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Probing anomalous Higgs couplings at the future μ^+p collider

We investigate Higgs boson pair production at a future high-energy muon–proton (μ^+p) collider through the charged-current vector-boson-fusion process $\mu^+p \rightarrow \bar{\nu}_\mu hh j$. Focusing on the $hh \rightarrow b\bar{b}b\bar{b}$ decay channel, we consider the characteristic final-state topology comprising four b -jets, a forward jet, and missing transverse momentum. The analysis is performed for two beam-energy configurations, $E_\mu = 0.5$ and 1 TeV with $E_p = 7$ TeV, corresponding to centre-of-mass energies of $\sqrt{s} \simeq 3.74$ and 5.29 TeV, respectively. We investigate the contributions of different production amplitudes and their destructive interference, which plays an important role in determining the di-Higgs production rate and its sensitivity to modifications of the Higgs interactions. Within an effective Lagrangian framework, we explore deviations from the Standard Model in the CP-even and CP-odd Higgs interactions involving the hhh , hWW , and $hhWW$ vertices. Using the characteristic kinematic distributions and a dedicated event-selection strategy, we derive projected 95% confidence-level exclusion limits on the anomalous couplings for an integrated luminosity of 1 ab^{-1} . Our results highlight the potential of high-energy μ^+p collisions to probe the Higgs self-coupling and its interactions with electroweak gauge bosons, providing complementary sensitivity to future Higgs-sector measurements

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