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Characterization of Time over Threshold based X-ray and Gamma-ray detector with pixelated GAGG coupled to SiPM array

Silicon photomultipliers (SiPMs) are promising photo detectors for Positron Emission Tomography (PET) and X-ray/Gamma-ray imaging system because of its high gain and photon counting capability. The individual readout is necessary to achieve a better spatial resolution especially in high flux applications.

In this study a prototype of photon counting pixel detector using SiPMs and Time over Threshold (ToT) ASIC was designed and fabricated for sub-mm PET and X-ray/Gamma-ray applications. The fabricated photo detector consists of 12 x 12 pixels with the pitch of 1.9 mm using KETEK PM1150 SiPMs individually coupled with Cerium doped GAGG scintillators. All channels are individually coupled to ToT ASIC through micro-coaxial cables. The TOT outputs of all channels are connected to data acquisition (DAQ) FPGA in parallel.

48 channels TOT-ASIC consists of current buffers and current comparators with internal DACs (digital-to-analog converter) of the 6 bit resolution. The ASIC was fabricated with 0.25 μm CMOS TSMC process using 2.5 V where power consumption is approximately 200 mW per chip. The first transmission image was successfully acquired with individual energy spectrum.

In this study various characteristics, such as timing resolution, energy resolution and count rate of fabricated pixel detector will be presented.

Summary

In this study a prototype of photon counting pixel detector using SiPMs and Time over Threshold (ToT) ASIC was designed and fabricated for sub-mm PET and X-ray/Gamma-ray applications.

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