T 51: Top Physics III (Cross Sections, Entanglement)

Time: Wednesday 16:15–18:15 Location: VG 1.103

T 51.1 Wed 16:15 VG 1.103

Measurement of the $t\bar{t}$ cross-section in the lepton+jets channel using pp collision data at $\sqrt{s}$ = 13.6 TeV with the ATLAS experiment — •Noah Scheugenpflug and Andrea Knue — TU Dortmund

In this contribution, the measurement of the top-quark pair production cross-section in the lepton+jets channel for proton-proton collision data at $\sqrt{s}$ = 13.6 TeV is studied. The data was recorded with the ATLAS detector at the LHC in 2022 and corresponds to an integrated luminosity of 29 fb-1. The cross-section is extracted using a profile likelihood fit. The configuration of the fit is validated by performing an Asimov fit. Events with exactly one electron or muon, at least four jets, with one or two of the jets being b-tagged, and missing transverse momentum are selected and divided into three signal regions according to their jet and b-tagged jet multiplicities. For each region, the signal-to-background separation power of a multitude of kinematic variables is studied. A selection of these variables is analyzed with respect to systematic uncertainties. The uncertainty is dominated by the luminosity and the $t\bar{t}$ signal modelling uncertainty.

T 51.2 Wed 16:30 VG 1.103

Observation of top-quark pair production in lead-lead collisions in the ATLAS experiment at the LHC — Anthony Badea[1], Weronika Bulanowska[2], Iwona Grabowska-Bołd[2], Santu Mondal[3], •Patrycja Potepa[2,4], and Matthias Schott[4] — [1]Harvard University, United States — [2]AGH University of Krakow, Poland — [3]Czech Technical University in Prague, Czech Republic — [4]Johannes Gutenberg University Mainz, Germany

In relativistic heavy-ion collisions, top quarks are expected to be attractive candidates for probing the quark-gluon plasma as well as to bring unique information about the time evolution of strongly interacting matter. We report the first observation of top-quark pair production in lead-lead collisions at the centre-of-mass energy of 5.02 TeV in the ATLAS experiment at the LHC. The dataset was recorded in 2015 and 2018, amounting to an integrated luminosity of 1.9 nb^{-1}. Top-quark pair production is measured in the $e\mu$ channel, with a significance of 5.0 standard deviations. The result is compared to theory predictions based on different nuclear PDF sets.

T 51.3 Wed 16:45 VG 1.103

Studies of top quark pair production with the CMS experiment in the dilepton decay channel including the boosted region — •Iakov Andreev and Olaf Behnke — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

We present an ongoing analysis of differential cross section measurements for top-pair ($t\bar{t}$) production in proton-proton collisions at a center-of-mass energy of 13 TeV, using events containing two oppositely charged leptons. The data were recorded with the CMS detector at the CERN LHC. We study kinematic distributions of the $t\bar{t}$ system, the top quark and antiquark and their decay products. For the first time in differential cross section measurements in the dilepton channel, the phase space includes events with highly boosted top quarks (with momenta above several hundred GeV). This phase space is characterised by small angular separations between the leptons and the b jets originating from the top quark decays. This necessitates the inclusion of non-isolated prompt muons and electrons in both the online trigger and the offline analysis. The talk presents the basic event selection and the adaptations made to include the region of boosted top quarks. Initial kinematic distributions are presented alongside estimates of signal and background processes.

T 51.4 Wed 17:00 VG 1.103

Towards the measurement of $t\bar{t}$ spin correlations using dilepton final states in pp collisions at $\sqrt{s}$ = 13 TeV with the ATLAS detector — Diptaparna Biswas[1], Beatrice Cervato[1], Markus Cristinziani[1], Carmen Diez Pardos[1], Ivor Fleck[1], Arpan Ghosal[1], Gabriel Gomes[1], Jan Joachim Hahn[1], Vadim Kostyukhin[1], Nils Krengel[1], Buddhadeb Mondal[1], Stefanie Müller[1], •Sebastian Rentschler[1], Elisabeth Schopf[1], Katharina Voss[1], Wolfgang Walkowiak[1], Adam Warnerbring[1], and Tongbin Zhao[1,2] — [1]Experimentelle Teilchenphysik, Center for Particle Physics Siegen, Universität Siegen — [2]Shandong University, China

The top quark is the heaviest known elementary particle and it decays before hadronizing. Consequently, measurements of the angular distributions of top quark decay products give access to the spin of the top quark, allowing the precise testing of perturbative QCD in the top quark- antiquark pair ($t\bar{t}$) production process. In this contributions first studies towards the measurement of the $t\bar{t}$ spin correlations are presented using the data collected using proton-protons collisions at a centre-of-mass energy of 13 TeV. The data correspond to an integrated luminosity of 140 fb^{-1} collected with the ATLAS detector. The measurements are performed using events with two oppositely charged leptons (electrons or muons) and two or more jets, where at least one of the jets is identified as originating from a bottom quark. The spin correlations are measured from the angular distributions of the two selected leptons.

T 51.5 Wed 17:15 VG 1.103

Measurement of $t\bar{t}$ spin entanglement in the lepton+jets channel in ATLAS — Katharina Behr, Eleanor Jones, and •Fiona Ann Jolly — DESY, Hamburg, Germany

The top quark, one of the heaviest known elementary particles, is mostly produced in pairs ($t\bar{t}$) at the LHC. These $t\bar{t}$ final states are sensitive to characteristic quantum effects such as quantum entanglement of $t\bar{t}$ spins. One of the kinematic regions most sensitive to entanglement is characterised by low values of the invariant mass of the $t\bar{t}$ system, just above the kinematic 'turn-on' for $t\bar{t}$ production ($m_{t\bar{t}} \geq 2m_t$) The presence of entanglement is probed via a high-precision measurement of an angular variable sensitive to the $t\bar{t}$ spin correlation in this region.

In this talk, sensitivity studies for using the lepton+jets $t\bar{t}$ decay channel for quantum entanglement measurements in the $m_{t\bar{t}}$ threshold region are presented. The calculation of the relevant angular variable relies on the identification of the down-type quark jet coming from the W boson decay, which has the highest spin-analysing power among the hadronic top quark decay products. Furthermore, the potential effects of a possible $t\bar{t}$ quasi-bound state in the turn-on region, known as "toponium", are discussed.

T 51.6 Wed 17:30 VG 1.103

Quantum Entanglement in Top Quark Pairs in the Lepton + Jets Channel Using Boosted Topologies — •Jannis Vornholt and Andrea Knue — TU Dortmund

Quantum entanglement, a fundamental prediction of quantum mechanics, had been experimentally observed with electrons and photons, earning recognition through the 2022 Nobel Prize in Physics. At the LHC, this phenomenon had been observed in top quark pairs at production threshold in 2023, providing a high-energy test of quantum mechanics. A test of quantum entanglement of top quark pairs is also possible at high $m_{t\bar{t}}$ at the LHC and is the topic of this talk. The lepton + jets channel is considered, whereby the hadronically decaying top quark is reconstructed as a large radius jet.
The angle between the decay products of the top quarks can be used as indicator for quantum entanglement. First reconstructed properties are discussed.
The presented studies are performed with ATLAS Monte Carlo simulations under Run 2 conditions.

T 51.7 Wed 17:45 VG 1.103

Measurement of the differential t-channel production cross-section of single top quarks and top antiquarks in proton-proton collisions at 13 TeV using the full Run 2 dataset recorded with the ATLAS detector — Dominic Hirschbühl, Lukas Kretschmann, •Maren Stratmann, and Wolfgang Wagner — Bergische Universität Wuppertal, Wuppertal, Deutschland

The t-channel production is the dominant process for single top quark and single top antiquark production at the LHC. The measurement of the differential cross section can contribute to constraining proton PDFs and has not been measured with the full Run 2 dataset up to date. This measurement uses the full Run 2 dataset recorded with the ATLAS detector in the years 2015-2018. The differential production cross-sections of the top-quark and top-antiquark as well as their ratio are measured on parton level as a function of the transverse momentum

p_T and rapidity $|y|$ of the top quark.

T 51.8 Wed 18:00 VG 1.103

Measurement of differential cross sections in the process $pp \to W^+W^-b\bar{b}$ — Daniel Britzger[1], •Johannes Hessler[1,2], and Stefan Kluth[1] — [1]Max Planck Institute for Physics, Garching, Germany — [2]Technical University Munich, Garching, Germany

Precise measurements of differential cross sections in the process $pp \to W^+W^-b\bar{b}$ offer an outstandingly rich physics potential at highest precision. Although the process is theoretically and experimentally well defined, dedicated measurements of $W^+W^-b\bar{b}$ production cross sections were not (extensively) performed in the past at the LHC. We will report on ongoing measurements in the single-lepton channel with Run-II data taken by the ATLAS experiment. The analysis comprises three signal regions, focusing on the interference between $t\bar{t}$ and tW processes, the explicit reconstruction of the kinematics of the $WbWb$ system and on phase spaces motivated by BSM searches.