Directional Analysis of neutron and photon flux in LSDTS

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1. Introduction

A lead slowing down time spectrometer(LSDTS) system has been designed in order to analyze the contents of the special materials such as U-235, Pu-239, Pu-241 of spent fuel[1,2]. However, the target in LSDTS emits a high intensity of neutron and gamma rays when operating. For example, a typical neutron yield of LSDTS is about 1E+12 neutrons/s[3,4]. In this study, a directivity evaluation was carried out with a simplified and real size model of the LSDTS system in order to increasing accurate determination. The MCNPX code[5], a popular Monte Carlo three dimensional code, was used for analysis of neutron and photon flux and this study was also performed for the distance effect. Additionally, many central processing units was used in order to reduce the operating time and to get highly efficient results.

2. Methods and Results

Three parts were considered to evaluate particle directional analysis for LSDTS: Neutron, Photon, Photo fission Flux. The medium of LSDTS is full of pure lead blocks, which provides an inherent radiation shielding effect.

Target is composed of tantalum and air in cylindrical shape. Radiation directivity is evaluated by the electron impact target. The electron moves from right side to center of target. And the target was assumed to be positioned at the center of geometry in lead. Electron impacts the target and emits radiation. Influence depending on direction and distance is evaluated. The detector is positioned 10, 20, 30 and 40 cm from target and 6 directions as shown at Fig. 1.

2.1 Neutron Flux depending on direction

The model to detect neutron is described in Fig. 1. Detectors are positioned in left, left up, right up, right, right down and left down as shown in Fig. 1. Flux of left side is bigger than right side in Table I because of the electron directivity. But when the distance is over 30 cm, the flux of left side is similar to the right side. This means that neutron flux has direction effect until 20 cm. The neutron flux becomes isotropy when the distance is over 30 cm as showing the results in Table I.

2.2 Photon Flux depending on direction

Photon flux is also considered for comparing with neutron flux. Photon flux is bigger than neutron flux as showing the Fig. 2.

This model informed that how much the intensity of photon was changed when the direction and distance were changed. From the analysis, Flux of the left side is much bigger than the right side in photon flux. Similarly with neutron flux, Directivity effect only exists until 20 cm and disappear over 30 cm. It means the flux almost has isotropy from 30 cm.

2.3 Photo fission Flux depending on direction

In photo-fission case, it can be anticipated that Photo-fission flux intensity is smaller than photon because photo fission is generated when the photon arrived to the nuclear fuel. But the shape of photo-fission flux is similar with photon flux in Fig. 3.

In consideration of the operating time of the code, although the flux has large error when the distance is over 30 cm, the photon and the photo-fission at 10 cm can be compared

3. Conclusions

It was found that the flux of neutron and photon have directivity only under 20 cm from target in LSDTS system. When the detector is located over 30 cm, the flux of neutron and photon have isotropy. And the flux of photon has bigger directivity than neutron.

Up and down side in Fig. 1 shows similar shape and the intensity is also middle of left and right side.

Additionally, directivity has to be considered when the flux is measured in LSDTS system.

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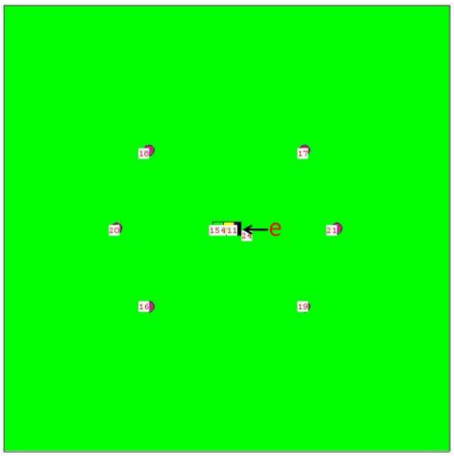

Fig. 1. Configuration of flux measurement problem.

Table I: Neutron flux at different distance and direction

	10cm	20cm	30cm	40cm
Left	1.29E-05	7.63E-06	3.99E-06	2.97E-06
Left up	1.19E-05	6.16E-06	4.59E-06	3.29E-06
Right up	9.46E-06	6.57E-06	4.00E-06	2.66E-06
Right	9.90E-06	5.52E-06	4.03E-06	2.53E-06
Right down	1.02E-05	6.64E-06	3.93E-06	2.48E-06
Left down	1.12E-05	6.43E-06	4.80E-06	3.26E-06

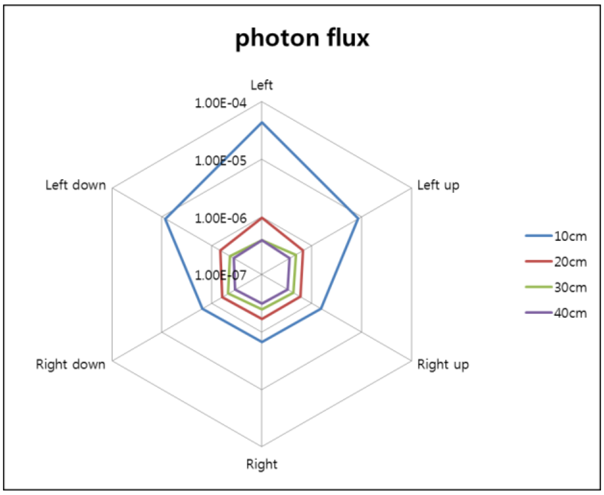

Fig. 2. Photon flux depending on the direction and the distance.

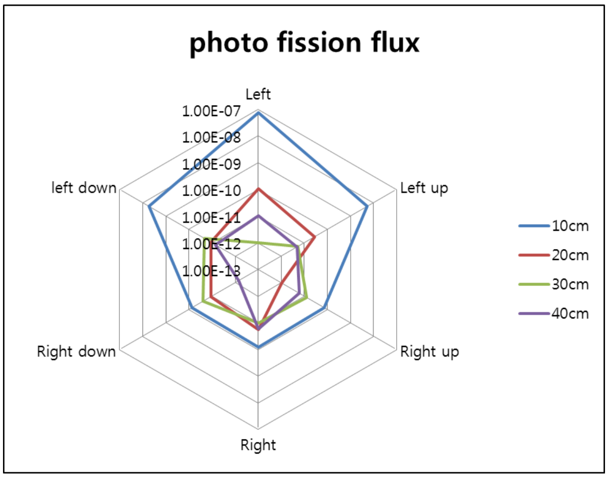

Fig. 3. Photon fission flux depending on the direction and the distance.