 <b>MLF Experimental Report</b>	提出日 Date of Report 2014/07/01
課題番号 Project No. 2014A0207 実験課題名 Title of experiment Shallow muonium search in the perovskite oxide $\text{KTaO}_3$ 実験責任者名 Name of principal investigator Takashi Ito 所属 Affiliation Advanced Science Research Center, Japan Atomic Energy Agency	装置責任者 Name of responsible person Prof. Yasuhiro Miyake 装置名 Name of Instrument/(BL No.) Muon D1 実施日 Date of Experiment 2014/04/29 9:00 – 2014/05/01 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. Potassium tantalite $\text{KTaO}_3$ Single crystal wafer (20x20x0.5mm <sup>3</sup> )
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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>The charge states of positive muon in <math>\text{KTaO}_3</math>, analogous to those of interstitial hydrogen, were studied by the ZF, LF and TF-<math>\mu</math>SR techniques at the D1 area. A high quality single crystalline sample of <math>\text{KTaO}_3</math> was mounted on a silver sample holder of a <math>^4\text{He}</math> flow cryostat. Conventional pulsed <math>\mu</math>SR measurements were performed using a new D1 <math>\mu</math>SR spectrometer in the temperature range from room temperature down to 3 K. Typical ZF-<math>\mu</math>SR spectra at cryogenic temperatures are shown in Fig. 1 (preliminary, no pileup correction). A marked increase in the muon spin relaxation rate was observed below about 10 K. The ZF spectra were fit to the static Gaussian Kubo-Toyabe function [1], and the relaxation rate <math>\Delta</math> was obtained as a function of temperature as shown in Fig. 2. The <math>\Delta</math> steeply increases below <math>\sim 10</math> K with decreasing temperature, and does not saturate even at our lowest temperature. This can be ascribed to shallow muonium formation as in the case of isomorphous <math>\text{BaTiO}_3</math> [2], but might be associated with muon diffusion instead. To distinguish these, further <math>\mu</math>SR studies are necessary at lower temperatures using a <math>^3\text{He}/^4\text{He}</math> dilution refrigerator.</p>
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## 2. 実験方法及び結果(つづき) Experimental method and results (continued)

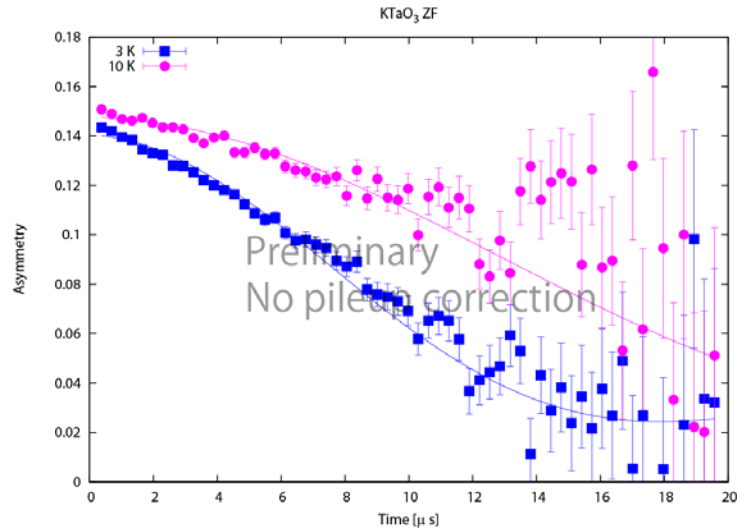


Fig. 1: ZF- $\mu$ SR spectra in  $\text{KTaO}_3$  at 10 K (circle) and 3 K (square). The solid curves are the best fits to the Kubo-Toyabe function [1].

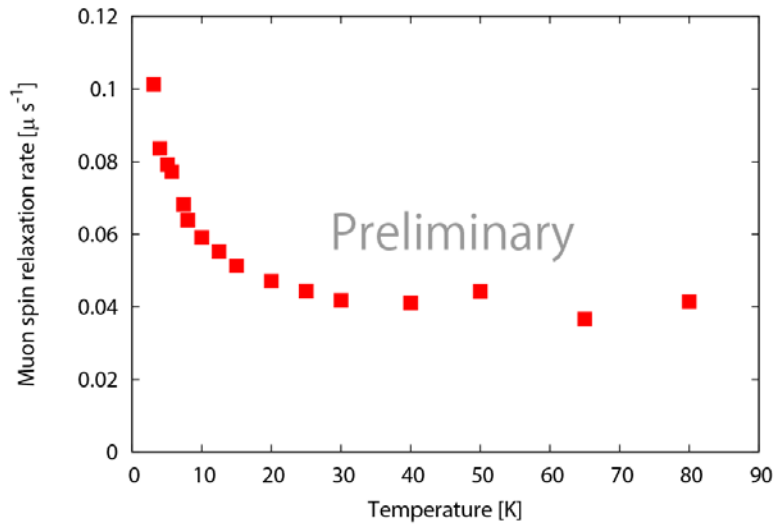


Fig. 2: The muon spin relaxation rate  $\Delta$  in  $\text{KTaO}_3$  under ZF as a function of temperature.

### References

- [1] R. S. Hayano *et al.*, Phys. Rev. B **20**, 850 (1979).
- [2] T. U. Ito *et al.*, Appl. Phys. Lett. **103**, 042905 (2013).