The Compact Muon Solenoid Experiment

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Search for Heavy Neutral Higgs in di-boson final state at $\sqrt{s} = 13$ TeV

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Abstract

We summarise the recent results on neutral heavy Higgs searches in the di-boson final state using 13 TeV data set collected by the CMS in 2015 and 2016. The search mainly targets for a scalar search where gluon-fusion and vector boson fusion production hypothesis are considered. Search strategy covers a mass range from few hundred GeV to TeV level by testing narrow and wide-width hypotheses.

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Keywords: CMS, heavy Higgs

1 Introduction

A new boson with a mass of about 125 GeV was reported in 2012 by the ATLAS [1] and CMS [2,3] collaborations at the CERN LHC which is consistent with the Higgs boson of the standard model (SM) of electroweak (EW) interactions. However, such a particle can be realised in several Beyond Standard Model (BSM) scenarios such as two-Higgs doublet models which predict the existence of an additional resonance at high mass with couplings similar to those of the SM Higgs boson. In this paper, we cover the search results for heavy neutral resonance decaying to WW and ZZ with fully final leptonic states using CMS.

2 Data and simulated samples

We cover the details of $H \rightarrow ZZ \rightarrow 4\ell$ ($\ell=e,\mu$). Details for $H \rightarrow WW \rightarrow 2\ell 2\nu$ can be found in [4]. The data samples used for the analysis were recorded in proton-proton collisions at 13 TeV corresponding to total integrated luminosity of 12.9 fb^{-1} . The signal samples were generated for the gluon-gluon fusion (ggH) and vector boson fusion (VBF) production modes at next-to-leading order (NLO) in QCD using POWHEG v2 for different masses.

3 Event selection and background estimation

Each event is required to have four isolated leptons grouped into $2e2\mu$, $4e$ and 4μ final states and to separate gluon fusion and VBF production, a matrix-element based discriminant has been used. The main processes producing the backgrounds are $Z + jets$, $t\bar{t} + jets$, $Z\gamma + jets$, $WW + jets$ and $WZ + jets$ and are denoted as $Z + X$ since they are dominated by the $Z + jets$ process. The background is estimated using two independent control regions in data by requiring the presence of two leptons which satisfy the "tight" identification criteria, plus two additional opposite-sign (OS) or same-sign (SS) leptons satisfying

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relaxed (“loose”) identification requirements. The category of events composed with two leptons which pass (P) the lepton tight identification requirements and two leptons which pass the loose identification but fail (F) the tight identification are denoted as the 2P2F region. Backgrounds which intrinsically have only two prompt leptons, such as $Z + \text{jets}$ and $t\bar{t}$ are estimated by this control region [5].

4 Results

The observed p-value and the 95 percent CL upper exclusion limit are calculated for every generated mass point from 130 GeV up to 2.5 TeV for different signal width hypothesis. The expected and observed exclusion limits on the sum of ggH and VBF cross sections times branching fraction is shown in Fig. 1.

Fig. 1: (a) Distribution of reconstructed invariant mass m_{4l} (b) Combination of the OS and SS method predictions for the background in the signal region and the parametrized m_{4l} shape. (c) Observed and expected upper limits at the 95% CL on the $X \rightarrow ZZ \rightarrow 4\ell$ cross section as a function of resonance mass at several Γ_X values [5].

5 Conclusion

A search for a heavy Higgs boson in the $X \rightarrow WW \rightarrow 2\ell 2\nu$ and $X \rightarrow ZZ \rightarrow 4\ell$ decay channels has been carried out in various jet categories in order to maximize the exclusion limits using 2015 and 2016 data samples recorded at $\sqrt{s} = 13$ TeV corresponding to total integrated luminosity of 12.9 fb^{-1} of proton-proton collisions by the CMS. The exclusion limits on the cross section times branching ratio have been reported and no significant excess with respect to the SM background expectation has been observed.

References

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