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PERFORMANCE OF A PET DETECTOR MODULE WITH LSO SCINTILLATOR CRYSTALS AND PHOTODIODE READOUT*.

W.W. Moses†, S.E. Derenzo†, M.H. Ho†, M.S. Andreaco‡, M.J. Paulus‡, and R. Nutt‡, †Life Science Division, Lawrence Berkeley Laboratory, Berkeley, CA, and ‡CTI PET Systems, Knoxville, TN.

We present performance results for a prototype PET detector module[1] consisting of 64 3x3x20 mm LSO scintillator crystals coupled on one end to a single photomultiplier tube and on the opposite end to a 64 pixel array of 3 mm square silicon photodiodes (typically pixel parameters are 5 pF capacitance, 300 pA dark current, 73% quantum efficiency). The photomultiplier tube provides an accurate timing pulse and energy discrimination for the all the crystals in the module, while the silicon photodiodes identify the crystal of interaction. The LSO used for this detector has a light output approximately 2x lower than "typical" LSO.

When a 2.8 mm fwhm beam of 511 keV photons is directed at one of 16 neighboring crystals, the crystal of interaction is correctly identified ~50% of the time. If the definition of "correct" is expanded to include the adjacent 4 crystals (which can be excited by either the tails of the excitation beam or Compton interactions in the detector), the "correct" fraction is ~80%, compared to ~50% for conventional block detectors with 4 mm square crystals[2]. The timing resolution for a single detector module is 750 ps fwhm, which is insufficient for time of flight but is should be better than BGO in rejecting randoms. Large crystal to crystal variations in the photopeak position are seen due to imperfect reflector coating and coupling to the photodiodes. Depth of interaction dependence of the photopeak position is also observed but not yet corrected for, which degrades the pulse height resolution to ~50% fwhm.

These results show that detector modules based on this hybrid design[1] will improve the performance of PET cameras without excessive cost. Further improvement may be possible with better LSO scintillator material, reflector coating, or surface treatment, and may yield a module that is capable of depth of interaction measurement.

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[1]W.W. Moses, et al., *IEEE Trans. Nucl. Sci.*, **NS-42**, p. 1085, 1995.
[2]S.R. Cherry et al., *IEEE Trans. Nucl. Sci.*, **NS-42**, p. 1064, 1995.

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