T 75: Higgs Physics VII

Time: Thursday 16:15–18:15 Location: KH 01.019

T 75.1 Thu 16:15 KH 01.019

Projection Studies of the ttHH 1L Channel for the HL-LHC — •Doğa Elitez[1], Lucia Masetti[2], and Paul Gessinger[1] — [1]CERN — [2]JGU Mainz

The Higgs boson self-coupling is a central ingredient of electroweak symmetry breaking, and constraining this coupling is essential for validating the Standard Model and determining the shape of the Higgs potential. The cross-section for Higgs-pair production in association with top quarks (ttHH) is expected to increase significantly at higher LHC beam energies, making ttHH production a compelling process to study in the high-luminosity LHC (HL-LHC) era. A particularly challenging and informative decay channel is the ttHH(6b) one-lepton channel, in which one of the top quarks decays semi-leptonically and produces an electron or muon, while the Higgs pair decays into four b-quarks. In this talk, projection studies of the ttHH(6b) one-lepton channel for the HL-LHC are presented.

T 75.2 Thu 16:30 KH 01.019

Higgs self-coupling measurement from di-Higgs production at a future e+e- collider — •Julie Torndal[1,2], Jenny List[1], Bryan Bliewert[1,2], Mikael Berggren[1], Junping Tian[3], Taikan Suehara[3], Dimitris Ntounis[4], and Caterina Vernieri[4] — [1]DESY, Harmburg, Germany — [2]Universität Hamburg, Hamburg Germany — [3]SLAC, Menlo Park, United States — [4]The University of Tokyo, Tokyo, Japan

Linear e^+e^- colliders have the energy reach to directly access the Higgs self-coupling at tree-level through di-Higgs production while offering a clean experimental environment. At a centre-of-mass energy of 550 GeV, two processes contribute, who have different dependencies on the value of κ_λ offering a complementarity important for BSM scenarios. The leading contribution comes from Higgs strahlung, ZHH, with a small addition from the WW fusion. In this contribution, the ongoing analysis of the $HH \to 4b$ channel will be presented using fast SGV (Simulation à Grande Vitesse) based simulation of the ILD (International Large Detector) concept with the full SM background. Improvements in flavour tagging and kinematic reconstruction will be discussed, and the status of the event selections using advanced machine learning techniques will be presented before evaluating the cross-section precisions for each channel and translating those into a precision on κ_λ for the SM and BSM case. The precise measurement of the Higgs self-coupling offers new insights central to the Higgs sector, in determining the shape of the Higgs potential and understanding the mechanism behind electroweak symmetry breaking.

T 75.3 Thu 16:45 KH 01.019

Improving the event reconstruction and scalability of the Higgs self-coupling analysis at ILD — Mikael Berggren[1], •Bryan Bliewert[1,2], Jenny List[1], Dimitris Ntounis[3], Taikan Suehara[4], Junping Tian[4], Julie Munch Torndal[1,2], and Caterina Vernieri[3] — [1]Deutsches Elektronen-Synchrotron DESY, Germany — [2]Universität Hamburg, Germany — [3]SLAC National Accelerator Laboratory, USA — [4]University of Tokyo, Japan

The shape of the Higgs potential gives crucial insight into the Higgs mechanism. At future e^+e^--colliders and center-of-mass energies of $\geq$ 550 GeV, the Higgs potential can be probed directly by measuring the self-coupling λ through di-Higgs production. In an ongoing effort, the projected sensitivities for λ are updated assuming the ILD concept at an LCF 550-like facility. In our contribution, we discuss recent advancements in event reconstruction: First, we cover the identification and removal of low-p_t hadrons (overlay) using machine learning (ML) and its effect on the di-jet invariant mass resolution. Second, we present how variables based on leading order matrix elements improve the event selection. Furthermore, we have designed our analysis using a modern distributed pipelining system (luigi/law) and present key concepts of this framework. It covers all steps from detector simulation to sensitivity extraction, greatly improving automation, reproducibility and scalability and producing results in a few hours for 150M events with o(1000) computing nodes. We conclude by showing the impact of the reconstruction advances on the measurement of the di-Higgs cross-section and the corresponding precision on λ.

T 75.4 Thu 17:00 KH 01.019

Assessing uncertainties in the determination of the trilinear Higgs self-coupling from single-Higgs observables — Henning Bahl[1], Philip Bechtle[2], Johannes Braathen[3], 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

Probing the nature of the Higgs potential is a primary objective of the next generation of flagship particle physics experiments, for which measuring λ_{hhh}, the trilinear Higgs self-coupling, will play a crucial role. Despite operating below the di-Higgs production threshold, circular e^+e^- machines will still have indirect access to λ_{hhh} via its loop-level contributions to single-Higgs production observables. In this work, we investigate how well λ_{hhh} can be determined by such indirect effects within a global EFT fit. While most studies to date assume that future measurements will be compatible with SM predictions, here we consider non-SM values of λ_{hhh}, using an inert doublet extension of the SM as an example of a New Physics scenario that could be realised in nature. We find that theory uncertainties related to the truncation of the EFT expansion and to higher-order corrections, which are often neglected, can have a substantial impact on the resulting precision for λ_{hhh}.

T 75.5 Thu 17:15 KH 01.019

Beam-beam effects at the Hybrid Asymmetric Linear Higgs Factory — •Shriyansh Ranjan[1,2], Jenny List[1], and Mikael Berggren[1] — [1]Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany — [2]Universität Hamburg, Hamburg, Germany

Since the discovery of the Higgs boson in 2012, probing the Higgs potential has become a primary objective for understanding vacuum stability and searching for Beyond Standard Model (BSM) physics. This precise measurement of the Higgs potential requires the clean environment of an e+e- collider. The Hybrid Asymmetric Linear Higgs Factory (HALHF) utilizes plasma-wakefield acceleration (PWFA), an emerging accelerator technology, to create high-energy collisions capable of such precision.

However, the resulting beam conditions drive strong-field QED processes that reshape the luminosity spectrum and increase detector backgrounds. To address these challenges, advanced simulation tools are required. Our study models these beam-induced backgrounds for HALHF using cutting edge simulation software, providing inputs helpful in designing the asymmetric ILD detector at HALHF.

This talk presents simulation results for the highly asymmetric e+e- collisions at HALHF, evaluating the beam-induced backgrounds as well as the luminosity spectrum and its impact on key physics measurements. The outcomes will be discussed across different center-of-mass energies from 250 GeV to 550 GeV.

T 75.6 Thu 17:30 KH 01.019

Probing Strong First-Order Electroweak Phase Transition scenarios in 2HDM with FCC-ee/CEPC — •Anisha Anisha[1,2], Francisco Arco[3], Stefano Di Noi[1], Christoph Englert[4], and Margarete Mühlleitner[1] — [1]Institute for Theoretical Physics, Karlsruhe Institute of Technology (KIT), Wolfgang-Gaede Straße 1, D-76131, Karlsruhe, Germany — [2]Institute for Astroparticle Physics, Karlsruhe Institute of Technology, Hermann-von-Helmholtz-Platz 1, D-76344, Eggenstein-Leopoldshafen, Germany — [3]Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, D-22607 Hamburg, Germany — [4]Department of Physics and Astronomy, University of Manchester, Oxford Road, Manchester M13 9PL, United Kingdom

We investigate the potential of future electron-positron colliders, such as FCC-ee and CEPC, to probe 2-Higgs-doublet models (2HDMs) that facilitate a strong first-order electroweak phase transition (SFOEWPT), a necessary condition for electroweak baryogenesis. Focusing on a 2HDM in the CP-conserving limit, we identify parameter regions consistent with an SFOEWPT and evaluate their compatibility with projected precision electroweak and Higgs measurements, as well as searches for exotic Higgs bosons. We show that radiative corrections to $e^+e^- \to hZ$ production introduce deviations in the cross

section that are resolvable with the anticipated sub-percent precision at lepton colliders even when experimental outcomes of the LHC and Z pole measurements are in agreement with the SM. This underscores the opportunities of a precision lepton collider to explore BSM quantum corrections to the Higgs sector more broadly.

T 75.7 Thu 17:45 KH 01.019

Higgs Measurements at Photon Colliders — •Ayoade Sotona — Universität Hamburg

The Photon-Collider offers a complementary experimental programm for possible future linear colliders to e+e-. The cross-section of photon-photon collisions can be multitudes higher than those of corresponding electron-positron collisions, which makes them particularly interesting for (Di-)Higgs production and the measurement of trilinear couplings.

T 75.8 Thu 18:00 KH 01.019

Probing the Higgs potential via Higgs pair production at photon-photon colliders — •Gudrid Moortgat-Pick[1,2], Marten Berger[1], Georg Weiglein[2], and Johannes Braathen[2] — [1]University of Hamburg — [2]Deutsches Elektronen Synchrotron

A $\gamma\gamma$ collider, either in conjunction with an e^+e^- linear collider or as a stand-alone facility, offers a very attractive Higgs physics programme at relatively low centre-of-mass (c.m.) energies. A c.m. energy as low as 280 GeV can probe the Higgs potential via the Higgs pair production process providing access to the trilinear Higgs-boson self-coupling. High polarisation of the photon beams (produced via Compton backscattering) can be achieved and adjusted by flipping the polarisation of the incident laser. The prospects for exploring the Higgs pair production process at a $\gamma\gamma$ collider are assessed by comparing different running scenarios utilising different types of the incident laser. The possibility to use photon polarisation has been exploited as well.