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Development and Evaluation of PET-Compton imager based on Ce:Gd3Ga2.7Al2.3O12 and CeBr3 scintillators with SiPM arrays

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PET (Positron Emission Tomography) is currently an important tool in molecular imaging and medical diagnosis. Compton imager is a promising tool for future molecular imaging with multi-nuclides based on Compton scattering. Previously we have developed GAGG based Compton imager for environmental application [1][2] and GAGG based PET system[3]. Here we have developed PET-Compton hybrid imager based on two-layer structure using thin scatters and thick absorbers for multi-nuclide imaging. For achieving the good spatial resolution of Compton imager, the energy resolution of scintillators is one of the most important. CeBr3 is a promising scintillator because of its high light yield over 70000 photon/MeV, excellent energy resolution ~ 3% with no background radiation and fast decay time.
In this study, we present the development of PET-Compton hybrid detector which consists of 8 by 8 MPPC (Multi Pixel Photon Counter / SiPM) array individually coupled with 2.5 x 2.5 x 9mm3 Ce:Gd3Ga2.7Al2.3O12 scintillators (absorbers) and MPPC array individually coupled with 2.5 x 2.5 x 1.5mm3 CeBr3 scintillators (scatters). The pixel size of MPPC is 3mm by 3mm and operated at the voltage of 55V. CeBr3 scintillators are grown, packaged and mounted on the MPPC array. The signals from MPPC-scintillators are individually amplified and converted with dynamic time over threshold (dTOT) circuit to record the energy and timing information. In the experiment the image of 111In and 18F-FDG, which are used as SPECT and PET tracers, was acquired using the developed detector for Compton imaging and PET imaging.
[1] Jiang, Jianyong, et al. "A prototype of aerial radiation monitoring system using an unmanned helicopter mounting a GAGG scintillator Compton camera." Journal of Nuclear Science and Technology 53.7 (2016): 1067-1075.
[2] Kamada, Kei, et al. "2inch diameter single crystal growth and scintillation properties of Ce: Gd 3 Al 2 Ga 3 O 12." Journal of Crystal Growth 352.1 (2012): 88-90.
[3] Yoshino, M., et al. "Development and performance evaluation of Time-over-Threshold based digital PET (TODPET2) scanner using SiPM/Ce: GAGG-arrays for non-invasive measurement of blood RI concentrations." Journal of Instrumentation 12.02 (2017): C02028.

Has accepted

Author: SHIMAZOE, Kenji (The University of Tokyo)

Co-authors: KOYAMA, Akihiro (University of Tokyo); Ms UENOMACHI, Mizuki (The University of Tokyo); Mr NAKADA, Naoki (The University of Tokyo); Mr MIZUMACHI, Yuuki (The University of Tokyo); Prof. TAKAHASHI, Hiroyuki (The University of Tokyo); YOSHINO, Masao (C&A, IMR Tohoku University); Prof. KAMADA, Kei (C&A, IMR Tohoku University); Dr SHOJI, Yasuhiro (C&A, IMR Tohoku University); Mr HAYASAKA, Shoki (C&A); Prof. YOSHIKAWA, Akira (C&A, IMR Tohoku University, NICHe Tohoku University); Dr FUJIWARA, Kentaro (The University of Tokyo); Dr TAKAHASHI, Miwako (The University of Tokyo); Dr MOMOSE, Toshimitsu (The University of Tokyo)

Presenter: SHIMAZOE, Kenji (The University of Tokyo)

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