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Toward di-Higgs observation with a calibratable jet-free $HH \to 4b$ framework

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In this talk, we present a calibratable, jet-free framework that enhances the search significance of the flagship LHC channel $HH \to 4b$ by more than a factor of five compared to existing strategies. The approach employs a mass-decorrelated discriminant for identifying $h_1 h_2 \to 4b$ with variable $h_{1,2}$ masses, together with a simultaneous estimator of (m_{h_1}, m_{h_2}), both constructed from multiclass classification on all-particle inputs. The HH signal response is calibratable using $ZZ \to 4b$. Within a highly realistic simulation framework, we demonstrate the robustness of the method and identify two prerequisites for attaining this sensitivity.

Our results suggest that, with LHC Run 2 and 3 data, observation-level sensitivity to HH is within reach, enabling constraints on κ_λ comparable to HL-LHC projections and providing an accelerated path to precision Higgs self-coupling measurements. We therefore advocate for close theory–experiment collaboration to establish, from first principles, the ultimate reach of HH measurements at the LHC.

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