CO2-1 Study on Precise Epi-thermal Neutron Measurement Using a Photonuclear Reaction Neutron Source with KURRI-LINAC

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INTRODUCTION: Precise measurement for epi-thermal neutrons is important in various studies such as characterization of a thermal neutron reference field with a graphite pile and irradiation dose evaluation in a boron neutron capture therapy [1]. Epi-thermal neutrons mixed in the thermal neutron reference field have an effect on calibration of neutron dosimeters or survey meters. The epi-thermal neutrons are usually measured with a bonner sphere and a gold foil activation method. However, these detectors are not always appropriate for precise measurement of neutron spectrum or neutron flux. In the present paper, we report on two detectors that we have developed.

EXPERIMENTS: One is a fluence detector (LiF-SSD) composed of a ^{6}LiF radiator with a 53 μm thickness and a silicon surface barrier semiconductor detector with a depletion depth of 100 μm. The radiator was evaporated on a tantalum disc with a 0.5 mm thickness. The detector and the radiator are put in a vacuum chamber of less than 50 Pa. Neutron fluence is derived by counting the alpha particles and the tritons emitted from the ^{6}Li(n,α)T reaction. The other detector is a spectrometer composed of a ^{3}He proportional counter, a polyethylene moderator and filters made of Au, Ag, Co, W and Na having several absorption resonances. The epi-thermal neutron spectrum is derived by an unfolding method using response functions obtained for the resonance filters. As for the spectrometer, the test was performed for the simple formation in order to verify this suggestion. In the test, the silver filter was put in front of a ^{3}He proportional counter. Moreover, a borated polyethylene block was put between the filter and the proportional counter to reduce thermal neutrons below 1eV.

Epi-thermal neutrons were produced using a water moderator and the photonuclear reaction in a tantalum target with a pulsed electron beam from the KURRI-Linac. A multi-stop type TDC was used to obtain time of flight (TOF) spectra. Trigger signals from the accelerator and timing signals from the detector were used as start signals and stop signals, respectively. Events detected by each detector were stored as two dimensional data of the TOF and the pulse height (PH). The reference neutron spectrum from the neutron source was obtained with the total absorption type BGO scintillation detector and the ^{10}B(n,αγ) reaction.

RESULTS: Fig. 1 shows the PH spectrum measured with the LiF-SSD. In this figure, the peak around 500 ch. and the regions from 200-450 ch. and below 200 ch. respectively correspond to tritons, alpha particles and gamma rays produced by the ^{6}Li(n,α)T reaction in the LiF-SSD. The detection efficiency is derived by comparing between the reference neutron spectrum and the TOF spectrum measured with the LiF-SSD. It is necessary to improve the detection efficiency of the LiF-SSD.

Fig.2 shows the response functions of the spectrometer for the epithermal neutrons with and without the silver filter. Silver isotopes have the first resonance energies of 5.1 eV (Ag-109) and 16.3 eV (Ag-107), which are clearly seen as dips in the response function shown in Fig.2. In future, the response functions will be measured for other filter materials in order to make practical.

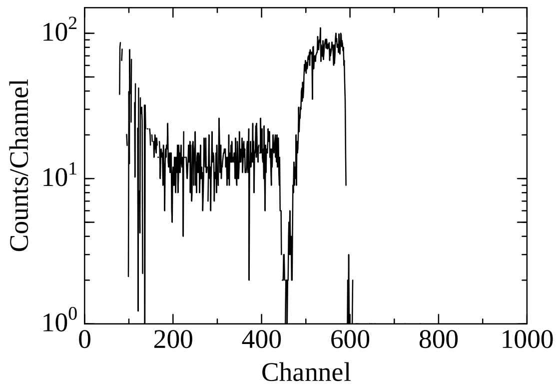

Fig. 1. Pulse height spectrum measured with the LiF-SSD.

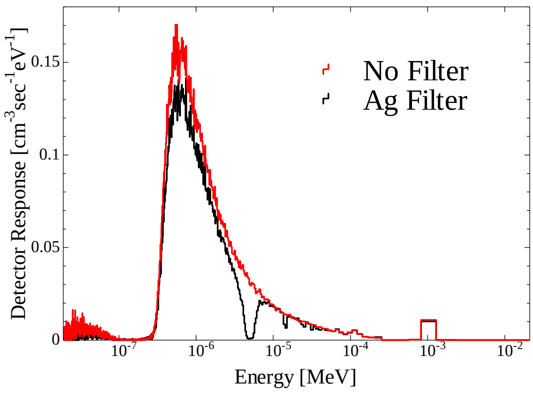

Fig. 2. Response functions of the spectrometer for the epi-thermal neutrons with and without Ag filter.

REFERENCE:

[1] Y. Sakurai and T. Kobayashi, Nucl. Instrum. Meth. A, **453** (2000) 569-596.

採択課題番号 20019　熱中性子フルエンス率測定の高度化とその国際標準化に関する研究　共同通常
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