T 74: Gaseous Detectors II

Time: Thursday 16:15–18:00 Location: KH 01.014

T 74.1 Thu 16:15 KH 01.014

Upgrading the CMS muon end cap for the high-luminosity LHC using ME0 GEM detectors — Erik Ehlert, Kerstin Hoepfner, Daniel Klee, Alexander Schmidt, and •Shawn Zaleski — III. Physikalisches Institut, RWTH Aachen University, Aachen, Germany

Gas electron multiplier (GEM) chambers have been operating as part of the CMS Muon end cap system since the beginning of Run 3. The GE1/1, first GEM system installed alongside the CSC chambers, provides an improved transverse momentum measurement of muons that pass through the CMS end caps. The ME0 system, a planned upgrade of the CMS Muon system for the high-luminosity LHC, is similar in design to that of the GE1/1 system, however it consists of a stack of six triple-GEM chambers. These ME0 stacks will be installed adjacent to the new high granularity hadron calorimeter (HGCAL) and will extend the pseudorapidity reach of the Muon system from 2.4 to 2.8. The GEM collaboration has built more than six stacks that will be installed during Long Shutdown 3 (LS3). All stacks that will be installed must undergo a rigorous set of quality control (QC) checks, the final of which is testing the full ME0 stack using a cosmic ray muon test stand (QC8). This talk will give an overview of the QC8 setup and present some results from the ME0 cosmic ray test stand QC checks.

T 74.2 Thu 16:30 KH 01.014

Integration of new Gas Monitoring Chambers into the ND280 Near Detector Gas System — Stefan Roth, •David Smyczek, Jochen Steinmann, and Nick Thamm — RWTH Aachen University - Physics Institute III B, Aachen, Germany

A new pair of Time Projection Chambers for high angle measurements (HAT) has been installed during the upgrade of the T2K near detector ND280. To improve their calibration, drift velocity and gain are continuously monitored using new Gas Monitoring Chambers (GMC) which were installed in November 2025. One pair of GMCs is monitoring the supply and the exhausts of the ND280 Time Projection Chambers. A second pair of GMCs is monitoring the freshly mixed gas. One of those GMCs has been equipped with resistive Micromegas to compare the results to its counterpart using conventional Micromegas. The first measurements of these new monitoring chambers will be presented.

T 74.3 Thu 16:45 KH 01.014

Modeling Electron Transport Properties in Gaseous Detector Gases — Stefan Roth, •Max Schmit, David Smyczek, Jochen Steinmann, and Nick Thamm — RWTH Aachen University - Physik Institute III B, Aachen, Germany

Electron transport parameters in gases can be derived by solving the Boltzmann equation. Two approaches are commonly used: analytical solutions and Monte Carlo methods. Both modeling approaches are outlined, with emphasis on their treatment of the electron energy distribution function and the use of electron-molecule cross-section data. Differences in required inputs and in the resulting transport coefficients are discussed. Electron drift velocity and diffusion coefficients are evaluated for commonly used detector gases. Comparison results and the current status of the study are presented, highlighting their implications for detector simulations.

T 74.4 Thu 17:00 KH 01.014

Performance Studies on Ecofriendly Gas Alternatives for RPC Detectors — Roberto Guida[2], Stefania Juks[3], •Maximilian Kerker[1], Beatrice Mandelli[2], Gianluca Rigoletti[2], Stefan Roth[1], and Mattia Verzeroli[4] — [1]RWTH Aachen University — [2]CERN — [3]Université Paris Saclay — [4]Shanghai Jiao Tong University

Resistive Plate Chambers are important particle detectors used as muon triggers in many experiments at the Large Hadron Collider. At the ALICE, ATLAS, and CMS LHC experiments, a gas mixture made of 65-95% R-134a, 4.5-10% i-C4H10 and 0.3-0.5% SF6 is used. R-134a and SF6 are greenhouse gases having a significant global warming potential of 1430 and 24300 respectively. In this work, a study was conducted searching for alternatives for SF6. In particular, two chlorinated hydrofluoroolefins, R-1233zd and R-1224yd, were identified as possible SF6 replacements. These gases were tested in different concentrations both in laboratory conditions and at the Gamma Irradiation Facility at CERN under LHC-like conditions. The RPC performance was evaluated by measuring the detector's efficiency, currents, streamer probability, cluster size and time resolution. The results were compared against SF6-based gas mixtures. Preliminary results will be presented.

T 74.5 Thu 17:15 KH 01.014

Replacing SF6 in Resistive Plate Chamber Detectors for HL-LHC Experiments and Beyond — •Giorgia Proto and Oliver Kortner — Max Planck Institute for Physics

The Resistive Plate Chambers (RPC) are gaseous detectors with excellent timing performance and are used for triggering on muons in the LHC experiments. They operate with the standard gas mixture, composed of C2H2F4/i-C4H10/SF6,that has a high Global Warming Potential (GWP) of 1430 due to the presence of C2H2F4(GWP~1450) and SF6(GWP~22400).The C2H2F4 and SF6 are not recommended for industrial uses anymore, thus their availability will be increasingly reduced over time and the search for an alternative gas mixture is of absolute priority. The most critical component to replace is the SF6, because it acts as streamer suppressor, thus allowing for RPC operation at low current, for high rate capability and longevity. In this work the SF6 is replaced with the Chloro-Trifluoropropene (C3H2ClF3, GWP~5), never been tested in the RPC detectors before. The performance of the RPC detector in terms of efficiency, streamer probability and time resolution have been studied in the Gamma Irradiation Facility (GIF++) at CERN at high irradiation rates, as expected at the High Luminosity LHC. The performance of the RPC detector with enivornment-friendly gases and status of the aging campaign performed using the new gas is presented.

T 74.6 Thu 17:30 KH 01.014

Investigation of the protection layers used in GridPix detectors — •Felix Becker, Jochen Kaminski, Klaus Desch, Sabine Hartung, and Yevgen Bilevych — Physikalisches Institut, Universität Bonn

The GridPix detector is a gaseous detector based on the Timepix technology. It is based on a pixel readout ASIC with a grid structure applied on top of it, which grants gas amplification. In the production process of the GridPix, a high-resistive protection layer is applied on the surface of the Timepix. This protection layer helps avoiding the chip getting damaged by sparks inside the detector and increases the longevity immensely. However, the exact electric properties, such as the resistivity of the layer, are not completely known. The main goal of this investigation is to find a reliable method for measuring the layer's resistivity. To do so, the results of multiple measuring methods, are compared. The first method is using charged particles. Because electrons accumulate at the surface of the protective layer if its resistivity is non-zero, a potential builds up on its surface. This potential lowers the effective electric field between the grid and the surface of the protective layer, what lowers the gas amplification. This effect takes place, until a steady state is reached. This charge-up effect and the discharge of the protective layer can be used to calculate the material resistivity. A second method is detaching the grid and measuring the resistivity directly via an voltage-current measurement. The presentation will describe the steps taken in the analysis, including the considerations behind each measurement method.

T 74.7 Thu 17:45 KH 01.014

From Wafer to Detector: GridPix Production at the FTD — •Sabine Hartung, Yevgen Bilevych, Jochen Kaminski, and Klaus Desch — Physikalisches Institut Universität Bonn

GridPix detectors combine a pixel ASIC with an integrated Micromegas-type amplification structure (InGrid). The photolithographic fabrication of the grid directly on the Timepix/Timepix3 ASIC enables precise alignment of grid holes to the pixels and a well-defined amplification gap. This provides single-electron efficiency and an excellent spatial resolution. Such properties make GridPix detectors a promising candidate for precision TPCs as well as X-ray and low-background applications.

The production of GridPixes requires a sequence of photolithographic steps. To reduce the probability of spark damage during the operation, the chip is first coated with a Si_xN_y protection layer. As amplification gap an aluminium grid is built on top of freestanding pillars. Achieving high production yield demands precise control of technological conditions.

In this contribution, the first results of the GridPix production as implemented in the Forschungs- und Technologiezentrum Detektorphysik (FTD) in Bonn are presented.