PCR Evaluation of NIM Module Based Compton Suppression Gama Spectroscopy System by Source-to-Detector Distance

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1. Introduction

Compton scattering produces Compton continuum over a large area in the gamma-ray spectrum. Compton scattering makes it difficult to precisely measure the low X-ray energy peaks of the Compton continuum area. This problem occurs in the measurement of spent fuel containing various fission product to emit high energy gamma. Compton continuum is mainly generated by gamma rays of 662 keV from ^{137}Cs in the spent fuel. This makes it difficult to perform low energy area peak analysis from 100 to 400 keV [1]. The Compton continuum area can be suppressed using a Compton suppression system. The greatest advantage of Compton suppression system is to significantly reduce the Compton continuum and improve the detection limit [2]. In this study, the performance of the developed Compton suppression system with various source positions was evaluated.

2. Methods and Results

NIM Module using a traditional analog signal was used to implement the Anti-Coincidence. The main detector is a HPGe(P-type Coaxial HPGe). BGO(Well-type BGO) and NaI(Well-type NaI) detector were used as guard detectors to measure scattered gamma rays. A Cs-137 source was placed in several distances from the surface of HPGe detector. The configuration of each NIM Module is shown in the Fig. 1.

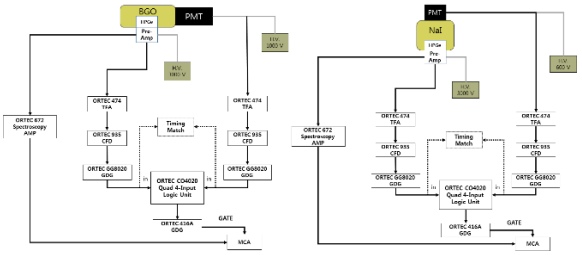

Fig. 1. NIM Module schematic diagram.

2.1 HPGe and BGO Compton suppression result

As shown in Table 1, the Compton continuum of measured spectra of the Compton suppression system are clearly different from the unsuppressed spectra. As the distance increases, the measured counts are lower, but the Peak to Compton ratio (PCR) increases. The PCR factor of the Compton suppression system is about three times better compared to the unsuppressed system.

2.2 HPGe and NaI Compton suppression result

As shown in Table 2, the measurement results of Compton continuum are clearly different when the Compton suppression system is used or not. As the distance increases, the counts are measured lower but the Peak to Compton ratio increases. We can see that the Compton suppression system is PCR factor over three times when using it.

Table 1. HPGe and BGO Cs-137 Peak to Compton ratio

Distance	State	358~385 keV	662keV	Peak to Cpmpton ratio	PCR factor
20 cm	w/o suppression	91184	88590	96.2	2.5
	w/ suppression	35088	84096	237.3	
30 cm	w/o suppression	38364	38528	99.4	2.6
	w/ suppression	14315	38048	263.1	
40 cm	w/o suppression	21913	23396	105.7	2.8
	w/ suppression	7699	23342	300.2	

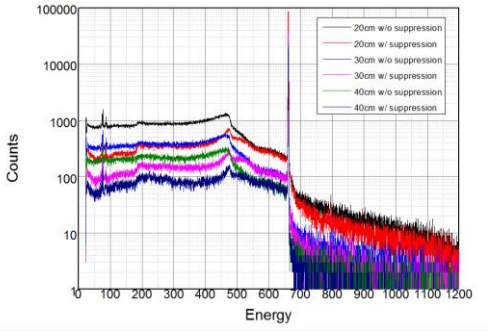

Fig. 2. Cs-137 Spectrum Using HPGe and BGO.

Table 2. HPGe and NaI Cs-137 Peak to Compton ratio

Distance	State	358~385 keV	662keV	Peak to Cpmpton ratio	PCR factor
20 cm	w/o suppression	119895	80208	66.2	2.3
	w/ suppression	51486	78050	150.1	
30 cm	w/o suppression	61324	39967	64.5	3.7
	w/ suppression	16542	40116	240.1	
40 cm	w/o suppression	35276	24926	69.9	3.7
	w/ suppression	9370	24734	261.3	

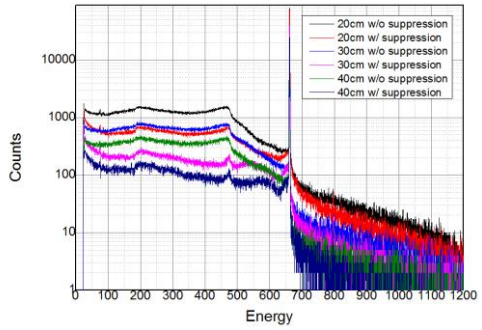

Fig. 3. Cs-137 Spectrum Using HPGe and NaI.

3. Conclusion

Comparisons using two different guard detectors confirm that the most ideal position for measuring the 662 keV gamma ray from ^{137}Cs is 40 cm. The two methods are no measured under the same conditions, so there are difficult to compare. As a result of comparison, Peak to Compton ratio is clearly high for BGO. The low 100 keV area means that the high density BGO absorbed the high gamma energy of 500 keV. However, the PCR factor shows that Compton suppression is higher in NaI. The reason is that NaI absorbs energy well below 100 keV at the Compton edge, and the light intensity is high enough to keep the low threshold. Therefore, the two BGO is additionally installed behind NaI, so that it is designed to catch X-ray of low energy area. We will continue to measure the Compton suppression system.

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