T 65: Trigger+DAQ 2

Time: Wednesday 16:00–18:00 Location: Geb. 30.23: 3/1

T 65.1 Wed 16:00 Geb. 30.23: 3/1

Optimization of the Level-1 Tau Trigger at ATLAS for Run 3 — •Philipp Rincke[1,2], Stan Lai[1], and Arnaud Ferrari[2] — [1]II. Physikalisches Institut, Georg-August-Universität Göttingen, Deutschland — [2]Department of Physics and Astronomy, Uppsala University, Sweden

The Level-1 calorimeter trigger system of the ATLAS detector was updated for Run 3 of the LHC, including the introduction of the electron feature extractor (eFEX) and jet feature extractor (jFEX). For tau signatures, both the eFEX and jFEX reconstruct tau objects, which are referred to as eTAUs and jTAUs respectively.

By geometrically matching the eTAUs and jTAUs in a topological processor, combined tau objects (cTAU) are reconstructed in the Level-1 Trigger. This allows to combine the better energy resolution of eTAUs with the larger isolation area of jTAUs. So far the tau isolation criterion has not been optimized for cTAUs and the proposed cTAU trigger items have not been commissioned. In this talk, the current status of the investigations to optimize the isolation criterion for cTAUs are presented.

T 65.2 Wed 16:15 Geb. 30.23: 3/1

Commissioning of the Upgraded ATLAS Level-1 Jet Trigger — •Moritz Hesping, Anamika Aggarwal, Volker Büscher, Ralf Gugel, Christian Kahra, Emanuel Meuser, Niklas Schmitt, and Duc Bao Ta — Johannes Gutenberg Universität Mainz

For Run 3 of the LHC, the ATLAS level-1 calorimeter trigger (L1Calo) has received a major upgrade. An important part of this is the Jet Feature Extractor (jFEX). This system is responsible for the measurement of jets, tau leptons and forward electrons at level 1, and the calculation of the missing transverse energy and total energy of the event. It receives input from the calorimeters at a finer granularity than the Run 2 systems.

In this talk, results from the physics commissioning of the jFEX jet triggers are presented. This includes measurements of trigger efficiencies and rates, as well as optimization studies for the tuning of the system's parameters such as trigger thresholds and energy calibrations.

T 65.3 Wed 16:30 Geb. 30.23: 3/1

Commissioning and Validation of the jFEX $E_{\mathrm{T}}^{\mathrm{miss}}$ Algorithm for the ATLAS Level-1 Trigger — Anamika Aggarwal, Volker Büscher, Ralf Gugel, Moritz Hesping, Christian Kahra, Emanuel Meuser, •Niklas Schmitt, and Duc Bao Ta — Johannes Gutenberg-University, Mainz

During the last long shutdown of the LHC, the ATLAS level-1 calorimeter trigger underwent a major upgrade to cope with increased event rates when running at higher energies and instantaneous luminosity during Run 3 and beyond. As part of this phase-1 upgrade, a new system of feature extractor modules was implemented. These modules receive inputs from the calorimeters with finer granularity and execute more advanced algorithms. The new **J**et **F**eature **EX**tractor (jFEX) reconstructs jets, tau-leptons, forward electrons and energy sums, including $E_{\mathrm{T}}^{\mathrm{miss}}$. A big improvement compared to the Run 2 trigger is a new event-by-event pile-up correction. The latter provides a real-time correction for in-time pile-up that leads to additional energy deposits in the calorimeters. The commissioning of the new system, along with the performance validation using early Run 3 data, is crucial to assure optimal data-taking conditions.

This talk will give an overview about the calibration of the new jFEX $E_{\mathrm{T}}^{\mathrm{miss}}$ trigger as well as the parameter optimization for the pile-up correction algorithm. Furthermore, efficiency- and rate measurements based on 2023 proton-proton data are presented.

T 65.4 Wed 16:45 Geb. 30.23: 3/1

Implementation of a two-level AI-enhanced trigger on a single chip for live reconstruction — •Patrick Schwäbig for the Lohengrin-Collaboration — Physikalisches Institut, Universität Bonn, Deutschland

For years, data rates generated by modern detectors and the corresponding readout electronics exceeded by far the limits of data storage space and bandwidth available in many experiments. The solution of using fast triggers to discard uninteresting and irrelevant data is a solution used to this day. Using FPGAs, ASICs or directly the readout chip, a fixed set of rules based on low level parameters is applied as a pre-selection. Only a few years ago, live track reconstruction for triggering was rarely possible. With the emergence of highly parallelized processors for AI inference, attempts to sufficiently accelerate tracking algorithms become viable. The Xilinx Versal Adaptive Compute Acceleration Platform (ACAP) is one such technology and combines FPGA and CPU resources with dedicated AI cores. Our approach is to implement a two-level trigger on a single chip by utilizing the tightly integrated combination of FPGA and AI cores to profit from their individual strengths. In this talk our concept for a two-level trigger setup, implemented on a Xilinx VC1902, including AI algorithms and Timepix3 readout, will be shown. They will be used in an envisioned mid-size ultra-high rate fixed-target dark matter experiment (Lohengrin) at the ELSA accelerator at the University of Bonn.

T 65.5 Wed 17:00 Geb. 30.23: 3/1

Implementation of Graph Neural Networks for online track reconstruction at the ATLAS experiment — •Poppy Hicks, Sebastian Dittmeier, and André Schöning — Physikalisches Institut, Universität Heidelberg, Heidelberg

The upcoming High Luminosity upgrade to the LHC poses several challenges, most notably the huge increase in data to process. This necessitates improvements to the Trigger and Data Acquisition systems at the ATLAS experiment, including to its final stage, the Event Filter. Significant effort is being invested into computing R&D for the Event Filter, to keep resources within capacity; one promising avenue is the use of algorithms based on graph neural networks (GNNs) for track reconstruction in the Inner Tracker detector. GNNs demonstrate exceptional capability at modelling complex relationships within graph-structured data. Here, a graph represents detector hits as nodes; edges connecting these nodes represent the possibility the hits belong to the same particle. A GNN is used to score these edges to quantify that probability. In this talk, an overview of the use of GNNs for track reconstruction will be summarized; the focus will be on optimizing graphs for subsets of the data, in the pursuit of minimizing GPU memory requirements and maximising throughput.

T 65.6 Wed 17:15 Geb. 30.23: 3/1

ML Pile-up Rejection at the ATLAS High Level Trigger (HLT) based on Hit-level Information — •Mathias Backes — Kirchhoff-Institut für Physik Heidelberg

The rejection of pile-up in proton collisions at the LHC is crucial for analyses like the Di-Higgs. One possibility to reject pile-up is by reconstructing the primary vertex position of several jets in the same event, which is implemented offline as well as in the trigger. In the case of the ATLAS experiment, this is implemented in the High Level Trigger (HLT). The main bottleneck of the HLT is the CPU usage, which is significantly increased by performing a track reconstruction.

Here we study a possibility to save computing resources by extracting the primary vertex position directly from the position of the hits in the inner detector, without performing a track reconstruction algorithm. Using ideas that have already been applied in trackless flavour tagging algorithms, we aim to construct a DeepSet neural network which is trained to predict the primary vertex z position as well as its uncertainty on a jet-by-jet basis. Events can consequently be rejected if not all required jets originate in the same vertex.

T 65.7 Wed 17:30 Geb. 30.23: 3/1

Testing of the ATLAS MDT Trigger Processor board — •Davide Cieri, Markus Fras, Oliver Kortner, and Sandra Kortner — Max-Planck-Institut für Physik, Munich, Germany

The 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 improving the muon momentum resolution and thus refining the muon selectivity, 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.

We present here the results of the testing done on the produced pro-

totype board. In particular, the results of the thermal tests and the connection tests with the other system within the ATLAS L0Muon are shown.

T 65.8 Wed 17:45 Geb. 30.23: 3/1

The TARGET module calibration procedure and performance for the SST Camera — •Benjamin Schwab for the CTA-Collaboration — ECAP, FAU Erlangen-Nürnberg

The SST Camera is part of the Small Sized Telescope (SST) which will probe the TeV gamma-ray universe as part of the Cherenkov Telescope Array Observatory (CTAO). The basis of this camera builds the TeV Array Read-out with GSa/s sampling and Event Trigger (TARGET) module with its ASICs (Application Specific Integrated Circuit) CTC and CT5TEA. The tasks of the TARGET module range from supplying the silicon photomultiplier pixel with the needed high voltage to the shaping, sampling, triggering and digitisation of events. A total of 64 pixel can be handled with one module, resulting in a total number of 32 modules per camera. The required calibration routines for the module commissioning and the performance of the signal and trigger path shall be discussed in detail.