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Phenomenological Demonstration of Deep Neural Networks in the search for BSM Physics with LArTPCs

The high intensity of POT and excellent particle identification and reconstruction capabilities of LArTPCs make experiments within the SBN program sensitive to a multitude of BSM models. One such example is the demonstrated sensitivity of the program's detectors to dilepton pairs originating from exotic Higgs Portal Scalar decays. Columnated showers that come from scalar decays to electron/positron pairs have topologies similar to those of photon pair production or single showers, making them difficult to distinguish from background. In this work, `Geant4` is used to generate the distribution of charge deposited by Higgs Portal Scalar events within a box of ^{40}Ar. This configuration of `Geant4` provides theorists and phenomenologists a fast and accessible way to simulate LArTPC data. We then apply projections to create two dimensional images of each simulated event, similar to those captured by wire planes in operating detectors. Finally we harness the power of deep neural networks to distinguish images of signal and background events for the Higgs Portal Scalar model at the SBN program, improving upon the projected sensitivity from cut-and-count techniques by 30% in $\sin\theta$ for the benchmark scalar mass of 10 MeV.

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