# T 105: Muon detectors

Time: Friday 11:00–13:05 Location: L-3.016

**Group Report** T 105.1 Fri 11:00 L-3.016

**Inbetriebnahme neuer Myondriftrohrkammern für den ATLAS-Detektor** — Šejla Hadžić, Oliver Kortner, Hubert Kroha, Patrick Rieck, Marian Rendel, Daniel Soyk und •Elena Voevodina — MPI für Physik, München, Deutschland

Die Effizienz des Triggersystems des ATLAS-Experiments ist im Pseudorapiditätsbereich $|\eta| < 1,0$ durch Lücken in der Akzeptanz des RPC-Triggersystems begrenzt. Die begrenzte Hochratenfähigkeit der installierten RPC-Kammern würde die Triggereffizienz am HL-LHC weiter verringern. Um beide Schwächen des aktuellen Systems zu beseitigen, ist die Installation neuer hochratenfähiger RPC-Kammern in der innerste Lage des Myonspektrometers für $|\eta| < 1,0$ bis zum Start der HL-LHCs vorgesehen. Um den für diese Kammern benötigten Platz zu schaffen, werden die zur Zeit verwendeten Präzisionmyondriftrohrkammern in der innersten Myonspektrometerlage durch Myondriftrohrkammern mit kleinerem Rohrdurchmesser, sogenannte sMDT-Kammern, ersetzt werden. 2020 während der Betriebspause des LHCs werden im Bereich $|\eta| = 1,0$ werden 16 Pakete aus den neuen RPC- und sMDT-Kammern in den ATLAS-Detektor eingebaut werden. Die 16 sMDT-Kammern wurden am MPI für Physik in München entwickelt und im Jahr 2019 hergestellt. Sie wurden ausgiebig mit Myonen aus der Höhenstrahlung getestet. Die detailierten Teste der Myonnachweiseffizienz und der Myonspurauflösung der sMDT-Kammern wurden nach dem Zusammenbau der sMDT-Kammern mit den RPC-Kammern am CERN wiederholt. Im Vortrag werden die Prüfverfahren und die Testergebnisse vorgestellt.

T 105.2 Fri 11:20 L-3.016

**Triple GEM detectors for the CMS Muon Upgrade** — •Giovanni Mocellin, Thomas Hebbeker, Kerstin Hoepfner, Henning Keller, and Shawn Zaleski — III. Physikalisches Institut A, RWTH Aachen University

With the increase of the instantaneous luminosity delivered to the experiments during Phase-2 of the LHC planned to start after the Long Shutdown 3, the detectors have to be upgraded to improve the performance and to sustain higher particle fluxes. The detectors in the forward regions are the most affected. In the CMS experiment, to cope with the higher event rates and larger radiation doses, triple-layer Gas Electron Multipliers (GEM) will be installed in the endcaps to complement the existing Cathode Strip Chambers and further extend the coverage. For the first time, such detectors will have large sizes of the order of 1 $m^2$, thus high requirements on the uniformity across the detector are needed. Chambers are built in production sites spread over 7 countries around the world. To test their integrity, quality and performance, the GEM chambers undergo multiple quality control tests at the sites. After shipment to CERN, a final major test with cosmic rays is performed before installation. The first endcap has been equipped with 144 detectors and is being integrated in CMS. This talk gives an introduction to GEM detectors in CMS, presents their performance in quality control tests, status of installation and initial results during operations in CMS.

T 105.3 Fri 11:35 L-3.016

**Gas Electron Multiplier Quality Control Tests and Performance Studies** — •Shawn Zaleski, Thomas Hebbeker, Kerstin Hoepfner, Henning Keller, and Giovanni Mocellin — III. Physikalisches Institut A, RWTH Aachen University

The Compact Muon Solenoid (CMS), one of the primary experiments at the CERN LHC, will be upgraded to be able to record the higher event rates as well as deal with the related increased radiation doses expected during the next running of the LHC. The installation of the Gas Electron Multiplier (GEM) GE1/1 detector in the CMS muon station endcaps will be the first in a series of upgrades to better handle these higher rates. The hardware for the GE1/1 detector chambers are produced in seven countries throughout the world. The chambers are then qualified in a series of steps called quality checks (QCs). Several of the QC stages, in particular the tests for gas tightness, high voltage, and gas uniformity will be discussed.

GEMs are being employed in an increasing number of application areas, from university lab experiments to large scale experiments such as CMS. As such, the characteristics of a GEM with 10 cm x 10 cm active gas area has been studied for the purpose of integrating into the particle physics advanced undergraduate laboratory course at RWTH Aachen University. Aspects which can be studied are: chamber performance, impact of HV applied across an individual GEM foil on the gain and gas mixture.

T 105.4 Fri 11:50 L-3.016

**Optimierung der Impulsformung in Myondriftrohrkammern für den Betrieb bei hohem Gammastrahlungsuntergrund an zukünftigen Hadroncolliderexperimenten** — •Oliver Kortner, Hubert Kroha, Robert Richter und Korbinian Schmidt-Sommerfeld — MPI für Physik, München, Deutschland

Myondriftrohrkammern mit dünnen Rohren, sogenannte sMDT-Kammern, eignen sich zur Instrumentierung großflächiger Myonsysteme von Experimenten an zukünftigen Collidern. Sie zeichnen sich durch hohe Myonnachweiseffizienz und Ortsauflösung bei hohem $\gamma$-Strahlungsuntergrund aus, wie er zum Beispiel im ATLAS-Myonspektrometer am HL-LHC oder im Myonsystem des für den FCC-Hadroncollider konzipierten Detektors auftreten werden. Teststrahlmessungen mit sMDT-Kammer an der Gammabestrahlungseinrichtung des CERN zeigten, dass die Ortsauflösung der sMDT-Kammern vor allem durch die Überlagerung von Signalen durch den $\gamma$-Strahlung mit darauffolgenden Signalen von Myonspuren beieinträchtigt wird. Simulationen des Verhaltens der sMDT-Rohre unter hohem Strahlungsuntergrund ergaben, dass dieser Effekt durch eine Verstärkerschaltung mit aktiver Wiederherstellung des Impulsbodens der verstärkten Signal weitgehend eliminiert werden kann. Im Vortrag werden diese Simulationsergebnisse und der erfolgreiche Einsatz solcher Verstärkerschaltungen im Testrahl vorgestellt.

T 105.5 Fri 12:05 L-3.016

**Position Reconstruction in the ATLAS New Small Wheel** — •Patrick Scholer, Ulrich Landgraf, and Stephanie Zimmermann — Albert-Ludwigs-Universität Freiburg

During the current shutdown of the LHC, the innermost end cap of the Muon Spectrometer of the ATLAS detector will be replaced by the so called New Small Wheel (NSW). It uses Micro Mesh Gaseous Detectors (Micromegas) and small-strip Thin Gap Chambers (sTGCs) as its detector technologies; both providing a high spatial resolution at high incidence rates.

This talk will discuss the position reconstruction with the NSW detectors. The focus is set on the Micromegas detectors where the measurement of the drift time of the primary ionization can be used to turn it into a micro time-projection chamber. The performance of different reconstruction algorithms applied on the Monte Carlo simulation of the NSW and on test-beam data will be compared. Furthermore, the impact of different detector imperfections applied in the Monte Carlo simulation will be presented. These imperfections contain e.g. worsening of charge and time resolutions and reduced efficiencies in different detector regions.

T 105.6 Fri 12:20 L-3.016

**CMS Drift Tube Chambers : Upgrade activities during LHC Long Shutdown II** — •Archana Sharma, Thomas Hebbeker, Kerstin Hoepfner, Hans Reithler, and Saranya Ghosh — III. Physikalisches Institut A, RWTH Aachen University

To sustain and extend its discovery potential, the Large Hadron Collider (LHC) will undergo a major upgrade in the coming years, referred to as High Luminosity LHC (HL-LHC), aimed to increase its instantaneous and integrated luminosity respectively by a factor of five and ten beyond the original design value. After delivering an integrated luminosity of more than 160 fb-1 until the end of Run 2, from the beginning of 2019, LHC is shutdown for two years (LS2) in order to get its accelerator-chain and detectors upgraded for the HL-LHC phase. During this LS2, The CMS experiment aims to upgrade its electronics and detector performance to improve the data taking and a precise reconstruction of all the particles in high pile-up conditions of HL-LHC. Drift Tube (DT) chambers as one of the important part of CMS muon system responsible for identifying, measuring and triggering on muons by the precise measurement of their position. This talk briefly summarizes the ongoing activities/plans related to the electronics upgrades of DT chambers along with some details about the gas monitoring in the DT system using Drift Velocity Chambers (VDC).

T 105.7 Fri 12:35 L-3.016

**A Large Scale Cosmic Muon Test Stand** — Dmitry Eliseev, Thomas Hebbeker, Markus Merschmeyer, and •Lars Steffen Weinstock — III. Physikalisches Institut A, RWTH Aachen University, Aachen, Germany

The CMS Drift Tubes (DT) system is used to precisely measure the tracks of muons in the barrel region. In order to provide higher acquisition rates, that are required by the phase 2 upgrade, and to add more flexibility to the trigger logic the on-chamber electronics of the DT system are being upgraded. The verification of this new generation of readout electronics requires several test setups using actual DT chambers. For this purpose a large scale cosmic muon test stand is being equipped with new readout electronics and a scintillator based trigger system. The trigger system consists of three layers with plastic scintillator tiles that are read out by silicon photomultipliers (SiPMs) providing fast trigger signals and data for muon track reconstructions. Using this setup several functional tests can be performed on the new DT system.

This talk gives an overview of the cosmic muon test stand and focuses on the trigger system.

T 105.8 Fri 12:50 L-3.016

**Production of new small-diameter Monitored Drift Tube (sMDT)-chambers for the ATLAS-Muonspectrometer** — •Marian Rendel, Patrick Rieck, Oliver Kortner, and Hubert Kroha — Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), München

Within the second long shutdown of the Large Hadron Collider, 2019-2021, Monitored Drift Tube (MDT)-chambers at the ends of the inner barrel layer will be replaced by 16 new small-diameter Monitored Drift Tube (sMDT)chambers with half the tube diameter, together with new thin-gap RPC trigger chambers. Additionally, 96 more MDT chambers in the inner barrel layer will be replaced for the high-luminosity LHC. In this talk the current status of the production of the sMDT chambers is presented. Furthermore the development for the production of the additional 96 sMDT chambers will be discussed.