T 84: Methods in particle physics 5 (tagging)

Time: Thursday 16:00–18:00 Location: Geb. 20.30: 2.066

T 84.1 Thu 16:00 Geb. 20.30: 2.066

Development of flavour-tagging algorithms for the LHCb in Run 3 — •Jonas Rönsch, Johannes Albrecht, Quentin Führing, and Vukan Jectić — TU Dortmund University, Dortmund, Germany

The Standard Model allows the oscillation of the flavour from neutral B mesons, which can lead to a change in flavour between production and decay. For studies in the field of heavy flavour physics, e.g. analyses of CP violation in the decay of neutral B mesons, knowledge of the initial flavour is necessary. This information can be retrieved through the process of flavour-tagging. At the LHCb experiment, a flavour-tagging technique involving the charge of particles which are connected to the production flavour of the B meson. For Run 3 of the LHC, most components of the LHCb detector were upgraded. Consequently, the existing flavour-tagging algorithms must be revisited and adapted according to the Run 3 detector conditions. The reimplementation and optimization of the flavour tagging algorithms based on simulated Run 3 data samples will be presented in this contribution.

T 84.2 Thu 16:15 Geb. 20.30: 2.066

Recent results in Heavy-Flavor Jet Tagging algorithms in the CMS Experiment — Alexander Jung, Ming-Yan Lee, Andrey Pozdnyakov, •Uttiya Sarkar, Alexander Schmidt, Jan Schulz, and Ulrich Willemsen — III. Physikalisches Institut A, RWTH Aachen University

Identification of heavy-flavor jets plays an important role in many physics data analyses in the CMS Experiment. The method is implemented in the CMS physics reconstruction chain and relies primarily on charged particle tracks and secondary vertices within the jets. There has been a continuous evolution of heavy-flavor tagging algorithms, with each new algorithm consistently outperforming its predecessor. This presentation gives an overview of jet flavor tagging in CMS and discusses the comparison between data and simulation for various input variables, tagging discriminants, and other relevant kinematic observables. These comparisons are made across different phase space regions that are enriched in b, c, and light (udsg) quark jets, respectively. Studies are performed using the proton-proton collision data recorded by the CMS detector during the early part of the LHC Run 3.

T 84.3 Thu 16:30 Geb. 20.30: 2.066

Calibration of b-jet taggers at the ATLAS experiment — •Johannes Hessler, Daniel Britzger, and Stefan Kluth — Max-Planck-Institut für Physik

Flavor tagging describes the identification of jets originating from heavy quarks in high energy physics. It plays an important role in many analyses at the ATLAS experiment.

This talk will discuss the calibration of the most recent machine learning based ATLAS b-jet taggers. The focus will be on the c-jet mistag rate. It accounts for the misidentification of c-jets as b-jets.

T 84.4 Thu 16:45 Geb. 20.30: 2.066

Calibration of boosted vector boson tagging algorithms in ATLAS using diboson events — •Simone Ruscelli and Chris M. Delitzsch — TU Dortmund

The unprecedented centre-of-mass energy of the pp collisions at the Large Hadron Collider enables vector bosons production with a transverse momentum much larger than their rest mass, resulting in the collimation (or boost) of their decay products. The hadronic decay products of the vector bosons are captured within a large-radius ($R = 1.0$) jet. To distinguish such a jet from a quark/gluon-initiated jet, boosted object identification (tagging) algorithms are developed that exploit the radiation pattern within the large-radius jet, also known as jet substructure. The state-of-the-art tagging algorithms are based on machine learning techniques and significantly outperform simple cut-based taggers using a few jet substructure variables. Before such tagging algorithms can be used in analyses, they must be calibrated to match the efficiency obtained in Monte Carlo Simulation to that in data. To calibrate boosted W/Z boson tagging algorithms, $t\bar{t}$ events and V+jets events are used. While V+jets events cover the $p_{\mathrm{T}} > 500$ GeV range, W bosons from top-quark decays are only available up to $p_{\mathrm{T}} \approx 350$ GeV. In these feasibility studies, diboson events (WZ and ZZ) in which the Z-boson decays into a pair of charged leptons are explored to fill the gap in p_{T} between the $t\bar{t}$ and V+jets selections, but also to provide a cross-check to the current analyses in regions of overlap. The studies use $\sqrt{s} = 13$ TeV pp collisions recorded by the ATLAS detector at the Large Hadron Collider between 2015 and 2018.

T 84.5 Thu 17:00 Geb. 20.30: 2.066

Overview of adversarial studies for heavy flavour tagging — •Alexander Jung, Ming-Yan Lee, Uttiya Sarkar, Alexander Schmidt, Hendrik Schönen, Jan Schulz, and Ulrich Willemsen — III. Physikalisches Institut A, RWTH Aachen University, Germany

Neural networks have become indispensable in jet tagging algorithms. The ever-increasing performance in classifying jets comes with the disadvantage that these algorithms are susceptible to mismodeled input data. Networks are trained on simulated samples with a fixed detector setup. The real setup is not always constant, e.g. misalignment can occur or parts of the detector can fail. However, it would not be feasible to take these variations into account in the simulation, which means that mismodeling occurs "by design". In this contribution, we will look at how neural networks react to mismodeling, i.e. how robust they are against them and how their robustness can be improved.

T 84.6 Thu 17:15 Geb. 20.30: 2.066

b-tagging with Graph Neural Networks and additional Hit information — •Roman Kuesters and Spyros Argyropoulos — University of Freiburg, Freiburg im Breisgau, Germany

With a large region of the parameter space of new physics models already excluded by ATLAS and CMS, searches for new physics increasingly focus on the hunt for heavy resonances that often produce high-momentum B-hadrons.

B-hadrons with a high momentum are likely to decay after the first instrumented detector layers, thereby leaving fewer hits in the detector. This leads to a reduced track reconstruction efficiency and, consequently, a reduced b-jet identification efficiency.

Using hit information directly in the b-jet identification algorithms has been proposed to circumvent this problem. The talk will present how hit information can improve the b-jet identification at high momenta.

T 84.7 Thu 17:30 Geb. 20.30: 2.066

A study of ML based heavy flavour tagging — •Pradyun Hebbar, Stefan Kluth, and Daniel Britzger — Max Planck Institute for Physics, Munich, Germany

Heavy Flavour tagging, the identification of jets originating from t, b and c quarks, is a critical component of the physics programme of the ATLAS experiment at the Large Hadron Collider (LHC). Flavour tagging is of particular importance for the study of the Standard Model (SM) Higgs boson and the top quark, which preferentially decay to b quarks through the channels H to bb, and t to bW+. In recent years, with the advent of machine learning, many deep learning algorithms have shown drastically improved performance for flavour tagging compared to the traditional taggers. One such algorithm - PELICAN, the permutation equivariant and Lorentz invariant or covariant aggregator network, has achieved state-of-the-art performance for top tagging with fewer learnable parameters (as low as 11k) than the previous highest-performing networks. The goal of my study is to extend the PELICAN architecture for the objective of flavor tagging (specifically, b tagging) and compare its performance with other state-of-the-art b-tagging algorithms like ParticleNet and GN2!

T 84.8 Thu 17:45 Geb. 20.30: 2.066

Soft Secondary Vertex tools for the ATLAS experiment — 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], 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

Several interesting physics processes lead to the production of low-energy (soft) b-quarks in the final state, that may fragment into b-

hadrons without the creation of a reconstructable jet. Moreover, b-hadrons in jets are sometimes so soft that their decay products are distributed wider than the standard jet cone (the typical cone ΔR is about 0.4). The tools described in this contribution are targeting secondary vertices which are not detectable by standard Flavour Tagging algorithms. It is important to develop and optimize such b-tagging tools in order to extend the overall capability to identify b-quarks. In particular, we will describe the performance and the calibration of the tools.