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Probing exotic $Z \to b\bar{b}\gamma$ decay at HL-LHC with Machine Learning approaches

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We investigate the sensitivity of high luminosity LHC for rare Z decay into $b\bar{b}\gamma$. As a bench mark we consider a model with axion like particles where Z decays to axion
and photon and axion decays into two bottom quarks, leading to a final state with two b-tagged jets and an isolated photon. We focus on distinguishing signal events from background using kinematic features and spatial distributions, including transverse momentum, angular separation (ΔR), and invariant mass. We compared different ML models like Boosted Decision Trees (BDT), Convolutional Neural Networks (CNN), and Graph Neural Networks (GNN), using these three variables for BDT and GNN, and using images on the $\eta - \phi$ plane with pixel intensity as PT for CNN. Our preliminary results show improved classification accuracy, with the aim of setting new upper boundson ALP production.

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