| MLF Experimental Report | 提出日 Date of Report<br>8 Aug., 2017 |
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| 課題番号 Project No.<br>2014B0241<br>実験課題名 Title of experiment<br>Development of neutron detectors<br>実験責任者名 Name of principal investigator<br>Tatsuya Nakamura<br>所属 Affiliation<br>Japan Atomic Energy Agency, J-PARC center | 装置責任者 Name of responsible person<br>Tatsuya Nakamura<br>装置名 Name of Instrument/(BL No.)<br>BL 10<br>実施日 Date of Experiment<br>2014 12/16-17, 12/21-22<br>2015 4/15-16<br>2016 6/16-6/18 |

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.

In foil, Au foil

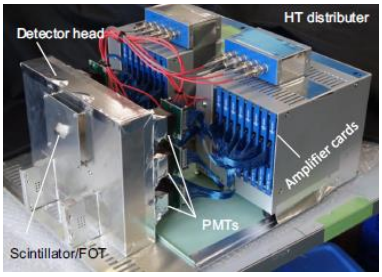
2. 実験方法及び結果 （実験がうまくいかなかった場合、その理由を記述してください。）
Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

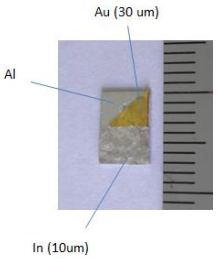
Three types of scintillation neuron detectors have been developed in house aiming for applications in the J-PARC MLF. The detector performances were evaluated by using a pulsed neutron beam in the BL10. Our ideas implemented in the detectors have all functioned successfully. The experimental results obtained within the available beam terms are summarized below.

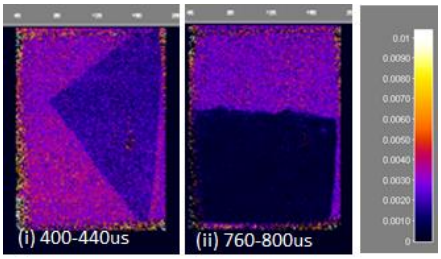
(1) A time-of-flight neutron imager using a ZnS scintillator/wavelength-shifting fiber with a fiber optic taper

We aimed at developing a 100-μm spatial resolution neutron detector in a cost effective way, by combing a developed wavelength-shifting (WLS) fiber technology with a fiber optic taper (FOT). The key idea is to measure neutron transmission image with a fine diameter fiber (ϕ100 μm) after expanding the scintillation image with a FOT device. The detector comprises a thin scintillation screen (100 μm), WLS fiber, and FOT (image expanding rate of three). The detector exhibited a spatial resolution of about 60 μm. Moreover a superior gamma-ray sensitivity of $10^{-8}$ was achieved. The detector measured transmission images of Au/In foils successfully, demonstrating a good temporal resolution. Although the detector had limited count rate capability (<20 kcps), we demonstrated one of the solutions to provide a 100-μm resolution detector.

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

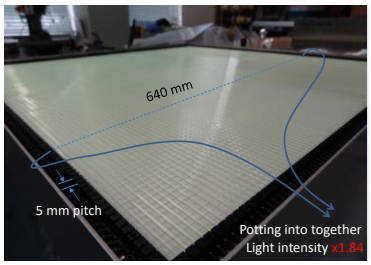


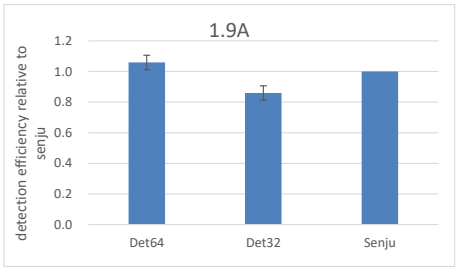




(2) A large area position-sensitive scintillation neutron detector as an alternative to $^{3}$He PSDs

In order to develop a detector technology that can be alternative to $^{3}$He PSDs a large area neutron detector has been produced by using scintillator/WLS fiber technology. The detector structure is somehow similar to "conventional" SENJU detector. Two key technologies have been developed for this detector. First thing is to collect scintillation light from both sides of the WLS fiber. It increased the collected light by a factor of 1.8. Second technology is to develop a spring-driven fiber pulling jig. This mechanical device keeps the fibers in a proper position with an appropriate tension. We produced the detectors that has a size of 32 × 32 cm$^2$ and 64 × 64 cm$^2$. Those detectors exhibited a similar detection efficiency to that of SENJU detector, demonstrating the feasibility of the large area detector with the developed detector technologies.




(3) A 2.5-mm spatial resolution two-dimensional detector for jBIX instrument in the J-PARC MLF

A first prototype detector which is dedicated to a planned protein single crystal neutron diffractometer in MLF was developed. The detector performances are evaluated by using a collimated beam (1 × 1 mm$^2$) in BL10. The detecting head structure is similar to that in SENJU. The detector is designed compact, lightweight, and modular in order to fit several tens detectors in a space-limited blockhouse. The detector has a size of 38 × 38 × 46 cm$^3$ and it weighted 20 kg. The 128 WLS fibers placed in a regular gap of 2.5 mm for both in x and y directions. The detector exhibited a spatial resolution of 2.5 mm and a superior position linearity (The deviation from the linear fit is less than 0.2% ). A count uniformity measured with flood irradiation with moderated neutrons was 13% (= sigma/average), which is acceptable to jBIX.