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The PanEDM Experiment: Commissioning Progress and Subsystem Overview

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The PanEDM experiment, coupled to the new ultracold neutron source SuperSUN at the Institut Laue-Langevin, aims to measure the neutron electric dipole moment (nEDM) with a sensitivity of 4×10^{-27} e·cm after 100 beam-days in its first phase.

The search for a CP-violating electric dipole moment is among the most powerful and long-standing precision tests of the Standard Model, and stringently constrains new physics scenarios. A finite nEDM violates time-reversal symmetry and, under CPT conservation, implies CP violation - an essential ingredient for explaining the observed baryon asymmetry of the Universe. The nEDM remains today among the best-motivated experiments in particle physics, delivering constraints at and above the energy scales accessible with colliders.

PanEDM employs trapped ultracold neutrons (UCN) that can be stored for hundreds of seconds, during which coherent spin precession will be driven within a tightly controlled magnetic environment. Key elements of the apparatus include: a compact magnetically shielded room with a mHz shielding factor of 6 million; a nonmagnetic vacuum chamber made from laminated glass-fiber composite; a low-energy UCN spectrum enabling long storage times with high density; and low-noise Cs magnetometers with stability below 50 fT for integration times between 70 and 600 s. PanEDM will operate without a comagnetometer in phase I, exploring the limits of magnetic field control and stabilization.

The high-density UCN source SuperSUN is based on a superfluid-helium conversion medium that, unlike flux sources of UCN, enables storing high neutron densities for long times on the order of several hundred seconds. Its recently demonstrated in-situ storage density of 273 cm^{-3} is the highest achieved to date, and opens a path towards several further generations of statistics improvements based on the same production mechanism.

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