MLF Experimental Report

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課題番号 Project No.

2009A0046

装置責任者 Name of responsible person

Dr. F. Maekawa

実験課題名 Title of experiment

Development of neutron scintillator monitor detector

装置名 Name of Instrument/(BL No.)

NOBORU /(BL10)

実験責任者名 Name of principal investigator

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所属 Affiliation

Japan Atomic Energy Agency, J-PARC center,

実施日 Date of Experiment

December 12 -16, 2009

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.

A rolled nickel foil and a YAG single crystal

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.

The purpose of the experiments is to evaluate the scintillator monitor detectors. A scintillator monitor detector (no position sensitivity) and the area neutron scintillator detectors were prepared for this purpose. The monitor detector employed a ZnS scintillator that incorporated with neutron converter material. The position-sensitive detector had a pixel size of 5 mm with 64 x 64 channels. The neutron-sensitive area was 320 x 320 mm. This detector was recently developed as a demonstrator detector for the single crystal diffractometer instrument to be constructed in the BL18 of the MLF in 2010.

(1) Scintillator monitor detector

Two types of scintillator monitor were prepared. One used ^{6}LiF as neutron converter and the ZnS as scintillator. The other used $^{nat}B_2O_3$ and the ZnS. The ZnS employed in the detector was produced in the lab in JAEA with a less amount of afterglow. The neutron-sensitive part has 50 x 50 mm^2 with the thickness of 0.1 mm each. The mixing density of the ^{6}LiF and $^{nat}B_2O_3$ converter was adjusted rather high for the "monitor" detector to save the experimental time. The neutron flux in the beam was also measured with a conventional ^{6}Li glass scintillator (GS-20) purchased from the Applied Scintillation Technologies. Figure 1 shows the

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

time-of-flight spectra measured in the BL10. Both the ^{6}LiF and the $^{nat}B_2O_3$ type monitor detectors reproduced the similar time-of-flight spectra with that by the conventional GS-20 detector. This result clearly demonstrated a capability of time-of-flight measurement with these monitor detectors. The detector efficiencies were estimated to about 7.5% for neutrons with the wavelength of 2.6Å, which roughly agreed with the estimated neutron absorption probability in the scintillator material. This type of monitor detectors would have less contamination with gamma-rays from the environment since the detectors were one or two orders less gamma sensitive to the GS-20 detector (about 10^{-6} for ^{60}Co gamma-ray). Mixing the other converter materials that have less neutron-capture cross-section such as Al would be the work in the near future.

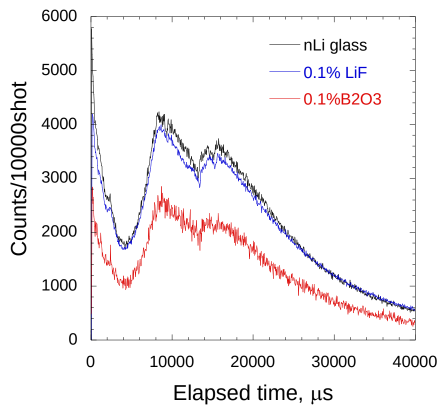

Figure 1 Time-of-flight spectra measured with the monitor detectors at the BL10.

(2) Position-sensitive neutron detector

The purpose of this experiment was to demonstrate the detector principle of the newly developed “Large area WLSF detector”. The detector was the first prototype incorporating the new idea to achieve the large detection area with an affordable manufacturing cost. The detector employed the wavelength shifting (WLS) fibre technology as used in the iBIX detector, but the each pixel cell was more ore less light-insulated. According to this cell structure the detector required only 64 x2 WLS fibres for light read out for 320 x 320 mm neutron-sensitive area.

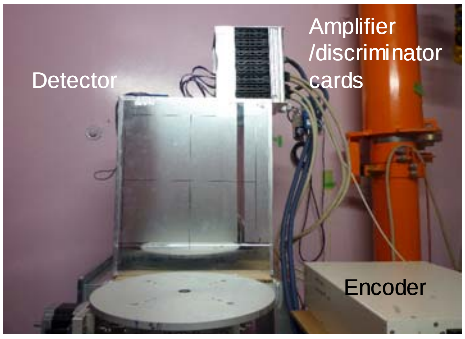

Figure 2 The large area position-sensitive neutron detector set up in the BL10.

To begin an imaging capability of the detector was evaluated by measuring the profile of the collimated beam. The measured profile matched reasonably well with the opening degree of the jars, confirming the position sensitivity of the detector. For the sample measurement the detector was positioned at the 90 degrees against the sample, where the distance from the moderator to sample was 13.4 m and the sample to detector 0.28 m. The count uniformity was evaluated by using a plastic sample, revealing that the deviation was ±30% from the average count. The result suggested that the detector manufacturing process and the technique should require further improvement. Figure 3 shows one of the neutron diffraction images from the rolled nickel foil. The detector clearly measured the diffracted neutrons, demonstrating the detector principle successfully. The precise characterization of the detector performances is the future works.

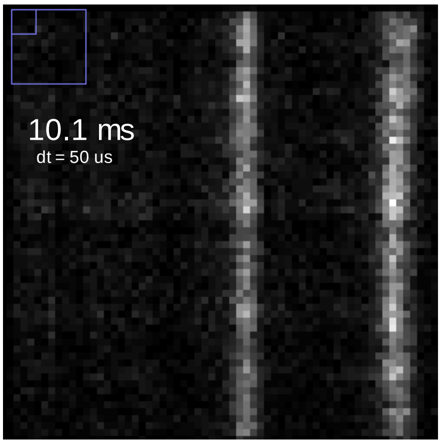

Figure 3 Diffraction pattern from the Ni foil at the summed imaged of 10.1 ms.