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General Abstract:

Many current and next generation experiments in fields such as neutrino physics and dark matter searches use liquid noble elements as mediums for detection. The substances, such as liquid argon, produce ionization charge and scintillation photons in interactions with high energy charged particles. Using scintillation photons for measurements requires understanding how light travels through liquid argon between production and detection. However, the attenuation and scattering properties of liquid argon is not consistently agreed upon. We aim to quantify the attenuation due to Rayleigh scattering in liquid argon systems by measuring the Rayleigh scattering length using the TallBo Cryostat at Fermilab.

First, we confirm the operation of all installed equipment in the apparatus. Initial studies with the silicon photomultiplier detector data collection system resulted in many issues, largely due to electronic grounding problems. As a result, we modified our procedures to accommodate for data collection without usage of the problematic equipment. We also optimized the settings and procedures for data collection quality and quantity. Finally, we filled the cryostat with liquid argon, beamed light downwards from the top of the cryostat, measured the amount of light at points on the bottom and side for different wavelengths, and repeated measurements at different liquid levels.

Analysis of the resulting measured photon rates use plots of trigger rates versus liquid depth. We expect the photon rate to decrease via exponential decay as the liquid level lowers. However, our photon rates do not decrease exponentially. Further data collection and analysis is required to accurately measure the Rayleigh scattering length. The results from the study will inform development of analysis techniques of Department of Energy experiments such as DUNE and SBND.