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Machine Learning Framework for Time Pick-Up of Nuclear Detector Signals

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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.

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