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Non-Resonant Anomaly Detection for Semi-Visible Jets with Leptonic Decays at the Large Hadron Collider

In this study, we explore the capabilities of Non-Resonant Anomaly Detection techniques, Reweight and Generate, for identifying semi-visible jets (SVJ) within the Hidden Valley (HV) dark sector model. Using simulated events generated from PYTHIA, MadGraph5, and Delphes, we trained a Boosted Decision Tree (BDT) to select optimal features for distinguishing the signal from QCD backgrounds. With an AUC value of 0.998, the features selected are H_T, MET, m_{jj}, and N-subjettiness ratios (τ_{21} and τ_{32}). Our results confirm that both Reweight and Generate provide reliable background extrapolation, as validated by Wasserstein distance metrics. Additionally, the Reweight method improves the detection significance from 2.6σ to approximately 5σ, demonstrating its potential for enhancing sensitivity in non-resonant searches.

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