Muon neutrino reconstruction in MicroBooNE

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on behalf of the MicroBooNE Collaboration

MicroBooNE

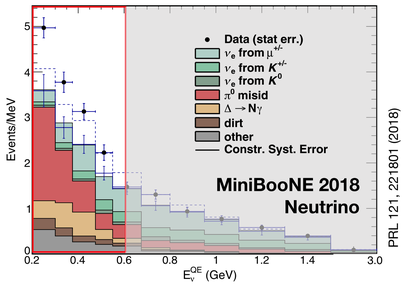
- Study low energy ν_e appearance
- Measure ν-Ar cross sections
- R&D for LArTPC technology for the SBN program and DUNE

- 8 GeV protons on Be target (BNB)
- 470 m baseline
- (2.6x2.3x10.4) m³ fiducial volume
- 85 tons active mass of liquid Ar
- 3 planes of sense wires

Low Energy Excess

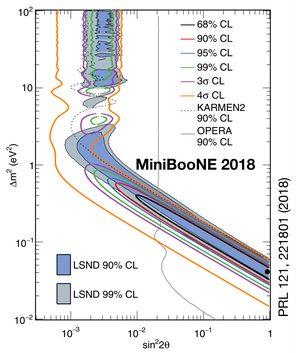
➡ **MiniBooNE :**

- Observed a 4.7σ excess ν_e appearance [200-600] MeV
- Compatible with a 3+1 model
- Tensions with LSND and ICARUS
- Could be linked to systematic uncertainties, e/γ mis-ID



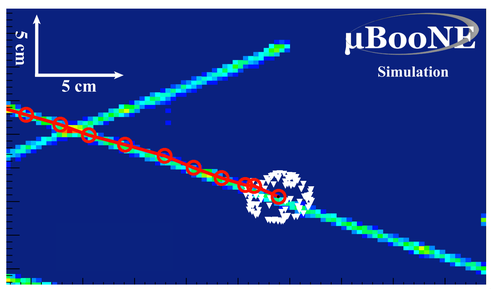
➡ **MicroBooNE :**

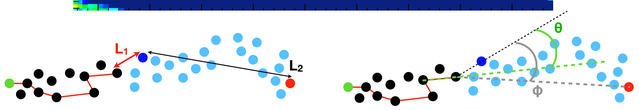
- LArTPC : good e/γ separation
- Dominated by CCQE 1L1p events
- Constrain beam-νe from K decays with 1μ1p



Track Reconstruction

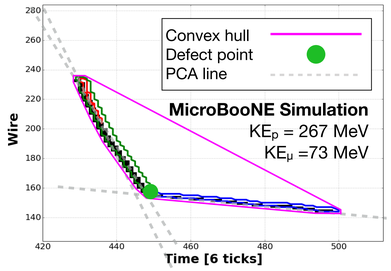
- Reconstruction starts from 3D vertex position
- Stochastic search in near-by 3D-space
- Finds best path through the found 3D-points
- Self diagnostic tool to remove failed reconstructions by searching around the end points of the tracks for signs of failure modes such as un-responsive wires or continued charge deposition

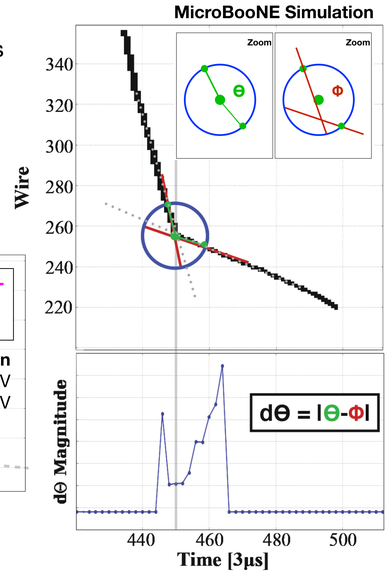




Vertex Finding

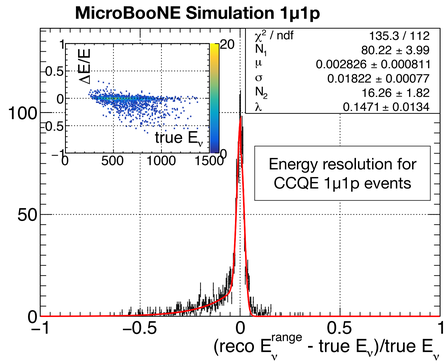
- OpenCV tools to find vertex seeds
  - defect points of convex hulls
  - PCA line crossings
- Scan tracks around seeds to find best position using the dΘ metric
- Match seeds across 3 planes to find 3D vertex

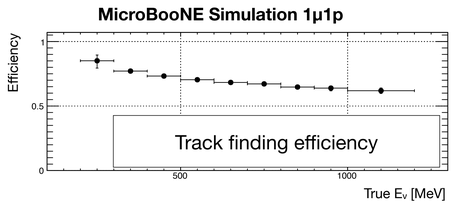




Performance

$$E_\nu^{\text{visible}} = KE_p + KE_\mu + m_\mu + m_p - m_n + B$$



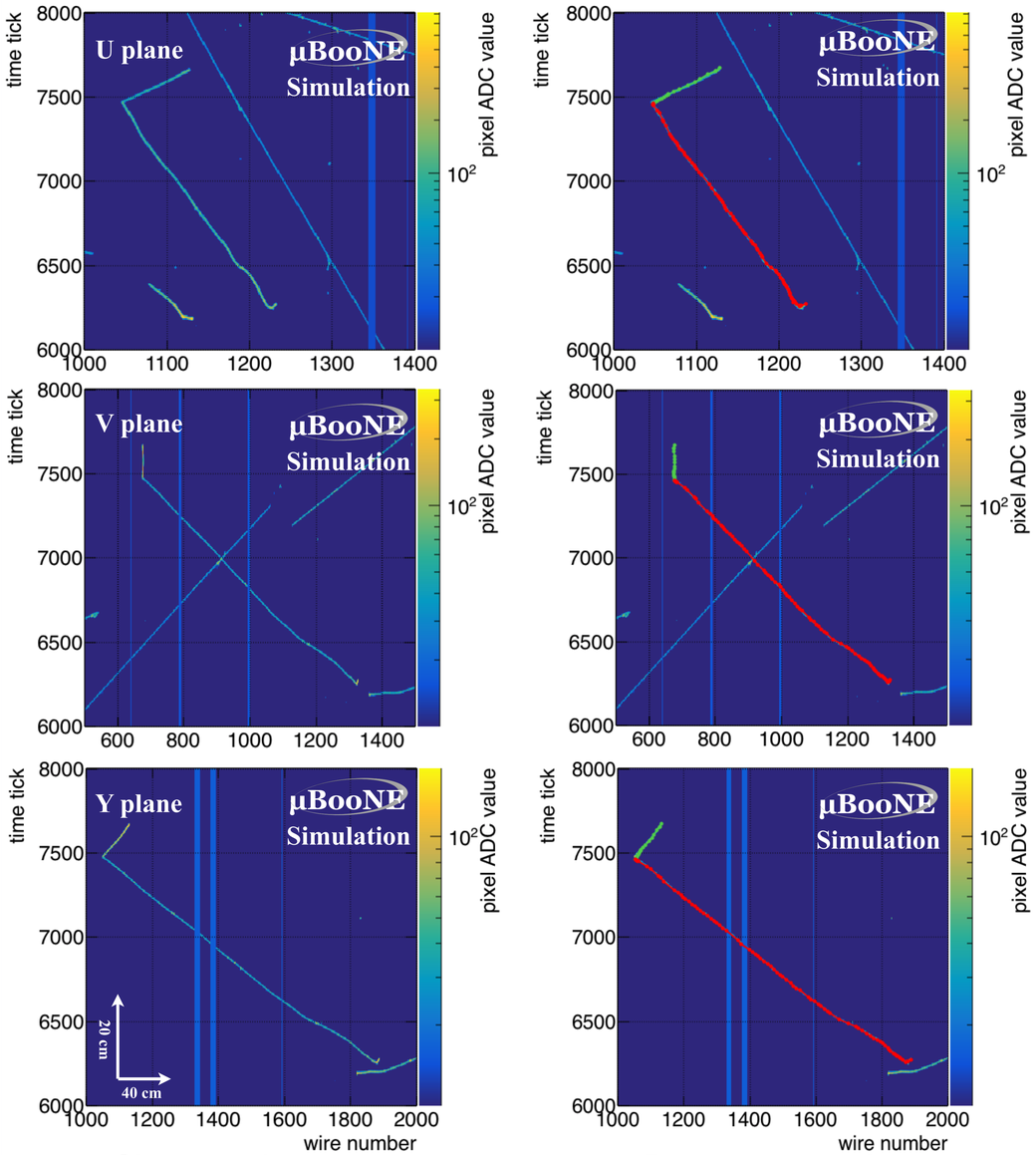


- Reconstruct μ and p KE from their ranges
- Energy resolution ~2% on CCQE 1μ1p events
- Efficiency ~70%

More details in arxiv:2002.09375

Reconstruction Example

- Reconstruction example of a simulated ν_μ CCQE events
- left : 3-plane views from MicroBooNE's readout
- right : reconstructed tracks (proton in green, muon in red) overlaid on top of the displays



Simulated:
E_ν = 974.8 MeV
KE_μ = 602.9 MeV
KE_p = 225.9 MeV

Reconstructed:
E_ν = 993.4 MeV
KE_μ = 626.8 MeV
KE_p = 220.6 MeV

- Reconstruction error of 1.9% typical of the overall energy resolution

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