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Three-Higgs Boson Production within the Standard Model and its Triplet Extension

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In High Energy Physics, double and triple Higgs production play a crucial role in assessing the Higgs self-couplings, namely the trilinear and quartic Higgs couplings, which are responsible for endowing elementary particles with mass and shaping the Higgs potential. Directly measuring these couplings presents challenges, as they require the simultaneous production of two or more Higgs bosons. Additionally, achieving accurate measurements of the quartic Higgs coupling at the LHC necessitates high luminosity. Muon colliders, with their higher center-of-mass energies compared to proton colliders, offer advantages that potentially mitigate some of the difficulties associated with measuring these couplings. In our research, we focused on investigating the production of three Higgs particles through the interaction of high-energy muon beams emitting collinear photons at the one-loop level. We employed the Effective Photon Approximation (EPA) to establish Parton Distribution Functions and determined the total cross-sections of these processes. This analysis was conducted within the frameworks of the Standard Model and the Higgs Triplet Model (HTM). Notably, in the HTM, a hierarchy exists between the masses of singly charged Higgs bosons and doubly charged Higgs bosons, and we thoroughly investigated this influence in our research at the 3, 10, and 100 TeV Muon Colliders. To perform these calculations for the 2-to-3 processes, we used the FeynRules, GoSam-2.0, FeynArts, and FormCalc Mathematica packages to generate analytic expressions for the scattering amplitude and numerical results for the cross-sections. In my talk, I will cover our preliminary results regarding three-Higgs production through photon fusion.

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