Search for non-resonant Higgs boson pair production in the dilepton final states of the bbWW day mode at CMS

Lara Markus
University 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 Higgs self-coupling can be directly probed by measuring the cross section of Higgs boson pair (HH) production. In my thesis, I search for non-resonant pair production of Higgs bosons decaying into a b quarkâantiquark pair and two W bosons, with subsequent decays of the W bosons into leptons and neutrinos. For this purpose, I use data recorded by the CMS detector during Run 2 and Run 3 of the Large Hadron Collider, corresponding to center-of-mass energies of 13 and 13.6 TeV, respectively. As these analyses are mainly constrained by statistical uncertainties, especially the next few years will be a particularly interesting period for Higgs boson pair production.
The analysis strategy is developed using simulated protonâproton collisions recorded by the CMS experiment in 2017, corresponding to an integrated luminosity of 41.48 fb^{-1}, and is now being prepared for Run 3. The first step in the analysis strategy is an event selection tailored to the topology of the final state. We require exactly two isolated leptons and at least one b-tagged jet. Additionally, a cut on the invariant mass of the dilepton system, $m_{\ell\ell} < 80$ GeV, is applied. Next, a deep neural network is trained to classify events as either signal or background. The use of the NN is twofold: first, as a multiclassifier, it is used to perform event categorization according to the signal and main background processes; second, its output score is used as a sensitive observable to perform statistical inference and derive upper limits on the HH production cross section, assuming Standard Model predictions.
Using the 2017 data, the expected upper limit on the HH production cross section is 26 times the value predicted by the Standard Model, at 95% confidence level. The upper limit is also derived as a function of various Higgs boson coupling modifiers, κ_λ, leading to an exclusion of κ_λ outside the range $[-12.3, 18.8]$ seen in the Figure below. In addition, the results of the analysis are projected to higher-luminosity periods to estimate the achievable sensitivity for future measurements with the developed strategy.

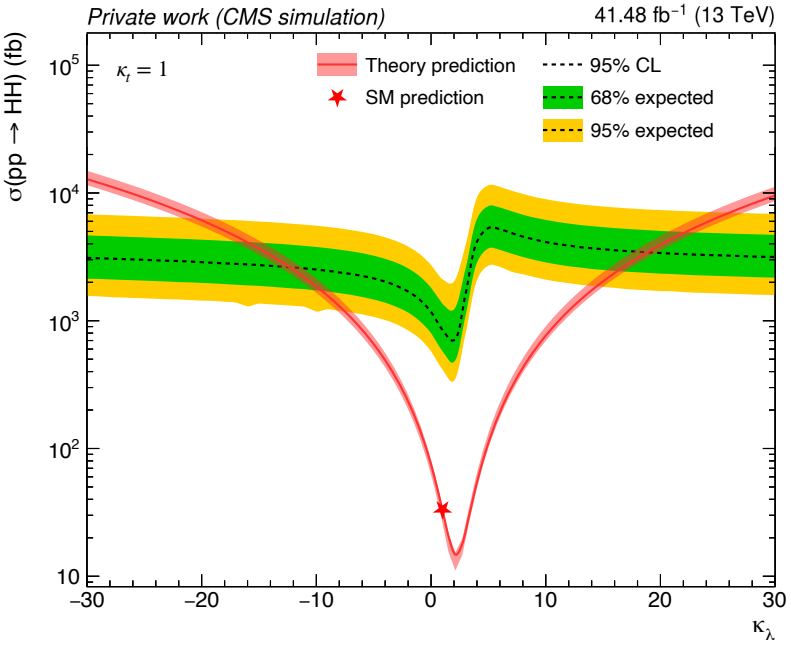

Abbildung 1: Exclusion limits on κ_λ using 2017 data.