T 71: Detectors VI (Gaseous Detectors)

Time: Thursday 16:15–18:15 Location: VG 1.101

T 71.1 Thu 16:15 VG 1.101

Results of an aging study for the graphite coating of thin-gap RPCs for the ATLAS phase 2 upgrade. — •Davide Costa[1,2], Francesco Fallavolita[2], Oliver Kortner[2], Hubert Kroha[2], and Giorgia Proto[2] — [1]Department of Physics, Technical University of Munich, Munich — [2]Max Planck Institute for Physics, Garching bei Munchen

The increase of total electrode resistance is a well-established cause of decrease in Resistive Plate Chamber (RPC) rate capability over time, as it leads to a lower effective voltage being applied across the gas gap. Additionally, a degradation of the graphite electrode might lead to non-uniformities in the field, which could become more significant over the large area of the RPC, worsening detector performance. While previous works have associated this increase in electrode resistance mostly to the degradation of the graphite coating, it is not clear that this is the case. This contribution presents preliminary results of a long-term study performed at the Max Planck Institute for Physics in Munich, which induces aging at varying rates by simulating the expected charge accumulation from 10 years of operation at the event rates predicted for the High-Luminosity LHC (HL-LHC). This study aims to confirm the expected performance of the graphite coating, and to disentangle effects due to degradation of the coating from potential contributions from the high-pressure phenolic laminate (HPL) electrode plates themselves. Further tests will investigate the potential mechanisms behind the aging phenomena.

T 71.2 Thu 16:30 VG 1.101

Quality assurance and quality control of the production of thin-gap RPCs for the ATLAS phase 2 upgrade. — •Davide Costa[1,2], Francesco Fallavolita[2], Oliver Kortner[2], Hubert Kroha[2], Giorgia Proto[2], Pavel Maly[2], and Daniel Soyk[2] — [1]Department of Physics, Technical University of Munich, Munich — [2]Max Planck Institute for Physics, Garching bei Munchen

The planned upgrades to the ATLAS muon spectrometer for the phase 2 upgrade of the LHC have increased the demand for better-performing Resistive Plate Chambers (RPCs). The upgrade requires gas gaps reduced thickness, both of the electrode plates and the gas volume itself, which lead to improved rate-capability and longevity, as well as allowing for the installation of additional triplets of thin-gap RPCs, with the aim to improve acceptance and efficiency of the ATLAS muon trigger. In order to improve production rate and assure redundancy, facilities for the production and certification of RPCs have been set up at the Max Planck Institute for Physics (MPP) in Munich, in collaboration with German industrial partners. This contribution illustrates the role the MPP has played in setting up the infrastructure, developing quality assurance as quality control (QA/QC) standards, in order to ensure that efficient production be accompanied by high performance standards, as well as the Institute*s ongoing participation in the development of innovative solutions for detector construction that allow to more reliably reach the required performance goals.

T 71.3 Thu 16:45 VG 1.101

Effect of Different O_2 and H_2O Concentrations on MicroMegas Detector Performance in Ar-CO_2 Gas Mixtures at Various Drift Volumes — •Burkhard Böhm and Raimund Ströhmer — Universität Würzburg, Germany

In particle physics the MicroMegas detectors (MM), a prominent type of Micro-Pattern Gaseous Detectors (MPGDs), are used in several experiments. They are valued for their simple single-stage amplification and high and stable gain. However, their performance can be significantly affected by the composition of the gas mixture, including the contamination from ambient air. Since processes in multi-component gas mixtures can be highly complex, experimentally investigating the signal behavior at different levels of O_2, H_2O and their combination in an argon-based atmosphere is crucial.

To evaluate the effect of impurities in drift volume and amplification region separately, we performed studies with maximum drift distances from 5 mm to 2.5 mm. The aim is to determine the magnitude of electron attachment, a major factor in signal degradation, in the amplification stage and whether it can be mitigated by using a smaller drift volume.

Precise control of oxygen and water levels was achieved by introducing O_2 and humidified Ar-CO_2 into a resistive MM chamber. The resulting effects on gas gain, primarily due to electron attachment in the drift region, and the amplification of primary electrons were systematically studied. This research provides valuable insights into optimizing MPGDs performance in environments with varying gas impurities.

T 71.4 Thu 17:00 VG 1.101

Investigation of micro-pixel charge sharing Micromegas detectors — •Nirmal Mathew, Otmar Biebel, Valerio D'Amico, Stefanie Götz, Ralf Hertenberger, Eshita Kumar, Daniel Grewe, Nick Schneider, Chrysostomos Valderanis, and Fabian Vogel — LMU München

Micro-MEsh GAseous Structure (Micromegas) detectors are Micro Pattern Gaseous Detectors (MPGD's) used for their high-rate capability and excellent spatial resolution achieved through narrow amplification gap and fine strip pitch readouts. However, this performance comes at the expense of requiring a large number of readout channels for individual strips. The development and testing of Pixalated Avalanche Detectors (PAD's) are investigated, which leverage charge-sharing principles across multiple pixel layers, alternative to strip-based readouts in Micromegas, to reduce the number of readout channels strongly. Each successive layer is designed with larger pixels than the one below, culminating in a final layer that aggregates charge information to determine the particle hit position. This approach reduces the number of readout channels while maintaining comparable spatial resolution.

Two prototypes were tested: one with five pixel layers, and a hybrid PAD with three layers and novel strip-like readouts. The detectors were calibrated using an Fe-55 source and tested in a hodoscope setup to track cosmic muons. The performance and efficiency of these measurements will be presented, demonstrating the feasibility of PADs as a cost-effective alternative to traditional MPGDs.

T 71.5 Thu 17:15 VG 1.101

GridPix Production: Latest Developments in Bonn — •Sabine Hartung, Yevgen Bilevych, Jochen Kaminski, and Klaus Desch — Physikalisches Institut Universität Bonn

GridPix detectors are Micropattern Gaseous Detectors designed for high-resolution imaging and the detection of single primary electrons. They incorporate a highly pixelated readout ASIC chip, such as the Timepix or Timepix3, which feature 256 x 256 pixels with a pitch of 55 x 55 μm. To minimize the probability of chip damage by sparks an additional protective layer is applied to the surface of the chip. The Micromegas-like gas amplification stage is constructed on top of the chip by photolithographic postprocessing.

Until recently, this wafer-based production process was carried out at the Fraunhofer Institute IZM in Berlin. Now it is being transferred to the Forschungs- und Technologiezentrum Detektorphysik (FTD) in Bonn. The advancements of this technology at the FTD in Bonn enables not only the continuation of the established process but also the adoption of more flexible production techniques, such as new maskless methods, which allow for greater optimization possibilities.

This presentation will provide an overview of the general technological steps and outline the current status of production at the Bonn facility.

T 71.6 Thu 17:30 VG 1.101

GridPix-based X-ray Polarimeter — •Vladislavs Plesanovs, Markus Gruber, Klaus Desch, and Jochen Kaminski — Rheinische Friedrich-Wilhelms-Universität Bonn, Germany

X-rays are a powerful tool for probing the elemental composition and electromagnetic properties of matter. By measuring X-ray emission spectrum, scientists can characterize the chemical compositions of test targets, while in astrophysics, X-ray polarization unveils the intricate magnetic structures of distant galaxies and nebulae. Several testbeam campaigns with GridPix-based detectors have demonstrated impressive capabilities in reconstructing X-ray polarization.

To push the limits of performance, we are developing a novel GridPix-based polarimeter. This gaseous detector integrates a Timepix3 ASIC readout, offering a zero-suppressed 40 Mhits s^{-1} readout rate with a 55 μm pixel pitch. 1 μm thick aluminum grid mounted on 50 μm high pilars, both deposited using photolithographic methods, define the amplification gap and ensure near-perfect alignment of grid holes and pixels - allowing for precise detection of individual primary electrons.

This work presents an overview of X-ray polarimetry and the GridPix detector's production and operation. The main focus will be on the current status and development decisions of this project.

T 71.7 Thu 17:45 VG 1.101

Negative Ion Gridpix based High resolution TPC (NIGHT) detector — •Saime Gürbüz, Thomas Block, Can Cihan Çetinkaya, Klaus Desch, Jan Glowacz, Jochen Kaminski, and Michael Vogt — Physikalisches Institut, Bonn, Germany

The Negative Ion Time Projection Chamber (NITPC) equipped with a Gridpix pixelated readout represents a cutting-edge approach to high-precision particle detection, with significant potential for directional dark matter searches. The proof-of-concept detector, NIGHT, combines a Timepix ASIC with an InGrid amplification stage, offering an active area of 1.4 cm × 1.4 cm and a drift length of 3 cm.

Operating with a He:SF_6 gas mixture, the detector profits the electronegative properties of SF_6 to achieve negative ion drift, reducing diffusion and enhancing spatial resolution. As the carrier gas, Helium supports near-atmospheric operation and optimal ion transport properties. The Gridpix readout, featuring micromesh amplification, ensures high spatial and temporal resolution even for low-energy particle tracking.

The NIGHT detector's design, operational principles, and performance will be presented in this talk. Gain measurements are conducted with radioactive sources in the laboratory and further tested at the ELSA electron accelerator. These studies aim to validate the detector's capabilities and demonstrate the advantages of pixelated readouts combined with negative ion drift for precision particle detection and directional dark matter experiments.

T 71.8 Thu 18:00 VG 1.101

BODELAIRE: A Time-Projection-Chamber for Neutron Science — •Thomas Block[1], Klaus Desch[1], Saime Gürbüz[1], Jochen Kaminski[1], Markus Köhli[3,4], Michael Lupberger[1,2], and Jan Glowacz[1] — [1]Physikalisches Institut, Universität Bonn — [2]HISKP, Universität Bonn — [3]Physikalisches Institut, Universität Heidelberg — [4]StyX Neutronica GmbH, Mannheim

Due to the increase in demand and price of Helium-3 alternative approaches for developing detectors for various applications in neutron science are of utmost importance.

The Boron Detector with Light and Ionisation Reconstruction (BODELAIRE) combines the concept of a time projection chamber (TPC) with a boronated glass vessel as a neutron conversion stage. It deploys a GridPix-based readout with high granularity and high time resolution, which makes it a suitable candidate for imaging experiments. The naturally abundant isotope Boron-10 absorbs incoming neutrons and decays into an alpha particle and a Lithium ion. One ion enters the drift volume of the TPC and creates a trace of electron-ion pairs, which the readout detects. The other ion, which is emitted in the opposite direction, creates a light signal in the scintillator layer on the glass vessel, which is used to trigger the readout. The light is coupled to a FPGA-controlled silicon photomultiplier-based electronic board, which creates the trigger signal. Trigger signal thresholds can be set by the user.

In this work the detector concept of BODELAIRE and its current stage of development will be presented.