T 29: Top quark decay and top properties I

Time: Tuesday 16:00–18:05 Location: Td

Group Report T 29.1 Tue 16:00 Td

Top quark mass measurements at the University of Hamburg with CMS — Christoph Garbers, Johannes Haller, Roman Kogler, Johannes Lange, Alexander Paasch, Peter Schleper, •Dennis Schwarz, and Hartmut Stadie — Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg

Being the heaviest particle that we know of, the top quark is of special interest in the Standard Model of particle physics. Its mass plays a crucial role in quantum loop corrections to the Higgs boson mass, and precise measurements of this fundamental parameter provide important tests of the theory. Ambiguities in the top quark mass scheme arise from the use of non-perturbative parton shower models in direct measurements that could be resolved by new analysis strategies.

In this talk, efforts of the CMS group of the University of Hamburg in the area of top quark mass measurements are presented, which include the most precise single direct measurement to date and an alternative approach using the jet mass of boosted hadronic top quark decays.

T 29.2 Tue 16:20 Td

Measurement of the top quark pole mass using $t\bar{t}$+1 jet events with the CMS experiment — Matteo Defranchis, Katerina Lipka, and •Sebastian Wuchterl — DESY, Hamburg

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. Therefore, a precision measurement of m_t, together with the masses of the W and Higgs bosons, allows for stringent tests of self-consistency of the SM. Furthermore, 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 ($t\bar{t}$) pair 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 $t\bar{t}$ pair is produced in association with one additional jet. This analysis is performed using proton-proton collision data collected by the CMS experiment at the LHC in 2016-2018 with $\sqrt{s} = 13$ TeV, corresponding to a total integrated luminosity of 137 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 29.3 Tue 16:35 Td

Measurement of the jet mass in decays of boosted top quarks using the full Run-2 dataset of the CMS detector — •Alexander Paasch, Johannes Haller, Roman Kogler, and Dennis Schwarz — Institut für Experimentalphysik, Universität Hamburg

Hadronic decays of boosted top quarks result in single large-radius jets. The mass of the jets is sensitive to the top quark mass. At the LHC, it is commonly used as a discriminator against jets originating from light quarks and gluons. For this reason, a measurement of the jet mass of boosted top quark decays is of special interest for both, studies of the Standard Model and searches for new physics.
In this talk, a measurement of the jet mass is presented using the full Run-2 dataset of the CMS experiment corresponding to a significantly larger statistics than an earlier result. In addition, the two dominant systematic uncertainties, namely the uncertainties related to final state radiation and the jet energy scale, are significantly reduced by measurements in dedicated control regions.

T 29.4 Tue 16:50 Td

A nuisance parameter fit for the top quark mass measurement — •Christoph Garbers, Peter Schleper, and Hartmut Stadie — Universität Hamburg, Hamburg, Germany

The top quark is the heaviest known particle in the standard model. It plays a crucial role in consistency checks of the Standard Model and in search for new physics.
In the $t\bar{t}$ to lepton+jets channel a top quark mass of 172.25±0.63 GeV was measured. With the 35.9fb^{-1} data recorded by CMS in 2016 this measurement was limited by systematic uncertainties, especially the correction of jet energies and the description of color reconnection in simulation.
A method to improve this measurement by inserting systematic uncertainties as nuisance parameters into a profiled likelihood fit with multiple additional observables will be presented.

T 29.5 Tue 17:05 Td

Measurement of the top quark mass in single top quark enriched events — •Soureek Mitra[1], Thomas Müller[1], Tariq Aziz[2], Sashi Dugad[2], Ravindrbabu Karnam[2], Mintu Kumar[2], and Gagan Mohanty[2] — [1]Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT), Karlsruhe, Germany — [2]Tata Institute of Fundamental Research (TIFR), Mumbai, India

The mass of the top quark (m_t) is one of the important parameters of the standard model (SM) of particle physics. It has the largest contribution to the radiative correction of the Higgs boson self-coupling among the SM particles; thus it is directly related to the stability of the electroweak vacuum. A measurement of m_t is presented in a sample enriched with single top quark events produced in the t channel, using 35.9 fb^{-1} of proton-proton collision data recorded at $\sqrt{s} = 13$ TeV by the CMS experiment in 2016. Candidate events are selected by requiring an isolated charged lepton (muon or electron), exactly two jets, and large missing transverse momentum. One of the jets is identified to originate from a bottom quark, whereas the other stems from the hadronization of a light-flavour quark. A multivariate discriminant is designed to separate signal from backgrounds and the selection criterion on the discriminant output is optimized to ensure an event sample with high signal purity. The masses of top quark and antiquark are measured separately based on the charge of the lepton in the final state, and their ratio and difference are determined as a test of the CPT invariance.

T 29.6 Tue 17:20 Td

Measurement of top quark charge asymmetry in $t\bar{t}\gamma$ production in the ATLAS experiment — Ivor Fleck, Carmen Diez Pardos, and •Amartya Rej — Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen

The top quarks and anti-top quarks produced via initial quarks at the LHC are emitted in slightly different directions depending on their charge, referred to as charge asymmetry (A_c). The asymmetry is due to QCD interference contributions at next-to-leading order accuracy and it is sensitive to New Physics models. Such asymmetry was observed at the Tevatron experiment, where quark anti-quark ($q\bar{q}$) annihilation was the dominant mode of $t\bar{t}$ production. The asymmetry is diluted at the LHC owing to the very large fraction of gluon fusion initiated $t\bar{t}$ production. However, recently its evidence has been found by the ATLAS experiment.

In $t\bar{t}$ production associated with a photon ($t\bar{t}\gamma$), the fraction of top quark pairs produced via $q\bar{q}$ annihilation increases compared to $t\bar{t}$ production and also leading order QED interference contributes to the charge asymmetry. Hence a larger value of charge asymmetry is expected to be found in this process with higher sensitivity to New Physics models. Still, this process has a tiny cross-section compared to $t\bar{t}$ production, one of the dominant background processes. Thus the background discrimination becomes challenging. In this presentation, the ongoing effort for the charge asymmetry measurement in $t\bar{t}\gamma$ production in the ATLAS experiment will be presented highlighting the analysis methods and related challenges.

T 29.7 Tue 17:35 Td

Top-antitop energy asymmetry in jet-associated top-quark pair production at ATLAS — •Alexander Basan[1], Asma Hadef[1], Lucia Masetti[1], Eftychia Tzovara[1], and Susanne Westhoff[2] — [1]Universität Mainz — [2]Universität Heidelberg

The top quark is particularly well suited to probe the standard model (SM) and many extensions thereof at the electroweak symmetry-breaking scale and beyond.

At hadron colliders, the $t\bar{t}$ production is symmetric at leading order perturbation theory under the exchange of the top- and anti-top-quark, while interferences at higher orders create an asymmetry. This charge

asymmetry can provide sensitive probes for many models beyond the standard model like massive color-octet states, extra dimensions, flavor violating gauge bosons and axigluons. Within the framework of effective field theories (EFT), the charge asymmetry is especially sensitive to four-quark operators and one operator that modifies the top-gluon interaction.

In inclusive jet-associated top-quark pair production the asymmetry arises already at leading order in quark-gluon interactions. Furthermore, the $t\bar{t}j$ final state allows the definition of a new observable, the energy asymmetry, expressed in terms of the distribution of the energy difference $E_t - E_{\bar{t}}$.

This talk presents the measurement strategy in lepton+jets events with a high p_T hadronically decaying top quark at ATLAS with a center of mass energy of $\sqrt{s} = 13\,\text{TeV}$ as well as expected sensitivities to the Wilson coefficients.

T 29.8 Tue 17:50 Td

Measurement of helicity fractions of W bosons decaying from top quarks in dileptonic $t\bar{t}$ events at $\sqrt{s} = 13$ TeV with the ATLAS detector. — Tomas Dado[1,2], Thomas Peiffer[1], •Ishan Pokharel[1], Arnulf Quadt[1], Elizaveta Shabalina[1], and Knut Zoch[1] — [1]II. Physikalisches Institut, Georg-August-Universität Göttingen — [2]now at: Technische Universität Dortmund

Due to the large difference between the top and b-quark masses, the W boson in the Wtb vertex is heavily polarised. A measurement of three helicity fractions of W bosons from top-quark decays is presented. They are extracted from the differential distribution of the observable $cos\theta^*$, defined as the angle between the charged lepton and the top quark in the W boson rest frame. The reconstructed $cos\theta^*$, distribution in the dilepton channel of $t\bar{t}$ events is unfolded to parton level. Event reconstruction is performed using the neutrino weighting algorithm, owing to the fact that two neutrinos need to be reconstructed from one measurement of missing transverse energy. The helicity fractions are extracted from the fit of the unfolded $cos\theta^*$ differential distribution to an analytical function that relates the observable to the helicity fractions of the W boson. The fractions are constrained to unity in the fit via Lagrange multiplier.