

# Measurement of muonium hyperfine structure at J-PARC

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(Received June 14, 2016)

Measurement of the hyperfine structure (HFS) of the ground state of muonium is planned at the J-PARC. Muonium is a hydrogen-like bound state of positive muon and electron. The HFS of muonium is a good probe for testing the QED theory. Moreover, the muon mass  $m_\mu$  and the magnetic moment  $\mu_\mu$  are determined from the latest muonium HFS experiment at LAMPF. Muonium HFS can be determined by either a direct measurement in zero field or an indirect measurement of the Zeeman effect in a strong magnetic field. We performed the commissioning run with the muon beam in zero field in 2016. In this paper, developments and performance tests of the apparatuses toward the commissioning run are described.

**KEYWORDS:** muonium, spectroscopy, fundamental physics

## 1. Introduction

The MuSEUM (Muonium Spectroscopy Experiment Using Microwave) group is planning to measure the energy splitting of the ground state hyperfine structure (HFS) of muonium at the Japan Proton Accelerator Complex (J-PARC) [1]. The experimental apparatus has been constructed at the Muon Science Establishment (MUSE) of the Material and Life Science Experimental Facility (MLF) in J-PARC, which provides the world's highest intensity pulsed muon beam. Muonium is a hydrogen-like bound state that consists only of leptons, and its HFS is a good probe for testing the QED theory. The latest experiment at the LAMPF obtained the following value: [2]

$$\Delta_{\text{Mu}}^{\text{ex}} = 4.463302765(53) \text{ GHz (12 ppb)} . \quad (1)$$