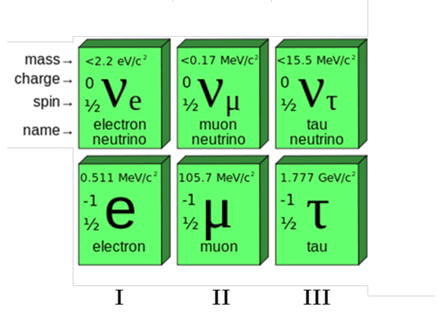
Electrons For Neutrinos:

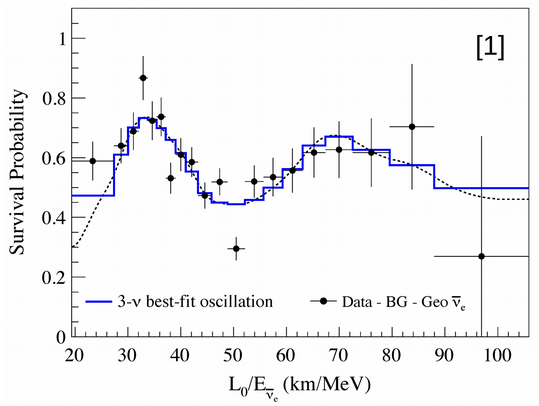
Using Electron Scattering to Develop New Energy Reconstruction for Future Deuterium-Based Neutrino Detectors

Adrian Silva – for the e4v Collaboration
Laboratory for Nuclear Science, Massachusetts Institute of Technology

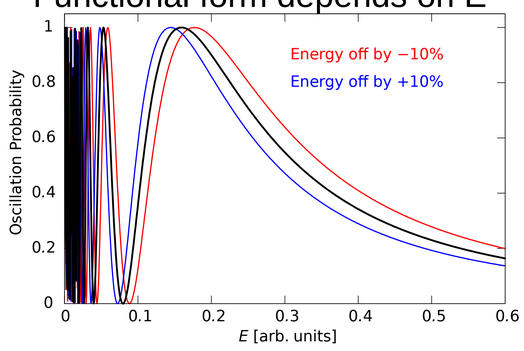
Neutrinos



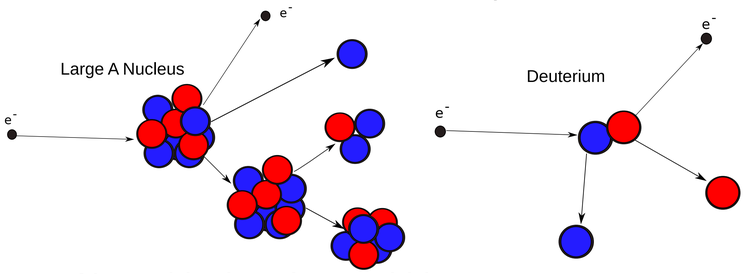
Neutrinos can oscillate between flavor states with probability $P(\nu_\mu \to \nu_x) = sin^2(2\theta)sin^2(\frac{\Delta m^2 L}{4E_\nu})$



Functional form depends on E



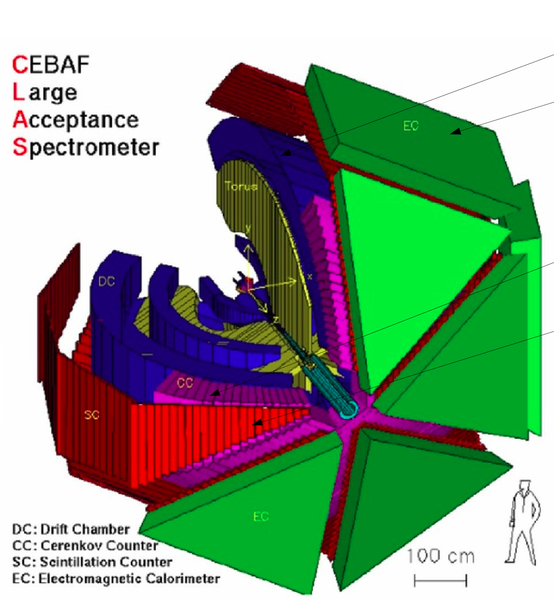
Minimize uncertainty on E to get useful results about oscillation parameters



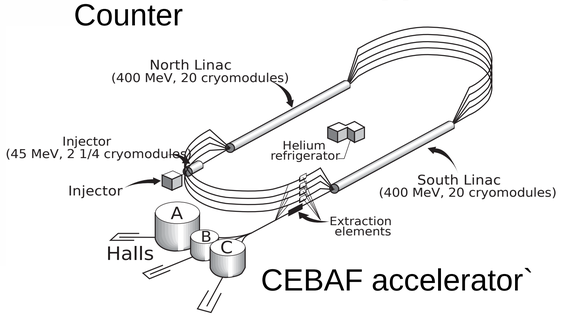
No residual nucleus to hide momentum or energy. Deuterium constrains kinematics!

$$E_{rec} = \frac{(E_e + E_p - m_d)^2 - (\vec{p_e} + \vec{p_p})^2 - m_n^2}{2(E_e + E_p - m_d) - 2(p_{e,z} + p_{p,z})}$$

Data Mining



[2]

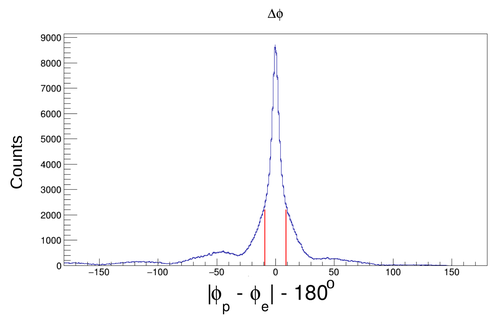


Test equation on CLAS electron scattering data from Hall B experiment eg2: d(e,e'p) scattering with E = 5.014 GeV

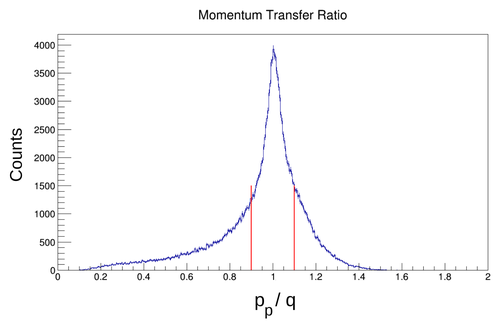
Kinematic Cuts

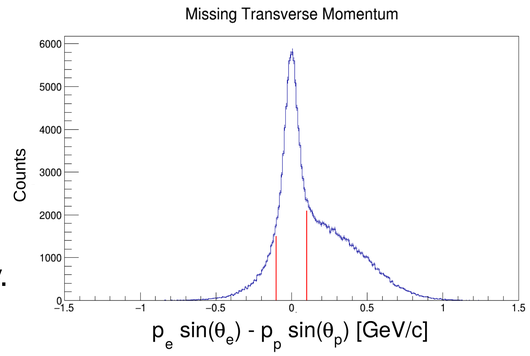
Attempt to isolate quasielastic scattering events

Select events with small proton angle out of scattering plane

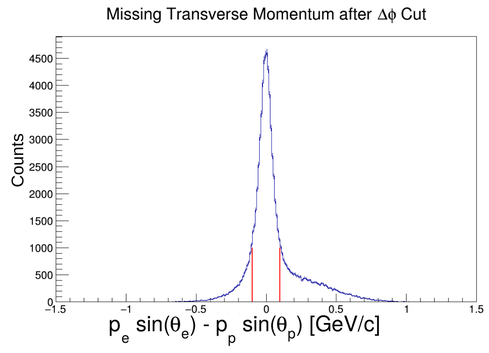


Select events where electron momentum transfer is roughly final proton momentum



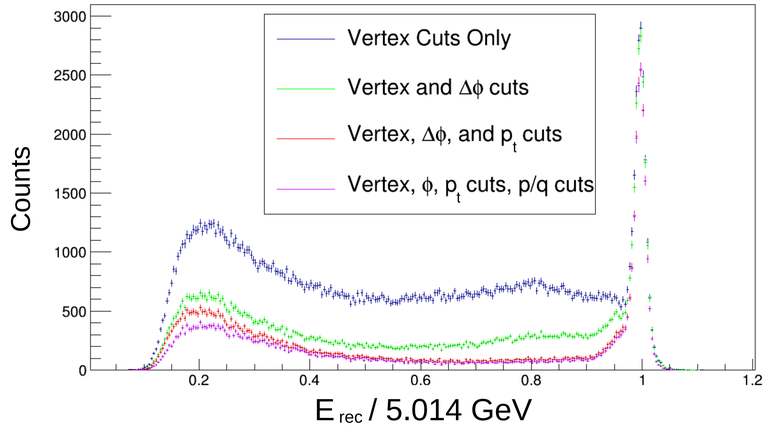


Select events with small total momentum out of scattering plane

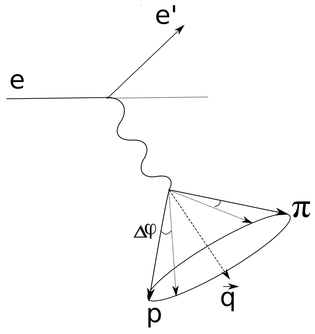


Δϕ cut reduces inelastic background

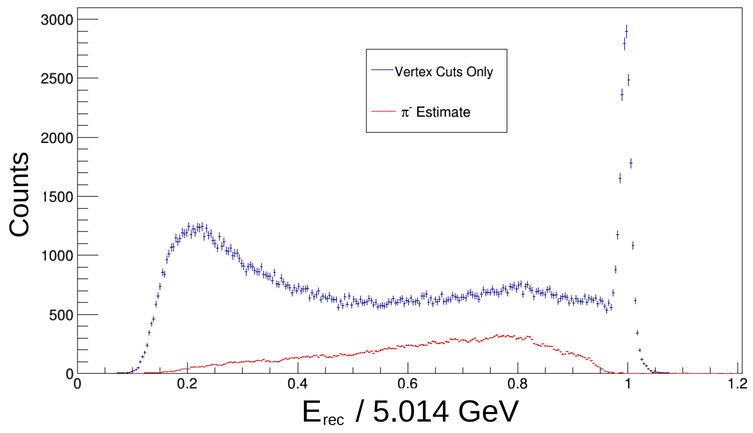
Results



Estimation of Pion Production Background



Use pion production events to create an estimate of $d(e,e'p)\pi^-$ events by rotating the pion around the q vector



Explanations of remaining background: Initial state radiation? π^0 production?

References

[1] KamLAND, PRL 100, 221803 (2008)
[2] B.A. Mecking et al. NIM A 503, pp513-553 (2003)

Acknowledgements

This work was supported by the Paul E. Gray UROP Fund.