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Search for $t\bar{t}HH$ production at CMS Run 2 with each Higgs boson decaying to a b-quark pair

Precision measurements of Higgs boson couplings to Standard Model (SM) particles remain a central focus at the LHC and the upcoming HL-LHC. In particular, the interaction between the Higgs boson and the top quark is particularly compelling due to the large $\sim O(\text{nb})$ $t\bar{t}$ cross section and $O(1)$ top-quark Yukawa coupling. The $t\bar{t}HH$ process offers a unique opportunity to probe the top-quark Yukawa coupling while enabling a direct measurement of the Higgs boson's trilinear self-coupling. This analysis searches for SM $t\bar{t}HH$ production with the CMS detector, focusing on single-lepton and di-lepton decays of the top-quark pair and Higgs decay to b-quarks using full Run 2 data. Advanced machine learning techniques are employed for event reconstruction and classification to enhance sensitivity.

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