T 8: Top quark production I

Time: Monday 16:00–18:30 Location: Th

T 8.1 Mon 16:00 Th

Measurement of the Single-Top production cross section in the s-channel at $\sqrt{s}$=13 TeV with the ATLAS detector — •Ken Kreul — Humboldt Universität zu Berlin

The production of single top-quarks in electroweak processes (Single-Top) is an important part for the study of the Standard Model and possible extensions. Single-Top production is possible in three channels: t-channel, s-channel and via associated production of a W-boson. In proton-proton collisions at the Large Hadron Collider (LHC), the s-channel has the lowest production cross section and is dominated by many background processes. During the LHC run at 8 TeV, the s-channel was already observed with a significance of 3.2σ using the Matrix Element Method. In this method, the matrix elements for the most important signal and background processes are integrated over the available phase space to compute process likelihoods, which can then be combined to a discriminant. The method is now applied to current ATLAS data at $\sqrt{s}$=13 TeV to improve the previous result using the higher luminosity of up to 139 fb^{-1}.

T 8.2 Mon 16:15 Th

Measurement of the t-channel single top-quark production cross-section in proton-proton collisions at a centre-of-mass energy of 13 TeV with the ATLAS detector — Olga Bessidskaia Bylund, Dominic Hirschbühl, •Joshua Reidelstürz, Mohsen Rezaei Estabragh, and Wolfgang Wagner — Bergische Universität Wuppertal, Wuppertal, Deutschland

The measurement of the single top-quark t-channel production cross sections σ_{tq} and $\sigma_{\bar{t}q}$ and their fraction R_t as well as the total cross section $\sigma_{tq,\bar{t}q}$ is presented. These measurements provide a precise test of the standard model and are sensitive to new-physics phenomena by probing the properties of the Wtb vertex and placing limits on the CKM matrix element $|V_{tb}|$. Data taken with the ATLAS detector from 2015 to 2018 corresponding to an integrated luminosity of $\mathcal{L} = 139\,\mathrm{fb}^{-1}$ at a center-of-mass energy of 13 TeV is analyzed using corresponding samples of simulated events. Requirements are applied to the data selecting events with the signature expected for the signal process. To further enhance the separation between signal and background events a neural network is trained using the Monte Carlo simulated data combining several kinematic variables. The neural network output distribution is then used in a binned profile maximum likelihood fit including all systematic uncertainties to determine the cross sections.

T 8.3 Mon 16:30 Th

Sensitivity studies of differential cross-sections of t-channel single-top-quark production on physics beyond the standard model parameterised by effective field theories — •Mohsen Rezaei Estabragh[1], Wolfgang Wagner[1], Dominic Hirschbuehl[1], Joshua Aaron Reidelsturz[1], and Olga Bessidskaia Bylund[2] — [1]Bergische Universität Wuppertal, Wuppertal, Germany — [2]University of Paris-Saclay

Unique features of the top quark such as its large mass and its decay before hadronisation, providing access to spin information via its decay products, make the top quark a fascinating object of many high energy physics studies, including searches for physics beyond the standard model (BSM). The aim of this study is to consider the sensitivity of t-channel single top-quark production to BSM physics, parameterised in a model-independent way via higher dimension operators in the framework of effective field theory (EFT).

At leading order three EFT operators contribute to $t-channel$ single top-quark production. The presented study investigates the impact of these operators on differential production cross-sections. The operator $O_{\Phi q}^{(3)}$ modifies the magnitude of the Wtb vertex, while $O_{qq}^{(1,3)}$ affects angular distributions of top-quark production. The operator O_{tW} mainly impacts the decay of top quarks.

T 8.4 Mon 16:45 Th

Search for single production of top quarks in association with a photon with the ATLAS detector at $\sqrt{s} = 13$ TeV — •Björn Wendland, Johannes Erdmann, and Kevin Kröninger — TU Dortmund, Experimentelle Physik IV

Analyses of top quark production in association with a photon are important tests of the Standard Model as top quark properties with respect to the electroweak interaction such as the top quark charge or the structure of the top quark and photon vertex can be probed. Top quark pair production with a photon in leptonic final states was observed and investigated extensively by the ATLAS and CMS collaborations. No significant deviations from the Standard Model expectations were found by now.

With the rich datasets collected by the ATLAS and CMS experiments during Run 2 of the LHC programme, it is feasible to observe single production of top quarks in association with a photon. The CMS collaboration reported evidence corresponding to $4.4\,\sigma$ for this process using a partial Run 2 dataset.

In this talk, studies of t-channel single production of top quarks with a photon using the full Run 2 dataset collected by the ATLAS detector are presented. As the leptonic decay channel of the top quark is used in this analysis, the final state consists of either an electron or a muon, a jet containing B hadrons, missing transverse energy, a photon and an additional jet produced in forward direction.

T 8.5 Mon 17:00 Th

Differential Measurement of the Associated Production of a Single Top Quark and a Z Boson at the CMS Experiment — •David Walter, Abideh Jafari, and Nicolas Tonon — DESY, Hamburg, Germany

The top quark is the heaviest particle of the standard model (SM) and can be produced through strong interactions in top quark-antiquark pairs, or polarised as a single top quark (or antiquark) via the electroweak interaction. The associated production of a single top quark and a Z boson (pp $\rightarrow$ tZq) includes the tZ coupling as well as the coupling of three vector bosons (WWZ) and is therefore a unique process to study the couplings of heavy particles in the SM. As early as 2018, the CMS Collaboration observed the production of tZq in its final state with three leptons. It was found to be in agreement with the SM prediction.

In an ongoing analysis, a differential tZq cross section measurement is being carried out. This can give more detailed insight into the modeling of the process in the SM while some of the distributions are also sensitive to beyond-SM effects. The analysis makes use of 137 fb^{-1} of pp collision data, collected at the LHC with the CMS experiment at a center of mass energy of $\sqrt{s} = 13$ TeV. A full event reconstruction is performed and multivariate analysis techniques are exploited to isolate the signal from various background contributions. A maximum likelihood based unfolding is performed to extract the differential cross section at parton level and to correct for detector effects and hadronization effects.

T 8.6 Mon 17:15 Th

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, Elizaveta Shabalina, and Knut Zoch — II. Physikalisches Institut, Georg-August-Universität Göttingen

Through the associated production of the $t\bar{t}Z$ process, the strength and structure of the coupling of the top quark and the Z boson can be measured which provides sensitivity to the top quark's weak isospin in 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 first observed by CMS and first measured by ATLAS at $\sqrt{s} = 8$ TeV by considering $t\bar{t}W$ and $t\bar{t}Z$ processes simultaneously, and later measured with increased precision at $\sqrt{s} = 13$ TeV by both experiments. The effect of deep neural networks (DNN) on the sensitivity of a refined analysis using $139\,\mathrm{fb}^{-1}$ is investigated and presented within a measurement of the inclusive cross section in $t\bar{t}Z$ final states. The analysis selects event with three charged leptons in proton-proton collisions data, taken between 2015 and 2018 with the ATLAS detector.

T 8.7 Mon 17:30 Th

Differential cross-section measurement of the tZq process with the ATLAS detector — •Nilima Akolkar and Ian Brock — Physikalisches Institut, Universität Bonn

The associated production of a single top-quark with a Z-boson (tZq) is a rare process that has been discovered by the CMS and ATLAS Collaborations. This process is of a special interest, as it allows to probe the couplings of the Z-boson to the quark sector and W-boson simultaneously.

This talk will focus on the differential cross-section measurement of the tZq production, analyzed in the trilepton decay channel. The data used were collected with the ATLAS detector during Run 2 of the LHC, corresponding to an integrated luminosity of 139 fb^{-1}. The differential cross-section is measured using unfolding and the preliminary results will be presented.

T 8.8 Mon 17:45 Th

Measurement of the tZq cross section in events with two leptons — •Federica Cecilia Colombina — Windmühlenweg 27, 22607 Hamburg, Germany

In the years 2016-2018 the CMS Experiment at CERN's Large Hadron Collider (LHC) recorded a large amount of proton-proton collision data at a centre-of-mass energy of 13 TeV, corresponding to an integrated luminosity of 137 inverse fb. In this work, events in which a single top quark is produced in association with a Z-boson are investigated. Particular focus is on final states in which two leptons originate from the Z boson and the top quark decays hadronically. The discrimination between signal and backgrounds is optimized by testing different methods for the event reconstruction in conjunction with a Deep Neural Network (DNN). It is shown that the use of jet kinematics that are associated with the particles in the final state improves the performance over cases where the event reconstruction information is not used. A statistical fit is then performed to the DNN output, reaching an expected signal significance for tZq events of 2.4 standard deviations. Further optimization of the analysis, e.g. by use of additional control regions, is being studied.

T 8.9 Mon 18:00 Th

Measurement of highly boosted W-boson-associated single top quark production using the CMS detector — •Christopher Matthies, Paolo Gunnellini, Johannes Haller, Roman Kogler, and Matthias Schröder — Institut für Experimentalphysik, Universität Hamburg

A cross-section measurement of the associated production of a single top quark and a W boson (tW) in boosted ℓ+jets final states in pp collisions at $\sqrt{s} = 13\,\text{TeV}$ with the CMS experiment is presented. Boosted hadronic decays of both the W boson or the top quark are reconstructed as large-radius jets using the HOTVR algorithm for the first time. Deep learning techniques are employed to discriminate tW from top quark pair production and other background processes. It is shown that a measurement up to a transverse momentum of about 1 TeV of the top quark or associated W boson is feasible, extending the phase space covered by previous measurements considerably.

T 8.10 Mon 18:15 Th

Using Machine Learning Techniques to Probe the Interference Between tW and $t\bar{t}$ — •Federico G. Diaz Capriles and Ian C. Brock — Physikalisches Institut, Bonn

The production of two W-bosons in conjunction with two b-quarks ($WWbb$) is not only the signature of top-quark pair production ($t\bar{t}$) but also single top-quark production in association with a W-boson (tW) at the next-to-leading-order. The modeling difficulty of the interference between these two processes becomes a significant systematic uncertainty in a differential cross-section measurement.

A machine learning approach is used in order to study the interference in depth. The network is trained to pick out differences between a mixed Monte Carlo sample of tW and interference against a Monte Carlo sample of only tW. The resulting classifier is expected to differentiate between interference-like and tW-like events. This classification can aid in the scrutiny of the modeling of the interference-inclusive Monte Carlo.