

# Second Generation Readout Electronics Design for a PET Detector That Achieves ~100 ps CTR and <2 mm DOI Resolution

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This study introduces second-generation front-end electronics design for side-readout detectors, with the ultimate goal of realizing near 100 ps CTR Time-of-Flight 3D Position Sensitive (TOF-3DPS) detectors. Leveraging a previously proposed timing signal multiplexing scheme based on RF amplifiers and summing circuits, this design utilizes complex programmable logic devices (CPLDs) and discrete components to facilitate high-precision measurements of energy and Depth of Interaction (DOI). Experimental results on a single  $3 \times 3 \times 10$  mm<sup>3</sup> LYSO:Ce crystal demonstrated an 11.66% energy resolution, a  $1.44 \pm 0.44$  mm FWHM DOI resolution, and a ~112 ps FWHM DOI-calibrated CTR. Further tests on a detector unit comprising a  $4 \times 2$  array of  $3 \times 3 \times 10$  mm<sup>3</sup> LYSO:Ce crystals, side-coupled with a  $4 \times 6$  array of  $3.16 \times 3.16$  mm<sup>2</sup> SiPMs, yielded a  $12.29 \pm 1.16\%$  energy resolution and a DOI-calibrated CTR of  $120.56 \pm 5.38$  ps FWHM. The front-end circuit, designed to read out two detector units, occupies a compact footprint of only 27 mm × 95 mm, enabling easy integration and stacking of multiple units to form a complete TOF-3DPS detector module.

## Field

Detectors and electronics

**Primary authors:** ZHAO, Zhixiang (Stanford University); HUANG, Qiu (Shanghai Jiao Tong University); LEVIN, Craig (Stanford University)

**Presenter:** ZHAO, Zhixiang (Stanford University)

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