

Acknowledgement:

CLAS3 Collaboration, Virginia Space Grant Consortium, and Jefferson Science Associates

Electrons for Neutrinos: Lepton Energy Reconstruction in the Resonance Region

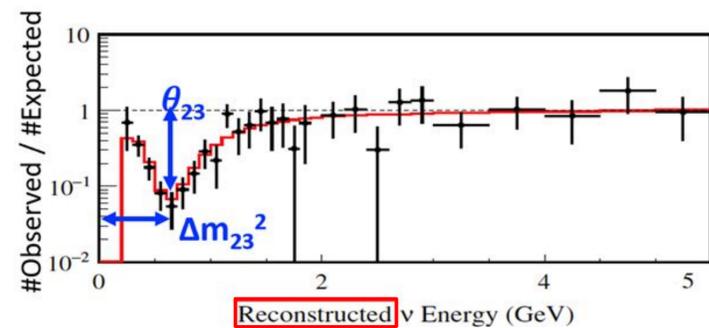
Alicia Mand, Old Dominion University



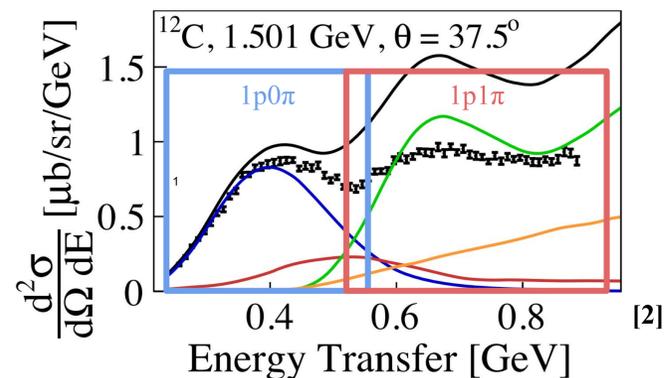
Neutrino Oscillation

- Neutrinos oscillate as a function of their energy (E_0)
- Must Reconstruct E [1]

$$P(\nu_\mu \rightarrow \nu_\mu) = \sin^2(2\theta_{23}) \times \sin^2\left(\frac{\Delta m_{32}^2 L}{4E_\nu}\right)$$



Test Energy Reconstruction Using Electrons



- Lots of different eA reaction mechanisms
- Previous work focused on **quasielastic** using $1p0\pi$ [3]
- Now focus on **resonance** and “**deep inelastic**” using $1p1\pi$

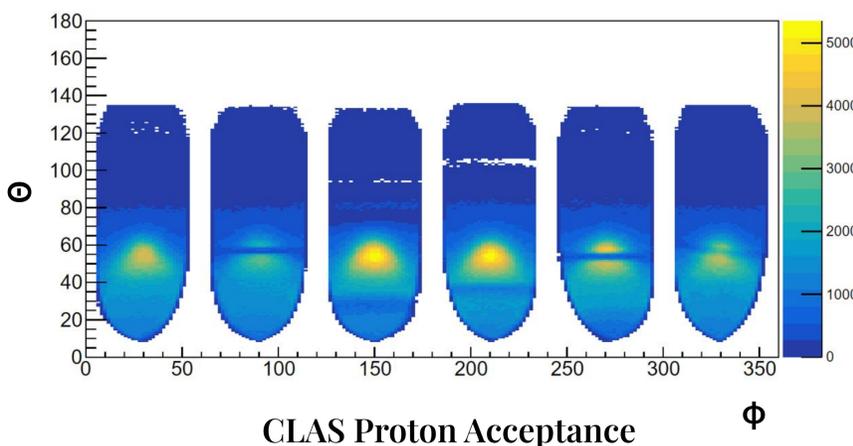
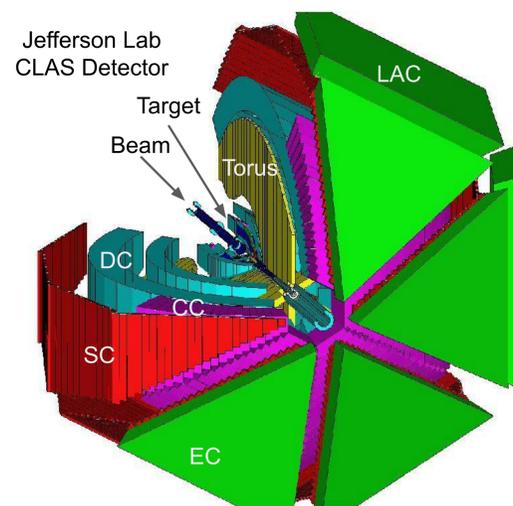
$$E_0 = E'_l + E_\pi + T_p + \epsilon$$

References:

- [1] T2K, Phys. Rev. D 91, 072010 (2015)
 [2] A. Papadopoulou, et al, Phys. Rev. D 103, 113003 (2021)
 [3] Khachatryan, M., Papadopoulou, A., Ashkenazi, A. et al, Nature 599 (2021)

CLAS data

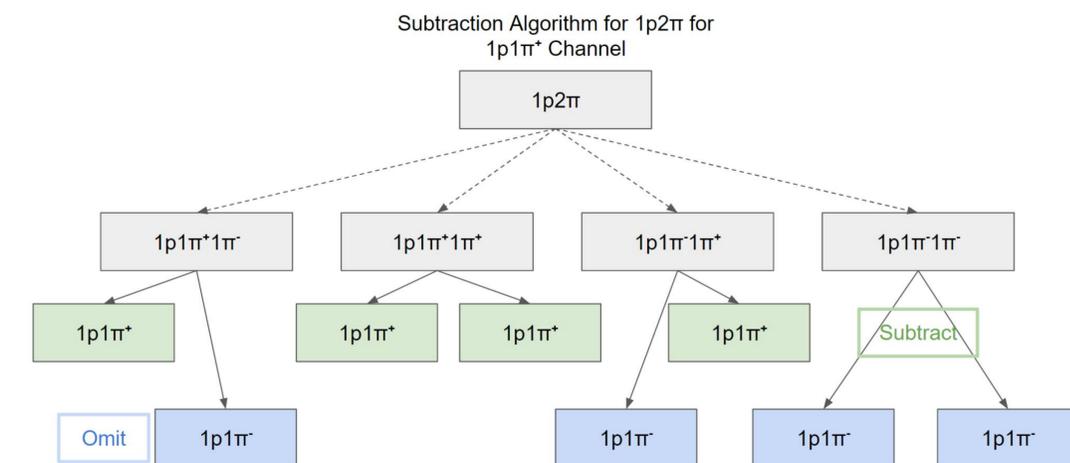
- Electron scattering from
 - ^3He , ^4He , ^{12}C , and ^{56}Fe at 2.2 and 4.4 GeV
- Jefferson National Accelerator Facility (JLab)
- CEBAF Large Acceptance Spectrometer (CLAS)



- Select $(e, e'p\pi)$ events (events with one detected electron, proton, and pion with no other particles)
- Subtract for events with undetected extra particles
 - ex: $2p1\pi$ events can appear as $1p1\pi$ events with an undetected pion

Subtracting for Extra Events

- Events might appear to be something they are not
- We must subtract for these extra events based on their probability of appearing as $1p1\pi$ events
- Subtraction is complicated!



Results and Conclusions

- π^- events reconstruct better than π^+ events
- Lighter nuclei reconstruct better than heavier nuclei
- Lower energies reconstruct better than higher energies
- We CAN use electrons
- Subtraction is even more complicated than initially thought!

