MLF Experimental Report	提出日 Date of Report July 26, 2011
課題番号 Project No. 2010B0029 実験課題名 Title of experiment Development of neutron detectors 実験責任者名 Name of principal investigator Tatsuya Nakamura 所属 Affiliation Japan Atomic Energy Agency, J-PARC center,	装置責任者 Name of responsible person Dr. Maekawa 装置名 Name of Instrument/（BL No.） NOBORU /(BL10) 実施日 Date of Experiment Feb 7-9, 2011

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.

The purpose of the experiment is to develop new types of neutron detectors. An aluminum rod and tin crystal were irradiated with neutrons to check detector system.

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.

Two types of new detectors were tested in this term. One was a scintillator monitor detector and the other was a two-dimensional scintillator detector for "*SENJU*" instrument.

i) ZnS scintillator monitor detector

A GS-20 glass scintillator detector has been extensively used in the ISIS pulsed neutron facility thanks to its superior temporal response and robustness. On the other hand the glass had to be mechanically processed into a bead form to decrease a detector efficiency (A detector efficiency usually required in a beam line is in the order of 10^{-5}.) The initial motivation to develop new scintillator monitor detector was to provide the one with easy-tuning of the detector efficiency. The anticipated monitor detector, ZnS scintillator mixed with a neutron converter material of low cross section, has a great advantage to adjust detector efficiency. By simply selecting the proper converter material and controlling the mixed amount the detector efficiency was adjusted as request. In the demonstrative experiment the detector efficiency was tuned around 10^{-3} to 10^{-4}, which was still rather "high" as monitor detector, to save the experimental time. The neutron-sensitive area of the detector had a size of 50 x 50 mm^2 with a layer thickness of 0.1 mm, just enough to cover the beam at BL10.

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

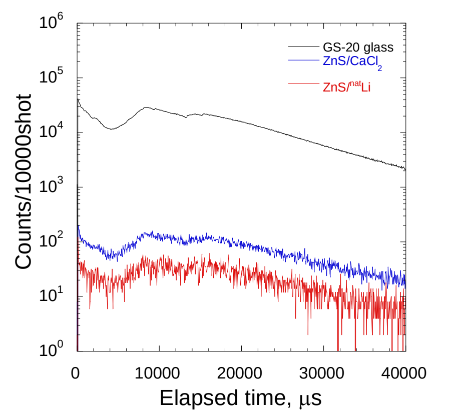

Figure 1 Time-of-flight spectra measured with ZnS/CaCl2, ZnS/^{nat}Li and GS-20 glass (reference) monitor detectors.

Three detectors were prepared for the test; ZnS/^{nat}Li, ZnS/ $CaCl_2$ and a GS-20 glass scintillator for reference. Figure 1 shows the time-of flight (TOF) spectra measured at the distance of 12.5 m from the mercury target. Both the ZnS/^{nat}Li and ZnS/$CaCl_2$ detectors exhibited similar TOF spectra to the reference detector, indicating the feasibility of those as a beam monitor. These detectors exhibited much less detector efficiency as expected; 2.1x 10^{-3} and 3.4 x 10^{-4} for the ZnS/$CaCl_2$ and ZnS/^{nat}Li, respectively. These results demonstrated that the easy-tune of the detector efficiency by selecting the converter materials and adjusting their amounts. The detector efficiency measured with ZnS/^{nat}Li detector agreed well with the calculated result whilst the ZnS/$CaCl_2$ counted more by a factor three than expected. This result could be due to the threshold voltage set lower for the ZnS/$CaCl_2$ detector to detect 598-keV proton generated in ^{35}Cl(n,p)^{35}S reaction. The origin of this should be clarified in future.

(2) Beam line detectors for "*SENJU*" instrument

Three beam line detectors for "*SENJU*" instrument were successfully tested in this run. The detectors were manufactured by fully exploiting the scintillator detector technologies developed in the neutron instrumentation group in JAEA. These detector modules, each of which had 64 x 64 pixels with a pixel size of 4 mm, were assembled in a row to mock up one detector bank (Figure 1). All the detector components including detector electronics (amplifier, encoder, data acquisition boards and even the cables) were identical to the one to be used in the instrument. The detectors measured neutrons without oscillation for over one day, confirming the stability of the detector system. Figure 2 and 3 show some of the examples of the measured spectra. The detectors measured Debye-Scherrer ring of the Al_2O_3 sample clearly. Moreover the Bragg peaks of the single crystal Sn were measured clearly with a descent spatial resolution in a reasonable intensity, confirming the soundness of the detector system.

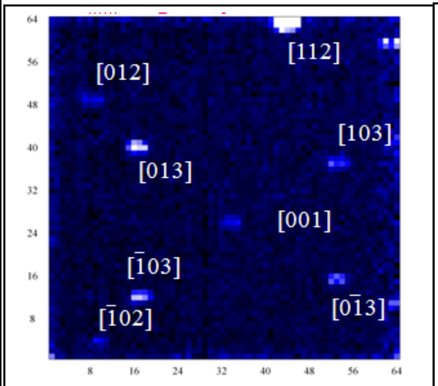

Figure 3 Diffraction pattern from an Sn crystal (tof: 10.0~10.1 ms).

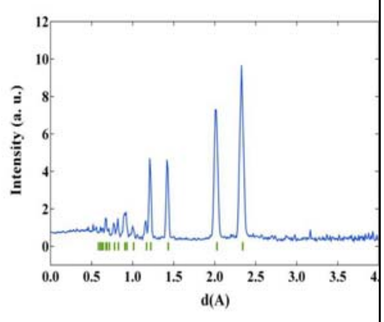

Figure 2 d-spacing of the Al_2O_3 measured in this test.

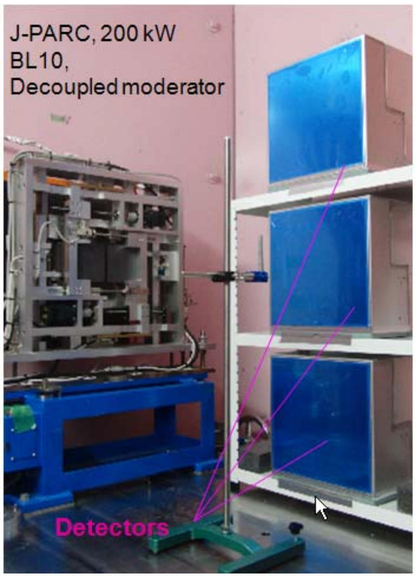

Figure 1 Mock-up of the one bank of the "SENJU" instrument assembled in the BL10.