# T 94: Trigger+DAQ 3

Time: Thursday 16:00–17:45 Location: Geb. 30.23: 3/1

T 94.1 Thu 16:00 Geb. 30.23: 3/1

**Hypothesis Firmware on L0Global** — •Emanuel Meuser — Institut der Physik, Johannes Gutenberg Universität Mainz

During the LHC's upgrade to higher luminosity, the ATLAS trigger system will also be upgraded. The L0Global Trigger System will be added as a time-multiplexed trigger system, combining, for the first time in ATLAS, cell data from the calorimeters and Trigger Objects from upstream systems of an event onto a singular FPGA. The L0Global will also replace the L1Topo in its current functionality. Since L0Global will host a large number of algorithms, the FPGA resources for the individual algorithms are rather slim. Thus, the current parallel implementation of the L1Topo algorithmic firmware has to be adapted for usage on the L0Global.

The individual components of the firmware are serialized to take advantage of the L0Global's highly increased latency budget (from new event data every 25 ns on L1Topo to new event data every 1200 ns on L0Global) and to reduce the algorithms resource cost (from 2.5M LUTs on L1Topo to 100k LUTs on L1Topo). The overall structure of the firmware will also be adapted to fit the L0Global*s framework. These Phase-II related firmware adaptations will be discussed in detail.

T 94.2 Thu 16:15 Geb. 30.23: 3/1

**Development of machine-learning based topological algorithms for the CMS level-1 trigger** — Johannes Haller, Gregor Kasieczka, Karla Kleinbölting, •Finn Labe, Artur Lobanov, Matthias Schröder, and Shahin Sepanlou — Institut für Experimentalphysik, Universität Hamburg

Using a HH process as an example, the possibility of using machine learning to construct trigger selections using full event topologies is studied. Targeting the CMS level-1 trigger, it is shown that simple neural networks can provide increased sensitivity at low rate costs and that these neural networks can be deployed in the FPGA-based electronics of the trigger system.

T 94.3 Thu 16:30 Geb. 30.23: 3/1

**The Forward Feature Extractor for the HL-LHC ATLAS Calorimeter Trigger** — •Adrian Alvarez Fernandez, Bruno Bauss, Dennis Layh, Ulrich Schaefer, Stefan Tapprogge, and Christian Kahra — Johannes Gutenberg University (Mainz)

The ATLAS detector will undergo many upgrades to account for the more challenging running conditions of the High Luminosity LHC (HL-LHC). Some of these Phase-II upgrades will be focused on improving the trigger system, a crucial part to deal with the higher data rates and increased pile-up. Phase-I upgrades for Run 3 introduced the Feature EXtractors for a more refined processing of the calorimeter information and to better discriminate between jets, photons, electrons and taus. A Forward Feature EXtractor (fFEX) is being developed for the HL-LHC, which will make use of the full detailed calorimeter granularity in the forward region. It will complement the existing Phase-I systems by providing more flexible algorithms in the regions of |eta|>2.5 for electrons and taus and |eta|>3.2 for jets. The hardware design of the fFEX has been finalized and will be discussed in this presentation, as well as the current state of firmware and algorithmic design.

T 94.4 Thu 16:45 Geb. 30.23: 3/1

**Forward Electron Identification at the ATLAS First Level Trigger for the High Luminosity LHC** — •Maximilian Linkert, Dennis Layh, and Stefan Tapprogge — Institut für Physik, Johannes Gutenberg-Universität, Mainz

As part of the high luminosity LHC the challenge is to properly trigger events in the forward region of ATLAS covering a pseudo rapidity of $2.5 < |\eta| < 4.9$. New first level trigger modules (being under development) based on FPGAs will be used the first time to access the full granularity of the calorimeters in this region to efficiently identify electrons and positrons. The aim is to use machine learning to gain efficiency compared to classical algorithms. The algorithms need to be optimized to run on the FPGAs, thus dealing with a simultaneous optimization of the signal efficiency, background rejection, resource consumption and latency. Moreover, the algorithm implementation needs to address non trivial changes in the geometrical calorimeter segmentation within the region under consideration. The present status of the investigations and next steps will be presented.

T 94.5 Thu 17:00 Geb. 30.23: 3/1

**Elevating LHCb's beauty selection for Run 3: A neural network approach** — Johannes Albrecht[1], Gregory Max Ciezarek[2], Blaise Delaney[3], Niklas Nolte[4], and •Nicole Schulte[1] — [1]TU Dortmund University, Dortmund, Germany — [2]CERN, Geneva, Switzerland — [3]Massachusetts Institute of Technology, Cambridge, USA — [4]META AI (FAIR)

The performance of LHCb's beauty physics program relies significantly on $b$-hadron triggers, specifically topological triggers. These triggers are designed for the comprehensive identification of $b$-hadron candidates, leveraging the distinct decay topology of beauty particles and their anticipated kinematic properties. Constituting the predominant component on the trigger selection output, topological triggers play a crucial role in the success of numerous physics analyses within LHCb.

In this contribution, we present the Run 3 implementation of the topological trigger, seamlessly integrating Lipschitz monotonic neural networks. This architecture ensures resilience in the face of varying detector conditions and enhances sensitivity to long-lived candidates. This framework can potentially open avenues for the discovery of new physics at LHCb. The primary focus is on synergizing a comprehensive physics selection with state-of-the-art machine learning approaches, all within the constraints of available computational resources.

T 94.6 Thu 17:15 Geb. 30.23: 3/1

**Online Track Reconstruction for the Mu3e Experiment** — •Haris Avudaiyappan Murugan — Institute of Nuclear Physics, Johannes Gutenberg University of Mainz, Germany

The Mu3e experiment aims to find or exclude the lepton flavour violating decay of a positive muon to two positrons and an electron with a branching fraction sensitivity of $10^{-16}$. To observe such a rare event, we require a tracking detector from custom-designed High-Voltage Monolithic Active Pixel Sensors (HV-MAPS) together with timing detectors made from scintillating fibre and tiles for the experiment. The detector will be streaming up to 1 TBit/s of data to the filter farm composed of the graphics processing unit (GPU), in which the data rate is reduced to less than 100 MB/s and this filtered data is stored for later analysis. This reduction can be achieved by selecting potential signal events with two positrons and one electron originating from a single vertex through online track and vertex reconstruction on the GPU. The misalignment of thin pixel tracking detectors can affect the precision of track reconstruction. Track-based alignment algorithm requires constraints from global parameters of the actual position of the pixels which can be measured using a camera alignment system. By calibrating the track reconstruction and histogramming the momentum of tracks on the GPU, the searches can be extended to observe potential two-body decays of the muon.

T 94.7 Thu 17:30 Geb. 30.23: 3/1

**A New Track Fit for the ATLAS Event Filter** — •Abhirikshma Nandi, André Schöning, Sebastian Dittmeier, and Christof Sauer — Physikalisches Institut, Universität Heidelberg, Heidelberg, Germany

The ATLAS experiment is going through a comprehensive set of upgrades in preparation for data taking at the High-Luminosity Large Hadron Collider. The Trigger and Data Acquisition (TDAQ) systems are being upgraded to handle an increased trigger rate and run even more sophisticated algorithms online to retain performance in the face of increased event complexity. The ATLAS Event Filter (EF) has to provide the second level of filtering, reducing the Level-0 trigger rate of 1 MHz to 10 KHz for storage. To this end, it is required to perform track reconstruction (EF Tracking) for the entire Inner Tracker (ITk) at a maximum rate of 150 kHz. A new, parallelizable track fit, based on hit triplets, is being developed for EF Tracking. The general triplet fit is a generalization of the Multiple Scattering-only triplet fit, developed originally for the Mu3e experiment, and includes hit uncertainties. Results from the general triplet track fit will be summarized along with an overview of the work in the broader context of the EF Tracking project.