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Precision measurement of muonium hyperfine splitting at J-PARC

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Muonium is the bound state of a positive muon and an electron. In the standard model of particle physics, muonium is considered as the two-body system of structureless leptons. There is no severe strong interaction effects as in a hydrogen atom, or annihilation effects and intensive recoil effects as in a positronium. Therefore, muonium is the appropriate system for precision test of fundamental interactions.

At J-PARC(Japan Proton Accelerator Research Complex), we are going to measure muonium's hyperfine splitting precisely. Our experiment has three major objectives; test of QED with the highest accuracy, precision measurement of the ratio of muon's magnetic moment to proton's one, and search for CPT violation via the sidereal oscillation.

The uncertainty of latest experimental result[1] is mostly statistical uncertainty(more than 90% of total uncertainty). Hence, higher statistics is essential to the higher precision of measurement. Our goal is more than 10 times accuracy with 200 times of statistics relative to the latest experiment. For improvement of precision, we use the J-PARC's highest intensity pulsed muon beam and highly segmented positron detector with SiPM(Silicon PhotoMultiplier). After the improvement of statistical precision, it becomes more important to reduce systematic uncertainty. Thus, we reduce systematic uncertainty by using longer cavity, high precision magnet, and online/offline beam profile monitor. In this talk, we discuss the experimental overview and R&D status of each components.

[1] : W. Liu et al.,PRL. 82, 711 (1999).

Summary

Experimental overview and R&D status of the precision measurement of muonium hyperfine splitting in J-PARC.

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