MLF Experimental Report	提出日 Date of Report
課題番号 Project No. 2015A0211 実験課題名 Title of experiment Muonium ionization in $LaAlO_3$ 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 2016/05/17 9:00 – 2016/05/18 9:00 2016/05/19 9:00 – 2016/05/20 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.

Lanthanum aluminate

$LaAlO_3$

Single-crystalline wafer, 20x20x0.5 mm^3

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.

The ionization behavior of muonium in $LaAlO_3$, analogous to that of interstitial hydrogen, was studied by the transverse field (TF) μSR technique in the muon D1 area. A high-quality single-crystalline sample of $LaAlO_3$ with a pseudo-cubic (100) plane surface was attached to a graphite sample holder and it was mounted in an infrared furnace. Pulsed μ^+SR measurements were performed over the temperature range 300-1100 K with the general purpose D1 spectrometer. A pulsed surface muon beam with a single-bunch time structure was incident to the sample with an initial muon spin polarization direction along the pseudo-cubic [100] direction. A TF of 2 mT was applied to investigate the fraction of muons in diamagnetic environments (Mu^+ or Mu^-) as a function of temperature. Figure 1 shows the TF-μ^+SR spectra at 300 and 1050 K. The initial asymmetry lost at 300 K is almost fully recovered at 1050 K. The data between 300 and 1100 K were fitted to an exponentially damped cosine function and the temperature dependence of the fraction of the diamagnetic muon was obtained. Regarding this as an ionization curve of muonium,

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

we estimated its ionization energy to be about 0.4 eV from a preliminary analysis. This suggests that the muonium in $LaAlO_3$ forms an impurity level deep inside the bandgap.

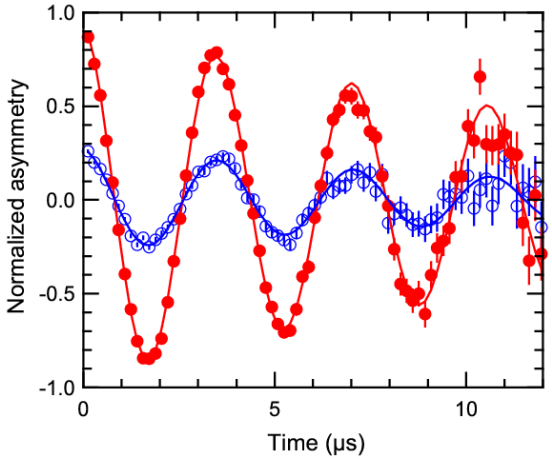

Fig. 1.: TF-μ^+SR spectra at 300 K (open circle) and 1050 K (closed circle) under a TF of 2 mT. The spectra have been normalized after subtracting the background mainly from the graphite sample holder. The solid curves are the best fits to an exponentially damped cosine function.