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Comparative Analysis of Novel Time-Walk Correction Methods for Metascintillators

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Development of novel scintillator materials and effective Time-Walk Correction (TWC) methods aim to improve coincidence time resolutions (CTRs) in Time-of-Flight Positron Emission Tomography (ToF-PET) systems. This study introduces an innovative approach using metascintillators coupled with advanced photodetector technologies to address the limitations of time-walk effects on CTR. We evaluated Linear (L-), Differential (D-), and Hyperbolic (H-) TWC strategies, focusing on their impact on enhancing CTR in ToF-PET applications. The H-TWC method aims to mitigate long-tailed coincidence time distributions, thus leading to a more standardized Gaussian distribution and improving the CTR.
Our experimental setup employed 3×3 mm^2 NUV-HD-MT photodetectors from Fondazione Bruno Kessler (FBK) coupled with 3×3×5 mm^3 LYSO:Ce,Ca reference crystals and novel 3×3×15 mm^3 BGO-EJ232 metascintillator heterostructures. Results indicate that while all the TWC methods do not improve the CTR values on the reference crystals measurements, the H-TWC demonstrates improvements from 50 ps up to 60 ps when metascintillator pixels are used. Our findings indicate that while L-TWC and D-TWC methods demonstrate similar improvements, the hyperbolic approach significantly enhances CTR values by effectively neutralizing heavy-tailed distributions.

Field

Software and quantification

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