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Deep learning for time estimation in monolithic PET detectors using digitized readouts

Monday, 30 May 2022 12:00 (20 minutes)

We perform a simulation study to investigate the potential of convolutional neural networks (CNNs) for gamma arrival time prediction in monolithic PET detectors with waveform digitizers. GATE v8.2 is used to simulate gamma interactions and production of scintillation light in a 50x50x16 mm³ monolithic LYSO crystal, coupled to an 8x8 readout array of silicon photomultipliers (SiPMs). The SiPM waveforms are then simulated as a sum of bi-exponential functions, where we include additional sources of noise such as dark counts. The waveforms are simulated at varying sampling rates from 1 GS/s to 20 GS/s. A 3D CNN is trained to predict the gamma arrival time in the crystal from the leading edge portion of the matrix of detector waveforms, resulting in a coincidence time resolution (CTR) of 140 ps full width at half maximum (FWHM) for the fastest sampling rate. This is a 24% improvement compared to the conventional methodology of leading edge discrimination after baseline correction, followed by an averaging of the first few timestamps, resulting in a CTR of 173 ps FWHM at the same sampling rate. In addition, the 3D CNN maintains respectable timing performance over a large range of sampling rates, only degrading to 191 ps FWHM at 1 GS/s.

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