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Diphoton jets to probe light fermiophobic Higgs boson signals at the HL-LHC

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We study the phenomenological signatures associated with a light fermiophobic Higgs boson within the type-I two-Higgs-doublet model at the HL-LHC. Our exhaustive parameter scan revealed a captivating mass range between 1 GeV and 10 GeV. This range retains a substantial number of viable parameter points, primarily due to the current experimental difficulties in probing soft decay products of the light fermiophoibic Higgs, two photons. A major obstacle arises as two photons from its decay tend to merge into one jet because of their proximity. This leads to dominating QCD backgrounds. To address this, we utilize EFlow objects within the Delphes framework, identifying a jet containing two photons, termed a diphoton jet. Through our full detector-level simulations across 18 benchmark points, the majority presented signal significances beyond 5 at an integrated luminosity of 3/ab. In challenging scenarios with a heavier charged Higgs boson, our incorporation of machine learning techniques demonstrated a significant enhancement.

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