

 <b>MLF Experimental Report</b>	提出日 Date of Report
課題番号 Project No. 2011B0027  実験課題名 Title of experiment High Magnetic Field Neutron Diffractions in Frustrated Multi-ferroics  実験責任者名 Name of principal investigator Hiroyuki Nojiri  所属 Affiliation Institute for Materials Research, Tohoku University	装置責任者 Name of responsible person Kenichi Oikawa  装置名 Name of Instrument/(BL No.) BL10  実施日 Date of Experiment 2012.04.08-2012.04-16

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.
<p>TbMnO<sub>3</sub> single crystal</p>

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.
<p>We have succeeded in examining the high magnetic field phase of TbMnO<sub>3</sub> by combining a pulse magnet and the two-dimensional detector array. The combination enabled us to trace the multi-peaks in a single set up for the longer pulse width of J-Parc pulse magnet.</p> <p>TbMnO<sub>3</sub> has a distorted perovskite showing gigantic magneto-electric effect and a rich phase diagram in high magnetic fields. [Phys. Rev. B <b>72</b>, 100102 R(2005)]. Figure 1 shows the phase diagram for H//a. The low field part of the diagram is mostly interpreted by a spin current model and the ferroelectricity is attributed to a spiral structure. In higher field side, the condition for this model is not fulfilled and thus the origin must be different. A plausible modeling has not been established, because there had been no way to determine the spin structure in such high magnetic field yet.</p> <p>We have examined the magnetic field dependences of incommensurate-magnetic peaks of both Tb and Mn origins. Also, the intensities of several commensurate peaks have been examined. The magnetic fields as high as 40 T were generated without troubles.</p>

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

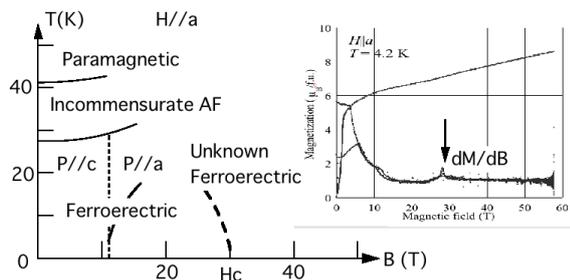


Fig. 1 Phase diagram and magnetization of  $\text{TbMnO}_3$ . The arrow shows the critical field  $H_c$ .

Figure 2 shows the Time of Flight (TOF)-vertical scattering angle plot of the one PSD tube set along the vertical direction. For the long pulse width, we can monitor the several Bragg peaks simultaneously in a single setting of time delay of the pulsed field to the kicker pulse of pulsed neutron beam. The Mn incommensurate peak does not show the shift at the critical field  $H_c$ , but the intensity shows the decrease. While (001) speak shows the increase at  $H_c$ , (002) peaks shows the decrease. The analysis of results is in progress.

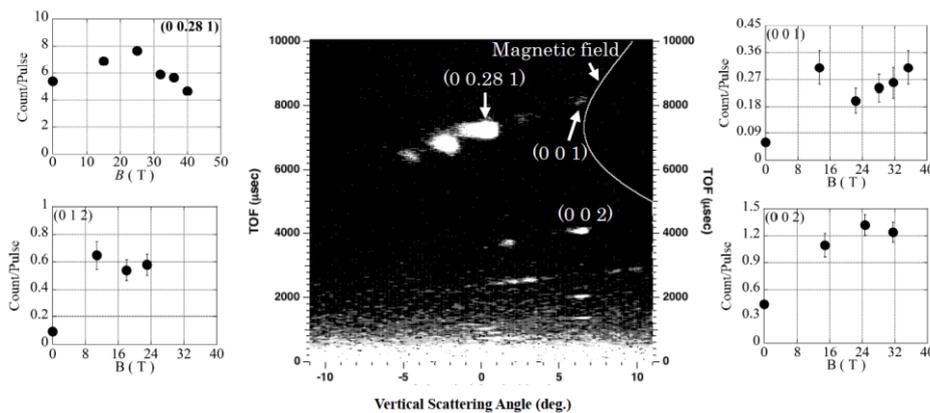


Fig. 2 TOF-vertical scattering angle plot and the field dependences of intensities of several peaks.

In conclusion, we have succeeded in measuring Bragg peaks in the high magnetic field phase of multi-ferroic compound  $\text{TbMnO}_3$  up to 40 T. It is the highest magnetic field record of the magnetic neutron diffraction. It has been demonstrated that the combination of white neutron and the long pulse magnet is powerful in scanning the wide area in reciprocal space.