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Long polarization lifetimes and feedback control of polarization direction

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The observation of an electric dipole moment (EDM) or its upper limit at levels near 10−29 e cm would either uncover new forms of CP violation or put at risk many models that seek to explain the excess of matter over anti-matter in the present universe. This talk presents new results on studies of the feasibility of conducting an EDM search using a polarized deuteron beam circulating in a storage ring. In the EDM experiment, the selection of an appropriate match of electric and magnetic bending fields makes possible holding the direction of the polarization always parallel to the momentum. In this configuration, the transverse electric field always present in a storage ring will rotate the polarization into the vertical direction at a rate proportional to any EDM on the deuteron. For this, it is necessary to maintain the polarization for times up to a thousand seconds to allow an opportunity for the EDM signal to become observable despite the instability of this configuration.

A time-marking system for polarimeter events has been installed on the COSY Synchrotron at the Forschungszentrum-Jülich in Germany. The clock time information makes possible the unfolding of the anomalous precession (˜ 120 kHz at pd = 0.97 GeV/c) so that polarimeter events may be sorted according to the direction of the rotating polarization assuming a precise value for the precession rate. From this analysis it is possible to measure the magnitude of the in-plane polarization (IPP) as a function of time and determine the rate at which the polarization decoheres. This tool allows the study of ways to lengthen the IPP lifetime even though the polarization direction is not locked to the momentum. A combination of beam bunching, electron cooling, and the adjustment of ring sextupole fields permits the cancellation of decoherence that arises from transverse betatron oscillations in the beam.

This talk will present the most recent results taking advantage of sextupole magnet settings that also give zero chromaticity. From runs made in 2015, it has now been demonstrated that IPP lifetimes can exceed 1000 seconds.

The data acquisition and analysis system also yields the phase (or direction at a particular time) of the rotating IPP. Drifts in the COSY storage ring are slow enough that the phase may be tracked smoothly over many 1-second time bins. This capability now makes it possible to consider using the phase information in a slow feedback stream to the ring rf cavity so that the direction may be made to point in a particular place and held over time. Such a capability is essential for the EDM search. Results will be shown illustrating the operation and calibration of this feedback system. With the use of the rf solenoid in the ring, a mock EDM-type experiment was run in which the solenoid was used to drive a vertical accumulation of the polarization.

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