T 98: Higgs Physics X

Time: Friday 9:00–10:30 Location: KH 02.013

T 98.1 Fri 9:00 KH 02.013

Towards a CP-independent cross section measurement of $t\bar{t}H$ and tH production in the $H \to \gamma\gamma$ decay channel at CMS — Johannes Erdmann, Jan Hermanns, •Florian Mausolf, and Peter Wissmann — III. Physikalisches Institut A, RWTH Aachen University

The top-quark Yukawa coupling, the Higgs boson's strongest interaction with fermions, plays a central role in theory and experiment. While a purely CP-odd structure has been excluded experimentally, the possibility of a significant CP-odd admixture remains consistent with current LHC constraints. The presence of a CP-odd component or a change in the CP-even coupling strength would influence both the cross sections and kinematics of top-quark-associated Higgs-boson production processes. Particularly, the effect on the kinematics can lead to model dependencies of the measurement due to its effect on selection efficiencies.

This talk presents a measurement of $t\bar{t}H$ and tH production cross sections, with a special focus on minimizing model dependencies related to the CP-properties of the top-quark Yukawa coupling. This is achieved by using neural network classifiers trained with a decorrelation against such model assumptions in the training samples. The events are then categorized with a novel differentiable categorization optimization technique and the cross sections are extracted via a maximum likelihood fit using data recorded in 2022 and 2023 with the CMS detector.

T 98.2 Fri 9:15 KH 02.013

Focusing the Inference Lens: Probing the top-Higgs CP Structure with Neural Simulation-Based Inference — •Stefan Katsarov[1], Levi Evans[1], Alexander Held[2], Stephen Jiggins[1], Judith Katzy[1], Nino Kovacic[3], Jay Sandesara[2], and Chris Scheulen[4] — [1]DESY, Hamburg — [2]University of Wisconsin-Madison — [3]University of Zagreb — [4]University of Geneva

Neural Simulation-Based Inference (NSBI) is an emerging statistical framework that leverages modern neural networks as powerful function approximators to achieve the statistical objective of accurately estimating probabilistic relationships between data and parameters of interest. This approach enables inference directly from the full dimensionality of reconstruction-level data.

We implement NSBI to measure the CP structure of the top-Higgs coupling in a ttH and tH enriched signal region. This measurement is directly sensitive to a CP-odd top-Higgs coupling, which has not yet been experimentally excluded. It could provide direct evidence of physics beyond the Standard Model, potentially hinting at an explanation for the observed matter-antimatter asymmetry in the Universe.

The ttH and tH processes exhibit interference effects, leading to degenerate structures in conventional observables. These otherwise prohibitive features lend themselves well to the high-dimensional approach of NSBI. I will outline the methodology used to construct our likelihood ratio function and compare the resulting fits with an analysis that used physics-motivated observables and a conventional classifier.

T 98.3 Fri 9:30 KH 02.013

Searching for $H \to c\bar{c}$ in $t\bar{t}H$ production with the ATLAS detector — Diptaparna Biswas, Carolina Costa, Markus Cristinziani, Carmen Diez Pardos, Ivor Fleck, Gabriel Gomes, Jan Joachim Hahn, Nikolaos Kamaras, Vadim Kostyukhin, •Nils Benedikt Krengel, Austin Olson, Inês Pinto, Sebastian Rentschler, Elisabeth Schopf, Katharina Voss, Wolfgang Walkowiak, and Adam Warnerbring — Experimentelle Teilchenphysik, Center for Particle Physics Siegen, Universität Siegen

Since the discovery of the Higgs boson in 2012, its couplings to other particles have been investigated extensively by the LHC experiments as key tests of the Standard Model. Significant effort is now directed toward measurements of the Yukawa couplings to second-generation fermions. The measurement of the charm-quark-Yukawa coupling with the ATLAS experiment is being expanded by an additional mode $t\bar{t}H(c\bar{c})$, in which a Higgs boson is produced in association with a top–antitop quark pair and decays into a charm–anticharm quark pair.

The experimental challenges of $t\bar{t}H(c\bar{c})$ lie in the efficient simultaneous identification of bottom and charm jets and the discrimination of signal from background processes. Especially in the all hadronic channel, the rejection of QCD multijet background is challenging, yet the addition of this channel, if feasible, can provide a significant boost to the sensitivity of the analysis. This presentation will showcase first investigations of the all-hadronic channel and how modern machine learning methods, such as transformers, can help overcome the experimental challenges.

T 98.4 Fri 9:45 KH 02.013

Search for $H \to c\bar{c}$ in the Vector Boson Fusion Channel with CMS Run-3 Data — •Jialiang Sun, Konstantinos Nikolopoulos, and Philipp Gadow — University of Hamburg, Hamburg, Germany

Quark Yukawa couplings to the Higgs boson have so far been experimentally established only for the third generation. Observation of Higgs decays to a charm quark-antiquark pair would provide direct access to the charm Yukawa coupling, testing the Higgs coupling to second-generation quarks and probing potential deviations from the Standard Model. Currently, the most stringent constraints on this coupling are obtained by searches for associated Higgs production with a vector boson or a top-quark pair. Further improvements are expected by combining these results with the vector boson fusion (VBF) production mode using Run-3 data. In this talk we present a sensitivity study of Higgs decays to a charm quark-antiquark pair in the VBF channel, using CMS proton-proton collision data collected in 2024 at a center-of-mass energy of 13.6 TeV. Backgrounds from QCD multijet production and Z/W+jets are estimated using data-driven methods. A boosted decision tree is trained to suppress the overwhelming QCD background, and a preliminary expected upper limit on the $H \to c\bar{c}$ signal strength is derived.

T 98.5 Fri 10:00 KH 02.013

Investigation of a boosted event topology in the search for the Higgs boson decay to a charm-anticharm pair in vector boson associated production mode at CMS in Run 3 — •Patrick Kersten, Alexander Schmidt, Andrey Pozdnyakov, Valentyn Vaulin, Pedro Gouveia Pinto Da Costa, Ishmeet Kaur Vohra, Jan Terörde, and Arnd Meyer — III. Physikalisches Institut A, RWTH Aachen University

The search for the Higgs boson decay into a charm-anticharm pair in events where the Higgs boson is produced in association with a W or Z boson is an important contribution to the aim of measuring the Higgs boson coupling to charm quarks. In addition to the so-called "resolved" event topology, the topology with highly energetic Higgs boson decays, resulting in a boosted event topology is explored. The potential improvement on the analysis sensitivity when adding the boosted topology is investigated. This talk presents the first expected results using early Run-3 data recorded by the CMS experiment focusing on the preliminary expected limits on the Higgs-charm coupling.

T 98.6 Fri 10:15 KH 02.013

Investigations on the κ_c/κ_b ratio measurement using Higgs boson decays to charm quarks in the vector boson associated production mode at CMS — •Jan Terörde, Alexander Schmidt, Andrey Pozdnyakov, Valentyn Vaulin, Patrick Kersten, Pedro Gouveia Pinto Da Costa, Ishmeet Kaur Vohra, and Arnd Meyer — III. Physikalisches Institut A, RWTH Aachen University

The associated production of a Higgs boson and a vector boson (Z or W boson), is one of the most promising channels in the search for the decay of the Higgs boson to charm (c) quarks. The simultaneous treatment of the H → cc and H → bb channels improves the overall sensitivity and enables to extract combined limits as well as to potentially constrain the κ_c/κ_b ratio. This contribution focuses on the κ_c/κ_b ratio measurement, the systematic uncertainties of the analysis and how these uncertainties affect the measurement of κ_c/κ_b.