T 109: Higgs, Di-Higgs III

Time: Thursday 15:50–17:20 Location: HSZ/0105

T 109.1 Thu 15:50 HSZ/0105

Higgs-associated Top Quark Pair Production in the Bottom-Antibottom Higgs Decay Channel with ATLAS at 13 TeV — Arnulf Quadt, •Chris Scheulen, and Elizaveta Shabalina — II. Physikalisches Institut, Georg-August Universität Göttingen

The bottom anti-bottom Higgs decay channel of Higgs-associated top quark pair production offers direct access to measurements of the top Yukawa coupling and Higgs-p_{T} differential cross-section, which are sensitive to potential new physics. To incorporate improvements such as developments in b-tagging and Monte Carlo simulation of the dominant $t\bar{t}+b\bar{b}$ background, a legacy analysis of the $t\bar{t}H(H\to b\bar{b})$ process with the full ATLAS Run 2 dataset of $\mathcal{L}=139\,\mathrm{fb}^{-1}$ is currently ongoing.

This talk will outline the general analysis strategy and provide an insight into the expected sensitivity of the analysis. Additionally, a focus will be placed on specific aspects of this round of analysis, such as the application of a muon-in-jet correction technique utilised to improve the Higgs mass and Higgs-p_{T} resolution.

T 109.2 Thu 16:05 HSZ/0105

Fake Estimation for the Search of the $t\bar{t}H(H\to b\bar{b})$ Process in the Single Lepton Channel — •Alexander Froch, Andrea Knue, and Ksenia Solovieva — Albert-Ludwigs-Universität Freiburg

The coupling of the Higgs boson to the standard model (SM) fermions, called Yukawa coupling, is one of the most basic but also most interesting properties in Higgs physics. In the standard model the top quark, with the largest mass of all SM fermions, should have the largest Yukawa coupling to the Higgs boson of approximately 1. To measure this property, the production of a top-antitop quark pair in association with a Higgs boson is studied. Due to its small production rate at the LHC, the most dominant decay of the Higgs boson (into a pair of b-quarks) is used. One of the top quarks is required to decay hadronically while the other one decays leptonically. This results in a final state with at least 4 b-quarks, a lepton and 2 additional non-b-quarks. The selected sample of events are split into signal- and background-dominated sub-samples called regions. While the signal region is not strongly affected by fake leptons, in dedicated control regions where additional correction are derived, the fake lepton contribution is not negligible.

In this talk, the current status of the fake estimation of the analysis in the single lepton channel will be discussed.

T 109.3 Thu 16:20 HSZ/0105

Measurement of the $ttH(b\bar{b})$ Cross Section in Events with High Higgs Boson Momentum at the ATLAS Experiment — •Doga Elitez, Lucia Masetti, Eftychia Tzovara, Asma Hadef, Alexander Basan, and Jessica Höfner for the ATLAS-Collaboration — Johannes Gutenberg Universität Mainz

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 where one of the top quarks decays semi-leptonically and produces an electron or a muon. The so-called boosted topology targets events containing a Higgs boson produced at high transverse momentum, whose decay products are contained in a large radius jet. In this talk, methods to improve background rejection, event reconstruction, and increase the sensitivity above the current p_T range are presented.

T 109.4 Thu 16:35 HSZ/0105

Search for Higgs boson pair production via vector-boson fusion in final states with four b-quarks in the boosted regime using data collected by the ATLAS detector at $\sqrt{s}=13$ TeV — •Marcus Vinicius Gonzalez Rodrigues, Janna Katharina Behr, and Kunlin Ran for the ATLAS-Collaboration — DESY, Hamburg, Germany

Searches targeting Higgs boson pair production via vector-boson fusion (VBF) provide unique access to the coupling of a Higgs boson pair to a vector boson pair (HHVV), and allow to set constraints on theories that predict resonant production of heavy particles that interact directly with the Higgs boson. The ultimate goal of this analysis is to improve the constraints on the HHVV coupling and search for heavy particles produced via VBF. For this purpose we consider the VBF di-Higgs pair production with final states containing four b-quarks in the boosted regime, where a pair of particle showers initiated by b-quarks from the decay of a high transverse momentum Higgs boson produces one single merged large-radius jet.

This analysis relies on data collected by the ATLAS detector at $\sqrt{s}=13$ TeV with an integrated luminosity of 139fb^{-1}. To improve the signal vs. background discrimination a Boosted Decision Tree (BDT) is used to define signal regions sensitive to the HHVV coupling, whereas a Parametric BDT is employed to define signal regions targeting resonant production in a wide range of masses. In this presentation the BDT performance will be shown with regard to the HHVV coupling constraints and to the limits on the resonant production.

T 109.5 Thu 16:50 HSZ/0105

Search for non-resonant Higgs Boson pair production in the decay channel bbWW at the CMS experiment — Martin Erdmann, •Peter Fackeldey, Benjamin Fischer, and Dennis Noll — III. Physikalisches Institut A, RWTH Aachen University

A measurement of the Higgs boson pair production can directly determine the trilinear Higgs coupling and probe the structure of the Higgs potential.

We present a search for Higgs boson pair production with one Higgs boson decaying into b quarks and the other Higgs boson decaying into W bosons. It includes final states with one or two leptons and resolved or boosted event topologies. The central challenge of this analysis is a tiny signal among a large amount of different backgrounds. To address this, we use physics process multiclass classification that is driven by a deep neural network.

We present results corresponding to the data recorded at the CMS experiment during Run 2.

T 109.6 Thu 17:05 HSZ/0105

Search for Higgs Boson Pair Production in Multi-Lepton Final States with the ATLAS Detector — Anamika Aggarwal, Janek Both, Volker Büscher, Antoine Laudrain, Christian Schmitt, •Niklas Schmitt, and Duc Bao Ta — Johannes Gutenberg-University, Mainz

After the discovery of the Higgs boson in 2012 at the LHC, many of its properties have already been determined precisely using 139 fb^{-1} of proton-proton collisions at $\sqrt{s}=13$ TeV. However, one of the biggest challenges in this field remains the measurement of the coupling of the Higgs boson to itself. It allows for a deep insight into the real shape of the Higgs potential and hence has a big impact on the understanding of fundamental interactions not only at the electroweak scale. In order to constrain the trilinear self-coupling, the Di-Higgs production cross section is measured. While decay modes including b-quarks typically have larger branching fractions, leptonic final states are generally much cleaner and have less SM background. Accordingly, probing this channel as a complement to $b\bar{b}$ analyses will be very promising.

Dedicated neural networks in the 2,3 and 4 lepton final states have been trained to distinguish all relevant signal processes against the sum of all SM backgrounds. This talk will highlight the performance of these multi-lepton channels compared to other HH decay modes and also introduces a regression network used for probing the sensitivity to the Higgs boson self-coupling. In addition, a first look into Run 3 data, as well as projections for the full Run 3 dataset, are presented.