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DOCTORAL THESIS

Measuring the Muon Neutrino Magnetic Moment in the NOvA Near Detector

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ABSTRACT

Measuring a large neutrino magnetic moment would be a clear indication of physics beyond the Standard Model (BSM), shedding light on the correct BSM theory or the potential Majorana nature of neutrinos. It would manifest in the NOvA Near Detector as an excess of neutrino-on-electron elastics scattering interactions at low electron recoil energies. Leveraging an intense and highly pure muon neutrino beam, along with the finely segmented liquid scintillator near detector specifically designed for electromagnetic shower separation, enables NOvA to achieve world-leading sensitivity in probing the effective muon neutrino magnetic moment. Despite facing statistical limitations stemming from the low cross section of the signal process, systematic uncertainties have a significant impact on this result. To address these challenges, the NOvA Test Beam experiment focuses on mitigating some of the largest systematic uncertainties within NOvA by investigating particle interactions and energy deposition in a small-scale replica NOvA detector. We discuss the calibration of the NOvA Test Beam detector, which is a crucial step in analysing the Test Beam data before they can be utilised to reduce NOvA systematic uncertainties.

Keywords: neutrino NOvA electromagnetic testbeam calibration