Development of compact, highly sensitive beam position monitors for storage rings

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Our existence in the universe $\eta \sim 6 \times 10^{-18}$

CP violation is needed

What makes the EDM so special?

More sources for CPV

Violation of parity symmetry

Violation of T symmetry

Introduction

The JEDI collaboration is currently preparing for measuring the Deuteron EDM in the COoler SYnchrotron (COSY). One of the major challenges that one needs to worry about is the precise knowledge about the beam position along the ring.

Motivation

Our existence in the universe

CP violation is needed

Theoretical background

A current-carrying wire (to mimic COSY beam)
Faraday's law
Induced voltages

\[
\frac{d\phi}{dt} = \left(\frac{\partial \phi}{\partial x} \right) \frac{d\hat{F}}{dt} + \left(\frac{\partial \phi}{\partial y} \right) \frac{d\hat{E}}{dt}
\]

\[
\frac{d\bar{I}}{dt} = \left(\frac{\partial \bar{I}}{\partial x} \right) \frac{d\hat{F}}{dt} + \left(\frac{\partial \bar{I}}{\partial y} \right) \frac{d\hat{E}}{dt}
\]

\[
\phi = C_1 x - C_2 (x^2 - 3y^2) + C_3 (x^2 - 10y^2z^2 + 5y^4x) + \ldots
\]

\[
\bar{I} = C_1 y - C_2 (y^2 - 3x^2) + C_3 (y^2 - 10x^2z^2 + 5x^4y) + \ldots
\]

* $C_i$ : Constants depend on coil parameters

Methodology

1. Winding process
2. Assembly
3. Position and Calibration tests
4. Installation

Grid map

Precise positions:
With knife edge around the wire to electrically determine the wire positions

Controlling potential noise sources

Noise at the input of the lock-in amplifier

Use the proper signal pre-amplifier depending on improved SNR values.

Control the current strength at the test-stand (0.1 – 1.0 mA)

Summary

Rogowski coil BPM’s are highly sensitive and compact devices
Currently, the greatest goal is to have a perfectly produced, tested, and calibrated coils with zero issues
In the final prototype ring, we would have several of such monitors for distinct experimental purposes

Beam position monitors along the ring

- Beam center of mass
- Longitudinal bunch shape
- Beam closed orbit
- True EDM signal

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