T 3: Higgs: Produktion und Zerfälle

Zeit: Montag 16:00–18:30 Raum: H04

T 3.1 Mo 16:00 H04

Search for Higgs boson production in association with a single top quark at the CMS experiment — Thorsten Chwalek, Nils Faltermann, •Kevin Flöh, and Thomas Müller — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

Higgs boson production in association with a single top quark (tH) is a very rare process with a production cross section of about one tenth of the production cross section of the associated production of a top quark pair and a Higgs boson ($t\bar{t}H$). In contrast to $t\bar{t}H$ production, it is sensitive not only to the amplitude but also to the relative sign of the top-Higgs and W-Higgs couplings. This presentation will focus on the channel with the Higgs boson decaying into a pair of bottom quarks ($b\bar{b}$). In order to obtain event specific object variables, a jet-quark assignment is implemented under two signal and one background hypothesis. Jointly with global variables, the object variables are used to discriminate between signal and background events using boosted decision trees (BDT). Additionally, a control region dominated by dileptonic top quark pair production events is used to constrain uncertainties on the flavor composition of additional jets. Finally, the BDT outputs of the dileptonic and the signal regions of the $b\bar{b}$ channel are fitted collectively with the multilepton and diphoton decay channels to obtain limits on several coupling scenarios and tH production. Furthermore, a simultaneous fit for tH and $t\bar{t}H$ signal strength is performed.

T 3.2 Mo 16:15 H04

Fake-Rate Determination for the ttH Coupling Measurement with a Signature of Two Same Electric Charge Light Leptons Associated with a Tau Using the ATLAS Detector at the LHC — •Andre Sopczak[1], Babar Ali[1], Simonetta Gentile[2], Andres Melo[1], Santu Mondal[1], and Antonio Policicchio[2] — [1]Czech Technical University in Prague — [2]Universita di Roma Sapienza

After the discovery of a Higgs boson, the measurements of its properties are at the forefront of research. The determination of the associated production of a Higgs boson and a pair of top quarks is of particular importance as the ttH Yukawa coupling is large and can probe for physics beyond the Standard Model. The analysis is based on data taken by the ATLAS experiment recorded from 13 TeV proton-proton collisions. The ttH production was analysed in various final states. The focus of this presentation is on the fake rate determination in the final state with two light leptons of same electric charge and one hadronically decaying tau lepton.

T 3.3 Mo 16:30 H04

Measurement of the $t\bar{t}H$ production cross-section with $H \to b\bar{b}$ in the boosted topology with the ATLAS detector — •Eftychia Tzovara, Peter Berta, Lucia Masetti, and Alexander Basan — Institute of Physics, JGU Mainz, Germany

Studying the coupling of the Higgs boson to the top quark (the heaviest particle in the SM) is of particular interest, since it could be very sensitive to effects of physics beyond the SM (BSM). The most favorable production mode for a direct measurement of the Higgs-top Yukawa coupling is the Higgs production in association with a pair of top quarks, $t\bar{t}H$. The newly observed decay to two bottom quarks ($H \to b\bar{b}$) has the largest branching fraction of about 58%. This analysis aims at events in which one of the top quarks decay semi-leptonically, producing an electron or a muon. In the single-lepton channel, the so-called boosted topology, targets events containing a Higgs boson and the hadronically decaying top quark produced at high transverse momentum.

Due to the highly complex final state and the large Standard Model backgrounds, measuring the signal strength in this process is very challenging and the reconstruction of the Higgs boson becomes a complicated task. The ultimate goal is to constrain the background events of the boosted channel in order to maximise the statistical significance of the measurement. For this purpose, multivariate techniques are used to discriminate between signal and background events, in particular from $t\bar{t} + jets$ production. In this talk, the challenges of this decay channel and the suppression of the background processes will be discussed.

T 3.4 Mo 16:45 H04

Untersuchung multivariater Analysemethoden für die $t\bar{t}H(b\bar{b})$-Analyse am CMS-Experiment — •Jan van der Linden, Karim El Morabit, Ulrich Husemann, Philip Keicher, Jörg Schindler, Matthias Schröder und Michael Wassmer — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Die Stärke der Top-Higgs-Yukawa-Kopplung kann durch eine Messung der assoziierten $t\bar{t}$+H-Produktion direkt bestimmt werden und ist daher von besonderem Interesse bei der Untersuchung der Higgs-Boson-Eigenschaften. Aufgrund des kleinen Wirkungsquerschnitts ist vor allem der Zerfall des Higgs-Bosons in ein $b\bar{b}$-Paar durch sein hohes Verzweigungsverhältnis interessant. Die nötige Sensitivität wird in dieser Suche nur durch die Verwendung multivariater Analysemethoden erreicht. Eine große Herausforderung stellt hierbei die Separation von Signal ($t\bar{t}$+H) und einer Klasse von $t\bar{t}$-assoziierten Untergrundereignissen ($t\bar{t}$+X) dar.
In diesem Vortrag werden verschiedene multivariate Analysemethoden, unter anderem Convolutional Neural Networks, vorgestellt, die im Rahmen der $t\bar{t}H(b\bar{b})$-Analyse im semileptonischen Zerfallskanal studiert werden.

T 3.5 Mo 17:00 H04

Studies on systematic uncertainties for the ttHbb ATLAS analysis at 13 TeV — •Filip Nechansky — DESY Zeuthen

The discovery of the Higgs boson in 2012 marked an important point in modern science, confirming more than 50 years old theoretical prediction. All measurements so far suggest that the properties of the new found boson are in agreement with the Standard model prediction. Since it is known that SM is not a complete theory, a hunt is on to find any deviation which could point to a new theory and the untouched ground around the Higgs boson is a promising area to find it. Therefore, it is important to probe all its properties as precisely as possible.

Due to its mass, the coupling of the top quark to Higgs boson is the strongest. Since top is too heavy to be produced by a Higgs decay, the most direct way to study its coupling is in a production of a top quark pair where the top radiates a Higgs boson. Analysis of such process at ATLAS is divided based on the decay products of the top quarks and the Higgs. This talk will report on a signature where the Higgs boson decays into two b-quarks, a channel which is not well established because of a difficult background modelling. The measurement was done with Run 2 data at 13 TeV proton collisions. Specifically, sensitivity to different systematic uncertainties will be discussed.

T 3.6 Mo 17:15 H04

Suche nach Produktion von Top-Quark-Antiquark-Paaren in Assoziation mit Higgs-Bosonen bei CMS — Karim El Morabit, Ulrich Husemann, •Philip Keicher, Jörg Schindler, Matthias Schröder, Jan van der Linden und Michael Wassmer — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Die assoziierte Produktion des Higgs-Bosons mit der Top-Quark-Antiquark-Paarproduktion ermöglicht eine modellunabhängige Messung der Top-Higgs-Yukawa-Kopplung. Diese ist von großer Bedeutung für die theoretische Beschreibung des Standardmodells und daher von besonderem physikalischen Interesse.

Präsentiert wird eine multivariate Analyse im semileptonischen Zerfallskanal des Top-Quark-Antiquark-Systems und dem Zerfall des Higgs-Bosons in ein Bottom-Quark-Antiquark-Paar. Dabei werden die Analysestrategie, die wichtigsten Untergrundprozesse und Systematiken und eine multivariate Klassifikation mit beispielsweise neuronalen Netzen zur Trennung von Signal und Untergrund vorgestellt. Abschließend werden aktuelle Ergebnisse und ein Ausblick auf mögliche zukünftige Messungen präsentiert.

T 3.7 Mo 17:30 H04

Differenzielle ttH-Wirkungsquerschnittsmessungen am HL-LHC — •Florian Henkes, Ulrich Husemann, Matthias Schröder und Philip Keicher — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Eine Messung des Wirkungsquerschnittes für die Higgs-Boson-Produktion in Assoziation mit einem Top-Quark-Antiquark-Paar (ttH)

ermöglicht eine direkte Bestimmung der Stärke der Top-Higgs-Yukawa-Kopplung. Die ttH-Produktion wurde im vergangenen Jahr erstmalig am LHC beobachtet. Die Sensitivität der Messung wird sich mit weiteren Daten, wie sie im zukünftigen LHC Run 3 und am High-Luminosity LHC produziert werden, weiter erhöhen und somit insbesondere auch differenzielle Messungen ermöglichen. Diese Möglichkeiten werden in diesem Vortrag genauer untersucht. Zur Planung der Analysen des High-Luminosity LHC ist die Verwendung von Simulationen unabdingbar. Hierbei stellt der große Rechenaufwand bei der Simulation der Detektoren eine große Herausforderung dar, weshalb man sich vereinfachter Simulationen bedient. Diese können mit dem Programm Delphes erzeugt werden.

In diesem Vortrag werden mit Delphes durchgeführte Studien zur Analyse des differentiellen Wirkungsquerschnitts der tt-H Produktion vorgestellt.

T 3.8 Mo 17:45 H04

Efficiency measurement of hadronic $\tau\tau$ triggers and their application in the SM $H \to \tau\tau$ analysis of CMS — •Maximilian Burkart, Artur Gottmann, Günter Quast, and Roger Wolf — Karlsruher Institut für Technologie, Karlsruhe, Deutschland

The most promising decay channel to measure the coupling of the Higgs boson to fermions is the decay into two tau leptons where the vector-boson-fusion (VBF) production mechanism constitutes a high share of the analysis' sensitivity. To increase the available amount of signal events a dedicated trigger targeting specifically the VBF production channel of the Higgs boson in the decay into two subsequently hadronically decaying tau leptons has recently been developed by the CMS Collaboration.

This talk covers the efficiency measurement of triggers for hadronically decaying tau leptons using the tag-and-probe method in $Z \to \tau_\mu \tau_\mathrm{h}$ events. The main focus of the talk lies on the application of the measured trigger efficiencies in the SM $H \to \tau\tau$ analysis and the sensitivity gains from the usage of the VBF trigger especially.

T 3.9 Mo 18:00 H04

Study Towards Analysing the Higgs Self-Coupling in the $gg \to hh \to 4\tau$ Channel at the ATLAS Detector — •Henrik Junkerkalefeld, Klaus Desch, Christian Grefe, and Philip Bechtle — Physikalisches Institut, Bonn, Germany

The Higgs boson discovery at the LHC in 2012 completes the predicted particle content of the Standard Model (SM) leaving not much space for BSM physics in the accessibly TeV scale. This heralds the precision measurement era of SM parameters of which the Higgs self-coupling is one of the last unmeasured ones. Its high sensitivity to new physics scenarios further increases its relevance. Due to the very small cross sections, the power of the LHC to measure the self-coupling is estimated to be limited, which motivates the investigation of this process in as many channels as possible.

Apart of more intensively studied decay channels, the $hh \to 4\tau$ channel shapes up as a very promising additional decay because a very limited amount of other processes is expected to produce four truth taus. However, a large background containing several sources of QCD jets can fake hadronically decaying tau leptons and has to be fought.

This work studies the conspicuity of dihiggs production within multi-tau events. To that effort, a novel method to increase the efficiency of detecting events with many truth taus and separating them from fake taus is developed. Moreover, the dominating background is studied and first attempts to separate the very similar process $ZZ \to 4\tau$ from the background are made.

T 3.10 Mo 18:15 H04

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

One goal of the LHC is to investigate the observed Higgs boson as precisely as possible by being as model independent as possible. The Simplified Template Cross Sections (STXS) method provides finely-grained measurements of cross sections in well-defined phase space regions. These regions are defined to minimize the dependence on theoretical uncertainties, to isolate possible beyond the SM effects and to maximize experimental sensitivity. The common definiton of the STXS across the Higgs boson decay channels allows a simple combination of the individual measurements, so that the STXS will benefit from a global combination of them.

This talk presents the first results for the STXS in the H$\to \tau\tau$ decay channel published by ATLAS in November 2018 and early studies with the full proton-proton data set recorded from 2015 until 2018. It will point out the most sensitive phase space regions in the published H$\to \tau\tau$ analysis and summarize possible optimisation of the analysis strategy, to increase the sensitivity in these regions and to expand the measured phase space. To this end the definition of the signal event selection as well as the number of measured cross sections are studied.