HK 43: Instrumentierung

Zeit: Donnerstag 14:00–16:00 Raum: HZ 8

Gruppenbericht HK 43.1 Do 14:00 HZ 8
CASCADE-Neutronendetektor: Ein GEM-basierter Festkörperdetektor — •Michael Liebig, Markus Köhli, Gerd Modzel und Ulrich Schmidt — Physikalisches Institut, Universität Heidelberg

Der CASCADE-Detektor ist ein orts- und flugzeitaufgelöster Detektor für thermische Neutronen. Er detektiert die Konversionsprodukte in dünnen Schichten absorbierter Neutronen mit Hilfe von borbedampfter Gas Elektron Multiplier (GEM)-Folien. Die Technologie stellt eine Alternative zu klassischen He-3-Zählrohren dar und eröffnet neue Anwendungfelder, wie etwa der Spin-Echo-Technik (MIEZE).

Aufgebaut ist der CASCADE-Detektor bisher aus einem Stapel von bis zu acht mit Bor-10 beschichteter ladungstransparenter GEM-Folien. Parallel zu einer mikrostrukturierten Streifenauslese wird das Ladungssignal an den GEMs verwendet die Konversionsschicht zu identifizieren.

Das hier vorgestellte neue Design verbessert durch Materialienwahl und eine neue Geometrie vor allem seine Effizienz bei MIEZE-Messungen, da überkoppelnde Signale reduziert werden und selbstspannende Rahmen eine optimale Positionierung ermöglichen. Die Ausleseelektronik besteht aus einem FPGA-Board und dem ladungsempfindlichen Verstärker nXYter, einem selbsttriggernden 128-Kanal-ASIC, der für statistisch verteilte Neutronen entwickelt wurde.

HK 43.2 Do 14:30 HZ 8
First Measurement of dE/dx with a GEM-based TPC — •Felix Valentin Böhmer for the GEM-TPC-Collaboration — Technische Universität München

Realizing gas amplification for TPCs with GEM foils – instead of the traditional setup using MWPCs and a gating grid – promises to allow continuous operation of such a detector: exploiting the intrinsic suppression of ion backflow that is characteristic for GEMs lifts the constraint to low-rate environments entailed by the presence of a gating system. While the spatial resolution achievable with GEM foils is comparable to or better than that of MWPCs, fluctuations of the gain in a multi-GEM system could compromise the energy resolution of the detector.

We have studied the specific energy loss ("dE/dx") performance of a TPC based on a triple-GEM readout – the largest of its kind to date – on data from a 3-weeks physics campaign inside the FOPI spectrometer at GSI, Germany. Particle identification capabilities for particles originating from π-induced reactions are studied as a function of the momentum. Resolutions are extracted using an exponentially modified Gaussian as a fit function, and are found to be in good agreement with expectations. A dedicated Monte Carlo study has been performed to investigate the impact of the track length on the peak asymmetries in a truncated mean analysis.

Supported by the BMBF, the DFG Cluster of Excellence "Universe" and the EU 7^{th} framework program

HK 43.3 Do 14:45 HZ 8
Ion back flow and energy resolution in GEM detectors for the ALICE TPC — •Esther Bartsch, David Just, Rainer Renfordt, and Harald Appelshäuser for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

For the upgrade of the Time Projection Chamber (TPC) of the ALICE experiment at the CERN LHC it is planned to replace the multiwire proportional readout chambers by Gas Electron Multiplier (GEM) stacks. The high interaction rate of 50 kHz foreseen for the Run 3 period of the LHC makes a readout scheme desirable that can accommodate the 100 times higher rates. GEM-based readout chambers that can be operated in continuous mode are the prime candidate. However, the backflow of positive ions into the detector volume turns out to be too high in commonly used triple-GEM stacks, producing unacceptable levels of space charge and thus distortions of the drift field. Several measures to reduce the ion back flow (IBF) can be taken: addition of a fourth GEM foil, optimization of the GEM voltages and transfer fields between the foils.

A dedicated test detector for the characterization of triple and quadruple GEM stacks was set up at the IKF in Frankfurt. The results of systematic studies of the IBF and the energy resolution in different arrangements of standard and large-pitch GEM foils will be presented.

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HK 43.4 Do 15:00 HZ 8
Discharge probability studies in GEM structures for the ALICE TPC upgrade — •Piotr Gasik for the ALICE-Collaboration — TU München, Boltzmannstr. 2, 85748 Garching, Germany

A large Time Projection Chamber (TPC) is the main device for tracking and charged particle identification in the ALICE experiment at the CERN LHC. After the second long shutdown in 2018, the LHC will deliver Pb beams colliding at an interaction rate of about 50 kHz, which is about a factor of 100 above the present readout rate of the TPC. In order to make full use of this luminosity, a major upgrade of the TPC is required. It is foreseen to replace the existing MWPC-based readout with Gas Electron Multiplier (GEM) foils.

The GEM foils are commonly known structures used as proportional counters, which permits to obtain high gains at very high radiation rates. However, highly ionizing particles, which may be produced during heavy ion collisions, may trigger an electrical breakdown which may result in damage of the foils or readout electronics.

The key parameter for a long-term operation of the GEM-based TPC is the stability against electrical discharges. We performed discharge probability studies in triple and quadruple GEM structures in Ne- and Ar-based gas mixtures to find operational conditions for the upgraded ALICE TPC. Preliminary results from these measurements will be discussed in this contribution.

This work is supported by BMBF and DFG Cluster of Excellence "Universe" (Exc 153).

HK 43.5 Do 15:15 HZ 8
Secondary vertex reconstruction with a GEM-TPC at FOPI — •Sverre Dørheim for the GEM-TPC-Collaboration — Technische Universität München

A Time Projection Chamber (TPC) with GEM amplification was built and installed in the FOPI experiment at GSI, Darmstadt, in the end of 2010, in order to improve vertex and track reconstruction and provide additional information on specific energy loss for particle identification.

After several test runs with cosmic rays and particle beams, it was successfully operated for a three-week physics campaign with a 1.7-GeV π^- beam impinging on nuclear targets. The goal of this physics campaign is to investigate strangeness production in nuclear matter. Two important probes in this investigation are Λ and K^0_S. The reconstruction of such neutral particles relies heavily on the ability to distinguish the decay vertex from the main interaction vertex. Here, the excellent position resolution of the GEM-TPC plays an important role.

I will discuss the reconstruction of secondary decay vertices, including the alignment of the TPC, reconstruction of tracks, particle identification, and vertexing algorithms. First results on yields of Λ and K^0_S will be presented.

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HK 43.6 Do 15:30 HZ 8
THick Gas Electron Multiplier (THGEM) detector readout based on TDC-FPGAs — •Maximilian Büchele, Horst Fischer, Matthias Gorzellik, Tobias Grussenmeyer, Florian Herrmann, Phillip Jörg, Paul Kremser, and Sebastian Schopferer — for the THGEM group of the COMPASS collaboration, Physikalisches Institut, Albert-Ludwigs-Universität Freiburg

The RD51 program has been investigating a novel photon detector technology called THGEM, aimed to be operated in future Ring Imaging Cherenkov (RICH) Counters. The THGEM design is adopted from the Gas Electron Multiplier (GEM) using Printed Circuit Board (PCB) material. The manufacturing process uses standard PCB drilling and etching techniques which allows to cover large detector areas at gains up to 10^6 in a mechanically robust and very cost-efficient manner. Promising results have also been obtained with a hybrid approach, which combines the THGEM with a Micromega layer to further suppress the ion back flow to the photocathode.

In the course of the RICH-1 detector upgrade of the COMPASS experiment at CERN, the existing Multi Wire Proportional Chambers will partly be replaced by a set of THGEMs. For the digital readout, we are designing a front-end board processing 384 detector channels by TDC-FPGAs. The boards reading a single THGEM chamber are connected in a star topology in order to exploit the data rate capability of the optical transceivers interfacing with the downstream data acquisition system.

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HK 43.7 Do 15:45 HZ 8

Ionenrückfluss in Dreifach- und Vierfach-GEM-Detekoren — Markus Ball, •Julia Bloemer, Andreas Hönle, Korbinian Eckstein und Bernhard Ketzer — Technische Universität München

Nach dem zweiten langen Shutdown des LHC in 2018 wird der ALICE-Detektor Pb-Pb-Kollisionen mit einer deutlich höheren Kollisionsrate von mindestens 50 kHz aufnehmen. Der herkömmliche Betrieb der ALICE-TPC (Zeitprojektionskammer) mit Vieldrahtkammern und einem Sperrgitter zur Ionenunterdrückung erlaubt jedoch nur eine Kollisionsrate von mehreren kHz. Die verwendete TPC muss in diesem Zuge für eine kontinuierliche Auslese weiterentwickelt werden.

Eine alternative Technik der Gasverstärkung stellen hier Gas Electron Multiplier (GEMs) dar, die eine intrinsische Unterdrückung von zurückdriftenden Ionen ermöglichen. Um die Feldverzerrungen durch Ionen in einem beherrschbaren Rahmen zu halten muss ein Rückfluss von Ionen bis unter Werte von 1% minimiert werden. Eine Vielzahl von Parametern steht dabei zur Optimierung zur Verfügung, dazu gehören Gasmischung, Spannungs- und Feldkonfigurationen, die Anzahl der Folien sowie ihre mikroskopische Struktur.

Dieser Vortrag gibt eine Übersicht der systematischen Studien zu Detektoren mit drei und vier GEM-Folien an der TUM.

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