HK 31: Instrumentation VII

Time: Wednesday 15:45–17:00 Location: SR Exp1A Chemie

HK 31.1 Wed 15:45 SR Exp1A Chemie

The Stabilized Voltage Divider – A Rate-Capable HV-Scheme for GEMs — •Jakob Krauss[1], Philip Hauer[1], Karl Flöthner[1,2], Christian Honisch[1], and Bernhard Ketzer[1] — [1]Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn, Germany — [2]CERN, Geneva, Switzerland

GEM detectors are widely used as tracking detectors in modern particle physics experiments. Typically, stacks of multiple GEM foils are used to provide the required gain. For discharge-safe operation, the potentials of the electrodes are often generated through a resistor chain from a single input channel, and a large-valued resistor is used to limit the current in case of a shorted segment. When such a detector is subjected to high particle rates, of up to several MHz/cm^2, the large number of charges moving inside the detector lead to non-negligible potential drops over the bias resistor. The performance of the detector is degraded, as the detector gain and efficiency are highly sensitive to the potentials, calling for improvements of the high-voltage scheme.

The newly developed Stabilized Voltage Divider (SVD) uses MOSFETs to provide the nominal potentials and limit the current in case of a short circuit in the GEMs, while having a low output impedance during normal operation. Strong emphasis was put on the adequate response of the SVD to discharges, minimizing the risk of damage to the detector's GEMs and readout. Measurements demonstrating the resilience to discharges and the superior rate capability of the SVD will be presented.

Supported by BMBF.

HK 31.2 Wed 16:00 SR Exp1A Chemie

Simulation of the MAGIX 4-stage GEM Time Projection Chamber — •Sara Fechner for the MAGIX-Collaboration — Institute for Nuclear Physics, Johannes Gutenberg University Mainz, Germany

Located at the MESA electron accelerator MAGIX will perform high-precision scattering experiments in the low energy regime. The physics program includes the study of hadrons and few-body systems, as well as reactions relevant to nuclear astrophysics and dark sector searches. The experimental setup is designed to minimize background and multiple scattering. Key parts are the windowless gas jet target and two high-resolution spectrometers with a 4-stage GEM Time Projection Chamber (TPC) for precise tracking around the focal plane.

A dedicated simulation framework accompanies the experiment and aims to model the entire process - from particle generation over scattering to the detector response. For the TPC, this includes the ionization of the Argon gas mixture by the initial electron, the drift of the electrons inside the electric field, their multiplication in the GEM stack, and the subsequent electronic readout.

This contribution will introduce the MAGIX TPC and the physics used to model its detector response.

HK 31.3 Wed 16:15 SR Exp1A Chemie

A Low-Material Time Projection Chamber for MAGIX — •Lucie Bister for the MAGIX-Collaboration — Institute for nuclear physics, Johannes Gutenberg University Mainz, Germany

The MAGIX experiment at the MESA accelerator in Mainz is designed for high-precision electron scattering experiments at low energies, covering nuclear structure investigations, astrophysics, and dark sector searches.

The setup consists of a windowless gas jet target, followed by two high-resolution magnetic spectrometers that focus the scattered electrons onto their focal plane. Due to the significant impact of background effects like multiple scattering at low energies, a low-material time projection chamber (TPC) has been developed to achieve a momentum resolution of $\Delta p/p < 10^{-4}$. In order to have no material in the particle path, an innovative open field-cage design has been developed, ensuring that the only material in the particles' trajectory is a 75 μm thin Kapton foil. This design minimises the material budget and preserves track quality.

This talk will briefly introduce the MAGIX experiment with an emphasis on the low-material TPC, its design considerations, and the field-cage geometry that allows for accurate tracking with minimal material interference.

HK 31.4 Wed 16:30 SR Exp1A Chemie

Test Measurements and Simulation of the PUMA Time Projection Chamber — •Rico Holz[1], Clara Klink[1,2], and Alexandre Obertelli[1] — [1]TU Darmstadt, Darmstadt, Germany — [2]CERN, Genève, Switzerland

The antiProton Unstable Matter Annihilation (PUMA) experiment at CERN studies the distribution of protons and neutrons in the nuclear density tail using low-energy antiprotons. By studying stable and short-lived nuclei, PUMA investigates surface phenomena such as nuclear halos and neutron skins. The experiment leverages the sensitivity of antiprotons to both neutrons and protons, with the neutron-to-proton annihilation ratio serving as the key observable. The antiproton-nucleon annihilation process conserves the electrical charge. PUMA uses this feature to disentangle the annihilation on neutrons and protons by measuring the charges of pions emitted from the annihilation with a time projection chamber (TPC) surrounding the reaction area [1].

The TPC and its operation will be described. The timing of the data acquisition is controlled by a plastic-scintillator trigger barrel positioned on the TPC's outer side. This contribution will present recent developments in the PUMA TPC and its associated simulation code, along with preliminary test measurements.

[1] T. Aumann et al., Eur. Phys. J. A (2022) 58:88

HK 31.5 Wed 16:45 SR Exp1A Chemie

Characterization of a prototype GEM detector with VMM3a readout at AMBER — •Pascal Henkel[1], Michael Lupberger[1], Martin Hoffmann[1], Karl Jonathan Flöthner[1,3], Virginia Klapper[1], Jan Glowacz[2], and Bernhard Ketzer[1] — [1]Helmholtz-Institut für Strahlen- und Kernphysik der Universität Bonn, Germany — [2]Physikalisches Institut der Universität Bonn, Germany — [3]CERN, Geneva, Switzerland

AMBER is a fixed-target experiment at the M2 beamline of CERN's SPS that uses muon and hadron beams for research on fundamental questions of hadron physics. Updating the spectrometer with a free-streaming readout is necessary for the upcoming precision measurement of the proton charge radius in muon-proton elastic scattering. New next-generation large-size triple-GEM detectors will be used for the reconstruction of muon trajectories in the spectrometer. Front-end electronics based on the VMM3a ASIC will allow a self-triggering data acquisition.

A prototype of such a detector was operated during a test run in September 2023. The aim was to define the working point of the detector in terms of thresholds as well as gas and electronics gains that fulfills the requirements both from physics and system readout bandwidth. In this talk, results will be presented which show that tracking efficiencies above 97 percent can be reached in a triple-GEM with VMM3a readout while matching the requirements of time and position resolution.

Supported by BMBF (05P2024 - AMBER).