New paradigm of detection: 10×14 URA patterned sensitive collimator

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1. Introduction

A common method of radiation imaging is mechanical collimation which shows good performance at the low radiation energy and the other is electronic collimation whose angular resolution is better at higher radiation energy [1-3]. Many researchers have developed equipment combining two kinds of collimation methods showing good performance in wide range of radiation energy. [4-8]. However, most of them used passive collimators made of high Z material such as Pb or W and the scattered radiations in the mechanical collimator were regarded as noise events and discarded. In this research, the mechanical collimator itself was replaced by a sensitive detector consisting of a URA patterned scintillator. Since our sensitive collimation could be used as both mechanical can electronic collimation simultaneously, the scattered radiation in the mechanical collimation, which was discarded in the conventional gamma cameras, was recovered as an effective event for the electronic collimation (Compton imaging) to reconstruct the radiation image. As a result, the detection efficiency and image quality can be dramatically increased. The sensitive collimation using both mechanical and electronic collimation, and hence it can cover very broad energy range (several keV ~ MeV) of the incident radiation. We developed sensitive collimation using 10×14 URA patterned scintillator whose spatial resolution was improved in comparison of the previous prototype [9].

2. Methods and Results

2.1 Sensitive Collimator system

As shown in the Figure 1 and 2, the active collimator was constructed with a 10×14 URA patterned BGO array coupled to a position sensitive photomultiplier tube (PSPMT) and the planar detector was made of a CsI(Na) array coupled a PSPMT(H8500). The BGO scintillator made by SICCAS technology, consisted of 20×28 pixels whose size was 1.5×1.5×5 mm^3 each and the CsI(Na) scintillator made by Hilgus technology, consisted of 20×20 pixels whose size was 2×2×5 mm^3 each. The distance between the active collimator and planar detector was 3cm. This design was based on the optimized variables calculated by Monte Carlo simulation [10].

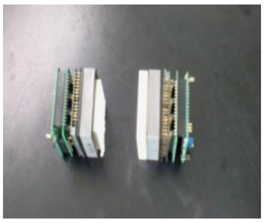


Fig.1. Active collimator (left) and planar detector (right) of the portable and active collimation system

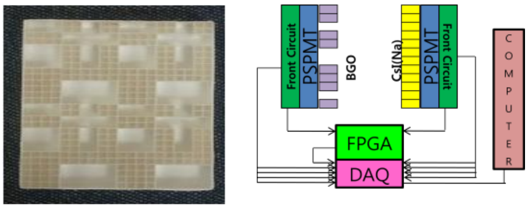
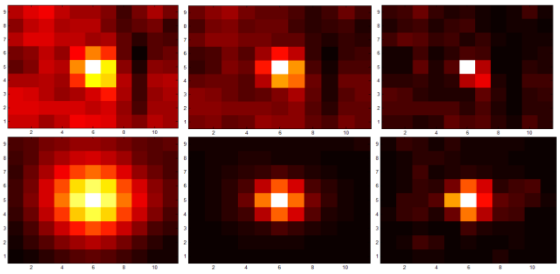


Fig.2. 10×14 URA patterned BGO (left) and Schematic diagram of the sensitive collimation system (right)

2.2 performance of sensitive collimator

The reconstruction images from mechanical, electronic, and dual collimation for a 356keV point source were shown in Figure 3. The images of dual collimation were shaper than those of electronic collimation and had fewer artifacts than those of mechanical collimation especially at high iteration. As show in Figure 4, the reconstructed images were quantitatively evaluated using resolution-variance curve. The curve of sensitive collimation was closer than those of other collimations to origin, which proved the superiority of the sensitive collimation method.



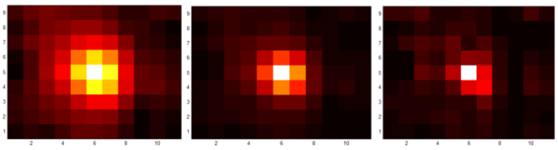


Fig.3. Reconstructed images using MLEM method for a 356keV point source. Top, middle and bottom row are for mechanical, electronic and dual collimation, respectively. Left, middle and right column are for 1st, 30th, and 100th iteration, respectively

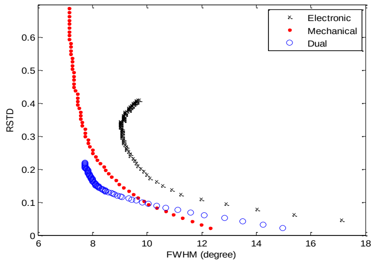


Fig.4. Resolution-variance graph for a 662keV point source reconstructed by MLEM method.

The reconstruction images from mechanical, electronic, and dual collimation for a 662keV point source were shown in Figure 5. The images of dual collimation were slightly smoother than those of electronic collimation and had much fewer artifacts than those of mechanical collimation especially at high iteration. As shown in Figure 6, the performance of the sensitive collimation was again better than those of the mechanical and electronic collimation method.

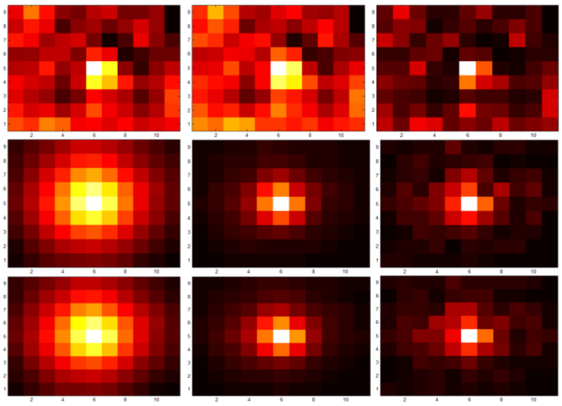


Fig.5. Reconstructed images using MLEM method for a 662keV point source. Top, middle and bottom row are for mechanical, electronic and dual collimation, respectively. Left, middle and right column are for 1st, 30th, and 100th iteration, respectively

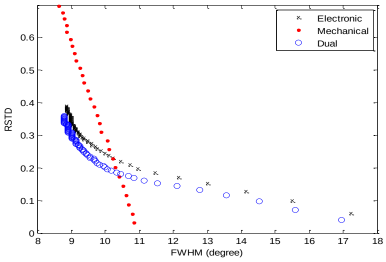


Fig.6. Resolution-variance graph for a 662keV point source reconstructed by MLEM method.

3. Conclusions

The portable and sensitive collimation was developed and its performance was evaluated. The sensitive collimation method showed its superiority to other collimation methods

4. Acknowledgement

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