16p-A12-12

Design of asymmetric PET detector using APD and SiPMs with DOI capability

The University of Tokyo [1], Takahashi Lab [2], J.Jiang[1], K.Shimazoe[1] , H.Takahashi[1]
E-mail: jjy06.tsinghua.edu@gmail.com

I. INTRODUCTION

While designing positron emission tomography (PET) detectors, to increase the spatial resolution is always an important issue for researchers. We present a new kind of asymmetric PET detector. The detector module is composed by 2×2 GAGG crystals coupled on one end to a single APD and on the other end to a 2×2 pixel array of SiPMs. The SiPMs identify the crystal of interaction and is good at timing while APD is well in energy resolution. The ratio $R = APD/SiPMs$ suggests the depth of interaction. Figure 1 shows the schematic of the detector. GAGG is a new scintillator with energy resolution of 4.3 % @ 662 keV, light output of 60000 photons/MeV, 88ns decay time and low self-background radiation.

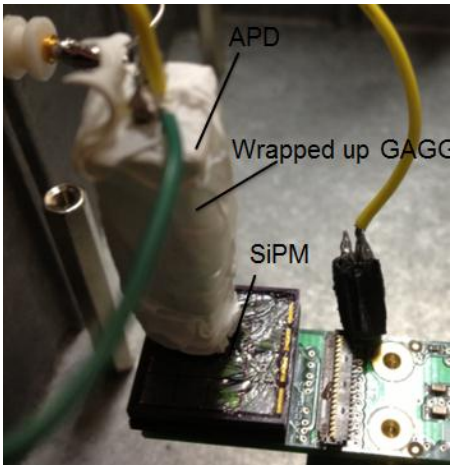

Fig. 1: Schematic of the PET detector. The Array of GAGG crystals is in the middle of a single APD and SiPMs array.

II. EXPERIMENTS AND ANALYSIS

A. *Identify the crystal of interaction by SiPMs*

We directly use a ^{137}Cs source to excite the crystals and then connect the signals to two pre-tested signal processing boards (four channels). By checking the digital output through an oscilloscope, we tested the ability of discriminating crystal of interaction of the SiPMs. Figure 2 shows the signals from the oscilloscope.

B. *Depth of Interaction*

As we have mentioned above, the ratio $R = APD/SiPMs$ suggests the depth of interaction. When a collimated gamma beam is incident to the crystal and the incident point is closer to the APD, there would be more photons collected by APD than SiPMs. On the contrary, if the point of interaction is closer to SiPMs, SiPMs would collect more photons. Based on this theory, we carried out an simple experiment to test the depth of interaction by placing a collimated gamma beam at two different position (one is closer to the APD, the other is closer to the SiPM). Figure 3 shows the result of the experiment. ^{22}Na source was used as the gamma beam.

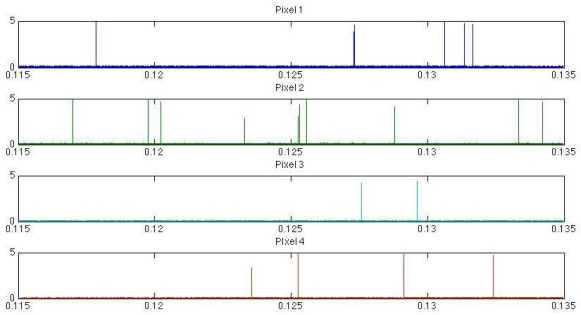

Fig. 2: Signals from four pixels of SiPMs respectively.

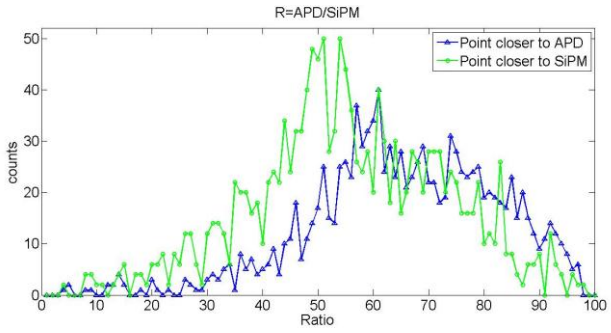

Fig. 3: Result of the DOI test experiment. The x axis is the ratio of the energy of APD and SiPMs multiplied by 100.

III. CONCLUSION

The feasibility of a asymmetric PET detector using APD and SiPMs with DOI capability has been successfully shown. The SiPM shows good identification of the crystal of interaction. And the depth of interaction could be measured through the ratio of APD and SiPMs.

In the future, we will be focusing on the following work:

1) Search a more reasonable calibration algorithm, and get the relationship between the ratio and the depth of interaction.
2) We will also enlarge the number of crystals and pixels of SiPMs to realize a high sensitivity and spatial resolution.
3) Finally, we will use smaller and thinner GAGG crystals to build a multichannel system.