T 55: Bosonic and Rare Higgs decays

Time: Wednesday 16:00–18:30 Location: Te

T 55.1 Wed 16:00 Te

Background Modelling in the ATLAS $H \to \gamma\gamma$ Differential Cross Section Analysis — •Nils Gillwald — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

Since its discovery in 2012, efforts to measure the Higgs boson properties as precisely as possible are ongoing in order to probe the Standard Model of particle physics and look for potential deviations from its predictions. Differential cross section measurements are an important part of these efforts. They aim at providing model-independent differential measurements of different kinematic and event observables, offering access to e.g. properties of perturbative QCD, the spin and CP nature of the Higgs boson, bottom and charm Yukawa couplings and potential new heavy particles coupling to the Higgs boson. This talk focuses on an analysis in the $H \to \gamma\gamma$ decay channel, using the full Run-2 data set taken between 2015 and 2018.

The general measurement strategy uses a signal and background fit to data to extract signal and background yields, which are then unfolded to particle level. For this fit, a functional form describing the background distribution needs to be determined. This is done based on Monte Carlo simulated templates. The potential bias on the measurement due to the choice of the background model is the largest systematic uncertainty in the fit procedure. This uncertainty is called the *spurious signal* uncertainty.

In this talk, the $H \to \gamma\gamma$ differential cross-section analysis is discussed with an emphasis on the background modelling strategy and the resulting spurious signal estimate.

T 55.2 Wed 16:15 Te

Measurement of $H \to WW^*$ Decays in the $\ell\nu qq$ Final State with a Large-R Jet — •Johannes Hinze, Karsten Köneke, and Benedict Winter — Universität Freiburg

The talk presents a study of $H \to WW^*$ decays at large transverse momenta ($p_{\mathrm{T},H} > 200$ GeV) with one leptonic ($W \to \mu\nu$ or $W \to e\nu$) and one hadronic W boson decay, where the experimental signature of the hadronic W boson decay is a large-R jet. The lepton provides means to efficiently trigger event candidates and to eliminate background events in particular from multijet events. Further background events, primarily from W+jets events, can be suppressed via W-boson taggers for large-R jets. The measurement benefits from the larger branching fraction in comparison with $\ell\nu\ell\nu$ final states, and from the reduced background levels for large transverse momenta. The measurement will contribute significantly in an area of the phase space that is considered particularly sensitive to possible BSM effects.

T 55.3 Wed 16:30 Te

Combination of Higgs boson measurements using Simplified Template Cross Sections at the ATLAS experiment — •Joshua Clercx — Hamburg University, Hamburg, Germany — DESY, Hamburg, Germany

Experimental measurements of certain high energy physics parameters could show deviations from the theoretical predictions, which would indicate the existence of physics beyond the standard model (BSM). Depending on where these deviations are found, it also gives some insight into which BSM physics theories are interesting to further investigate. Measurements in the Higgs sector are especially interesting, as there are many opportunities to detect BSM effects here. The most precise measurements in the Higgs sector are obtained by combining measurements of cross sections of different Higgs boson production processes in several Higgs boson decays. This is typically done in the Simplified Template Cross Sections (STXS) framework: measurements of cross sections of mutually exclusive regions of phase space, defined per production process, are combined. What will be presented is the most recent combination from the summer of 2020, which is based on analyses of 13 TeV data.

T 55.4 Wed 16:45 Te

New limit on the Higgs-to-invisible branching fraction based on a combination of ATLAS searches at $\sqrt{s} = 7$, 8 and 13 TeV — •Philipp Mogg — Ludwigs-Maximilians-Universität München

In the Standard Model the Higgs-to-invisible branching fraction is very small, hence, current experiments are not expected so be sensitive to it. However, many extensions of the Standard Model suggest a significantly higher branching ratio, as e.g. Higgs-portal models, where the Higgs boson acts as a mediator between dark matter and ordinary matter. This contribution presents a novel combination by the ATLAS collaboration of different searches sensitive to invisible Higgs decays. Together with the LHC Run 1 search results, the present combination obtains the currently best direct limit on the Higgs-to-invisible branching fraction. The talk will highlight the analyses entering the combination, as well as the interpretations made, as in particular in Higgs-portal dark matter models.

T 55.5 Wed 17:00 Te

Di-higgs physics with the CMS experiment in multilepton final states - Motivation and results — •Torben Lange, Tobias Kramer, Oliver Rieger, and Peter Schleper — Institut für Experimentalphysik, Universität Hamburg

With the conclusion of the LHC Run 2 data taking period an unprecidented amount of high energy collision data is now available. The dataset consists of 137 fb^{-1} recorded by the CMS experiment at a center of mass energy of $\sqrt{s} = 13$ TeV. This allows for the study of rare processes including the production of two SM higgs bosons either with our without the so far unmeasured trilinear di-higgs self coupling or BSM physics. The presented analysis is the first CMS search for di-higgs processes in the multilepton final states motivated by $h \to WW$ and $h \to \tau\tau$ decays. It aims at providing limits on the trilinear higgs self coupling as well as various cross section limits for BSM scenarios featuring either EFT modified couplings or heavy resonances decaying into higgs bosons. This talk focuses on the theoretical motivation and projected results of the presented analysis. There is a second talk focusing on the experimental methodology.

T 55.6 Wed 17:15 Te

Di-Higgs physics with the CMS experiment in multilepton final states - Experimental methodology — •Tobias Kramer, Torben Lange, Oliver Rieger, and Peter Schleper — Institut für Experimentalphysik, Universität Hamburg

The first CMS analysis searching for di-Higgs events in multilepton final states is presented. The full LHC Run 2 dataset corresponding to 137 fb^{-1} recorded by the CMS experiment at a center of mass energy of $\sqrt{s} = 13$ TeV is used. Several scenarios for producing events with two SM Higgs bosons are considered, such as the decay of heavy resonances as well as non-resonant production via the SM as well as EFT modified couplings. The targeted Higgs decays are $h \to WW$ and $h \to \tau\tau$ leading to various multilepton final states. The analysis aims at providing limits on the yet to be discovered trilinear Higgs self coupling as well as cross section limits for different BSM scenarios. This talk focuses on the experimental challenges. There is a second talk about the theoretical motivation and projected results.

T 55.7 Wed 17:30 Te

Search for pair-produced Higgs bosons decaying to W bosons and bottom quarks at CMS — •Mathis Frahm, Johannes Haller, Matthias Schröder, Dennis Schwarz, and Roman Kogler — Institut für Experimentalphysik, Universität Hamburg

The Higgs boson self-coupling is an important parameter of the Standard Model, since it is related to the shape of the Higgs potential. At the LHC, this parameter can be probed by measuring the Higgs boson pair production cross section. In the Standard Model, HH production occurs in processes that include the Higgs-boson self-coupling and in processes that include a fermion loop. Due to destructive interference of these two contributions, the resulting production cross-section is small, amounting to only 33 fb at the LHC.

In this talk, studies of the properties and the reconstruction of the signal are presented, focusing on the decay channel of two W bosons and two bottom quarks, where one W boson decays leptonically and the other one hadronically.

T 55.8 Wed 17:45 Te

Search for non-resonant di-Higgs production in the decay channel bbWW with one leptonically decaying W boson with the CMS experiment. — Martin Erdmann, Peter Fackeldey, Benjamin Fischer, and •Dennis Noll — III. Physikalisches Institut A - RWTH Aachen University

A measurement of the di-Higgs production can directly determine the trilinear Higgs coupling and probe the structure of the Higgs potential.

We present a search for Higgs boson pair production with one Higgs boson decaying into b quarks and the other one decaying into W bosons, with one W boson decaying leptonically. The search works in different kinematic regions (resolved or boosted Higgs decays) and on different flavours of the final state lepton (electron or muon).

The core of the analysis is a Neural Network driven Physics Process Multi-classification using a specialised physics motivated architecture, the Lorentz-Boost Network (LBN), in conjunction with a Residual Neural Network.

Expected limits, based on simulations corresponding to the Full Run 2 dataset, are presented.

T 55.9 Wed 18:00 Te

Search for non-resonant di-Higgs production in the decay channel bbWW with two leptonically decaying W boson with the CMS experiment — Martin Erdmann, •Peter Fackeldey, Benjamin Fischer, and Dennis Noll — III. Physikalisches Institut A - RWTH Aachen University

A measurement of the di-Higgs boson production constitutes a direct test of the electroweak symmetry breaking in the standard model of particle physics (SM). The coupling strength between three Higgs bosons (self-coupling) determines the shape of the Higgs potential and thus the vacuum stability of the universe. The cross section of the di-Higgs boson production is about a factor of thousand smaller in comparison to a single SM Higgs boson, making it a highly challenging statistically search.

The expected sensitivity for the HH→bbWW($l\nu l\nu$) final state is shown corresponding to Run II data.

T 55.10 Wed 18:15 Te

Search for Di-Higgs production in the $bb\gamma\gamma$ final state with the ATLAS detector — •Florian Beisiegel, Jochen Dingfelder, and Tatjana Lenz — Physikalisches Institut, Universität Bonn

The discovery of the Higgs boson in 2012 was a great success of modern particle physics since it served as a proof of the Higgs mechanism introduced in 1964. One focus of the current particle physics experiments at the LHC is the measurement of the Higgs properties, such as its coupling strengths to fundamental particles. In addition to the coupling of the Higgs boson to fermions and gauge bosons, the Higgs mechanism also predicts a Higgs self-coupling. The triple-Higgs self-coupling can be measured in the di-Higgs production channel (non-resonant production). Di-Higgs analyses also facilitate the search for new heavy particles that decay to two Higgs bosons (resonant production).

This talk presents a search for Di-Higgs production in the $bb\gamma\gamma$ final state using 139 fb^{-1} of proton-proton collisions at 13 TeV recorded with the ATLAS detector. The analysis aims to measure the non-resonant SM HH production cross section and the Higgs boson self-coupling as well as search for resonant di-Higgs production. The focus is put on studies to improve the limits on the non-resonant SM production cross-section using a 2D fit in the $m_{\gamma\gamma}$ and m_{bb} variables.