（ ※本報告書は英語で記述してください。ただし、産業利用課題として採択されている方は日本語で記述していただいても結構です。 ）

CROSS TOKAI Experimental Report J-PARC	承認日Date of Approval 2015/11/30 承認者Approver Yamazaki Dai 提出日Date of Report 2015/11/07
課題番号 Project No. 2014A0133	装置責任者 Name of responsible person TAKEDA Masayasu
実験課題名 Title of experiment A quest for the spin current excited by neutron II	装置名 Name of Instrument/（BL No.） SHARAKU(BL17)
実験責任者名 Name of principal investigator TAKEDA Masayasu	実施日 Date of Experiment 2014/11/5 9:00 ～ 2014/11/6 9:00
所属 Affiliation Japan Atomic Energy Agency	2014/11/11 9:00 ～ 2014/11/12 7:00 2014/11/19 21:00 ～ 2014/11/20 9:00

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.

$Pt/Y_3Fe_5O_{12}/Gd_3Ga_5O_{12}$(= substrate)

$Pt/Y_2GdFe5O_{12}/ Gd_3Ga_5O_{12}$(= substrate)

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.

A sample is the same sample as used in the prior experiment in 2013B. It is a Pt/YIG on a GGG substrate. Here YIG is Yttrium iron garnet ($Y_3Fe_5O_{12}$), and GGG is Gadolinium Gallium Garnet ($Gd_3Ga_5O_{12}$). At the first, we confirmed the induction of the spin current by the temperature gradient controlled by a Peltier device at ambient temperature. Then the sample was set in a cryocooler, and the magnetic field dependence of the spin voltage with or without irradiation of neutrons was measured at the lowest temperature of 2.3 K which could reached by the cryocooler. If the spin-voltage signal appeared even in the absence of the temperature gradient, the signal would be due entirely to the neutron irradiation. Hysterisis curves of the voltage were measured under external magnetic fields between – 10 kOe and + 10 kOe, and the signal was accumulated about twenty times. We could not unfortunately detect the signal originating in Spin-Zeebeck effect using unpolarized neutrons. The same measurement was performed without operation of disk choppers which eliminated the flame-overlapping neutrons because we expected to increase the signal from the spin current with increasing the neutron flux. We did not see any signals again (Fig. 1 (a)).

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

We also tried to detect the spin current signal using polarized neutrons (Fig.1 (b) and (c)). The polarized neutron could make contrast of the spin current signal due to the net magnetization according to the spin state (up and down or + and -) of neutrons. As seen in Figs. 1 (b) and (c), neither the signals nor the distinct difference between the two spin states was detected. We speculate that the signals were not detected because of not enough large absorption cross-section of YIG, and think the sample with Gadolinium iron garnet ($Gd_3Fe_5O_{12}$) instead of YIG we recently successfully synthesized is a candidate in the next experiments.

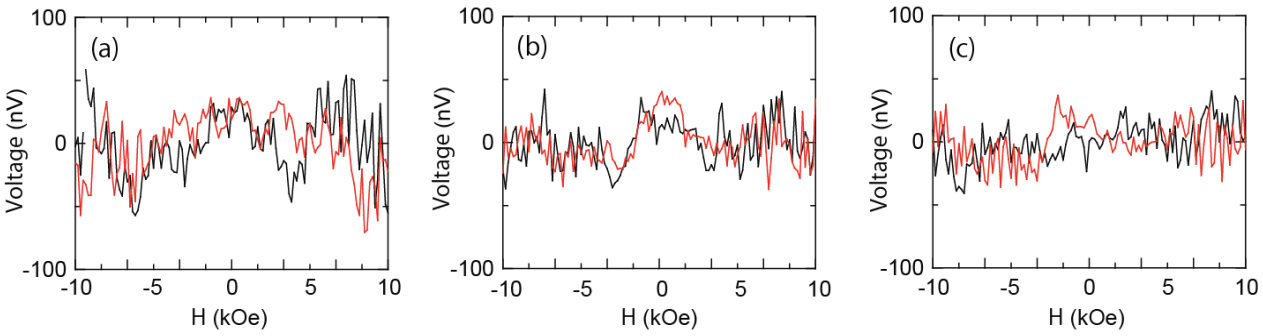

Figure 1 Results of the Spin-Zeebeck effect of Pt/YIG ($Y_3Fe_5O_{12}$)/GGG ($Gd_3Ga_5O_{12}$) at 2.3 K: (a) using unpolarized neutrons, (b) using polarized neutrons with up-spin state, and (c) using polarized neutrons with down-spin state. The flame-overlapping eliminating disk choppers were not operated in (a) but operated in both (b) and (c).