T 7: Top Quarks: Properties 1

Time: Monday 16:15–18:15 Location: T-H20

T 7.1 Mon 16:15 T-H20

Measurement of the top quark pole mass using $t\bar{t}$+1 jet events with the CMS experiment — •Sebastian Wuchterl[1], Katerina Lipka[1], and Matteo Defranchis[2] — [1]Deutsches Elektronen Synchrotron (DESY) — [2]CERN

The top quark is the most massive elementary particle known. Its mass, m_t, is a fundamental parameter of the Standard Model (SM), and its value needs to be determined experimentally. A precise measurement of m_t and the masses of the W and Higgs bosons play a crucial role in precision tests of the SM. Additionally, the value and the uncertainty of m_t are driving predictions for the energy dependence of the Higgs quartic coupling, which determines the stability of the electroweak vacuum. In proton-proton collisions at the LHC, top quark-antiquark ($t\bar{t}$) production can be used to extract m_t in different renormalization schemes.

In this work, the pole mass of the top quark is measured using events in which the $t\bar{t}$ system is produced in association with one additional jet. This analysis is performed using proton-proton collision data collected by the CMS experiment in 2016-2018 with $\sqrt{s} = 13$ TeV, corresponding to a total integrated luminosity of 138 fb^{-1}. Events with two opposite-sign leptons in the final state are analyzed to measure the normalized differential cross section as a function of the inverse of the invariant mass of the $t\bar{t}$+1 jet system. This observable has been chosen due to strongest sensitivity to m_t at the threshold of the $t\bar{t}$ pair production.

T 7.2 Mon 16:30 T-H20

Measurement of the jet mass distribution in hadronic decays of boosted top quarks and determination of the top quark mass with CMS — •Alexander Paasch[1], Johannes Haller[1], Roman Kogler[2], and Dennis Schwarz[3] — [1]Institut für Experimentalphysik, Universität Hamburg — [2]DESY, Hamburg — [3]Austrian Academy of Sciences, Vienna

The top quark is the heaviest known elementary particle. Due to its high mass it plays an important role in the electroweak sector of the Standard Model and the measurement of its properties is of special interest. In contrast to conventional top quark mass measurements, we provide an analysis in the boosted regime. At these high energies, the top quark decay products are collimated and are clustered into a single large-radius jet with a mass sensitive to the top quark mass.

In this talk, we present the measurement of the jet mass distribution and top quark mass in hadronic decays of boosted top quarks, using 137 fb^{-1} of data collected by the CMS experiment during the LHC Run-2. New techniques such as a refined calibration of the jet mass scale and improving the description of the final state radiation through a measurement of jet substructure variables substantially increase the precision compared to earlier analyses. The result represents a large step towards the precision observed in measurements at threshold production.

T 7.3 Mon 16:45 T-H20

Measurement of the top-quark mass in $t\bar{t}$ events using the template method in the lepton+jets channel with the ATLAS detector — •Dimbiniaina Rafanoharana and Andrea Knue — Albert-Ludwigs-Universität Freiburg

The top-quark mass is a fundamental parameter of the Standard Model (SM). Its precise determination is therefore crucial to test the consistency of the SM. A multitude of measurements was performed at the Tevatron and the LHC using different methods and final states.

The combination of the ATLAS measurements at $\sqrt{s} = 7$ TeV and at $\sqrt{s} = 8$ TeV has a relative overall uncertainty of 0.28% and a relative statistical uncertainty of 0.14%. The measurement precision is therefore limited by the understanding of systematic effects.

In this presentation, an investigation of the systematic effects in the top-quark mass measurement using the template method in $t\bar{t} \to$ lepton+jets channel at $\sqrt{s} = 13$ TeV is shown. The studies are performed using different observables sensitive to the top-quark mass as well as different event selections, aiming at reducing the overall uncertainty.

T 7.4 Mon 17:00 T-H20

Neural network based estimators to measure the top quark mass — Christoph Garbers, Johannes Lange, •Nathan Prouvost, Peter Schleper, and Hartmut Stadie — Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg

The top quark is the heaviest known particle in the Standard Model. As such, the top quark mass is an important parameter for constraining and checking the validity of Standard Model predictions. In the semileptonic decay channel, a value of the top quark mass of 172.25 ± 0.63 GeV has been measured with 35 fb^{-1} of the 2016 data at the CMS experiment. The mass of the top quark from a kinematic fit and the reconstructed mass of the W boson are used as variables. It is expected that adding more variables will improve the measurement. This presentation focuses on the development of neural network based estimators of the top quark mass using nuisance parameters for the systematics and multiple observables.

T 7.5 Mon 17:15 T-H20

Measurement of the top quark width from Wb scattering — Thorsten Chwalek[1], Matteo Defranchis[2], Nils Faltermann[1], Jan Kieseler[2], Matthias Komm[2], •Marco Link[1], Martijn Mulders[2], Thomas Müller[1], Michael Pitt[2], and Pedro Silva[2] — [1]Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT) — [2]CERN

The top quark is the heaviest elementary particle in the standard model (SM). As such it is especially interesting to search for hints of physics beyond the standard model (BSM). Current measurements of the top quark decay width make strong assumptions on the branching ratio of the top quark into a W boson and a bottom quark (Wb).

This talk explores the possibility of the model independent measurement of the top quark decay width in Wb→Wb scattering via a top quark propagator at the CMS experiment. Generator level studies are used to develop reconstruction methods for the Wb system. In combination with a measurement of the single top cross section this measurement could be sensitive to effects from BSM physics. Given the limited size of the current data set and the small cross section of the signal process, the measurement will be interesting with the increase of data expected during HL-LHC data taking.

T 7.6 Mon 17:30 T-H20

Measurement of top-quark pair spin correlation in the ℓ + jets channel using the ATLAS experiment — •Oleksandr Burlayenko, Andrea Knue, and Zuzana Rurikova — Albert-Ludwigs Universität Freiburg, Experimentelle Teilchenphysik AG Herten

The top quark is the heaviest known fundamental particle and has a lifetime on the order of 10^{-25} s. This lifetime is shorter than the quantum chromodynamic (QCD) hadronization time scale $1/\Lambda_{QCD} \approx 10^{-24}$ s, and much shorter than the spin decorrelation time scale $m_t/\Lambda^2_{QCD} \approx 10^{-21}$ s. This gives an opportunity to study the spin properties of a bare quark, as top-quark spin information is preserved in the angular distribution of its decay products.

The Standard Model predicts the $t\bar{t}$ pairs to have correlated spins. The degree of the this correlation is sensitive to the production mechanism of the top quark. The ATLAS collaboration measured it at 13 TeV in the dilepton channel. In this measurement, a discrepancy between the predicted and observed results was found.

This work presents ongoing studies of the $t\bar{t}$ spin correlation in the lepton + jet channel at $\sqrt{s} = 13$ TeV. While this channel provides a larger dataset to study, the analyzing power is reduced compared to the dilepton channel. In this talk, first studies will be presented including different event selections and different observables for this final state.

T 7.7 Mon 17:45 T-H20

Extracting top-Yukawa coupling from $t\bar{t}$ cross-section using ATLAS data — •Supriya Sinha — DESY, Hamburg and Zeuthen, Germany

This work aims to extract the top-Yukawa coupling (Y_t) from $t\bar{t}$ cross section close to the threshold. In order to achieve this, one can use the kinematic distributions in $t\bar{t}$ production along with the virtual Higgs boson loop correction. This boson exchange modifies the differential distributions near $t\bar{t}$ production threshold energy. It becomes highly sensitive to Y_t, and hence, is used to extract its value.

This talk introduces the involved physics processes and gives an in-

sight to the analysis strategy. The decay channel considered for the analysis is the lepton+jets final state. Full Run-II data with the integral luminosity of 139 fb^{-1} taken from the ATLAS experiment at 13 TeV, is used.

T 7.8 Mon 18:00 T-H20

Sensitivity studies for the measurement of the top-Yukawa coupling using four-top final states — Arnulf Quadt, Elizaveta Shabalina, and •Sreelakshmi Sindhu — II. Physikalisches Institut, Georg-August-Universität Göttingen

The top quark is the heaviest particle in the Standard Model and hence a precise measurement of its properties is key to identifying evidence for physics beyond the Standard Model. One such property is the top-Yukawa coupling, which describes the strength of the interaction between the top quark and the Higgs boson. The production of four top quarks can be mediated by the Higgs boson, making this process highly sensitive to the top-Yukawa coupling. Various kinematic variables from the decay of the four top process in the trilepton and same-sign dilepton channels are studied to identify the observables that are most sensitive to the top-Yukawa coupling. To get better sensitivity, the top quarks are reconstructed to directly probe the properties of the top quark. The neural network is studied to further improve the sensitivity of the four top quark production to the top-Yukawa coupling. In this talk, a summary of these sensitivity studies will be presented.