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Development of a positron-imaging detector with background rejection capability

Seiichi YAMAMOTO,*,*** Tatsuya HIGASHI,** Keiichi MATSUMOTO*** and Michio SENDA***

**Department of Electrical Engineering, Kobe City College of Technology*
***Department of Diagnostic Imaging & Nuclear Medicine, Kyoto University Graduate School of Medicine*
****Department of Molecular Imaging, Institute of Biomedical Research and Innovation*

Objective: Intra-operative probes have recently become important instruments in nuclear medicine. In such an application, the radiopharmaceutical F-18-fluorodeoxyglucose (FDG) is promising. For the FDG-guided surgery, we developed and tested a positron-imaging detector with background rejection capability. ***Methods:*** The detector consists of an array of phoswich scintillators, a multi-channel position-sensitive photo-multiplier tube (PSPMT) and an electronic circuit. The scintillators and the PSPMT are encased in a tungsten shield and replaceable collimators are mounted on the top of the detector. Positrons are detected by the plastic scintillators while annihilation photons are detected by the BGOs. By employing a pulse-shape analysis, we can distinguish the true events (positrons) from background gamma events. The dimensions of each plastic scintillator are 2 mm × 2 mm × 3 mm and those of the BGO are 2 mm × 2 mm × 15 mm. These scintillators are optically coupled to each other and combined in an 8 × 8 array, which is optically coupled to a 1-inch square 8 × 8 multi-channel PSPMT via optical fibers. Position determination of the positrons is performed by 64-channel threshold circuits while the pulse shape analysis is applied for the summing signal. ***Results:*** The spatial resolution was measured by positioning an F-18 point source onto one pixel of the detector and found than the spillover to the neighbor pixel was less than 20%. The background count rate was less than 2 cps for a 20-cm diameter, 20-cm long cylinder phantom containing 3.7 MBq of F-18. ***Conclusion:*** These results indicated that the developed positron-imaging detector will be useful for FDG-guided surgery.

Key words: positron, back ground rejection, surgery