T 67: Higgs Physics VII (HH and Trilinear Coupling)

Time: Thursday 16:15–18:45 Location: ZHG104

T 67.1 Thu 16:15 ZHG104

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, 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 shape can be directly probed by measuring the cross section of Higgs boson pair production in pp collisions at the LHC.
This talk presents a search for non-resonant pair production of Higgs bosons decaying into a b quark anti-quark pair and two W bosons, with subsequent decays of the W bosons into leptons and neutrinos. The analysis strategy is developed using Run 3 data of the CMS experiment, with a corresponding center-of-mass energy of at 13.6 TeV. The analysis is implemented in a columnar-based framework 'columnflow'.

T 67.2 Thu 16:30 ZHG104

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 — •Lars Linden, Valerio d'Amico, Celine Stauch, Stefanie Götz, Bao Tai Le, Tim Rexrodt, 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, 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. This talk will present some early results of a search for VBF Di-Higgs production in the $b\bar{b}W^+W^-$ final state with a single lepton, using the ATLAS run 2 and 3 datasets.

T 67.3 Thu 16:45 ZHG104

Efficiency measurements of di-lepton triggers in a search for di-Higgs production in CMS data — •Balduin Letzer, Lukas Ebeling, Mathis Frahm, Johannes Haller, Karla Kleinbölting, Finn Labe, Artur Lobanov, and Matthias Schröder — Institut für Experimentalphysik, Universität Hamburg

With a collision rate too large to store all events at the CMS experiment, a fast online selection (trigger selection) of interesting events is performed. The knowledge of the efficiency of this trigger selection is crucial in many physics analyses. A common method to measure the trigger efficiency in data uses a dataset selected with an orthogonal trigger selection. The method is used to measure the efficiency of different trigger selections in a search for di-Higgs production in the bbWW final state with two leptons, using data from the LHC Run-3. The results are used to derive correction factors that are applied to the simulated signal and background events in the analysis, in order to improve their modelling of the data.

T 67.4 Thu 17:00 ZHG104

Higgs self-coupling measurement at the ILC — •Bryan Bliewert[1,2], Julie Munch Torndal[1,2], and Jenny List[1] — [1]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [2]Universität Hamburg, Hamburg, Germany

Measuring the Higgs self-coupling represents a cornerstone of the physics program of future colliders because it gives important insights into the shape of the Higgs potential. This contribution summarizes the updated projections for the determination of the Higgs self-coupling from di-Higgs production at future e^+e^- colliders. In particular, we will present an update of the analysis of di-Higgs production at 500 GeV using full simulation of the ILD detector concept, incorporating advancements through state-of-the-art particle ID and flavor tagging as well as covering the $HH \to b\bar{b}b\bar{b}$ and $Z \to q\bar{q}/e^+e^-/\mu^+\mu^-/\bar{\nu}\nu$ channels. Based on the experience of previous analyzes, we extrapolate these to cover some of the remaining decay modes, e.g. $HH \to \bar{b}bWW$ or $Z \to \tau^+\tau^-$, as well as the contribution from the W W fusion production mode. We study the dependency of the results on the center-of-mass energy as well as on the value of the trilinear coupling realized in nature.

T 67.5 Thu 17:15 ZHG104

Top-Yukawa-induced corrections to Higgs pair production — Arunima Bhattacharya[1], Francisco Campanario[1], •Sauro Carlotti[2], Jamie Chang[3], Javier Mazzitelli[3], Milada Margarete Mühlleitner[2], Jonathan Ronca[4], and Michael Spira[3] — [1]University of Valencia-CSIC, Spain — [2]Karlsruher Institut für Technologie, Germany — [3]Paul Scherrer Institut, Switzerland — [4]University of Padua, Italy

After the discovery of the Higgs boson in 2012, the measurements of the Higgs self coupling is still a challenge for current and future experiments in particle physics. Higgs-boson pair production via gluon fusion is a loop-induced process. In order to increase the accuracy of the theoretical predictions for this process, higher-order corrections are necessary to reduce theoretical uncertainties and to describe differential distributions reliably. The next-to-leading order (NLO) corrections involve the evaluation of two-loop Feynman diagrams. In particular, for electroweak (EW) corrections, many different mass scales appear in the calculation, such as the gauge boson, bottom, top quark, and Higgs boson masses. Further complications include numerical instabilities due to virtual thresholds which require careful treatment.

In my talk, I will present results for the EW corrections induced by the top Yukawa coupling with contributions from light-quark loops without using any reduction techniques to master integrals. The calculations is done by keeping the masses as fully symbolic parameters, allowing, in the future, for a study of parametric and mass scheme/scale uncertainties.

T 67.6 Thu 17:30 ZHG104

Quark-initiated Double Higgs Production at one loop — •Philipp Rendler — Karlsruhe Institute of Technology

We present the analytic amplitude for double Higgs production in the quark-initiated channel at one loop, with full dependence on all mass scales. The calculation is performed using the method of differential equations employing a large mass expansion to fix the integration constants. The results are written in terms of iterated integrals, with integrals from simpler topologies being expressed in terms of Generalized PolyLogarithms. This amplitude forms a part of the electroweak corrections to Higgs boson pair production.

T 67.7 Thu 17:45 ZHG104

Double Higgs production in vector boson fusion at NLO QCD with anomalous couplings — •Jens Braun[1], Pia Bredt[2], Gudrun Heinrich[1], and Marius Höfer[1] — [1]Institute for Theoretical Physics, Karlsruhe Institute of Technology (KIT), Wolfgang-Gaede-Str. 1, 76131 Karlsruhe, Germany — [2]Department of Physics, University of Siegen, Walter-Flex-Straße 3, 57068 Siegen, Germany

We present a calculation of the NLO QCD corrections to Higgs boson pair production in vector boson fusion, combined with the leading operators parametrising anomalous interactions in non-linear Effective Field Theory (HEFT). Based on our Monte Carlo implementation using GoSam+Whizard, we investigate the effects of anomalous Higgs couplings on various observables.

T 67.8 Thu 18:00 ZHG104

$\gamma\gamma b\bar{b}$ in a variable flavor number scheme — •Orcun Kolay[1], Stefan Höche[2], and Frank Siegert[1] — [1]Technische Universität Dresden, Germany — [2]Fermi National Accelerator Laboratory, Batavia, USA

Measuring Higgs boson pair production is crucial for directly probing the Higgs trilinear coupling, with $HH \to \gamma\gamma b\bar{b}$ emerging as one of the most sensitive final states at the HL-LHC. Given the significant continuum diphoton background, precise background modeling is essential to improve search sensitivity. This talk will present a novel approach that combines $\gamma\gamma b\bar{b}$ (4-flavor scheme, 4FS) and $\gamma\gamma$+jets processes (5-flavor scheme, 5FS) within the Sherpa framework. By incorporating b-quark mass effects and employing a variable flavor number scheme, this improved methodology enables more accurate predictions for scenarios involving fake heavy-flavor jets and aligns seamlessly with $\gamma\gamma$+jet simulations. These advancements provide a more comprehensive and precise description of the background for the $HH \to \gamma\gamma b\bar{b}$ analysis.

T 67.9 Thu 18:15 ZHG104

Comparison between off-shell and on-shell sensitivity to trilinear Higgs couplings at future colliders based on EFTs and models with an extended Higgs sector — Henning Bahl[1], Philip Bechtle[2], Johannes Braathen[3], Klaus Desch[2], Christian Grefe[2], Sven Heinemeyer[4], Jenny List[3], •Murillo Vellasco[2], and Georg Weiglein[3,5] — [1]Institute for Theoretical Physics (ITP), Universität Heidelberg, Germany — [2]Physikalisches Institut, Universität Bonn, Germany — [3]Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany — [4]Instituto de Física Teórica (UAM/CSIC), Universidad Autónoma de Madrid, Spain — [5]Institut für Theoretische Physik, Universität Hamburg, Germany

Measuring the Higgs potential is one of the main goals of the next generation of high-energy particle colliders. Studies of the future sensitivity to trilinear Higgs coupling, λ_{hhh}, have been mainly performed within the framework of EFTs, which offer some degree of model-independence. However, not only is the EFT approach not valid if BSM degrees of freedom are not fully decoupled, but one must often make a selection of relevant operators to consider out of larger set thereof.

In this work, we have investigated the sensitivity to λ_{hhh} at future colliders based on UV-complete models with extended Higgs sectors, while also comparing with results from EFT analyses. In particular, we considered cases where on-shell measurements sensitive to λ_{hhh} would show considerable deviations from the SM value, all the while avoiding large deviations in off-shell observables. The results highlight the need to go beyond EFT frameworks.

T 67.10 Thu 18:30 ZHG104

Renormalisation scheme dependence of the trilinear Higgs coupling in extended scalar sectors — •Marc Hannig[1], Marco Menen[1,2], Elina Fuchs[1,2,3], Henning Bahl[4], Georg Weiglein[3,5], and Johannes Braathen[3] — [1]Institut für Theoretische Physik, Leibniz Universität Hannover — [2]Physikalisch-Technische Bundesanstalt (PTB), Braunschweig — [3]Deutsches Elektronen- Synchrotron DESY, Hamburg — [4]Institut für Theoretische Physik, Universität Heidelberg — [5]II. Institut für Theoretische Physik, Universität Hamburg

The trilinear Higgs coupling λ_{hhh} of the detected Higgs boson is a critical observable for understanding of the Higgs potential. With improving experimental bounds in the future, the theoretical predictions of this coupling for constraining BSM parameters become increasingly significant. Using the public code `anyH3`, this study investigates the numerical stability of different renormalization schemes for λ_{hhh} at one-loop level in extended scalar sectors. By comparing predictions of the coupling for various schemes, this study develops algorithmic criteria for switching between renormalisation schemes depending on the parameter region of the BSM model. This approach ensures numerically stable and reliable predictions for the trilinear Higgs coupling.