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Energy Reconstruction of Low Energy Events in LArTPC

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LArTPCs & Their Relevance

Liquid **Ar**gon **T**ime **P**rojection **C**hambers are a type of detector that observe the interactions between neutrinos and Argon atoms. The energy & trajectory from these interactions are measured via the charge and light emitted. The goal is to enable LArTPCs to detect low energy events. To do so, studying LArTPCs with and without photosensitive doping will help determine how well the light is converted into charge, possibly yielding in improved energy resolution and low energy measurements.

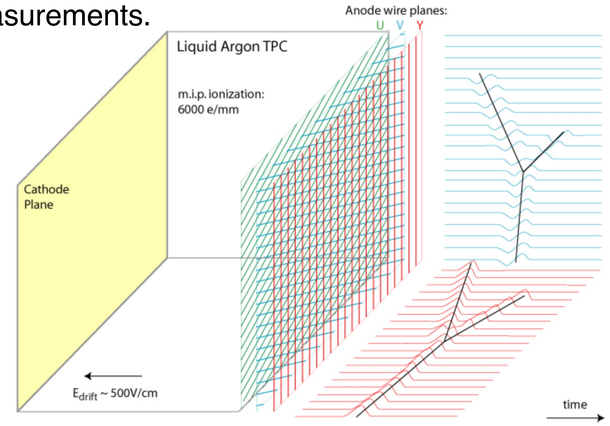

Figure 1: Final Step of LArTPC detecting Light and Charge from Neutrino Event

Steps To Improve LowE Events Detection

2.5 MeV Electron Monte Carlo simulations with photosensitive doping ranging from 0% to 100% in increments of 25% were used to make energy distribution plots via LArSoft Files and Root. The energy distribution plots created help determine the **ideal reconstructed energy** and **improve resolution at low energies.**

Energy Distribution Plots + Additional Results

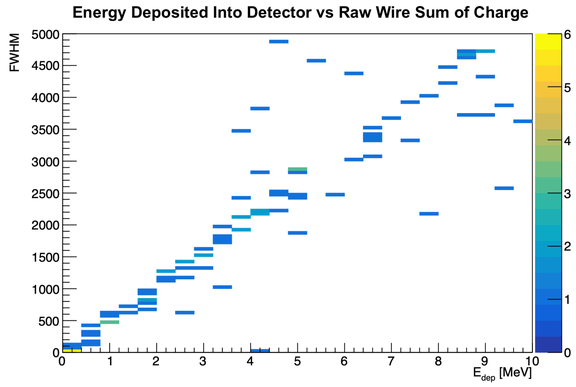

Figure 2: Undoped 2.5 MeV Deposited Energy Distribution based on Sum of Raw Wire Charge

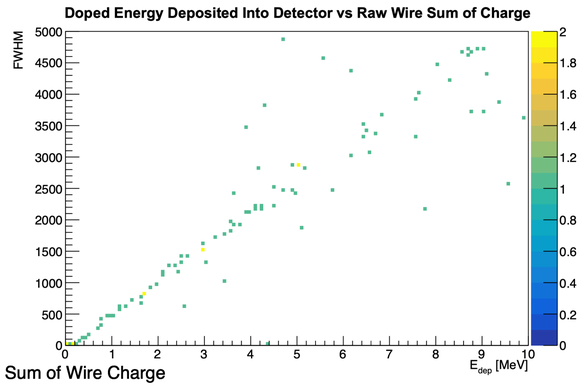

Figure 3: LArTPC Doped 2.5Mev Deposited Energy Distribution Plot based on Raw Wire Sum of Charge

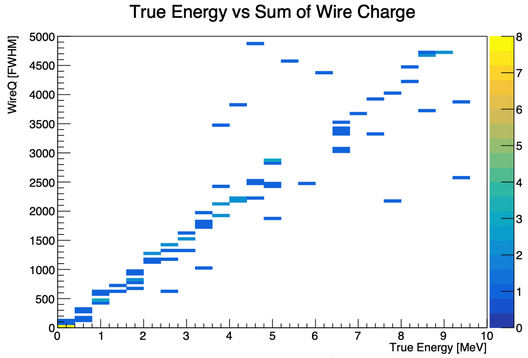

Figure 4: Undoped 2.5 MeV True Energy Distribution based on Sum of Raw Wire Charge

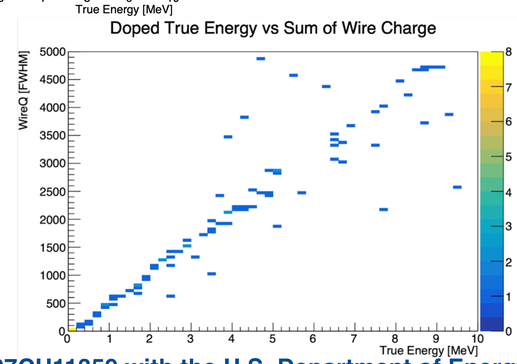

Figure 5: LArTPC Doped 2.5Mev True Energy Distribution Plot based on Raw Wire Sum of Charge

Results (con.)

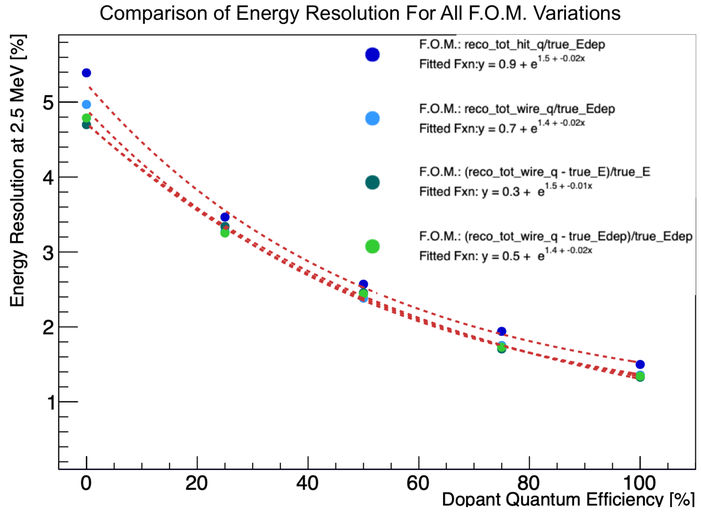

Figure 6: 2.5 MeV Energy Resolution Plots based on 4 Figures of Merit

Conclusion

After making numerous energy distribution plots of the low energy events that were both doped and undoped, we discovered the True Energy Deposited, True Energy, and Sum of Wire Charge are the most useful variables for enhancing energy resolution and energy reconstruction within the LArTPCs. To determine whether the Energy Deposited **or** True Energy variables have any significant difference between them in terms of Energy Resolution, we chose **4 distinct figures of merit (2 ratio based and 2 percent-difference based)** to make the comparison. Although we found both variables to be close in resolution percentage. the true Energy deposited variable appeared to be more effective in both figures of merit.

Acknowledgements

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References

Lepetic, I. (n.d.). *MeV-Scale Physics in LArTPCs. International Workshop on Next Generation Nucleon Decay and Neutrino Detectors.* Medellin; Colombia.

Psihas, F. (2022.). *Low Energy Physics with Liquid Argon TPCs.* Lecture.

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