

Goals for prototype proton EDM ring

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1 Preliminary Statement of Goals

Quantitative goals:

- ▶ 1. Demonstrate the ability to store enough protons (e.g. 10^8) to be able to perform proton EDM measurements in a predominantly electric storage ring.
- ▶ 2. Demonstrate the ability to store counter-circulating beams in a predominantly electric storage ring—as required for eventual EDM precision.

Qualitative goals:

- ▶ 3. Demonstrate frequency domain control and measurement capability; e.g. phase-locked Koop wheel frozen spin beam control.
- ▶ 4. Investigate and understand the general relativistic correction to the proton EDM measurement—it is expected to produce a “fake” EDM measured value of 3×10^{-28} e-cm. This process is initially useful as a “standard source”, but eventually must be exactly subtractible.

2 Guaranteed findings

- ▶ 1. Even in an “all-electric” storage ring the presence of some intentionally-applied magnetic fields cannot be avoided:
 - ▶ (a) to suppress sparking (almost certainly)
 - ▶ (b) Wien-filter (transverse) for frequency domain control (certain)
 - ▶ (c) Solenoidal (longitudinal) for polarization control (certain)
- ▶ 2. The presence of even the tiniest amount of magnetic field prevents counter-circulating beams from being identical; e.g. if one beam has frozen spin, the other cannot; nor can their orbits be *exactly* CW/CCW symmetric.
- ▶ 3. The goals for the prototype ring therefore have to include achieving counter-circulating beams in a ring with superimposed electric and magnetic bending.
- ▶ 4. It is not good enough for electric and magnetic deflections to be matched at the level of integrated bends—to “eliminate” CW/CCW deviations, the electric and magnetic dipole field shapes have to be closely matched—the conflict between “constructive” and “destructive” electric and magnetic bending “amplifies” field shape differences.

3 Revised statement of goals

- ▶ 1. Demonstrate the ability to store enough protons (e.g 10^8) to be able to perform proton EDM measurements in a predominantly electric storage ring, recognizing that some superimposed magnetic bending is likely to be necessary to meet this goal.
- ▶ 2. As shown on the previous page, the inevitable presence of non-vanishing magnetic field makes exactly-symmetric CW/CCW beams impossible. Since simultaneously counter-circulating beams will be needed for reducing systematic error, a prototype ring has to demonstrate the ability to store and control simultaneously counter-circulating beams in a ring with superimposed electric and magnetic bending.
- ▶ 3. To lend confidence to an eventual full-scale EDM ring proposal, experimental methods are to be developed and demonstrated, for measuring the proton EDM in a ring with superimposed electric and magnetic bending (as required to freeze the proton spins in a small ring). Cost-saving measures in the prototype, such as room temperature operation, minimal magnetic shielding, avoidance of obsessively tight manufacturing and field-shape matching tolerances, are expected to limit the precision of the prototype ring EDM measurement, but data needed for reliable cost estimation and extrapolation of systematic error evaluation to the full scale ring has to be obtained.