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MLTiming: A machine learning framework for gamma-ray time pick-up

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Accurate timing characterization of radiation events is crucial in nuclear medicine, particularly for Positron Emission Tomography (PET). In PET, achieving a good coincidence resolving time (CRT) between detector pairs enhances the Time-of-Flight (TOF) information for each detected coincidence, which significantly improves the signal-to-noise ratio of the images. This study introduces a method to train models, based on the newly-developed Kolmogorov-Arnold networks (KANs), for assigning precise timestamps to incoming radiation signals in each detector. We trained the models with event pairs consisting of a measured event and its copy delayed a know amount of time where the delay acted as a label during training. Trained models were evaluated using data from a 60Co point source and a pair of conic 2" LaBr3(Ce) detectors in coincidence mode, connected to Hamamatsu R9779 PMTs sampled at 5 Gs/s. We report that our method has achieved a 6% increase in CTR and around 40% increased accuracy in source location compared to the widely used constant fraction discrimintation (CFD) method for the evaluation set.

Abstract

Primary author(s) : Sr. AVELLANEDA , Jose (Universidad Complutense de Madrid)

Co-author(s) : Dr. SÁNCHEZ -TEMBLEQUE , Victor (Universidad Complutense de Madrid); Dr. FRAILE, Luis Mario (Universidad Complutense de Madrid); Dr. UDIAS, José manuel (Universidad Complutense de Madrid); Dr. LÓPEZ HERRAIZ, Joaquín (Universidad Complutense de Madrid)

Presenter(s) : Sr. AVELLANEDA , Jose (Universidad Complutense de Madrid)

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