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## Prospects of non-resonant Higgs pair production at the HL-LHC and HE-LHC

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We study the prospects of observing the non-resonant Higgs pair production in the Standard Model (SM) at the high luminosity run of the 14 TeV LHC (HL-LHC), upon combining multiple final states chosen on the basis of their yield and cleanliness, namely,  $b\bar{b}\gamma\gamma$ ,  $b\bar{b}\tau^+\tau^-$ ,  $b\bar{b}WW^*$ ,  $WW^*\gamma\gamma$  and  $4W$  channels by employing multivariate analyses using the Boosted Decision Tree (BDT) algorithm to optimise the discrimination between signal and backgrounds and find it performing better than simple cut-based analyses. We also explore the implications of varying  $\lambda_{hhh}$  for the most sensitive search channel for the double Higgs production, namely,  $b\bar{b}\gamma\gamma$ . (arXiv:1712.05346)

Upon continuation of the previous work, here, we analyse the prospects of observing the non-resonant Higgs production in the Standard Model at the proposed high energy upgrade of the LHC, namely, the HE-LHC ( $\sqrt{s} = 27$  TeV and  $15 ab^{-1}$  of integrated luminosity). Various di-Higgs final states are considered based on their cleanliness and production rates, namely,  $b\bar{b}\gamma\gamma$ ,  $b\bar{b}\tau^+\tau^-$ ,  $b\bar{b}WW^*$ ,  $WW^*\gamma\gamma$ ,  $b\bar{b}ZZ^*$  and  $b\bar{b}\mu^+\mu^-$  channels. The signal-background discrimination is performed through multivariate analyses using the Boosted Decision Tree Decorrelated (BDTD) algorithm in the TMVA framework, the XGBoost toolkit and Deep Neural Network (DNN). The variation in the kinematics of Higgs pair production as a function of the self-coupling of the Higgs boson,  $\lambda_{hhh}$ , is also studied. The ramifications of varying  $\lambda_{hhh}$  on the  $b\bar{b}\gamma\gamma$ ,  $b\bar{b}\tau^+\tau^-$  and  $b\bar{b}WW^*$  search analyses optimized for the SM hypothesis is also explored. (arXiv:2006.11879)

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