply-bound kaonic nuclear states search experiment. The TPC has a cylindrical design with an inner diameter of 170 mm, an outer diameter of 280 mm, and a drift length of 300 mm filled with P10 gas (90:10 argon-methane) at atmospheric pressure. A TGEM is used for the amplification of the TPC in order to realize a self-supporting structure in a limited space. We use a double TGEM structure and the maximal effective gain of more than 10^4 is achieved with 100x100 mm^2 TGEM prototypes. Moreover, we have been developing a resistive-electrode TGEM (RETGEM) with graphite electrodes, which has the advantage of being fully spark-protected. The results of our recent studies on the TGEM prototypes and the TPC commissioning using cosmic rays are discussed.

59 Development of X-Ray Imaging Device using GEM.

Poster

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Abstract

Today, the film shot method is used in nondestructive inspection. However, because of bad detection efficiency, strong X-ray is needed. Due to this, the large size of radiation source must be selected. Against this problem, we change X-ray into electron by photo-electron converter, and increase electron with GEM (Gas Electron Multiplier). By detecting electron and image processing, we will be able to do nondestructive inspection with weak X-ray. Based on this idea, we are developing X-ray imaging device.

More detail specification will be discussed below.

$Target\ X-ray\ energy$

At first, 500keV hard X-ray is used.This energy is used in many nondestructive inspection.

GEM

In order to satisfy the size of imaging, 200mm x 200mm is needed.

$Imaging\ specification$

Imaging area is 200mm x 200mm, and resolution is 1.52mm. Strip anode is used in readout.

Readout circuit

To satisfy imaging specification, 256 readout channel is needed. Each channel has these ICs.

(1) ADC(10bit, 10Msps, the pipelined method)

(2) TDC(4bit, 100MHz)

(3) 2 FIFOs(10depth).

After analog-digital conversion, the data will be processed by FPGA(Field Programmable Gate Array). After the FPGA change raw data into data which image processing software can handle easily, SiTCP send this to PC through a ethernet cable.

$Image\ processing\ software$

The data is come from SiTCP. And, image processing software analyze and display. So as to decrease statistical error, counting method is used. If ADC's value is more than threshold, the position counter count up. In future, in order to increase resolution, a weighted average method will be selected.

60 Pixelized Micromegas detectors with low discharge rate for COMPASS experiment

Poster

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Abstract

Future COMPASS physics programs using high intensity muon and hadron beams of a few hundred GeV impinging on various targets are being prepared for the years 2014 and beyond. We plan to replace the present large size Micromegas micropattern gaseous detectors by new ones featuring new characteristics to cope with the foreseen higher beam intensities: reduced discharge rate to stand five times larger hadron flux, detection of beam particles (few hundred of kHz/mm^2) using a pixel read-out in the center of the detector, light and integrated electronics using APV25 chips, improved robustness.

Discharge rate reduction studies were done in 2009 and 2010 in order to reduce the rate and impact of dicharges by a factor greater than 10. Two promising solutions were particularly identified and studied: the addition of a preamplifying GEM foil above the micromesh and the use of the "buried resistor" technology proposed by R. de Oliveira et al. (cf. M. Vandenbroucke talk).

After tests done in 2009 on 30x10cm prototypes, a prototype with nominal 40x40cm active area and with pixel read-out in the center has been tested on the COMPASS environment in 2010 during the major part of the beam period. Good performances of the prototype were achieved, validating the pixel readout with APV electronics and the Micromegas bulk technology used for the first time on a large and thin honeycomb board. New detectors are prepared for the 2011 COMPASS run beginning in June, and each of the two selected solutions for discharge rate reduction will be implemented in distinct prototypes. The detectors will be tested in COMPASS environment and performance will be measured in nominal conditions in order to fully qualify the detector design and decide whether technology is the most appropriate to reach the goals of the project.

An overview of the pixelized Micromegas project for COMPASS experiment will be presented. Extensive review of the 2010 detector performance will be shown, in particular in term of discharge probabilities, efficiencies and spatial resolutions. Preliminary results of the 2011 low discharge prototypes will be given. Possible choices concerning discharge rate reduction technology will be discussed, and the project time-line will be outlined.

61 Development of a new imaging device using a VUV scintillator and a gas photomultiplier with a μ-PIC and GEM

Oral

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Abstract

We have developed a new imaging device consisting of a VUV scintillator coupled to a gas photomultiplier (GPM) with a micro pixel chamber (μ-PIC) and gas electron multipliers (GEMs). Generally, the VUV scintillator has a short decay time of less than $\sim$ 10 nsec. Thus the new detector is expected to be used in high rate counting ($\sim 10^4$ to 10^5 Hz) with a higher detection efficiency than a gas detector only.

The GPM had the order of 10-nm thick CsI photocathode evaporated and deposited on a 5-mm thick MgF_2 window with a diameter of 54 mm. Both of μ-PIC and two GEMs had a detection area of 10 cm $\times$10 cm, and the GPM was filled with $Ar+C_2H_6$ mixture gas (9 : 1) at 1 atm. The μ-PIC had an anode pitch of 400μm, and the GEMs had 70-μm diameter holes of 140μm pitch and the insulators were liquid crystal polymer of 50 and 100μm thick.

We optimized the electric field in the drift region (between drift plane and first GEM), and the other region by the measurement of current in the μ-PIC, GEMs, and Drift plane, in order to obtain the higher collection efficiency of photoelectrons. Then we decided the electric field of 0.25 kV/cm. In addition, electric fields in the transfer (between the first and second GEM), and induction (between the second GEM and μ-PIC) were 1.0 and 3.0 kV/cm, respectively. Total gas gain of the GPM was approximately 2×10^5, and the GPM was estimated to have a quantum efficiency (QE) of 1% at 175 nm.

As a VUV scintillator, we used 8-mol% Nd doped LaF_3, and 1-mol% Nd:$LuLiF_4$ crystals with a size of from 10 mm $\times$10 mm $\times$1 mm to 20 mm $\times$20 mm $times$20 mm. The Nd:LaF_3, and Nd:$LuLiF_4$ had decay times of 7, and 12 nsec, respectively. We measured the light output of these crystals using a photomultiplier R8778 (Hamamatsu), and 1-mm thick Nd:$LuLiF_4$ had higher rate than the same thickness of Nd:LaF_3 by 2.4 times. Here, Yanagida et al. reported 1 mol% Nd:$LuLiF_4$ has a light output of 300 ph/MeV. Although each crystal had low light outputs and low QE of the GPM, using the new detector, we succeeded in obtaining the crystal images irradiated with 5.5 MeV alpha and 0.122 MeV gamma rays from ^{241}Am and ^{57}Co sources, respectively.

62 THGEM operation in high pressure Ne/CF_4

Poster

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Abstract

The recent interest in THGEM-based detectors operating in neon gas mixtures is motivated by the relatively low operation voltages. THGEM detectors have been investigated in Ne/CH4 and Ne/CF4 in UV detectors where the top THGEM electrode has been coated with a CsI photocathode, in x-ray and neutron imaging detectors, or in sampling elements for Digital Hadron Calorimetry. Following extensive investigations in Ne mixtures at atmospheric pressure, and a variety of applications, this work focuses on high pressure operation. It has been motivated by recent applications of gaseous photomultipliers operating at cryogenic temperatures, e.g. for scintillation recording in noble liquid detectors, with high gas densities; also x-ray imaging and that of charged particles would benefit from higher gas densities.

We will present room temperature operation of Single- and Double-THGEM detectors in pressures up to 3 bar of Ne/CF4 with relevant characteristics such as charge gain and energy resolution with soft x-rays. Gains of 5×10^3 and 3×10^3 were obtained with a Single-THGEM detector and of 7×10^4 and 3×10^4 were obtained with a Double-THGEM, in 1bar and 3bar Ne/CF4 (5%), respectively; they were slightly higher with Ne/CF4 (10%). Thus the maximum achievable gain was not significantly affected by the 3-fold increase of gas pressure. The energy resolution for 5.9keV x-rays was of the order of 23% FWHM.

We also report on the effect of our getter-based gas purification system and the consequent gas impurity level on the THGEM 's operation and performance.

63 First results with THGEM-MIGAS in Ne mixtures

Poster

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Abstract

The Thick Gas Electron Multiplier with a Micro Induction Gap Amplifying Structure (THGEM-MIGAS) results from a combination of the already proven THGEM with a Micromegas induction region, typically few hundred microns deep. The THGEM is a robust gas electron multiplier manufactured from PCB-like material (FR-4 or G-10) copper clad on both sides with an hexagonal pattern of holes drilled through it, followed by chemical etching of a small rim around each hole (typically 0,1 or 0,05mm). The combination of a THGEM and a Micromegas has already been used as an alternative to Double-THGEM, to reduce the ion backflow in the multiplier cascade. Combining a thick gas electron multiplier with an induction gap set at few hundreds of micrometers results in two electron multiplication stages, providing higher charge-gains and reduced ion backflow, when compared to a Single-THGEM structure, as well as more efficient charge extraction from the THGEM holes and faster pulse rise-times. The virtues and limitations of the micro induction amplifying region were already proven in studies with GEMs, the GEM-MIGAS, and this concept can be applied to the THGEM. In this work, we present the first results of the THGEM-MIGAS operation with an induction region thickness ranging from 300 up to 800µm in Ne and Ne/(5%)CF4 gas mixtures at atmospheric pressure, using a Fe55 X-ray source. The present studies evaluate the performance operation in terms of the charge-gain characteristics, X-ray energy resolution, charge stability and pulse rise-time. Experimental studies done so far with a THGEM-MIGAS, having 400 µm induction gap achieve charge-gains of $2x10^4$ and $4x10^4$ in Ne and Ne/(5%)CF4, respectively. Values one order of magnitude higher than those obtained in Single-THGEM configuration and approximately half of those obtained for the Double-THGEM. Electric field simulations of the THGEM-MIGAS structure were performed, as an initial step for this work, evaluating the electric field profile in the different regions. The analysis made so far shows that an increase on the induction field strength leads to a deviation of the maximum electric field value from the center of the THGEM 's hole to the induction region. Further experimental work is being undertaken exploring the induction gap thickness in the μm range.

64 Neutron beam monitor based on single THGEM

Poster

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Abstract

A new thermal neutron beam monitor with Gas Electron Multiplier (GEM) is developed to meet the needs of the next generation neutron facilities. A prototype has been constructed with single 50mm x50mm native THGEM(200um thick). Enriched boron-10 is coated on one surface of the aluminum cathode plate as the neutron convertor. 96 channel pads with each area of 4 mm x 4mm are used for fast signal readout. The maximum counting rate for each channel is 1MHz. In order to study the basic characteristics of boron-coated GEM, several irradiation tests were carried out with α source 239Pu and neutron source 252Cf. The signal induced by neutron has high signal-to-noise ratio. A clear image obtained from α source 239Pu is presented, which shows that the neutron beam monitor based on boron-coated GEM has good two-dimensional imaging ability.

65 Laser Etched LCP-GEMs and Their Applications to Space Missions

Oral

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Abstract

We present the production processes and properties of our laser etched LCP-GEMs in which liquid crystal polymer (LCP) is employed as an insulator layer. Recently the LCP-GEMs are widely used not only for the ground-based experiments, but also for the space missions which require high reliability to the GEMs. We present those space applications and their detectors.

The LCP-GEMs have basically the similar geometrical structure and electrical properties of the ordinary GEMs developed in CERN. A laser etching technique is used for drilling the hole of the LCP-GEMs, resulting that the cylindrical hole shape were formed. As widely believed, the cylindrical hole shape is the best for preventing the unexpected charging-up inside the wall of the holes. Consequently the LCP-GEMs shows very good (a few %) stability of electrical gain with elapsed time from the application of high-voltage. We also mention the importance of the new material, LCP, and foil thickness (100 micron) of our LCP-GEMs at the conference.

The LCP-GEMs were already flown by the rocket experiments CyXESS and EXOS, in which a GEM-based X-ray imaging detector combining with grating arrays were set on the mirror focal plane. In our X-ray polarimetry experiments onboard the GEMS satellite and the XACT rocket experiment, a GEM time projection chamber is employed and will be launch by 2014. Another activity on the X-ray polarimetry is led by INFN/Pisa; the LCP-GEMs is combined with an innovative pixel imaging ASIC.

66 Development of Micro Pixel Chamber with higher resistive electrodes

Oral

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Abstract

The Micro Pixel Chambers (μ-PIC) using resistive materials for its electrodes were developed and tested. The μ-PIC is one of MPGDs, in which there is no floating devices such as wire, mesh nor foil. It has been operated around 10^4 of gas multiplication for MIP particle and X-ray. However, the highly ionizing particles, such as low energy proton or heavy ions, invoke sparks between electrodes due to excess amount of ionization electrons, and it may destroy the electrodes. This is very critical problem for using MPGD for intense hadron experiments, such as LHC. To overcome this problem, the new design of the μ-PIC were developed. The cathode electrodes are covered by resistive materials, which reduce the electric field between anodes and cathodes on existence of dense ionized particle. In our first prototype, the gas gain more than 10^4 was observed. To overcome the remnant problems of discharges, several design of materials and structures were tested. The results of the tests and progress of developing new design will be reported.

67 Development of a Low-Power Read-Out System Using CMOS ASICs for a μ-PIC.

Poster

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Abstract

For astronomical observations, we have been developing an Electron Tracking Compton Camera (ETCC) based on a gaseous time projection chamber (μ-TPC) with a micro pixel gaseous chamber (μ-PIC), and scintillation cameras. With this camera, we have the balloon born experiment named SMILE. In a balloon-borne experiment, the power consumption is seriously restricted by capacity of batteries. To detect celestial gamma-rays, however, our Compton camera needs a detection volume of 30 × 30 × 40cm3 and the number of readout channels reaches more than 1500. Thus the power consumption has become a serious problem.

We have developed low power CMOS Front-End ASICs for a gaseous detector in collaboration with KEK. The chip, named FE2099bal, integrated 16 channels of a charge sensitive front-end amplifier, a shaper, and a discriminator has been designed and fabricated with the TSMC CMOS 0.5 µ m process. The equivalent noise charge at the input capacitance of 100 pF is around 5000 electrons. The power consumption is about 18mW/ch. Using 8 FE2009bal chips coupled with 10cm × 10cm μ-PIC, we successfully measured three-dimensional (3-D) tracks of cosmic-ray muons.

The readout board has also been developed. This board processes 128 analog signals from the μ-PIC. The board consists of two parts for processing analog signals and digital signals, and measures 118mm × 250 mm. The analog part is implemented using 8 FE2009bal chips. Two 10-bit 2ch ADCs with 100MHz sampling clock are also mounted on the board to measure analog output wave forms from FE2009bal chips. A Field programmable Gate Array (FPGA) is employed for digital signals from ASICs and ADCs. The count of the clock from the trigger input is also calculated by FPGA. The processed data is sent to VME memory board via 50MHz, 32bit parallel LVDS signals (1.6Gbps). Using this system, the total power consumption is about 80W for a 30cm × 30cm μ-PIC (1536 strips).

We present an introduction of the system and results of the experiments with this system.

68 Gaseous Detectors with Micropattern Gas Amplification Stages and CMOS Pixel Chip Readout

Oral

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Abstract

Gas Electron Multipliers (GEMs) and Micromegas have been used in many applications and have shown excellent performance. In particular the spatial resolution has improved significantly compared to wire based gaseous detectors. The limiting factor is given by the readout structure, since the pitch between the areas of gas amplification is significantly smaller than conventional pads or strips. To fully exploit the benefits of MPGDs we use a CMOS pixel chip with a pixel pitch of 55 µm (Timepix) in combination with a GEM stack or a Micromegas.

Both combinations have been tested in a time projection chamber with a maximum drift distance of 26 cm. Various running conditions were tested with the GEM-setup among which are high magnetic fields, hadron test beams and measurements with enlarged pixel sizes. Finally, also first results of an x-ray detector based on InGrids, the combination of Micromegas with a pixel detector, is presented.

69 Fast neutron beam test for Micro Pixel Chamber

Poster

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Abstract

The Micro Pixel Chamber(μ-pic) has been tested under fast neutron source.

This detector is developed as one candidate of replacement for ATLAS endocarp muon detector in LHC luminosity upgrade.

Under the ATLAS conditions, a higher background rate by neutrons are expected. The estimated rates of these may reach to about 500[Hz/cm^2] after the ATLAS luminosity upgrade.

The detector stability and operation conditions need to be studied under intense neutron conditions. Especially, fast neutron (around few MeV or tens few MeV) produce large energy deposit due to recoiled proton or nucleus.

The test was performed with a tandem accelerator(d(3MeV)+Be $\rightarrow$ B + n(7MeV)). Then, 7MeV neutron source (3MeV deuteron +Be target) were used for the test. Signal stabilities and spark rates were measured in various operation condition of μ-pic.

The results of the neutron beam test will be reported.

70 Simulation of GEM-TPC performance on Super-FRS beam diagnostics

Poster

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Abstract

Superconducting Fragment Separator will be constructed as one of the main devices exploited by NuSTAR collaboration at future FAIR facility. The monitoring on the separator will be performed with different types of detectors depending on the properties of the beam. One detector type that is considered to be used in beam diagnostics is GEM-TPC. Groups in Helsinki Institute of Physics and Comenius University in Bratislava are studying and developing GEM-TPC detectors for the Super-FRS.

To optimize the active volume of the detector and the materials to be used, different simulation tools to study the performance of the GEM-TPC detector in Super-FRS environment have been used. We will present the results of the simulations and discuss the different variations for detector geometries.

71 Performance studies of Micro Pixel Chamber for ATLAS upgrade

Oral

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Abstract

The LHC upgrade at 2022 will turn up luminosity to $5*10^{34}$.Therefore not only muons but cavern background will be increased.Those high rates will exceed the design limit in current detectors.The new detectors should be provided with high position resolution(¡100[μm]) for efficient trigger, high time resolution(¡25[μsec]) for accurate bunch ID, high efficiency for MIP, stability operation in high rate environment and correspondence for high energy deposit in gas volume by background fast neutron and gamma.Micro Pixel Chamber(μ-PIC) is being developed for the one of candidates of ATLAS endcap muon detector.mu-PIC is one of MPGDs and its microscopic anode and cathode are printed on insulated board, which permit high position resolution and stability operation in high rate environment by fast ion collection to cathode.In fact, mu-PIC has been already operated in 10^7[count/sec] gamma environment. μ-PIC have no floating structure such as wire, mesh or foil.It is made by printed-circuit-board(PCB) technology, which is suitable to bulk production.Other performances:time resolution, efficiency and correspondence for high energy deposit, are being studied now.The operation tests of time resolution and efficiency for MIP are performed with cosmic muon source.In addition, correspondence for high energy deposit is studied using fast neutron(few MeV$\sim$) source.In this presentation, the results of these operation tests will be reported.

72 The accelerator beam monitoring system using transparent microstrip gas counter for medical use

Poster

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Abstract

Gaseous radiation detectors are used in various applications, however, recent progress in the micro-pattern gaseous detectors can expand the application area of these well established radiation detectors. Optical observation is often very important since it provides tremendous information on the object (like a biological sample) to be detected. In particular, radiation imaging itself provides just a part of information on the application target. Microstrip gas counters (MSGCs) are still useful micropattern gas detectors because of its uniform response, high counting rate capability, fine resolution, etc. Normal metals such as Cr and Au are used in conventional MSGCs, which inhibit the use of optical readout through the substrate since most of the scintillation light is emitted during the avalanche process and the anode strip absorbs or reflects the light. Indium tin oxide (ITO) is widely used transparent electrode material. If the MSGC is transparent, it is also possible to observe the light of gas proportional scintillation counters through the substrate. This function simplifies the optical detector arrangement for position-sensitive beam monitoring detectors with Ar and CF4 gas mixture. We have decided to develop a transparent MSGC by using ITO electrodes.

Our new micro pattern gaseous detector is developed to meet the requirements of radiation therapy. In the therapy, doctors need to know where the beam is irradiated and the intensity of the beam. We have combined ITO MSGC with cooled CDD cameras via mirror to bend the light. Information of the position and size of the beam can be obtained through image of CCD camera, and the intensity of the beam can be obtained through the current in MSGC.

73 Study on New Glass Gem

Oral

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Abstract

Recently, various kinds of gaseous detector has been playing important roll in radiation detection and measurement. Especially, GEM (Gas Electron Multiplier) is one of the most widely used micro patterned gaseous detectors as electron multiplier. The most popular structure of the GEM is made with kapton 50 to 100 µ m thick foils. Thickness, diameter of the holes, and the pitch of the holes of the GEM are 100μ m, 70μm, and 140μm, respectively. GEM is widely used because of its great spatial resolution. GEM is used as Compton Camera, Time Projection Chamber, for medical use, and others.

However, the conventional kapton foiled GEM has weak points. One of the weak point is since the foil is soft material, there are difficulty in uniformity. And another weak point is the outgas from the organic material.

In order to overcome these weak points of GEM, we have developed GEM with glass material. The glass is called PEG3, the photo sensitive glass material made of HOYA-PENTAX co. ltd. Using this material and we made electrodes with Cr layer. Using this GEM, we obtained 2000 gas gain with Fe-55 source.

In the conference, we will introduce our new structure with guard rings in each hole and the detailed characteristics of our new glass GEM.

74 Production, progress and application of GridPix detectors.

Oral

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Abstract

We will report on the production of GridPix (= TimePix + protection layer + InGrid) by IZM, Berlin. GridPix has been operated succesfully in pure gaseous

Ar in a LAr cryostate, which is relevant for WIMP search and 0v-double beta decay experiments. There is a strong interest to apply GridPix as photondetector (in the range of 100 ev - 1 MeV). In addition, GridPix can be well applied as Level 1 momentum trigger due to its accurate intrinsic measurement of track angles.

75 THGEM-based potential active elements for DHCAL: Laboratory and Beam results

Oral

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Abstract

We will report on the results of an extensive R&D program aimed at the application of Thick-Gas Electron Multipliers (THGEM) as active elements for Digital Hadron Calorimetry (DHCAL). Results will presented on gain, efficiency and charge spread of a 10x10 cm2 prototype detector with 1cm2 readout pads. The detector is comprised of single- or double-THGEM multipliers coupled to the pad electrode either directly or via resistive anode. It has been investigated in the laboratory with x-rays and cosmics and at the CERN-RD51 test beam with muons and hadrons, employing standard discrete electronics and the SLAC-KPiX readout system. It has been shown that even the single-element THGEM-based detector can deliver sufficient charges above noise, when irradiated with MIPs, yielding efficiencies above 95%. The operation with resistive anodes, useful for discharge damping, will be discussed; methods will be presented to reduce charge-spread with such films.

The new method showed good prospects for the design of very thin detectors with competitive performances, simplicity and cost that could become potential active elements for DHCAL. Further developments will be discussed.

76 Further investigations of a cryogenic gaseous photomultiplier for noble-liquid scintillation

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Abstract

Recent results on the operation of a cryogenic gaseous photomultiplier (GPM) for UV scintillation-light detection from liquid-xenon will be reported. The GPM consists of a Thick Gas Electron Multiplier (THGEM) coated with a reflective CsI photocathode followed by additional electron multipliers: THGEM or Parallel Ionization Multiplier (PIM) and MICROMEGAS. The photon detector, with a MgF2 window, has been operated in gas-flow mode with: Ne/CH4 (95:5), Ne/CF4 (95:5) and Ne/CH4/CF4 (90:5:5) at cryogenic temperatures (down to 165K). Gains of 10^4 were measured with soft X-rays at 173 K with a double-THGEM detector. Liquid-xenon scintillation signals induced by 238Pu alpha-particles were observed with a CsI-coated double-THGEM detector in He/CH4 (92.5:7.5) and with a triple-structure detector combining a CsI-coated THGEM, a PIM and a MICROMEGAS in Ne/CH4 (90:10) with a fast-current preamplifier. We will discuss the operation principles, CsI photocathode properties at cryogenic conditions and amplification properties. Applications to a liquid-xenon TPC Compton Camera and to dark-matter detection will be discussed.

77 Recent results from T2K

78 Links of detectors and Physics

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August 24, 2011

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