T 9: Associated Higgs production and Higgs quantum numbers I

Time: Monday 16:00–18:15 Location: Ti

T 9.1 Mon 16:00 Ti

Simplified Template Cross Section Measurement of the Process $pp \to HW \to WWW \to l\nu l\nu l\nu$ with ATLAS — •Moritz Hesping, Volker Büscher, Ralf Gugel, Thomas Honig, Christian Schmitt, and Natalie Wieseotte — Johannes Gutenberg Universität Mainz

The measurement of the couplings of the Higgs boson is of great scientific interest, since it has the potential of testing possible extensions to the Standard Model. The decay of a Higgs boson into a pair of W bosons after production in association with a W boson is especially useful, since in this process the Higgs boson exclusively couples to W bosons.

As the total cross section of the process $pp \to HW \to WWW \to l\nu l\nu l\nu$ has previously been measured at the ATLAS detector using data from 2015 and 2016, the next step is now to extend this out to the scheme of Simplified Template Cross Sections (STXS), using the full run 2 dataset. The STXS mesurement of this process requires access to the transverse momentum of the associated W boson, which due to the presence of three neutrinos in the final state cannot be fully reconstructed. This talk details the analysis strategy used to enable a STXS measurement of the Higgs-W coupling.

T 9.2 Mon 16:15 Ti

Search for WH production at the CMS Experiment using Deep Learning Techniques — •Frederic Engelke — III. Physikalisches Institut A, RWTH Aachen University

The analysis of the associated production of a Higgs boson with a vector boson via Higgs-Strahlung provides a possibility to detect Beyond the Standardmodel (BSM) effects. For a full understanding, the VH production cross section has to be investigated very precisely.

This analysis is performed blinded in the WH $\to$ bb $\ell\nu$ final state producing an expected upper limit on σ_{WH}. A physics process multiclassification by a deep neural network is used for the enhancement of this analysis. The used simulations correspond to the data measured by the CMS detector in 2017 amounting to a luminosity of $\mathcal{L} = 41.2\ \mathrm{fb}^{-1}$.

T 9.3 Mon 16:30 Ti

Towards a measurement of single top quark production in association with a Higgs boson (tH) in the ditau channel at ATLAS — •Tanja Holm and Ian C. Brock — Physikalisches Institut Universität Bonn

Single top quark production in association with a Higgs boson sometimes is referred to as the 'golden channel' of single top-quark processes due to the opportunities it gives in studying the couplings of the Higgs boson. Especially interesting is $\frac{C_F}{C_V}$ which results in the cross-section changing by almost one order of magnitude.
The production of a top quark in association with a Z boson has been discovered at ATLAS and CMS in the trilepton channel, considering the top quark and the Z boson to decay leptonically. Hence a promising channel for the tH search is the multilepton channel where the Higgs decays into two τ leptons. Given that each τ has a 64.6% probability to decay hadronically we search for events containing two hadronic τ decays and events containing one hadronic τ decay.
This talk will discuss the search for the tH production in the hadronic τ channels in ATLAS using the Run 2 data of the LHC.

T 9.4 Mon 16:45 Ti

Neural network development in the analysis of single top-quark production in association with a Higgs boson and light-quark at ATLAS — •Christian Kirfel, Ian Brock, and Tanja Holm — Physikalisches Institut Bonn

A measurement of the single top-quark production in association with a Higgs boson and a spectator light-quark (tHq) gives insight into the properties of not only the top quark but also the Higgs boson. The associated production is uniquely sensitive to the relative sign of the top quark-Higgs boson Yukawa coupling. Additionally, the ditau decay of the Higgs boson allows for a reconstruction of the Higgs mass.

The extraction of a signal is limited by the plethora of background processes with higher cross sections. This makes the usage of multivariate analysis methods a necessary choice.

A variety of new methods have been used to optimise the network, including an evolutionary optimisation process. In addition, the use of negative weights in the training has been investigated. Both the development and the results of a deep neural network for the separation of the tHq channel from its backgrounds are presented.

T 9.5 Mon 17:00 Ti

Associated production of a single top quark and a Higgs boson in the H→ b$\bar{\mathrm{b}}$ decay channel at the CMS experiment — Thorsten Chwalek, Nils Faltermann, •Marco Link, and Thomas Müller — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

The associated production of a single top quark and a Higgs boson (tH) is a still undiscovered Standard Model (SM) 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$\bar{\mathrm{t}}$H). In contrast to t$\bar{\mathrm{t}}$H production, tH production is through interference also sensitive to the sign of the top-Higgs coupling.

This presentation focuses on the reconstruction of tHq, tHW, t$\bar{\mathrm{t}}$ and t$\bar{\mathrm{t}}$H events with a single lepton final state using boosted decision trees (BDT) and the results obtained from the combination of three channels (fully hadronic, single lepton and dilepton) with $137.2\,\mathrm{fb}^{-1}$ of proton-proton collision data recorded at $\sqrt{s} = 13\,\mathrm{TeV}$ by the CMS experiment from 2016 to 2018. These results include a limit on the SM tH production and measurements of the top-Higgs coupling, for a SM Higgs boson and for a mixture with a non-SM CP-odd Higgs boson.

T 9.6 Mon 17:15 Ti

Investigation of ttH(bb) Events with Very High Higgs Boson Momentum at ATLAS Detector — Lucia Masetti, Eftychia Tzovara, Alexander Basan, Andriani Panagi, Asma Hadef, and •Doga Elitez — Johannes Gutenberg Universität Mainz, Institut für Physik, Mainz, Germany

The coupling of the Higgs boson to the top quark is very sensitive to effects of the physics beyond the Standard Model (BSM) and the most favorable production mode for direct measurement of the top Yukawa coupling is the Higgs production in association with a pair of top quarks, $t\bar{t}H$. The 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 decays semi-leptonically and produces an electron or a muon plus several jets. The so-called ultra boosted topology targets events containing a Higgs boson produced at very high transverse momentum, which is contained in a single small-R jet. This topology is not included in the current high p_T (boosted) Higgs boson selection and requires a dedicated analysis. The challenges in terms of background rejection and the potential to increase the sensitivity above the current p_T range are presented in this talk.

T 9.7 Mon 17:30 Ti

STXS measurement of topquark-antiquark pair production in association with a Higgs boson at CMS — •Sebastian Wieland[1], Ulrich Husemann[1], Philip Keicher[1], Matthias Schröder[2], and Jan van der Linden[1] — [1]Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT) — [2]Universität Hamburg

Top quark-antiquark pair production in association with a Higgs boson offers a model-independent measurement of the top-Higgs Yukawa coupling. This is of great interest in order to precisely test the couplings of the Higgs boson to fermions predicted by the standard model. Since physics beyond the Standard Model may show in the spectrum of the transverse momentum of the Higgs boson, a joint effort of Higgs analyses in all channels is made in order to simplify and streamline potential combinations between measurements. In the context of these Simplified Template Cross Section (STXS) measurements the cross section is measured in common bins.

In this talk a multivariate STXS measurement in the semileptonic decay channel of the top quark-antiquark pair and the decay of the Higgs boson into a bottom quark-antiquark pair based on the full Run-2 dataset of the CMS experiment is presented.

T 9.8 Mon 17:45 Ti

Modelling studies of the $t\bar{t} + b\bar{b}$ background to the $t\bar{t}\,(H \to b\bar{b})$

analysis — •Stephen Eggebrecht, Andreas Kirchhoff, Arnulf Quadt, Elizaveta Shabalina, and Knut Zoch — II. Physikalisches Institut, Georg-August-Universität Göttingen

The measurement of the Yukawa coupling of the Higgs boson to the top quark is an important parameter of the Standard Model (SM). It could be used to either find deviations from the SM or to constrain BSM theories. To study this coupling, the production of a SM Higgs boson in association with a top-quark pair is used. The decay mode where the SM Higgs boson decays to bottom quarks has the highest branching ratio. Unfortunately, it suffers from a large $t\bar{t} + b\bar{b}$ background. It has a two times larger cross-section than the signal as well as similar kinematics. By reducing the modelling uncertainties of the $t\bar{t} + b\bar{b}$ background, a better sensitivity of the measurement can be achieved. For this purpose, four different Monte Carlo (MC) simulations are compared. All simulations have different generator tunes and parton distribution function (PDF) sets. Firstly, the kinematics of the additional b-jets are studied when the $t\bar{t} + b\bar{b}$ process is simulated in the 5-flavour scheme. Secondly, a comparison is made with $t\bar{t} + b\bar{b}$ kinematics simulated in the 4-flavour scheme, where the bottom quark is no longer treated as a massless particle. This treatment corresponds to the best available theoretical predictions and is expected to reduce the uncertainties on this background.

T 9.9 Mon 18:00 Ti

ANN based jet assignment in the simultaneous inclusive cross-section measurement of $t\bar{t}$+H/$t\bar{t}$+Z in the semi-leptonic channel targeting $b\bar{b}$ decays at the CMS experiment — •Lukas Armbruster, Ulrich Husemann, and Jan van der Linden — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Higgs production in association with a top quark-antiquark pair ($t\bar{t}$+H) is one of the main Higgs production channels at the Large Hadron Collider (LHC). Additionally, the subsequent decay of the Higgs boson into a pair of bottom quarks (H→ $b\bar{b}$) is one of the most favored decay channels, due to the fact that b-jets are well distinguishable from other jet background (b-tagging).

This is why this study's focus is on the $t\bar{t}$+H decay chain. However, there occur some very similar processes, mainly the production of a Z boson in association with a top quark-antiquark pair ($t\bar{t}$+Z) and the associated production of bottom quarks with a pair of top quarks ($t\bar{t}$+$b\bar{b}$). Since these processes are very similar to the $t\bar{t}$+H → $b\bar{b}$ process, it is of vital importance to discriminate these from each other.

One essential step for the discrimination of these processes is the correct assignment of the occurring jets to a certain hypothesis (e.g. $b\bar{b}$ from Z boson) for any event. The jet assignment is quite challenging, since there are many (b-)jets in a single event and therefore numerous jet combinations are possible.

In this talk the strategy of jet assignment via Artificial Neural Networks (ANNs) is presented, in contrast to traditional χ^2-methods.