T 47: Higgs 2 (ttH & tH production)

Time: Tuesday 16:00–18:00 Location: Geb. 30.41: HS 2

T 47.1 Tue 16:00 Geb. 30.41: HS 2

$t\bar{t}H$ Multi-Lepton Analysis Results — •Stephen Eggebrecht, Steffen Korn, Arnulf Quadt, Baptiste Ravina, and Elizaveta Shabalina — II Physikalisches Institut, Georg August Universität Göttingen

The Higgs boson production in association with a top quark pair ($t\bar{t}H$) plays a key role for studying the Yukawa coupling between the Higgs boson and the top quark. The coupling can be determined by measuring the cross-section of the $t\bar{t}H$ production process in various final states using the 140 fb^{-1} Atlas dataset at $\sqrt{s} = 13$ TeV. Multi-lepton final states are rare but pure since most backgrounds are significantly suppressed. An overview of $t\bar{t}H$ the multi-lepton analysis with a focus on the non-resonant $t\bar{t}H \to 4\ell$ process is presented.
It is the multi-lepton final state with the lowest production rate and has contributions from Higgs decay modes like $H \to WW^*$, $H \to \tau\tau$, and $H \to Z^*Z^*$. The dominant background arises from $t\bar{t}Z$, ZZ, and misidentified leptons from $t\bar{t}$ production. A multiclass dense neural network (DNN) is trained to separate signal events from these backgrounds and to define analysis regions. Additional fake lepton regions are defined to estimate the normalisation of the most important fake contributions. Preliminary fit results for the signal strength are presented for the 4ℓ channel. Furthermore, the combined performance of other multi-lepton final states is presented and discussed.

T 47.2 Tue 16:15 Geb. 30.41: HS 2

Reconstruction of the semi-leptonic $t\bar{t}(H \to WW^*)$ final state — •Arnulf Quadt, Ireas Tom Raschke, Baptiste Ravina, and Chris Scheulen — Georg-August-Universität, II. Physikalisches Institut, Göttingen, Germany

This talk will cover the analysis of $t\bar{t}(H \to WW^*)$ events in which the top quark pair decays fully hadronically and the W bosons decay semi-leptonically. The analysis uses the full ATLAS Run 2 dataset. The $t\bar{t}H$ process allows to probe the Yukawa coupling of the top quark directly, and has previously been studied in multi-lepton final states and in the boosted $t\bar{t}(H \to b\bar{b})$ channel. The semi-leptonic $H \to WW^*$ channel has not yet been explored.

The reason for this is the difficulty to reconstruct the event from the many jets in the final state. Classical algorithms that use jet kinematics are not suited for this channel. Hence, a modern neural network approach (SPANet) is implemented. It is expected to increase the background suppression. The leptonic W boson is then reconstructed from the single lepton in the event and the missing transverse energy using neutrino weighting.

T 47.3 Tue 16:30 Geb. 30.41: HS 2

ttH analysis with two light leptons and one hadronically decaying tau lepton with Run-2 ATLAS data — •Vladyslav Yazykov and Andre Sopczak — Czech Technical University in Prague

The latest results on the analysis with Run-2 ATLAS data are reported on the ttH 2lSS1tau channel.

T 47.4 Tue 16:45 Geb. 30.41: HS 2

Development of ATLAS Run-3 $t\bar{t}W$ samples — •Matthias Drescher, Arnulf Quadt, and Baptiste Ravina — II. Physikalisches Institut, Georg-August-Universität Göttingen, Germany

The top-quark pair production in association with a W boson ($t\bar{t}W$) can be used to understand quark-induced $t\bar{t}$ production, since $t\bar{t}W$ does not allow gluons in the initial state at leading order. Furthermore, the $t\bar{t}W$ process is a major background to other important processes such as $t\bar{t}H$ and 4t production. To provide the theoretical predictions used to design the analyses of these processes, a set of event data is generated by Monte Carlo event generators.

To be able to analyse the LHC Run 3 data at $\sqrt{s} = 13.6$ TeV, the existing $t\bar{t}W$ samples used in the ATLAS collaboration need to be updated. This is done separately for the two existing samples generated with the Sherpa and MadGraph5_aMC@NLO + Pythia 8 generators. In order to better assess the modelling uncertainty in future analyses, auxiliary samples containing variations of the generator parameters are derived from the two nominal configurations as systematic variations. Using the Rivet analysis framework, comparisons are made between different generator versions and between the nominal and systematic samples.

T 47.5 Tue 17:00 Geb. 30.41: HS 2

Progress towards the NNLO amplitude for ttH production — •Anton Olsson[1], Gudrun Heinrich[1], Jannis Lang[1], Bakul Agarwal[1], Vitaly Magerya[1], Yannick Klein[2], Stephen Jones[3], and Matthias Kerner[4] — [1]Institute for Theoretical Physics, Karlsruhe Institute of Technology, 76131 Karlsruhe, Germany — [2]Institute for Theoretical Particle Physics and Cosmology, RWTH Aachen University, 52056 Aachen, Germany — [3]Institute for Particle Physics Phenomenology, Durham University, Durham DH1 3LE, UK — [4]Institute for Astroparticle Physics, Karlsruhe Institute of Technology, 76344, Eggenstein-Leopoldshafen, Germany

We present numerical results for the two-loop virtual amplitude entering the NNLO corrections to Higgs boson production in association with a top quark pair at the LHC. We focus on the quark initiated channel and the colour factors containing closed quark loops, as a proof of concept to describe our method. Results for the finite part of the two-loop amplitude are visualized as functions of phase space variables.

T 47.6 Tue 17:15 Geb. 30.41: HS 2

Associated production of a Higgs boson and a single top quark from t-channel production (tHq) in channels with hadronically decaying tau leptons at ATLAS — •Florian Kirfel, Ian C. Brock, Oleh Kivernyk, and Christian Kirfel — Physikalisches Institut der Universtiät Bonn, Deutschland

A measurement of 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.

The decay of the Higgs boson into two tau leptons is covered by the presented analysis. Both cases in which one or two taus decay hadronically are considered and analysed based on the Run 2 LHC dataset from ATLAS.

The complete analysis workflow is covered, ranging from the treatment of tau lepton misidentification, over the application of a categorical neural network for signal isolation to a binned maximum likelihood estimation for the purpose of cross section estimation.

T 47.7 Tue 17:30 Geb. 30.41: HS 2

Analysis of tH(bb) production with ATLAS Run-2 data — •Martin Vatrt and Andre Sopczak — Czech Technical University in Prague

The latest results on the analysis tH(bb) are presented with focus on machine learning optimization using ATLAS Run-2 data.

T 47.8 Tue 17:45 Geb. 30.41: HS 2

Investigation of the ttH(bb) Reconstruction in Events with High Higgs Boson Momentum at the ATLAS Experiment — •Doga Elitez, Lucia Masetti, Jessica Höfner, Frederic Fischer, and Eftychia Tzovara — Johannes-Gutenberg Universität Mainz, 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, ttH. The decay to two bottom quarks (H to bb) 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. 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 analysis, two methods to identify and reconstruct the Higgs boson decay collimated in a single large-radius jet are compared. Additionally, methods to improve background rejection and event reconstruction are presented.