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Development of a Large-Angle Pinhole Gamma Camera with Depth-of-Interaction Capability for Small Animal Imaging

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The large-angle gamma camera was developed for imaging small animal models used in medical and biological research. In the simulation study, a large field of view (FOV) of this system provides higher sensitivity than typical pinhole gamma cameras by reducing the distance between the pinhole and the object. However, this gamma camera suffers from the degradation of the spatial resolution at the periphery region due to parallax error by obliquely incident photons. We proposed the new method to measure the depth of interaction (DOI) using three layers of monolithic scintillators to reduce the parallax error. The detector module consists of three layers of monolithic CsI(Tl) crystals with dimensions of 50.0 X 50.0 X 2.0 mm3, a Hamamatsu H8500 PSPMT and a large-angle pinhole collimator with an acceptance angle of 120°. The 3-dimensional event positions were determined by the maximum-likelihood position-estimation (MLPE) algorithm and the pre-generated look up table (LUT). Spatial resolution of the Tc-99m point source was measured as 3.10, 3.81 and 4.14 mm with the conventional method (Anger logic) and 2.39, 2.69 and 2.47 mm with DOI information at the center, 10 cm and 15 cm off-center of the FOV, respectively. We proved that high sensitivity can be achieved without degradation of spatial resolution by using a large-angle pinhole gamma camera which can be used as small animal imaging.
Keywords: Large-pinhole gamma camera, depth of interaction(DOI), maximum-likelihood position- estimation (MLPE)

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