T 60: Top Quarks: Decay and CP Violation and Mixing Angles

Time: Wednesday 16:15–18:30 Location: T-H19

T 60.1 Wed 16:15 T-H19

Tagging of Boosted Leptonically Decaying Top Quarks Using Convolutional Neural Networks — •Hala Elhag, Soham Bhattacharya, and Isabell Melzer-Pellmann — DESY, Hamburg, Germany

The study of boosted top quarks is very important for probing a wide variety of new physics models. The use of machine learning techniques for tagging leptonically decaying boosted top quarks has not yet been explored as extensive as the hadronic decay channel. In this study, we utilize an image based machine learning technique for tagging highly boosted leptonically decaying top quarks. Jet images – representing the energies of jet constituents displayed in the form of a grid of pixels – are used as inputs to our convolutional neural network (CNN) based tagger. This talk will discuss the details of the jet formation, jet preprocessing and the CNNs, and a few promising preliminary results will be shown.

T 60.2 Wed 16:30 T-H19

Studies for the search for $t \to Zc$ transitions via interference effects — •Lucas Cremer, Johannes Erdmann, Roni Harnik, Jan Lukas Späh, and Emmanuel Stamou — TU Dortmund University, Department of Physics

Exclusion limits for anomalous flavour-changing neutral currents (FCNC) are typically set by searching for two-body decays of the top quark, which are quadratic in the new physics (NP) coupling. The limits are constantly improved by new data, but the sensitivity to small couplings could be enhanced by an alternative approach. This approach takes advantage of the interference between the FCNC and the Standard Model (SM) contributions. The focus of this work is to access the experimental feasibility of this idea.

Concretely we investigate the three-body decay $t \to b\bar{b}c$ in the presence of an anomalous $t-Z-c$ coupling. In the SM, this process proceeds through the emission of a W boson, while the FCNC diagram contains an intermediate Z boson. The two contributions interfere. The dominant contribution of the interference is in the restricted kinematic region in which both intermediate bosons are onshell. In this region, both the SM and the pure FCNC contribution are suppressed by the small width of the gauge bosons, which enhances the impact of the interference contribution. Because the interference scales linearly with the NP coupling constant, while the pure FCNC contribution scales with the coupling constant squared, an analysis of events in this region can potentially improve the sensitivity to small coupling constants.

T 60.3 Wed 16:45 T-H19

Search for FCNC-couplings between the top-quark and the Higgs-boson in dilepton final states — •Marvin Geyik[1], Wolfgang Wagner[1], Oliver Thielmann[1], Abhishek Sharma[2], Frederic Deliot[3], Charles Grant[4], Paul Jackson[4], Peter Onyisi[5], Kyungeon Choi[5], and Marc Tost[5] — [1]Bergische Universität Wuppertal — [2]Columbia University — [3]Universite Paris-Saclay — [4]University of Adelaide — [5]University of Texas at Austin

Flavor-changing neutral current interactions are strongly suppressed in the Standard Model. Still, some extensions of the Standard Model predict tree-level FCNC-couplings between the top quark, other up-type quarks and neutral bosons, including the Higgs boson. These anomalous couplings can be parameterised in the framework of effective field theories (EFT). The presented analysis searches for the production of a single top-quark in association with a Higgs boson and for top-quark-antiquark production with one of the top quarks decaying to an up quark or a charm quark and a Higgs boson. Higgs decays to WW*, ZZ* and two taus leading to leptonic final states are considered in the event selection. Two analysis channels are defined: one with two leptons (electrons or muons) of the same electric charge and a second channel with three leptons. This talk focuses on advancements in the dilepton final state. The sensitivity of the analysis in setting limits to relevant coefficients of EFT operators will be presented.

T 60.4 Wed 17:00 T-H19

Search for flavour-changing neutral current couplings between the top-quark and the Higgs boson in the $H \to b\bar{b}$ decay channel and the tri-lepton final state with the ATLAS detector at the LHC — •Oliver Thielmann[1], Geoffrey Gilles[4], Wolfgang Wagner[1], Marvin Emin Geyik[1], Dominic Hirschbühl[1], Kyungeon Choi[2], Frederic Deliot[3], Charles Michael Grant[5], Paul Jackson[5], Peter Onyisi[2], Abhishek Sharma[6], and Marc Tost[2] — [1]Bergische Universität Wuppertal — [2]Austin — [3]Saclay CEA — [4]Nikhef — [5]Adelaide — [6]Columbia

A search for flavour-changing neutral current (FCNC) couplings between the top-quark and the Higgs boson in the $H \to b\bar{b}$ decay channel and the tri-lepton final state is presented. The search for FCNC couplings in the top-quark-Higgs-boson sector is a promising search for a theory beyond the SM. Proton-proton collision data produced by the LHC at a centre-of-mass energy of $\sqrt{s} = 13$ TeV and collected by the ATLAS experiment during 2015, 2016, 2017 and 2018, and corresponding to an integrated luminosity of 139 fb^{-1}, are used. Data is analysed in different final states, characterised by the number of isolated electrons or muons, missing transverse energy and the number of jets where either three (for $H \to b\bar{b}$) or one (for tri-lepton final state) of them are identified as b-jets. A machine learning analysis based on neural networks is conducted to improve the discrimination between the signal and the backgrounds. Preliminary results, interpreted in the context of an effective field theory for FCNC, are presented, where additional exclusion limits on the qtH effective coupling are derived.

T 60.5 Wed 17:15 T-H19

Search for charged lepton flavour violation in top-quark production and decay with the ATLAS experiment at 13 TeV — Markus Cristinziani[1], William George[2], •Gabriel Gomes[1], Carlo Gottardo[3], Chris Hawkes[2], Jacob Kempster[2], Alexios Stampekis[2], and Miriam Watson[2] — [1]Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen — [2]University of Birmingham — [3]NIKHEF

In the Standard Model (SM) with massless neutrinos, the flavour of charged leptons cannot be altered in weak interactions. However, the observed neutrino oscillations allow for charged lepton flavour violating (cLFV) processes, even though highly suppressed. Hence, experimental evidence of such rare processes would provide signs of new physics beyond the SM.

Investigations targeting a direct search for cLFV will be presented using proton–proton collision data collected by the ATLAS detector between 2015 and 2018 at $\sqrt{s} = 13$ TeV. Decays of a top quark into a pair of opposite-sign different-flavour (OSDF) leptons and an up-type quark, as well as single top-quark production in association with an OSDF dilepton pair, are examined. Thus, besides the top-quark decay channel, the single top-quark production channel is included, providing additional sensitivity. For signal-discrimination purposes, a multivariate discriminant, namely a boosted decision tree, is implemented and optimised.

T 60.6 Wed 17:30 T-H19

Measurement of *CP* violation in $B_s^0 \to D_s^+ D_s^-$ and $B^0 \to D^+ D^-$ decays with the LHCb experiment — •Louis Gerken, Philipp Ibis, and Antje Mödden — Experimentelle Physik 5, TU Dortmund

At the LHCb experiment, time-dependent measurements of *CP* violation are performed to test the Standard Model of particle physics. The decays $B_s^0 \to D_s^+ D_s^-$ and $B^0 \to D^+ D^-$ give access to the *CP* violation parameters ϕ_s and $\sin(2\beta)$. In these decays of neutral mesons, *CP* violation arises in the interference of the direct decay and the decay after mixing. Due to the similarities of the decays, a time-dependent *CP* violation measurement is performed in parallel for both decays.

In this talk, the current status of these measurements will be presented. The analysis uses data collected by the LHCb detector during 2015 to 2018 at a centre-of-mass energy of 13 TeV corresponding to an integrated luminosity of 6 fb^{-1}.

T 60.7 Wed 17:45 T-H19

Search for $B_s^0 \to D^{*+} D^{*-}$ and *CP* violation studies in $B_d^0 \to D^{*+} D^{*-}$ with the LHCb experiment — Sophie Hollitt, Philipp Ibis, •Jan Langer, and Antje Mödden — Experimentelle Physik 5, TU Dortmund

At the LHCb experiment, precision measurements are performed to search for physics beyond the Standard Model. For this purpose, e.g.

searches for unobserved decays and measurements of their branching fractions or measurements of *CP* violation in decays of neutral B mesons are carried out.

The primary aim of this analysis is to observe the decay $B_s^0 \to D^{*+}D^{*-}$. Besides, the branching fraction is measured relative to the decay $B_d^0 \to D^{*+}D^{*-}$. By measuring the relative branching ratio, dominant systematic uncertainties cancel out. Further, an angular and decay-time dependent *CP* violation measurement is performed in the $B_d^0 \to D^{*+}D^{*-}$ decay, which allows the measurement of the parameter $\sin(2\beta)$.

In this talk, the current status of both analyses is presented using the full data set of the LHCb experiment corresponding to an integrated luminosity of $9\,\mathrm{fb}^{-1}$.

T 60.8 Wed 18:00 T-H19

Measurement of the CKM mixing angle γ with $B_s^0 \to D_s^{\mp}K^{\pm}$ decays at the LHCb experiment — •Quentin Führing and Kevin Heinicke — Experimentelle Physik 5, TU Dortmund

In the Standard Model of particle physics the quark mixing matrix is expected to be unitary. To test this unitarity, the properties of the unitarity triangles are constrained. The mixing angle γ is such a property of interest.

To constrain the mixing angle γ, precise decay-time-dependent measurements of *CP* violation in $B_s^0 \to D_s^{\mp}K^{\pm}$ decays can be used. With an excellent decay-time resolution and a large number of B_s^0 decays, the LHCb experiment provides the necessary data for this measurement.

In this talk a decay-time-dependent analysis aiming to measure γ is presented. Data corresponding to an integrated luminosity of $6\,\mathrm{fb}^{-1}$ recorded by the LHCb experiment from 2015 to 2018 at a centre-of-mass energy of 13 TeV are used for this analysis.

T 60.9 Wed 18:15 T-H19

Measurement of *CP* violation in $B^0 \to \psi K_S^0$ decays with the LHCb experiment — Vukan Jevtic, Patrick Mackowiak, and •Gerwin Meier — Experimentelle Physik 5, TU Dortmund

Precision measurements of parameters of the Standard Model are important methods for tests of the Standard Model. One excellent parameter to measure is the CKM angle β, where the golden mode is $B^0 \to J/\psi K_S^0$ due to the dominant contributions of tree-level amplitudes. With new reconstruction types of the K_S^0 and the combination of different decay channels it is possible to increase the statistical sensitivity in the most precise measurement of this quantity to date.

In this talk the current status of the time-dependent $\sin(2\beta)$ measurement in the decays $B^0 \to J/\psi(\to \ell\ell)K_S^0(\to \pi^{\pm}\pi^{\mp})$ with $\ell = e, \mu$ and $B^0 \to \psi(2S)(\to \mu\mu)K_S^0(\to \pi^{\pm}\pi^{\mp})$ will be presented, where the full LHCb Run II dataset from 2015 to 2018 corresponding to $6\,\mathrm{fb}^{-1}$ is used.