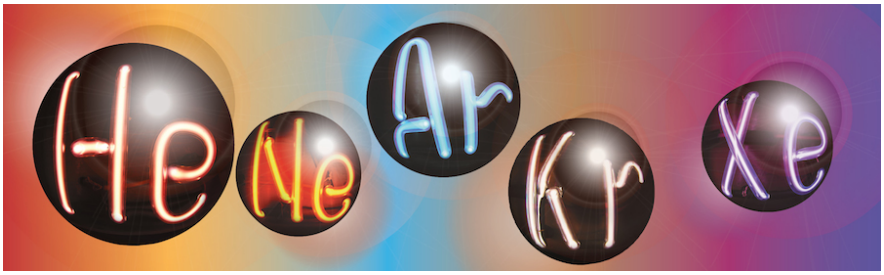

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Precise Magnetic Field Mapping of the EMPHATIC Phase 1 Magnet with COMSOL

Monday 26 August 2024 17:50 (20 minutes)

EMPHATIC (Experiment to Measure the Production of Hadrons At a Test beam In Chicagoland) is a Fermilab-based table-top size experiment focused on hadron production measurements. Flux is a limiting systematic for all neutrino cross section measurements by current experiments and we rely on a-priori predictions of the flux for analyses, including measurements of neutrino oscillations, neutrino-nucleus cross sections, and beyond-the-Standard Model searches. These flux predictions rely on simulations of the production and focusing of hadrons in and downstream of the neutrino production target, resulting in 10-20% uncertainties. The goals of the experiment are to address gaps in our understanding of hadron-scattering and hadron-production cross sections with better than 10% measurements and the first-ever measurement of the hadron spectrum downstream of a target and horn.

A compact Halbach array magnet with B.dl˜0.2 Tm is used to measure the momentum of the secondary particles. The Phase 1 Halbach array magnet is a ˜104 kg, 3 layer magnet with a total of 48 uniformly magnetized components of Neodymium (NdFeB N52) permanent magnets resulting in a dipole magnetic field. Hall probe data was taken for the central cylindrical bore of the magnet and a field map was constructed that showed a spatial asymmetry. COMSOL Multiphysics® Software is used for modeling the magnet and constructing the corresponding magnetic field map. We present a fitting approach where the hall probe data is used to determine a 1mm-spacing map of the entire volume of the magnet using COMSOL. The new map will allow for linear interpolation within the volume, and expand the map to outside the measurement volume, thus increasing the acceptance and precision of EMPHATIC's tracking system.

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