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Exploring correlations between HEFT Higgs couplings κV and κ2V via HH production at e+e− colliders

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In this work we explore the phenomenological implications at future e+e− colliders of assuming anomalous couplings of the Higgs boson to gauge bosons HVV and HHVV (V = W, Z) given by the κ-modifiers with respect to the Standard Model couplings, κV and κ2V, respectively. For this study we use the Higgs Effective Field Theory (HEFT) where these two κ parameters are identified with the two most relevant effective couplings at leading order, concretely a = κV and b = κ2V . Our focus is put on these two couplings and their potential correlations which we believe carry interesting information on the underlying ultraviolet theory. The particular studied process is e+e− ⟶ HHν¯ν, where the vector boson scattering subprocess WW ⟶ HH plays a central role, specially at the largest planned energy colliders. Our detailed study of this process as a function of the energy and the angular variables indicates that the produced Higgs bosons in the BSM scenarios will have in general a high transversality as compared to the SM case if κVˆ2 is different from κ2V. In order to enhance the sensitivity to these HEFT parameters κV and κ2V and their potential correlations we propose here some selected differential cross sections for the e+e− ⟶ HHν¯ν process where different kinematic properties of the BSM case with respect to the SM are manifested. Finally, we will focus on the dominant Higgs decays to b¯b pairs leading to final events with 4 b-jets and missing transverse energy
from the undetected neutrinos and will provide the expected accessibility to the (κV , κ2V) effective couplings and their potential correlations. In our study we will consider the three projected energies for e+e− colliders of 500 GeV, 1000 GeV and 3000 GeV.

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