Precise Measurement of Photomultiplier Tube Non-Linearity for the MOLLER Experiment

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The MOLLER (Measurement of a Lepton-Lepton Electroweak Reaction) experiment aims to measure the weak mixing angle with unprecedented precession at low momentum transfer. The measurement will be carried out with Jefferson Laboratory's state-of-the-art Continuous Electron Beam Accelerator Facility (CEBAF) to measure the parity violating scattering asymmetry of 11 GeV highly-polarized electrons on a liquid hydrogen target. This precision measurement will be sensitive to a variety of new physics including probing mass scales as large as 47 TeV. The University of Manitoba is leading the construction of MOLLER primary electron detector. It incorporates quartz bars and 224 Photomultiplier Tubes (PMTs) to integrate the total Cherenkov light yield by the flux of scattered electrons from each helicity state. Understanding the non-linearity of the PMTs is crucial for achieving MOLLER's proposed precision. Customized PMT voltage dividers and pre-amps have been developed at U. Manitoba to achieve the stringent design requirement of less than $0.5 \pm 0.1\%$ non-linearity. An apparatus to replicate a helicity-dependent PMT signal that is similar to what is expected at MOLLER was prepared to evaluate the PMT non-linearity. This talk will present the results of the non-linearity precision achieved with this apparatus and the non-linearity performance of the PMTs to be installed at MOLLER.

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