T 96: DAQ, Trigger and Electronics IV

Time: Thursday 16:00–17:45 Location: Tu

T 96.1 Thu 16:00 Tu

The phase-II upgrade of the first-level muon trigger for the ATLAS experiment at the HL-LHC — •Davide Cieri, Markus Fras, Oliver Kortner, Sandra Kortner, Hubert Kroha, and Robert Richter — Max-Planck-Institut für Physik, Munich, Germany

The first-level muon trigger of the ATLAS experiment will be upgraded to operate at the HL-LHC. The selectivity of the current system is limited by the moderate spatial resolution of RPC and TGC trigger chambers. The Monitored Drift Tube (MDT) chambers, currently used for the precision tracking, will be therefore included to improve the transverse momentum resolution and the redundancy. In the upgraded muon trigger system, the MDT trigger processors will receive MDT hits from the detectors and match them to the trigger candidates from the trigger chambers. Matching MDT hits are then used to improve the momentum resolution, by forming track segments and combining them for the determination of the transverse momentum.

An ATCA–based hardware demonstrator of the MDT trigger processor has been produced, comprising two powerful FPGA devices and a large number of state-of-the-art optical links. A description of the algorithms for the MDT track reconstruction is presented together with the evaluation of the needed trigger processor resources. The achieved trigger performance allows for the reconstruction of muon tracks within the allocated $1\mu s$ latency, with a momentum resolution of $\sim 6\%$ and a trigger efficiency above 95% for 20 GeV muons, reducing the trigger rate of $\sim 70\%$.

T 96.2 Thu 16:15 Tu

Development of calibration procedures for NSW Micromegas readout electronics — •Vladislavs Plesanovs, Stephanie Zimmermann, Gregor Herten, and Ulrich Landgraf — University of Freiburg

During the current LS2 at CERN, ATLAS muon spectrometer will be upgraded by exchanging one of its inner end-caps. The aim is to have extra input to the L1 muon trigger system to cope with expected rate and lower fake-muon trigger rate significantly. For this purpose the New Small Wheel (NSW) will consist of two complementary detector technologies: sTGC (trigger) and Micromegas (tracking). Data readout from these detectors will be conducted by dedicated front-end electronics.

Before physics data taking, a calibration of the readout electronics and signal conversion from digital units to physical values are required. The first procedure sets a global threshold above the noise in the readout chip level and adjusts it individually for each of /approx 2 million channels. The second calibration procedure converts input charge from ADC counts to Coulombs and TAC ADC to nanoseconds for further data processing.

The presentation focuses on the developed procedures, and their integration into ATLAS TDAQ software, which involves interplay with novel readout and TTC infrastructure like FELIX and ALTI. Also challenges that were tackled during development stage together with calibration results from on-detector front-ends will be presented.

T 96.3 Thu 16:30 Tu

Hardware Demonstrator of the MDT Trigger Processor for the ATLAS HL-LHC Upgrade — •Davide Cieri, Markus Fras, Oliver Kortner, Sandra Kortner, Hubert Kroha, and Robert Richter — Max-Planck-Institut für Physik, Munich, Germany

The novel MDT Trigger Processor (MDTTP) is a fundamental part of the upgrade of the first-level (L0) muon trigger of the ATLAS experiment at the HL-LHC. The new system will be responsible for refining the muon track candidate measurements using for the first time at L0 the precision tracking information from Monitored Drift Tube (MDT) chambers in addition to the trigger chamber information. The system will also transmit the MDT hit data to the data acquisition (DAQ) system in the event of a trigger accept. A total of 64 MDTTP boards will be installed in ATLAS, one for each MDT trigger sector. The design of the MDTTP is highly challenging, requiring a high number of optical links and high-performance processing units.

In this talk, the recently designed and assembled hardware demonstrator of MDTTP will be presented. The demonstrator consists of modular ATCA blade, composed by two modules: the Service Module responsible for the powering and the infrastructure; and the Command Module, which performs the trigger and DAQ processing. The Command Module mounts two powerful FPGA devices, which run the trigger and DAQ algorithms. In addition, the system employs eight 12-channel bidirectional optical tranciever modules with a link speed up to 25 Gbps, which are fundamental to provide communication with other components of the muon trigger system.

T 96.4 Thu 16:45 Tu

Performance of new Amplifier-Shaper-Discriminator chips for the ATLAS high-luminosity upgrade — Sergey Abovyan[1], Varuzhan Danielyan[1], Markus Fras[1], Oliver Kortner[1], Hubert Kroha[1], Robert Richter[1], •Simeon Simeonov[1], and Chrysostomos Valderanis[2] — [1]MPI für Physik, München, Bayern — [2]LMU, München, Bayern

The front-end electronics of the ATLAS muon drift-tube chambers will be upgraded in the experiment's phase-II upgrade to comply with the new trigger and read-out scheme at the HL-LHC. A new amplifier shaper discriminator chip was developed in 130 nm Global Foundries technology for this upgrade. A preproduction of 7500 chips was launched in 2019 and tested in 2020. The presentation will summarize the functionality of the new ASD chip, the test set-up and testing procedure as well as the test results which show a production yield of 93%. Based on the successful test of the preproduction chip the serial production of 80,000 chips was carried out in fall 2020.

T 96.5 Thu 17:00 Tu

Ongoing upgrade activities for the CMS DT system — •Dmitry Eliseev, Thomas Hebbeker, and Markus Merschmeyer — III. Physics Institute A, RWTH Aachen University

The Drift Tube (DT) system is a muon detection system located in the barrel region of the Compact Muon Solenoid (CMS) experiment. The DT system is a combination of numerous gas detector cells (DT cells) grouped within bigger units (DT chambers). In preparation for the LHC's High-Luminosity phase a number of upgrades are taking place for the DT system. Although the core hardware of the DT chambers will remain the same for the High-Luminosity phase, numerous improvements are provided for the DT signal acquisition chain. The upgrade involves replacing particular components in the data acquisition chain, as well as an essential change to the structure of this chain. These improvements result in a higher acquisition rate and a more advanced triggering.

This talk covers particular upgrade activities for the DT system: new structure of the DT acquisition chain, design and operation of the involved components. Special focus is given to the design of the On-Board DT (OBDT) electronics, located in a dedicated compartment of each DT chamber. The OBDT acquires multiple parallel signals from front-end circuits of every DT cell of the chamber. The OBDTs are then sending the data containing the full information of the muon hits from the DT chambers to the trigger and DAQ systems.

Current status of the upgrade activities, functional tests, hard- and software verification tests are covered in the talk as well.

T 96.6 Thu 17:15 Tu

Downstream tracking in the first stage of the upgraded LHCb trigger system — •Lukas Calefice[1,2], Johannes Albrecht[1], and Vladimir Gligorov[2] — [1]Experimentelle Physik 5, Technische Universität Dortmund — [2]Sorbonne Université, LPNHE/CNRS, Paris

The LHCb experiment is undergoing a major upgrade that will allow data taking at a five times higher instantaneous luminosity during the next run of the LHC. The upgrade equips the LHCb detector with a complete set of new tracking detectors to deal with the higher occupancy in the detector and increased radiation damage. Furtermore, the first hardware-based trigger stage will be removed. The LHCb trigger system is therefore redesigned to be able to process the higher data rate and make decisions in real time by moving to a GPU-based solution for a partial online event reconstruction in the first trigger stage.

Decay modes involving particles decaying downstream of the vertex locator can be found throughout the entire LHCb physics program. Particular interest evolved in very rare decays of kaons and the extension of $b \to sll$ transitions to the baryon sector. Enabling a downstream tracking in the first stage of the upgraded trigger system will show a large impact on the efficiencies of these modes.

This talk will cover the GPU implementation of the downstream tracking algorithm and give an outlook focusing on the implications for rare beauty and strange hadron decays.

T 96.7 Thu 17:30 Tu

Real-time reconstruction for the LHCb upgrade — •Peilian Li for the LHCb-Collaboration — Heidelberg University, Heidelberg, Germany

In 2022, the upgraded LHCb experiment will begin data taking with an instantaneous luminosity increased by a factor of five, from 4×10^{32} to 2×10^{33} $cm^{-1}s^{-1}$. The lowest level trigger in previous runs, a hardware-based trigger will be removed, requiring the first stage of the software trigger to process events at the non-empty LHC bunch-crossing rate of 30 MHz instead of the previous rate of 1 MHz. To cope with the unprecedentedly high event rate, an offline-quality real-time reconstruction is implemented in the second stage of the software trigger, with the integration of a real-time alignment and calibration. Thus the analysis will be performed on physics objects produced directly at the trigger level. This gives fast access to the data without the need for reprocessing and allows to store only objects relevant for specific analysis, which in turn significantly reduces the size of the stored events.

In this talk, we present an overview of the LHCb trigger to be used during Run 3 and its performance.