T 55: Methods in particle physics 4 (HCAL, jets)

Time: Wednesday 16:00–17:45 Location: Geb. 20.30: 2.066

T 55.1 Wed 16:00 Geb. 20.30: 2.066

Improving Hadron Reconstruction in the Belle II Electromagnetic Calorimeter using Graph Neural Networks — •Jonas Eppelt, Isabel Haide, and Torben Ferber — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

Our aim is to refine hadron reconstruction in the Belle II Electromagnetic Calorimeter (ECL), specifically addressing overlapping clusters. We are using Graph Neural Network (GNN) architectures, such as GravNet, to enhance clustering accuracy. Improving clustering precision holds significant implications for physics analyses, especially in searches for final states that include missing energy like $B \to K\nu\bar{\nu}$. These searches will profit from refined selection criteria. This presentation outlines our ongoing efforts to optimize hadron clustering using GNNs, aiming for better precision within the Belle II ECL.

T 55.2 Wed 16:15 Geb. 20.30: 2.066

Novel techniques for measuring the jet energy resolution from dijet events at CMS — •Yannick Fischer[1], Johannes Haller[1], Andrea Malara[2], Alexander Paasch[1], Daniel Savoiu[1], and Matthias Schröder[1] — [1]Institut für Experimentalphysik, Universität Hamburg — [2]Université libre de Bruxelles

The jet energy is a key observable in almost all analyses of the CMS experiment at the LHC, and hence, precise knowledge of the jet energy resolution (JER) is crucial for both measurements and searches. In this talk, a brief overview of the basic concept and the techniques used at CMS to measure the JER from dijet events will be given. Then, a new method will be introduced, based on the missing transverse momentum fraction. Latest results with recent CMS data will be shown. Finally, the implementation of the JER measurement in a new, columnar-based framework will be discussed, and the advantages of this framework for the measurement of the JER will be highlighted.

T 55.3 Wed 16:30 Geb. 20.30: 2.066

In Situ **Calibration of Large-Radius Jets Using the Direct Balance Method with Z+jets Events in ATLAS** — •Donna Maria Mattern and Chris Malena Delitzsch — TU Dortmund, Fakultät Physik

The calibration of the jet energy scale (JES) is a critical step in the preparation of jets that are utilized in precision measurements, as well as searches for physics beyond the Standard Model. Large-radius ($R = 1.0$) jets are reconstructed from unified flow objects which combine calorimeter signals with charged-particle tracks in the inner detector of the ATLAS detector to achieve optimal performance across a wide kinematic range. They are groomed in order to remove contributions from pile-up. After a Monte Carlo (MC) based calibration to the energy and mass scale of particle-level jets, an *in situ* calibration of the JES is performed to remove residual differences between data and MC simulated samples due to passive detector material, effects of the jet reconstruction algorithm, fragmentation, or pile-up. Different methods are combined to provide a calibration over a wide kinematic range. The direct balance method using Z+jets events, where the Z-boson decays into charged-lepton pairs, uses a selection with a back-to-back topology of the large-radius jets and the Z-bosons. Scale factors are derived to calibrate the large-radius jet's transverse momentum to the one of the well-calibrated reference object given by the reconstructed Z-boson. Data collected by the ATLAS detector in proton-proton collisions of LHC-Run 2, and corresponding MC simulated samples are used for the studies.

T 55.4 Wed 16:45 Geb. 20.30: 2.066

Measurement of single charged pion energy response of the ATLAS calorimeter from $W^{\pm} \to \tau^{\pm}(\to \pi^{\pm}\nu_{\tau})\nu_{\tau}$ events in LHC Run 2 and Run 3 — •Anubhav Gupta and Chris Malena Delitzsch — TU Dortmund Germany

Jets are collimated sprays of charged and neutral hadrons (or their decay products) resulting from energetic proton-proton collisions. In the ATLAS experiment, the energy of these particles is measured in calorimeters, while the momentum of charged particles is determined by the tracking system. To reconstruct jets, a particle-flow algorithm combines the information from both systems. The calibration of the jet energy scale relies heavily on the accurate simulation of hadron interactions with the calorimeter. Hence, gaining a better understanding of the calorimeter's energy response is essential. A powerful method to achieve this is by analyzing the ratio of the energy (E) of hadrons reconstructed in the calorimeter to the momentum (p) measured in the well-aligned tracking system. Charged pions from τ-decays provide a sample of high-p_{T} isolated particles to probe the higher energy regime where the *in-situ* measurements (at jet level) run out of statistics. A E/p measurement was performed using single charged pions events from τ-decays for Run 2 in a previous ATLAS software release. The detector simulation, using GEANT4, has been tuned on the results from this E/p measurement for LHC Run 3. In the talk, E/p measurement using single charged pions events from τ-decays for LHC Run 2 in current software release and for LHC Run 3 is presented.

T 55.5 Wed 17:00 Geb. 20.30: 2.066

Event reconstruction in the CMS High-Granularity Calorimeter — •Wahid Redjeb[1,2], Felice Pantaleo[2], Alexander Schmidt[1], and Marco Rovere[2] — [1]III. Physikalisches In- stitut A, RWTH Aachen University, Aachen, Germany — [2]CERN Geneva, Switzerland

The High-Granularity Calorimeter (HGCAL) will be a sampling calorimeter with both lateral and longitudinal fine granularity designed for the High-Luminosity LHC. The calorimeter will use silicon sensors, in the high radiation regions, providing high pile-up mitigation, and scintillators in the low radiation regions. For the physics object reconstruction a dedicated framework for HGCAL is currently under development: The Iterative Clustering (TICL), which utilizes the 5D (x,y,z,t,E) information from the reconstructed hits and returns particle properties and probabilities. Heterogeneous computing will play a fundamental role in the physics object reconstruction software to fully exploit the reach of the HL-LHC. Performance Portability libraries allow writing a single code basis that can be executed on different hardware architectures. In this talk we present and overview of the TICL framework and we show how heterogeneous computing has been integrated in the framework exploiting the Alpaka library. Additionally, we highlight the TICL Framework's capabilities to perform Particle Flow reconstruction in the challenging endcap region.

T 55.6 Wed 17:15 Geb. 20.30: 2.066

Extending the TICL Framework to the CMS Barrel Calorimeters — •Alessandro Brusamolino[1], Felice Pantaleo[2], Marco Rovere[2], and Markus Klute[1] — [1]Institut für Experimentelle Teilchenphysik, Karlsruhe Institute of Technology, Karlsruhe, Germany — [2]CERN, Geneva, Switzerland

The Iterative CLustering (TICL) is a reconstruction framework which is being developed for the High-Granularity Calorimeter (HGCal), a sampling calorimeter which will be installed in the CMS endcaps for the HL-LHC phase. These reconstruction algorithms aim at reconstructing physical objects starting from 5D hits (position, energy and time), returning particle properties and identification probabilities, and are designed with heterogeneous computing in mind, in order to speed up reconstruction time. In this talk we give an overview of the first efforts in extending TICL to the barrel calorimeters and present the benefits of having the same framework used across all of the CMS calorimeters, both in terms of physics and computing performances. Moreover, we discuss the need for a revision of the data structures used in the reconstruction software, in order to run it in an efficient way, fully exploiting the capabilities of parallel architectures.

T 55.7 Wed 17:30 Geb. 20.30: 2.066

Studies of the SND@LHC HCAL SiPM PCB using dedicated laser measurements — •Andrew Conaboy, Heiko Lacker, Anupama Reghunath, and Eduard Ursov — Humboldt University of Berlin

The Scattering and Neutrino Detector at the LHC (SND@LHC) is a compact experiment installed 480 m from the ATLAS interaction point. SND@LHC allows for a novel investigation of all three neutrino flavours in the pseudo-rapidity range $7.2 < \eta < 8.6$, with energies from 100 GeV to the TeV scale. Last year the SND@LHC collaboration published the observation of LHC muon-neutrino deep inelastic scattering (DIS) charged current interactions. The collaboration requires an energy calibration of the HCAL to reconstruct the energy deposition from

the hadronic final states of DIS. This requirement necessitates dedicated laser studies in order to understand how effects such as timewalk and signal saturation impact the timing and charge digitisation of the SiPM PCB used in the HCAL of SND@LHC. Latest results from these laser studies are presented in this contribution.