MLF Experimental Report	提出日 Date of Report March 28, 2017
課題番号 Project No. 2016B0154 実験課題名 Title of experiment Study of the anomalous magnetic ordering of a new cubic compound $Ce_6Pd_{13}Zn_4$ 実験責任者名 Name of principal investigator Eiichi Matsuoka 所属 Affiliation Graduate School of Science, Kobe University	装置責任者 Name of responsible person Toru Ishigaki 装置名 Name of Instrument/（BL No.） iMATERIA/(BL20) 実施日 Date of Experiment February 6-8, 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.

$Ce_6Pd_{13}Zn_4$, powdered sample

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.

(1) Experimental method

Recently, we have focused on a new cubic compound $Ce_6Pd_{13}Zn_4$. The magnetization, specific heat, and electrical resistivity measurements revealed that $Ce_6Pd_{13}Zn_4$ exhibits a second-order phase transition at T_t = 3.5 K and an additional resistivity anomaly at T_t' = 1.3 K. Although the decrease in T_t by magnetic field implies the occurrence of an antiferromagnetic (AFM) order at T_t, the order parameter of the transition is still controversial since the plateau appearing in the magnetic susceptibility and the appearance of an inflection of magnetization below T_t are not typical for AFM transition. In this study, the neuron powder diffraction experiment of $Ce_6Pd_{13}Zn_4$ has been performed using iMATERIA to determine the order parameter of the transition at T_t.

The powdered sample with the volume of 6 mmϕ × 20 mm was packed in the Al cell designed for this experiment. This sample cell was set on the 1K Cryo and the sample temperature was monitored using a thermometer mounted on the bottom of the Al cell. The diffraction patters were taken using the double frame mode (12.5 Hz mode) at the temperature range between 0.69 and 7.0 K.

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

(2) Experimental results

Almost all of the Bragg peaks appearing in the diffraction pattern at 7.0 K (> T_t) can be indexed on the basis of the cubic $Dy_6Fe_{16}O$-type structure, although small peaks of unidentified impurity phases are discernible. At 2.5 K (< T_t), the other Bragg peaks that cannot be explained as the nuclear scattering appear at 5600 and 16300 μs (time of flight). The intensities of these peaks increase at 0.69 K. These peaks are not superlattice peaks due to the change in the crystal structure but the AFM peaks since no change in the peak angles and intensities of nuclear peaks are observed between 0.69 and 7 K within the experimental precision.

The integrated intensity of the AFM peak at 16300 μs is almost temperature independent between 3.5 and 7 K. Below 3.5 K (= T_t), the integrated intensity increases gradually with decreasing temperature. We therefore conclude that the second-order phase transition at T_t is due to the AFM order. It is noteworthy that the integrated intensity shows a discontinuous increase below 1.3 K. This temperature corresponds to T_t' where the resistivity shows an anomaly. Possible explanation of such discontinuous increase is a change in the magnetic structure at T_t'.

Since the Ce atoms form a rectangular octahedron in the chemical unit cell of $Ce_6Pd_{13}Zn_4$, it is expected that the AFM structure is rather complex. Because of such complexity, the AFM peaks have not been indexed at the present stage. The determination of a magnetic structure is now in progress.