T 4: Higgs Physics I

Time: Monday 16:15–18:15 Location: KH 00.016

T 4.1 Mon 16:15 KH 00.016

Search for non-resonant Higgs boson pair production in dilepton final states of the bbWW decay mode at CMS — •Lara Markus, Matteo Bonanomi, Mathis Frahm, Johannes Haller, Balduin Letzer, and Matthias Schröder — Institut für Experimentalphysik, Universität Hamburg

The trilinear coupling of the Higgs boson is related to the shape of the Higgs potential, which makes it a crucial parameter of the Standard Model. The trilinear coupling can be directly probed by measuring the cross section of Higgs boson pair production in proton-proton collisions at the LHC.
A search for non-resonant Higgs boson pair production is presented, targeting final states where one Higgs boson decays to a pair of bottom quarks and the other Higgs boson decays to two W bosons, with subsequent decays of the W bosons into leptons and neutrinos. The analysis is performed on data collected at a center-of-mass energy of 13.6 TeV by the CMS detector in 2022 and 2023, with a corresponding integrated luminosity of 62.4 fb^{-1}. Events are selected based on the b-tagged jets multiplicity, and state-of-the-art neural network classifiers are used to enhance the sensitivity to the rare signal topology. Upper limits are set on the Higgs boson pair production cross section and as a function of the trilinear coupling strength.

T 4.2 Mon 16:30 KH 00.016

Search for Semiboosted Higgs Pair Production From Vector Boson Fusion in the Single Lepton $b\bar{b}W^+W^-$ Final State Using the ATLAS Detector — •Stefan Brückner, Lars Linden, Valerio d'Amico, Celine Stauch, Patrick Rudolph Schumacher, and Otmar Biebel — LMU Munich

The discovery of the Higgs boson solved one of the biggest problems in the standard model, the generation of particle masses. However, one property that is still not well known is the quartic coupling of a Higgs boson pair to a pair of electroweak gauge bosons. A process involving this coupling is the Di-Higgs production via vector boson fusion(VBF), which is the second most common production mode at LHC. The analysis in this talk focuses on events in the $b\bar{b}W^+W^-$ final state with a single lepton, using a semiboosted approach. In this semiboosted scenario, one of the two objects, either the $H \to b\bar{b}$ or the W boson, which decays hadronically, is represented by a large radius jet. Some results of the general kinematics of the process and the event selection strategy for the semiboosted approach will be presented in the talk.

T 4.3 Mon 16:45 KH 00.016

Search for Boosted Higgs Pair Production From Vector Boson Fusion in the Single Lepton $b\bar{b}W^+W^-$ Final State Using the ATLAS Detector — •Celine Stauch, Stefan Brückner, Lars Linden, Valerio d'Amico, Patrick Schumacher, and Otmar Biebel — LMU Munich

While the discovery of the Higgs boson solved one of the biggest problems in the standard model, even more than 10 years after its discovery, not all of its properties are well know. One of these is the quartic coupling of a Higgs boson pair to a pair of electroweak gauge bosons. A process suited to constrain this coupling is given by Di-Higgs production via vector boson fusion (VBF), the second most common production mode at LHC.
The presented search for VBF Di-Higgs production investigates the $b\bar{b}W^+W^-$ final state with a single lepton. For this study a boosted approach is investigated, where Large Radius jets represent the hadronically decaying W and the $H \to b\bar{b}$. This talk presents the Event Selection strategy using ATLAS run 2 datasets and first results for analysis optimizations to increase sensitivity.

T 4.4 Mon 17:00 KH 00.016

Search for Higgs Boson Pair Production in Three-Lepton Final States with the ATLAS Detector — Anamika Aggarwal, Volker Büscher, Christian Schmitt, •Niklas Schmitt, and Duc Bao Ta — Johannes Gutenberg-University, Mainz

After the discovery of the Higgs boson in 2012 at the LHC, many of its properties have already been determined precisely using 139 fb^{-1} of proton-proton collisions at $\sqrt{s} = 13$ TeV. However, one of the biggest challenges in this field remains the measurement of the coupling of the Higgs boson to itself. It allows for a deep insight into the real shape of the Higgs potential and hence has a big impact on the understanding of the physics of the universe. In order to constrain the trilinear self-coupling, the Di-Higgs production cross section is measured. While decay modes including b-quarks typically have larger branching fractions, leptonic final states are generally much cleaner and have less SM background.

This talk will give an overview about the three-lepton analysis, which relies on neural networks to distinguish the signal processes from all SM backgrounds. In addition, a dedicated treatment of leptons overlapping with jets is described, improving the sensitivity due to spin correlations in semi-leptonic $H \to WW$ decays. Finally, the status of the Run 2 plus partial Run 3 analysis, based on a combined dataset of about 300 fb^{-1}, will be shown.

T 4.5 Mon 17:15 KH 00.016

HH Analysis with Multileptons Using Run-2 ATLAS Data — •Ondrej Kulhanek and André Sopczak — CTU in Prague

The latest results with Run-2 ATLAS data are presented for the search HH in the multilepton channel.

T 4.6 Mon 17:30 KH 00.016

Studies towards a search for HHH production in the 4b2W channel in dilepton final states with CMS — •Parth Patil, Johannes Haller, Lara Markus, Mathias Frahm, Matteo Bonanomi, and Matthias Schröder — Institut für Experimentalphyisk, Universität Hamburg

The quartic coupling of the Higgs boson is an important parameter of the Standard Model (SM) Higgs sector and is related to the shape of the Higgs potential. Triple Higgs boson (HHH) production offers a direct probe of the quartic coupling. In the SM, HHH production is an extremely rare process evading current experimental sensitivity; however, the HHH production cross section can become large for non-SM scenarios, motivating a search for this process.

In this talk, studies towards a search for HHH production are presented, targeting events in which two Higgs bosons decay into bottom quark-antiquark pairs and one Higgs boson decays into a pair of W bosons, both of which decay leptonically. The analysis uses simulated data of the CMS experiment, corresponding to data-taking conditions at a center-of-mass energy of 13.6 TeV. Events are categorised based on the dilepton mass and b-tagged jet multiplicities, and deep neural networks are employed to discriminate the small signal from SM background processes.

Finally, a maximum likelihood fit is performed to establish expected exclusion limits on the HHH production cross section and constrain the quartic Higgs coupling.

T 4.7 Mon 17:45 KH 00.016

gg→HH NLO EW corrections in the forward limit — •Dominik Grau[1], Daniel Stremmer[1], Matthias Steinhauser[1], Joshua Davies[2], and Kay Schönwald[3] — [1]Karlsruher Institut für Technologie, Karlsruhe, Deutschland — [2]University of Liverpool, Liverpool, United Kingdom — [3]Cern, Genève, Switzerland

In this talk, we present the calculation of the NLO EW corrections to di-Higgs production via gluon fusion. We compute the electroweak amplitude using analytical approximations around the forward limit, which cover large parts of the phase space with sufficient accuracy. Our results are given in symbolic form, offering flexibility with respect to parameter value and renormalization scheme choices.

T 4.8 Mon 18:00 KH 00.016

Electroweak corrections to Higgs boson pair production: The light quark case — Marco Bonetti[1], Gudrun Heinrich[2], •Philipp Rendler[2], and William J. Torres Bobadilla[3] — [1]Institute for Theoretical Physics, University of Tübingen, Auf der Morgenstelle 14, 72076 Tübingen, Germany — [2]Institute for Theoretical Physics, Karlsruhe Institute of Technology (KIT), 76131 Karlsruhe, Germany — [3]Department of Mathematical Sciences, University of Liverpool, Liverpool L69 3BX, U.K.

We present a fully analytic computation of the electroweak corrections to Higgs-boson pair production mediated by light quarks in both the

gluon and quark-antiquark channels. The calculation is performed using the method of differential equations, employing a large mass expansion to generate boundary functions. We implement the results in the POWHEG BOX framework for phenomenological studies. The corrections to the differential cross section are found to be sizable, reaching up to -30% in the gluon channel and +10% in the quark channel near the production threshold. The quark channel has not been considered before in calculations of the NLO electroweak corrections to Higgs-boson pair production.