T 73: Higgs-Boson 6 (Zerfälle in Tau-Leptonen)

Zeit: Mittwoch 16:45–19:00 Raum: JUR 3

T 73.1 Mi 16:45 JUR 3

Analysis of the Higgs boson decaying to a pair of tau leptons using Run-2 data from ATLAS — •Stephanie Yuen, Benedict Winter, Will Davey, and Jochen Dingfelder — Physikalisches Institut, Nussallee 12, 53115 Bonn, Deutschland

In 2014, the ATLAS and CMS collaborations reported the combined Run-1 result of the discovery of the Higgs boson decaying into a pair of tau leptons. This $H \to \tau\tau$ decay channel has the highest sensitivity among channels directly probing the Higgs Yukawa couplings. With the increased luminosity expected in Run 2, ATLAS aims to not only independently establish 5σ evidence for $H \to \tau\tau$, but also to measure fiducial and differential $H \to \tau\tau$ cross sections with high precision. In addition, while CP studies in the bosonic decay channels of the Higgs indicate the compatibility of the Higgs boson's CP properties with that of SM predictions, fermions provide unique information on Higgs CP. This talk will discuss the analysis and background estimation methods for the $H \to \tau\tau$ decay channel, where both taus decay hadronically, for Higgs coupling and CP measurements with Run-2 data at ATLAS.

T 73.2 Mi 17:00 JUR 3

Higgs to Tau Pair coupling measurement in the lepton-hadron final state — Ulla Blumenschein[1,2], •Antonio De Maria[1], Arnulf Quadt[1], and Zinonas Zinonos[1,3] — [1]II. Physikalisches Institut, Georg-August-Universität Göttingen — [2]now at Queen Mary University of London — [3]now at Max Planck Institut für Physik

The decay of the Higgs boson into tau pair is currently the only accessible channel to establish the Higgs-Yukawa coupling to fermions. In this context, the final state in which one tau decays hadronically and the other one decays leptonically (lepton-hadron channel) plays an important role due to the high branching ratio and the moderate background. This talk outlines the main aspects of the ongoing analysis on the coupling measurement in this final state using data from proton-proton collisions recorded by the ATLAS detector at a center-of-mass energy of 13 TeV. In particular, the fitting strategy to extract the signal strength from the combination of the different signal/control regions is presented. The final part of the talk will be dedicated to the description and the demonstration of a new statistical tool, called FitBox, which is based on standard high-energy statistics software and provides important cross checks of the fit model.

T 73.3 Mi 17:15 JUR 3

Ditau mass reconstruction techniques at the ATLAS experiment — •Michael Hübner, Philip Bechtle, Klaus Desch, Christian Grefe, Peter Wagner, and Maike Hansen — Universität Bonn

Ditau mass reconstruction techniques play an important role in analyses involving the Higgs boson decaying to two tau leptons and are used to suppress background from $Z \to \tau\tau$ processes. In particular, the Missing Mass Calculator (MMC) was used in the paper providing evidence for the Yukawa coupling of the Higgs boson to tau leptons.

I will introduce the Missing Mass Calculator and show first results of MMC using the new tau substructure reconstruction. Additionally, I will show a performance comparison between different ditau mass reconstruction techniques.

T 73.4 Mi 17:30 JUR 3

Modelling of $Z \to \tau\tau$ processes with τ-embedded $Z \to \mu\mu$ data in ATLAS — Elias Coniavitis, •Alena Lösle, Dirk Sammel, Markus Schumacher, and Duc Bao Ta — Physikalisches Institut, Universität Freiburg

The decay channel $H \to \tau\tau$ is of great interest as it allows to investigate the coupling of the Higgs boson to fermions. In this channel the dominant and irreducible background contribution is given by $Z \to \tau\tau$ events. The embedding method allows to model $Z \to \tau\tau$ processes in a data-driven way by selecting $Z \to \mu\mu$ events in data and replacing the muons by τ-leptons from simulated $Z \to \tau\tau$ decays. The embedded $Z \to \tau\tau$ sample then contains similar conditions as the analysed data set, such as underlying event and pile-up acitivity, while also the kinematics of additionally produced jets does not rely on simulation.
In order to correctly embed simulated τ-leptons in $Z \to \mu\mu$ data events, all detector signatures arising from the original muons have to be identified and removed from the event in a first step. Here, one important task is the subtraction of the energy deposits by the muons in the electromagnetic and hadronic calorimeters. While this estimate currently relies on the simulation of $Z \to \mu\mu$ events, a new method to access the information by using a parametrization of the energy deposits in data has been developed.
In this talk I will give an overview of the status of embedding in ATLAS for LHC Run 2 and present a new method to subtract the energy deposits by muons in the calorimeters.

T 73.5 Mi 17:45 JUR 3

Data-driven estimation of backgrounds with jets misidentified as hadronic τ decays in the semileptonic Higgs decay-channel $H \to \tau_{had}\tau_{lep}$ at the ATLAS experiment. — •Fabian Becherer, Elias Coniavitis, Dirk Sammel, and Markus Schumacher — Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Germany

The discovery of a Higgs boson in 2012 at the LHC has led to studies aiming to measure the properties of this new particle, including its coupling to Standard Model particles. The most accessible way to measure the Higgs boson's couplings to leptons is to study its decay into a pair of τ-leptons. Analysis of the full LHC Run 1 data collected by the ATLAS detector already provided evidence for this decay channel. The large integrated luminosity and the increased signal cross section at $\sqrt{s}$ =13 TeV of the LHC Run 2 are expected to enable a 5σ observation of H$\to \tau\tau$ decays at the ATLAS experiment. This talk will discuss the analysis in the case where one τ decays leptonically and the other hadronically based on 36 fb^{-1} of data collected in pp-collisions in 2015 and 2016. In particular, it will focus on the data-driven estimation of background processes with a jet misidentified as a hadronically-decaying τ-jet, which are very important in this channel. This estimate is obtained using events with an inverted identification requirement on the τ-jet, extrapolated to the signal region using process-dependent fake-factors, measured in separate control regions for each background process and signal category.

T 73.6 Mi 18:00 JUR 3

Search for $H \to \tau\tau$ decays using multivariate techniques in proton-proton collisions at $\sqrt{s} = 13\,\text{TeV}$ with the ATLAS Detector — •Frank Sauerburger, Minoru Hirose, Karsten Köneke, and Karl Jakobs — Albert-Ludwigs-Universität, Freiburg, Deutschland

A multivariate analysis (MVA) using machine learning techniques to study the standard model decay of the Higgs boson to two τ leptons ($H \to \tau^+\tau^-$) is presented. The analysis focuses on the decay channel, in which one τ decays leptonically and the other τ hadronically. The background is estimated with a combination of Monte Carlo simulation and data-driven methods. A boosted decision tree (BDT) is trained on the background and signal model and employed to classify events into background and signal in order to enhance the sensitivity of the analysis. The analysis is performed with a dataset of proton-proton collisions at a center-of-mass energy $\sqrt{s} = 13\,\text{TeV}$ taken with the ATLAS Detector at the LHC during Run 2.

T 73.7 Mi 18:15 JUR 3

Establishment of the Standard Model $H \to \tau\tau$ signal in LHC Run II — •Raphael Friese, Roger Wolf, Andrew Gilbert, and Günter Quast — Institut für Experimentelle Kernphysik, Karlsruher Institut für Technologie (KIT)

The Standard Model $H \to \tau\tau$ analysis of the CMS experiment in the LHC Run I observed the presence of a Higgs boson decaying to a pair of two τ-leptons with a significance of 3.2 σ, with 3.7 σ expectation. The LHC run I took place in the years 2011 and 2012, incorporating an integrated luminosity of 24.9fb^{-1} at center-of-mass energies of 7 and 8 TeV,

The analysis presented here incorporates an integrated luminosity of 12.9fb^{-1} at a center-of-mass energy of 13 TeV, recorded in 2016 by the CMS experiment. The analysis covers the four most significant di-τ final states. It gets its significance from a classical approach doing cut-based event categorization. It is one step towards the full establishment of the $H \to \tau\tau$ coupling with a significance of 5σ the CMS collaboration is aiming to establish with the full dataset of 2016.

T 73.8 Mi 18:30 JUR 3

Machine learning for $H \to \tau\tau$ — •Carina Brandt, Adrian Perieanu, Oliver Rieger, Peter Schleper, Daniel Troendle, and Annika Vanhoefer — University of Hamburg

The search for $H \to \tau\tau$ at the LHC is a challenging task, due to the overwhelming background from the $Z \to \tau\tau$ process. Today, a dedicated mass reconstruction which is based on a likelihood method is used very successfully to reconstruct the mass of the higgs. With the significant advances in machine learning techniques in the last years, new and improved methods are now applicable to high energy physics data analysis. In this study modern machine learning (ML) algorithms have been exploited to improve the reconstruction of the mass and hence improve the seperation of Higgs and Z Bosons processes at CMS. First results based on Monte Carlo simulation at a centre of mass energy $\sqrt{s} = 13\,\text{TeV}$ will be presented.

T 73.9 Mi 18:45 JUR 3

Measurement of the energy scale of charged and neutral pions in hadronic τ decays at CMS — Vladimir Cherepanov, Gunter Flugge, •Olena Hlushchenko, Bastian Kargoll, Wolfgang Lohmann, Thomas Muller, Alexander Nehrkorn, Claudia Pistone, Hale Sert, Achim Stahl, and Alexander Zotz — III. Physikalisches Institut B, RWTH Aachen University, D-52056 Aachen

Decays of the Higgs bosons into two τ leptons are most promising to study Higgs boson coupling to fermions. To calculate the mass of the di-tau system, any bias in the energy measurement of the tau lepton decay products must be determined and corrected for. Since charged and neutral pions are measured using different sub-detectors these corrections should be estimated separately.

For this purpose K_s^0 mesons decaying either into two neutral or two charged pions are used and the procedure will be covered during the talk. Energies of the pions are scaled such that their invariant mass peak value equals to the nominal K_s^0 mass.

This approach is explicitly interesting for all analyses involving τ's. Possible application in the context of $H \to \tau\tau$ analysis is discussed.