T 69: Methods in Particle Physics IV

Time: Thursday 16:15–17:45 Location: KH 00.020

T 69.1 Thu 16:15 KH 00.020

Investigating the use of fast detector simulation for jet flavor identification algorithms in ATLAS — Diptaparna Biswas, Carolina Costa, Markus Cristinziani, Carmen Diez Pardos, Ivor Fleck, Gabriel Gomes, Jan Joachim Hahn, Nikolaos Kamaras, Vadim Kostyukhin, Nils Benedikt Krengel, •Austin Olson, Inês Pinto, Sebastian Rentschler, Elisabeth Schopf, Katharina Voss, Wolfgang Walkowiak, and Adam Warnerbring — Experimentelle Teilchenphysik, Center for Particle Physics Siegen, Universität Siegen

In the ATLAS experiment, identification of quark flavor in a given jet is done with machine learning algorithms known as "taggers", trained with simulated events. Taggers' performance depend on accurate simulation of jet constituents. Previously, only tracks associated to jets were used in training, but the latest tagger, GN3, also uses all particle-flow constituents. At the same time, approximation of calorimeter showers with generative modeling (FastSim) is becoming more adopted by the ATLAS Collaboration in lieu of full Geant4 simulation (FullSim).

Many rare signal samples and several background samples are produced using FastSim, making it essential to evaluate the performance of these samples in this new GN3 model. Recent studies indicate significant scope for improving performance of GN3-like models solely by increasing the amount of training data, making FastSim samples a desirable option for model training itself. This talk presents comparisons of FastSim and FullSim samples in the context of ATLAS taggers.

T 69.2 Thu 16:30 KH 00.020

Identification of low p_{T} b-hadrons at the ATLAS experiment — •Hagen Möbius — DESY, Zeuthen, Germany

The identification of b-hadrons in an event, called b-tagging, is an important part of the physics program of the ATLAS experiment, in particular for Standard Model precision measurements, studies of the Higgs boson and searches for physics beyond the Standard Model. The starting point for standard b-tagging techniques in the ATLAS experiment are jets, bundles of particles. This leads to constraints on the energy of both the b-hadron and the surrounding hadronic activity and consequently low p_{T} b-hadrons in a jet below the jet reconstruction threshold are not reconstructed.
This talk presents an algorithm with a jet-independent b-hadron identification strategy. The algorithm, called the NewVrtSecInclusiveTool, reconstructs secondary vertices that can be associated with the decay of low p_{T} b-hadrons. The procedure and performance of the algorithm are discussed. Furthermore, the origins of the tracks contributing to these secondary vertices are examined to assess the accuracy of the b-hadron reconstruction.

T 69.3 Thu 16:45 KH 00.020

Tagging at ATLAS with GN3: Beyond heavy-flavour — •Diptaparna Biswas[1] and ATLAS Collaboration[2] — [1]Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen, Germany — [2]CERN, Geneva, Switzerland

Accurate identification of jets that originate from heavy-flavour hadrons is pivotal for many ATLAS analyses, from Higgs-boson and top-quark measurements to searches for new physics. We present GN3, our newest jet flavour tagger, which introduces a full-transformer architecture tailored to the environment of LHC Run-2 and Run-3.

GN3 processes low-level track, neutral particle, and muon information to extract correlations between the inputs and infer the origin of the jet. Compared with the current Run-3 baseline, GN2, the new model achieves a significantly better separation of b- and c-jets from light-flavour jets across a wide kinematic phase-space.

In this talk, we will discuss the architecture and training workflow, as well as the newest results from GN3. Furthermore, we will highlight the new capabilities added to GN3, which extend its functionality into the realm of s-tagging.

T 69.4 Thu 17:00 KH 00.020

Reconstruction of Heavy Neutral Lepton decaying into lepton + ρ in SHiP — •Harshivraj Jatinbhai Oza for the SHiP-SBT-Collaboration — Humboldt Universität zu Berlin, Berlin, Germany

As part of the ongoing search for physics beyond the standard model, CERN has recently approved a new general-purpose beam dump experiment at SPS: SHiP (Search for Hidden Particles). SHiP aims to explore the intensity frontier by searching for feebly interacting particles in the GeV mass regime. Among several well-motivated candidates, the experiment is optimized for the discovery of Heavy Neutral Leptons (HNLs), hypothetical particles that could explain neutrino masses and mixing, provide a mechanism for baryogenesis, and potentially contribute to the dark-matter sector.

This talk presents the mass reconstruction strategy for the HNL decaying into a $lepton + \rho$ ($-> \pi\pi^0$), without explicitly reconstructing the π^0 exploiting the mass constraint $(P_\pi + P_{\pi^0})^2 = m_\rho^2$. Furthermore we explore the feasibility of taking advantage of the Surrounding Background Tagger (SBT) to identify photons from the π^0 decay as a means of improving the signal reconstruction and background suppression.

T 69.5 Thu 17:15 KH 00.020

Reconstruction of Neutrons and Sensitivity to the Decay $B \to Kn\bar{n}$ at Belle II — •Timur Lenkeit, Alexander Heidelbach, Thomas Kuhr, and Thomas Lueck — Ludwig-Maximilians-Universität München (LMU), München, Germany

Neutrons are often not taken into account in the detector design or the reconstruction software, but can nevertheless play an important role in understanding physical processes. We examine methods to improve neutron reconstruction at the Belle II experiment. Unlike photons or electrons, neutrons do not interact electromagnetically; their energy is recorded only indirectly through secondary particles from hadronic interactions, which results in irregular and diffuse signatures in the electromagnetic calorimeter (ECL). These features make it challenging to distinguish neutrons from other neutral particles. To address this, we investigate machine-learning*based classifiers that combine ECL variables to enhance neutron particle identification. In addition, we explore the use of variables related to the K_L^0 and Muon detector to recover information from neutrons that leave no signal in the ECL.

We then assess how these reconstruction strategies affect the background composition and the achievable sensitivity to the decay $B \to Kn\bar{n}$. With these studies, we aim to enable a determination of the corresponding branching fraction.

T 69.6 Thu 17:30 KH 00.020

Measurement of the η Reconstruction Efficiency at Belle II — •Johannes Mirfanger, Thomas Kuhr, and Thomas Lueck — Ludwig-Maximilians-Universität München (LMU), München, Germany

The precise reconstruction of η mesons is essential for a wide range of physics analyses at Belle II. This work presents a data-driven determination of the η reconstruction efficiency using the decay $D^{*+} \to D^0\pi^+$, comparing the two D^0 decay modes $D^0 \to K^-\pi^+$ and $D^0 \to K^-\pi^+\eta$. By forming the ratio of these channels and correcting for the known branching fractions, we extract the η reconstruction efficiency of the Belle II detector. A key strength of this method is the ability to directly compare data and Monte Carlo simulation, enabling a clean assessment of potential discrepancies between them.

The extracted efficiency is further studied as a function of key kinematic variables, including the η momentum and polar angle. This offers detailed insight into detector performance across phase space. Ongoing work focuses on evaluating the robustness of the efficiency under varied event-selection criteria and on optimizing cut strategies for future analyses. The presentation will discuss the current status and give an outlook on the analysis.