T 85: Experimentelle Methoden III

Zeit: Donnerstag 16:30–19:05 Raum: Z6 - SR 1.013

Gruppenbericht T 85.1 Do 16:30 Z6 - SR 1.013

Track reconstruction for the Mu3e experiment — •Alexandr Kozlinskiy for the Mu3e-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz

The *Mu3e* experiment is designed to search for the lepton flavour violating decay $\mu^+ \to e^+e^-e^+$. The aim of the experiment is to reach a branching ratio sensitivity of 10^{-16}. At first phase the experiment will be performed at an existing beam line providing 10^8 muons per second at the Paul-Scherrer Institute (Switzerland) which will allow to reach sensitivity of 10^{-15}. The muons with a momentum of about 28 MeV/c are stopped and decay at rest on a target. The decay products (positrons and electrons) with energies below 53 MeV are measured by a tracking detector consisting of two double layers of 50 μm thin silicon pixel sensors. The high granularity of pixel detector with a pixel size of 80×80 μm allows for a precise track reconstruction in the high occupancy environment of the *Mu3e* experiment reaching 100 tracks per reconstruction frame of 50 ns in the final phase of experiment. To deal with such high occupancy and combinatorics the *Mu3e* track reconstruction uses a novel fit algorithm that in the simplest case takes into account only the multiple scattering, which allows fast online tracking on a GPU based filter farm. The implementation of the 3-dimensional multiple scattering fit based on hit triplets is described. The extension of the fit that takes into account energy losses and pixel size is used for offline track reconstruction. The algorithm and performance of the offline track reconstruction based on a full Geant4 simulation of the *Mu3e* detector are presented.

T 85.2 Do 16:50 Z6 - SR 1.013

Topological b-hadron decay reconstruction and application for heavy-flavour jet tagging in ATLAS — •Geoffrey Gilles — Bergische Universität Wuppertal, Wuppertal, Germany

The identification of jets originating from the hadronisation of heavy-flavour quarks represents a key ingredient in the physics program of the ATLAS experiment. Exploiting the topological structure of weak b- and c-hadron decays, the multi-vertex finder algorithm - JetFitter - tries to reconstruct the full b-hadron decay chain inside b-jets and provides a complementary approach to conventional secondary vertex finder algorithms. Based on the hypothesis that the primary and displaced b- and c-hadron decay vertices lie on a common line approximating the b-hadron flight direction, an extension of the Kalman Filter formalism for vertex reconstruction implemented in JetFitter allows to solve this pattern recognition problem. Detailed information on the reconstructed decay cascades is then used to identify and discriminate heavy-flavour jets. This presentation will discuss about the principle of this algorithm and its performance in the context of a recent optimization campaign performed in view of the 2017 LHC data-taking by the ATLAS detector.

T 85.3 Do 17:05 Z6 - SR 1.013

Studien zur Identifikation von Strangejets mit dem ATLAS-Detektor — •Sonja Zeissner, Johannes Erdmann und Kevin Kröninger — TU Dortmund, Lehrstuhl für Experimentelle Physik IV

Die Identifikation von Jets aus Bottomquarks ist seit Jahren ein essentieller Bestandteil vieler Datenanalysen an Hochenergie-Kollidern. Neue Methoden erlauben heute zusätzlich die Identifikation von Jets aus Charmquarks und hadronisch zerfallenden Topquarks sowie die Unterscheidung von Quark- und Gluonenjets. Die Unterscheidung von leichten Jets aus Up-, Down- und Strangequarks ist hingegen herausfordernd. In diesem Vortrag werden Studien zur Identifikation von Strangejets vorgestellt, insbesondere unter dem Gesichtspunkt der Diskriminierung zwischen Strange- und Up-/Downjets.

T 85.4 Do 17:20 Z6 - SR 1.013

Measurement of the ATLAS muon reconstruction efficiency on 2016 data using $Z \to \mu\mu$ events — Johannes Junggeburth[1], •Nicolas Köhler[1], Hubert Kroha[1], and Max Goblirsch-Kolb[2] — [1]Max-Planck-Institut für Physik — [2]Brandeis University

The precise knowledge of the muon reconstruction efficiency is an important ingredient for all data analyses at the LHC with muons in the final state. A tag&probe method has been used in $Z \to \mu\mu$ events to determine the muon reconstruction efficiency from data. By applying the same procedure to Monte Carlo $Z \to \mu\mu$ events, an efficiency scale-factor used to correct the the Monte Carlo data is evaluated. Because of the large data set collected in Run-2 at 13 TeV center-of-mass energy, systematic uncertainties in the scale-factor measurement have become a significant source of uncertainty for the ATLAS data analyses. In this talk, the muon reconstruction efficiencies determined for the years of 2015-2017 are discussed as well as a new method for reducing the systematic uncertainties on the measurement by about one order of magnitude.

T 85.5 Do 17:35 Z6 - SR 1.013

Development of a new Soft Muon Tagger for ATLAS Run 2 — Julien Caudron[1], Markus Cristinziani[1], Mazuza Ghneimat[1], Carlo A. Gottardo[1], Sebastian Heer[1], Vadim Kostyukhin[1], Ö. Oğul Öncel[1,2], Arshia Ruina[1], and •Andrea Sciandra[1] — [1]Physikalisches Institut, Universität Bonn — [2]Institut für Kernphysik, Universität zu Köln

The identification of b-quark initiated jets (b-tagging) plays a fundamental role at LHC, as it helps in the identification of heavy particles that decay to bottom quarks, as for instance the top quark, the Higgs boson or heavy exotic particles. The Soft Muon Tagger (SMT) allows to identify jets from b-quarks taking advantage of the presence of a muon originating from b-hadron semileptonic decays. I will describe the development of a new b-tagging algorithm in ATLAS that takes advantage of the jet-muon angular distance. Despite the low BR($b \to \mu X$), the discriminating power of the muon and vertex variables is remarkable to reject light jets.

A performance enhancement has been obtained for all light rejection woking points through the implementation of the SMT output in the ATLAS baseline b-tagging algorithm MV2. A good modelling of input and output variables will be shown, comparing simulation to Run 2 data.

T 85.6 Do 17:50 Z6 - SR 1.013

Identification of Hadronic Tau Lepton Decays with Deep Neural Networks at the ATLAS Experiment — •Christopher Deutsch, Jochen Dingfelder, and William Davey — Physikalisches Institut, Bonn, Deutschland

The tau lepton is the heaviest lepton in the Standard Model and an important probe of physics at high energy scales, such as Higgs physics and physics beyond the Standard Model. Hadronic decays make up approximately two-thirds of the total tau lepton branching ratio.

Jets originating from quarks or gluons can mimic hadronic tau decays. They are more abundant than tau leptons due to the large multijet production cross section at the LHC. Therefore, dedicated algorithms to discriminate hadronically decaying tau leptons from jets are required.

In this talk, the latest developments on a novel tau identification algorithm based on deep learning for data collected with the ATLAS detector during Run 2 of the LHC are presented. The new algorithm combines information on reconstructed objects and high-level identification variables in a neural network to build a powerful discriminant. A recurrent neural network architecture is used, allowing to process input sequences of variable length such as charged particle tracks and clusters of energy in the calorimeter. The network is expected to improve the jet rejection by a factor of two compared to the tau identification algorithm currently in use at the ATLAS experiment.

T 85.7 Do 18:05 Z6 - SR 1.013

Determining systematic uncertainties of boosted tau pair reconstruction and identification efficiencies in ATLAS — •Fabian Petsch, Christian Wiel, David Kirchmeier, Arno Straessner, and Wolfgang Mader — IKTP, Dresden, Deutschland

Tau reconstruction and identification plays an important role in the search for new physics in the ATLAS experiment at the LHC. Pairs of tau leptons with a boosted topology are produced in some channels and are possible final states in BSM scenarios, such as a graviton decaying into two Higgs particles. Since the two taus may be characterized by a low spatial separation, standard tau identification is not possible in this regime. Therefore a special approach for reconstruction and identification of boosted tau pair topologies has been developed.

This talk focusses on semi-leptonic di-taus as final states. The calculation of systematic uncertainties for the reconstrucion and identification efficiencies using various simulated detector modifications is presented.

T 85.8 Do 18:20 Z6 - SR 1.013

Identification of hadronically decaying tau leptons in CMS and determination of their energy corrections — David HlushchenkoBrunner, Jordy Degens, Peter Fackeldey, •Olena Hlushchenko, Wolfgang Lohmann, Johannes Merz, Thomas Müller, Alexander Nehrkorn, Claudia Pistone, Dennis Roy, Hale Sert, Achim Stahl, Dominik Wolfschläger, and Günter Flügge — III. Physikalisches Institut B, RWTH Aachen University

To calculate the mass of a system including tau in the final state, any bias in the energy measurement or reconstruction of the tau lepton decay products must be determined and corrected for. In this talk, the identification method of tau leptons decaying into hadrons in the CMS experiment will be explained and the performance of the latest 2018 multivariate discriminators will be presented. The energy scales are determined to treat the charged and neutral components of the tau separately and are compared to the energy scale obtained without this separation. The application in the context of $H \to \tau\tau$ analysis is discussed.

T 85.9 Do 18:35 Z6 - SR 1.013

Reconstruction and Identification of Semi-Leptonic Di-Tau Decays in Boosted Topologies at ATLAS — Arno Straessner, Wolfgang Mader, David Kirchmeier, and •Christian Wiel — IKTP, Dresden, Deutschland

The reconstruction of boosted di-tau decays is important in the search for heavy resonances (e.g. Randall-Sundrum gravitons) decaying into a pair of Higgs bosons. Existing reconstruction and identification algorithms for pairs of tau leptons cease to work in the regime of very low spatial separation. Earlier studies showed successfully how to restore a high reconstruction efficiency if both tau leptons decay hadronically. In this talk algorithms for the case where one tau decays hadronically and the other one decays into lighter leptons are presented. The new identification algorithms show promising results by achieving high background rejections and signal efficiencies.

T 85.10 Do 18:50 Z6 - SR 1.013

Track classification in hadronic tau decays with recurent neural networks — •Max Märker, Dirk Duschinger, Richard Hartmann, Wolfgang Mader, and Arno Straessner — IKTP TU Dresden

Tau leptons often play an important role in searches for new physics, not only because the Higgs decay probability into tau leptons is magnitudes larger than that for decays into muons or electrons, but also physics beyond the Standard Model can introduce enhanced couplings to tau leptons. However, their short lifetime makes it hard to detect tau leptons directly. In fact, tau decays in the ATLAS detector at the LHC often take place before any detector component. The majority of these decays are those into hadrons and additional neutrinos, where the hadronic constituents are most often 1 or 3 charged pions plus additional neutral pions. The classification of tracks of hadronic tau decays plays a crucial role in ATLAS tau reconstruction in terms of rejection against QCD jets and electrons.

In previous ATLAS analyses Boosted Decision Trees (BDT) where used successfully to separate tracks from hadronic tau decays and tracks from pile-up, conversions and underlying event. With recent developments in the field of artificial neural networks, new approaches are investigated utilizing the higher flexibility of neural networks to further improve the reconstruction of the charge multiplicity of hadronic tau decays. The focus is set on architectures using recurrent neural networks in order to learn the the special kinematic properties of tau decays.