MLF Experimental Report	提出日 Date of Report: May 24/2010
課題番号 Project No. 2009B0050 実験課題名 Title of experiment Studies of Muonium formation in liquids 実験責任者名 Name of principal investigator Khashayar Ghandi 所属 Affiliation Professor at Mount Allison University	装置責任者 Name of responsible person Professor Miyake 装置名 Name of Instrument/（BL No.） MLF μSR spectrometer 実施日 Date of Experiment December 2009

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.

All samples were liquid: H_2O (water), CH_3OH (methanol), CCl_4

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.

Our research goals were: 1) to start muonium chemistry in J-PARC by detecting long-lived muonium signals, 2) to test the feasibility of the experiments with the target cells under a wide temperature range using a cryostat, 3) to shed light on the mechanism of muonium formation in methanol.

Muonium (Mu=μ+e−), with a mass only ~ 1/9'th that of its protonic cousin, is quite simply the light isotope of the H-atom. Hydrogen is the simplest atom in nature and consequently the study of its interactions and chemical reaction rates has been central to the field of reaction dynamics. Indeed H atom and Mu are quarks of chemists since studying their reactions provide chemists with the most fundamental aspects of chemistry and chemical dynamics. Therefore, to initiate muonium chemistry in J-PARC we decided to investigate the possibility and extent as well as mechanism of Mu formation in non-aqueous systems. Observation of Muonium was the most essential aspect of our study. The reason we selected non-aqueous systems is the lack of knowledge on radiation effects involving Mu formation in those media. We have observed Mu over a wide range of temperature from room temperature up to melting point of methanol.

For the first time we measured both Mu and diamagnetic muoniated fractions in methanol over this range of temperature.

See Figures 1 and 2.

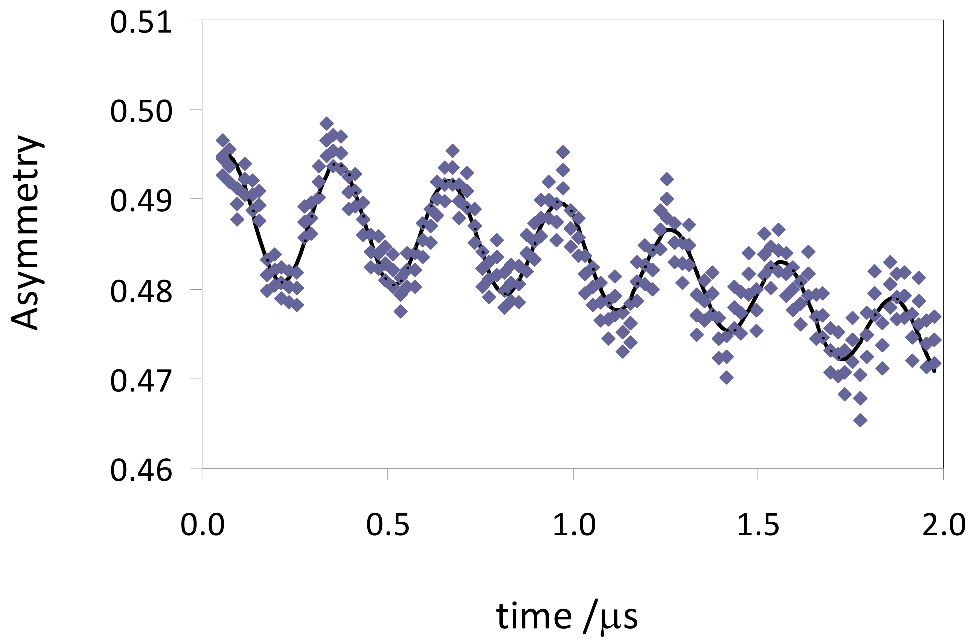

Figure 1 Mu signal in methanol at 180 K.

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

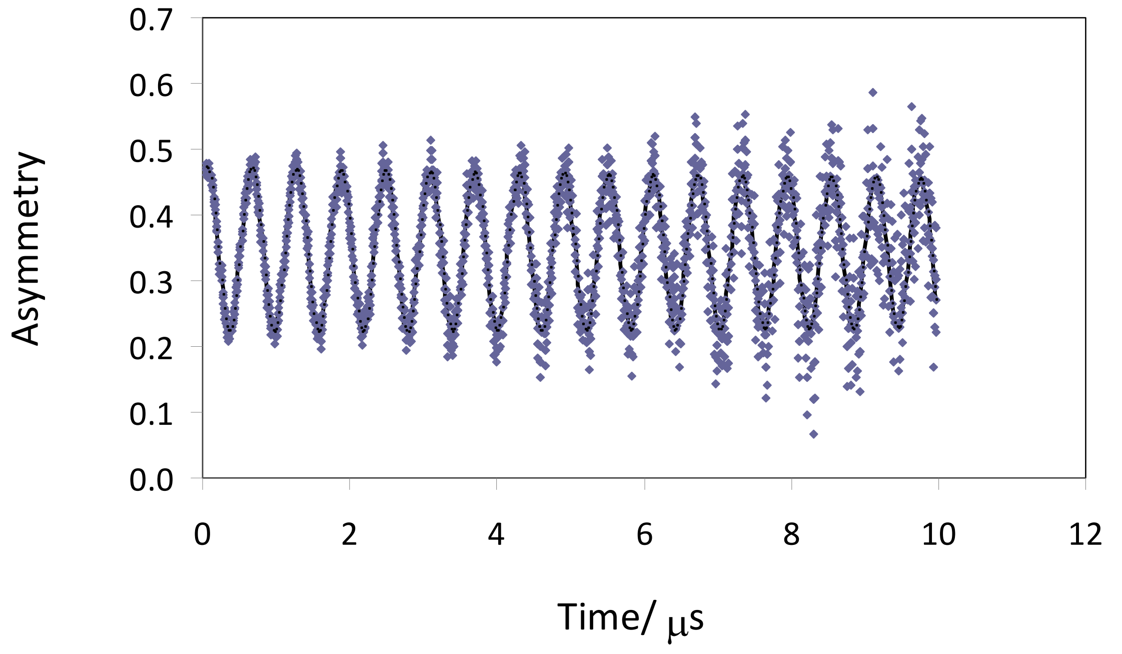

Figure 2 Diamagnetic signal in methanol at 180 K

Figure 1 clearly shows long-lived Muonium signal in methanol at J-PARC. This opens our way towards studies of muonium reactions in alcohols in the future, a subject relevant to one of my applied research interests, green chemistry. It will also open the door for our future study of reaction dynamics of Mu in methanol in J-PARC.

In addition, both Figures demonstrate that our target cells are appropriate for studies in cryostats. We also observed very interesting trends suggesting radiolysis effects are important factors in Mu formation in methanol. In addition, we found that Mu formation is increased at lower temperatures and muonium was long lived at all temperatures.

We also performed flash laser photolysis experiments on an ionic liquid, in collaboration with university of Tokyo at Tokai. Collaboration with strong radiation chemistry groups in Japan (in particular university of Tokyo) is essential for the future of muon chemistry in Japan. Moreover the work on ionic liquids have already been started by my group at TRIUMF and due to complementary nature of pulsed and continuous beam facilities it is important to extend those studies to J-PARC in the future.