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J-PARC muon g-2/EDM experiment: Test Operation of a Positron Tracking Detector and Consideration of Its Application to the MuSEUM Experiment

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The anomalous magnetic moment (g−2) and the electric dipole moment (EDM) of the muon provide sensitive probes of physics beyond the Standard Model. While the muon g−2 shows a potential discrepancy between theory and experiment, the EDM is predicted to be vanishingly small, making any observation a clear sign of new physics.

The J-PARC muon g−2/EDM experiment aims to provide an independent g−2 measurement and improve the EDM sensitivity to 10!"# # · cm. Using a 300 MeV/c low-emittance muon beam stored in a compact 3 T storage ring, decay positrons are tracked by silicon strip detectors installed inside the storage region to precisely extract both g−2 and EDM. The detector consists of 40 modules arranged radially around the center of the ring. The detector system must satisfy stringent requirements, including high-rate capability, minimal disturbance of the magnetic field, and precise sensor alignment.

We report on a beam test conducted in collaboration with the MuSEUM experiment, which performs a precision measurement of the muonium hyperfine structure, at the H1 area of the J-PARC MLF. A single test module, corresponding to the smallest unit of the silicon strip detector, was operated under a magnetic field of 1.7 T to verify its performance. Furthermore, by varying the aperture size of the upstream slit, we evaluated the detector response under three different beam-rate conditions. We present the results on signal–noise discrimination and performance evaluation in high-rate environments, and discuss future prospects for the application of this detector in the MuSEUM experiment.

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