Investigation of Neutron Flux Variation at PGA facility of the HANARO Research Reactor by Using Prompt Gamma-ray Activation

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1. Introduction

Facilities using a neutron beam extracted from a research reactor like the HANARO reactor undergo a variation of the neutron flux mainly due to a thermal powder variation of the reactor, which means that the neutron flux should be monitored during an experiment. In this study, we investigated the neutron flux variation at the ST1 beam port of the HANARO research reactor by using a SNU-KAERI prompt gamma-ray activation (PGA) facility.

2. Experiment

The SNU-KAERI PGA facility, which was installed at a ST1 horizontal beam line, uses a diffracted polychromatic thermal neutron beam [1]. As shown in Fig. 1, This system has an HPGe detector and BGO/NaI(Tl) guard detector system and its associated electronics for Compton-suppression. The prompt gamma-rays emitted from the thermal neutron capture provide information such as elemental concentration in a sample and characteristic of nuclear transition after neutron capture and neutron flux variation during irradiation. This facility has been used for the analyses of various biological, environmental and archeological samples and so on. In this study, we utilized this system as a monitor of neutron flux, for which the prompt gamma-ray spectra was repeatedly registered. Simultaneous analysis of a spectrum during neutron irradiation is possible by an EG&G Ortec GammaVision commercial software controlled by a GVU software [2] developed by Mr. Park at Seoul National University, who just transferred to the Korea Institute for Nuclear Safety. Variation of neutron flux at ST1 beam port was investigated by monitoring the peak count rate or total count rate of the spectrum. Each prompt gamma-ray spectrum was accumulated for 1,000 seconds and saved to a file and restarted new accumulation for a total irradiation time up to several tens thousands seconds.

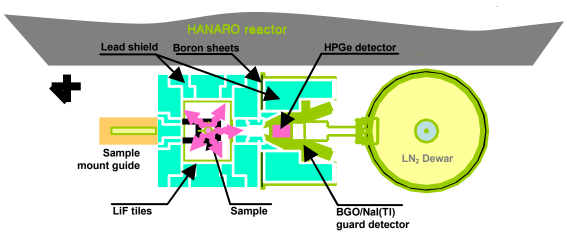

Figure 1. Upper view of the SNU-KAERI PGAA facility.

3. Results

Fig. 2 shows the count rate of the Ti 1381 keV peak for monitoring the rise of the neutron flux during the reactor startup, which represents that the neutron flux at a sample position is dependent on the reactor thermal power variation. There are various steps which shows that a level trip, thermal power calibration and so on influenced the thermal power.

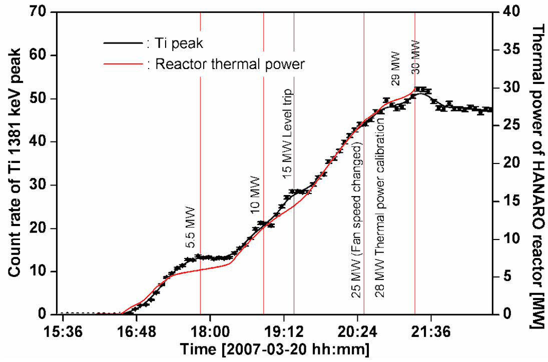

Figure 2. Variation of count rate of Ti 1381 keV peak and the thermal power of HANARO research reactor.

Fig. 3 shows the relative total count rate normalized to their mean value of the data accumulated for 100,000 seconds, where the neutron flux was fluctuated with a period of about 4000 ~ 8000 seconds and the fluctuation amplitude was within 3%. In this case, the neutron flux can be considered to be almost constant, which holds for most of the period but we can't generally expect this good situation. As shown in Fig. 4, the neutron flux variation exceeded 5% during a certain period for a reason we could not trace. Hence, the neutron flux is recommended to be monitored during an experiment.

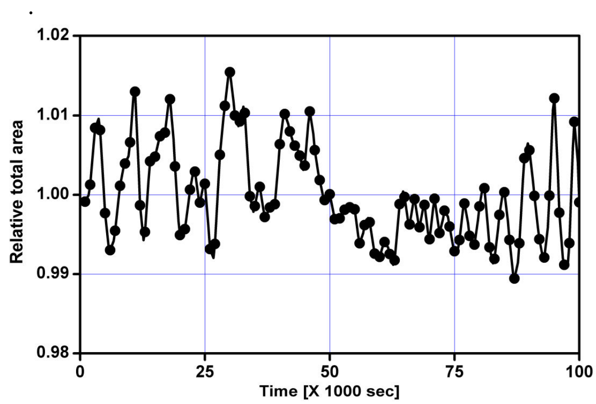

Figure 3. Relative total area according to the time.

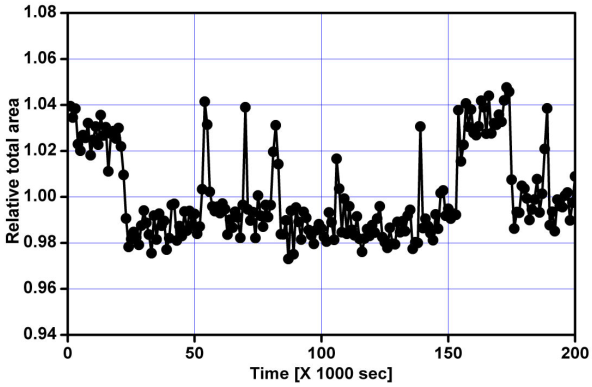

Figure 4. Relative total area according to the time.

REFERENCES

[1] S.H. Byun, G.M. Sun and H.D. Choi, Nucl. Instrum. Method A 487 (2002) 521-529.
[2] C.S. Park, GVU software, private communication.