MLF Experimental Report	提出日 Date of Report 14/1/2010
課題番号 Project No. 2009A0024 実験課題名 Title of experiment Experimental study on a calibration method of devices for neutrons from thermal to several 100 MeV using a spallation neutron source 実験責任者名 Name of principal investigator Tetsuro Matsumoto 所属 Affiliation National Institute of Advanced Industrial Science and Technology	装置責任者 Name of responsible person Fujio Maekawa 装置名 Name of Instrument/ (BL No.) NOBORU BL 10 実施日 Date of Experiment 30/5/2009, 12 h 15/11/2009, 12 h

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。（適宜、図表添付のこと）
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

No use.

2. 実験方法及び結果 （実験がうまくいかなかった場合、その理由を記述してください。）
Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

1. Introduction

In the present experimental theme, we have developed neutron measurement devices that can be used in a high flux neutron field with a spallation neutron source. Characteristics of the devices are evaluated using the NOBORU facility.

The devices will be applied for the study on single-event phenomenon of a semiconductor and epi-thermal neutron calibration of radiation protection devices. Experimental hours were 12 h x 2 (24 h).

2. First experiment

For the purposes, we must prepare detection devises that can be used in a high flux neutron field. We prepared the two kinds of neutron detectors as the first contribution in this proposal research.

One is a proton recoil telescope (PRT). The PRT is composed of CF_4 proportional counters (gas pressure 1 atm) and a 3" x 3" NE213 liquid scintillation detector as shown in Figure 1. The PRT was used to measure neutrons with energies above 20 MeV.

2. 実験方法及び結果（つづき） Experimental method and results (continued)

Another is a thermal neutron detector that is composed of an enriched ^{6}LiF radiator and a silicon surface barrier semiconductor detector (depletion depth of 100 μm, sensitive area of 150 mm^2) as shown in Figure 2. In the detector with the ^{6}LiF foil converter, alpha particles and tritons produced by the ^{6}Li(n,α)T reaction are observed with the silicon surface barrier detector. The detector was used to measure epi thermal neutrons. Events detected by the detector were stored as two dimensional data of the TOF and the pulse height.

2.1 Experimental results

In the PRT measurement, the PRT did not work exactly, because the NE213 scintillator has large sensitivity for the gamma rays and the gamma flash from the spallation neutron source has a large effect on the NE213 scintillator.

The thermal neutron detector was set on the beam axis. The TOF spectrum obtained with the detector is shown in figure 3. Figure 3 indicates that the detector has dead time during 1.2 ms from trigger signal due to pulsed protons from the accelerator because of the gamma flash. Therefore we were able to observe the neutrons from 0.001 eV to 0.3 eV as shown in figure 4. However, the neutron spectrum was not correct because background due to neutrons scattered slightly in the field of NOBORU facility were not subtracted from the TOF spectrum.

3. Second experiment

In order to solve effects of the gamma flash from the neutron source in the first experiment, we modified the PRT and the thermal neutron detector.

3.1 Experimental results

About the PRT, the two silicon surface barrier detectors (depletion depth: 1 mm and 3 mm, sensitive area of 700 mm^2) as a proton detector is used instead of the NE213 scintillator, because the sensitive volume of the silicon detector is considerably smaller than that of the NE213. However, energy range of recoil protons is limited that is measured at a time with the silicon detector. Typical experimental setup for the modified PRT is shown in Figure 5. In measurements, the thermal and epi-thermal neutrons are shielded by boron plates set in NOBORU beam line. CF_4 gas pressure in the proportional counter was also reduced to 0.1 atm.

It became possible to measure the neutrons in the high flux neutron field of NOBORU the modified PRT without effect of the gamma flash. The quantitative evaluation will be given in next experiment.

As for the thermal neutron detector, the silicon surface barrier detector is set out of the beam as shown in figure 6. The TOF spectrum is shown in figure 7. Figure 7 indicates that the gamma flash from the neutron source has no effect on the thermal neutron detector. Moreover, the neutrons scattered in the field was measured using Mn, In, Ag and Co resonance filters. We are evaluating the response functions of the thermal neutron detector because the detector structure was modified. The quantitative evaluation will be given in next experiment.

Figure

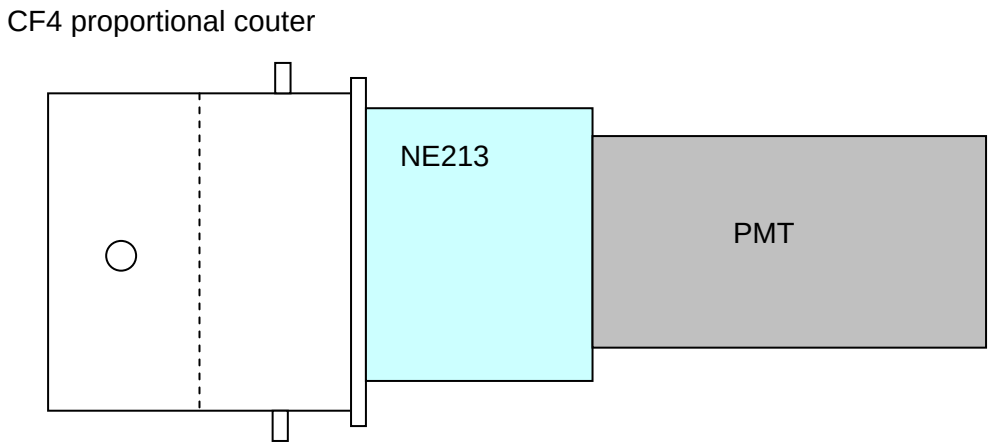

Figure 1 Schematic view of the PRT

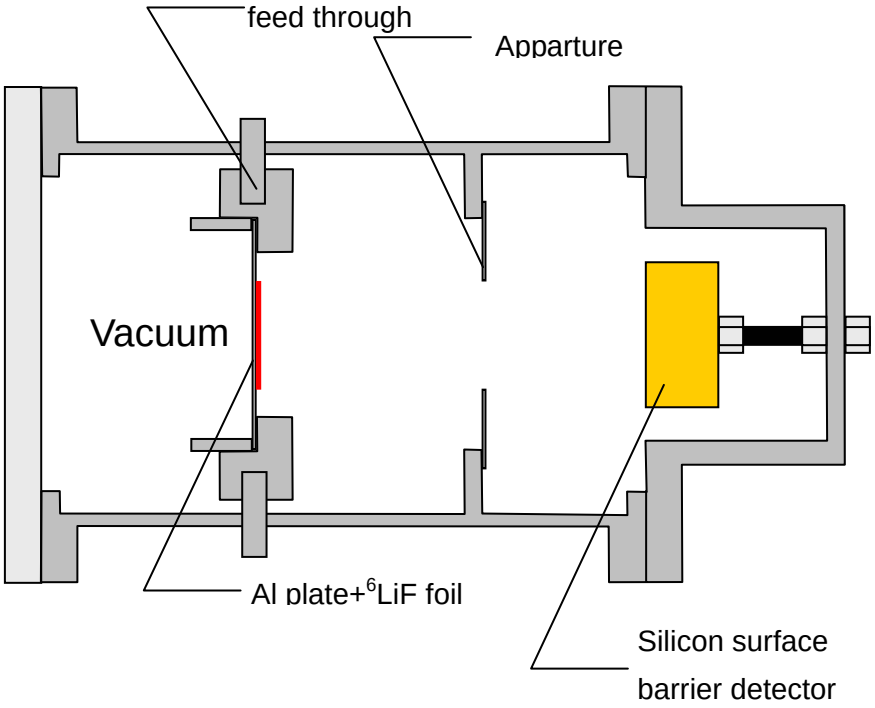

Figure 2 Schematic view of the thermal neutron detector

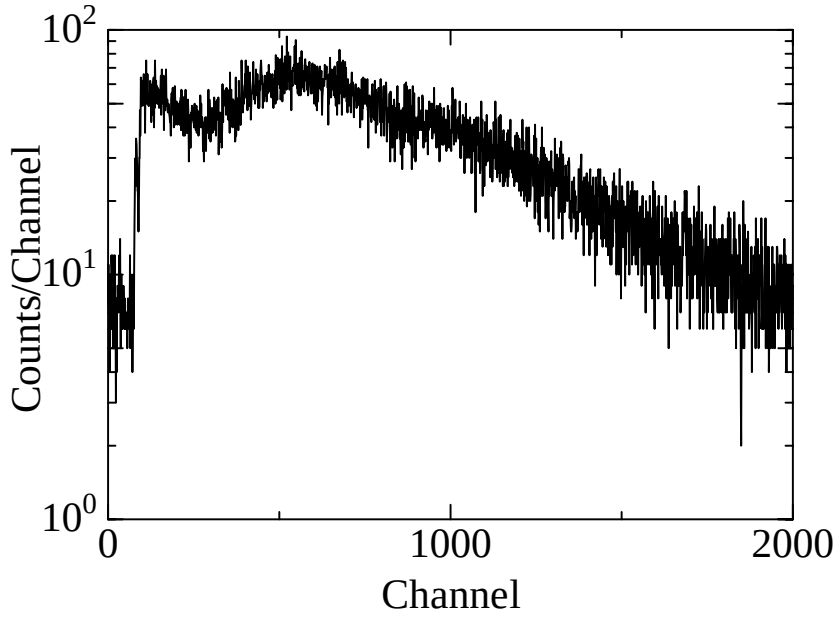

Figure 3 TOF spectrum measured with the thermal neutron detector

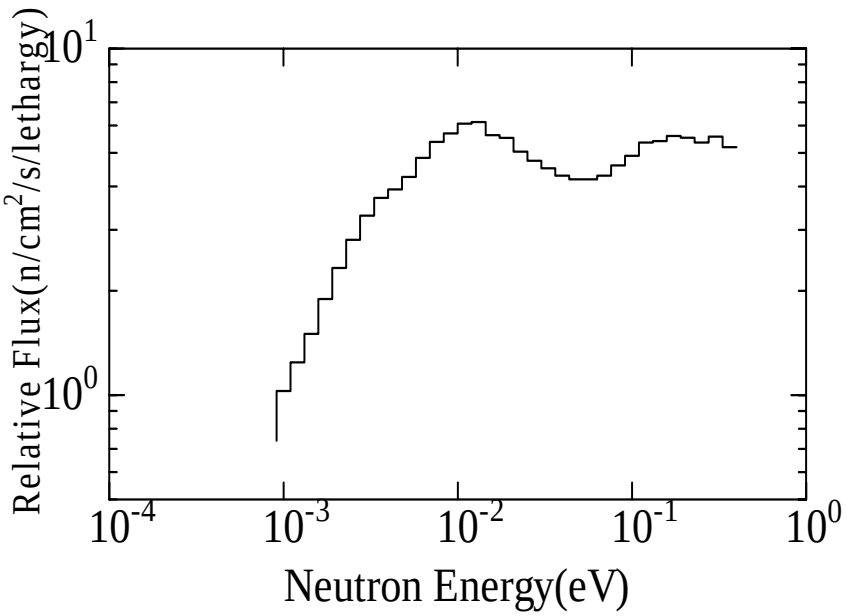

Figure 4 Neutron spectrum obtained with the thermal neutron detector. Scattered neutron effect is not corrected.

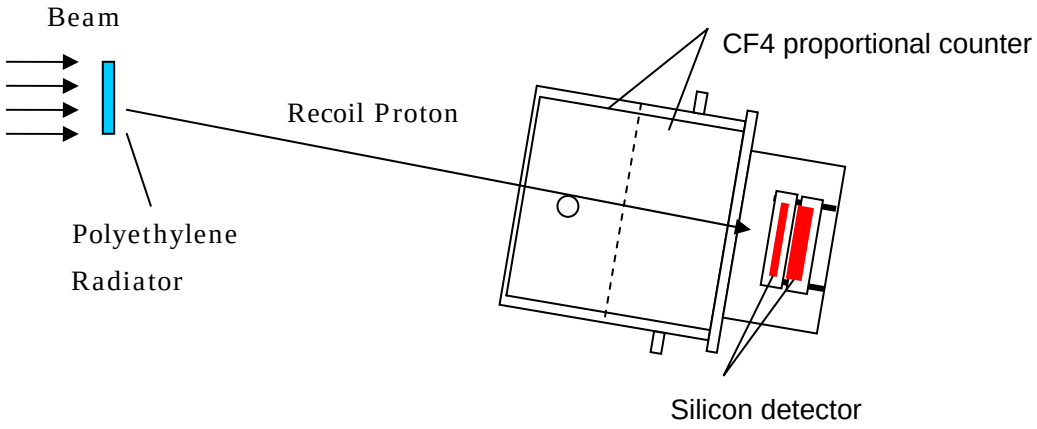

Figure 5 Modified PRT.

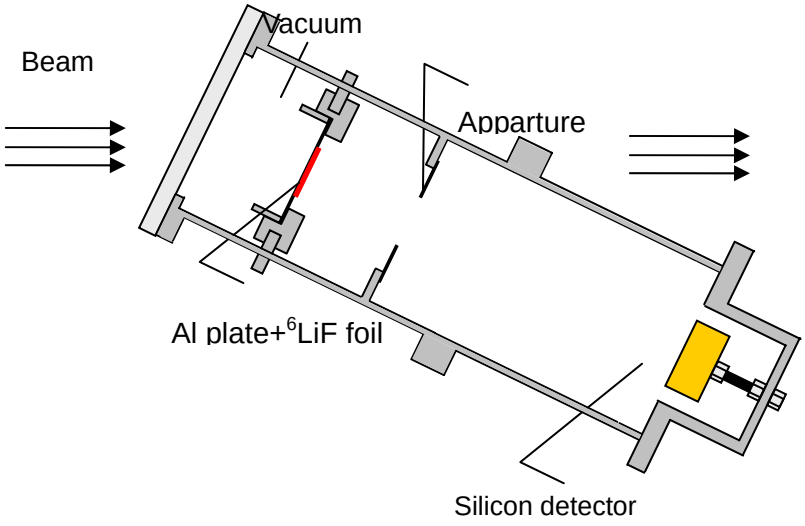

Figure 6 Modified thermal neutron detector and experimental setup

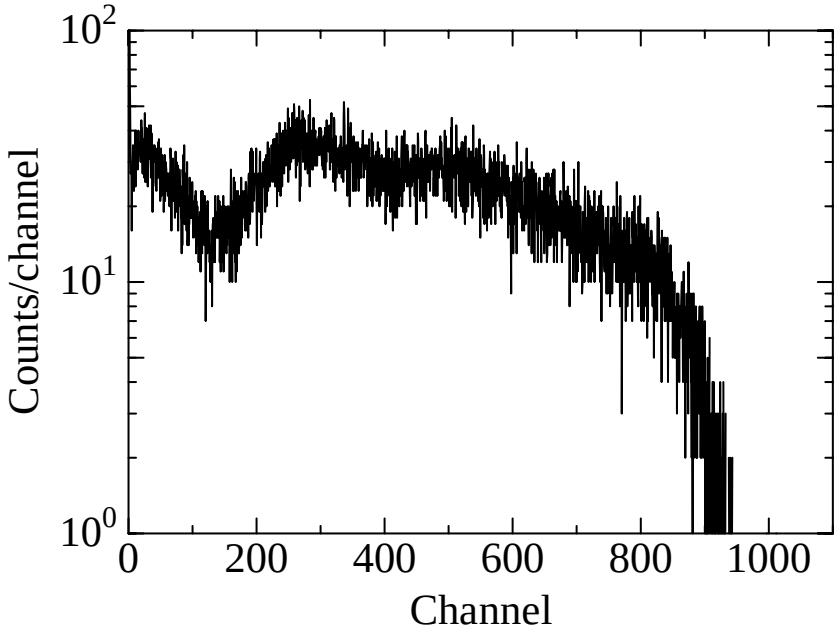

Figure 7 TOF spectrum observed with the modified thermal neutron detector