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Detecting highly collimated photon-jets from Higgs boson exotic decays with deep learning

Recently, there has been a growing focus on the search for anomalous objects beyond standard model (BSM) signatures at the Large Hadron Collider (LHC). This study investigates novel signatures involving highly collimated photons, referred to as photon-jets. These photon-jets can be generated from highly boosted BSM particles that decay into two or more collimated photons in the final state. Since these photons cannot be isolated from each other, they are treated as a single jet-like object rather than a multi-photon signature. The Higgs portal model is utilized as a prototype for studying photon-jet signatures.

In this paper, we will present the studies of photon-jet signatures in an ATLAS-like electromagnetic calorimeter with a full simulation of the electromagnetic showers using GEANT4. In particular, we will focus on the implementation of the three machine learning techniques: Boosted Decision Trees (BDT), Convolutional Neural Networks (CNN), and Particle Flow Networks (PFN) , and their identfication efficiency for photon-jet signatures from single photons and neutral pions within the SM backgrounds. The sensitivities for searching photon-jet signatures from the Higgs boson exotic decays at the High-Luminosity LHC will be also discussed.

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