（ ※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 2015/11/15
課題番号 Project No. 2014B0083 実験課題名 Title of experiment Investigation of an anomalously large 90 degree interlayer exchange coupling in ferromagnetic/nonmagnetic/ferromagnetic trilayers using the polarized neutron reflectometry 実験責任者名 Name of principal investigator TAKEDA Masayasu 所属 Affiliation Japan Atomic Energy Agency	装置責任者 Name of responsible person TAKEDA Masayasu 装置名 Name of Instrument/（BL No.） SHARAKU(BL17) 実施日 Date of Experiment 2015/4/11 10:00 - 2015/4/14 10:00 2015/4/15 21:00 - 2015/4/19 10:00

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.

Co_2MnSi(CMS)/Cr/CMS trilayers on a Si 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.

The sample is Co_2MnSi(CMS)/Cr/CMS trilayer on a MgO substrate. Polarized neutron reflectivity measurements were performed on BL17 with a spin analyzer after and before the sample to separate the spin-flip and the non-spin flip channel in the reflection process. External magnetic fields of 50 Oe and 10 kOe were applied parallel to the sample plane. The latter field is enough strong to saturate the sample magnetization.

We had measured this sample several times because unexpected and unreasonable results were obtained in the previous experiments as reported in 2014A: The spin-flip (SF) reflections were observed even in the forced-ferromagnetic state under the external magnetic field of 10 kOe. When all the magnetic moments in the sample align to the direction of the external magnetic field, the SF reflection must not be observed. Therefore we cannot be convinced whether the distinct SF reflectivity observed under the magnetic field of 50 Oe is intrinsic or spurious. The ferromagnetic moments of CMS are expected to align at a mutual angle of 90 degrees because of the strong 90 degree coupling between them under the external magnetic field of 50 Oe.

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

In this measurements, we saw the peculiar SF reflection under the strong magnetic field of 10 kOe again. We had spent most of our beam time to investigate origin of unexpected behaviors of polarized neutron devices in 2014A, and had to repeat the investigation this time. Unfortunately, we could solve the problem within the give beam time, and finally measured the reflectivity after carefully tuning the devices for polarized neutrons under the weak magnetic field of 50 Oe. Figure 1 shows comparison between the results in 2014A (red) and those in 2014B (blue). Both reflectivity curves are almost identical for non-spin-flip (NSF) reflections (Fig.1 (a) and (b)) in the lowest *q*-region. The discrepancy becomes clearer in the higher *q*-region. In case of the SF reflection profiles seem to be similar to each other in the middle *q*-region, but not in the other *q*-regions (Fig.1 (c) and (d)). We cannot publish the results in this situation. Enough beam time for the machine study is mandatory to clarify the origin of the problem. General users should not spend their beam time to conduct the machine study.

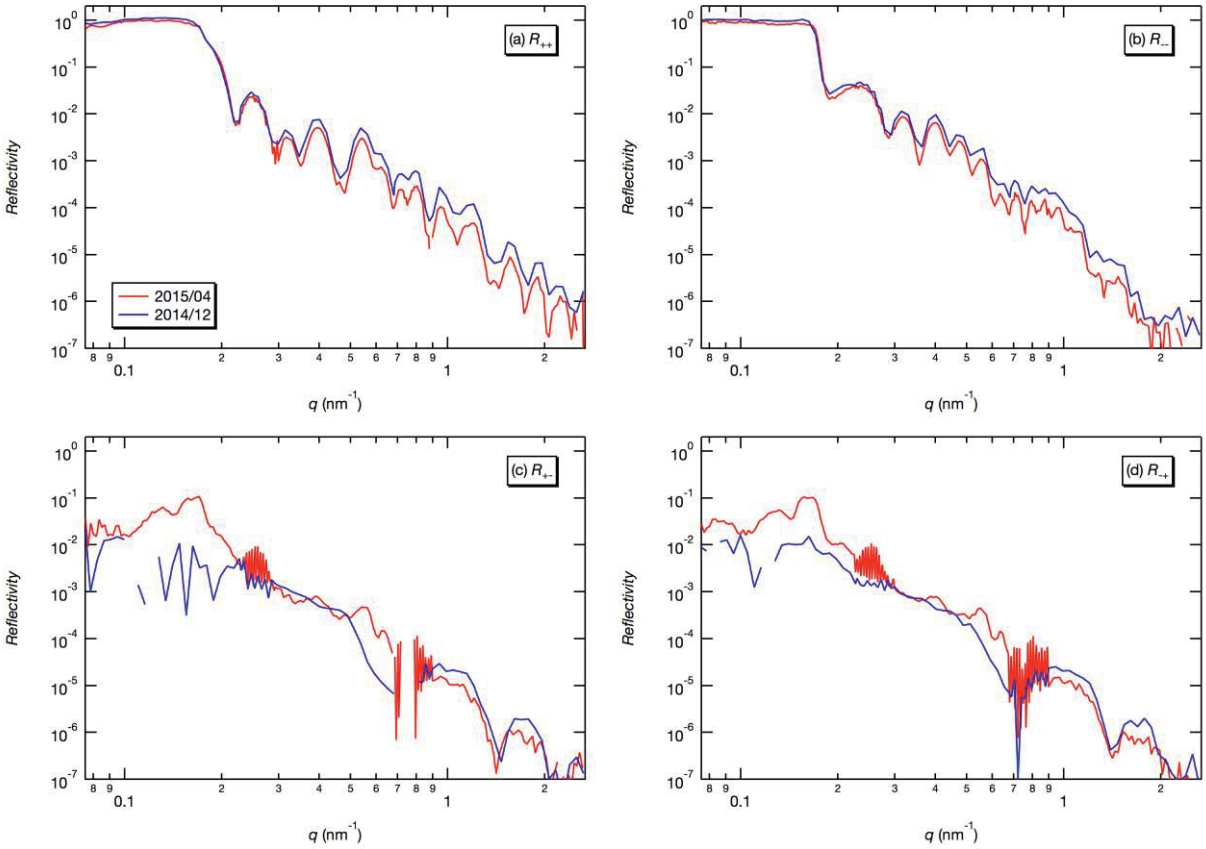

Fig. 1 Comparison between the polarized neutron reflectivity profiles of $Co_2MnSi/Cr/Co_2MnSi$ trilayer on a MgO substrate under a magnetic field of 50 Oe measured in 2014A (red) and those in 2014B (blue); (a) R_{++}, (b) R_{--}, (c) R_{+-}, and (d) R_{-+}.