（ ※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 2017/10/16 承認者 Approver Takashi Ohara 提出日 Date of Report 2017/10/16
課題番号 Project No. 2016B0151 実験課題名 Title of experiment Determination of the magnetic structure of a layered antiferromagnet EuMnBi2 with quasi 2D Dirac fermions 実験責任者名 Name of principal investigator Hideaki Sakai 所属 Affiliation Osaka University	装置責任者 Name of Instrument scientist Takashi Ohara 装置名 Name of Instrument/(BL No.) BL-18 Extreme Environment Single Crystal Neutron Diffractometer (SENJU) 実施日 Date of Experiment 2 Feb 2017 – 10 Feb 2017

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.

EuMnBi2 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.

Dirac fermions in magnetic materials have attracted a growing interest, since the quantum anomalous Hall effect was observed at zero fields in magnetic topological insulator films. To further explore such distinct quantum transport phenomena enriched by magnetic order, we have recently focused on a layered bulk antiferromagnet EuMnBi2, where the Bi layer hosting quasi 2D Dirac fermions and the magnetic blocking layer (Eu and Mn–Bi layers) stack alternatively (see Fig. 1b). In this material, the antiferromagnetic order of Eu sublattice has a marked impact on the Dirac fermion transport. However, the detailed magnetic structure has remained unclear, which needs to be clarified to seek the origin of strong coupling between the Dirac fermions and magnetic order.

In this experiment, to determine the type of the antiferromagnetic order of both Eu and Mn sublattices in EuMnBi2, we were supposed to perform the neutron diffraction measurements on the single-crystalline sample (inset to Fig. 1a) at magnetic fields. On the first day, we started the initial cooling of a superconducting magnet. However, a needle valve equipped with the variable temperature insert (VTI) was blocked at some

the blocking at all.

On the second day, we stopped using the superconducting magnet and gave up the measurements at magnetic fields. Instead, we decided to perform the measurements for magnetic structural analyses on the antiferromagnetic phase at zero field. We remounted the single-crystalline sample in the GM type fridge. This fridge worked well during the rest of beam time and enabled us to measure the neutron diffraction at zero field at 4 K (below TN) and at 30 K (above TN), where TN denotes the antiferromagnetic transition temperature of Eu sublattice.

Figure 1a shows the neutron diffraction intensity on the (H 0 L) plane at 4 K. As denoted by red arrows, we clearly observed the (H 0 L) reflections with H+L=odd, which completely disappear above TN. These reflections hence arise from magnetic scattering associated with the antiferromagnetically ordered Eu moments. By checking other extinction rules, we have determined a plausible type of antiferromagnetic order of Eu sublattice; the Eu moments order ferromagnetically in the ab plane and align along the c axis in the sequence of up-up-down- down, where the Bi square net intervenes between the Eu layers with magnetic moments up and down (Fig. 1b). This result is consistent with what was deduced from the resonant x-ray magnetic scattering. Full magnetic structural analyses considering both Eu and Mn sublattices are ongoing at present.

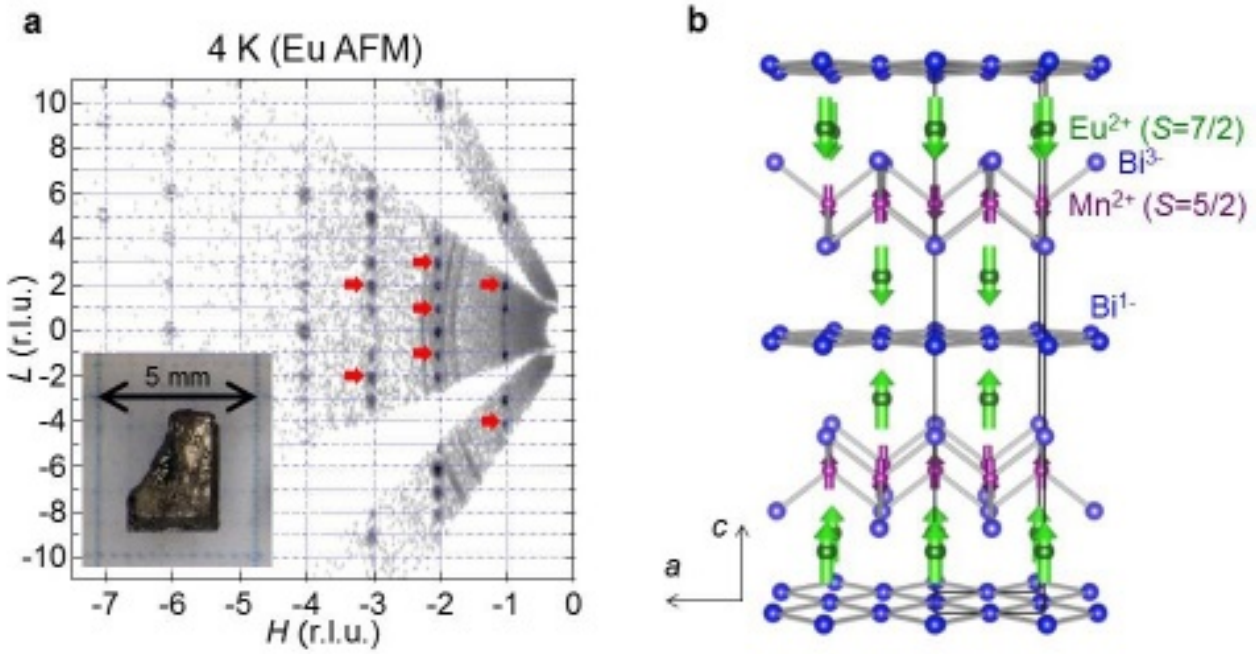

Fig. 1: a. Reciprocal-space map of neutron diffraction intensity for a single-crystalline EuMnBi2 measured at zero field. Red arrows denotes the magnetic scattering from the antiferromagnetically ordered Eu moments. Inset shows a photograph of the measured sample. b. Plausible magnetic structure for EuMnBi2.