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# Subtraction of low level background noise in measurement of enriched uranium using CdZnTe detector

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## 1. Introduction

Lead shielding refers to the use of lead to safeguard against scatter radiation. Lead shielding helps protect from radiation because of its high molecular density but also to protect measurement systems from background radiation. Characteristic X-ray induced this lead and radiation interaction interrupt measurement of low energy area. To address this problem, shield design included low level background subtraction is of great importance from the measurement of uranium enrichment using low energy level [1].

In this study, it have been the present work new samples lead shield of 5 cm and copper filter plates with 100×100 mm$^2$ area and the thickness of 0.2 ~ 2 mm were prepared, it have been undertaken to evaluate the former samples as γ-ray shields. Experimentally values of mass attenuation coefficients have been compared with theoretically calculated values of these samples using Monte Carlo simulation [2].

## 2. Experimental work and results

Shielding materials were prepared during this work in the form of cube with 150 × 150 × 150 mm$^3$ hole of square shape. In addition, there are ten samples of copper filters with the thickness of 0.2 mm, 0.4 mm, 0.6 mm, 0.8 mm, 1.0 mm, 1.2 mm, 1.4 mm, 1.6 mm, 1.8 mm and 2.0 mm as shown in Fig.1. The spectra were detected by CdZnTe (CZT). A uranium powder source with 4.5% enrichment is in a cylindrical container. The measurement time is 3600 seconds.

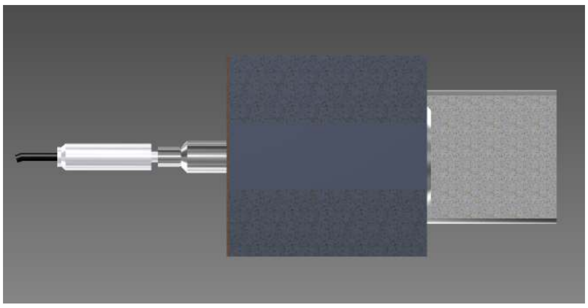

Fig. 1. Cross section of experimental setup geometry.

In the same way, we simulated using MCNPX 2.6 and the same geometry of experiments. The radiation source is defined as shown table 1. [3]

Table 1. Energy composition of 4.5% enriched uranium.

| Energy [MeV] | Intensity |
|---|---|
| 0.14377 | 393.75 |
| 0.16336 | 182.88 |
| 0.18262 | 14.04 |
| 0.18572 | 2052 |
| 0.19494 | 22.68 |
| 0.20212 | 38.88 |
| 0.20532 | 180.72 |
| 0.25823 | 8.73825 |
| 0.74281 | 11.46 |
| 0.76636 | 38.2955 |
| 0.78627 | 6.56085 |
| 1.00103 | 100.275 |

### *2.1 Experimental works*

The result of measurement is shown Fig. 2. Both of counts rate in the region of high and low energy decreased. For the more quantitative analysis, a net count area of binary peak of X-ray energy (90~150 keV) region and peak of a 185.7 keV were calculated to derive calibration curve of a CZT detector with MAESTRO-32 software. [4]

The calibration curve shows that the net peak areas at 185.7 keV and a characteristic energy region have linear relationship with thickness of Cu-filter as shown in Fig. 3. Fig. 3 shows the relative ratio of each Signal to Noise Ratio (SNR). The SNR is saturated from thickness of 1.6 mm.

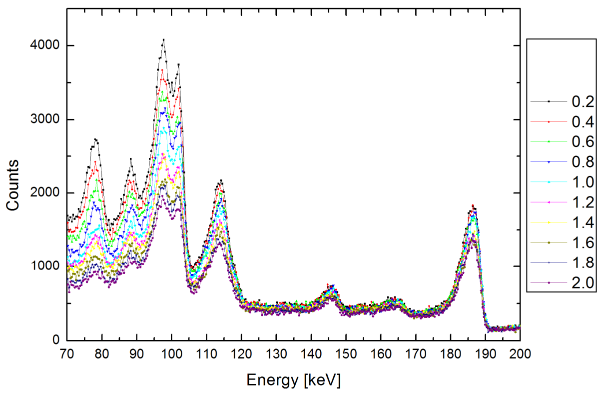


Fig. 2. Spectra of measured 4.5% enriched uranium powder with X mm Cu-filter where X = 0.2~2.0 mm (one step is 0.2 mm).

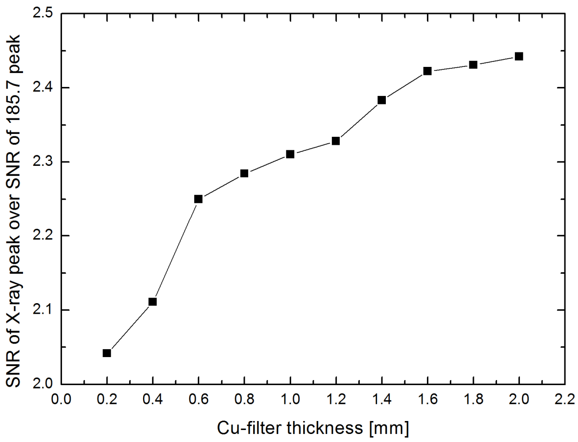


Fig. 3. Ratio of SNR with low energy (90~150 keV) region vs. high energy (185.7 keV) region of measurement.

*2.2 Simulation works*

The result of simulation is shown Fig. 4.

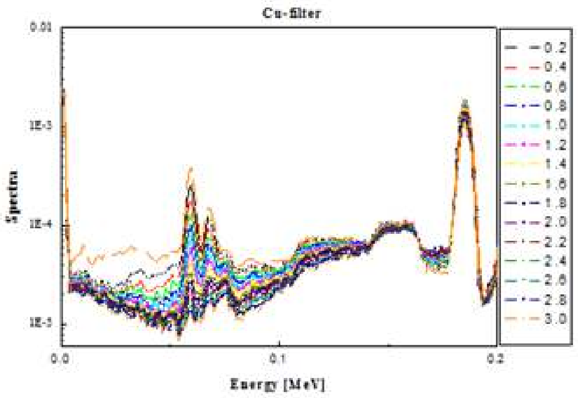


Fig. 4. Spectra of simulated 4.5% enriched uranium powder with X mm Cu-filter where X=0.2 ~ 3.0 mm (one step is 0.2 mm).

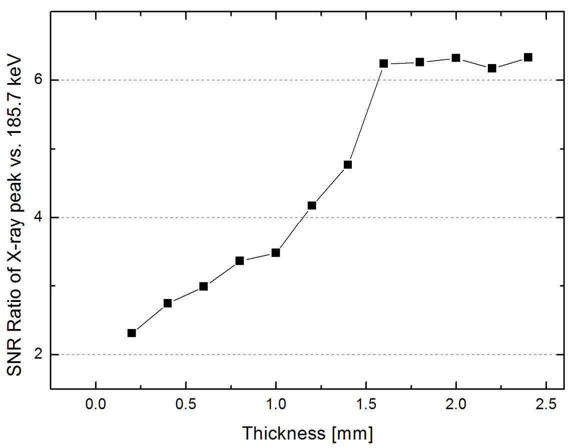


Fig. 5. Ratio of SNR with Low energy (90~150 keV) region vs. high energy (185.7 keV) region of simulation
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The result of simulation is shown Fig. 4. Both of counts rate in the region of high and low energy decreased like experimental result. From the same analysis method, net counts areas of two region were calculated from result of simulation. Fig. 5 shows the result.

## 3. Conclusions

The present study demonstrates that the combination of CZT measurements and computer simulations helps us understand the radiation production by shielding materials and the decrease of low-level background noise by Cu-filter. We carried out simulation of shielding using Cu-filter and verified the method by experimental measurement. We did not observe an evolution of relative ratio of low and high energy region using more than thickness of 1.6mm but only count rates deceased.

This result suggests that thickness of Cu-filter more than thickness of 1.6 mm is unnecessary for subtraction background characteristic noise.

## REFERENCES

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[4] MAESTRO-32 software user`s manual ver. 6.0