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Probing Trilinear Higgs Self-coupling at the HL-LHC via Multivariate Analysis

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We perform a multivariate analysis of the Higgs-pair production in $HH \to b\bar{b}\gamma\gamma$ channel at the HL-LHC to probe the trilinear Higgs self-coupling λ_{3H}, which takes the value of 1 in the SM. We consider all the known background processes. And, for the signal, we adopt the most recent event generator of OWHEG-BOX-V2 to exploit the NLO distributions for Toolkit for Multivariate Data Analysis (TMVA), taking account of the full top–quark mass dependence. Through Boosted Decision Tree (BDT) analysis trained for $\lambda_{3H} = 1$,
we find that the significance can reach up to 1.55 with about 6 signal and 14 background events. And, the Higgs boson self-coupling can be constrained to $0.53 < \lambda_{3H} < 6.80$ at 95\% confidence level (CL).
We also perform a likelihood fitting of $M_{\gamma\gamma bb}$ distribution and find the 1σ confidence interval (CI) of $-0.1 < \lambda_{3H} < 2.8 \cup 4.9 < \lambda_{3H} < 7.0$ for the $\lambda_{3H} = 1$ nominal set. Using BDTs trained for each value of λ_{3H}, we find a bulk region of $0.5| \sim \lambda_{3H}| \sim 5$ in which
it is hard to one cannot pin down the trilinear coupling.

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