T 33: Top Quarks: Production (Exp.) 2

Time: Tuesday 16:15–18:30 Location: T-H18

T 33.1 Tue 16:15 T-H18

An effective field theory approach using top quark polarisation and spin correlations in $t\bar{t}$ production at the LHC — •Andre Zimermmane-Santos, Afiq Anuar, Alexander Grohsjean, and Christian Schwanenberger — Deutsches Elektronen-Synchrotron, Hamburg, Germany

The Effective Field Theory (EFT) approach provides a systematic and model-independent way to search for new physics. It assumes new heavier particles exist outside the energy reach of the LHC. Nonetheless, their effects can be parametrized by new effective interactions constructed with Standard Model (SM) fields. Hence, new couplings can be identified and measured via small deviations from SM predictions.

In this study, we aim to use particular sets of observables related to the top quark polarisation and spin correlation in top quark pair events with two leptons in the final state. Each of those sets are sensitive exclusively to a subset of EFT couplings. This provides a natural way of uncorrelating EFT effects, allowing limits on their strength to be drawn with unprecedented precision. We investigate various EFT scenarios using the *dim6top* and *SMEFTatNLO* models. Subsequently, we also verify necessary translations between different EFT formalism. Our findings pave the way for the EFT interpretation using full CMS Run 2 data.

T 33.2 Tue 16:30 T-H18

Measurement of the dileptonic $t\bar{t}$ differential cross section in a BSM phase space at CMS — Valeria Botta, Lutz Feld, •Danilo Meuser, Philipp Nattland, and Marius Teroerde — I. Physikalisches Insitut B, RWTH Aachen University

Measurements of the $t\bar{t}$ production cross section yield important precision tests of the Standard Model (SM), while also probing scenarios for physics beyond the SM (BSM).

This analysis aims to measure the $t\bar{t}$ cross section in a phase space where additional contributions from BSM scenarios could be present. It is based on the data set recorded by CMS in the years 2016 to 2018 at a center-of-mass energy of 13 TeV, corresponding to an integrated luminosity of 138 fb^{-1}. The BSM scenarios considered include supersymmetric and dark matter models, where, similarly to the dileptonic $t\bar{t}$ channel, two leptons, b jets and undetected particles are produced.

Unlike previous measurements, where the differential cross sections were mainly measured as a function of kinematic variables of the leptons or top quarks, this analysis focuses on observables related to the neutrinos, like the missing transverse momentum and the angular distance between the missing transverse momentum and the nearest lepton, to separate BSM from SM $t\bar{t}$ events. In order to increase the sensitivity of the analysis multivariant techniques are used which improve the resolution of the missing transverse momentum in SM $t\bar{t}$ events. In this talk the analysis strategy will be presented and preliminary results on the improved missing transverse momentum resolution and on systematic uncertainties will be shown.

T 33.3 Tue 16:45 T-H18

Studying prospects of a measurement of the cross section of top-quark pair production with additional charm quarks in the lepton+jets channel at ATLAS at $\sqrt{s} = 13$ TeV — •Lukas Ehrke, Tobias Golling, Manuel Guth, Johnny Raine, and Knut Zoch — Université de Genève, Geneva, Switzerland

The goal of this analysis is to measure the inclusive cross section of $t\bar{t}$ production with additional charm quarks in the ATLAS collaboration. This talk focuses on the semileptonic $t\bar{t}$ decay channel for which it would be the first measurement of this cross section. The measurement will benefit several analyses where this process is a non negligible background, most notably in the search for a $t\bar{t}$ pair in association with a Higgs boson where the Higgs boson decays into two b-quarks.

To reduce background processes not containing a $t\bar{t}$ pair b-tagging is needed, whereas to identify the events with additional c-quarks c-tagging is needed. A further complication in the lepton+jets channel are c-quarks originating from the hadronically decaying W boson. Therefore, the existing flavour tagging methods are extended to allow for simultaneous b- and c-tagging. New working points are derived on a 2D plane, and based on the b- and c-multiplicity, multiple regions are defined with different contributions of the different $t\bar{t}$+jets components. Initial studies show promising sensitivity to the cross section. The measurement in the lepton+jets channel benefits from larger statistics compared to the dilepton channel. However, the charm quarks from the hadronic W decays pose a greater modelling challenge.

T 33.4 Tue 17:00 T-H18

Measurement of the inclusive production cross sections of a top-quark pair in association with a Z boson at $\sqrt{s} = 13$ TeV in final states with three leptons using deep neural nets with the ATLAS detector — •Steffen Korn, Arnulf Quadt, and Elizaveta Shabalina — II. Physikalisches Institut, Georg-August-Universität Göttingen

Through the associated production of a top quark pair and a Z boson, the strength and structure of the neutral current weak coupling of the top quark and the Z boson can be measured. It provides sensitivity to the top quark's weak isospin in the framework of the Standard Model (SM). The measurement of this fundamental parameter of the SM also serves as a probe to new physics beyond the SM. The process was measured by ATLAS and CMS at $\sqrt{s} = 13$ TeV with the full run 2 data set. In a new, refined analysis multivariate techniques are used to improve the sensitivity of the measurement. The impact of the usage of multi-class deep neural network for event classification on the systematic uncertainties for a measurement of the inclusive cross section of $t\bar{t}Z$ final states with three charged leptons is presented.

T 33.5 Tue 17:15 T-H18

First simultaneous differential measurement of tZq and $t\bar{t}$Z processes at the CMS Experiment — •Federica Colombina, Andreas Meyer, and Abideh Jafari — Notkestraße 85, 22607 Hamburg, Germany

At the Large Hadron Collider (LHC) at CERN, about millions of top quark events have been produced. The data recorded during LHC Run-2, in the years 2016-2018, gave access to first differential measurements of top quark production in association with Z-bosons, and precisely probes the coupling between top quarks and Z bosons for the first time. The cross sections of top quark pair producton, $t\bar{t}$Z, and single-top quark production, tZq, are similar, and both processes are mutual backgrounds to one another. Measurements of top-Z coupling and EFT analyses require measurements of both these processes and their correlation. In this analysis, tZq and $t\bar{t}$Z are measured simultaneously for the first time, aiming to better understand the correlation between these two processes. Furthermore, the evaluation of their differential cross section can bring evidence of possible deviations from the standard model, providing information for EFT analyses and new physics scenarios.

T 33.6 Tue 17:30 T-H18

Background model in a $t\bar{t}W$ cross-section measurement — •Marcel Niemeyer, Arnulf Quadt, and Elizaveta Shabalina — Georg-August University Goettingen

The top-quark pair production in association with a W boson is an interesting process by itself and exhibit an important background to processes like $t\bar{t}H$ or 4-tops production. Due to higher order electroweak corrections, the process is difficult to model. In consequence, a mismodelling of $t\bar{t}W$ has been observed in previous analyses. Thus, it is of high importance to measure this process to improve our understanding of it. The analysis is performed in the multi-lepton channel requiring 2ℓ (same-sign) or 3ℓ. The resulting event sample has a significant contribution from fake backgrounds.

To estimate this background, an extended template fit is performed that uses a discriminant based on isolation and b-tagging variables, referred to as a prompt lepton veto. The fit, the calibration of the prompt lepton veto, and the related systematic uncertainties will be discussed in this talk.

T 33.7 Tue 17:45 T-H18

Measurement of differential cross-sections of the $t\bar{t}\gamma$ production in the dilepton channel in proton-proton collisions at $\sqrt{s} = 13$ TeV with ATLAS detector — •Buddhadeb Mondal, Ivor Fleck, and Carmen Diez Pardos — Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen

The top quark being the heaviest fundamental particle in the Stan-

dard Model (SM) plays a very important role in the study of fundamental interactions. It has a very short lifetime and it decays before it hadronizes, passing its properties to its decay products. Top quark pair production in association with a photon ($t\bar{t}\gamma$) is a very important process for measuring the coupling between top quark and photon. A precise measurement of this coupling is necessary for testing the SM and also for probing any new physics effect at very high energy scale. Deviations from the SM coupling can be a limit of new physics phenomena that can be interpreted in the context of effective field theory approaches. In this talk, measurement of differential cross-section using 139 fb^{-1} of data collected by the ATLAS detector in proton-proton collisions at $\sqrt{s} = 13$ TeV will be presented. This measurement is done in the dileptonic decay channel of the $t\bar{t}$ pair.

T 33.8 Tue 18:00 T-H18

Measurement of $t\bar{t}+\gamma$ production with the full Run 2 ATLAS data set — •Andreas Kirchhoff, Arnulf Quadt, and Elizaveta Shabalina — II. Physikalisches Institut, Georg-August-Universität Göttingen

The optimal way to measure the top-photon coupling and later interpret it within an EFT-framework would be an e^+e^- collider with sufficient energy. As such a collider does not exist, another possibility to measure it is the production of $t\bar{t}$ pairs in association with a photon. Unfortunately, most of such photons will originate from the decay products of the top quarks and hence do not convey any information about the top-photon coupling. In contrast, photons produced in the production of the $t\bar{t}$ pair mostly originate from the top quark (beside a small contribution from ISR). The separation of photons originating from production and decay is tried for the first time in this ATLAS analysis. In this talk, the status of the currently ongoing full Run 2 analysis of the $t\bar{t}+\gamma$ process in the l+jets channel will be presented. The talk will focus on showing how deep neural networks are used to measure the $t\bar{t}+\gamma$ cross section, where the photon is emitted during production. First fit results will also be shown.

T 33.9 Tue 18:15 T-H18

Search for $t\bar{t}\gamma\gamma$ production in pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector — •Arpan Ghosal, Ivor Fleck, Carmen Diez Pardos, and Amartya Rej — Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen

The production of top quarks with photons gives access to measure the strength of the electroweak coupling of the top quark and the photon. While the production of top quark pairs ($t\bar{t}$) with one photon is being extensively studied, the $t\bar{t}$ production in association with two photons ($t\bar{t}\gamma\gamma$) has not been observed yet. The $t\bar{t}\gamma\gamma$ is a rare process and not only is it a good candidate for probing the top EW coupling but is also relevant as an irreducible background process to $t\bar{t}$ production in association with a Higgs boson decaying to two photons ($H \to \gamma\gamma$). Besides, new sources of CP-violation are expected from physics phenomena beyond the SM. These sources can appear as electric dipole moment terms in top-quark interactions, and their precise measurement is essential to determine the effects of new physics. Understanding the $t\bar{t}\gamma\gamma$ process can help put better bounds on top-quark dipole moments.

The cross-section of the process is expected to be of the order of 10 fb at $\sqrt{s} = 13$ TeV, much lower than the $t\bar{t}\gamma$ process. The presentation will discuss the ongoing efforts in the search for the process in semileptonic $t\bar{t}$ decay channel using the full Run 2 dataset collected by ATLAS detector at 13 TeV.