T 28: Top quark production II

Time: Tuesday 16:00–18:30 Location: Tc

T 28.1 Tue 16:00 Tc

Measurements of differential cross sections for $t\bar{t}$ production at $\sqrt{s}$ = 13 TeV with the CMS experiment — Maria Aldaya, Olaf Behnke, •Henriette Petersen, Mykola Savitskyi, Rafael Sosa, and Sebastian Wuchterl — Deutsches Elektronen Synchrotron (DESY)

Precision tests of the Standard Model are of utmost importance in particle physics, not only in order to test existing theories but also to probe the realm of new physics. The top quark is of particular interest in this context, as its heavy mass can link it to production- and decay-modes of new processes at higher energy scales. In this talk measurements of differential cross sections for $t\bar{t}$ production at $\sqrt{s} = 13$ TeV will be presented. The analysis is based on data obtained with the CMS experiment during 2016, 2017 and 2018 in Run 2 of the LHC, corresponding to an integrated luminosity of 137 fb^{-1}. In this period of time more than 100 million pp collisions with a $t\bar{t}$ pair in the final state have occurred, and therefore, Run 2 facilitates unprecedented precision in measurements of kinematic spectra and topologies in these events. The analysis is performed using the dileptonic decay channel. We perform differential measurements of the $t\bar{t}$ production cross section in bins of kinematic properties of the visible decay products, $t\bar{t}$ system and top quark. In this talk the general analysis strategy will be presented. This includes an overview of the event selection, kinematic reconstruction of the $t\bar{t}$ system, cross section unfolding procedure and results for full Run 2 differential cross sections compared to MC predictions based on NLO QCD models matched to parton showers.

T 28.2 Tue 16:15 Tc

Measurement and EFT interpretation of the $t\bar{t}$ cross section in the boosted lepton+jets channel with the ATLAS detector at $\sqrt{s}$ = 13 TeV — Johannes Erdmann, Kevin Kröninger, and •Kevin Sedlaczek — TU Dortmund University, Dortmund, Germany

Physics beyond the Standard Model (SM) can, in absence of resonances, be investigated in a model-independent way by using effective field theory (EFT) approaches. Without assumption of the underlying theory, effects of potential new particles at a low energy scale can be quantified by higher dimension expansions of the SM Lagrangian at a much higher energy scale.

At the LHC, physics in the top sector is entering a phase of precision measurements combined with very accurate predictions. Meanwhile, many theories beyond the SM predict deviations in the top couplings or new interactions coupling to the top quark. These aspects combined make model-independent measurements in the top sector a very attractive way to test the SM for deviations arising from new physics at higher energy scales.

In this talk, studies on a differential $t\bar{t}$ cross-section measurement are shown. The analysis is performed in the boosted lepton + jets channel on the full Run 2 dataset taken with the ATLAS detector at $\sqrt{s} = 13$ TeV. The EFT framework is used to derive bounds on the contributions of new physics via two EFT operators. The choice of variables for the unfolded differential distributions on basis of their sensitivity to the EFT operators as well as first simulation-based studies are presented.

T 28.3 Tue 16:30 Tc

Measurement of the $t\bar{t}$ production cross-section in the lepton+jets channel at $\sqrt{s} = 13$ TeV with the ATLAS experiment — •Baida Achkar[1], Tomas Dado[1,2], Jacopo Magro[3], Kevin Moor[1], Clara Nellist[1,4], Marcel Niemeyer[1], Arnulf Quadt[1], Leonid Serkin[5], and Elizaveta Shabalina[1] — [1]II. Physikalisches Institut, Georg-August-Universität Göttingen — [2]now at: Technische-Universität Dortmund — [3]Università di Udine/INFN — [4]now at: Radboud University Nijmegen/Nikhef — [5]ICTP Trieste/INFN

Studies of top-quark production and decays provide a precise probe of the Standard Model (SM) as well as its extensions. At the CERN Large Hadron Collider, top quarks are primarily produced in quark–antiquark pairs ($t\bar{t}$) and form an important background in many searches for physics beyond the SM. This talk reports ATLAS measurements of the $t\bar{t}$ cross-sections in the full phase space (inclusive) and in a phase space close to the experimental measurement range (fiducial) at $\sqrt{s} = 13$ TeV, using the full pp data set collected during 2015–2018 which corresponds to an integrated luminosity of $\mathcal{L} = 139$ fb^{-1}. Events with exactly one charged lepton and four or more jets in the final state, with at least one jet containing b-hadrons are used to measure the $t\bar{t}$ cross-section through a profile-likelihood fit to data of the distributions of discriminating variables in three non-overlapping regions. The $t\bar{t}$ fiducial cross-section is measured with a precision of 4.3% to be: $\sigma_{\text{fid}} = 110.7 \pm 4.8$ pb. The inclusive cross-section is measured with a precision of 4.6% to be: $\sigma_{\text{inc}} = 830 \pm 38$ pb. Results agree with the theoretical calculations at NNLO in QCD.

T 28.4 Tue 16:45 Tc

Systematic-aware top-quark pair reconstruction with deep learning — Tomas Dado, Johannes Erdmann, •Lars Kolk, and Olaf Nackenhorst — TU Dortmund University

The top quark plays a unique role in the Standard Model of particle physics as it is the most massive of all known elementary particles. Due to its large Yukawa coupling, a precise measurement of its properties is crucial in order to search for hints for physics beyond the Standard Model. Since the average lifetime of a top quark is smaller than the hadronisation timescale, it decays before it can form a bound state.

In the Standard Model, the top quark almost exclusively decays into a bottom quark and a W-boson. The W-boson can then either decay into a charged lepton and its respective neutrino or into an up- and a down-type quark. In this work, $t\bar{t}$ production with one charged lepton in the final state is studied, which results in four jets, two of which are b-jets, at leading order. In order to calculate the four momenta of the top quarks, the detected jets must be assigned to the final state particles of the hard scattering process, using the kinematic properties of the decay products. This process is called $t\bar{t}$ reconstruction.

Deep Neural Network (DNN) have shown to outperform commonly used algorithms in $t\bar{t}$ reconstruction with one charged lepton in the final state (J. Erdmann et al 2019 JINST14 P11015). In this work, the DNN approach is modified in order to minimise the impact of modelling uncertainties, which many top quark analyses suffer from. Initial studies of the top quark reconstruction using DNNs using Monte Carlo simulated samples are presented.

T 28.5 Tue 17:00 Tc

Jet activity measurement in top pair productions in dilepton channel with the ATLAS experiment — •Matthieu Robin — DESY, Zeuthen

The subject of this talk is the $t\bar{t} + jets$ measurement with the ATLAS detector.

This measurement allows to challenge the understanding of physics phenomena described by a robust theory (QCD), thus providing the necessary feedback to theorists to fine-tune the approximations and parameters used to perform the simulations of these phenomena and continue to further improve the precision one can reach. Achieving precision is indeed important for other analyses regarding the understanding and rejection of their QCD background (e.g.: $t\bar{t}H(H \to b\bar{b})$).

This study uses the full LHC run II dataset of 139 fb^{-1} to improve the results in statistically limited regions as well as method to better estimate and/or reject our signal backgrounds such as fake lepton background and pile-up jets. In this talk updated data/MC comparisons will be shown using updated b-tagging and jet reconstruction algorithms with some unfolded results and an emphasis on PU study that I performed with the help of the $t\bar{t} + jets$ analysis team of ATLAS.

T 28.6 Tue 17:15 Tc

Measurement of the dileptonic $t\bar{t}$ differential cross section in a BSM phase space at CMS — Lutz Feld, •Danilo Meuser, Johannes Schulz, 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). Although the dileptonic channel has the lowest branching ratio of all $t\bar{t}$ decay channels, its sensitivity is large due to small contributions from other SM processes.

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 137.2 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.

T 28.7 Tue 17:30 Tc

Constraining Effective Field Theory with $t\bar{t}\gamma$ events using ATLAS data at $\sqrt{s}$ = 13 TeV — •Binish Batool, Carmen Diez Pardos, and Ivor Fleck — Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen

The study of the production cross section of top anti-top quark pairs in association with a photon ($t\bar{t}\gamma$) probes the electroweak coupling of top quark and photon. The ATLAS detector at the Large Hadron Collider (LHC) has recorded data at the centre-of-mass energy of $\sqrt{s}$ = 13 TeV in Run 2, corresponding to an integrated luminosity of 139 fb^{-1}, which provides an opportunity to search for possible deviations from the Standard Model. These deviations can be interpreted in the context of model independent approaches, such as Effective Field Theories. The production cross section of $t\bar{t}\gamma$ is expected to be sensitive to three dimension-six operators, namely O_{tG}, O_{tB} and O_{tW}. In this talk, the sensitivity of the total and differential $t\bar{t}\gamma$ cross sections to those three operators is investigated and expected limits for the full Run 2 data from ATLAS at $\sqrt{s}$ = 13 TeV are provided.

T 28.8 Tue 17:45 Tc

Determination of Background from Misreconstructed Electrons in $t\bar{t}\gamma$ topologies with the ATLAS detector — Ivor Fleck, •Buddhadeb Mondal, and Carmen Diez Pardos — Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen

An effort is ongoing on measuring inclusive and differential cross-sections of the $t\bar{t}\gamma$ production in pp collision at $\sqrt{s}$ = 13 TeV with 139 fb^{-1} data collected by the ATLAS detector at CERN. One of the background sources comes from the misidentification of electrons as photons ($e \to \gamma$ fake). This happens mainly due to tracking inefficiency or failure to find a match between inner detector track and electromagnetic cluster. The $e \to \gamma$ fakes are not well described by Monte Carlo simulations. In this talk, a method to estimate the $e \to \gamma$ fake based on data using a "tag and probe" approach with $Z \to e^+e^-$ events will be presented.

T 28.9 Tue 18:00 Tc

Measurement of $t\bar{t} + \gamma$ production with full Run 2 data — •Andreas Kirchhoff, Arnulf Quadt, Elizaveta Shabalina, and Knut Zoch — 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 come from the decay products of the top quarks and hence have nothing to do with 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 will be presented with some first studies that use deep neural networks to enhance the sensitivity to the top-photon coupling.

T 28.10 Tue 18:15 Tc

Measurement of multi-differential cross sections for the production of top quark pairs plus additional jets in pp collisions at sqrt(s)=13TeV. — •Rafael Eduardo Sosa Ricardo, Maria Aldaya, Olaf Behnke, Henriette Petersen, Mykola Savitskyi, and Sebastian Wuchterl — DESY

Measurements of multi-differential cross sections for top quark pair ($t\bar{t}$) production in pp collisions at a center-of-mass energy of 13 TeV using events containing two opposite-sign leptons will be presented. The analyzed dataset was recorded with the CMS detector in during the years 2016, 2017 and 2018, corresponding to an integrated luminosity of $137 fb^{-1}$. The $t\bar{t}$ cross sections are measured double and triple-differentially as a function of the $t\bar{t}$ system kinematics, the top quark, and of additional jets in the event.

This talk comprises an overview of the analysis starting with the event selection, kinematic reconstruction of the $t\bar{t}$ system, and the cross section unfolding procedure. First cross section results will be compared to MC predictions based on NLO QCD matched to parton showers.