Searching for electric dipole moments using a compact frozen-spin trap

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(on behalf of the muEDM Collaboration)

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The frozen-spin technique [1] will enable a direct measurement of the muon electric dipole moment (EDM) with unprecedented sensitivity. The muEDM Collaboration is developing a compact frozen-spin trap to demonstrate this technique for the first time [2]. Using the high intensity continuous muon source at the Paul Scherrer Institute, a target sensitivity of 6×10^{-23} $e$cm could be realised, exceeding the current limit [3] by a factor of 1000 and thus extending our reach towards new physics involving CP violation. To implement the frozen-spin technique, 28 MeV/c muons will be injected off-axis into a 3 T superconducting solenoid and stored at its centre with an orbital radius of approximately 30 mm. A pulsed radial magnetic field will be used to kick the axial momentum as it enters the storage region such that it can be axially confined within a static weakly-focusing field. A radial electric field can be tuned such that the spin precession induced by the anomalous magnetic moment can be suppressed, thus permitting only spin precession out of the orbital plane. Scintillating fibres will be used for positron tracking to search for a corresponding change in the emission asymmetry over time. With systematic effects controlled [4], this would be the experimental signature for a nonzero EDM. This technique is also applicable to beta-radioactive ions [5], for which EDM measurements of light nuclei could offer complementary sensitivity to nucleon EDMs and additional sources of CP violation. This talk will detail the implementation of the frozen-spin technique and outline the key milestones for our Collaboration. In particular, the demanding requirements for the kicker magnet and pulsed power supply to achieve the pulsed magnetic field will be presented, along with the status of their development.

References

[1] F.J.M. Farley *et al.*, *Phys. Rev. Lett.* **93**, 052001 (2004).
[2] A. Adelmann *et al.*, *arXiv*:2501.18979 [hep-ex] (2025).
[3] G.W. Bennett *et al.*, *Phys. Rev. D* **80**, 052008 (2009).
[4] G. Cavoto *et al.*, *Eur. Phys. J. C* **84**, 262 (2024).
[5] I.B. Khriplovich, *Phys. Lett. B* **444**, 98 (1998).