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Advancements in DOI-capable TOF-PET modules based on High-Frequency Readout

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High-frequency (HF) front-end electronics offer a solution for exploiting fast light production in crystals and enhancing the performance of TOF-PET applications. Demonstrating improved time resolution by lowering the leading-edge detection threshold, they enable the use of the fastest photons, such as Cherenkov emission, and facilitate event discrimination in heterostructures.
Heterostructured scintillators consist of stacks of alternating layers of two materials with complementary properties: high stopping power (BGO) and ultrafast timing (plastic). However, layering poses a challenge to the best achievable time resolution due to worsened light transport. This issue can be mitigated by retrieving depth-of-interaction (DOI) information and using it to correct for the induced bias, through a double-sided readout method or a light-sharing mechanism in single-side readout using a matrix of scintillators coupled to an array of SiPMs. Readout integration in a multi-channel scheme is required for the light-sharing method to work.

We present the achievement of 174 $\pm$ 6 ps coincidence timing resolution (CTR) and 6.40 $\pm$ 0.04 mm DOI resolution in single-pixel heterostructures of 3x3x20 mm^3 using double-sided HF readout. Additionally, the integration of a multi-channel HF readout board to a matrix of 4x4 LYSO 3.1x3.1x15 mm^3 allows for a CTR lower than 130 ps. Finally, we outline the steps toward the implementation of this readout to a heterostructured scintillator matrix.

Field

Detectors and electronics

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