The Preliminary Test of PET Modality System by Using CsI(Tl)-PIN diode Detector

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1. Introduction

As the aging society is becoming, well-being life is what worldwide human pursuit in modern society. Although medical, science technology and the treatment of disease has developed consistently, the cancer still has the highest mortality. Hence, early detection and treatment is necessary to increase the survival rate, which development of diagnosis device is demanded [1]. The most advanced medical diagnosis device, positron emission computed tomography (PET) is widely established[2] and used in domestic medical center. In this study, the preliminary test of fabricated CsI(Tl)-PIN diode detector was proceed to evaluate the availability as PET imaging detector.

2. Methods and Materials

The fabricated gamma-ray detector was composed with CsI(Tl) scintillator sensor and with PIN diode. For electronic circuit, preamplifier and amplifier are housed with the detector [3].

The 20 of CsI(Tl)-PIN diode detectors was positioned in circular array at interval of 18° angle in 360°, and the detectors are located at 10 cm distance from the center.

The energy resolution and linearity was measured with ^{22}Na (511 keV, 1.28 MeV), ^{137}Cs (662 keV), and ^{60}Co (1.17 MeV, 1.33 MeV) gamma-ray source, using ORTEC® NIM module MCA (Multi-Channel Analyzer) to measure the energy spectrum. The gain matching of the detectors was done to adjust the photo-peak region at the same channel position.

The feasibility test of detectors were tested with ^{137}Cs source and ORTEC® SCA (Single-Channel Analyzer) and ULS® NIM module Counter, to measure in counting system. The energy window level of SCA was set from where photo-peak start to rise, 0.98V, and to where photo-peak has reach the falling edge, 1.14V.

The experiment of the CsI(Tl)-PIN diode detectors in PET mode was performed by moving the ^{137}Cs source to two coordinate points; at the center, and at (4, 4) in unit of cm. The imaging reconstruction is based on count rates of all 20 detectors at corresponding positions of the source. The image reconstruction was done by source location tracking algorithm, which was developed and is based on linear function algorithm.

3. Result

Figure 1 is the spectra measurement of a CsI(Tl)-PIN diode detector with the gamma-ray source ^{22}Na, ^{137}Cs, and ^{60}Co. The fabricated CsI(Tl)-PIN diode detectors energy resolution at 511 keV was about 6.35 %, 12.0 % at 662 keV, 6.55 % at 1.17 MeV, 8.0 % at 1.28 MeV, and 5.7 % at 1.33 MeV.

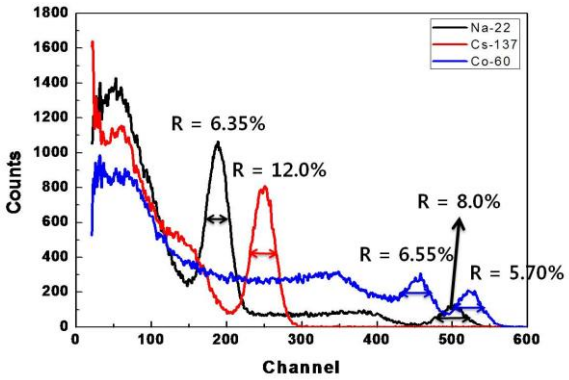

Figure 1 Spectra Measurement of the CsI(Tl)-PIN diode Detector (^{22}Na, ^{137}Cs, ^{60}Co)

Figure 2 is the linearity measurement of a CsI(Tl)-PIN diode detector with the gamma-ray sources. The purpose of the measurement was to evaluate the linearity for the medical using energy region and the measurement result shows that at the energy 511 keV ~ 1.33 MeV is linear, which can be derived that the system may be easy to operate for the calibration process.

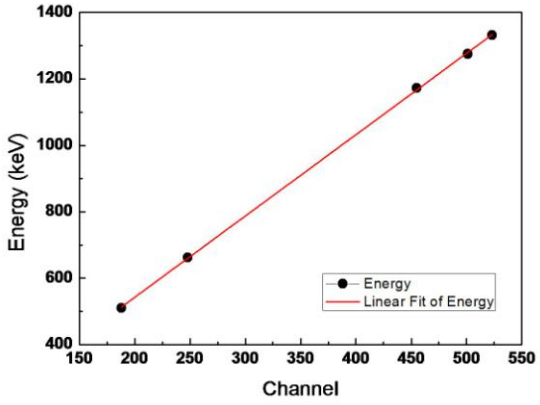

Figure 2 Linearity Measurement of the CsI(Tl)-PIN diode Detector (^{22}Na, ^{137}Cs, ^{60}Co) R^2=0.99

Figure 3 is the image reconstruction result, which shows the source's location while the source is moved.

The image reconstruction based on source location tracking algorithm was successfully done. However the spatial resolution is low to use in medical field. For further study, to obtain high spatial resolution images 1) the increased numbers of detectors are necessary and 2) suitable and accurate algorithm function needs to be applied to the imaging reconstruction algorithm.

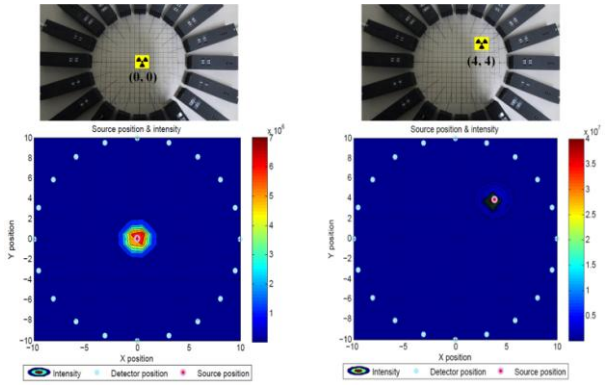

Figure 3 2-Dimensional Imaging Graph of CsI(Tl)-PIN diode Detector based on Source Location Tracking Algorithm

4. Conclusions

The CsI(Tl)-PIN diode detector was fabricated in portable size and the detectors' feasibility were tested in PET geometry array. The fabricated system had an appropriate performance from the spectrum and imaging results. For further study, the increment of detectors numbers and accurate algorithm need to be applied.

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