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Search strategies for pair production of heavy Higgs bosons decaying invisibly at the LHC

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The search for heavy Higgs bosons at the LHC represents an intense experimental program, carried out by the ATLAS and CMS collaborations, which includes the hunt for invisible Higgs decays and dark matter candidates. No significant deviations from the SM backgrounds have been observed in any of these searches, imposing significant constraints on the parameter space of different new physics models with an extended Higgs sector. Here we discuss an alternative search strategy for heavy Higgs bosons decaying invisibly at the LHC, focusing on the pair production of a heavy scalar H together with a pseudoscalar A , through the production mode $q\bar{q} \rightarrow Z^* \rightarrow HA$. We identify as the most promising signal the final state made up of $4b + E_{\text{miss}}$, coming from the heavy scalar decay mode $H \rightarrow hh \rightarrow bb\bar{b}b\bar{b}$, with h being the discovered SM-like Higgs boson with $m_h = 125$ GeV, together with the invisible channel of the pseudoscalar. We work within the context of simplified MSSM scenarios that contain quite heavy sfermions of most types with $\mathcal{O}(10)$ TeV masses, while the stops are heavy enough to reproduce the 125 GeV mass for the lightest SM-like Higgs boson. By contrast, the gauginos/higgsinos and the heavy MSSM Higgs bosons have masses near the EW scale. Our search strategies, for a LHC center-of-mass energy of $\sqrt{s} = 14$ TeV, allow us to obtain statistical significances of the signal over the SM backgrounds with values up to $\sim 1.6\sigma$ and $\sim 3\sigma$, for total integrated luminosities of 300 fb^{-1} and 1000 fb^{-1} , respectively.

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