T 84: Associated Higgs production and Higgs quantum numbers II

Time: Thursday 16:00–18:15 Location: Ti

T 84.1 Thu 16:00 Ti

Reconstruction of advanced neural network approaches for $t\bar{t}H$ and development towards tH event analysis — Nazim Huseynov[1], Lars Kolk[2], André Sopczak[3], Petr Urban[3], and •Cyrus Walther[2] — [1]JINR Dubna — [2]TU Dortmund — [3]CTU in Prague

The reconstruction of $t\bar{t}H$ events is performed using advanced machine learning approaches. The focus is on the Higgs boson mass reconstruction. The study is first based on generated truth information. The analysis is further developed towards the tH production process. Different neural network architectures are applied and the performance is tested. Optimizations of the machine learning algorithms are performed. The precision of the Higgs boson mass reconstruction is compared between the $t\bar{t}H$ and tH production processes. The aim is to apply the developed algorithms on a data set based on full ATLAS detector simulation.

T 84.2 Thu 16:15 Ti

Fake-Rate Determination for the ttH and ttW Production with a Signature of Two Same Electric Charge Light Leptons Associated with a Tau Using the ATLAS Detector at the LHC — Nello Bruscino[1], Arthur Chomont[1], Simonetta Gentile[1], Nazim Huseynov[2], Georgiy Ivannikov[3], Santu Mondal[3], and •André Sopczak[3] — [1]Università di Roma, Sapienza & INFN — [2]JINR Dubna — [3]CTU in Prague

After the discovery of a Higgs Boson, the measurements of fits 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 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 and ttW production was analyzed 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 84.3 Thu 16:30 Ti

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, Lucia Masetti, Doga Elitez, Asma Hadef, Andriani Panagi, and Alexander Basan — JGU Mainz, Germany

Studying the coupling of the Higgs boson to the top quark is of particular interest, since it could be sensitive to effects of physics beyond the SM. The Higgs production in association with a top-quark pair is the most favorable for a direct measurement of the top Yukawa coupling. The decay to a b-quark pair has the largest branching fraction. This analysis aims at events in which one of the top quarks decays semileptonically, producing an electron or a muon. In the single-lepton channel, the boosted topology, targets events with a Higgs and/or a hadronically decaying top produced at high transverse momentum.

Due to the highly complex final state and the large SM backgrounds, the reconstruction of the Higgs becomes a complicated task. As a result, measuring the signal strength in this process is challenging. 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. Finally, the measurement of the $t\bar{t}H(b\bar{b})$ cross-section, using the full LHC run-2 data, as well as further improvements on the boosted channel, will be presented.

T 84.4 Thu 16:45 Ti

Measurement of the top-Higgs coupling in the H → bb̄ final state at the CMS experiment — •Philip Keicher[1], Ulrich Husemann[1], Matthias Schröder[2], Jan van der Linden[1], and Sebastian Wieland[1] — [1]Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT) — [2]Universität Hamburg

The production of the Higgs boson in association with a top quark-antiquark pair enables the direct measurement of the top-Higgs coupling, which is modeled to be a Yukawa-type coupling in the standard model of particle physics (SM). This production channel is expected to be sensitive to many models beyond the SM. Therefore, its measurement is a good test of the SM and of great importance to the theory community.

In this talk, an analysis is presented where the top quark-antiquark pair decays semileptonically and the Higgs boson decays into a bottom quark-antiquark pair. This entails a discussion of the analysis strategy, which is based on a classification using neural networks, as well as the most dominant background processes and systematic uncertainties. Finally, the presentation will cover the current status of the evaluation of the full Run-II data set collected at the CMS experiment.

T 84.5 Thu 17:00 Ti

Improvements of the MVA classifiers for the $t\bar{t}H(b\bar{b})$ analysis in the dilepton channel with full Run2 data in the CMS experiment — •Angela Giraldi — CMS DESY, Hamburg, Germany

In the Standard Model (SM), the Higgs boson couples to fermions with a Yukawa-type interaction and a strength proportional to the fermion mass. The associated production of a Higgs boson with a top-quark pair ($t\bar{t}H$) is therefore the best direct probe of the top-Higgs Yukawa coupling, a vital element to verify the SM nature of the Higgs boson. In the SM, the Higgs boson decays into b-quark-antiquark pair with the largest branching fraction, and is thus experimentally attractive as a final state. The dominant background contributions arise from $t\bar{t}$+jets production, and in particular the $t\bar{t}b\bar{b}$ background is irreducible with respect to $t\bar{t}H, H \to b\bar{b}$. To better enhance the sensitivity, the signal is extracted exploiting multivariate analysis (MVA) techniques.

This talk focuses on the analysis of the $t\bar{t}H, H \to b\bar{b}$ process in final states with two leptons using proton-proton data collected by the CMS experiment at the LHC during 2016-2018 at $\sqrt{s} = 13$ TeV. The possibility to critically increase the sensitivity to the $t\bar{t}H$ signal is investigated using machine learning approaches. Detailed studies on the optimization and performance of MVA discriminants trained using Artificial Neural Networks are presented for the first time in this final state.

T 84.6 Thu 17:15 Ti

Improvements for POWHEG+Pythia8 tt+bb NLO Monte Carlo predictions — •Lars Ferencz and Judith Katzy — DESY, Hamburg, Germany

Measurements of tt+H production in the H → bb channel are strongly affected by theoretical uncertainties introduced by the irreducible tt+bb background. In order to reduce these uncertainties, it is important to work on improving predictions for these backgrounds. In this talk studies are presented focussing on improvements for tt+bb focussing on several different aspects of the simulation.
Studies of the scale used in the Matrix Element calculation, different parton shower and matching settings for POWHEG and Pythia8 are compared to theoretical predictions and data.

T 84.7 Thu 17:30 Ti

Associated production of two Higgs bosons with a top quark-antiquark pair in the CMS experiment — •Ellen Sarauer, Ulrich Husemann, and Philip Keicher — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

To investigate predictions of the Standard Model of Particle Physics, the Higgs boson and its coupling to fermions are of great interest. After the discovery of the associated production of a Higgs boson with a top quark-antiquark pair, further studies in this field provide new physical insights. The associated production of two Higgs bosons with a top quark-antiquark pair allows the direct measurement of the top-Higgs-coupling, as well as the triple Higgs coupling.

The presentation is about a multivariate analysis focusing on the final state with a single lepton and the Higgs bosons decaying into bottom quark-antiquark pairs. The main topics are the analysis strategy, the most important background processes and systematic uncertainties. Additionally, an introduction is given to the multivariate classification technique with neural networks to distinguish between signal and background processes. The study of the associated production of two Higgs bosons with a top quark-antiquark pair is based on the

simulated CMS dataset of 2017.

T 84.8 Thu 17:45 Ti

Messung der HZZ-Tensor-Kopplung in $pp \to H \to ZZ^* \to 4\ell$ -Zerfällen mit dem ATLAS-Detektor — •Verena Walbrecht, Sandra Kortner, Oliver Kortner und Hubert Kroha — Max-Planck-Institut für Physik

Ein wichtiger Zerfallsprozess für die Messung der Eigenschaften des Higgs-Bosons ist der Zerfall in zwei Z-Bosonen, die jeweils in ein e^+e^-- oder $\mu^+\mu^-$-Paar zerfallen, $pp \to H \to ZZ^* \to 4\ell$. Im Standardmodell wird das Higgs-Boson als Spin-0-Teilchen mit positiver CP-Quantenzahl vorhergesagt. Diese Hypothese wird auch von den Run-1-Daten des LHC bevorzugt. Dabei sind kleine Beimischungen anomaler, möglicherweise auch CP-verletzender Kopplungen mit geänderter Tensorstruktur nicht ausgeschlossen.
Solche Abweichungen vom Standardmodell können unter anderem im Rahmen effektiver Feldtheorien (EFT) beschrieben werden, in denen die Standardmodell-Lagrangedichte durch weitere Operatoren höherer Dimensionen erweitert wird. In diesem Vortrag werden die Messungen der Produktions- und Zerfallseigenschaften des Higgs-Bosons im Kanal $pp \to H \to ZZ^* \to 4\ell$ vorgestellt und im Rahmen einer effektiven Feldtheorie interpretiert, um die EFT-Parameterwerte einzuschränken. Die Messungen basieren auf dem vollen Run-2-Datensatz des ATLAS-Detektors.

T 84.9 Thu 18:00 Ti

Analysis of the CP structure of the Higgs boson in $\tau\tau$ decays — Andrea Cardini, •Oleg Filatov, Elisabetta Gallo, Alexei Raspereza, and Merijn van de Klundert — Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany

The Standard Model (SM) predicts the existence of a CP-even Higgs boson. Measuring the CP quantum number of the Higgs boson is therefore useful to confirm the prediction of the SM and search for evidences pointing to new physics. The study of bosonic decays of the Higgs boson has already excluded a CP odd Higgs, however direct measurement of a mixing angle between a CP-even and a CP-odd state has not been performed yet.

The H to $\tau\tau$ decay at tree level is sensitive to the CP parity of the Higgs boson and offers a possible measurement of the CP mixing angle. The decay planes of the two τ leptons are reconstructed using their decay products and the corresponding acoplanarity angle between the planes is used to estimate the CP mixing angle.

We present the first measurement of the CP structure of the Yukawa coupling between Higgs boson and τ leptons. The measurement is based on Run II data corresponding to an integrated luminosity of 137 fb^{-1} and collected by the CMS experiment in proton-proton collisions at the LHC.