Title: Optimizing the Pion Detector System and Utilizing Bayesian Analysis to Improve Background Correction in the MOLLER Experiment

Parity-violating electron scattering techniques have emerged as powerful tools for exploring New Physics beyond the Standard Model (SM) of particle physics. The Measurement of a Lepton Lepton Electroweak Reaction (MOLLER) Experiment at Jefferson Lab is focused on investigating new dynamics through accurate measurements of the parity-violating asymmetry (A_PV) in electron-electron scattering. To achieve the expected precision, the experiment requires corrections for background processes that are characterized by background asymmetries and fractional dilution factors. Pion asymmetries and pion dilution factors have significant contributions to the experimental corrections and will be measured in a dedicated pion detector system. The University of Manitoba has been designing, developing, and constructing the pion detector system for the MOLLER experiment. To confirm the effectiveness of the detector system, the outcomes from simulations, cosmic testing, and beam tests carried out at MAMI-B microtron in Mainz, Germany, will be compared.

Furthermore, a novel approach to improve the understanding of uncertainties introduced by experimental corrections is introduced. Bayesian analysis, a complementary method to the commonly used frequentist methods, will be explored to provide a more robust assessment of the uncertainties in the corrections. The potential benefits of employing Bayesian analysis in parity-violating electron scattering experiments will be discussed.