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Magnetic Shielding for the Neutron Electric Dipole Moment Experiment at TRIUMF

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If a non-zero neutron electric dipole moment (nEDM) were discovered, it would signify a previously unknown source of CP (or T) violation. New sources of CP violation are believed to be required to explain the baryon asymmetry of the universe. The TRIUMF nEDM experiment aims to measure the nEDM to the level 10^{-27} e·cm in its initial phase, which is over an order of magnitude more precise than the previous best experiment. The experimental method relies on placing ultracold neutrons in a bottle with electric and magnetic fields and performing precise NMR experiments over hundred second measurement times. The magnetic field B_0 in the experimental volume must be strictly controlled during this time, and a combined passive and active magnetic shielding system is being developed to meet the requirements of the experiment. Prototype systems have been constructed at U. Winnipeg. The prototype passive shielding system consists of 4 concentric cylindrical layers of high permeability metal (amumetal), and provides an estimated magnetic field reduction of 10^6, based on Opera simulations. The prototype active shielding system uses a fluxgate magnetometer to provide magnetic field measurements in a Helmholtz-like coil set. The currents in the coils are adjusted by custom software dependent on the fluxgate measurements, forming a feedback loop. The active system provides RMS shielding factors $>$ 1000 for magnetic field perturbation frequencies 20 mHz, and $>$ 100 for frequencies 0.5 Hz, and can therefore reduce magnetic field variations on the order of tens of μT to the level of tens of nT. The prototypes represent good progress towards the eventual system for nEDM experiments, where multi-axis low-frequency field drifts of 100 nT require active shielding to $<\sim$1 nT. The present magnetic shielding prototypes will be discussed, with focus on the active shielding system and with view to future improvements. Progress on internal coils and precision (co)magnetometers will also be discussed.

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