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Implementation of the frozen-spin technique for the search for a muon electric dipole moment

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In a dedicated experiment at the Paul Scherrer Institute (PSI) [A. Adelmann *et al.*, arXiv:2102.08838 (2021)], the muEDM Collaboration seeks to implement, for the first time, the frozen-spin technique [F.J.M. Farley *et al.*, Phys. Rev. Lett., **93**, 052001 (2004)] in order to advance the search for the muon electric dipole moment (EDM) with an improved sensitivity $\mathcal{O}(10^3)$ below the current direct limit $d_\mu < 1.8 \times 10^{-19}\, e\text{cm}$ (95% C.L.) [G.W. Bennett *et al.*, Phys. Rev. D, **80**, 052008 (2009)]. Muons from a high flux continuous beamline at PSI will be injected helically into a 3 T superconducting solenoid. To achieve a stable orbit at its centre, such that the frozen spin conditions may be realised, a sub-microsecond trapping scheme must be implemented. A pulsed radial magnetic field will transfer the longitudinal momentum into an almost purely tranverse orbit. The field will be generated by two circular coils supplied with synchronised and counter-propagating current pulses. The pulse should be $50 - 100$ns wide with peak amplitude $60 - 100$ A and critically it must occur with no more than 100 ns delay after a muon entrance trigger. Furthermore, any residual currents following the primary pulse must be suppressed to avoid systematic effects arising from oscillatory precession of the muon spin. The eddy currents induced in conductive elements of the system will contribute to the system inductance, thus altering the system resonance, and also cause damping of the magnetic field at the position of the muon orbit. A first prototype of the muEDM experiment has recently been developed to perform tests which provide essential input for the development of a pulsed current supply and inform design optimisation towards a first demonstration of the frozen-spin technique with muons at PSI.

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