T 3: Higgs I

Zeit: Montag 16:00–18:30 Raum: Philo-HS3

T 3.1 Mo 16:00 Philo-HS3

Higgs to Tau Pair coupling measurement in the lepton-hadron final state with the ATLAS Detector — •Antonio De Maria[1,2] and Arnulf Quadt[1] — [1]II. Physikalisches Institut, Georg-August-Universität Göttingen — [2]University of Pisa

The decay of the Higgs boson into a tau lepton pair is currently the only accessible channel to establish the Higgs-Yukawa coupling to leptons. 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 during 2015-2016. The final part of the talk will be dedicated to the description of further developments like the addition of a low lepton transverse momentum category and the impact of the missing transverse energy reconstruction quality on event selection and tau pair mass reconstruction.

T 3.2 Mo 16:15 Philo-HS3

Tau Identification and Search for SM $H \to \tau\tau$ with ATLAS — •Théo Megy, Lei Zhang, and Karsten Köneke — Albert-Ludwigs-Universität Freiburg

The decay of a Higgs boson into a pair of tau leptons is the most privileged channel in order to access Higgs boson couplings to leptons. The run 1 analysis in ATLAS reached an evidence for this process of 4.5σ, and the observation was reached by combining this result with CMS's. The aim is now to rediscover this process at 13 TeV with ATLAS. For this three final states, depending on the tau decay, are to be investigated. The semi-leptonic channel, in which the two tau leptons decay leptonically and hadronically respectively, is considered here.
An identification algorithm is used to select the hadronically decaying tau lepton, and suppress background events containing a jet faking a tau lepton. The analysis is therefore sensitive to the precise knowledge of the identification efficiency of tau leptons. The impact of the use of different identification working points on the analysis will be discussed. The possibility to use continuous tau identification in order to increase the sensitivity of the analysis will be introduced. The goal is to split the cut-based analysis signal region into several identification sub-regions. New identification working points are necessary for this, and as a consequence new scale factors need to be measured. The introduction of a flattened BDT might be helpful to define optimal working points. The use the continuous tau identification is also considered in the multivariate analysis.

T 3.3 Mo 16:30 Philo-HS3

Prospects for VBF $H \to \tau_{\text{lep}}\tau_{\text{had}}$ measurements at the High Luminosity LHC with the ATLAS detector — •Tobias Fitschen, Stan Lai, and Michel Janus — II. Physikalisches Institut, Georg-August-Universität Göttingen

Due to its status as the heaviest lepton in the Standard Model, the τ lepton serves as a particularly important probe for the coupling of the Higgs boson to fermions. Despite its larger branching fraction compared with the Higgs discovery channels ($H \to ZZ^*$ and $H \to \gamma\gamma$), the $H \to \tau\tau$ channel evaded observation until recently. This is a consequence of the di-tau signal being harder to separate from background processes.

The proposed High Luminosity upgrade for the LHC promises to deliver a significant improvement in instantaneous and consequently integrated luminosity. This has the advantage of a larger data sample but comes with the drawback of increased pile-up, further complicating the separation of signal and background, particularly in the $H \to \tau\tau$ channel.

This talk presents an approach for emulating the expected conditions at the High Luminosity LHC by overlaying pile-up jets and by degrading jet and $E_{\text{T}}^{\text{miss}}$ resolution in currently available data. The result of this process can then be used to make a prediction on the sensitivity to the VBF $H \to \tau_{\text{lep}}\tau_{\text{had}}$ decay channel with the ATLAS detector using the predicted High Luminosity LHC dataset.

T 3.4 Mo 16:45 Philo-HS3

Measurements of Simplified Template Cross Sections in the H$\to \tau\tau$ decay channel — •Fabian Becherer, Elias Coniavitis, and Markus Schumacher — Albert-Ludwigs-Universität Freiburg

The measurement of Simplified Template Cross Sections (STXS) is a new strategy to study the Higgs boson at the LHC. The measurements of the signal strength μ and coupling modifiers κ used in Run 1 make use of assumptions, such as the Standard Model kinematics or extrapolating from the measured phase space to the global phase space. These assumptions introduce theoretical uncertainties on the determined results and dependencies on the underlying physics model. The STXS technique allows the reduction of theory dependencies in a systematic way, which are directly folded into the measurements. It provides more finely-grained measurements of cross sections in well-defined phase space regions. These measurements will benefit from the global combination of the measurements in all decay channels and the higher cross section for the Higgs boson production at $\sqrt{\text{s}}$=13 TeV in Run 2. First results have been published by ATLAS utilising this technique in the H$\to$ZZ* $\to$4l and H$\to \gamma\gamma$ decay channel in 2017. This talk will present the first implementation of this technique in the H$\to \tau\tau$ decay channel at the ATLAS experiment. This will form an important input to combined ATLAS STXS results, in particular for vector boson fusion and high transverse momentum topologies.

T 3.5 Mo 17:00 Philo-HS3

Standard Model $H \to \tau\tau$ analysis with a multiclass neural net approach — Günter Quast, Raphael Friese, Roger Wolf, •Sebastian Wozniewski, and Stefan Wunsch — Karlsruhe Institute of Technology, Karlsruhe, Deutschland

Higgs physics is turning from discovery to measurement. One important element in the study of the discovered Higgs boson at 125 GeV is the investigation of its coupling to fermions. At the LHC, best access to this coupling is provided in the di-τ final state. In this talk, a multiclass neural net approach for the Standard Model $H \to \tau\tau$ analysis of CMS is presented, with the aim to optimally prepare the signal for the estimation of cross sections and properties of the coupling.

T 3.6 Mo 17:15 Philo-HS3

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 and Karsten Köneke — 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. The BDT is employed to classify events into background and signal in order to enhance the sensitivity of the analysis. The analysis is performed using a dataset of proton-proton collisions at a center-of-mass energy $\sqrt{s} = 13\,\text{TeV}$ corresponding to an integrated luminosity of $36.1\,\text{fb}^{-1}$ recorded with the ATLAS detector at the LHC during 2015 and 2016.

T 3.7 Mo 17:30 Philo-HS3

Measurement of the $H \to \tau\tau$ coupling exploiting tau lepton decay mode classification in the semi-leptonic final state at ATLAS — Philip Bechtle, Klaus Desch, Christian Grefe, •Lara Schildgen, and Peter Wagner — Physikalisches Institut, Universität Bonn

The decay of the Higgs boson into fermions plays an important role to gain a deeper understanding of the coupling properties of the Higgs. Because of the distinct signatures of the decaying tau leptons, the decay of the Higgs into a tau lepton pair is a unique channel to measure the Higgs coupling to fermions and is the first fermionic channel which gave a significance exceeding 5σ in combined measurements of ATLAS and CMS.

Due to its short lifetime, the tau lepton decays before reaching the detectors and is therefore reconstructed by its decay products. The reconstruction algorithm for hadronic taus used in ATLAS has been improved and extended for run-2. In particular, it allows identification of different hadronic tau decay modes. In this talk we will discuss how this information can be used to improve the measurement of the decay

of Higgs bosons into tau leptons using proton-proton collision data collected with the ATLAS detector at a center-of-mass energy of 13 TeV. We will focus on the semi-leptonic final state where only one of the two taus decays hadronically.

T 3.8 Mo 17:45 Philo-HS3

Optimizing the measurement of the signal strength for Higgs-boson production in the $H \to \tau\tau \to 2\ell 4\nu$ decay using multivariate techniques at $\sqrt{s} = 13\,\text{TeV}$ with the ATLAS detector — •Benjamin Rottler[1], Markus Schumacher[1], and Duc Bao Ta[2] — [1]Albert-Ludwigs-Universität Freiburg — [2]Johannes Gutenberg-Universität Mainz

The analysis of the decay of the Higgs boson to τ-leptons allows the determination of the τ-lepton Yukawa coupling as well as the coupling strength and structure of the Higgs boson to weak gauge bosons and gluons. Both the ATLAS and CMS experiment observed individually evidence for the Higgs to τ-lepton decay in Run-1. In Run-2 a higher sensitivity of this decay is expected due to the larger integrated luminosity and the enhanced cross-section at $\sqrt{s} = 13\,\text{TeV}$.

The selection for Run-2 can be optimized to the new run conditions and reconstruction tools with the help of multivariate analysis (MVA) techniques by maximizing the expected significance. In this talk an approach based on boosted decision trees (BDTs) is developed to increase the sensitivity of the $H \to \tau\tau \to 2\ell 4\nu$ channel for the full 2015 and 2016 Run-2 datasets corresponding to an integrated luminosity of $36.1\,\text{fb}^{-1}$ at a center-of-mass energy of $\sqrt{s} = 13\,\text{TeV}$. The choice of the BDT hyperparameters and collection of input variables used in the BDTs are optimized using a k-fold cross-validation method.

T 3.9 Mo 18:00 Philo-HS3

Measurement of the tau energy scale for Higgs analyses in the di-tau final state with the ATLAS experiment — •Michael Hübner, Philip Bechtle, Klaus Desch, Christian Grefe, and Peter Wagner — Universität Bonn

The decay of the Higgs boson into fermions, and tau leptons especially, is an interesting way to test the Standard Model. With this decay it is possible to probe, among other things, the Yukawa coupling of the Higgs to fermions and to test if the Higgs boson is a purely CP-even scalar or a CP-mixture.

The tau energy scale is one of the most important systematics for the Higgs coupling analysis. I will show a method to measure the tau energy scale with better precision than the conventionally used method. Additionally, it is possible to extract the energy scale for π^0s at the same time as the tau energy scale with the presented method.

T 3.10 Mo 18:15 Philo-HS3

Status of the $\mu \to \tau$ Embedding Method — •Per Ahrens, Roger Wolf, and Günter Quast — Karlsruher Institut für Technologie, Karlsruhe, Deutschland

In the $\mu \to \tau$ embedding method muons from selected $Z \to \mu\mu$ events in data are replaced by simulated τ decays to estimate the background from $Z \to \tau\tau$ events in Higgs boson searches in the di-τ final state at the LHC. After successful use with the LHC run-1 data of CMS, the method has been completely re-implemented to cope with the changed experimental environment and correspondingly adapted reconstruction software. The current status of the method is presented.