T 111: Experimentelle Methoden 4 (Rekonstruktion)

Zeit: Donnerstag 16:45–19:00 Raum: JUR 253

T 111.1 Do 16:45 JUR 253

Identification of Hadronically Decaying Tau Leptons at the ATLAS experiment — •Christopher Deutsch, William Davey, and Jochen Dingfelder — Physikalisches Institut, Universität Bonn

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 branching ratio of tau decays and play an important part in the physics programme of the ATLAS experiment.

Jets originating from quarks or gluons, which are more abundant than tau leptons due to the large multijet production cross section at the LHC, can mimic hadronic tau decays. At the ATLAS experiment an identification algorithm based on multivariate methods utilizing track and shower shape variables is used to discriminate hadronically decaying taus from jets.

This talk is concerned with the latest developments of the tau identification for ATLAS Run II data including measures to improve the rejection of jets while maintaining a robust algorithm suitable for different physics analyses. The focus lies on an improved input variable selection and a systematic investigation and optimization of multivariate methods for tau identification.

T 111.2 Do 17:00 JUR 253

Latest status of the tau lepton decay mode classification at ATLAS — Philip Bechtle, Klaus Desch, •Lara Schildgen, and Peter Wagner — University of Bonn

Due to its short lifetime, the tau lepton decays before reaching the detectors and can only be reconstructed by its decay products. For Run II, one integral part of the particle flow based tau reconstruction in ATLAS will be the decay mode classification algorithm *PanTau*.

The tau decay mode classification algorithm *PanTau* exploits information from the topology of the reconstructed tau decay products. It is based on particle flow techniques which combine the track measurements of charged tau decay products in the tracking detectors with the energy information from the calorimeters to provide reconstructed π^0 candidates. Decay mode specific discriminating variables are constructed which are exploited in a Boosted Decision Tree based algorithm. Using this method, *PanTau* allows for a classification of the individual tau decay modes. Taking into accout the additional information on the tau decay mode, the tau energy resolution and spatial resolution are significantly improved.

The talk summarizes the status of the *PanTau* development and presents the tau reconstruction performance using the latest algorithm tuning.

T 111.3 Do 17:15 JUR 253

Track classification in hadronic tau decays — •Richard Hartmann, Dirk Duschinger, 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 that 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 hadronic tau decays plays a crucial role in ATLAS tau reconstruction in terms of rejection against QCD jets and electrons.

Several changes have been applied to the LHC and the ATLAS detector during the first long shutdown phase. This requires a revision of the track selection criteria applied for hadronic tau decays. Improvements of the track selection are presented with focus on the efficiency to reconstruct the correct number of tracks for each hadronic tau decay. By using multivariate techniques, attempts are to obtain best separation of tracks from hadronic tau decays and tracks from pile-up, conversions, underlying event, etc. For this purpose track quality criteria as a function of the transverse momentum of the tau decay are considered.

T 111.4 Do 17:30 JUR 253

A new energy reconstruction of hadronic Tau Leptons using at ATLAS — •Tobias Klingl, Peter Wagner, Philip Bechtle, and Klaus Desch — Universität Bonn

Final states with hadronically decaying tau leptons play an important role in many measurements and searches of the ATLAS Collaboration already during Run 1 of the Large Hadron Collider. With the discovery of the Higgs boson, one of the crucial measurements in Run 2 will be the Higgs CP mixing angle via spin effects in $H \to \tau\tau$. This requires a good discrimination between the number of charged and neutral pions in the τ decay. The Run 1 reconstruction, however, solely differentiates tau decay modes by the number of charged pions, using calorimeter information only. To this end, the Run 2 reconstruction identifies charged pions by their tracks in the tracking system while using energy deposits in the calorimeter to reconstruct neutral pions. For energies below $E \approx 140\ GeV$ the good momentum resolution of the tracker yield to very good energy resolution of the new reconstruction. However, for energies rising above this threshold the calorimeter-based resolution improves over degrading track resolution. To achieve a smooth transition from the new reconstruction (low energies) to the Run 1 reconstruction (high energies) the corresponding energies are weighted by their respective core E_T resolutions after calibrating the mean of both distributions to zero. To handle non-Gaussian tails in the new reconstruction the Run 1 E_T is picked if the two reconstructed energy values are incompatible to each another.

T 111.5 Do 17:45 JUR 253

Recent developments in reconstruction of neutral pions in tau decays at ATLAS — •Simon Blanke, Benedict Winter, William Davey, and Jochen Dingfelder — Physikalisches Institut Universität Bonn

Hadronic decays of tau leptons are intensively studied at the LHC, since they are important signatures e.g. of Higgs boson decays or Supersymmetry. Dedicated techniques have been developed to reconstruct the hadronic decay products in tau decays and are being commissioned for use in physics analysis. They will help improving the 4-momentum reconstruction by using particle flow methods. They will also improve the sensitivity to tau polarization, which is beneficial for physics analysis to study the properties of e.g. the Higgs boson or potentially other new particles. Two-thirds of the hadronic tau decays involve neutral pions. Thus the reconstruction and identification of neutral pions is of key importance for the tau decay reconstruction.

The neutral pion reconstruction algorithm determines the energy deposited by charged hadrons in the electromagnetic calorimeter and subtracts it. The remaining neutral pion candidate clusters are identified by utilizing variables sensitive to their shape in the calorimeter.

T 111.6 Do 18:00 JUR 253

Measurement of the τ-lepton trigger efficiency with $t\bar{t}$-events with a tag-and-probe method with the ATLAS experiment at $\sqrt{s} = 13$ TeV — •Katharina Schleicher, Duc Bao Ta, and Markus Schumacher — Albert-Ludwigs-Universität Freiburg

The study of final states containing hadronically-decaying τ-leptons plays an important role in investigating Standard Model as well as beyond Standard Model processes. To select such final states the ATLAS experiment uses dedicated τ-lepton identification and reconstruction algorithms already at the trigger level with very similar algorithms as for the offline analysis. The measurement of the trigger efficiency and the determination of MC-to-data correction factors has been performed so far using a tag-and-probe method using $Z \to \tau\tau$ events. In order to complement the current method and to reach a higher transverse τ-lepton momentum range top-quark-pair events are utilised. Final states with two b-quarks, neutrinos, a μ-lepton (tag) and a hadronically decaying τ-lepton (probe) are investigated in the analysis presented here. The measurement has been performed on the full 2016 Run-2 data set in proton-proton collisions ($L = 33.3$ fb^{-1}) taken with the ATLAS detector at $\sqrt{s} = 13$ TeV.

T 111.7 Do 18:15 JUR 253

Verbesserung der Jet-Unsicherheiten mit der Rtrk-Methode — •Alexander Melzer, Alessandra Betti, Götz Gaycken, Stephan Hageböck, Ruth Jacobs, Vadim Kostyukhin, Tatja-

na Lenz, Elisabeth Schopf, Eckhard von Törne und Norbert Wermes — Physikalisches Institut, Universität Bonn, Deutschland

Mit Beginn von Run2 wurde die Schwerpunktsenergie des LHC fast verdoppelt. Dies erhöht nicht nur den Wirkungsquerschnitt vieler Prozesse, sondern führt auch zu Endzustandsteilchen mit höheren transversalen Impulsen. Die klassischen Kalibrationsmethoden sind bei hochenergetischen Jets nicht mehr anwendbar. Dabei profitieren allen Analysen von einer präzisen Messung der Masse und des Impulses sowie von dem Wissen um die Unsicherheiten dieser Größen. In diesem Vortrag wird die Rtrk-Methode für die Bestimmung der Jet-Unsicherheiten vorgestellt. Rtrk ist ein komplementärer Ansatz zu den herkömmlichen Methoden, der anstelle von Photonen oder anderer Jets die Informationen von Teilchenspuren aus dem inneren Detektor zur Hilfe nimmt. Zudem ermöglicht diese Methode es Unsicherheiten auf Substruktur-Variablen von Jets zu bestimmen, die sonst unzugänglich bleiben. Diese Variablen werden bei der Rekonstruktion von hadronisch zerfallenden W-, Z-, H-Boson-Jets und Top-Quark-Jets eingesetzt. Die gezeigten Ergebnisse basieren auf Daten, die in den Jahren 2015 und 2016 mit dem ATLAS-Detektor am LHC gesammelt wurden.

T 111.8 Do 18:30 JUR 253

Extrapolation of in-situ calibrations of large-radius jets to high p_T at ATLAS — •Eftychia Tzovara, Lucia Masetti, and Sabrina Groh — Institute of Physics, University of Mainz

Data-based, so called "in-situ", methods are used to correct the jet energy and mass calibrations and to determine their systematic uncertainties. A new technique for extracting the jet mass scale and resolution from resonance decays (e.g. W/Z, H, top) reconstructed in a single large-radius jet, is the "forward-folding" method. It is used to extract the relative difference in the jet mass response between data and simulation, by using non-parametric shapes for both the particle-level distribution and the response function, derived from the simulation. In order to use this method to set a systematic uncertainty on the jet mass scale and jet mass resolution for beyond Standard Model searches, an extrapolation to higher p_T regions is necessary.

Monte Carlo simulations can be used to extrapolate the large-radius jet forward-folding result from the phase space region where it is performed, to regions that are inaccessible to the measurement in data. However, since the extraction of the jet mass scale and resolution from a hadronic resonance requires the particle-level spectrum as input, its precision is limited by the corresponding modeling uncertainties. In this talk, methods to extrapolate large-radius jet calibrations to high p_T and to determine their uncertainties, with data collected by the ATLAS experiment at the center-of-mass energy of 13 TeV, are presented.

T 111.9 Do 18:45 JUR 253

Verbesserung der Auflösung von Jets gemessen mit dem ATLAS Detektor mithilfe der globalen sequentiellen Kalibration (GSC) — •Vincent Kitali[1] und Krisztian Peters[2] — [1]DESY, Hamburg — [2]DESY, Hamburg

Das Vorbereiten von Jets mit gut rekonstruierter Energieskala und Energieauflösung ist essentiell für die Arbeit vieler Analysegruppen in der ATLAS Kollaboration. Die globale sequentielle Kalibration (GSC) ist ein Verfahren, das ausgezeichnet dafür geeignet ist, die Detektorantwort auf die Jetmessung auszugleichen, um die Auflösung zu verbessern.

Ergebnisse der aktuellen Auflösungsverbesserung werden im Hinblick auf verschiedene Jet-Kollektionen vorgestellt.