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Boosting Higgs pair production in the $b\bar{b}b\bar{b}$ final state with multivariate techniques

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The measurement of Higgs pair production will be a cornerstone of the LHC program in the coming years. Double Higgs production provides a crucial window upon the mechanism of electroweak symmetry breaking and has a unique sensitivity to the Higgs trilinear coupling. We study the feasibility of a measurement of Higgs pair production in the $b\bar{b}b\bar{b}$ final state at the LHC. Our analysis is based on a combination of traditional cut-based methods with state-of-the-art multivariate techniques. We account for all relevant backgrounds, including the contributions from light and charm jet mis-identification, which are ultimately comparable in size to the irreducible $4b$ QCD background. We demonstrate the robustness of our analysis strategy in a high pileup environment. For an integrated luminosity of $L = 3 \text{ ab}^{-1}$, a signal significance of $S/\sqrt{B} \approx 3$ is obtained, indicating that the $b\bar{b}b\bar{b}$ final state alone could allow for the observation of double Higgs production at the High Luminosity LHC.

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