

Muon Penning Trap Experiment at J-PARC

Friday, 15 March 2024 13:30 (25 minutes)

“Muon precision measurements are one of the powerful probes in the search for new physics beyond the Standard Model of particle physics. As an example, muon anomalous magnetic moment ($g-2$) measurements show a discrepancy between the Standard Model prediction and experimental values, which is considered to be a sign of new physics. In standard muon precision measurements, muons were either accelerated or in muonium state. We propose a new method to precisely measure slow free muons by trapping them in an electromagnetic field, applying the Penning trap technique. This is the first time in the world that a penning trap has been used to trap particles as short-lived as muons (2.2 micro s), and will be realized using the high-intensity pulsed muon beam at J-PARC H-Line. The final goal is to measure the muon mass and magnetic moment with a precision of 1 ppb and the muon lifetime with a precision of 1 ppm.

Ultra-slow muons producing target in a 3 T superconducting magnet. The ultra-slow muons are transported to the trap region by the electric field. During the transport, an RF magnetic field is irradiated to rotate the spin direction by $\pi/2$ to be perpendicular to the magnetic field, and the Larmor precession is observed. The muon spins and positions are precisely controlled by the electromagnetic field, and their oscillation frequencies are measured with upper and lower detectors through decaying electrons or positrons. Currently, we are developing electrodes, which are important in the trap, and detectors to measure the fast spin rotation. We will report on the status of these developments.”

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Session Classification: Oral