（ ※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。 ）

MLF Experimental Report	提出日 Date of Report
課題番号 Project No. 2014B0289 実験課題名 Title of experiment Magnetic Field and Time Dependent Magnetic Structures in Frustrated Antiferromagnets 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 2015.3.3-3.12

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.

$LuFe_2O_4$ 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.

This proposal is to investigate the time dependent magnetic structures in the frustrated antiferromagnets under the stimulus of pulsed magnetic fields. The proposal has two steps, (1)time dependence of magnetic structure in $LuFe_2O_4$ in the giant hysteresis loop and the remnant state, (2) magnetic structure switching at the metamagnetic transition in $LiNiPO_4$. In the present run, we could only conducted the subject (1) because of the beam time changes.

$LuFe_2O_4$ shows a ferrimagnetic ordering below room temperature and this transition is associated with a charge ordering of trivalent and divalent Fe ions as shown in Fig. 1. As shown in Fig. 2, a giant hysteresis is observed in magnetization process at low temperatures. On the other hand, the charge and the magnetic ordering become diffusive in lower temperatures. The relation between these two unusual behaviors has not been clarified yet.

Figure 3 shows the comparison between the initial and the magnetized states. The TOF spectra are taken at zero fields. It is found that the intensity of magnetic [1/3 1/3 0] peak decreases in magnetized state. There is no change in the nuclear [1 1 0] peak. In the present scattering condition, the magnetic field is applied along the c-axis and the magnetic moments are also along c-axis. In this case, domain distribution does not affect to the intensity of [1/3 1/3 0] peak because there is no magnetic moment along the scattering vector.

The present results means that the magnetic correlation becomes weaker in the magnetized state. This finding contradicts with the simple expectation that the magnetic correlation is enhanced when the system is in fully magnetized ferromagnetic state. It should be noted that there is no broadening of magnetic Bragg peak, which rules out the lowering of dimensionality.

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

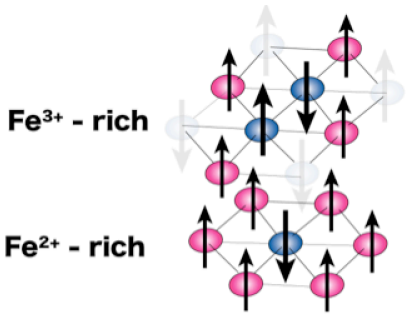

Fig. 1 Magnetic structure of $LuFe_2O_4$. Double hexagonal layers are consists of Fe^{3+} and Fe^{2+} rich layers with ferrimagnetic ordering.

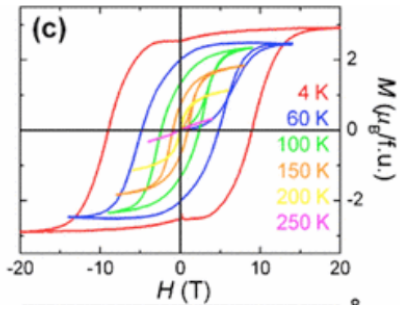

Fig. 2 Temperature dependence of magnetization curve with giant hysteresis and large remnant magnetization.(Phys. Rev. Lett. **101**(2008)137203).

Figure 4 shows the diffraction pattern in the magnetic field of 20 T. The magnetic field applied to [1/3 1/3 0] peak and not for [1 1 0] peak. Although the statistic is very low, we can see the clear reduction of [1/3 1/3 0] peak in 20 T magnetic fields. The small shift of the peak position is also found for [1 1 0] peak. This shift is absent in the TOF spectrum of Fig. 3. The difference of these two states is in the number of applied magnetic field pulses. Namely, by the repetition of the magnetic field application, the change of nuclear [1 1 0] is introduced. To understand the origin of this behavior, we are conducting the detailed analysis.

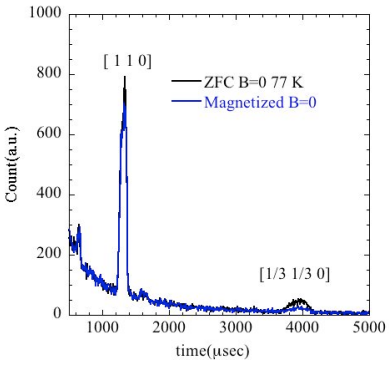

Fig. 3 TOF Spectrum at B=0 for initial ZFC and magnetized states.

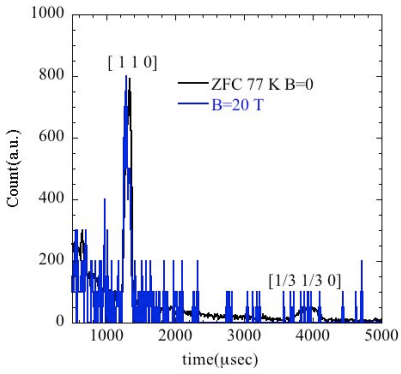

Fig. 4 TOF Spectrum in 20 T.

In summary, we have observed the large reduction of magnetic Bragg peak intensity after the single shot pulsed field. On the other hand, there is no change of the Bragg peak profile. When the magnetic field application is repeated, change of [1 1 0] peak is observed. The magnetic Bragg peak at 20 T is much reduced in intensity.