T 67: Myon Detectors

Time: Wednesday 16:15–18:40 Location: T-H26

Group Report T 67.1 Wed 16:15 T-H26

DT upgrade activities during LHC long shutdown II and readiness status for Run 3 — •Archana Sharma, Thomas Hebbeker, Kerstin Hoepfner, Hans Reithler, Markus Merschmeyer, and Dmitry Eliseev — III. Physikalisches Institut A, RWTH Aachen University

After delivering an integrated luminosity of more than 160/fb until the end of Run 2, at the beginning of 2019, LHC was shut down until the end of 2021 (LS2) in order to get its accelerator-chain and detectors upgraded for the HL-LHC phase, expected to deliver an instantaneous luminosity 5 times higher with respect to the present value. During this LS2, the Compact Muon Solenoid (CMS) experiment worked 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 Tubes (DT) detectors equip the CMS muon system barrel region, serving both as offline tracking and triggering devices. An upgrade of the current readout and trigger electronics is also planned in order to withstand event rates and integrated doses far beyond the initial design specification expected in HL-LHC. During LS2, prototypes of the new electronics were installed in four DT chambers with the same azimuthal acceptance, instrumenting a demonstrator of the HL-LHC DT upgrade (DT slice-test). This report briefly summarises the commissioning activities performed during LS2, along with the status of the slice-test and its performance with cosmic -ray events.

T 67.2 Wed 16:35 T-H26

A tester tool for the new read-out electronics of the MDT detectors of the ATLAS muon spectrometer in the Phase-II upgrade — •Thorben Swirski, Gia Khoriauli, and Raimund Ströhmer — Universität Würzburg

To make the ATLAS monitored drift tube detectors (MDT) ready for the new high rate environment in the High-Luminosity LHC, new read-out electronics, including new mezzanine cards, are being developed. These mezzanine cards feature a triggerless read-out mode to allow the MDT stations to be used in the trigger decisions. A tester-tool has been designed for mass quality testing of the new mezzanine cards. The tester-hardware is ready since summer 2021 and is now being programmed to allow for the testing of all functionalities of the mezzanine cards. The work allows the use of the tester tool not only for the mass testing of already produced cards, but also adds valuable insights during the ongoing prototyping effort. This talk will present the tester-tool, give an overview over the test-regime, show how the gathered data will be archived in a dedicated database and present examples of how the use of the tester tool has helped the development of the mezzanine cards.

Group Report T 67.3 Wed 16:50 T-H26

The small-diameter Drift Tube (sMDT) Chambers for ATLAS at High-Luminosity LHC and for Future Colliders — Davide Cieri, Gregor Eberwein, Oliver Kortner, Hubert Kroha, Patrick Rieck, Marian Rendel, and •Elena Voevodina — Max-Planck-Institut für Physik, München, Deutschland

The small-diameter Drift Tube (sMDT) detector technology with 15 mm tube diameter has proven to be an excellent candidate for precision muon tracking detectors in experiments at future hadron colliders like HL-LHC and FCC-hh where unprecedentedly high background rate capabilities are required. The upgrades of the inner barrel layer of the ATLAS Muon Spectrometer in the LS2 (2019-2021) and LS3 (2026-2028) shutdowns of the LHC machine use combinations of the sMDT detectors and RPC trigger chambers. We present the test results of the performance of the sMDT chambers under construction for the operation at HL-LHC and the measurements of the behavior of the detectors and their new readout electronics under very high background irradiation rates like at FCC-hh performed at the CERN Gamma Irradiation Facility (GIF++).

T 67.4 Wed 17:10 T-H26

Quality Control in the Construction of new small-diameter Muon Drift Tube (sMDT) Chambers for the ATLAS Muon Spectrometer at the HL-LHC — •Daniel Buchin, Marian Rendel, Alice Reed, Patrick Rieck, Oliver Kortner, and Hubert Kroha — Max-Planck-Institut für Physik, München

In order to improve the muon trigger efficiency and the rate capability of the ATLAS muon detectors for operation at the high luminosity upgrade of the Large Hadron Collider (HL-LHC), the Monitored Drift Tube (MDT) tracking chambers in the inner barrel layer of the ATLAS Muon Spectrometer will be replaced by small-diameter Muon Drift Tube (sMDT) chambers integrated with new thin-gap RPC trigger chambers. The sMDT chambers fit, together with the RPCs, into the very tight available space and provide an order of magnitude higher background rate capability compared to the current detectors.

The sMDT chambers are in serial production since January 2021. In the talk, the measures implemented to assure the quality of the chambers will be explained, starting from the results of the tests and inspections each individual assembled drift tube is undergoing. The dedicated quality control database and monitoring web interface will also be discussed.

T 67.5 Wed 17:25 T-H26

Construction of small-diameter Monitored Drift Tube (sMDT) chambers for the ATLAS Muonspectrometer at the HL-LHC — •Marian Rendel, Daniel Buchin, Alice Reed, Oliver Kortner, Hubert Kroha, Patrick Rieck, and Elena Voevodina — Max-Planck-Institut für Physik (Werner-Heisenberg-Institut)

For the high luminosity upgrade of the Large Hadron Collider, the Monitored Drift Tube (MDT) tracking chambers in the inner barrel layer of the ATLAS muon spectrometer will be replaced by small-diameter Monitored Drift Tube (sMDT) chambers integrated with new thin-gap RPC trigger chambers. The sMDT chambers fit, together with the RPCs, into the very tight available space and provide an order of magnitude higher background rate capability compared to the current MDT chambers.

Since January 2021 the sMDT chamber serial production is proceeding at a steady pace of one chamber every two weeks as planned. In this talk, the sMDT chamber design and the construction procedures will be explained as well as the technology transfer to the second production site at the University of Michigan.

T 67.6 Wed 17:40 T-H26

Measuring the geometry of the new small-diameter Monitored Drift Tube (sMDT) chambers constructed for the HL-LHC upgrade of the ATLAS Muonspectrometer — •Alice Reed, Daniel Buchin, Marian Rendel, Patrick Rieck, Elena Voevodina, Oliver Kortner, and Hubert Kroha — Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), München

In order to improve the muon trigger efficiency and the rate capability of the ATLAS muon detectors for operation at the high-luminosity upgrade of the Large Hadron Collider (HL-LHC), the Monitored Drift Tube (MDT) chambers in the inner barrel layer of the ATLAS Muon Spectrometer will be replaced by small-diameter Muon Drift Tube (sMDT) chambers integrated with new thin-gap RPC trigger chambers. The sMDT chambers fit, together with the RPCs, into the very tight available space and provide provide an order of magnitude higher background rate capability compared to the current detectors.

The sMDT chambers have to provide a sense wire positioning accuracy of better than 20 μm and this requires the geometry of the chambers to be measured with a high precision. The measurement procedure and results are discussed for the chambers in serial production.

T 67.7 Wed 17:55 T-H26

Fabrication of Resitive Plate Chambers — Oliver Kortner, Hubert Kroha, Daniel Soyk, and •Timur Turkovic — Max-Planck-Institut für Physik, Föhringer Ring 6, 80805 München, Germany

Resistive plate chambers (RPCs) with electrodes of high-pressure phenolic laminate (HPL) and small gas gap widths down to 1 mm provide large area tracking at relatively low cost in combination with high rate capability and fast response with excellent time resolution of better than 500 ps. They can be operated up to γ background count rates of up to 10 kHz/cm2 which is five times the maximum rate these RPCs will encounter in the innermost layer of the barrel muon spectrometer

of the ATLAS detector where they will be installed in the phase-II upgrade for the HL-LHC operation. A cost-effective production procedure which is compliant with industrial techniques was worked out and tested by a production of prototype thin-gap RPCs in the laboratory. Cosmic ray muons were used to check the proper functioning of these prototypes. The new production procedure has been transfered to several companies for the production of test samples. We will report about the RPC production in the laboratory and the technology transfer to industry.

T 67.8 Wed 18:10 T-H26

The CMS Muon upgrade and the commissioning of the first GEM station — •Francesco Ivone, Thomas Hebbeker, Kerstin Hoepfner, Giovanni Mocellin, and Shawn Zaleski — III. Physikalisches Institut A, RWTH Aachen University

The LHC will undergo a major upgrade to deliver ˜10 times more proton-proton collisions in the next two decades, which has been named High-Luminosity LHC (HL-LHC). To cope with the higher event rates and to improve the trigger capabilities in the forward region, the Compact Muon Solenoid (CMS) experiment will undergo several upgrades. These include the installation of an additional set of muon detectors based on the Gas Electron Multipliers (GEM) technology. The triple-GEM detectors named GE1/1 have already been installed during 2020. Two more stations, GE2/1 and GE0, will adopt the same technology during subsequent shutdowns. The GE1/1 system consists of 72 chambers made by two layers of Triple-GEM detectors, this will improve the muon triggering and tracking capabilities of CMS.

We report on the commissioning of the GE1/1 detectors, focusing on the performance measured during the first CMS commissioning runs which include cosmic-ray muons and collision events. We discuss on the strategy implemented to identify the optimum working point and the system performance stability.

T 67.9 Wed 18:25 T-H26

A first look at CMS gas electron multiplier data and certification — Thomas Hebbeker, Kerstin Hoepfner, Francesco Ivone, and •Shawn Zaleski — III Physikalisches Institut A, RWTH Aachen University

To accommodate the increased radiation doses expected during the upcoming Run 3 at the CERN LHC, one of the primary experiments there, the Compact Muon Solenoid (CMS) will be upgraded. The first part of this upgrade, the installation of the gas electron multiplier (GEM) GE1/1 detector has been completed recently to help CMS cope with the radiation levels. The GEM chambers that comprise the GE1/1 detector have passed a rigorous battery of quality checks and are currently being commissioned in the end caps of the CMS muon system.

Initial data has been recorded by the GE1/1 detector using cosmic ray muon as well as proton-proton collision data. Dedicated data collection runs with and without the CMS 3.8 T magnetic field were performed. Certification procedures for this new GEM system have been developed and are being integrated with the existing procedures from the other CMS muon subsystems.