THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

THE MEME TEAM
EE 494: Senior Design Projects
Fall 2018

Design of a Helmholtz Coil System for NASA's LEEIF Lab

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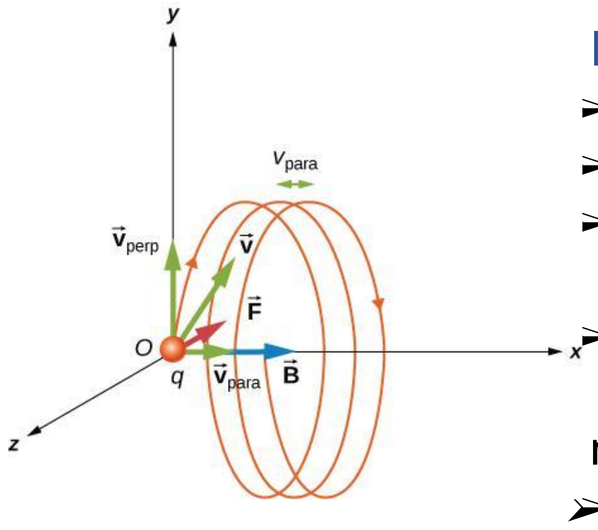
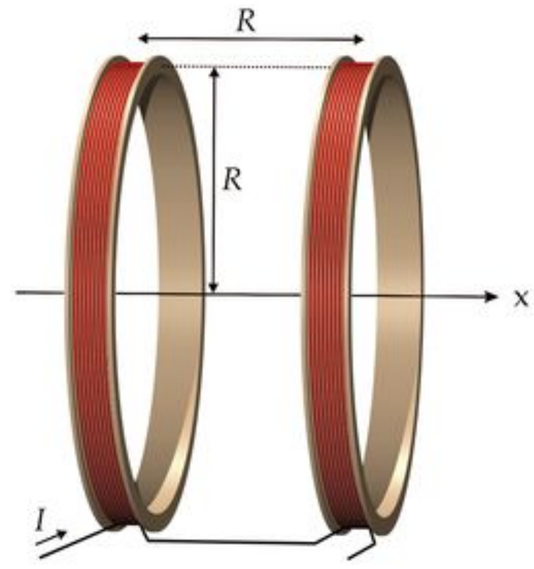


Introduction

- NASA's Low Energy Electron and Ion Facility (LEEIF)
- LEEIF uses test equipment to calibrate instruments
- At very low energies, particles are deflected by Earth's magnetic field
- Nullifying Earth's field removes this deflection, allowing testing at the low energies required for MEME-X mission
- We designed paired electromagnet sets, Helmholtz Coils, to minimize 2 largest field components



Theory

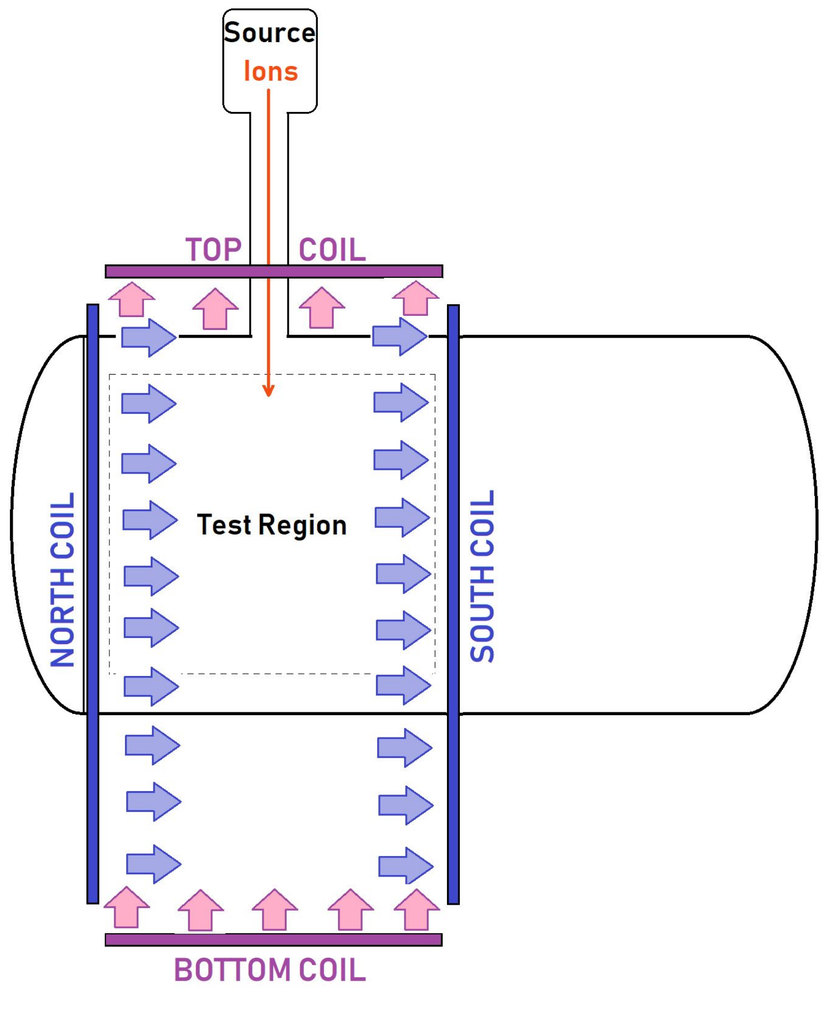
- Helmholtz coils are electromagnets designed to create a uniform field between them.
- Generate a magnetic field equal and opposite to Earth's to create a region free of magnetic interference.
- Used a theoretical application of the Biot-Savart law *(right)*
- Designed square coils, more electrically complicated but easier construction, safety, and maintenance

$$B(x) = \frac{\mu_0 n I R^2}{2(R^2 + x^2)^{\frac{3}{2}}}$$

Where:
B is the magnetic field
n is the # of wire turns
I is the current
R is the radius of the coils
X is distance from the coil

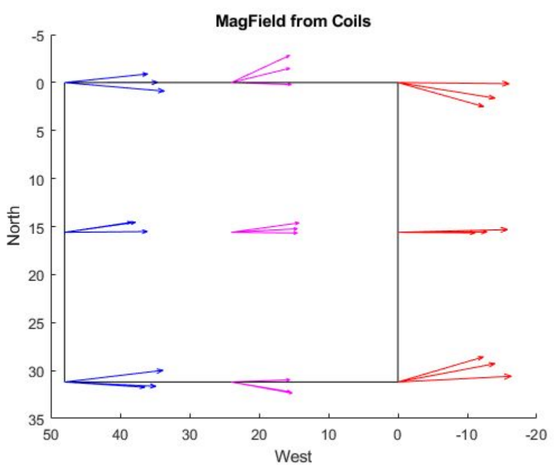
Methodology

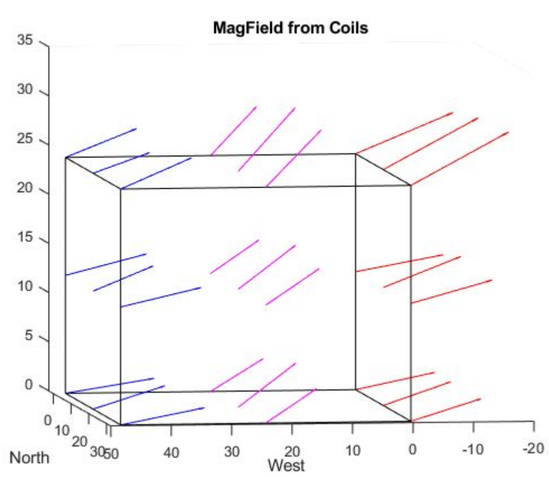
- First, conducted a survey of lab's current magnetic field
- Determined amount of coils and current needed to nullify
- Constructed truss of aluminum (non-magnetic)
- Assembled electromagnets and tied to power sources

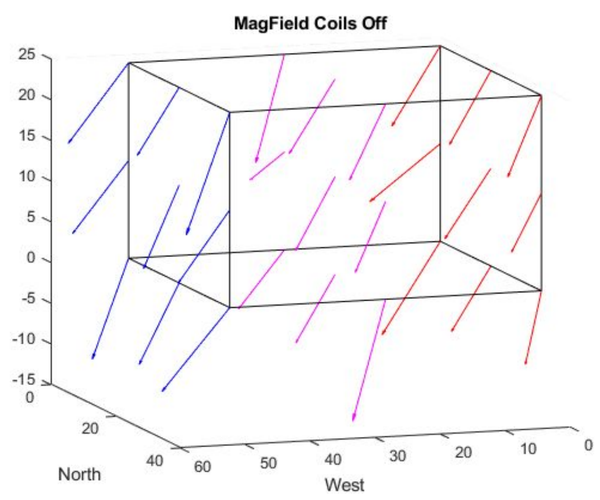


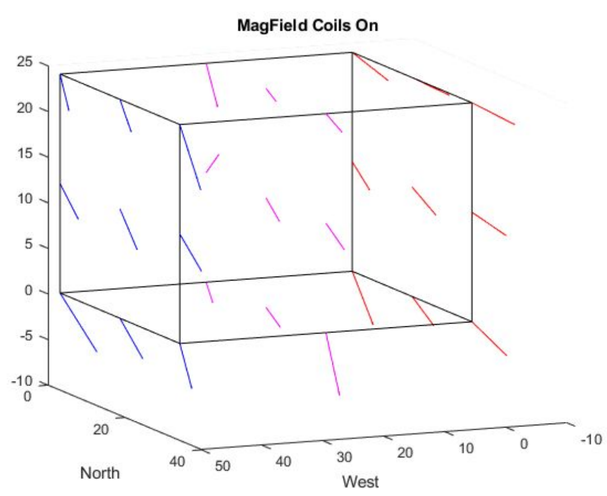
Results

- In x (North-South) and z (Top-Bottom), the two largest components of Earth's field, we created a region of ≤ 1 mG (Earth's normal values are 300-500 mG)
- Coil can be controlled to produce any desired field value inside the chamber, from roughly -500 mG to 1500 mG









Acknowledgements

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