T 18: Methods in Particle Physics I (Calo, Jets, Tagging)

Time: Monday 16:45–18:30 Location: VG 4.101

T 18.1 Mon 16:45 VG 4.101

Calibration of calorimeter signals in theATLAS experiment using an uncertainty-awareneural network — •Isabel Sainz Saenz-Diez — Kirchhoff Institute for Physics, Heidelberg University

Measuring energy deposits in the calorimeters are a key aspect of particle reconstruction. In the case of the ATLAS experiment at the Large Hadron Collider (LHC), the calorimeter signals are reconstructed as clusters of topologically connected cells (topo-clusters). These are calibrated in such way that they correctly measure the energy deposited by electromagnetic showers, but they do not compensate for the fraction of energy that does not contribute to the signal, which is part of the hadronic showers. In order to account for this energy, a local hadronic calibration of topo-clusters is applied. Machine Learning (ML) methods have been proposed as an alternative to the current hadronic calibration in ATLAS. Both a Deep Neural Net (DNN) and a Bayesian Neural Net (BNN) yield continuous unbinned calibration functions with an improved performance with respect to the standard calibration. Additionally, the BNN provide an estimation on the uncertainties of the calibration output. The talk will present the current status of the implementation and performance of the proposed models.

T 18.2 Mon 17:00 VG 4.101

Understanding punch-through effects on jet calibration using Run 2 and Run 3 data with the ATLAS detector — •Chiara Deponte and Chris Malena Delitzsch — Technische Universität Dortmund, Deutschland

At high energies, jets can penetrate beyond the calorimeter and deposit energy in the muon spectrometer, a phenomenon known as the punch-through. Since energy depositions in the muon spectrometer are not accounted for during jet reconstruction, the resulting jet energy tends to be smaller. To address this, corrections are applied during the jet energy calibration process to improve the jet energy resolution. In the ATLAS experiment, the Global Sequential Calibration mitigates punch-through effects by utilizing the number of muon segments associated with small-radius (R = 0.4) jets. The performance of this correction was studied using Monte Carlo simulation for Run 2 and 3, comparing both fast and full simulation.

T 18.3 Mon 17:15 VG 4.101

In-Situ Calibration of Small-Radius Jets Using the MPF Method with γ+jets Events in ATLAS — •Simone Ruscelli and Chris M. Delitzsch — Technische Universität Dortmund (Germany)

The V+jets calibration is a pivotal component of the in-situ jet calibration in ATLAS to correct for differences in the jet energy scale between data and Monte Carlo simulation due to the imperfect simulation of e.g. the detector materials, pile-up and jet formation. This presentation focuses on the γ+jets calibration of small-radius (R=0.4) jets, reconstructed from particle flow objects, using data collected with the ATLAS detector during Run 2. The Missing-E_{T} Projection Fraction (MPF) technique is used, which takes into account the full hadronic recoil in an event as opposed to the Direct Balance (DB) method, which only considers the balancing jet. The MPF method has numerous advantages, e.g. it is not strongly affected by the jet definition and is also robust to both pile-up and the underlying event.

T 18.4 Mon 17:30 VG 4.101

Run 3 performance and advancement of Heavy-Flavor Jet Identification in CMS — SVENJA DIEKMANN[1], MING-YAN LEE[1], SPANDAN MONDAL[2], •UTTIYA SARKAR[1], ALEXANDAR SCHMIDT[1], and SEBASTIAN WUCHTERL[3] — [1]III. Physikalisches Institut A, RWTH Aachen University, Germany — [2]Brown University, Providence, USA — [3]European Organization for Nuclear Research (CERN), Geneva, Switzerland

The identification of heavy-flavor jets is essential for many high-energy physics analyses, including studies of the top quark, Higgs boson, and new physics searches. Recent advances in machine learning, including graph networks, and transformers namely UParT (Unified Particle Transformer) algorithm, have significantly improved tagging performance for heavy-flavor (b, c) and hadronic tau jets. This talk presents the latest development of flavor taggers, their deployment in the CMS High Level Trigger (HLT) system and offline performances in proton-proton collision with the Run 3 data.

T 18.5 Mon 17:45 VG 4.101

Optimizing charm-jet tagging in ATLAS — Diptaparna Biswas[1], Beatrice Cervato[1], Markus Cristinziani[1], Carmen Diez Pardos[1], Ivor Fleck[1], Arpan Ghosal[1], Gabriel Gomes[1], Jan Joachim Hahn[1], Vadim Kostyukhin[1], Nils Krengel[1], Buddhadeb Mondal[1], Stefanie Müller[1], Sebastian Rentschler[1], Elisabeth Schopf[1], Katharina Voss[1], Wolfgang Walkowiak[1], •Adam Warnerbring[1], and Tongbin Zhao[1,2] — [1]Experimentelle Teilchenphysik, Center for Particle Physics Siegen, Universität Siegen — [2]Shandong University, China

Classifying jets based on the flavour of the parton that initiates the jet is a crucial task in analyses involving final states with b- or c-quarks. In recent years, jet flavour taggers in ATLAS have seen significant improvements, largely thanks to the adoption of end-to-end transformer models that directly use track-level inputs to predict the jet class. While b-jet identification remains the strongest feature of these models due to the distinct characteristics of b-jets, they can also be used for c-jet tagging. This talk will focus on charm tagging using GN2, the latest flavour tagging model developed by ATLAS. The presentation will cover the challenges of simultaneous b- and c-tagging, the trade-offs in parameter choices, and the performance of the model in terms of efficiencies and rejection rates for benchmark samples.

T 18.6 Mon 18:00 VG 4.101

Material interactions in ATLAS jet flavour tagging — Diptaparna Biswas[1], Beatrice Cervato[1], Markus Cristinziani[1], Carmen Diez Pardos[1], Ivor Fleck[1], Arpan Ghosal[1], Gabriel Gomes[1], Jan Joachim Hahn[1], Vadim Kostyukhin[1], •Nils Krengel[1], Buddhadeb Mondal[1], Stefanie Müller[1], Sebastian Rentschler[1], Elisabeth Schopf[1], Katharina Voss[1], Wolfgang Walkowiak[1], Adam Warnerbring[1], and Tongbin Zhao[1,2] — [1]Experimentelle Teilchenphysik, Center for Particle Physics Siegen, Universität Siegen — [2]Shandong University, China

Jet flavour tagging plays a crucial role in understanding particle physics processes. In the continuous effort to enhance flavour tagging performance the ATLAS Collaboration is currently deploying deep learning transformer models.

Jets originating from a b-quark are easy to tag because of the characteristic bottom hadron decays. Due to long lifetimes, B-hadrons decay far from the primary event vertex, producing a significant number of tracks with big impact parameters. However, this feature can be mimicked by interactions of particles with the detector material, also producing displaced tracks.

This presentation will demonstrate how material interactions may lead to the misidentification of jets originating from quarks of lighter flavour as b-jets, and it will discuss first results of an attempt to mitigate the influence of material interactions. This attempt consists of adding an auxiliary task, which identifies these interactions, to the flavour tagging machine learning model.

T 18.7 Mon 18:15 VG 4.101

Flavour Tagging with ParticleNet at ILD — •Ulrich Einhaus[1] and Bryan Bliewert[2,3] — [1]Karlsruhe Institut für Technologie KIT — [2]Deutsches Elektronen-Synchrotron DESY — [3]Universität Hamburg

With the exploitation of the LHC in full swing, the particle physics community is turning its focus on the next flagship collider, an e^+e^- Higgs factory. Many studies are ongoing studying physics prospects and optimising detector designs. In recent years, machine learning approaches to reconstruction algorithms have moved to neural network architectures, showing the performance advantages of their optimised exploitation of detector-level information. One area of application are flavour taggers, where several neural network approaches are actively under development.

This talk presents an implementation of the ParticleNet flavour tagger for the ILD detector concept, with data in full simulation. It covers the structure and performance, in particular the new strange tag, and highlights the dependence on specific observables and their impact on selected physics channels, informing further detector development.