MLF Experimental Report	提出日 Date of Report Oct 21, 2013
課題番号 Project No. 2012B0175 実験課題名 Title of experiment Development of neutron scintillation detectors 実験責任者名 Name of principal investigator Masaki Katagiri 所属 Affiliation Ibaraki University, Frontier Research Center for Applied Atomic Sciences	装置責任者 Name of responsible person Dr. Oikawa 装置名 Name of Instrument/（BL No.） NOBORU /(BL10) 実施日 Date of Experiment Dec 11-15, 2012 Jan 21-24, 2013, Mar 17-20, 2013

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 sample was used in the experiment. The detector performances were purely evaluated using a collimated pulsed neutron beam only.

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.

In this allocated experimental time the detector performances of (i) Evaluation of the detector performances of the renovated iBIX detector, and (ii) New detector alternative to ^{3}He-gas-based detector.

(i) Evaluation of the detector performances of the renovated iBIX detector

The proto-type position-sensitive scintillator detectors with a high spatial resolution were newly developed for iBIX in BL-03. Several modifications on the detector were done and the detectors were manufactured without optimization of neutron scintillator for TOF experiments. Also, measuring condition should be optimized by changing the measuring parameter, for example, discrimination level, coincidence time, for the new proto-type detectors as a function of time-of-flight.

In this experiment, relation between measured counts and photon discrimination level in the iBIX detector was evaluated as a function of TOF time. The results were shown in Fig.1. It is confirmed that the multi-counting was occurred in case of the discrimination less than 3 photons. Therefore, the discrimination level more than 4 photons was set on iBIX signal processing modules for practical operation. Also, relation between measured counting rate and coincidence time of x-axis signal and y-axis signal in the iBIX detector was evaluated as a function of TOF time.

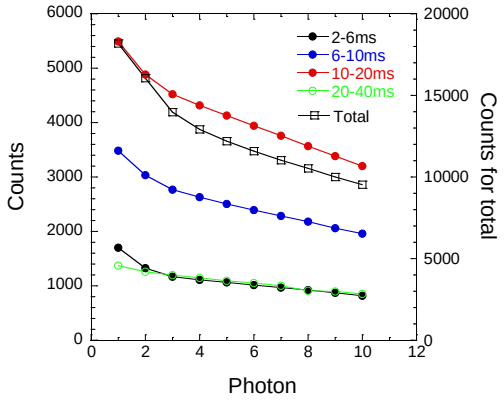

Figure 1 Measured counts vs. photon discrimination characteristics

Figure 2 shows the relations each TOF time range. Ideally speaking, the counting rate is flat at more than 3 μs of coincidence time because photons generated by the scintillator can be collected fully at 3 μs. The reason of the reduction from 2 μs is the dead time of signal a processing circuit. It is easily found that the best coincidence time is 1-2 μs without range of TOF time from 0 to 2ms because the effect of fast neutron is large in the short TOF time.

In conclusion, we could obtain the necessary parameters for the signal processing in iBIX detectors by these experiments.

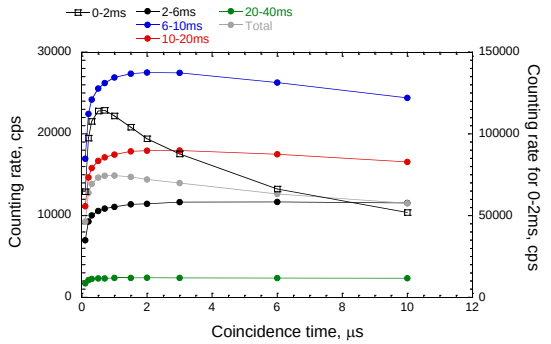

Figure 2 Relation between measured counts and coincidence time of x-axis signal and y-axis signal in the iBIX detector

(ii) New detector alternative to ^{3}He-gas-based detector

Feasibility of a position-sensitive scintillator neutron detector (PSD) using a translucent ZnS/$^{10}B_2O_3$ ceramic scintillator in the light reflecting tube was evaluated. The detector shown in Fig.1 was comprised of the opaque scintillator enclosed in the light reflecting tube that is 30mmϕ and 300mm length and two photomultiplier tubes attached at both end of it for light collection. The size of the used scintillator is 25mm wide x 240mm length. The combination of the translucent ZnS scintillator and the simple light reflecting guide structure ensure the detector high detector efficiency of 30–50%, a timing resolution <5 ns and a position-sensitivity by a simple solid angle model. Figure 4 shows position profile characteristics. The FWHM spatial resolutions of the detector were confirmed to be 20–30 mm over the neutron-sensitive length of 240 mm, which corresponded 8–12% of the total length. The events induced by a neutron or by a gamma ray were discriminated each other using the differences in pulse shapes, where the effective discrimination was done by running sum of the data. Time-of-flight spectra of a position-sensitive scintillator neutron detector were measured with a ZnS scintillator monitor at the BL-10. By this experiment, it is confirmed that the new detector alternative to ^{3}He-gas-based detector can be sufficiently used for TOF experiments.

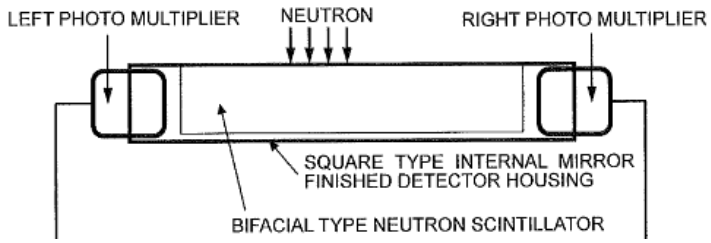

Figure 3 Structure of a new detector alternative to ^{3}He-gas-based detector

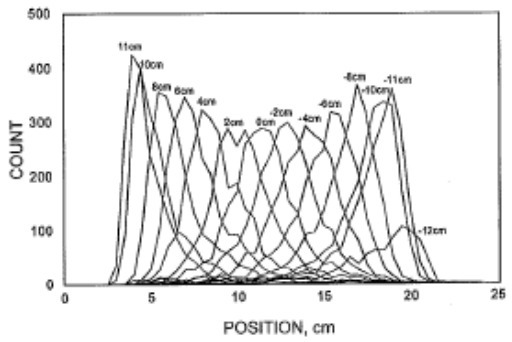

Figure 4 Position profile characteristics

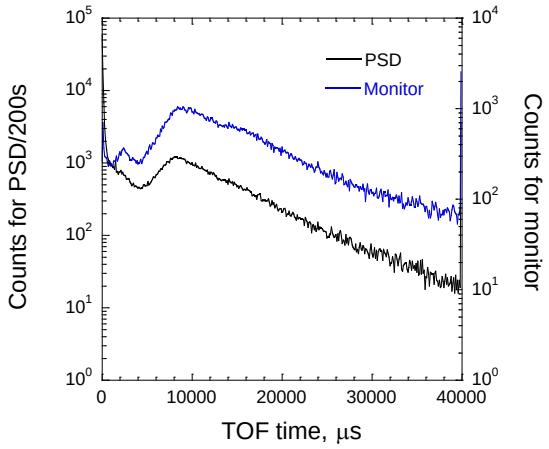

Figure 5 Time-of-flight spectra measured with a ZnS scintillator monitor detector at the BL10