The interpretation of the observed limits in a Type II 2HDM is performed in the “physics basis”. The inputs to this interpretation are the physical Higgs boson masses ($m_h, m_H, m_A, m_{H^\pm}$), the ratio of the vacuum expectation energies ($\tan\beta$), the CP-even Higgs mixing angle ($\alpha$) and $m_{12}^2 = m_A^2 \left[ \frac{\tan\beta}{\tan\beta + \tan\beta} \right]$. We assume that $m_H = m_A = m_{H^\pm}$.

The cross-sections and branching fractions in the 2HDM were calculated as described by the LHC Higgs Cross Section Working Group [72]. The exclusion regions, calculated using the combination of the $H \to hh \to bb\tau\tau$ and $A \to Zh \to \ell\ell\tau\tau$ analyses, in the $\cos(\beta - \alpha)$ vs. $\tan\beta$ plane for such a Type II 2HDM scenario with a heavy Higgs boson mass of 300 GeV are shown in Fig. 12. This can be compared to Fig. 5 in Ref. [38].

8 Summary

A search for a heavy scalar Higgs boson ($H$) decaying into a pair of SM-like Higgs bosons ($hh$) and a search for a heavy neutral pseudoscalar Higgs boson ($A$) decaying into a Z boson and a SM-like Higgs boson ($h$), have been performed using events recorded by the CMS experiment at the LHC. The dataset corresponds to an integrated luminosity of 19.7 fb$^{-1}$, recorded at 8 TeV centre–of–mass energy in 2012. No evidence for a signal has been found and exclusion limits on the production cross section times branching fraction for the processes $H \to hh \to bb\tau\tau$ and $A \to Zh \to \ell\ell\tau\tau$ are presented. The results are also interpreted in the context of the MSSM and 2HDM models.

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