MLF Experimental Report	提出日 Date of Report 2013/07/08
課題番号 Project No. 2012A0133 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 2012/11/05-2012/11/11

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.

$TbMnO_3$ 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.

We have investigated the magnetic phase diagram of $TbMnO_3$ in the high magnetic field up to 40 T. $TbMnO_3$ is one of the most well known multi-ferroic compounds and the low field phase diagram has been explained by the spin current model. When magnetic fields beyond 30 T are applied, the magnetization shows a meta-magnetic transition at 32 T as depicted in Fig. 1. To understand the nature of this transition and to investigate the origin of the multi-ferric behavior in the high magnetic field range, we have studied the magnetic structures between 25-40 T.

Figure 2 shows the magnetic field dependence of incommensurate magnetic peaks caused by the incommensurate modulation of Tb moments. It is found that the Tb-peak shifts to longer TOF region between 0 and 17 T and that the peak position does not vary between 17 and 40 T. This finding shows that the Tb-incommensurate structure is robust in extremely high magnetic field of 40 T, though a small change of pitch is observed.

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

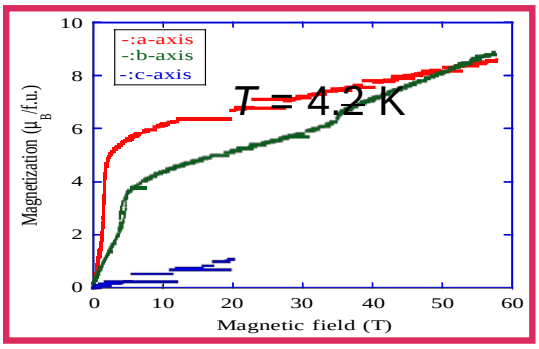

Fig.1 Magnetization Curve(Tokunaga)

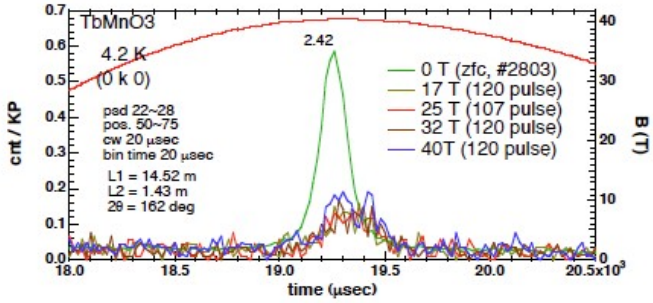

Fig.2 Magnetic Field Dependence of TOF Spectrum and the magnetic field curve(red line).

These behaviors are much different from the magnetic field dependence of Mn-incommensurate peaks. In case of Mn-structure, an incommensurate –commensurate transition is observed and the modulation is commensurate between 5 and 40 T. The field dependence of Mn peak and Tb peak are plotted in Fig. 3. Mn-peak shows a reentrant like behavior at 32 T and Tb peak shows a upturn increase above 32 T. A tentative analysis shows a possible contribution of exchange-striction mechanism. A complete analysis of the present result is under preparation.

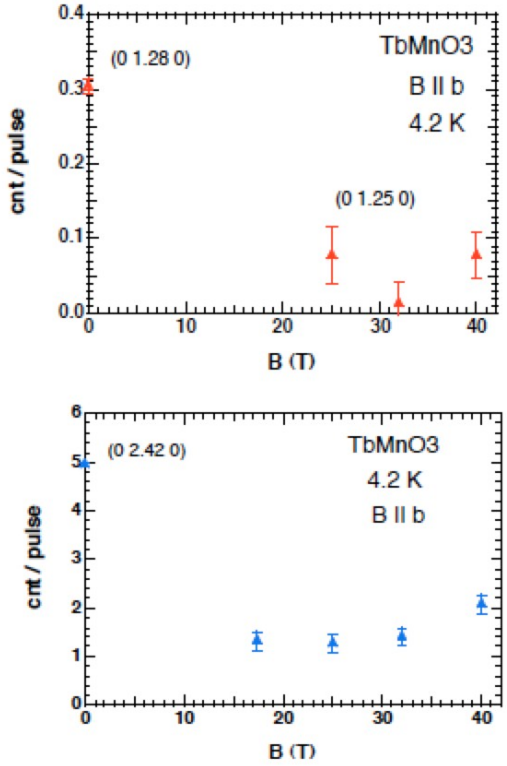

Fig. 3 Intensity of Incommensurate Peaks. Mn peak(upper panel) and Tb peak(lower panel).