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Double photon emission coincidence imaging of 111-In using high resolution Ce:GAGG-SiPM pixel detectors

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Single photon emission computed tomography(SPECT) is a useful medical imaging modality using single photon detection from radioactive tracers, such as 99Tc and 111In, however further development of increasing the contrast in the image is still under investigation.
A novel method (Double Photon Emission CT / DPECT) using a coincidence detection of two cascade gamma-rays from 111In is proposed and characterized in this study. 111In, which is well-known and commonly used as a SPECT tracer, emits two cascade photons of 171 keV and 245 keV with a short delay of approximately 85 ns. The coincidence detection of two gamma-rays theoretically determines the position in a single point compared with a line in single photon detection and increases the signal to noise ratio drastically. A pixel detector consists of 8 × 8 array of high-resolution type 1.5 mm thickness Ce:GAGG (~3.9 % @ 662 keV, 6.63g/cm3, C&A Co. Ce:Gd3Ga2.7Al2.3O12 2.5×2.5×1.5mm3) crystals coupled a 3 mm pixel SiPM array (Hamamtsu MPPC S13361-2050NS-08). The signal from each pixel is processed and readout using time over threshold (TOT) based parallel processing circuit to extract the energy and timing information. The coincidence was detected by FPGA with the frequency of 400 MHz. Two pixel detectors coupled to multi-hole collimators are located at the degree of 90 to determine the position and coincidence events (time window = ~1μs) are detected and used for making back-projection image. The image quality of SPECT and DPECT are compared and characterized including the detection efficiency and sensitivity.

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