First study of neutrino angle reconstruction using quasielastic-like interactions in MicroBooNE[1]

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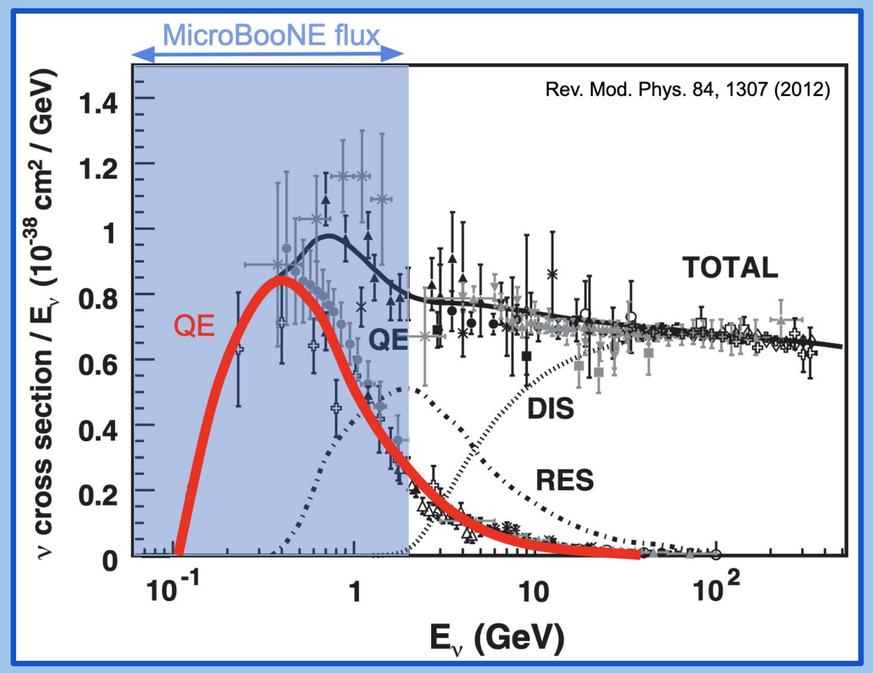
Why charged-current quasielastic (CCQE) interactions?
- Simplest nuclear process with two particles in the final state
- Dominant at low energies relevant for MicroBooNE



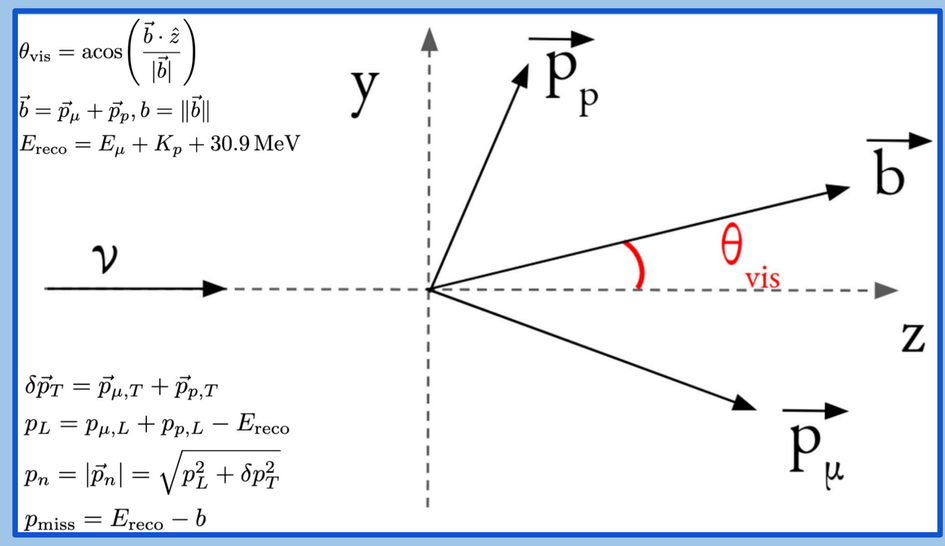
The reconstructed neutrino direction (θ_{vis}) is crucial for the DUNE sub-GeV atmospheric oscillation studies[2]

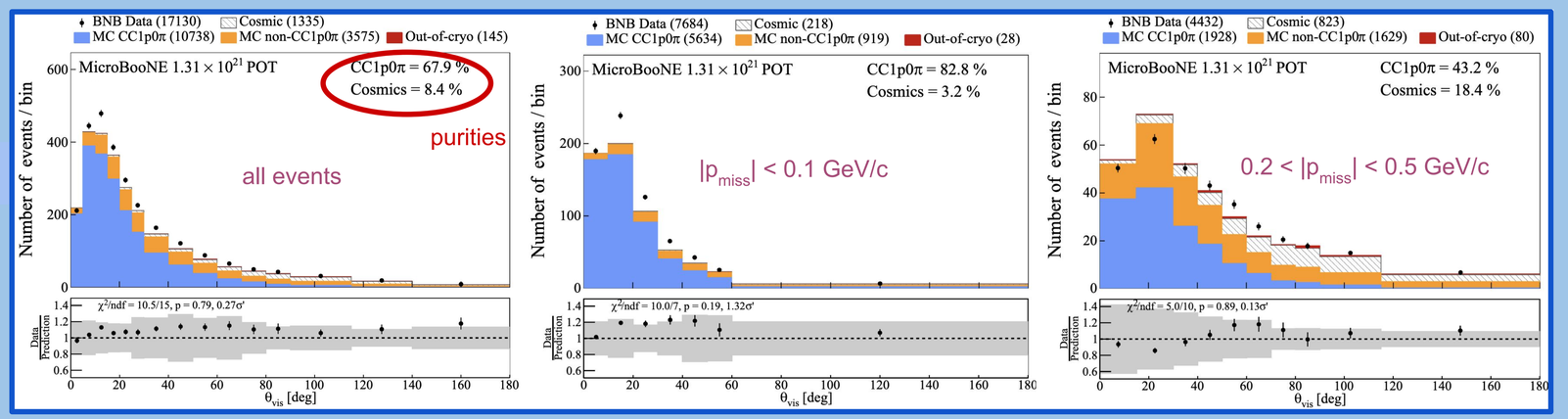
MicroBooNE allows for a data-driven quantification of this angular deviation by investigating the deviation with respect to the well-known direction of neutrinos

We find that the neutrino direction reconstruction performance using the single-proton selection is, in most cases, better than assumed in already published literature using an inclusive selection

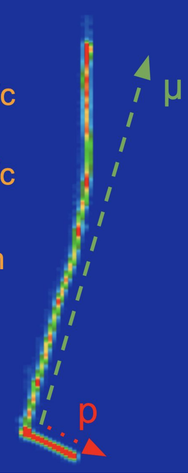
We also present flux-integrated single- and double-differential cross-section measurements of ν_μ CCQE-like scattering events on argon as a function of θ_{vis}

$$\theta_{\text{vis}} = \text{acos}\left(\frac{\vec{b}\cdot\hat{z}}{|\vec{b}|}\right)$$
$$\vec{b} = \vec{p}_\mu + \vec{p}_p, b = \|\vec{b}\|$$
$$E_{\text{reco}} = E_\mu + K_p + 30.9\,\text{MeV}$$
$$\delta\vec{p}_T = \vec{p}_{\mu,T} + \vec{p}_{p,T}$$
$$p_L = p_{\mu,L} + p_{p,L} - E_{\text{reco}}$$
$$p_n = |\vec{p}_n| = \sqrt{p_L^2 + \delta p_T^2}$$
$$p_{\text{miss}} = E_{\text{reco}} - b$$

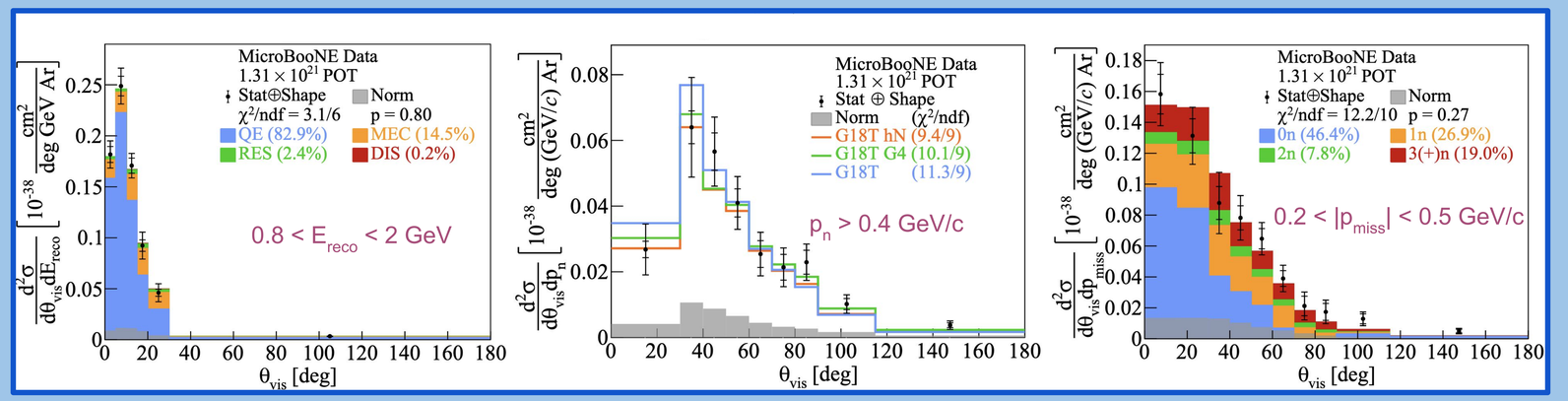




Signal definition
- Single muon with $100 < P_\mu < 1200$ MeV/c
- Single proton with $300 < P_p < 1000$ MeV/c
- No neutral mesons
- No charged pions with $P_\pi > 70$ MeV/c



BNB Run 1
Data event 6904
Run 5127
Subrun 138



[1] Phys. Rev. D 111, 113007 (2025) [2] Phys. Rev. Lett. 123, 081801 (2019)