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Development of Muon Trigger Detector for muEDM experiment at PSI

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The muEDM experiment at the Paul Scherrer Institute (PSI) aims to measure the muon electric dipole moment (EDM) with unprecedented sensitivity, targeting a precision of $\sigma(d_\mu) = 6 \times 10^{-23}$ e · cm, which represents an improvement by three orders of magnitude over the current limit established by the muon g−2 experiment at Brookhaven National Laboratory (BNL). Central to this effort is the muon trigger detector (MTD) located at the entrance of the solenoid, which enables fast and precise identification of muons within the solenoid storage acceptance. The trigger activates a pulsed magnetic field that guides muons into stable orbits; the stored muons are exposed to a radial electric field enabling the "frozen-spin" technique, thereby isolating the spin precession induced by the EDM.

The MTD employs plastic scintillators read out by silicon photomultipliers (SiPMs) and comprises two subsystems: a 100-μm-thick gate detector for incident muon detection, and an aperture detector that rejects non-storable muons via anti-coincidence logic. The electronics must generate the trigger signal within 15 ns to ensure proper storage of the selected muons. For the aperture detector, open-drain gated wired-AND logic is adopted to reduce the number of logic gate layers, thereby minimizing propagation delay. For the gate detector, an additional delay module is inserted to delay the gate signal, as the aperture detector is typically hit several nanoseconds later than the gate detector.

This system ensures selective triggering of only storable muons while suppressing background events. An MTD prototype was validated using surface muons at the PSI πE1 beamline, and its performance was assessed by comparing experimental data with Geant4-based simulation results. This talk presents the key design principles, prototype test results, and the progress made toward achieving the breakthrough sensitivity goal of the muEDM experiment.

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