# T 20: DAQ, trigger and electronics I

Time: Monday 16:30–17:50 Location: L-3.015

**Group Report** T 20.1 Mon 16:30 L-3.015

**The Phase-II upgrade of the first-level muon trigger for the ATLAS experiment at the HL-LHC** — •Davide Cieri, Sergey Abovyan, Varuzhan Danielyan, Markus Fras, Oliver Kortner, Sandra Kortner, Hubert Kroha, Sebastian Nowak, and Robert Richter for the ATLAS-Collaboration — Max-Planck-Institut fuer Physik, Munich, Germany

The first-level muon trigger of the ATLAS experiment will be upgraded to operate at the High-Luminosity 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 RPC and TGC trigger systems. These seeds provide a Region-of-Interest and the bunch-crossing timing which is used for calculating the MDT drift time. Matching MDT hits are used by the MDT trigger algorithm to improve the momentum resolution, by forming track segments and combining them for the determination of the transverse momentum.

An FPGA-based hardware demonstrator of the MDT trigger processor is currently under production. A description of the proposed track finding algorithm is presented, together with the obtained performance and its FPGA implementation.

T 20.2 Mon 16:50 L-3.015

**Synchronisation of the Mu3e DAQ System** — •Martin Müller for the Mu3e-Collaboration — Institute for Nuclear Physics, JGU Mainz

The Mu3e experiment will search for the lepton flavour violating decay $\mu^+ \to e^+e^-e^+$ and is aiming for a sensitivity of one in $10^{16}$ muon decays. Since this decay is highly suppressed in the Standard Model to a branching ratio of below $\mathcal{O}(10^{-54})$, an observation would be a clear sign for new physics.

In the Mu3e detector, four layers of silicon pixel sensors will be used to track electrons and positrons and a time resolution of $\mathcal{O}(100$ ps) will be provided by scintillating tile and fibre detectors. The overall detector is expected to produce a data rate from 80 Gbit/s (Phase I) to 1 Tbit/s (Phase II), which will be processed in a three-layer, triggerless DAQ system using FPGAs and a GPU filter farm for online event selection.

The talk will focus on the synchronisation of the different detector parts and the firmware implementation of the clock and reset distribution in the Mu3e DAQ system.

T 20.3 Mon 17:05 L-3.015

**The XENONnT Data Acquisition System** — •Alexey Elykov for the XENON-Collaboration — University of Freiburg

The XENONnT experiment at the Laboratori Nazionali del Gran Sasso, is a liquid xenon-based multi-ton-scale dark matter detector which will be operational from early 2020. It will allow us to probe new parameter spaces of potential dark matter candidates and search for long sought-after decay processes. The scintillation and photoionisation signals that will occur in the detector due to particle interactions will be detected by 494 PMTs, amplified, digitised and recorded by a Data Acquisition (DAQ) system. This system is predominantly based on commercially available hardware and accompanied by custom-developed firmware and software. In combination with a novel data processing framework, it can operate with high efficiency both during the acquisition of low rate dark matter search data and throughout high rate calibration efforts. In this talk, an overview of the XENONnT DAQ system will be presented.

T 20.4 Mon 17:20 L-3.015

**Status and plans of upgrade activities for the CMS DT system** — •Dmitry Eliseev, Thomas Hebbeker, Archie Sharma, Markus Merschmeyer, and Jonas Roemer — III. Physikalisches Institut A, RWTH Aachen University

The Drift Tube (DT) system of the Compact Muon Solenoid (CMS) experiment consists of about 172 thousand oblong gas detector cells (DT cells). By design of the DT system multiple DT cells are grouped in separate DT chambers, located in the barrel region of CMS. One of the LHC's High-Luminosity upgrade activities is the replacement of the read-out chain of the DT chambers with a more advanced version. The upgraded DT read-out will provide a higher acquisition rate and flexible trigger settings for the DT system. The upgrade involves replacing particular components of the read-out chain, as well as an essential change in this chain's structure. This talk will present an overview of the new read-out chain structure and an overview of the design and operation of the involved components. Special focus will be given to the design of the On-Board DT (OBDT) electronic. Each OBDT board is situated directly on the DT chamber and handles the multiple outputs of the DT cells front-end circuitry. In this way the OBDTs provide the origin for the streams of the muon hit-data. The current upgrade status, functional tests, hard- and software verification tests of the new DT read-out will be discussed in the talk as well.

T 20.5 Mon 17:35 L-3.015

**Data flow in the Mu3e filter farm** — •Marius Köppel for the Mu3e-Collaboration — Institute for Nuclear Physics, Johannes Gutenberg University Mainz

The Mu3e experiment at the Paul Scherrer Institute searches for the decay $\mu^+ \to e^+e^+e^-$. This decay violates lepton flavour conservation - so an observation would be a clear indication for Physics Beyond the Standard Model. The Mu3e experiment aims for an ultimate sensitivity of one in $10^{16}$ $\mu$ decays. To this end, more than one billion $\mu$ tracks per second need to be detected and reconstructed.

Since the corresponding data rate of about 1 TB/s cannot be saved to disk, a trigger-less on line readout system was designed which is able to analyze the data while running. A farm with PCs equipped with powerful graphics processing units (GPUs) will perform the data reduction. The talk presents the ongoing integration of the sub detectors into the Field Programmable Gate Array (FPGA) based readout system which is used to preprocess, sort and transport the data to the filter farm.