Proton light yield of water-based liquid scintillator

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Introduction

- Water-based liquid scintillator (WbLS) [1] emerging as a target material with possibility of Cherenkov/scintillation separation
- Candidate material for THEIA [2], ANNIE [3], and NEO
- Characterization of proton light yield (PLY) improves reach
- Supernova-ν energy measurement (νp scattering)
- Fast-neutron background rejection (np scattering)

Methodology

- Broad-spectrum neutron beam produced via 33 MeV deuteron breakup on Be target at 88-Inch Cyclotron at LBNL
- Neutrons undergo n-p elastic scattering in target and are scattered into 11 auxiliary detectors
- Double time-of-flight method [4] results in relatively pure sample of proton recoils

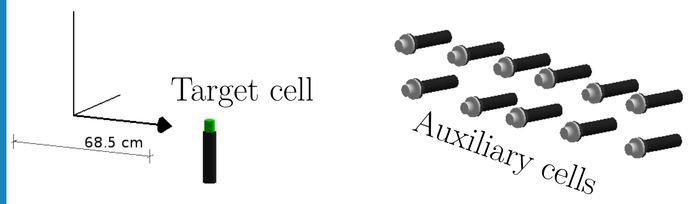

Figure 1: Experimental geometry

Results

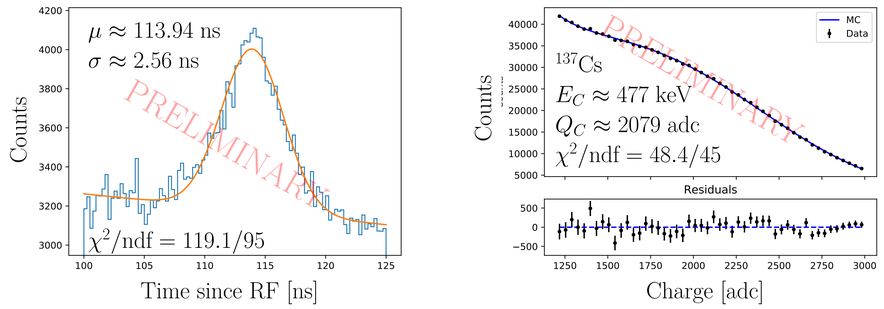

Figure 2: Fits to measured incoming γ timing (left) and spectrum of ^{137}Cs Compton edge (right).

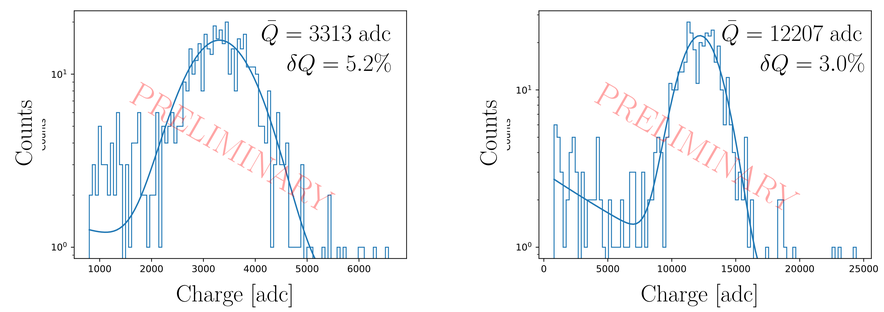

Figure 3: Fits to charge populations for proton energies (T_p) in the range 2.00 MeV $\leq T_p <$ 2.25 MeV (left) and 2.25 MeV $< T_n <$ 5.50 MeV (right).

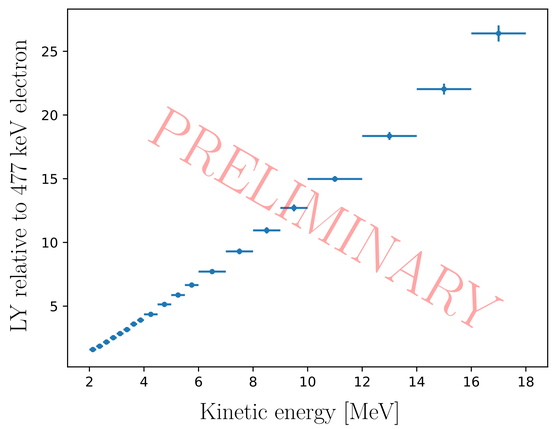

Figure 4: WbLS PLY relative to ^{137}Cs Compton edge.

Next Steps

- Correct for nonlinearity of PMT response
- Future measurements of other scintillator concentrations, as well as isotopically loaded samples

Conclusion

- Proton recoils from n-p scattering detected
- Calibration of light levels performed using radioactive sources
- Proton light yield of 5% WbLS and LAB + 2 g/L PPO measured

References

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[2] Askins et al. *Eur. Phys. J. C.*, 80:416, 2020.

[3] Back et al. `arXiv:1707.08222`, 2017.

[4] Brown et al. *J. Appl. Phys.*, 124:045101, 2018.

Acknowledgements

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