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Machine learning in PET imaging with PETALO

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PETALO (Positron Emission Time-of-flight Apparatus with Liquid xenOn) is a novel PET imaging detector concept in which liquid xenon (LXe) scintillating cells are arranged in a ring around the observed volume, and silicon photomultipliers (SiPMs) lining the cells detect the primary scintillation created by 511 keV gamma rays emitted in positron-electron annihilation within the volume. The fast scintillation decay time of LXe could allow for a high-resolution determination of the location of emission points through time-of-flight (TOF) analysis. However, the reconstruction of gamma ray interactions within the LXe cells presents several challenges. In particular, a large fraction of such gammas interact by Compton scattering and leave multiple distinct regions of energy deposition in a cell. We discuss the use of a neural network in identifying such events based on the scintillation pattern left on the SiPMs, and we consider the direct integration of this network in the PETALO electronic readout system to quickly tag and/or reject events that may pose potential problems in reconstruction.

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