Magnetic Shielding Design and Optimization for NuDot
Sarah Vickers¹ on behalf of the NuDot Collaboration
¹Department of Physics and Astronomy, University of North Carolina at Chapel Hill

Contact Me
Sarah Vickers
svickers@email.unc.edu

PMTs & EMF
- Electrons from decay events excite the scintillator and create isotropic scintillation light, electrons moving faster than speed of light in scintillator emit directional Cherenkov light
- Photomultiplier tubes (PMTs) collect light from the electrons
- PMTs are sensitive to magnetic fields around them, particularly on the y-axis
- Goal: reduce field to 0.1 EMF, leading to 99% efficiency

Neutrinoless Double Beta Decay
- Beta decay: $n \rightarrow p + e^- + \bar{\nu_e}$
- Double beta decay ($2\nu\beta\beta$): $2n \rightarrow 2p + 2e^- + 2\bar{\nu_e}$, Standard Model, observed, 2 neutrinos emitted
- Neutrinoless double beta decay ($0\nu\beta\beta$): $2n \rightarrow 2p + 2e^-$ occurs in theory if the neutrino is its own antiparticle (Majorana)

NuDot Experiment
- ½-ton prototype liquid scintillator detector
- NuDot Goals:
  - Demonstrate Cherenkov and scintillator light separation using fast-timing PMTs
  - Mid-size test for future multi-ton scale scintillator experiments searching for $0\nu\beta\beta$
- My Project: designing a set of magnets that will counteract the Earth's Magnetic Field within the NuDot experiment
- Aided in the assembly and preparations needed to get NuDot ready for the first data-taking runs

Magnetic Field Simulations
- The core of my project has been calculations and simulations in both Wolfram Mathematica and COMSOL Multiphysics to find the optimal designs for these magnets.
- A variably-pitched vertical solenoid (left) and two sets of square Helmholtz coils (right) make up the final design.

Circuit Design
- Circuit design for all of the coils, with the induction symbol indicating a coil or set of coils which act as resistors.
- All coils operate at 2A
- Each set of Helmholtz coils will be wired in series and are represented here as a single element
- Switches allow us to operate only horizontal or vertical coils as needed

Acknowledgements
NuDot is supported by NSF award numbers 1554875 and 1806440.
NuDot would not be possible without the support of Bates Laboratory and Triangle Universities Nuclear Laboratory

References