T 43: DAQ and Trigger 2

Time: Tuesday 16:15–18:15 Location: T-H28

T 43.1 Tue 16:15 T-H28

Calibration and Trigger Studies for the OSIRIS pre-detector of JUNO — •Runxuan Liu[1,2], Philipp Kampmann[3], Kai Loo[4], Livia Ludhova[1,2,3], Alexandre Göttel[1,2], Nikhil Mohan[3,2], Luca Pelicci[1,2], Mariam Rifai[1,2], Apeksha Singhal[1,2], and Cornelius Vollbrecht[1,2] — [1]Forschungszentrum Jülich GmbH, Nuclear Physics Institute IKP-2, Jülich, Germany — [2]III. Physikalisches Institut B, RWTH Aachen University, Aachen — [3]GSI Helmholtz Centre for Heavy Ion Research, Darmstadt, Germany — [4]Institute of Physics and EC PRISMA$^+$, Johannes Gutenberg Universität Mainz, Mainz

JUNO is a 20 kt liquid scintillator detector under construction in Jiangmen, China, which is expected to start data-taking in 2023. Its main goal is to determine the neutrino mass hierarchy with the measurement of reactor neutrinos from two adjacent nuclear power plants. This requires stringent limits on the radiopurity of the detector. The OSIRIS pre-detector is designed to monitor the liquid scintillator during the several months of filling the large volume of JUNO. OSIRIS will contain 18 ton of scintillator and will be equipped with 76 20-inch PMTs. OSIRIS will utilize two calibration systems: a laser fiber system and an insertion system for an LED or radioactive sources. The data acquisition system will have no global hardware trigger: instead, each PMT will provide a data-stream composed of the digitized PMT pulses, each containing a time stamp. Based on the latter, dedicated event builder software will organize these data streams into events. This talk will discuss the several trigger modes that are realized in the event builder software, a coincidence trigger and the calibration trigger.

T 43.2 Tue 16:30 T-H28

The MDT Trigger Processor for the ATLAS HL-LHC Upgrade — •Davide Cieri, Markus Fras, Oliver Kortner, and Sandra Kortner — Max-Planck-Institut für Physik, Munich, Germany

The novel MDT Trigger Processor (MDTTP) system 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. 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.

We present here the recently designed prototype of the MDTTP. The prototype adopts a ATCA design, composed by two modules: the Service Module responsible for the powering and the infrastructure; and the Command Module, performing the trigger and DAQ processing and communicating with the other components of the ATLAS muon trigger. The Command Module mounts a state-of-the-art Xilinx Virtex Ultrascale+ FPGA, and employs ten 12-channel bidirectional optical transceiver modules with a link speed of up to 14 Gbps.

T 43.3 Tue 16:45 T-H28

The ATLAS Global Event Processor and the jet energy determination perspectives at level-0 trigger in Run-4 — •Fernado Del Rio — Kirchhoff Institut für Physik, Universität Heidelberg

Run 4 of the LHC, scheduled to take place between 2028 and 2032, is planned to deliver never-before-seen conditions for high energy physics measurements, including a center of mass energy of 14 TeV and an average number of interactions per crossing of 200. Under these challenging conditions the triggering algorithms and their performance becomes more important than ever.

Amongst the changes that will be implemented in ATLAS for this Run we highlight the construction and installation of the Global Event Processor (GEP), a single board with the whole detector information made for triggering at 40 MHz with offline-like algorithms for the reconstruction of all objects, such as electrons, photons, muons and jets. In the particular case of jet reconstruction, access to layer information allows for state-of-the-art calibration techniques to be applied at the trigger level. This talk will discuss the potential of having a level 1 version of the Global Sequential Calibration, a part of the jet calibration sequence tailored for improving the resolution in the measurement of jet energy. This improvement in resolution naturally yields a better trigger efficiency and a higher sensitivity to dijet mass resonances, allowing ATLAS to fully exploit the large statistics given by Run4.

T 43.4 Tue 17:00 T-H28

Trigger optimization studies in the search for displaced heavy neutral leptons with the ATLAS detector. — •Julius Ehrsam, Heiko Lacker, and Christian Appelt — Humboldt University, Berlin, Germany

Adding heavy neutral leptons (HNLs) with masses below the electroweak scale to the SM Lagrangian can help explain observed Beyond-Standard-Model phenomena such as neutrino oscillations, matter-antimatter asymmetry, and dark matter. We study a new trigger option for the ATLAS experiment designed explicitly for the search for HNLs produced in events $pp \to W + X$, $W \to \ell +$ HNL, with HNL $\to \mu^+\mu^-\nu$, resulting in a prompt lepton and a displaced vertex due to the expected long HNL lifetime. The proposed trigger uses a muon as the prompt lepton and the angular separation between the two muons from the HNL decay.

T 43.5 Tue 17:15 T-H28

Optimizing the ATLAS b-jet Trigger for the LHC Run 3 — •Victor H. Ruelas Rivera — Humboldt-Universität zu Berlin, Berlin, Germany

The Higgs potential provides a way to experimentally probe and understand the underlying principles of mass generation and electroweak symmetry breaking. The shape of the Higgs potential is proportional to the Higgs self-coupling, λ_{HHH}, which can be probed at the LHC via proton-proton collisions ($pp \to HH$). Di-Higgs to 2 pairs of quarks ($HH \to b\bar{b}b\bar{b}$) is one of the most sensitive decay channels and it relies heavily on b-jet triggers. Triggers select information in real-time from the collisions and help mitigate ATLAS data acquisition getting overwhelmed by QCD jets. However, $HH \to b\bar{b}b\bar{b}$ is difficult to trigger due to the soft signal kinematics and high thresholds of hadronic triggers. Hence, more signal can be gained in Run 3 with better b-jet triggers. One of the goals of Run 3 is to improve the $HH \to b\bar{b}b\bar{b}$ triggers to enhance signal acceptance of SM and Beyond Standard Model (BSM) scenarios. The taggers that will be used for the b-jet trigger in Run 3 exploit multivariate analysis techniques, mainly Deep Neural Networks. This talk presents the optimization of the neural-network based flavour tagging discriminant used by the b-jet trigger. The algorithm is optimized on tracks, jets and vertices reconstructed by the High Level Trigger (HLT) software. The training software, network architecture and simulated events are being shared with the ATLAS offline b-tagging group to address redundancies and combine efforts towards a unified training framework for quick model re-optimization.

T 43.6 Tue 17:30 T-H28

Development of the Topological Trigger for LHCb Run 3 — Johannes Albrecht[1], Gregory Max Ciezarek[2], Niklas Nolte[3], Miroslav Saur[1], and •Nicole Schulte[1] — [1]TU Dortmund University, Department of Physics — [2]CERN — [3]MIT

In Run 3, the LHCb experiment will undergo a significant upgrade including the conversion to a software-only trigger system. This means the trigger software will have to efficiently process a substantially higher amount of data compared to previous years. The largest trigger algorithm for beauty physics in LHCb software is the Topological Trigger, which produces output used for most analyses. It is an inclusive trigger, aiming to select beauty decays based on topological and kinematic properties. Due to its inclusive nature, it can select candidates and trajectories from decays that might not have been discovered yet.

Two contributions to the Topological Trigger are shown. The first contribution will serve as a baseline for the collaboration and is based on a boosted decision tree algorithm. This approach has proven to be efficient in former years of data taking but has been optimized and remodeled for simulation of LHCb's upgrade. One of the major changes for the upgrade is the rise in the number of primary vertices during the interaction. Since primary vertex information is crucial for the Topological Trigger, the algorithm needs to be optimized to the conditions in the upgrade. The second contribution will explore a more experimental technique using a newly developed neural network architecture

providing a robust model for the selection. Finally, both performances are compared.

T 43.7 Tue 17:45 T-H28

Study of potential lifetime bias in the LHCb reconstruction software for Run 3 — •Paula Herrero Gascón and Peilian Li — University of Heidelberg, Physikalisches Institut Heidelberg, Germany

The upgraded LHCb experiment will restart data taking in spring 2022 at an instantaneous luminosity of up to 2×10^{33} cm^{-2} s^{-1}. To effectively select the interesting b and charm hadron events at these high rates a full software trigger system is required. The entire reconstruction framework and its algorithms have been reimplemented and optimized. To be well-prepared for the coming data taken, it is essential to validate the physics performance for this completely new system. The precise reconstruction of the decay-time of b hadrons is vital for many time-dependent physics measurements at LHCb. This talk will focus on a performance study of the decay-time reconstruction for Run 3 and investigate potential reconstruction-induced biases.

T 43.8 Tue 18:00 T-H28

Performance of Belle II's Level 1 Single Track Trigger — •Felix Meggendorfer[1,3], Christian Kiesling[1,4], Elia Schmidt[1,4], Kai Lukas Unger[2], Steffen Bähr[2], Alois Knoll[3], Alexander Lenz[3], Sebastian Skambraks[2], and Jürgen Becker[2] for the Belle II-Collaboration — [1]MPI for Physics, Munich, Germany — [2]KIT, Karlsruhe, Germany — [3]TUM, Munich, Germany — [4]LMU, Munich, Germany

Belle II is the world record holder for the highest instantaneous luminosity, and the machine is still more than a factor 20 away of what it is capable of. These high collision rates make it mandatory to have an efficient trigger system. The Neurotrigger is a level 1 track trigger using the central drift chamber in the Belle II experiment. It estimates the z vertex and the polar angle θ of the tracks. To suppress the dominating background of events coming from outside of the interaction point, a cut on the track vertices along the beam axis is combined wit a momentum cut. This trigger, the 'STT', operates without a prescale and outperforms all other track triggers in Belle II. It is the first of its kind in high energy physics and most important for events with low charged multiplicity, such as tau pair production and candidates for dark matter searches.