The 8th International Conference on Micro Pattern Gaseous Detectors (MPGD2024)

Report of Contributions

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Contribution ID: **1** Type: **not specified**

EIC and ePIC Detector （Invited speech）

Monday 14 October 2024 09:00 (30 minutes)

Invited speech
EIC and ePIC Detector

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Presenter: TORRE, Silvia Dalla (INFN, Trieste)

Session Classification: Session1

Contribution ID: **2** Type: **not specified**

Comparative study of resistive MPGD technologies

Tuesday 15 October 2024 11:40 (25 minutes)

Resistive Micro-Pattern Gaseous Detector (MPGD) technologies, such as Micro-Mesh Gaseous Structure (Micromegas), Micro Resistive WELL (uRWELL), and Resistive Plate WELL (RPWELL), are single-stage amplification detectors where signals are induced on the readout electrode through a resistive material. While these technologies have been extensively studied for various applications, their performance has not been systematically compared under similar controlled conditions using an identical readout scheme. In this study, we present the first comparative results on the characterization of Micromegas, uRWELL, and RPWELL detectors.

The characterization is conducted using a laboratory cosmic test bench and the SPS NA H4 beam facility, employing a common setup with VMM3a/SRS readout . Key performance parameters evaluated include:
detection efficiency
charge and time response
pad multiplicity
gain uniformity
electrical stability
rate capability
Additionally, the characterization is performed considering the potential application of Resistive MPGDs in Digital Hadron Calorimetry (DHCAL).
Our findings facilitate informed choices for their application in various experimental scenarios, including DHCAL.

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Presenter: ZAVAZIEVA, Darina (Ben-Gurion University of the Negev, Weizmann Institute of Science)

Session Classification: Session 6

Contribution ID: **3** Type: **not specified**

PMT analysis for Negative Ion Drift and 3D reconstruction

Monday 14 October 2024 11:40 (25 minutes)

CYGNO/INITIUM is a directional TPC detector for low energy rare event searches with the purpose of detecting low mass (0.5-50 GeV/c2) WIMPs and performing solar neutrino spectroscopy. This project establishes itself by its strong directionality capabilities, the use of gaseous He:CF4 at atmospheric pressure, and optical readout.

In CYGNO detectors, the amplification is achieved by a stack of three GEMs that amplify the primary charge and, consequently, produce light due to the scintillating properties of the gas. The readout of our detectors is carried out through the combined use of a sCMOS camera and PMTs. The high sensitivity of these sensors renders possible the 3D reconstruction of ionizing events and the measurement of the energy, direction and head-to-tail asymmetry of particles.

Complementary, the goal of INITIUM is to test and characterize the introduction of SF6 in the CYGNO gas mixture. SF6 leads to the creation of negative ions at the primary ionization stage. The ion drift, when compared to electrons, strongly suppresses diffusion, allowing for much better spatial resolutions.

In this presentation, we will present the PMT analysis of real data taken in the context of the CYGNO/INITIUM experiment. On one side, we will discuss the longitudinal diffusion measurements obtained through the analysis of PMT waveforms in negative ion drift (NID) mode. The results were cross-analysed with the transverse diffusion measurements obtained with the sCMOS sensor, and also compared with literature. On the other side, we will discuss the CYGNO's results on 3D track reconstruction capability achieved by merging the light time profile (dZ) obtained with the PMT signals with the 2D (X-Y) projection of the sCMOS camera. When merged with the direction and 3D head-to-tail capabilities of CYGNO, this is expected to allow CYGNO to reduce backgrounds coming from known sources and to improve particle identification.

David J. G. Marques on behalf of the CYGNO collaboration

Author: MARQUES, David (Gran Sasso Science Institute)

Presenter: MARQUES, David (Gran Sasso Science Institute)

Session Classification: Session 2

Contribution ID: **4** Type: **not specified**

Study on the long-term stability of thermal bonding Micromegas detectors for high gas pressure experiments

Monday 14 October 2024 10:20 (25 minutes)

Micro-pattern gas detectors (MPGDs) are widely used to measure particle momentum and trajectory in high-energy physics research. Operating at high pressures has expanded their ability to measure the energy spectrum of electrons and gamma rays at the MeV energy level, and have considerable prospects in the next generation of rare event searches and space astronomy experiments. For example, the NEXT and PandaX-III experiments are committed to searching for neutrino-less double beta decay events of 136Xe at pressures of 10 bar and above, and experiments such as HARPO, SMILES-2+, AdEPT, and MeGaT are designed to detect MeV gamma rays in the balloon-based or satellite-based scenarios. However, to date, how to ensure the long-term stable and high-performance operation of MPGD detectors under high-pressure conditions remains a big challenge.

Over the past few years, we've researched high-stability, high-performance Micromegas detectors using thermal bonding for the PandaX-III experiment under 10 bar xenon conditions. We developed a low-background, high-resolution detector and conducted tests under high-pressure conditions. However, the detector with thermal bonding film spacers still faces challenges in achieving long-term stability under high-pressure xenon conditions. To this end, we continue to study methods to achieve high-pressure stability of detectors, starting from the materials and manufacturing processes. We will review the relevant research experience, demonstrate the performance of the detector, and focus on analyzing the key factors that affect the stability.

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Session Classification: Session1

Contribution ID: **5** Type: **not specified**

Real time Migdal effect searches with deep learning-based object detection

Monday 14 October 2024 11:15 (25 minutes)

A number of direct dark matter detection experiments invoke the Migdal effect to extend their sensitivities to sub-GeV masses; however, this effect has yet to be observed in nuclear scattering. The Migdal in Galactic Dark mAtter expLoration (MIGDAL) experiment aims to, for the first time, directly image and characterize the Migdal effect in nuclear scattering by recording high statistics of nuclear recoils in a low pressure optical gas time projection chamber (OTPC). The OTPC uses double glass GEM amplification with combined optical and charge readouts, capable of fully reconstructing 3D ionization tracks in the 50 Torr CF4 volume.
This talk will highlight results of commissioning runs in the presence of a high intensity neutron beam from a D-D generator. Additionally, we will introduce our novel application of YOLOv8 –a state-of-the-art deep learning-based object detection algorithm trained on real data –that enables real time Migdal effect searches on high resolution images recorded by the CMOS camera readout of the OTPC. Our simulation studies quantify YOLOv8's ability to detect faint electronic recoils heavily obscured by bright overlapping nuclear recoils. The results of these studies illustrate the importance of mitigating diffusion and optical effects that obscure the electronic recoil signature of the Migdal effect. Finally, we apply YOLOv8 to a large sample of real data, demonstrating its ability to efficiently select Migdal effect candidates while reducing orders of magnitude of background.

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Session Classification: Session 2

Contribution ID: **6** Type: **not specified**

Wavelength shifters for optically read out MPGDs

Tuesday 15 October 2024 12:05 (25 minutes)

Optical readout of MPGDs achieves high spatial resolution with state-of-the-art pixellated imaging sensors for applications ranging from optical Time Projection Chambers (TPCs) to imaging and detector characterisation. Gas mixtures containing CF4 are the most popular choice for optically read out MPGDs due to their strong visible light yield. This presents challenges due to decreasing availability of CF4 and its classification as greenhouse gas and limits the usability of optical readout. Alternative approaches include the use of UV-sensitive imaging sensors or the use of wavelength shifting to convert light to a wavelength range compatible with the sensitivity of readout devices.

We present studies of solid wavelength shifters including Tetra-Phenyl-Butadiene (TPB) and PolyEthylene Naphthalate (PEN) layers which were used to convert secondary scintillation light in the (V)UV range to visible light. The re-emission of both materials is compatible with conventional imaging sensors. In comparison, TPB achieves higher conversion efficiency, while PEN is readily available and may be advantageous for integration into detectors due to its higher robustness.

Spectroscopic measurements are performed to confirm re-emission from wavelength shifting layers. The achievable spatial resolution of GEM and Micromegas detectors combined with semi-transparent wavelength shifting layers deposited on right substrates to enable optical readout is studied. X-ray radiography is used to quantify the effect of the separation of amplification stage and wavelength shifter spatial resolution. The deposition of a wavelength shifting layer on the anode in a bulk glass Micromegas detector minimises blurring and yielded the best results with spatial resolution comparable to the case of direct readout of CF4-based gas mixtures.

Operation in pure noble gases with wavelength shifters coupled to (M-)THGEM detectors is studied which extends the versatility of the optical readout approach for TPCs and reduces limitations on gas mixture composition.

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Presenter: BRUNBAUER, Florian Maximilian (CERN)

Session Classification: Session 6

Contribution ID: **7** Type: **not specified**

Improving understanding of negative ion avalanche formation (to be confirmed)

Gaseous Time Projection Chambers (TPCs) have distinct advantages in a WIMP dark matter search, as well as other fields, owing to their ability to sense the highly directional nature of the signals [1,2]. How- ever, increasing the detector scale has presented technical challenges, especially electron diffusion over large drift distances. Electronegative TPC gases, such as SF6 [3] form negative ions, which show much lower levels of signal diffusion, promising increased track resolution. This improvement however, is ac- companied by low achievable gain and poor energy resolution. Efforts to improve the energy resolution have been focused on optimising electron detachment during avalanche amplification in the MPGD de- tector elements.

In this presentation I will give an overview of the CYGNUS-Oz collaboration, and discuss experimental and simulation investigations focusing on negative ion detachment and avalanche. The experimental measurements make use of an upgraded CYGNUS-1 prototype gaseous TPC operating at the Australian National University. The simulation studies make use of COMSOL multiphysics field simulations and a version of Garfield++ [4], modified to simulate electronegative gases.

[1] C. Lisotti et al., arXiv:2404.03690
[2] S. Vahsen, C. O'Hare and D. Loomba, Annu. Rev. Nucl. Part. Sci. 2021. 71 189-224
[3] N.S. Phan et al., 2017 JINST 12 P02012
[4] H. Schindler, Garfield++. http://garfieldpp.web.cern.ch/garfieldpp/, Accessed: 05-06-2024

Keywords

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Session Classification: Session 2

Contribution ID: **8** Type: **not specified**

Optical readout of MPGDs: applications and R&D (Invited speech)

Monday 14 October 2024 14:00 (30 minutes)

Invited speech
Optical readout of MPGDs: applications and R&D

Author: BRUNBAUER, Florian Maximilian (CERN)

Presenter: BRUNBAUER, Florian Maximilian (CERN)

Session Classification: Session 3

Contribution ID: **9** Type: **not specified**

GEM Detectors for the CMS Endcap Muon System:status of three detector stations

Monday 14 October 2024 14:30 (25 minutes)

The High-Luminosity LHC (HL-LHC), due to start operations in 2029, aims to achieve instantaneous luminosities 5 to 7.5 times higher than the LHC nominal value. To effectively address the muon triggering and reconstruction performance under high background levels, the CMS collaboration is conducting several upgrades for the present systems. Among these, the Gas Electron Multiplier (GEM) detector project aims to instrument the very forward region of the CMS Muon system. The first Triple-GEM station (GE1/1) was installed during Long Shutdown 2 (LS2, 2019-2021), and demonstrators of the second station (GE2/1) were installed in Winter 2023-24. A new six-layer station (ME0) is scheduled for installation during the third Long Shutdown (LS3, 2026-2028), and is currently in the production phase. GE1/1 and GE2/1 are considered as early Phase-2 upgrades, aimed to reduce the pT threshold by combining GEM and Cathode Strip Chamber (CSC) hits in the forward muon system at twice the LHC's design luminosity. In Run-3, started in 2022, commissioning of the GE1/1 station and GE2/1 demonstrators is nearly complete: most chambers operate stably with an efficiency exceeding 95%. Insights gained from the first large-area GEM station have led to improvements in the detector and electronics design. This talk will provide a general overview of the status of the three CMS GEM stations, the lessons learned from the production of GE1/1 and GE2/1, the design improvements, the start of ME0 construction, and the ongoing R&D for ME0.

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Session Classification: Session 3

Contribution ID: **10** Type: **not specified**

ATLAS Micromegas Performance Studies with LHC Run3 Data

Monday 14 October 2024 14:55 (25 minutes)

ABSTRACT SUBMITTED BY THE ATLAS-MUON-SPEAKERS-COMMITTEE ON BEHALF OF THE ATLAS MUON COMMUNITY
THE SPEAKER NAME CAN ONLY BE COMMUNICATED AFTER THE SELECTION DONE UPON ACCEPTANCE OF THE CONTRIBUTION

After successfully completing Phase I upgrades during LHC Long Shutdown 2, the ATLAS detector is back in operation with several upgrades implemented. The most important and challenging upgrade is in the Muon Spectrometer, where the two inner forward muon stations have been replaced with the New Small Wheels (NSW) system. One of the two detector technologies used in the NSW are the resistive Micromegas (MM).
After massive construction, testing and installation work in ATLAS, the Micromegas are now fully operational in the experiment participating in the muon spectrometer tracking and trigger systems. A huge effort has gone into the operation of the new data acquisition system, as well as the implementation of a new processing chain within the muon software framework.
Tracking is performed with full consideration of the absolute alignment of each individual detector module by the ATLAS Muon Spectrometer optical alignment system. All the deviations from the nominal geometry of all the constituent elements of each MM module are accounted for through the modelling of the real chamber geometry reconstructed from the information of the construction databases.
After an overview of the strategies adopted for the simulations and reconstruction, the studies on the performance of the MM in LHC run-3 data taken from 2022 to 2024 will be reported.

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Session Classification: Session 3

Contribution ID: **11** Type: **not specified**

Development of a new large area Micromegas detector and its ToRA-based readout electronics for AMBER experiment at CERN

Thursday 17 October 2024 11:15 (25 minutes)

In the context of the Physics-Beyond Colliders initiative at CERN, AMBER (NA66) is a fixed-target experiment at M2 beam line of the SPS, devoted to various fundamental QCD measurements. Several upgrades of the spectrometer are planned for the medium and long-term AMBER program. Among the R&D plans, a portion of the COMPASS Multi-Wire Proportional Chambers (MWPCs) will be replaced to address their structural aging. The chosen technology to substitute the most aged MWPCs is the Micro-Pattern Gaseous Detectors (MPGD), specifically a resistive bulk MICRO-MEsh-GAseous Structure (micromegas) detector. Three adjacent large-area micromegas detectors will cover a total active area of roughly 1x1.5 mˆ2; each micromegas module having an area of about 1x0.5 mˆ2. Each module has two readout planes in a face-to-face configuration and a common cathode providing an XUV space measurement. For the lateral modules an uniform 10MOhm/sq Diamond-Like Carbon (DLC) layer will be deposited above the readout strips, whereas the central module is planned with a double resistive layer configuration.

Currently, both the mechanical structure and the readout planes of the lateral micromegas detector have been designed, and the production of the first module is underway, expected to be ready within the end of September 2024. The first test with TIGER-based front-end electronics is foreseen in October 2024. Leveraging results gained from prior tests, with TIGER based FEs, and relying on the expected signal properties for both Micromegas and Wire chambers, a new 64-channel mixed-signal front-end Application Specific Integrated Circuit (ASIC) for time and energy measurements is under development together with the detector. The ongoing work on the detector and on the front-end electronics based on the new ASIC ToRA (Torino Readout for AMBER), will be presented.

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Session Classification: Session 12

Contribution ID: **12** Type: **not specified**

Performances of a Medium-Size Boron-coated GEM detector for thermal neutrons at the ISIS Neutron and Muon Source

Monday 14 October 2024 15:45 (25 minutes)

Experiments at neutron spallation sources require detectors with specific features such as capability to sustain high count rates and high detection efficiency.
Gas detectors based on Gas Electron Multiplier (GEM) technology distinguish themselves from other gaseous detectors thanks to their good spatial resolution, good detection efficiency, large surface covering and very high rate capability (>MHz/mm2). Moreover, coupling a GEM detector with a custom electronic readout, high rates are sustained avoiding dead time and pile-up phenomena. This system makes GEM detectors very attractive for facilities where a high neutron flux rate is expected, such as the European Spallation Source (ESS).
Future experiments will need detectors with more stability and higher detection efficiency today available ones; in this work, the measurements of a detector based on GEM technology optimized for thermal neutrons, jointly developed by UNIMIB and ISTP-CNR, are shown.
The detector is characterised by the exploitation of the innovative double-sided boron-coated GEM foils (BGEM). The presence of multiple BGEM foils, at least 6, will allow us to increase the detection efficiency with respect to the single-layer boron-coated GEM detector. This work presents the measurements performed with thermal and epithermal neutrons at the ISIS Neutron and Muon Source at the VESUVIO beam line.
The Medium Size Boron-GEM (I-MS-BGEM) detector has been characterised in terms of counting rate stability and capability to discriminate gamma rays from neutrons and it has shown a detection efficiency of 16% at 1.8Å.
Starting from these results, future boron GEMs will be developed with different anode configurations, in order to also perform imaging with good spatial resolution.

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Presenter: CANCELLI, Stephanie (University of Milano-Bicocca)

Session Classification: Session 3

Contribution ID: **13** Type: **not specified**

Research on TPC physics experiments and simulation methods at Back-n white neutron source

Monday 14 October 2024 16:40 (25 minutes)

In response to the needs of cross-section measurement at the CSNS Back-n white neutron source, Multi-purpose Time Projection Chamber (MTPC) is constructed. As a gas detector, MTPC has the characteristics of large solid angle and high detection efficiency. Compared with traditional ionization chambers, MTPC uses a resistive micromegas readout at the anode. This design enables MTPC to have the advantages of high electron gain and multi-channel readout, which can realize three-dimensional reconstruction of particle tracks and better identification of charged particles. From the design of the detector system to the conduct of the experiment, our team has completed a complete preliminary study. It is worth mentioning that during this process, we completed the design and processing of the detector structure, the development of the dedicated electronics system, and the development of the simulation and data analysis program. Currently, MTPC is widely used in neutron nuclear reaction cross-section measurements. The experiments that have been successfully carried out include 6Li(n, t)4He, 232Th(n, f) and n-p scattering experiments.

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Presenter: CHEN, Haizheng (Dongguan Neutron Science Center)

Session Classification: Session 4

Contribution ID: **14** Type: **not specified**

Performance of resistive MPGD for hadron calorimeter

Monday 14 October 2024 17:05 (25 minutes)

A multi-TeV muon collider has been proposed as a powerful tool to explore the Standard Model with unprecedented precision, as a possible successor of the High-Luminosity LHC. The Muon Collider aims for precise Higgs boson coupling measurements and searches for new physics at the TeV scale, requiring accurate event reconstruction and particle identification. The Particle Flow Algorithm (PFA), which integrates data from various subsystems, is well-suited for this task. However, one major challenge for the Muon Collider is mitigating the muon beam-induced background (BIB), which affects the detector performance. Therefore, the implementation of a PFA at the Muon Collider calls for the use of precise, robust and radiation-hard detector technologies allowing for precise signal reconstruction and background rejection.

This contribution presents the studies for the development of a hadronic calorimeter for the Muon Collider using resistive Micro Pattern Gas Detectors (MPGD). This MPGD-based calorimeter is ideal for PFA thanks to the high-granular readout capabilities (O(cm2)) and particularly suitable for the Muon Collider background conditions, thanks to its radiation-hard technology and high rate capabilities (up to 10 MHz/cm2). Furthermore, resistive MPGDs, such as resistive Micromegas and μ-RWELL, offer excellent spatial resolution, operational stability (discharge quenching), and uniformity, making them well-suited for calorimetry.

The results of the characterization studies performed with muon beam at CERN SPS on three MPGD technologies, resistive MicroMegas, μ-RWELL, and RPWELL, are presented. Additionally, preliminary results for an HCAL cell prototype consisting of eight layers (˜1 λ) of alternating stainless steel and MPGD detectors tested with pion beams of energy ranging up to 10 GeV are shown.

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Presenter: STAMERRA, Anna (INFN, Bari)

Session Classification: Session 4

Contribution ID: **15** Type: **not specified**

The CYGNO experiment, a Gaseous TPC for directional Dark Matter searches

Monday 14 October 2024 09:55 (25 minutes)

The CYGNO experiment, a Gaseous TPC for directional Dark Matter searches

Davide Fiorina, on behalf of the CYGNO collaboration

The CYGNO/INITIUM project introduces an innovative approach to directional Dark Matter detection using a gaseous Time Projection Chamber (TPC). Targeting low mass (0.5-50 GeV) WIMPs, the experiment uses a He/CF4 gas mixture sensitive to both spin-dependent and spin-independent interactions at atmospheric pressure with optical readout. Building on the success of our 50 L prototype, LIME, we aim to deploy a 0.4 m^3 demonstrator, CYGNO04, at Laboratori Nazionali del Gran Sasso (LNGS) between 2024 and 2026 to validate the technology's performance and scalability.

In CYGNO detectors, particle interactions ionize the gas, creating electrons that drift to the amplification stage, consisting of three Gas Electron Multipliers (GEMs). The readout system combines a scientific CMOS (sCMOS) camera and Photomultiplier Tubes (PMTs) to detect light produced during electron avalanches. This light is captured in a two-dimensional (X-Y) projection by the sCMOS camera and a time profile (dZ) by the PMTs, enabling 3D reconstruction of ionizing events. High granularity and rapid response allow detailed energy deposition mapping, supporting topology, directional, and head-to-tail recognition.

Results from LIME, which conducted data taking at the underground LNGS labs, show significant advancements in particle identification and 3D tracking capabilities. We will present these findings alongside our latest R&D progress with smaller prototypes aimed at optimizing the gas mixture composition with the addition of SF6 and H-rich gases, as well as enhancing experimental techniques. Additionally, we will present a feasibility study for a solar neutrino observatory, indicating further scientific potential.

Recent progress on the CYGNO-04 status will be presented, highlighting its role in the project's future. The CYGNO/INITIUM project will contribute substantially to Dark Matter detection, and the possibility that this same detector could perform neutrino measurements sets the stage for future large-scale experiments.

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Presenter: DAVIDE, Fiorina (GSSI & INFN)

Session Classification: Session1

Contribution ID: **16** Type: **not specified**

Simulating Timing Performance of Resistive Detectors with Garfield++

Monday 14 October 2024 17:55 (25 minutes)

With the stringent requirements on the performance and robustness of timing detectors under the unprecedented conditions of future high energy physics experiments, contemporary detector designs are being refined with the incorporation of resistive elements for increased operational stability. Thorough simulations of the signal formation process and noise sources in these devices are therefore crucial for comprehending and optimizing their performance.

In this presentation, the Garfield++ simulation chain for evaluating the performance of resistive timing detectors will be discussed, covering strategies for simulating large avalanches, signal induction in the presence of resistive elements, contributions from the front-end electronics, and signal arrival time corrections. Along the way concrete examples, such as the resistive plane PICOSEC Micromegas (MM), will be highlighted. Emphasis will be placed on the contribution of resistive elements, such as diamond-like carbon layers, to signal formation —particularly to the leading edge of the signal. In addition to influencing the signal induction on the readout electrodes, resistive elements also contribute to the noise power spectrum of the detector.

Given the crucial role of the signal-to-noise ratio in the timing performance, a breakdown of the different noise sources will be provided, especially for the Johnson–Nyquist noise arising from the resistive elements. Following Nyquist's work, the complex impedance Z(f) of the detector, as seen by the input of the front-end electronics, will be identified as the key quantity defining the thermal noise power spectrum. Analytical expressions for Z(f) will be presented for some toy examples, while for more complex detector geometries a numerical methodology using the finite element method will be outlined.

These strategies are applicable across resistive gaseous detector technologies such as (multi-gap) resistive plate chambers, resistive Micromegas (MM), and μRWELL. In the final part of the presentation, a brief illustration will be provided on how these simulations can be extended to solid state detectors such as silicon photomultipliers, AC-coupled LGADs, and 3D diamond sensors.

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Session Classification: Session 4

Contribution ID: **17** Type: **not specified**

Future Colliders for High Energy Physics in China (CEPC & STCF) （Invited speech）

Tuesday 15 October 2024 09:00 (30 minutes)

Invited speech
Future Colliders for High Energy Physics in China (CEPC & STCF)

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Presenter: LIU, Jianbei (University of Science and Technology of China)

Session Classification: Session 5

Contribution ID: **18** Type: **not specified**

Robust photocathodes and spatial resolution studies of resistive PICOSEC Micromegas precise-timing detectors

Tuesday 15 October 2024 10:20 (25 minutes)

The PICOSEC Micromegas precise-timing detector concept, combining a Cherenkov radiator, semi-transparent photocathode and double stage amplification stage, has demonstrated a time resolution below 20ps for minimum ionising particles. To extend the versatility of PICOSEC Micromegas detectors for various applications, specific developments of robust detector elements including carbon-based photocathodes and resistive Micromegas as well as detector variants targeting improved spatial resolution and rate-capability are presented.

Photocathodes made on thin layers of diamond-like carbon (DLC) or boron-carbide (B4C) were evaluated as an alternative to CsI for improved stability under prolonged ion back flow. Time resolution values better than 40 ps were achieved and the optimal thicknesses of semi-transparent photocathodes of the two materials were determined.

PICOSEC prototypes based on resistive Micromegas technology have previously been shown to achieved comparable spatial resolution to non-resistive prototypes. Multi-pad detectors can provide spatial information of detected particles and resistive or capacitive charge sharing may be exploited to increase spatial resolution. Prototypes with higher readout granularity down to 2.5 mm pitch are presented and compared for achievable spatial resolution and the impact of sharing signals across multiple readout pads on achievable timing precision.

While resistive Micromegas are favourable for challenging operating conditions, high anode resistivity limits the achievable rate capability. A resistive PICOSEC Micromegas prototype using vertical charge evacuation with double DLC layers is presented to combine protection from discharges with improved rate capability. The presented developments target specific optimisation of the PICOSEC Micromegas concept and highlight the versatility of this precise-timing concept.

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Co-author: BRUNBAUER, Florian (CERN)

Presenter: JANSSENS, Djunes (CERN)

Session Classification: Session 5

Contribution ID: **19** Type: **not specified**

Experimental comparison of strip micromegas readouts in gaseous TPCs for directional recoil detection

Tuesday 15 October 2024 09:55 (25 minutes)

Imaging the detailed 3D topology of ionization in detectors is broadly desirable in nuclear and particle physics. Of particular interest is the directional detection of nuclear recoils from neutrinos or dark matter, which may prove critical for probing dark matter beneath the neutrino fog and affirming its galactic origin. Gaseous time projection chambers (TPCs) can provide the required low-energy directionality and in this context high-resolution x/y strip readouts are identified as the optimal balance between cost-efficiency and performance. We present an experimental comparative analysis of nine distinct x/y strip configurations with a Micromegas amplification stage. The VMM3a ASIC within the RD51 Scalable readout system (SRS) is used to read out individual strips, while the Micromegas avalanche charge is recorded with a pulse height analyzer system. These two complementary charge readout techniques are used with radioactive sources to characterize the gain, gain resolution, x/y charge sharing, and point resolution of each setup, in order to identify the optimal charge readout configuration. Additionally, we discuss how these results have informed the design of a 40L strip Micromegas TPC currently under development.

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Presenter: MAJD, Ghrear (University of Hawaii)

Session Classification: Session 5

Contribution ID: **20** Type: **not specified**

PICOSEC Micromegas precise-timing detectors towards large-scale applications and optimization

Tuesday 15 October 2024 09:30 (25 minutes)

Precise-timing detection techniques are in high demands for future particle physics experiments. PICOSEC Micromegas (MM) is a precise timing gaseous detector based on a Cherenkov radiator coupled with a semi-transparent photocathode and a MM amplifying structure. Single-channel prototype has successfully achieved a sub-25ps time resolution with MIP, followed by ongoing developments to make the concept suitable for physics applications. The main objective is to develop robust, large-area and scalable detectors with high time resolution, along with a dedicated fast-response readout electronics. New single-channel detector prototype was designed focusing on improving stability, reducing noise, ensuring signal integrity and achieving uniform time response over entire active area. Recent developments towards robust PICOSEC MM include producing resistive MM and optimizing robust photocathodes. Resistive MM equipped on the single-channel prototype obtained comparable precision to a non-resistive prototype, exhibiting an excellent time resolution of 12 ps. Alternative photocathodes, including Diamond Like Carbon (DLC) and Boron Carbide (B4C) are measured in details as replacements for CsI, which can be easily damaged by ion back flow and discharges. Further progress includes the design and fabrication of a resistive 10x10 cm2 area multi-channel prototype, achieving a timing performance of 20 ps for individual pads. A large-area solution of 20x20 cm2 utilizing crystal splicing has been developed, facilitating further expansion to large area coverage. Meanwhile, two types of readout electronics systems—one with RF pulse amplifiers and SAMPIC-based waveform digitizers, another with RF amplifiers and DRS4-based waveform digitizers—have been developed and tested with the detectors, both achieving timing performance comparable to results obtained with oscilloscopes. Additionally, efforts have been made to find environmentally friendly gases as replacement of the original working gas, successfully reaching a time resolution of ˜17 ps with a Ne/Iso mixture as an alternative to the standard Ne/CF4/C2H6 gas mixture. These advancements demonstrate the potential of PICOSEC MM to meet the stringent requirements of future particle physics experiments.

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Co-author: ZHOU, Yi (University of Science and Technology of China)

Presenter: MENG, Yue (University of Science and Technology of China)

Session Classification: Session 5

Contribution ID: **21** Type: **not specified**

The SampaSRS integration: applications, results and future collaborations

In this work we present the latest results and applications of the SAMPA chip integrated into the Scalable Readout System (SRS). Developed to work as the Front-End of ALICE TPC and Muon Chamber, SAMPA is now adapted to the SRS framework developed by the RD51 (now DRD1) collaboration. Using a custom developed hybrid and adapter board it is possible to read data from up to 512 electronic channels (16 SAMPAs). We present the results of a triple-GEM based X-ray imaging system that is capable of reaching a position resolution better than 400 μm, with 10% energy resolution for 5.9 keV (σ). We also are going to present future work and collaborations with different groups that intend to use SAMPA as their readout electronics.

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Session Classification: Session 6

Contribution ID: **22** Type: **not specified**

The micro-RWELL for future HEP challenges and beyond

Monday 14 October 2024 09:30 (25 minutes)

The challenges posed by the forthcoming High-Energy Physics experiments, necessitate the development of particle detection technologies that are easily engineered and compatible with industrial-scale production. The micro-RWELL, a single-amplification stage resistive MPGD based on sequential build-up technology, effectively meets these demands. In this contribution, we provide an overview of the detector characteristics, outlining the design and testing steps conducted at INFN-LNF. Additionally, we offer a schematic description of the construction processes performed at the ELTOS Company and CERN MPT Workshop.
The experience detailed in this contribution indicates that a significant portion of the detector construction can be effectively carried out by the industry, providing substantial advantages in terms of production time and cost-effectiveness. Furthermore, it is crucial to highlight the significant effort invested in the production of large DLC (Diamond-Like-carbon) foils, a fundamental component of the detector amplification stage. The acquisition of the DC-magnetron sputtering machine, a fruitful joint venture between CERN and INFN, represents a crucial development, allowing a remarkable advancement in this technology.
The results of the tests carried out with an X-ray gun at LNF and particle beams at the CERN North Area beam facility are then discussed in detail. Preliminary outcomes of the co-production pilot test performed in 2023 are summarized, indicating a production yield of approximately 90%. The fruitful experience gained in this phase of the technology transfer is a first step towards the construction of larger detectors, as envisaged for the forthcoming challenges in HEP.
In parallel with the technology transfer to industry and the refinement of the detector construction process, aimed at meeting the significant construction challenges of future large-scale High Energy Physics experiments, we have pursued various R&Ds to optimize the micro-RWELL detector for other applications. These include their deployment as fine tracking detectors for the Muon system of FCC-ee, the development of a low-mass cylindrical micro-RWELL for the Inner Tracker of low momentum e^+e^- colliders, and the creation of a simplified micro-RWELL for use as a slow neutron sensor in Radiation Portal Monitors for airports or ports in Homeland Security applications.
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Presenter: GIOVANNETTI, Matteo (INFN-LNF)

Session Classification: Session1

Contribution ID: **23** Type: **not specified**

Towards MPGDs with embedded pixel ASICs

Monday 14 October 2024 17:30 (25 minutes)

Lucian Scharenberg on behalf of the CERN EP-DT-DD GDD team

To reconstruct the interaction position of particles, most MPGDs employ anode structures with strip pitches or pad sizes of hundreds of micrometres up to several millimetres. By using hybrid pixel ASICs with pixel pitches of typically 50 µm as readout anode, the granularity is increased significantly. This offers the possibility for various experimental applications (e.g. X-ray polarimetry, rare-event searches, micro-dosimetry or neutron detection) to perform the event selection, based purely on geometrical parameters, i.e. the event topology.

In this presentation, a new research line within the CERN EP R&D programme is presented. The goal is to combine MPGDs with the Timepix4 ASIC. The Timepix4 has an active area of around 7 cm² with 512 x 448 square pixels (55 µm pitch). It can record particle interactions with up to 3.6 MHz/mm², each of its pixels provides the charge information with around 700 electrons resolution and the signal arrival time with around 200 ps resolution. Most importantly, however, the Timepix4 contains Through Silicon Vias (TSVs), which enable a full connection of the ASIC from the back side. Thus, it can be tiled on four sides, allowing it to cover large areas without loss of active area.

As part of the research line, triple-GEM and µRWELL detectors are read out with the Timepix4. The goal of the µRWELL studies is to investigate a possible next step, the embedding of the Timepix4 ASIC into a µRWELL foil, using standard PCB technologies. An additional target of the research line is the investigation of producing and embedding hybrid ASICs with larger pixel pitch, as most MPGD applications do not require anode structures with 55 µm pixel pitch. Nonetheless, they would profit from the ambiguity-free results of a pixelated anode.

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Presenter: SCHARENBERG, Lucian (CERN)

Session Classification: Session 4

Contribution ID: **24** Type: **not specified**

Progress of Experiments in China's Underground Laboratories （Invited speech）

Tuesday 15 October 2024 14:00 (30 minutes)

Invited speech
China's underground laboratories have emerged as key players in the global effort to explore fundamental physics. The Jinping Underground Laboratory (CJPL), situated deep within the mountains of Sichuan, hosts several cutting-edge experiments. The PandaX-4T experiment, employing a two-phase liquid xenon detector, leads the search for dark matter and precision neutrino measurements. The PandaX-III experiment, utilizing high-pressure xenon gas detectors, aims to search for neutrinoless double beta decay, providing insights into the nature of neutrinos. The China Dark Matter Experiment (CDEX) uses high-purity germanium detectors to probe low-mass dark matter, while the Jinping Underground Nuclear Astrophysics (JUNA) experiment investigates key nuclear reactions relevant to stellar evolution and nucleosynthesis. Meanwhile, the Jiangmen Underground Neutrino Observatory (JUNO), located 700 meters underground, is designed to study the neutrino mass hierarchy and offers a wide array of physics goals, including the precise measurement of oscillation parameters and detection of supernova neutrinos. This talk will summarize recent progress and discoveries from these pioneering experiments.

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Presenter: MENG, Yue (Shanghai Jiao Tong University)

Session Classification: Session 7

Contribution ID: **25** Type: **not specified**

A cylindrical μRGroove detector for the super tau-charm facility

Tuesday 15 October 2024 14:30 (25 minutes)

The Micro-Resistive Groove (μRGroove) is a single-stage MPGD featuring a groove amplification pattern. When developed into a cylindrical structure, it requires only two cylinders (electrodes) with independent support foams, offering advantages such as a simple structure, easy installation, and high mechanical strength. Additionally, the cathode of μRGroove can serve as a 1D readout strip (X-strip). With just one additional 1D readout (V-strip) located at the bottom of the amplification structure, 2D position resolution can be achieved. This geometry avoids the induced charge-sharing effect, increases the signal amplitude, and helps reduce the material budget. In this study, we present the design and production of the cylindrical μRGroove, with the first prototype having an effective area of 131 mm in diameter and 100 mm in length. This includes its detachable mechanical structure, low-mass type electrode design, vacuum gluing process, and reversible installation method. The total material budget of the sensitive area is ˜0.23% X0, and it can achieve an energy resolution of ˜26% and a maximum effective gain of ˜10000. The induced signal amplitudes on the X and V readout strips are roughly the same. Further beam test were conducted by 150GeV/C muons at the CERN-SPS beamline. Preliminary results show a detection efficiency >95% and a spatial resolution of <100μm for vertically incident particles. Results of μTPC mode and oblique incident particles are still under analysis. Due to its low mass, good spatial resolution, and high rate capability, the cylindrical μRGroove could be an ideal solution for the inner tracker in STCF experiments.

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Presenter: HE, Siqi (University of Science and Technology of China)

Session Classification: Session 7

Contribution ID: **26** Type: **not specified**

μ-RWELL muon system and pre-shower for FCC-ee

Tuesday 15 October 2024 14:55 (25 minutes)

This presentation provides a full review of the R&D for the μ-RWELL technology for the FCC-ee application, with the report
on update on the detector optimization, on the studies to improve the ASIC, and on the evaluation of the proposed performance within the IDEA framework

In the IDEA experiment, μ-RWELL technology is proposed for the muon systems and the pre-shower. This MPGD exploits a compact manufacturing technique and provides competitive performance. This design keeps the cost of the entire system affordable and, benefiting from the ongoing technological transfer within the MPGD community will maintain a strong connection with industries.

Optimizing the readout electronics channels is needed to advance this technology's state of the art and meet the IDEA requirements. Ongoing activities focus on readout segmentation with various schemes, such as strips, capacitive sharing, and top-readout. Performance comparisons between new TIGER electronics and the APV-25 will be reported. These inputs will be used to define the final configuration for the detector proposal.

Moreover, the activities include simulations for both the detector and the experiment: a simulation of the μ-RWELL with TIGER or APV electronics is performed, and tuning with experimental data will improve their reliability and provide a useful tool to define the
characteristics of a new ASIC. Additionally, a simulation of the μ-RWELL muon system in the IDEA simulation framework is implemented in DD4HEP. This powerful tool connects the gas detector community to the needs of the FCC experiment.

Author: FARINELLI, Riccardo (INFN - Bologna)

Presenter: FARINELLI, Riccardo (INFN - Bologna)

Session Classification: Session 7

Contribution ID: **27** Type: **not specified**

Development of the high-rate capable DLC-RPC based on the current evacuation pattern

Tuesday 15 October 2024 15:20 (25 minutes)

The DLC-RPC, a thin resistive plate chamber based on diamond-like carbon (DLC) electrodes, is being developed for further background suppression in the MEG II experiment. The detector should have ultra-low mass (\(< 0.1˜\%˜X_0\)) and high-rate capability (up to \(3˜\rm{MHz/cmˆ2}\)) due to high-intensity (\(7 \times 10ˆ7˜/\rm{s}\)) and low-momentum (\(28˜{\rm MeV/}c\)) muon beam passing through it. Additionally, the detector must have high efficiency (\(> 90˜\%\)) for MIP particles to identify background events efficiently. The DLC-RPC consists of thin polyimide films as the substrate to minimize the material budget and spacing pillars (\(\sim 350\)nbsp;mu;\(\rm m\)nbsp;thick) formed by photolithographic technology. The prototype detector was verified to have a rate capability of up tonbsp;\(1˜{\rm MHz/cmˆ2}\)nbsp;using an actual muon beam. We have developed the DLC-RPC with low resistivity (\(\sim 10 {\rm M\Omega/sq}\)) and strip-shaped current evacuation patterns to improve the rate capability. However, discharges tend to occur near the evacuation patterns due to the lower quench of the resistive electrode as the current path shortens. We have studied the discharge phenomena near the evacuation patterns with low-resistivity DLC in parallel plate geometry using the prototype DLC-RPC electrode, produced by the CERN Micro-Pattern Technologies workshop. We have also investigated the design of protection covers on the evacuation patterns to mitigate these discharges.

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Presenter: TAKAHASHI, Masato (Kobe University)

Session Classification: Session 7

Contribution ID: **28** Type: **not specified**

China spallation neutron source and neutron detectors （Invited speech）

Wednesday 16 October 2024 09:00 (30 minutes)

Invited speech
China spallation neutron source and neutron detectors

Author: SUN, Zhijia (Institute of High Energy Physics, Chinese Academy of Sciences)

Presenter: SUN, Zhijia (Institute of High Energy Physics, Chinese Academy of Sciences)

Session Classification: Session 9

Contribution ID: **29** Type: **not specified**

A novel technology for element-sensitive 3D tomography

Wednesday 16 October 2024 09:30 (25 minutes)

Muon Induced X-ray Emission (MIXE) [1] is an advanced non-destructive technique that utilizes muons to analyze the elemental composition within materials. This method is particularly valuable in fields requiring non-destructive structural analysis, such as archaeology, battery research, meteoritics, environmental science, geology and mechanical engineering. The use of the high-rate continuous muon beam at the Paul Scherrer Institute (PSI) has facilitated significant advancements in MIXE technology[2].

To advance the technique towards a universal tomographic method, additional tracking information fr

An independent small fiber detector was constructed and used successfully to calibrate the drift t

However, the detector initially faced limitations due to multiple scattering in high-density gas

Addtionally, with the new prototype, the samples can be tested at muon momenta down to $\sim$ 25 MeV/c, while initial results still showing robust imaging capabilities.

For the first time, the combined use of MIXE and low-density gas TPC technologies has realized world

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Pages 18-24, ISSN 0168-9002, https://doi.org/10.1016/j.nima.2017.11.088

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Presenter: ZHAO, Xiao (PSI)

Session Classification: Session 9

Contribution ID: **30** Type: **not specified**

New Mission Concept: a high precise MeV Gamma Telescope using TPC Technique read out with Micromegas

Wednesday 16 October 2024 09:55 (25 minutes)

Cosmic MeV gamma-ray observation presents a valuable diagnostic tool for studying the universe. The "MeV gap", ranging from about 0.1-100 MeV, has not yet been observed with the same sensitivity as neighboring energies, leaving questions like the origin of gamma-ray and positron excesses toward the galactic inner region. Traditional nonlinear imaging methods using Compton circle superposition and coded mask apertures can't effectively discriminate background from signal. This sensitivity gap is limited by the angular resolution of gamma rays and the tracking of Compton scattered electrons, crucial for background suppression.
To address these challenges, we propose a new mission concept: the MeV Gamma-ray Telescope (MeGaT), consisting of an advanced Micromegas-based high-pressure TPC and a pixel readout CZT detector. MeGaT offers excellent angular resolution and background rejection through precise 3D trajectory reconstruction and accurate energy resolution for both Compton scattered electrons and gamma rays. The MeGaT prototype, a 30cm cubic design operating at 3-5 bar gas pressure, will be discussed in this presentation. Along with its design, performance expectations, and the current status of its R&D will be also discussed.

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Presenter: WU, Libo (Deep Space Exploration Laboratory)

Session Classification: Session 9

Contribution ID: **31** Type: **not specified**

Development and Preliminary Results of a Large-Volume Time Projection Chamber for X-ray Polarimetry

Wednesday 16 October 2024 10:20 (25 minutes)

Development and Preliminary Results of a Large-Volume Time Projection Chamber for X-ray Polarimetry

Davide Fiorina, on behalf of the HypeX collaboration

We present the development and initial results of a large-volume, increased field-of-view Time Projection Chamber (TPC) designed for X-ray polarimetry. This instrument utilizes a triple-GEM detector with optical readout, combining a scientific CMOS (sCMOS) camera to detect secondary scintillation light produced in the TPC amplification stage. Originally optimized for directional Dark Matter searches, this system has been adapted for X-ray polarimetry.

X-ray polarimetry offers a new window into the high-energy universe, providing critical insights into the magnetic fields, geometries, and emission mechanisms of cosmic sources such as black holes, neutron stars, and supernova remnants. Unlike traditional X-ray observations, which focus on intensity and energy, polarimetry adds the dimension of polarization, enhancing our understanding of these extreme and energetic phenomena.

The prototype TPC, with a cylindrical active volume of radius of 3.7 cm and height of 5 cm, was tested at the INAF-IAPS calibration facility in Rome, Tor Vergata. The aim was to assess the instrument's sensitivity to low-energy X-ray polarization and optimize parameters such as gas mixtures, amplification structures, and detector geometry. Testing showed complete reconstruction of photoelectrons in the 10-60 keV range with angular resolutions down to 15° and energy resolutions between 10-15% for the 5-45 keV range.

Data analysis involved measuring, reconstructing, and simulating electron tracks from a collimated 90Sr source. Angular resolution for electrons was better than 30° for energies above 10 keV and better than 20° for energies between 20 keV and 60 keV. The estimated modulation factor was greater than 0.6 for X-rays above 10 keV and greater than 0.8 for X-rays between 20 keV and 60 keV.

This TPC design extends X-ray polarimetry sensitivity to higher energies and enables observation of rapid transient phenomena like Gamma Ray Bursts (GRBs) and solar flares. Future improvements will explore different gas mixtures to enhance the photoelectric cross-section, with planned tests using fully polarized beams at the INAF calibration facility.

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Presenter: DAVIDE, Fiorina (GSSI & INFN)

Session Classification: Session 9

Contribution ID: **32** Type: **not specified**

Development and experimental study of the high spatial resolution muography system with Micromegas detectors

Wednesday 16 October 2024 12:05 (25 minutes)

Cosmic ray muons possess strong penetrating power and do not pose ionizing radiation hazards, making them an ideal probe for detecting special materials and large structures. Muon imaging includes both transmission and scattering imaging. In recent years, a new method called muon metrology has been developed, focusing on fine spatial resolution and large-area detectors.
In this work, we have designed and constructed a series of muon imaging facilities. These facilities include Micromegas detectors based on the thermal bonding technique and scalable readout systems. Thanks to the thermal bonding method, Micromegas detectors can be fabricated in sizes of 40 cm×40 cm40 and 60cm×60cm with spatial resolutions in the range of hundreds of micrometers. Additionally, a channel-encoded multiplexing method has been developed to reduce the number of electronic channels by an order of magnitude.
Using these muon imaging facilities, we have successfully conducted imaging experiments in both muon scattering imaging and transmission imaging. In our muon scattering imaging experiments, we were able to accurately reconstruct tungsten and lead structures with 2-cm resolution. For transmission imaging, we applied our facilities to image a subway tunnel, a mountain at Hefei City, and a blast furnace at Anyang City. These experiments demonstrated the high spatial resolution and effectiveness of our detectors.

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Presenter: WANG, Yu (University of science and technology of China)

Session Classification: Session 10

Contribution ID: **33** Type: **not specified**

Application of the VMM3a/SRS for tracking systems and TPCs

Wednesday 16 October 2024 11:40 (25 minutes)

The ATLAS/BNL VMM3a ASIC (Application Specific Integrated Circuit) was originally developed within the ATLAS New Small Wheel (NSW) upgrade and has been successfully integrated into the SRS (Scalable Readout System) of the RD51 collaboration. This integration provides a self-triggered continuous readout system for a wide range of gaseous detectors. Depending on the detector it is for example possible to switch the polarity, adjust the electronics gain or even change the peaking time. The system allows recording particles with MHz interaction rate in energy, space and time.

The first part of the contribution will exploit the possibility to integrate the VMM3a into a tracking system of an experiment. Because of the rate capability and self triggered readout the VMM3a is considered as a potential front end electronics for the new triple GEM detectors of the AMBER experiment. This contribution will show results of an AMBER prototype, read out with the VMM3a/SRS system. It will be shown how the VMM3a can help to understand and commission a new prototype. Even without a track reference it is possible to perform a basic detector characterisation, due to the self-triggered readout mode.

The second part explores the possibility to use the VMM3a as front end electronics for a TPC. Thanks to the trigger-less readout there is no long buffer needed until the trigger signal comes to indicate the event in the data. The VMM3a can provide all time and amplitude information continuously and allows for offline track reconstruction of the data. This aspect is even more interesting by using a TPC in the TWIN configuration. For this data of the TWIN GEM TPC will be presented. In this configuration, in combination with the VMM3a, it allows reconstructing tracks without any external t0. Thus this presents a possibility of an extremely low material budget tracking system, suitable for tracking of low energy particle beams.

This work has been sponsored by the Wolfgang Gentner Programme of the BMBF (grant no. 13E18CHA).

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Presenter: FLÖTHNER, Karl Jonathan (University of Bonn, Germany,CERN, Geneva, Switzerland)

Session Classification: Session 10

Contribution ID: **34** Type: **not specified**

A 512-channel FEE prototype based on the custom ASIC for MPGD

Wednesday 16 October 2024 11:15 (25 minutes)

The Micro-Pattern Gas Detector (MPGD) is widely used in high energy physics experiments due to its good spatial and temporal resolution, high rate capability, cost-effective, and suitability for mass production. The MPGD-based Ring Imaging CHerenkov (RICH) detector is one of the candidates for the barrel part of the Particle Identification Detector (PIDB) at STCF. The total readout channel of the PIDB is 518,400 and the front-end readout electronics will be installed directly behind the detector, requiring a readout electronics with a large number of channels. The prototype design, which includes 16 prototype custom ASICs, achieves a readout of 512 channels on a single board. The functionalities of the readout electronics have been validated and an energy spectrum test has been performed with the RICH detector prototype. The ENC is less than 0.5 fC for all channels and the time resolution is better than 1 ns for a 16 fC signal with 20-pF input capacitance and 100-ns charge collection time, meeting the design requirement.

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Presenter: LI, Jiaming (University of Science and Technology of China)

Session Classification: Session 10

Contribution ID: **35** Type: **not specified**

Quantum Information: From Test of Quantum Foundations to New Quantum Tuechnologies (Invited speech)

Thursday 17 October 2024 09:00 (30 minutes)

Invited speech
Quantum Information: From Test of Quantum Foundations to New Quantum Tuechnologies

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Session Classification: Session 11

Contribution ID: **36** Type: **not specified**

Commissioning of the CGEM Inner Tracker

Thursday 17 October 2024 09:30 (25 minutes)

The extension of the BESIII experiment (IHEP, Beijing) until 2030 was the reason for a program to improve both the accelerator and the detector. In particular, the current inner drift chamber suffers from aging and it is proposed to replace it with a detector based on cylindrical GEM (CGEM) technology.
The inner CGEM tracker consists of three coaxial layers of triple GEM. The tracker is designed to restore efficiency, improve z-determination and secondary vertex position reconstruction with a resolution of 150 μm in the xy-plane and better than 500 μm along the beam direction.
A special readout system was developed: The signals are processed by TIGER, a custom 64-channel ASIC that provides analog charge readout via a fully digital output to an FPGA-based readout module, the GEM Read Out Card. The module configures the ASICs and organizes the incoming data by creating the event packets when the trigger arrives. The three layers were assembled in October 2023 and a cosmic ray data collection campaign is underway to evaluate the performance of the CGEM tracker prior to installation. In this presentation, the general status of the CGEM project will be presented with special attention to the full cosmic ray characterization and the first implementation of the uTPC algorithm on a cylindrical GEM.

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Session Classification: Session 11

Contribution ID: **37** Type: **not specified**

Nano-pattern gaseous detector (NPGD)

Thursday 17 October 2024 09:55 (25 minutes)

Gas detectors are widely preferred in many research centers and industries, including CERN, due to their superior features such as rapid and sensitive detection, low radiation damage, and low cost. Currently, Gas Electron Multiplier (GEM) and Micromegas detectors are recognized in the literature as the most advanced members of the gas detector family. These microstructured gas-filled detectors excel in fast and precise radiation detection and offer longer operational lifespans in terms of radiation damage. Despite these advantages, these detectors, which typically have an internal volume of approximately 100 cm^3 in standard sizes, require a continuous flow of gas. This gas mixture, usually consisting of a noble gas and a molecular gas of high purity, represents a significant cost factor. The operation of Micro-Pattern Gas Detectors (MPGDs) involves the consumption of substantial amounts of gas. Additionally, carbon dioxide (CO_2) is commonly used as the molecular gas in these detectors due to its low cost and abundance in nature. The environmental impact of this practice is frequently debated among the scientific community and closely monitored by CERN. This situation may lead to the future restriction of gas-filled detectors' usage, potentially eliminating the technological benefits they provide.

In comparison to microstructured gas detectors, a nanostructured gas detector has been designed and prototyped, capable of detecting radiation using significantly less gas mixture. Utilizing Anodic Aluminum Oxide (AAO) nanotube structures, a GEM-like design has been achieved. The nanostructured detector prototype, fabricated based on this design, has been characterized using a ^{55}Fe source. Detailed characterization results will be presented.

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Session Classification: Session 11

Contribution ID: **38** Type: **not specified**

Production of Resistive Micromegas: Technology Transfer to Industry

Friday 18 October 2024 11:35 (25 minutes)

In recent years, Resistive Micromegas detectors have undergone an intense R&D phase to ensure their technological advancements for safe operation under diverse experimental conditions. Both low and high-rate versions have matured to be employed in upgrades of current detectors, large apparatuses at future colliders, and applications beyond high-energy physics.

Thus far, the advancement and development of Micromegas have been primarily conducted at CERN. The state-of-the-art technology includes resistive structures based on DLC (Diamond-Like Carbon). A collective effort is underway to perfect the technology of sputtering and to produce high-quality, cost-effective DLC foils, utilising the new magnetron sputtering machine available at CERN.

To meet the demands of massive production for large and challenging projects, significant involvement from industrial partners is essential. Consequently, an extensive process of technology transfer to industry has been underway for several years with ELTOS S.p.A, a well-known company already involved in the large-scale production of detector elements for CERN experiments.

This presentation will review the steps involved in the production of resistive Micromegas, the advancements in DLC production, and will primarily focus on the industrialization process at ELTOS. Notably, the production at ELTOS includes bulk processing using photo-imageable films to encapsulate the mesh on the anode, which is a non-standard PCB process. Finally, the critical aspects that still need to be resolved will be highlighted.

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Presenter: IODICE, Mauro (INFN Roma Tre)

Session Classification: Session 15

Contribution ID: **39** Type: **not specified**

Numerical simulation of space charge effects in MPGDs

Thursday 17 October 2024 16:30 (25 minutes)

Space charge effects are known to significantly influence the response of gaseous ionization detectors. In this respect, the Micro Pattern Gaseous Detectors (MPGDs) are no exception. Operating regime, avalanche to streamer transition, gain and different resolutions are affected by the space charge build-up within these detectors. However, despite its conceived importance, it is quite difficult, both experimentally and numerically, to quantitatively estimate the space charge effects. In this work, we will present our attempts within the Garfield++ framework to numerically model the space charge accumulation in three important MPGDs, namely, Micromegas, GEM and THGEM.

Numerical modelling of space charge accumulation is problematic because, by definition, a large number of charge particles are involved in the process. Although conceptually simple, it is computationally very expensive to model the interaction among these particles in a dynamic system. To tackle this problem, we have introduced several simplifying assumptions, as well as made extensive use of parallelization in the neBEM solver, which is an integral part of the Garfield++ distribution. Various representations of space charge have been attempted. For example, they have been represented as point charges, line charges and area charges. Both OpenMP and GPU-based CUDA have been implemented to accelerate computations. The effects of these variations have been explored by studying few figures of merit related to these detectors to optimize the models.

The results obtained have been compared with those achieved using fluid model based on a commercial FEM package. To our great satisfaction, the models, although very fundamentally different, seem to yield similar results. In our presentation, we will share our experience of these initial attempts, discuss the results obtained, and the pros and cons of different approaches explored during the investigations.

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Presenter: TITOV, Maxim (CEA)

Session Classification: Session 13

Contribution ID: **40** Type: **not specified**

High Spatial Resolution Time Projection Chamber Technology R&D for the Future Circular e+e- Collider

Thursday 17 October 2024 11:40 (25 minutes)

High Spatial Resolution Time Projection Chamber Technology R&D for the Future Circular e+e- Collider
The future linear and circular electron positron colliders were been proposed as a Higgs and a high luminosity Z pole factory in last few years. The Circular Electron Positron Collider (CEPC) accelerator Technology Design Report (TDR) has been released in 2023. The baseline design of a detector concept consists of a large 3D tracking system, which is a high precision (about 100m) spatial resolution Time Projection Chamber (TPC) detector as the main track embedded in a 3.0T solenoid field, especially for the accelerator operating at Tera-Z. TPC requires the longitudinal time resolution (<100ns) and the physics goals require PID resolution (<3%). A number of critical issues are still remaining regarding the TPC research. The simulation and Particle IDentification (PID) resolution show TPC technology potential to extend Tera Z at the future e+e- collider.

In this talk, we will present the feasibility and status of high precision TPC as the main track detector for e+e collider. The traditional pad readout is designed about 1mm x 6mm and the pixelated readout is designed about 55m x 55m or bigger size. Compared with the pad readout, the pixelated readout option will obtain the better spatial resolution of single electrons, the very high detection efficiency in excellent tracking and good dE/dx performance. A smaller prototype TPC has been developed with a drift length of 500 mm, gaseous chamber, 20000V field-cage, the low power consumption FEE electronics and DAQ have been commissioned and some studies have been finished. Some updated experimental results including the spatial resolution, the gas gain, the laser track reconstruction and dE/dx will be reported. The track performance results and summarize the next steps of the pad/pixelated TPC technology for e+e- collider will presented in this talk. Finally, we will review the track reconstruction performance results and summarize the next steps towards TPC construction for CEPC physics and detector TDR.

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Presenter: QI, Huirong (CAS,Institute of High Energy Physics)

Session Classification: Session 12

Contribution ID: **41** Type: **not specified**

The Ultra-Low material budget GEM based TPC for tracking with VMM3a readout

Thursday 17 October 2024 12:05 (25 minutes)

The GEM based Time projection Chamber in Twin configuration [1] used for tracking of particles has evolved during the last years. This detector has been mainly developed for the tracking of protons to Uranium for the Super-FRS at the FAIR facility [2]. The detector consists of two GEM-TPCs inside the same vessel. One GEM-TPC is rotated by 180 degrees with respect to the other one at the middle plane, such that the drift field of both GEM-TPCs are in opposite directions with the sensitive area perpendicular to the incoming particles. The readout geometry of each of the GEM-TPCs is a one-dimensional (1D) strip parallel to the incoming beam. This configuration is named Twin. The readout electronics used is the VMM3a based Scalable Readout System.
The main idea behind this configuration is the ability to increase the tracking efficiency at higher rates i.e. when the multiplicity of hits within the drift volume poses a challenge in their association to the corresponding track. This is achieved by using the Control Sum method.
The HGB4-2 detector, which stands for Helsinki-Bratislava-GSI generation four (4th) prototype two (2) has been tested in the H4 beamline of the SPS at CERN with muons and pions as primary particles. Using different gas mixtures like: Ar/CO2 (70/30), He/CO2 (90/10) and (70/30). During the latest campaigns, scans of the drift fields have been performed in order to quantify the combined effect of the drift velocity and the diffusion on its overall performance.
One of the last pending measurements for this detector was the spatial resolution and rate capability for protons in Minimum Ionizing Regime, therefore, to mimic such projectiles, pions were used. As result this prototype is now finalized, and suitable for mass-production for the Finnish in-kind contribution to FAIR. In addition, such concept exhibiting very good spatial resolution, lower than from the requirements.
References:
[1] F. Garcıa, et al, A GEM-TPC in twin configuration for the Super-FRS tracking of heavy ions at FAIR, Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, Volume 884, 2018, Pages 18-24, ISSN 0168-9002, https://doi.org/10.1016/j.nima.2017.11.088.
[2] Conceptual Design Report (CDR) and Baseline Technical Report (BTR) for FAIR at http://www.gsi.de/fair/reports/index.h
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References:
[1] F. Garcıa, et al, A GEM-TPC in twin configuration for the Super-FRS tracking of heavy ions at FAIR, Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, Volume 884, 2018, Pages 18-24, ISSN 0168-9002, https://doi.org/10.1016/j.nima.2017.11.088.
[2] Conceptual Design Report (CDR) and Baseline Technical Report (BTR) for FAIR at http://www.gsi.de/fair/reports/index.h

Author: GARCIA, Francisco (HIP)

Presenter: GARCIA, Francisco (HIP)

Session Classification: Session 12

Contribution ID: **42** Type: **not specified**

Resistive High Granularity Micromegas for Future Detectors. Status and Perspectives

Thursday 17 October 2024 10:20 (25 minutes)

The presented project aims to establish the use of single amplification stage resistive MPGD based on Micromegas technology, for a stable and efficient operation up to 10 MHz/cm2 particle rate. Key challenges include the miniaturization of readout elements (small pads at mm2 scale), the optimization of the spark protection system, and ensuring reliability and robustness during operation. Various resistive patterns were implemented using different techniques, categorized into two families: one employing a pad-patterned configuration and the other utilizing a structure based on a double layer of DLC foils (Diamond Like Carbon structure).
The two categories implement different charge evacuation methods: embedded resistors using independent pads the first, and double DLC uniform resistive foils the latter, relying on a network of dot-connections to ground in the active area.
The presentation will include a comparative analysis of results obtained with different resistive layouts and configurations, emphasizing their response under high irradiation and high-rate exposure, as well as their tracking performance at test-beams. The discussion will highlight the advantages and performance of the solution featuring the double DLC layer.
Comprehensive results from a recently tested medium-sized detector (400 cm^2) will be reported, along with preliminary measurements conducted on the first large-area module (50x40 cm^2) designed as a full-size module for tiling in future experiments. Additionally, initial promising results on the capacitive sharing technique, aimed at reducing the number of readout channels while maintaining high spatial resolution for applications at low to medium rates, will also be presented

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Presenter: IODICE, Mauro (INFN Roma Tre)

Session Classification: Session 11

Contribution ID: **43** Type: **not specified**

Technical challenges for the new T2K ND20 High Angle TPCs

Thursday 17 October 2024 16:55 (25 minutes)

The Near Detector of the T2K experiment at J-PARC has recently being upgraded in order to reduce the present systematic uncertainties affecting the oscillation parameters measurements and to exploit the increased neutrino beam power of the J-PARC complex.
One of the major improvement to the T2K ND280 detector consisted in the the integration of two large size (˜ 3m3 each) new horizontal High -Angle Time-Projection Chambers (HATPC).
The new HATPCs are based on a gaseous active volume contained in a Field Cage made of lightweight composite material, combining optimal mechanical and electrical properties with minimal radiation length and dead volume.
The readout is performed by innovative Resistive Micromegas modules featuring a resistive layer for charge spreading on top of the readout plane to enhance spatial resolution performance. The mentioned technologies have been studied in test beams and cosmic rays campaigns. After the installation at J-Parc in Fall 2023, a commissioning period of data taking with cosmics and then with a neutrino beam has been performed.
In this talk the details about the detector concepts, the design and construction methods are presented within the technological challenges and the solution adopted to cope with the challenging requirements of the upgrade. Furthermore the results of the characterization and commissioning performance of the HA-TPCs at CERN and J-Parc, including also the first results using beam neutrinos interactions will be illustrated.

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Session Classification: Session 13

Contribution ID: **44** Type: **not specified**

Ceramic GEM neutron detector and its applications at China Spallation Neutron Source

Thursday 17 October 2024 17:20 (25 minutes)

Ceramic GEM neutron detector and its applications at China Spallation Neutron Source

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Session Classification: Session 13

Contribution ID: **45** Type: **not specified**

MicroPattern Gaseous Detectors for Particle Detection in Space

Thursday 17 October 2024 17:45 (25 minutes)

MicroPattern Gaseous Detectors for Particle Detection in Space

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Presenter: LIU, Hongbang (Guangxi University)

Session Classification: Session 13

Contribution ID: **46** Type: **not specified**

Application of Micro Pattern Gaseous Detectors in Space X-ray Polarimetry

Thursday 17 October 2024 18:10 (25 minutes)

Application of Micro Pattern Gaseous Detectors in Space X-ray Polarimetry

Author: JIANG, Weichun (Institute of High Energy Physics, Chinese Academy of Sciences)

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Session Classification: Session 13

Contribution ID: **47** Type: **not specified**

SALSA: a new versatile readout ASIC for MPGD detectors

Friday 18 October 2024 09:00 (25 minutes)

The Sao Paulo University and the CEA Saclay IRFU teams are developing a new readout ASIC for MPGD detectors, named SALSA. This ASIC is meant to be versatile and adapted to different kinds of MPGD applications like tracking, time projection chambers or photon detection. This 64-channel chip, designed in the TSMC 65nm technology, will integrate preamplifier and shaper frontends with 12-bit per channel ADC able to reach 50 MS/s sampling rate. The frontend part will be able to manage large capacitance readout electrodes up to 1 nF, with four configurable amplitude ranges from 0-50 fC to 0-5 pC, and 12 peaking times up to 500 ns. An integrated data processing block will take in charge baseline correction, zero-suppression and feature extraction before to format the data in packets to be transmitted by up to four gigabit links.

The SALSA project was launched in 2020 in the framework of the EIC project, and has produced in 2022-23 different prototypes to evaluate a first version of the frontend and ADC blocks, as well as the phase-locked loop (PLL) block that generates internal clocks. A larger prototype, SALSA1, is currently under production to validate and measure the performance of the frontend-ADC chain, as well as of some service blocks. The SALSA2 prototype, which will include all the data processing functionalities of the final ASIC but with a limited number of channels, is presently under development. It will be submitted for production within the first months of 2025. The final pre-series prototype is expected during 2026, for a series production in 2027. After a presentation of the project and the target specifications of the ASIC, its architecture and its features will be detailed, and results will be given from the tests of the prototypes. The next major steps of the project will be then described.

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Session Classification: Session 14

Contribution ID: **48** Type: **not specified**

Progress on Readout Electronics for TPC for Large Collider Experiments

Friday 18 October 2024 09:25 (25 minutes)

Progress on Readout Electronics for TPC for Large Collider Experiments

Author: DENG, Zhi (Tsinghua University)

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Session Classification: Session 14

Contribution ID: **49** Type: **not specified**

GEM operation in Nitrogen based gas mixtures: opening new applications for X-Rays, UV-light and neutron detection with the use of environmental-friendly mixtures

Friday 18 October 2024 09:50 (25 minutes)

GEM based detectors have been historically operated using gas mixtures containing mainly Ar, CO2 and CF4. CO2 being a polyatomic gas is used as quenching gas to stop the release of secondary electrons following the primary multiplication. Quenching gases are usually heavy, organic molecules or diatomic molecule gases. In this contribution we explored the possibility of operating GEM devices with gas mixture containing Ar and/or N2 by performing a series of performance measurements with some GEM based detectors. Removing CO2 allows the use of environmental-friendly gases that is a major development for next generation of gaseous detectors. N2 offers a series of advantages: it can be used in recirculating systems of sealed detectors since most of purifying systems are not sensitive to it; it has a sufficiently high thermal neutron cross section (due to the reaction n+14N -> p + 14C, that shows a cross section of about 10 b for thermal neutron energies, i.e. 25 meV) and it scintillates mainly emitting photons with wavelength higher than 250 nm. These three N2 features pave the way to the development of sealed X-Rays GEM based detectors, low mass neutron beam monitors and of GEM photon amplifiers. In Milano, two N2-based detectors have been developed: one Triple GEM detector operated with Ar/N2 gas mixtures in proportion 90%/10%, 80%/20% and 70%/30% equipped with a padded anode featuring 256 pads with an area of 6x6 mm2 and a single GEM completely operated in N2 and read-out by a Photo-Multiplier Tube (PMT). The Triple GEM detector was read-out using GEMINI front-end electronics and was first tested using 4.5 keV fluorescence X-Rays emitted by a Ti-Target irradiated by Bremsstrahlung X-rays emitted by a 40 kV X-Rays generator. The counting rates, gain and energy resolution as a function of the sum of the potential difference over the GEM foils have been measured and compared to the standard values obtained with the reference gas mixture Ar/CO2 70%/30%. The gas mixture Ar/N2 90%/10% showed similar results to the reference mixture, since we measured the same gain (a value of about 2000) and a similar energy resolution (about 25% at 4.5 keV). This proves that N2 can also be used as quenching gas and that this gas mixture can be a potential candidate to develop sealed X-Rays detectors. The same detector was then tested as neutron beam monitor at the Triga Mark 2 reactor of the L.E.N.A laboratory in Pavia: it was proven that the efficiency and therefore the counting rate reduces as the amount of N2 is reduced (keeping the same neutron flux) and that the detector is able to online reconstruct the 2D thermal neutron beam profile with all above cited Ar/N2 mixtures. Finally, the scintillation properties of N2 can open a new development towards the realization of gaseous photon multipliers. This study was performed by realizing an experimental setup made of a vacuum chamber hosting a cathode mesh, a single GEM and an anodic mesh, filled with pure N2. The vacuum chamber was closed on one side by a window that allows the transmission of photons with wavelength higher than 200 nm. The window is then coupled with a Hamamatsu R9420-100-10-mod PMT whose spectral response ranges from 300 to 650 nm. An 241Am source emitting 5 MeV alpha particles was placed in the N2-filled chamber just outside the cathode mesh (which is placed at 12 mm from the GEM foil) and in order to register signals on the PMT potential differences from 400 V to 500 V must be applied to the single GEM foil; the time duration of the signals registered by the PMT was also varied by changing the drift field and since it was possible to reconstruct the electron drift veloc-

ity in N2, this confirms that the registered signals come from primary electron scintillation in the GEM holes. If the GEM foil would be covered with UV converter photocathodes (like CsI) whose quantum efficiency decreases above 200 nm, this achievement opens the way to the development of N2-based wavelength shifting gas photon multipliers.

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Session Classification: Session 14

Contribution ID: **50** Type: **not specified**

MIMAC –35 x 35 cm2 : 3D-nuclear recoil tracks detection for directional Dark Matter detection and Neutron spectroscopy

Friday 18 October 2024 10:45 (25 minutes)

MIMAC –35 x 35 cm2 : 3D-nuclear recoil tracks detection for directional Dark Matter detection and Neutron spectroscopy

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Presenter: ZHANG, Zhiyong (University of Science and Technology of China)

Session Classification: Session 15

Contribution ID: **51** Type: **not specified**

No neutrino Double beta decay Experiment - NvDEx

Friday 18 October 2024 11:10 (25 minutes)

Observing nuclear neutrinoless double beta decay (0vbb) would be a revolutionary result in particle physics. Observing such a decay would prove that the neutrinos are their own antiparticles, help to study the absolute mass of neutrinos, explore the origin of their mass, and may explain the matter-antimatter asymmetry in our universe by lepton number violation. We propose developing a time projection chamber (TPC) using high-pressure 82SeF6 gas and Topmetal silicon sensors for readout in the China Jinping Underground Laboratory (CJPL) to search for neutrinoless double beta decay of 82Se, called the NvDEx experiment. Besides being located at CJPL with the world's thickest rock shielding, NvDEx combines the advantages of the high Q value (2.996 MeV) of 82Se and the TPC's ability to distinguish signal and background events using their different topological characteristics. This makes NvDEx unique, with great potential for low-background and high-sensitivity 0vbb searches. NvDEx-100, a NvDEx experiment phase with 100 kg of SeF6 gas, is being built, with plans to complete installation at CJPL by 2026. This report will introduces the NvDEx concept and its advantages, and the progress of the NvDEx-100 construction.

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Session Classification: Session 15

Contribution ID: **52** Type: **not specified**

Cryogenic setup for the characterization of novel optical amplification structures (MPGD-based) for Dark Matter searches

Compelling astrophysical and cosmological evidence for the existence of dark matter (DM) has led to numerous direct detection experiments, including DarkSide, XENON, LZ, etc., searching for particle DM candidates. These experiments rely on noble liquid detectors, in which vacuum ultraviolet (VUV) scintillation or scintillation and ionization, induced by elastic scattering of WIMPs on nuclei, is registered.
One of the main challenges in argon-based detectors is the relatively low efficiency of available VUV-optimized photosensors. This limitation makes light collection and detection of S1 and S2 light in liquid argon (LAr) challenging. Therefore, efficient wavelength shifter (WLS) materials are needed to enable light collection with standard photosensors.

Over the past decade a significant progress was observed in the development of new optical amplification structures, including new WLS materials and methods of applying these to new structures capable of enhancing scintillation light detection. As future experiments require much larger target masses (multi-ton scale) to improve current sensitivity limits, new optical amplification structures/technologies scalable to such sizes are mandatory to improve or even maintain the performance of these detectors. One such example is the recently developed WLS FAT-GEM (wavelength-shifting field-assisted transparent gaseous electroluminescence multiplier) that combines the characteristics of FAT-GEMs with reflecting and WLS coatings to maximize S2 light collection, which opens the possibility to the scale-up of future Dark Matter detectors.

In this work the plans for development of novel optical amplification structures, namely a floating FAT-GEM (Field-Assisted Transparent Gaseous Electroluminescence Multiplier) with wavelength-shifting capabilities (WLS FAT-GEM) will be discuss. A cryogenic setup, recently commissioned for studying new wavelength-shifting materials for optimised light collection in noble element radiation detectors, will be presented along with its first reasults and its new extension that enables the study of these MPGD-based structures, potentially interesting for rare-event searches.

Author: CORTEZ, André (Astrocent, CAMK PAN)

Presenter: CORTEZ, André (Astrocent, CAMK PAN)

Session Classification: Session 15

Contribution ID: **53** Type: **not specified**

Welcome remarks

Monday 14 October 2024 08:30 (20 minutes)

Presenter: ZHAO, Zhenguo (University of Science and Technology of China))

Session Classification: Opening

Contribution ID: **54** Type: **not specified**

Practical information

Monday 14 October 2024 08:50 (10 minutes)

Presenter: LIU, Jianbei (University of Science and Technology of China)

Session Classification: Opening

Contribution ID: **55** Type: **not specified**

Georges Charpak Prize Award Ceremony

Thursday 17 October 2024 14:00 (10 minutes)

Author: TORRE, Silvia Dalla (Istituto Nazionale di Fisica Nucleare)

Presenter: TORRE, Silvia Dalla (Istituto Nazionale di Fisica Nucleare)

Session Classification: The 100th Anniversary of Georges Charpak's Birth

Contribution ID: **56** Type: **not specified**

Anton Oed Prize Award Ceremony

Thursday 17 October 2024 14:10 (10 minutes)

Author: TITOV, Maxim (CEA)

Presenter: TITOV, Maxim (CEA)

Session Classification: The 100th Anniversary of Georges Charpak's Birth

Contribution ID: **57** Type: **not specified**

Georges Charpak: between Reality and Imagination (Invited speeche)

Thursday 17 October 2024 14:20 (30 minutes)

Author: SAULI, Fabio (CERN)

Presenter: SAULI, Fabio (CERN)

Session Classification: The 100th Anniversary of Georges Charpak's Birth

Contribution ID: **58** Type: **not specified**

Georges Charpak: the Man beyond science（Invited speeches）

Thursday 17 October 2024 14:50 (30 minutes)

Author: GIOMATARIS, Ioannis (CEA-Saclay)

Presenter: GIOMATARIS, Ioannis (CEA-Saclay)

Session Classification: The 100th Anniversary of Georges Charpak's Birth

Contribution ID: **59** Type: **not specified**

Public lecture on gaseous detectors

Thursday 17 October 2024 15:20 (30 minutes)

Author: TITOV, Maxim (CEA)

Presenter: TITOV, Maxim (CEA)

Session Classification: The 100th Anniversary of Georges Charpak's Birth

Contribution ID: **60** Type: **not specified**

Questions and answers

Thursday 17 October 2024 15:50 (10 minutes)

Session Classification: The 100th Anniversary of Georges Charpak's Birth

Contribution ID: **61** Type: **not specified**

Recent results on the low-pressure GEM-based TPC at an Accelerator Mass Spectrometer

Monday 14 October 2024 12:05 (25 minutes)

Author: SHAKIROVA, Tamara (Budker Institute of Nuclear Physics)

Co-author: MCKIE, Lachlan (Australian National University)

Presenter: SHAKIROVA, Tamara (Budker Institute of Nuclear Physics)

Session Classification: Session 2

Contribution ID: **62** Type: **not specified**

Study of signal formation in the ERAMs of T2K TPC

Monday 14 October 2024 15:20 (25 minutes)

In recent years, the near detector of the T2K experiment underwent an important upgrade of part of its equipment, which involved the construction of a set of new instruments. As a part of the upgrade, two gaseous TPCs, placed above and below the active target, will enable the study of particles generated at large angles by neutrino interactions. Each High Angle TPC (HA-TPC) includes a large active volume defined by rectangular cross-section Field Cages with lightweight composite material walls and two readout planes instrumented with eight Resistive Micromegas each.
A deep knowledge of this detector is crucial to achieve good performance. This communication reports the studies that are being carried out in order to get a deep comprehension of the signal formation in an ERAM detector operating with the T2K gas mixture; in particular, the aim of the study is to determine the effect of the ions on the electron spread in the resistive layer and the consequent electric signal generation. Preliminary studies have been carried out on non-resistive Micromegas to determine the ion drift velocity in the T2K gas mixture; experimental data are compared with the results of a dedicated Monte Carlo simulation.

Author: D'AGO, Daniele (University of Padova and INFN Padova)

Presenter: D'AGO, Daniele (University of Padova and INFN Padova)

Session Classification: Session 3

Contribution ID: **63** Type: **not specified**

Exploitation of a 2D triple GEM detector at the MASTU spherical tokamak

Tuesday 15 October 2024 11:15 (25 minutes)

Author: AGOSTINO, Celora (University of Milan-Bicocca)

Co-author: CORTEZ, André (Astrocent ; CAMK PAN)

Presenter: AGOSTINO, Celora (University of Milan-Bicocca)

Session Classification: Session 6

Contribution ID: **64** Type: **not specified**

1. A Flexible Electronics System for the Readout of CSNS Multi-purpose TPC

Tuesday 15 October 2024 16:45 (4 minutes)

The Back-n White Neutron Source at CSNS (China Spallation Neutron Source) has advantages of high flux and wide energy spectrum, which makes it a powerful facility for nuclear data measurement and neutron resonance transmission imaging. To promote the applications, a project, Multi-purpose Time Projection Chamber (MTPC), was proposed by the CSNS Back-n group. The MTPC, using Micromegas Detector as its readout endcap, is planned mainly for the measurements of neutron-induced charged particle emission reaction and fission reaction, as well as for neutron beam measurement and neutron resonance photography. This presentation will introduce an optical fiber-based flexible electronics system, that is intended to provide a general readout solution for the CSNS MTPC.

The function of its front-end electronics is mainly implemented by low noise pre-Amplifiers (ASICs or discrete components) and multi-channel digitizing modules with the waveform sampling rate of 40 or 80 MSPS, and a 12-bit precision. With the assistance of Giga-bit optical links, data streams from the front-end electronics are collected to the Data Concentration Module (DCM) and afterwards transferred to PC or computer servers. By configuring the number of optical fibers, the readout system can be easily scaled up to thousands of channels.

This electronics system has been installed with the prototype MTPC, and several experiments have been successfully conducted. The system can also be extended to the readout of MPGDs in other applications.

Author: FENG, Changqing (University of Science and Technology of China)

Presenter: FENG, Changqing (University of Science and Technology of China)

Session Classification: Poster Session

Contribution ID: **65** Type: **not specified**

2. Improvement of sensitivity for MeV Gamma ray Telescope using Time Projection Chamber technology

Tuesday 15 October 2024 16:49 (4 minutes)

The observation of gamma rays in the MeV energy band is crucial to astronomical research. There are fantastic scientific opportunities on dark matter detection, cosmic ray physics and gamma-ray astronomy via MeV gamma ray observations. MeV Gamma ray Telescope (MeGaT) is a new generation of high-resolution space MeV gamma ray detection telescopes by using Time Projection Chamber (TPC) technology surrounded by CdZnTe. Sensitivity is an important parameter of the telescope, which is related to angular resolution, effective area and the flux of backgrounds. The angular resolution includes the Angular Resolution Measure (ARM), Scatter Plane Deviation (SPD) and Point Spread Function (PSF). Thanks to the precise measurement of the direction of compton recoil electron by TPC and Micromegas, the angular resolution of incident primary gamma and the sensitivity of MeGaT are improved.

In this report, we will introduce the definitions of three kinds of angular resolutions, the calculation method of sensitivity, and how MeGaT can accurately measure the scattering direction of electrons to improve the sensitivity of the telescope in the MeV energy band.

Author: WU, Libo (Deep Space Exploration Laboratory)

Co-author: ZHOU, Rui (University of Science and Technology of China)

Presenter: ZHOU, Rui (University of Science and Technology of China)

Session Classification: Poster Session

Contribution ID: **66** Type: **not specified**

3. Design and optimisation challenges while codesigning a new front-end ASIC together with a resistive Micromegas detector for AMBER experiment

Tuesday 15 October 2024 16:53 (4 minutes)

The Apparatus for Mesons and Baryon Experimental Research (AMBER, NA66) is a high-energy physics experiment at CERN's M2 beam line at the Super Proton Synchrotron (SPS). Its broad physics program extends beyond 2029. Measurements of the anti-proton production cross-section on He, proton, and Deuterium to support the dark matter searches, the charge-radius of the proton to contribute to the solution of the puzzle in the values and the Kaon and Pion PDFs using Drell-Yan process are already approved for the initial part of the experiment. For this new apparatus we are designing together with the CERN MPT workshop both a resistive MICRO-MEsh GAseous Structure (Micromegas) detector and a new custom 64 channel fully digital front-end ASIC ToRA (Torino Readout for AMBER) for timing and energy measurements. The ASIC is closely tailored to the specifications of the Micromegas but also should be fully suited to equip some of the existing Wire type detectors to make them compatible with the future trigger-less Data Acquisition system (DAQ) of AMBER. This simultaneous design of the ToRA ASIC and of the associated detector aims to achieve a good optimisation of their performance. We must face the challenges coming from the integration with the resistive Micromegas with 1.0-2.5 fC signals at the low end of the charge amplitude spectrum up to 100-150 fC for high signal amplitudes. AMBER Micromegas will have a ˜1.2x0.5 mˆ2 size with ˜1.2 m long strips of up to ˜150 pF capacitance reaching rates of up to 500 kHz/strip. To face these conditions, we need a good control over the system noise and signal integrity performance of the detector itself together with the full signal path to the ASIC to be able to make use of target intrinsic ENC of the ToRA of ˜1000-1500 e- at 150pF. The use of ToRA with Wire detectors adds the requirements of variable gain to cope with charges of up to 1-1.5 pC, a 10-bit ADC resolution and a ˜1ns time resolution. To address the issue of the cooling we expect to reach a <10 mW/ch power consumption. The 65nm design node was chosen for the ToRA ASIC.

We present the models of the detector and signal path elements used in simulation together with simulation results and real measurement of signal integrity on produced test elements. The architecture of the ToRA v1 ASIC will be presented in the contest of this optimisation work with some considerations towards the ToRA v2 review.

Author: ALEXEEV, Maxim (University of Turin and INFN sez. Torino)

Co-authors: ALICE, Chiara (University of Turin ; INFN-To); MAZZA, Giovanni (INFN Torino)

Presenter: ALEXEEV, Maxim (University of Turin and INFN sez. Torino)

Session Classification: Poster Session

Contribution ID: **67** Type: **not specified**

4. TPC Track Denoising with Machine Learning Techniques

Tuesday 15 October 2024 16:57 (4 minutes)

Spurious signals caused by microdischarges are a known effect inherent to all gaseous detectors, namely micropattern gaseous detectors. During the reconstruction in imaging and tracking detectors, such as time projection chambers (TPC), these signals are added to the actual track-generated signal as extra pixels or clusters, compromising the performance of the detector. We study the capability of machine learning techniques to denoise events measured by TPCs. These techniques were applied to real data from a prototype TPC operating with the SAMPA chip integrated with CERN's SRS frontend. We attempt to evaluate to what extent difficult operating conditions that generate noisy data and artefacts in the signals can be overcome with such techniques. The events were mainly studied as 3D matrices as opposed to more common representations using waveforms or 2D projections. We measure the recognition performance by manual labeling of measured data and by applying several screening cuts, allowing to compare it with standard techniques. The methods were developed to be independent of the particular geometry of the measured tracks.

Author: GAJDOŠ, Matěj (IEAP, Czech Technical University in Prague)

Co-authors: LUZ, Hugo Natal da (IEAP, Czech Technical University in Prague); BREGANT, Marco (Instituto de Física da Universidade de São Paulo); GEOVANE, Souza (Instituto de Física da Universidade de São Paulo)

Presenter: LUZ, Hugo Natal da (IEAP, Czech Technical University in Prague)

Session Classification: Poster Session

Contribution ID: **68** Type: **not specified**

5. Future missions of the former LHCb Outer Tracker gaseous detector at GSI/FAIR

Tuesday 15 October 2024 17:01 (4 minutes)

The former Outer Tracker of LHCb/CERN based on gas-filled straw-tubes has been kindly donated to GSI for further use in experiments at GSI and at the Facility for Antiproton and Ion Research (FAIR) and predominantly in PANDA, the anti-Proton ANnihilation in DArmstadt.
This formidable gaseous tracking detector of LHCb employed in LHC Run 1 and Run 2 performed continuously and above expectations until its replacement, by a scintillating fibres based tracker due to the high rates expected at the forthcoming LHC runs.
Upon arrival at GSI, the complete straw-tube tracker is being stored and gradually prepared for use at several beam-lines and experiments, owing to the modular structure of the detector.
We report on the endeavor to transport the complete straw-tube tracker from CERN to GSI and the first upgrades of the Front-End Eelectronics to interface with modern readout systems. We give an outlook of the various use cases of the straw-tube modules with emphasis to the PANDA experiment and conclude with outlines on further possibilities of their re-purposing.

Author: BELIAS, Anastasios (GSI Helmholtzzentrum für Schwerionenforschung GmbH)

Presenter: BELIAS, Anastasios (GSI Helmholtzzentrum für Schwerionenforschung GmbH)

Session Classification: Poster Session

Contribution ID: **69** Type: **not specified**

6. Study on the bias analysis and correction in MPGD μTPC mode

Tuesday 15 October 2024 17:05 (4 minutes)

The μTPC (micro time projection chamber) is a working mode in MPGD which has mm-level gas gap for particle energy deposition. Similar to TPC, the μTPC method measures the signal time of each readout channel and calculates the corresponding drift distance. By reconstructing the track segment in the gas gap, the spatial resolution is significantly better than that of the charge centroid method, when the particle is not vertically incident. However, the μTPC method has a theoretical bias of reconstruction position, which is not easy to get observed in experiments. The induced signal of any readout channel may come from several primary ionized electrons that arrive at the readout plane at different times, but the measured signal time is usually the time of the first electron signal exceeds the energy threshold. When the number of electrons is larger than 1, the measured time is ahead of the real drift time. Thus, most of the measured time of readout channels are ahead of expected, the reconstructed center point of the track segment is also biased. However, this effect is not significant, and the deviation of the bias is related to the detector structure, the electronic system parameters, the gas parameters, and the track incidence angle, which is roughly around 1 times of the spatial resolution, such as 100 μm. In the experiment, this bias is often covered by the alignment deviation. In order to correct this bias, we analyzed the measurement principle of μTPC method, and proposed the correction method based on electron transverse and longitudinal diffusion analysis. Using the initially fitted track incidence angle and the measured charge of readout channel as input, the signal time of each readout channel can be corrected, and more accurate reconstruction performance is obtained. The simulation results show that this method can partially correct the position bias of the track segment mid-point and improve the spatial resolution by about 15% at the same time. The experimental data based on the cylindrical μRGroove detector is also being analyzed, and the preliminary result also presents an improve the μTPC method performance.

Author: FANG, Zhujun (University of Science and Technology of China)

Presenter: FANG, Zhujun (University of Science and Technology of China)

Session Classification: Poster Session

Contribution ID: **70** Type: **not specified**

7. Development of a Portable Low Background α and β Detection Module based on Micromegas and Waveform Digitizing Electronics

Tuesday 15 October 2024 17:09 (4 minutes)

This presentation introduces a Time Projection Chamber (TPC) system based on Micromegas, designed for low background α and β detection. The system comprises a TPC and an anti-coincidence Micromegas detector, both manufactured using a thermal bonding method. Additionally, the system includes a power module, front-end electronics, and back-end electronics, all integrated to achieve high precision and stability in low background detection.

The power module provides high voltage for drift and avalanche processes, ensuring stable power for the readout electronics. The front-end electronics amplify and convert signals from the Micromegas, while the back-end electronics handle digitization, trigger selection, data compression, information extraction, and data uploading. This integrated approach ensures seamless operation and reliable data for analysis.

A distinctive aspect of the TPC is its ability to accurately log particle trajectories and ionization, aiding in superior discrimination between α, β, and background. This precision reduces the need for extensive shielding, thus enhancing system portability and reducing size. Enhanced tracking and identification capabilities are vital for reliable detection.

Additional testing, including baseline measurements, spatial resolution tests, and source counting rate evaluations, have been introduced. Initial results illustrate the system's effectiveness in distinguishing low-energy α and β particles with notable accuracy and sensitivity, supported by high spatial resolution and gain.

In conclusion, the low background α and β detection system based on Micromegas shows broad prospects for low background detection applications.

Author: TANG, Songsong (University of Science and Technology of China)

Co-authors: GAO, Changbo (Ltd；JIANWEI Scientific Instruments (Anhui) Technology Co.); FENG, Changqing (University of Science and Technology of China); LIU, Shubin (University of Science and Technology of China); ZHANG, Zhiyong (University of science and technology of china); WEN, sichen (Ltd；JIANWEI Scientific Instruments (Anhui) Technology Co.)

Presenter: TANG, Songsong (University of Science and Technology of China)

Session Classification: Poster Session

Contribution ID: **71** Type: **not specified**

8. Mass production and performance of large area thermal bonding Micromegas\DMM detectors

Tuesday 15 October 2024 17:13 (4 minutes)

Micromegas detectors have been widely studied and applied in high-energy physics experiments due to their advanced performances such as high spatial resolution, high counting rate, radiation resistance, and cost-effectiveness, since its invention in the 1990s. In response to the performance requirements of different experiments, high-performance, large-area Micromegas detectors and their mass production have become important technical issues that need to be overcome.
This report will introduce the progress of Micromegas manufacturing technology based on the thermal bonding method. In recent years, we have developed large area Micromegas detectors with sensitive areas of 400 × 400 mm2 and 600 × 600 mm2, and completed the production of a batch of detectors for cosmic ray track detection by adopting a series of quality control methods such as material selection, condition control, and high-voltage aging etc. The test results show that its position resolution reaches about 130 um and the detection efficiency reaches better than 95%. In addition, several large-area, high-performance double Micromegas (DMM) detectors have been also successfully fabricated. Preliminary test results of higher than 105 gas gain and better than 10% gain uniformity indicate its good application potential in future.

Author: WEN, sicheng (Ltd；JIANWEI Scientific Instruments (Anhui) Technology Co.)

Co-author: ZHANG, Zhiyong (University of science and technology of china)

Presenter: WEN, sicheng (Ltd；JIANWEI Scientific Instruments (Anhui) Technology Co.)

Session Classification: Poster Session

Contribution ID: **72** Type: **not specified**

9. Performance study of 400mmx400mm and 600mmx600mm micromegas track detectors using cosmic rays

Tuesday 15 October 2024 17:17 (4 minutes)

The large area and high spatial resolution of particle detection are important aspects in the research and application of MPGD. Currently, there is no satisfactory technological solution to address these challenges, particularly in achieving long-term stable, high-resolution readout of large area detectors, and managing high irradiation background and counter rates. In this study, we utilized the thermal bonding method for manufacturing Micromegas detectors and conducted production and research on large area Micromegas detectors ranging from 400mmx400mm to 600mmx600mm in size. Several large area Micromegas detectors have been successfully developed, and a cosmic ray test system has been established. Using this system, we developed an alignment algorithm and investigated the position resolution, detection efficiency through performance testing, and micro-TPC reconstruction. A new alignment algorithm for plate detectors based on MillepedeII was developed using this system, effectively addressing the convergence issue of traditional algorithms in the rotation alignment of the x/y direction. The results of the cosmic ray test demonstrate that the detection efficiency of the 400mmx400mm thermal bonding Micromegas detector exceeds 95%, with a position resolution of approximately 130 micrometers. The position resolution of micro-TPC reconstruction is approximately 160 micrometers for particles with incident angles greater than 20 degrees. This paper covers the manufacturing of large area Micromegas detectors, cosmic ray testing, and data analysis methods.

Author: LIU, Yulin (University of science and technology of china)

Co-authors: LIU, Jianbei (University of Science and Technology of China); WANG, Yu (University of Science and Technology of China); ZHANG, Zhiyong (University of science and technology of china)

Presenter: LIU, Yulin (University of science and technology of china)

Session Classification: Poster Session

Contribution ID: **73** Type: **not specified**

10. Study of MPGD based photo detectors for the RICH system in STCF

Tuesday 15 October 2024 17:21 (4 minutes)

The Super τ-Charm Facility (STCF) is a high-luminosity electron-positron collider under development in China, following the BEPCII. The STCF requires better particle identification for charged hadrons within its energy range, necessitating a ≥3σ resolution for π/K identification at momentum ranges of 2GeV/c and below. To meet these stringent requirements, a Cherenkov detector has been selected as the particle identification detector for the STCF. Our research focuses on a micro-pattern gas detector based on THGEM combined with Micromegas. This setup fulfills the RICH (Ring Imaging Cherenkov) detector's demands for a photo-detector, providing high gain, large area coverage, and high counting rate capabilities. The Micromegas component has been specifically developed using a thermal bonding technique, and the THGEM utilizes a copper reduction process in order to enhance voltage resistance and increase the surface area of the photocathode coating. We have successfully developed a 32cm×32cm RICH detector, achieving a gain of up to 10ˆ5 with a gain uniformity better than 20%. Cherenkov radiation photoelectrons can be detected by plating CsI (Cesium Iodide) on the THGEM as a photocathode. Furthermore, we are exploring the development of a novel photo-detector based on a double micro-mesh gaseous structure(DMM). This new detector aims to provide better time resolution, lower ion feedback, and higher gain. We have successfully developed a 32cm×32cm DMM detector, and its gain uniformity is better than 15%.

Author: WANG, Anqi (University of Science and Technology of China)

Co-authors: SHAO, Ming (University of science and technology of china); ZHANG, Zhiyong (University of science and technology of china)

Presenter: WANG, Anqi (University of Science and Technology of China)

Session Classification: Poster Session

Contribution ID: **74** Type: **not specified**

11. An SU-8 Delayed Development Processing Technology for MPGD

Tuesday 15 October 2024 17:25 (4 minutes)

SU-8 is a high-contrast, epoxy-based photoresist designed for micromachining and other microelectronic applications where a thick, chemically, and thermally stable image is desired.μGroove is a high-performance single-stage MPGD featuring a groove amplification pattern, typically fabricated by chemical etching. In this study, we present the process of μGroove with smaller amplification units on a quartz substrate using SU-8. Specifically, SU-8 served as a sacrificial layer, and an Al film acted as a supporting layer. During the exposure of the positive photoresist, the negative photoresist SU-8 was also exposed synchronously without any positional offset. Finally, through delayed development of SU-8, we achieved self-alignment of the cathode metal layer (aluminum) and the SU-8 supporting layer, completing the prototype with a groove pitch of 140μm, a width of 70μm, a thickness of 50μm for SU8 and 100nm for Al. When read from the cathode, the effective gain of the induced signal can reach up to 1600, with an energy resolution of approximately 9.5%. By fixing the detector voltage at 370V and scanning the drift electrode, the gain increases almost linearly with the drift electrode voltage, with the energy resolution also around 12%. Based on the delayed development technology of SU-8, we also explored some MPGD structures, such as Micromegas and μRGroove on PCB. Due to the high precision of the SU-8 photolithography process, it is possible to fabricate microstructures with smaller granularity and effectively bond them with readout chips, showing potential in the field of ultra-high precision detection.

Author: WE, Liu (University of science and technology of china)

Co-authors: HE, Siqi (University of Science and Technology of China); ZHOU, Yi (University of Science and Technology of China); WEI, Yu (University of Science and Technology of China)

Presenters: WE, Liu (University of science and technology of china); HE, Siqi (University of Science and Technology of China); ZHOU, Yi (University of Science and Technology of China); WEI, Yu (University of Science and Technology of China)

Session Classification: Poster Session

Contribution ID: **75** Type: **not specified**

12. Research on rapid imaging with cosmic ray muon scattering tomography

Tuesday 15 October 2024 17:29 (4 minutes)

Cosmic ray muons tomography is a non-destructive imaging technique that uses the natural radiation of cosmic ray muons to create tomographic images of objects. Here presents a novel imaging algorithm that effectively utilizes experimental measurement data to achieve rapid and clear imaging of cosmic ray muons. A clear image can be obtained with only 20 min of measurement time and approximately 200 effective muons. However, the current detection flux is only about 0.044 cm−2 min−1, which is significantly lower than the natural cosmic ray flux of about 1 cm−2 min−1.

Author: WEN, Qungang (Anhui University)

Presenter: WEN, Qungang (Anhui University)

Session Classification: Poster Session

Contribution ID: **76** Type: **not specified**

13. Design of Highly Integrated Muon Imaging Readout Electronics for Micromegas Detector

Tuesday 15 October 2024 17:33 (4 minutes)

Muon imaging technology is an innovative imaging technique that can be applied in volcano imaging, heavy nuclear material detection, and archaeological research. The Micromegas detector is a promising choice for muon imaging due to its high spatial resolution and large area. However, the large number of readout channels poses a challenge for electronics. A highly integrated front-end electronics was designed and implemented for the multi-channel readout requirements of Micromegas detectors. The electronics use a current-based readout chip, ADAS1128, which integrates 128 current amplifiers for multi-channel charge measurement. The performance of the front-end electronics was first tested under floating input conditions. Then, the energy resolution was obtained with a radioactive source test. Finally, a muon image system was set up to verify the imaging capacity of Micromegas detectors. Test results indicate that for muons with incident angles from 0 to 5 degrees, the spatial resolution of the system is better than 200 μ m. The muon image system can reconstruct the boundaries for objects with a size of 2 cm.

Author: WANG, Ting (University of Science and Technology of China)

Co-authors: FENG, Changqing (University of Science and Technology of China); LIU, Shubin (University of science and technology of china); WANG, Yu (University of Science and Technology of China); ZHANG, Zhiyong (University of science and technology of china)

Presenter: WANG, Ting (University of Science and Technology of China)

Session Classification: Poster Session

Contribution ID: **77** Type: **not specified**

14. A high rate and high timing photoelectric detector prototype with RPC structure

Tuesday 15 October 2024 17:37 (4 minutes)

To meet the needs of high count rate and high time resolution in future high energy physics experiments, a prototype of gas photodetector with RPC structure was developed. Garfield++ simulated the detector's performance, and the single photoelectron performance of different mixed gases was tested with an ultraviolet laser. The detector uses a low resistivity () float glass so that it's rate capability is significantly higher than that of ordinary float glass(), the laser test results show that in MRPC gas(), the single photoelectron time resolution is best to reach 20.3 ps at a gas gain of . Increasing the proportion of can effectively reduce the probability of photon feedback while hardly changing the time resolution and maximum gain. In addition to being applied to high-precision time measurement scenarios(eg:T0, TOF), the detector can also quantitatively test the single photoelectron performance of different gases and will be used to find eco-friendly MRPC gases.

Author: ZHAO, Yiding (University of Science and Technology of China)

Co-author: SHAO, Ming (University of science and technology of china)

Presenter: ZHAO, Yiding (University of Science and Technology of China)

Session Classification: Poster Session

Contribution ID: **78** Type: **not specified**

15. Research on the calibration method of the avalanche gap of MTPC anode plate

Tuesday 15 October 2024 17:41 (4 minutes)

This report presents an investigation on the calibration of anode plate of the Multi-purpose Time Projection Chamber (MTPC). MTPC mainly acquires the energy of the emitted particles from the responsed pad. The energy information on the pad mainly depends on the gain uniformity. Therefore, it is necessary to calibrate the electron avalanche gain and the energy resolution of MTPC. The Micromegas detector is applied as the anode plate of MTPC, and the avalanche gap between the mesh and the resistive layer directly determine the gain of the anode plate. This report delineates the approach for calibrating the avalanche gap of the anode plate via X-ray source and alpha source. By fitting the curve of elctron avalanche gain with photon feedback coefficient, we obtain the avalanche gap of the anode plate.

Author: CHU, Tianzhi (Chinese Academy of Sciences；Shenzhen University;Institute of high energy physics；China Spallation Neutron Source)

Co-authors: CHEN, Haizheng (Institute of High Energy Physics；Chinese Academy of Sciences); YI, Han (Institute of High Energy Physics；Chinese Acadamy of Sciense); CHEN, Hongkun (Sun Yat-sen University)

Presenter: CHU, Tianzhi (Chinese Academy of Sciences；Shenzhen University;Institute of high energy physics；China Spallation Neutron Source)

Session Classification: Poster Session

Contribution ID: **79** Type: **not specified**

16. An improve of performance in MTPC with waveform deconvolution technique

Tuesday 15 October 2024 17:45 (4 minutes)

The multi-purpose time projection chamber (MTPC), which is designed for measuring neutron nuclear data of varied field, is fabricated at China Spallation Neutron Source (CSNS). Its drift region is flexible, ranging from 70mm to 150mm. Ionization electrons are avalanched and collected via a resistive Micromegas detector with 1521 readout channels. As timing precision plays an important role in particle 3D track reconstruction as well as in time-of-flight method (for measuring neutron energy), we have developed deconvolution technique combined with waveform fitting for software waveform analysis. We have modeled the anode signals which contains energy and space information of detected particles. T0 of signals are obtained by utilizing FFT deconvolution technique. Data from 6Li(n,t)α experiment is used to study the detector's enhanced performance. A simulation of MTPC signals and noises is applied to estimate the timing resolution and timing bias of our software. The result shows that the timing precision of analysis result is significantly improved.

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Session Classification: Poster Session

Contribution ID: **80** Type: **not specified**

17. FOML，a deep learning based fast online multi-track locating algorithm for MPGD with silicon pixel sensors

Tuesday 15 October 2024 17:49 (4 minutes)

Mirco Pattern Gaseous Detector (MPGD) plays a vital role in particle detection at The Heavy Ion Research Facility in Lanzhou and the High-Intensity Heavy Ion Accelerator Facility. The MPGD has amplification structures of a few micron meters. However, the pad size of the readout plane does not match the high granularity due to limitations on the integration level of readout electronics. To address this, using silicon pixel sensors with a pixel size of a few microns to read the MPGD becomes a good candidate, but this produces a vast amount of data from silicon pixels. Therefore, we have developed a Fast Online Multi-Track Locating (FOML) algorithm based on deep learning approaches. This FOML can extract the information of each track in real time and significantly reduces the data volumen. In our network, the lightweight and efficient effect is achieved by implicitly reusing features in the backbone network. In feature fusion, BiFPN and attention mechanisms are used for more comprehensive information transmission and fusion of different levels of features. Finally, learning the target location and category information through different network branches can reduce the computational complexity and improve the detection efficiency. The FOML is expected to achieve a detection speed of 452 frames per second while providing a position accuracy of ˜2um.

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Session Classification: Poster Session

Contribution ID: **81** Type: **not specified**

18. Multi-dimensional measurement ASIC for Micro-Pattern Gas Detectors

Tuesday 15 October 2024 17:53 (4 minutes)

Abstract
Micro-Pattern Gas Detectors are cost-effective, enabling large-area, continuous charged-particle detection with less detection material. Their wide application and rapid development raise the demand for high sensitivity, integration, and resolution. Silicon pixel detector ASIC can be used as readout circuits for Micro-Pattern Gas Detectors, enabling accurate measurement and fast readout of data in high-energy physics experiments.
Therefore, we designed a silicon pixel detector ASIC which will measure and simultaneously record the time of arrival (TOA), the energy information (Time Over Threshold, TOT), and the position of the particles. The ASIC consists of 1024 rows × 1024 columns of pixel units and a readout control circuit. The readout control circuit adopts two levels of FIFO, one level of continuous arbitration circuit, the four levels of cyclic arbitration circuit, and the Token Ring control circuit, which will read out at 200 MHz without loss. The precision of the measurement is 5 ns, the spatial resolution is 15 μm, the dead time is 40 ns, and the readout efficiency is higher than 99%.

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Session Classification: Poster Session

Contribution ID: **82** Type: **not specified**

19. Impact of a strong electric field below the GEM on light yield and saturation in a He:CF4 based Time Projection Chamber

Tuesday 15 October 2024 17:57 (4 minutes)

CYGNO is an international collaboration working on the development of a directional detector whose main goal is the direct detection of rare events, such as Dark Matter (DM) in the mass range below few tens of GeV/c2, by means of a gaseous detector. It consists in a Time Projection Chamber (TPC) filled with a He:CF4 gas mixture at atmospheric pressure (900 to 1000 mbar) equipped with an amplification stage composed of a triple Gas Electron Multiplier (GEM) structure. Given the scintillating properties of the gas, the readout is optical, based on sCMOS cameras and photomultiplier tubes. The intrinsic information provided by the TPC technology coupled to the spatial granularity and time resolution of the GEM and of the optical sensor combination allows to image the three-dimensional energy deposition of electron and nuclear recoils down to few keV of energy.

In low energy rare event searches, the detection of the smallest energy deposition possible is of the utmost importance to improve directional capabilities and DM sensitivity. Besides, while the optical readout can cover wide readout areas with a limited number of sensors, the solid angle coverage strongly suppresses the number of photons they can collect. As a result, extremely large avalanche gains are required from the amplification stage which is limited by the onset of space-charge saturation effects.
The possibility of introducing a strong electric field, above 10 kV/cm, below the last GEM to distort the electric field and increment the light yield was tested with a CYGNO prototype.
We will present the studies of the effect of such field on the GEM hole electric field and the experimental results on the light yield, intrinsic diffusion estimation and space-charge saturation level suppression.
Achieving large gains in rare event searches detectors optically readout is an extremely relevant problem wherein advancements and new developments could pave the way for the realisation of large-scale experiments.

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Session Classification: Poster Session

Contribution ID: **83** Type: **not specified**

20. Studies of an event-building algorithm of the readout system for HFRS-TPC

Tuesday 15 October 2024 18:01 (4 minutes)

The High-energy Fragment Separator (HFRS), which is currently under construction, is a leading international radioactive beam device. It will significantly enhance the experimental capability in the medium-heavy nuclear region. Given the high-energy and high-intensity properties of HFRS, it is imperative to implement a highly reliable identification of nuclides at high counting rates (~10 MHz) and meet the large dynamic range requirements (Z=1~92), which poses a great challenge to radioactive particle detection and readout electronics technology. As the counting rate of the projectiles increases, there is a strong possibility that the readout signals from different particles experience time disorder, so the twin TPCs are chosen as a position-sensitive detector. However, due to the large number of readout channels and the vast amount of data, higher requirements for data transmission, processing and storage have been posed, which bring great challenges to the development of readout electronics.

Therefore, we propose a new online event building algorithm for HFRS-TPC. Our algorithm employs a combination of software and hardware to compress massive amounts of data using a hierarchical processing strategy, and addresses the issue of particle time disorder at high counting rates. The readout system employs a three-tiered structural design consisting of Front-End Electronics (FEEs), slave Data Acquisition units (slave DAQs), and a server. The main function of the FEE is to process the signals from the detectors at the channel level. The FPGA firmware of the FEE features an on-line algorithm for extracting time and energy information to minimize data volume. The slave DAQ executes the aggregation of detector level data using a high-performance FPGA (Xilinx Kintex UltraSCALE 060), which aggregates and packages data from multiple FEEs with 10-Gbps high-speed optical fiber links. Subsequently, the particle multiplicity is restored by cluster reconstruction. Once this is completed, the Center of Gravity (CG) approach is used to determine the original incident positions of the particles on the readout strips in each detector. Finally, both the incident position and drift time from the two TPCs are relayed to the hit-matching module on the server, and the two-dimensional trajectory of the incoming particles is ultimately reconstructed.

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21. Calibration for the SAMPA ASIC in HERD transition radiation detector front-end electronics

Tuesday 15 October 2024 18:05 (4 minutes)

The High Energy cosmic-Radiation Detection facility (HERD) is a part of the Chinese Cosmic Lighthouse Program in China's Space Station, which will be launched in 2027. HERD is expected to work 10 years in orbit and will indirectly detect dark matter, measure cosmic rays and observe high-energy gamma rays. As a sub-detector of HERD, the transition radiation detector's (TRD) main scientific goal is to calibrate the electromagnetic Calorimeter (CALO) at the TeV energy range, improve the measurement accuracy of the CALO, and detect astronomical phenomena of high-energy gamma rays. The front-end readout electronic (FEE) of the prototype of TRD uses four SAMPA ASICs for 128 signals of anode, realizing a high-speed, low-power, and high-reliability data acquisition system. In this work, we completed the calibrations of the gain and shaping time in the unsupported modes of SAMPA to achieve adjustable dynamic range on orbit. The effect of the different fitting algorithm on the test results is also discussed under different modes of operation.

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22. Prototype design of the high-precision clock generation and distribution for multiple detectors cooperative work at HIAF-HFRS

Tuesday 15 October 2024 18:09 (4 minutes)

Nuclear physics using radioactive beams has been the most dynamic research area in nuclear science. A High Intensity Heavy-Ion Accelerator Facility (HIAF) is currently under construction, and a cutting-edge High Energy Fragment Separator (HFRS) with high energy and intensity capabilities is being installed. HFRS is an important facility in the HIAF, located between BRing and SRing, with a total length of 180 m. It is designed to study the properties of rare isotopes and their nuclear reactions relevant to astrophysics. HFRS is characterized by high magnetic rigidity, large optical acceptance of ions, and accurate particle identification. HFRS identifies particles using time-of-flight measurements, position measurement and energy loss measurement from multi-detector cooperation can identify isotopes with mass numbers up to 200. HFRS provides accurate energy loss measurement with multiple sampling ionization chambers, time measurement with diamond detectors and position resolution with GEM-TPC detectors. High-precision clock generation and distribution is a prerequisite for these detectors to work together to accurately measure particle motion time intervals and position resolution for accurate particle identification. It also helps to correlate and align data from different channels of different detectors along the time axis to construct particle trajectories and restore physical phenomena accurately. This paper describes the prototype design of high-precision clock generation and distribution for multiple detectors in HFRS at HIAF. The system is based on a master-slave architecture design. The master board generates a high-precision 40 MHz clock through a high-quality crystal oscillator. Then, it feeds it to the input of a low-jitter clock fan-out chip, which can distribute the 12 LVPECL level signal outputs to the optical transceivers and then transmit to the slave boards via optical links. The slave board receives the clock signals from the master board, then fans out 10 LVDS differential clock signals through a low jitter clock chip, and provides synchronized clock signals to the front-end electronics or DAQ system through the differential LEMO connectors. The test results indicate that the time interval error (TIE) jitter is better than 3 ps, and the cycle-to-cycle period (C-C period) jitter is better than 8.7 ps after transmission over 200 m optical fiber. The system can provide a stable and accurate 40 MHz synchronous clock to meet the design requirements.

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23. Study of Charge Dynamics in THGEM-based Detectors –A Numerical Approach

Tuesday 15 October 2024 18:13 (4 minutes)

Muography is a method for scanning a target object by analyzing how it interacts with muons. Indeed, the interaction mode depends on the energy of the incident muon, as well as the characteristics of the medium participating in the interaction. Electromagnetic interaction between cosmic muons and the atoms of the target object causes the trajectories of cosmic muons to deviate before reaching some of the position sensitive particle detectors used to image the target. The characteristic features of the material determine the magnitude of the deviation. The track deviations are then used as a body of information to generate images and predict the target's material composition and geometry. Position-sensitive detectors placed at suitable locations all around the target can be used to monitor the incoming and outgoing muons. Detectors based on THick Gaseous Electron Multipliers (THGEM) are likely to satisfy the necessary requirements and a detailed numerical study has been carried out in this work to qualify their performance.

To employ THGEM for imaging purposes, study of detector parameters like efficiency, gain, gain uniformity, space charge, discharge probability etc. are crucial, especially for long term and consistent operation of the detector. All these phenomena, in their turn, depend on the dynamics of charged particles within the device. Because of the large number of particles involved and their complex interactions, the dynamic processes of generation and loss of charged particles, and their transport within the detector volume are extremely expensive to simulate numerically.

We have proposed a hybrid fast numerical model to estimate the response, charge dynamics of avalanche and streamer / discharges of THGEM-based ionization detectors. Information related to primary ionization is obtained from HEED, while all the transport properties are evaluated using MAGBOLTZ. The transport is simulated following hydrodynamic model using COMSOL that solves the electrostatics problem with space charge using Electrostatics (ES) from the AC/DC module, and the dynamics of charged particles by the Transport of Dilute Species (TDS) of the Chemical Reaction Engineering (CRE) module. The effective gain estimated from the simulation has been compared with the available experimental data and good agreement is observed. Positive streamers or discharges driven by ionic space charges have been observed. Since the hydrodynamic model is deterministic in nature, sources of fluctuations have been introduced in terms of different possible combination of initial conditions. Initial number of primaries, position and configuration of the seed cluster are found to have significant impact on the subsequent development of detector response. It may be mentioned here that variation of all these model parameters and their resulting outputs have been managed in a seamless manner with the help of a python interface, without the monotonous and repeated intervention of a human user.

In this presentation, we propose and evaluate possible algorithms / approaches that show some promise in relation to the above-mentioned problems. Effect of different simulation parameters will also be demonstrated using simple examples. Particle model of charge transport using Garfield++ will also be used to address some of the problems to appreciate the advantages and disadvantages of these two approaches presently available for particle detector simulation.

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24. New Structure UV-C Detector Using Photocathode Vapour

Tuesday 15 October 2024 18:17 (4 minutes)

Prototypes capable of detecting UV photons using photocathode vapors and their characterization data are well-documented in the literature. However, no research has been found that explores the impact of different vaporization methods of these gas-phase photocathodes on their quantum efficiency and signal production capabilities. In this study, Ethylferrocene (EF) and TMAE photocathode vapors were vaporized using heating and ultrasonic vibration methods, and the photon interaction performance of the resulting vapors was compared. Additionally, mixtures of these vapors in various ratios were tested, and the results were analyzed and compared. The findings from these experiments will be presented.

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