A HIGH PERFORMANCE PHOSWICH DETECTOR MODULE FOR SMALL ANIMAL PET

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If spatial resolution and sensitivity are both to be high in a small ring diameter, small animal PET scanner, parallax or depth-of-interaction (DOI) errors must be minimized. We have devised a two-layer-phoswich DOI PET detector module for this application in which a 9 x 9 array of phoswich elements (2.25 mm pitch) is optically glued to a Hamamatsu R5900 miniature position-sensitive photomultiplier tube. Each phoswich element is comprised of a 2 mm x 2mm x 7 mm crystal of LGSO optically glued to a 2 mm x 2 mm x 8 mm GSO crystal. All crystal are chemically etched on all surfaces including the output end. Each glue, and the order of the scintillators in the phoswich, was selected based on measured transmission data and on measured properties of the two scintillators.Surface reflection is achivied bye placing each 15 mm-deep phoswich element into a pre-formed white vinyl matrix or "egg crate" rather than by painting or wrapping or wrapping each individual element. Identification of the scintillator-of-interaction is accomplished by "delayed charge integration" (DCI), a method that exploits the light decay time difference between LGSO (40 nsec). Three pairs of modules were placed in time coincidence and exposed to 511 keV annihilation radiation. After appliying DCI and photopeak energy windowing, position detection accuracy (FWHMM as percent of pitch) averaged along the same row in three different modules was 23% in the LGSO layer and 26% in the GSO layer. Energy resolution averaged over all elements in 6 modules was 22% in the LGSO layer and 23% in the GSO layer. Identification of the scintillator-of-interaction was near 100% when only LGSO and GSO photopeak events were considered. This module (1) provides two reliable levels of depth information, (2) possesses excellent position detection accuracy in both layers and (3) has other properties, e.g. short light decay time that make it a choice for use in small animal PET scanner.