Magnetic Field Measurement and Mapping Techniques

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Introduction

- All modern accelerators have magnets as major components.
- These magnets are used for bending and focusing the beam, as well as for higher order corrections.
- Magnets are also integral to all large detector set ups for various experiments.
- A thorough characterization of the magnetic field in the magnets is crucial for proper operation of an accelerator, or for analyzing experimental data.

Need for Magnetic Measurements

- Magnets are often designed for high field quality using sophisticated computational tools.
- The as-built magnets almost never exhibit the perfect design field quality. This is partially due to limitations of computational tools, but largely due to systematic and random construction errors.
- It is necessary, therefore, to actually measure the field in the as-built magnets, and iterate the design if any systematic errors are noticed.
- The measurements can also be used to monitor trends and random errors in a large magnet production run.

"Mapping" Vs. "Measurements"

- The term "***Mapping***" usually implies providing a detailed description of the field components in a volume of interest.
- "***Mapping***" can be ***explicit***, which involves measurements of field components on a 3-D grid.
- "***Mapping***" can also be achieved by measuring in a limited region (e.g. on a surface) and deriving the field components in the region of interest using Maxwell's equations.
- The term "***Measurement***" is more general, and may include, for example, measurements of magnetic center, dynamic effects, etc.

Outline of Lectures

- **Overview of Magnetic Measurement Techniques** (Lecture 1)
- **Harmonic Description of 2-D Fields** (Lecture 2)
- **Harmonic Coils** (Lecture 3)
- **Determination of Magnetic Axis** (Lecture 4)
- **Dynamic Effects in Superconducting Magnets** (Lecture 5, Part I)
- **Measurements as a Tool to Monitor Magnet Production** (Lecture 5, Part II)

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