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Simulation of experimental setup for multiplicity analysis by using the HANARO DNAA system

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1. Introduction

The delayed neutron activation analysis (DNAA) is one of the neutron activation analyses (NAA) methods, and has the advantage of non-destructively performing quantitative and qualitative analysis of trace components. The DNAA, which is applied in various fields, is also used for the evaluation of environmental samples such as the International Atomic Energy Agency (IAEA) Strengthened Safeguards Systems program, and is also applied to the multiplicity evaluation of fissile materials (such as U, Pu and Th) in environmental samples[1, 2].

The multiplicity analysis of fissile materials is done through time coincidence measurement, and for this, an electronic device called a shift register (SR) is widely used.

Time to digital converter (TDC), a digital device, is a device that has the potential to replace SR, which is an analog device, and it is intended to apply it to the HANARO DNAA system to conduct research on the multiplicity analysis of fissile materials.

This paper is described the results of calculating the neutron behavior and measurement efficiency emitted from samples irradiated in HANARO DNAA system through simulation using the Monte Carlo N-Particle (MCNP) code before applying TDC to the HANARO DNAA system.

2. Methods and Results

In this section the structures used in the simulation of the HANARO DNAA system was described.

2.1 Description of DNAA Detector

Figure 1 shows the structure of the installed He-3 detector. Eighteen He-3 proportional counters, 2 inches in diameter and 13 inches in active length, are arranged in two concentric rings around the flight tube. A polyethylene mediator surrounds the detector and flight tube to form a cube of approximately 18 inches in each dimension. A 2-inch lead shield is molded around the flight tube and air outlet line at the counting location. The polyethylene moderator is covered with a 0.5-inch aluminum plate and surrounded by a 4 inch boronized polyethylene neutron shield and 1 inch lead.

The detectors are grouped into three groups of six, and the aggregate signal from each group is amplified and converted to a digital signal. Bias is typically +1000 to +1600 V and is applied to all six detectors in the group via a manifold with capacitors for smoothing. Ultimately, the total count for each detector group is obtained from a 3-channel scalar that also controls the count time.

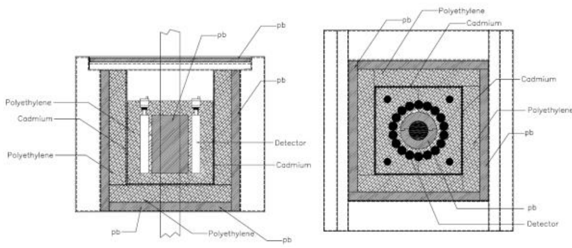

Fig. 1. Structure of He-3 proportional counter installed in HANARO DNAA system

2.2 Sample container

The rabbits, polyethylene sample containers, 22.5 mm in diameter and 46.5 mm height, are loaded into the pneumatic tube in a loading station, irradiated for pre-selected time, and automatically moved to the delayed neutron counting assembly.

Fig. 2. Photograph of the Rabbit

2.3 Monte Carlo N-Particle simulation

The Monte Carlo N-Particle code 6.2 (MCNP 6.2) was used for calculating the neutron behavior and measurement efficiency emitted from samples irradiated in HANARO DNAA system. The result of co

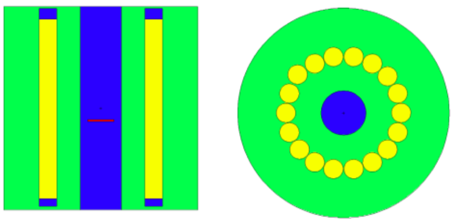

Fig. 3. The geometry of the installed He-3 detector

-nstructing the geometry of the He-3 detector using the MCNP code is shown in fig.3, and the and the neutron behavior and measurement efficiency are being calculated.

REFERENCES

[1] Mumba NK, Vas L, Buczkó CM: Uranium and thorium analyses by delayed fission neutron counting technique using a small neutron generator. Journal of Radioanalytical and Nuclear Chemistry 1985, 95:311-22.
[2] Kinlaw M, Hunt A: Fissionable isotope identification using the time dependence of delayed neutron emission. Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment 2006, 562:1081-4.