MLF Experimental Report	提出日 Date of Report 2014.07.30
課題番号 Project No. 2014A0184 実験課題名 Title of experiment CLARIFYING THE MYSTERIOUS INTERMEDIATE PHASE OF PARTIAL MAGNETIC ORDER IN CLINOATACAMITE 実験責任者名 Name of principal investigator X.G. Zheng 所属 Affiliation Saga University	装置責任者 Name of responsible person S. Torii 装置名 Name of Instrument/（BL No.） BL-08 実施日 Date of Experiment 5/13 21:00 - 5/16 9:00

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.

$Cu_2(OD)_3Cl$ in powder form

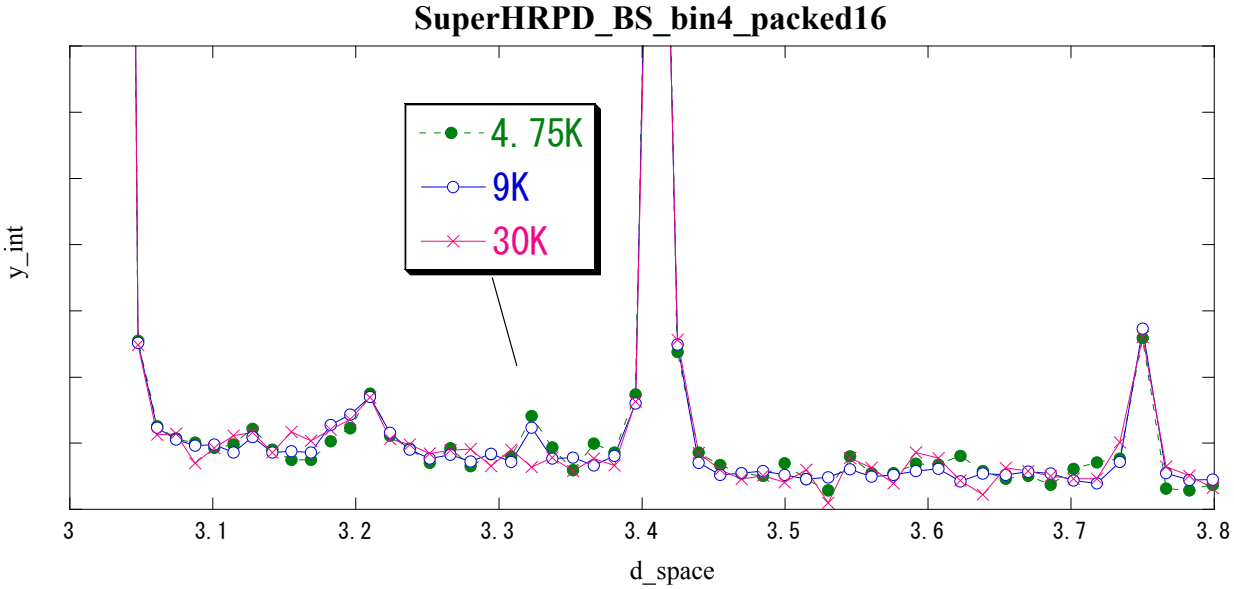
2. 実験方法及び結果（実験がうまくいかなかった場合、その理由を記述してください。）
Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

In recent years, geometrically frustrated magnets, in which localized magnetic moments interact through competing exchange interactions that cannot be simultaneously satisfied because of their geometric configuration, receive intense attention because they are playgrounds for unconventional states such as spin liquid and other novel properties. Herbertsmithite $ZnCu_3(OH)_6Cl_2$ has attracted a lot of interest as a promising candidate to display a spin-liquid ground state on almost perfectly decoupled two-dimensional (2D) kagome layers. Clinoatacamite, $Cu_2(OH)_3Cl$, as the parent compound for Herbertsmithit and one of the pyrochlore lattice systems itself for the s = 1/2 AFM Heisenberg spin, has also drawn intense attention in recent years since our report on its unconventional phase transitions. Susceptibility and specific-heat measurements display unexplained unconventional successive transitions at T_{c1} =18.1 K and T_{c2} = 6.4 K. The low temperature phase below T_{c2} = 6.4 K is well defined by a canted Néel order, on the other hand, the intermediate phase for temperatures $T_{c2} < T < T_{c1}$ still remains mysterious.

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

Distinct oscillations of the muon spins with time around the baseline of 1/3, with three muon spin precession frequencies, were observed. Although the muon spin rotation measurements probe the local magnetic fields at the muon stopping sites, the fact of the observed three precession frequencies from three muon stopping sites and the baseline of 1/3 for the untextured powder sample unambiguously demonstrated the existence of a uniform static local field, felt by the muons throughout the whole sample, hence, it implies the development of a long-range magnetic order. However, only a very small entropy (~0.05Rln2) was released at T_{c1}, and neutron diffraction experiments found no sign of magnetic ordering. The nature of the intermediate phase is still unknown and it is termed as a "devil compound". Obviously further experimental and theoretical investigations are demanded.

In 2014A0184 (beam time: 3 days) we had run a preliminary measurement on SuperHRPD. We successfully observed a new magnetic reflection in the $T_{c2} < T < T_{c1}$ intermediate phase (Fig. 1 below).



Fug. 1 Preliminary results on clinoatacamite $Cu_2(OD)_3Cl$, showing new magnetic reflection at around d = 3.32. The data have been packed 16 times to show the presence of the weak magnetic peak.

Further experiments are needed to clarify the new magnetic order.