T 71: Higgs 3 (coupling to b and c quarks)

Time: Wednesday 16:00–18:00 Location: Geb. 30.41: HS 2

T 71.1 Wed 16:00 Geb. 30.41: HS 2

Progress of the ATLAS Run 2 $t\bar{t}H(H\to b\bar{b})$ Legacy Analysis at 13 TeV — Arnulf Quadt, •Chris Scheulen, and Elizaveta Shabalina — II. Physikalisches Institut, Georg-August-Universität Göttingen

The bottom anti-bottom Higgs decay channel of Higgs-associated top quark pair production offers direct access to measurements of the top Yukawa coupling and Higgs-p_{T} differential cross-section, which are sensitive to potential new physics. To incorporate improvements such as developments in b-tagging and Monte Carlo simulation of the dominant $t\bar{t}+b\bar{b}$ background, a legacy analysis of the $t\bar{t}H(H\to b\bar{b})$ process with the full ATLAS Run 2 dataset of $\mathcal{L}=140\,\mathrm{fb}^{-1}$ is currently ongoing.

This talk will outline the analysis strategy and provide an insight into the expected sensitivity. A special focus will be placed on ongoing studies, such as recent improvements and validation of the transformers – an advanced deep learning architecture – developed in the analysis for event classification and Higgs-p_{T} reconstruction. Among others, developments herein consist of the inclusion of missing transverse energy in the model inputs, performance comparisons of competing reconstruction methods, and the optimisation of the region definitions obtained from the event classification networks.

T 71.2 Wed 16:15 Geb. 30.41: HS 2

Background Modelling using ML in $t\bar{t}H(bb)$ Final States — Steffen Korn, Arnulf Quadt, Chris Scheulen, and •Paul Wollenhaupt — II. Physikalisches Institut, Georg-August- Universität Göttingen, Germany

Systematic differences between simulated samples and measured data are challenging for many high-energy physics analyses. The machine learning field of domain translation provides a powerful framework for learning mappings that systematically correct the distribution of simulated samples. Analogous to the ABCD method, which extrapolates the absolute number of events in a signal region (SR) from the translations of yields in control regions (CRs), mappings from sample to data distributions are first learned in the CRs and then extrapolated to the blinded SR. This domain translation approach is used to improve the background modelling of $t\bar{t}H(\to b\bar{b})$. Specifically, regions are defined based on the number of jets and b-tagged jets. The distributions of the jet kinematic variables, which are systematically mis-modelled due to the NLO approximation of the top quark, are then extrapolated for events with at least six hadronic jets, three of which are b-tagged.

T 71.3 Wed 16:30 Geb. 30.41: HS 2

Extracting the Gluon Fusion Component of the Higgs Production in Association with a Z Boson through the ZH-WH Symmetry at the CMS Experiment — •Svenja Diekmann, Niclas Eich, and Martin Erdmann — III. Physikalisches Institut A, RWTH Aachen University

The gluon fusion production mechanism of the associated ZH production ($gg\to ZH$) is a yet unmeasured Standard Model process, sensitive to various new physics scenarios. The considered final state of the invisible Z boson decay and two b-jets is not only populated by large backgrounds arising from other processes, but also by the dominant quark initiated ZH production ($qq\to ZH$). In order to separate these two production mechanisms, the total ZH production can be utilised in combination with the WH production to extract the gluon fusion component by analysing the ratio of their cross sections. The strategy and first expected results of this analysis to extract the gluon fusion component of the ZH production are shown using the 2017 dataset of the CMS experiment.

T 71.4 Wed 16:45 Geb. 30.41: HS 2

Transfomer based Search for the Gluon-Fusion induced ZH Production in the $H\to b\bar{b}$, $Z\to e^+e^-/\mu^+\mu^-$ Final States with the CMS Experiment — •Niclas Eich, Svenja Diekmann, and Martin Erdmann — RWTH Aachen University

The gluon fusion induced ZH production is yet to be measured. Its estimated cross section in the Standard Model is relatively small with only 0.12 pb, making a search difficult over the vast number of background events. We present the blinded results of our analysis in the $H\to b\bar{b}$, $Z\to e^+e^-/\mu^+\mu^-$ final states, at the CMS experiment for the Run 2 data taking period.

In this, we leverage Machine Learning methods, employing a transformer-based process classifier to differentiate between signal and various background processes. Subsequently, we enhance the analysis sensitivity by subjecting the classifier's predictions to K-Means clustering. This two-step approach allows us to create bins for a statistical evaluation in a multi-dimensional space. The final results are presented as sensitivity analysis, including systematic and statistical uncertainties.

T 71.5 Wed 17:00 Geb. 30.41: HS 2

Flavour Sensitive Observables in Hadronic Higgs Decays at NLO QCD — •Benjamin Campillo Aveleira[1,2], Aude Gehrmann-De Ridder[2,4], and Christian Tobias Preuss[2,3] — [1]Institute for Theoretical Physics, KIT, 76128 Karlsruhe — [2]Institute for Theoretical Physics, ETH, CH-8093 Zürich, Switzerland — [3]Department of Physics, University of Wuppertal, 42119 Wuppertal — [4]Department of Physics, University of Zürich, CH-8057 Zürich,

We study flavour sensitive observables in hadronic Higgs decays up to next-to-leading-order in QCD. In a first step we look at an infrared safe definition of jet flavour. The two algorithms that will accomplish this and that will be discussed in this talk are the flavour dressing and flavour k_T algorithm. Having an infrared flavour safe algorithm, we apply it to flavour-sensitive observables. The main observables of interest are the energy of the (sub-)leading flavoured jet and the angle between the leading $b\bar{b}$ pair as well as its invariant mass. It will be shown: The distributions look quite different in the two categories and thus they can be used as a discriminator. Furthermore, we also discuss that the flavour dressing algorithm is better suited to make theoretical predictions, which can be used to compare to experiments.

T 71.6 Wed 17:15 Geb. 30.41: HS 2

PAIReD jet tagging in CMS: Testing and developing a new approach of Hcc and Hbb classification in the CMS experiment — Gaetano Barone[1], Alexander Jung[2], Ming-Yan Lee[2], Spandan Mondal[1], Uttiya Sarkar[2], Alexander Schmidt[2], •Jan Schulz[2], and Ulrich Willemsen[2] — [1]Brown University, Providence, USA — [2]III. Physikalisches Institut A, RWTH Aachen University, Germany

Machine learning, for example in the form of jet flavor tagging, can provide indispensable help in analyzing the rare Higgs decay into two charm quarks. In a recent tagging approach, a new unconventional type of jet is defined, the so-called PAIReD jet. It has been shown that classifiers for PAIReD jets have a higher background rejection compared to the traditional jet definitions in CMS analyses (AK4, AK8, AK15). However, so far these studies have only been carried out with CMS-independent simulations. Therefore, the testing of the approach with official CMS simulations as well as the concrete implementation in CMS are essential steps towards a more advanced physics analysis and will be presented in this talk. Furthermore, possible further developments and improvements of the originally proposed PAIReD tagger will be discussed.

T 71.7 Wed 17:30 Geb. 30.41: HS 2

Analysis strategies for the search for the Higgs boson decay to a charm-anticharm pair at CMS — •Valentyn Vaulin[1], Alena Dodonova[1], Ming-Yan Lee[1], Spandan Mondal[2], Andrzej Novak[1], Andrey Pozdnyakov[1], and Alexander Schmidt[1] — [1]III. Physikalisches Institut A, RWTH Aachen University, Germany — [2]Brown University, Providence, USA

During the recent years substantial progress has been made in constraining the Higgs boson coupling to charm quarks. In this talk the search for the Higgs boson decay into a charm-anticharm pair, where the Higgs boson is produced in association with the W or Z boson, will be presented. A general overview of the analysis strategies as well as the implementation of the columnar analysis framework with the intention to reproduce the Run 2 results of the VHcc analysis will be shown.

T 71.8 Wed 17:45 Geb. 30.41: HS 2

Charge-asymmetry measurement in WH($\tau\tau$) and WH(WW)

events — Sebastian Brommer, Nils Faltermann, Markus Klute, •Ralf Schmieder, Nicolo Trevisani, Roger Wolf, and Xunwu Zuo — Karlsruhe Institute for Technology, Karlsruhe, Germany

At the LHC, an asymmetry in W^+ H and W^- H production is expected as the parton distribution functions (PDFs) favour the production of positively-charged W bosons in proton-proton collisions. The measurement of the WH charge asymmetry provides a consistency test for the Standard Model (SM), as it is sensitive to enhanced Yukawa couplings to the first and more so to second generation quarks like the c quark. The production of an H in association with a W boson can happen through the exchange of a c quark in the t channel. Experimentally, the WH charge asymmetry measurement is independent of any challenging c jet tagging algorithms. This talk reports the status of this measurement in the channels in which the Higgs boson decays into a pair of τ leptons and into a pair of W bosons respectively.