T 30: Higgs Charm, Di-Higgs

Time: Tuesday 17:00–18:30 Location: HSZ/0105

T 30.1 Tue 17:00 HSZ/0105

Introduction of a new framework in the analysis of the Higgs boson decay to a charm-anticharm pair in the vector boson associated production mode at CMS — •Valentyn Vaulin[1], Annika Stein[1], Xavier Coubez[1,2], Alena Dodonova[1], Ming-Yan Lee[1], Spandan Mondal[1], Andrzej Novak[1], Andrey Pozdnyakov[1], Manuella Guirgues[1], and Alexander Schmidt[1] — [1]Physics Institute III A, RWTH Aachen University, Germany — [2]Brown University, USA

During the last years the analysis techniques to measure the Higgs boson coupling to charm quarks using the full Run-2 data of the CMS experiment have been established. The Higgs boson decay into charm-anticharm pair, where the Higgs boson is produced in association with the W or Z boson, has been analysed in a resolved topology with individually reconstructed jets and in a boosted topology with merged jets. In this talk a concept of a new analysis framework is presented with the intention to reproduce the known results of the VH search from Run-2 analysis by CMS. The Z → 2l decay channel of the associate vector boson and resolved jet topology of the H → $c\bar{c}$ decay are considered for this study. Furthermore, the results of the current state of ML-supported analysis in the new framework will be discussed.

T 30.2 Tue 17:15 HSZ/0105

Direct search for Higgs boson decay to a pair of charm quarks in the vector boson associated production mode at CMS — •Annika Stein[1], Bjorn Burkle[2], Xavier Coubez[1,2], Alena Dodonova[1], Manuella Guirgues[1], Luca Mastrolorenzo[1], Ming-Yan Lee[1], Spandan Mondal[1], Andrzej Novak[1], Andrey Pozdnyakov[1], Alexander Schmidt[1], and Valentyn Vaulin[1] — [1]III. Physikalisches Institut A, RWTH Aachen University, Aachen, Germany — [2]Brown University, Providence, USA

The search targets Higgs bosons produced in association with a vector boson (W, Z) and probes the coupling of the Higgs boson to charm quarks via the H → c$\bar{c}$ decay, using full Run-2 data of the CMS experiment. Two topologies contribute to the full analysis, the "boosted" topology, where the two jets from a Higgs boson candidate are merged into one large-radius jet, and a "resolved" topology which utilizes two reconstructed small-radius jets. Compared to a previous search, the analysis techniques have been improved by exploiting a DNN-based charm jet tagging algorithm along with a new calibration method, improved jet-energy regression, and a "kinematic fit" to constrain momenta of the jets using leptons. The most stringent constraint on the Higgs-charm Yukawa coupling modifier, κ_c, at the observed (expected) 95% CL interval is set to $1.1 < |\kappa_c| < 5.5$ ($|\kappa_c| < 3.4$). A validation of the analysis is carried out with a search for Z → c$\bar{c}$ in VZ events, which leads to its first observation at a hadron collider with a significance of 5.7 standard deviations. Further developments that feature novel machine learning methods will be discussed.

T 30.3 Tue 17:30 HSZ/0105

Search for boosted Higgs boson decays to a charm quark pairs — •Andrzej Novak, Xavier Coubez, Ming-Yan Lee, Luca Mastrolorenzo, Andrey Pozdnyakov, Annika Stein, and Alexander Schmidt — Physics Institute III A, RWTH Aachen

The Higgs boson decay to charm quarks (H → $c\bar{c}$) has the highest branching fraction of the yet unobserved decays. Moreover, it is predicted to be the strongest coupling to the second generation of fermions, which as of now remains unconfirmed. This talk presents a recent search by the CMS experiment for H → $c\bar{c}$ at high transverse momentum, primarily targeting the gluon fusion production mode. The method is validated with the Z → $c\bar{c}$ decay, which is observed for the first time in this channel and provides the strongest constraint yet at the LHC. The observed (expected) upper limit on H → $c\bar{c}$ process is set at 47 (39) times the SM prediction. The analysis was enabled by recent developments in deep learning tools for jet identification in such topologies.

T 30.4 Tue 17:45 HSZ/0105

Discrimination of Di-Higgs and Higgs-Z Boson Final States Using Neural Networks — •Lars Linden, Otmar Biebel, Christoph Ames, and Celine Stauch — Ludwig-Maximilians-Universität, München

Precise measurements of Higgs boson pair production are of significant importance for new physics searches and determining the Higgs potential's exact shape. These processes have small cross-section however, making them exceptionally rare. As a result, neural networks are used to improve the experimental sensitivity for these processes. The employed network uses general event jet information and specific variables sensitive to di-Higgs production for event classification. This talk presents a network structure for distinguishing $gg \to HH$ from the important background process $gg \to HZ$ and its respective sensitive variables.

T 30.5 Tue 18:00 HSZ/0105

Separation of HH and HZ processes in LHC events — •Celine Stauch, Otmar Biebel, Christoph Ames, and Lars Linden — LMU München

LHC Processes with HH final states and HZ final states are kinematically very similar due to H and Z boson being close in mass and both final states having similar cross sections in proton-proton collisons. While the H boson is a scalar particle, the Z boson has a spin of 1. The spin of the Z boson transfers to the jets in the final state leading to a correlation of the angles of these jets.

For HH or HZ final states resulting in at least 4 jets all possible combinations of the four energetically highest jets are calculated in order to find the combination closest in mass to a H or Z boson. A variable sensitive to the correlation of the angles of the final state jets is introduced, which is a modification of the Ellis-Karliner angle. This variable is investigated using generator simulation data for the best combination of jets in HH final states ans HZ final states.

T 30.6 Tue 18:15 HSZ/0105

A neural network based regression of the neutrinos in H→ $\tau\tau$ decays for a resonant HH→bb$\tau\tau$ analysis — Philip Keicher, •Tobias Kramer, Nathan Prouvost, Marcel Rieger, Peter Schleper, Jan Voss, and Bogdan Wiederspan — Universität Hamburg

The CMS resonant HH→bb$\tau\tau$ analysis searches for heavy spin 0/2 resonances decaying into two Higgs bosons which subsequently decay into bottom quarks and tau leptons. It uses the Run 2 data collected from 2016-2018 at a center of mass energy of $\sqrt{s} = 13\,\text{TeV}$ corresponding to an integrated luminosity of 138 fb^{-1}. As a wide range of resonance masses is covered, reconstructing the invariant mass of the HH system and therefore the individual Higgs bosons is crucial. Especially for the Higgs boson decaying into tau leptons a significant amount of information is lost in the form of neutrinos not being measured by the detector. This talk presents a study on how to regress the full HH system using deep neural networks in order to improve the mass resolution of a potential new heavy particle.