T 11: Higgs: bosonic decays and quantum numbers

Time: Monday 16:30–18:00 Location: H-HS XII

T 11.1 Mon 16:30 H-HS XII

Search for Di-Higgs production in the $bb\gamma\gamma$ final state with the ATLAS detector — •Florian Beisiegel, Jochen Dingfelder, Tatjana Lenz, and Norbert Wermes — Physikalisches Institut, Uni 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 strength as well as searching for resonant Di-Higgs production.

T 11.2 Mon 16:45 H-HS XII

A method to search for the non-resonant di-Higgs production cross-section in the dileptonic HH→bbWW final state — Martin Erdmann, •Peter Fackeldey, Benjamin Fischer, and Dennis Noll — III. Physikalisches Institut A, RWTH Aachen University

The measurement of the di-Higgs boson production is 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 statistically challenging search.
The expected sensitivity for the HH→bbWW($l\nu l\nu$) final state is shown corresponding to Run II data.

T 11.3 Mon 17:00 H-HS XII

Background modeling in the measurements of differential Higgs boson cross sections in the diphoton channel with the ATLAS detector — •Nils Gillwald — DESY, Hamburg, Germany

Since the discovery of the Higgs boson in July 2012, efforts have been underway to measure its properties as precisely as possible. An important part of these efforts is the differential measurements of the $H \to \gamma\gamma$ cross section. Such measurements of different spectra of kinematic and event observables offer access to e.g. properties of perturbative QCD, the spin and CP nature of the Higgs boson, bottom and charm Yukawa couplings and new heavy particles coupling to the Higgs boson. The dominating uncertainty for the latest full LHC Run 2 results in the measurement of $H \to \gamma\gamma$ differential cross sections is the estimation of the spurious signal, i.e. the potential bias on the measurement due to the background modeling. Improving the estimate on the spurious signal, and thus the background modeling, is therefore of utmost importance for a precise measurement. In this talk, I present the work in progress on the improvements of the background modeling. This includes a discussion on shortcomings as well as potential further improvements for Run 2 and beyond.

T 11.4 Mon 17:15 H-HS XII

Investigation of the CP properties of VBF Higgs production in the $H \to \tau_{\text{had}}\tau_{\text{had}}$ channel with the ATLAS detector — •Serhat Ördek and Stan Lai — Georg-August-Universität Göttingen

Recent studies at the LHC have led to the observation of the Higgs boson decay to tau leptons with a rate compatible with the Standard Model expectation. This observation opens the possibility of a more in-depth investigation of the properties of the production and decay of a Higgs boson into tau leptons, including whether or not the Higgs boson couplings involved violate CP conservation. The analysis presented in this talk focuses on events where Higgs bosons are produced via vector boson fusion in order to investigate the tensor structure of their coupling to electroweak gauge bosons. For this, a profile likelihood fit using a matrix-element observable method is employed in the decay to tau leptons to test whether a CP-odd component and hence CP violation is present in the coupling. Emphasis will be placed on the fully hadronic final state.

T 11.5 Mon 17:30 H-HS XII

Measurement of the Higgs boson CP quantum number in tau-tau decays with the CMS experiment — •Oleg Filatov, Elisabetta Gallo, Alexei Raspereza, Andrea Cardini, and Merijn van de Klundert — Deutsches Elektronen-Synchrotron (DESY)

The Standard Model (SM) predicts the existence of a CP-even Higgs boson. Measuring the CP quantum number of the Higgs boson is therefore useful to confirm the prediction of the SM and search for evidences pointing to new physics. The study of bosonic decays of the Higgs boson has already excluded a CP-odd Higgs, however direct measurement of a mixing angle between a CP-even and a CP-odd state has not been performed yet. The H->tautau decay at tree level is sensitive to the CP parity of the Higgs boson and offers a possible measurement of the CP mixing angle. The decay planes of the two tau leptons are reconstructed using the decay products in the mutau channel and the angle between them is used to estimate the CP mixing angle. The Run 2 data collected by the CMS experiment in proton-proton collisions at the LHC are used to estimate the sensitivity of the CP measurement.

T 11.6 Mon 17:45 H-HS XII

Test of CP invariance in vector-boson fusion production of the Higgs boson using $H \to \tau\tau$ decays at $\sqrt{s} = 13$ TeV with the ATLAS detector — Kathrin Becker[1,2], •David Hohn[1], Alena Lösle[1], Dirk Sammel[1], and Markus Schumacher[1] — [1]Albert-Ludwigs-Universität Freiburg — [2]University of Warwick

Violation of CP invariance is one of the Sakharov conditions to explain the observed baryon asymmetry in our universe. While CP violation is already realised in the Standard Model via the CKM matrix, it is not sufficient to explain the amount of observed baryon asymmetry. Hence, it is interesting to search for new sources of CP violation in the Higgs sector. The vector-boson fusion production allows to investigate the CP structure of the Higgs-boson coupling to electroweak gauge bosons HVV and to test its CP invariance.

The analysis discussed in this talk is performed in the $H \to \tau\tau$ decay channel and uses the CP-odd *Optimal Observable* to search for additional CP-odd contributions to the SM HVV coupling structure. The result is based on data taken by the ATLAS detector in 2015 and 2016 at $\sqrt{s} = 13$ TeV corresponding to an integrated luminosity of 36.1 fb^{-1}. This talk focuses on the $\tau_{\text{lep}}\tau_{\text{lep}}$ and $\tau_{\text{lep}}\tau_{\text{had}}$ analysis categories and the combined result.