

Tracking Efficiencies Proton Decay & Atmospheric Neutrinos

Tracking Efficiency Module in LArReco

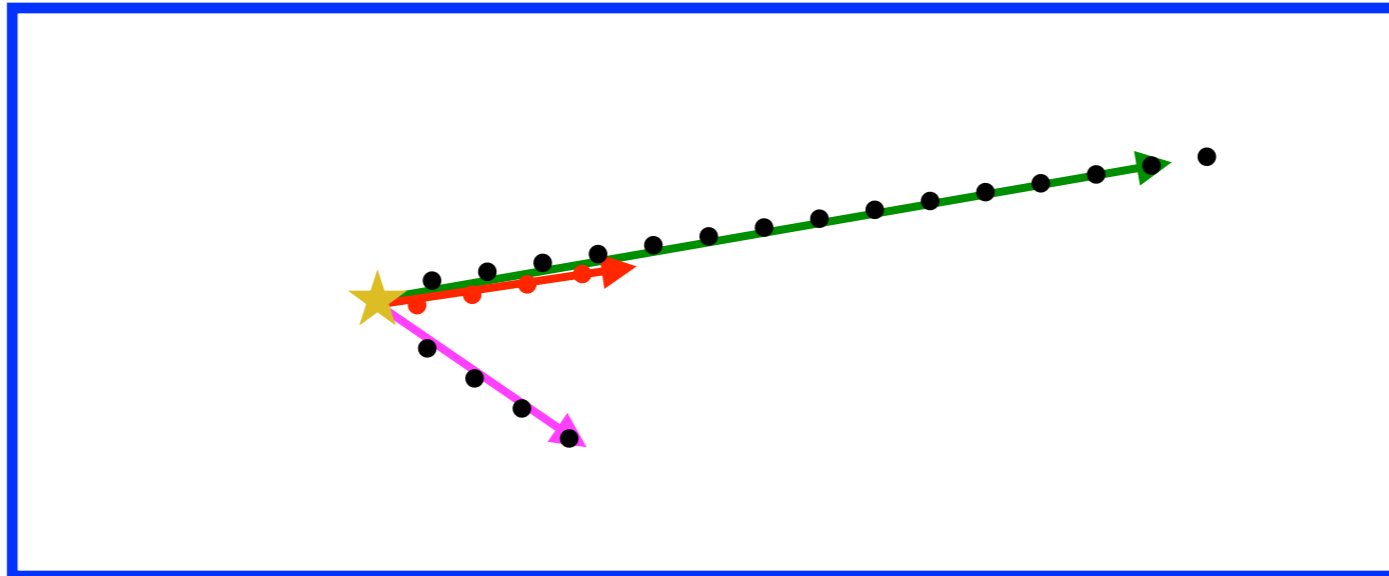
NeutrinoTrackingEff_module.cc
Lives at *larreco/TrackFinder*

Fiducial volume

Loop over tracks, grab all hits associated to the track

Use “BackTracker” to find MCParticle

```
art::Ptr<recob::Hit> hit = track_hits[j];  
std::vector<sim::TrackIDE> TrackIDs = bt->HitToTrackID(hit);
```



Save the best track based on purity a.k.a Efrac

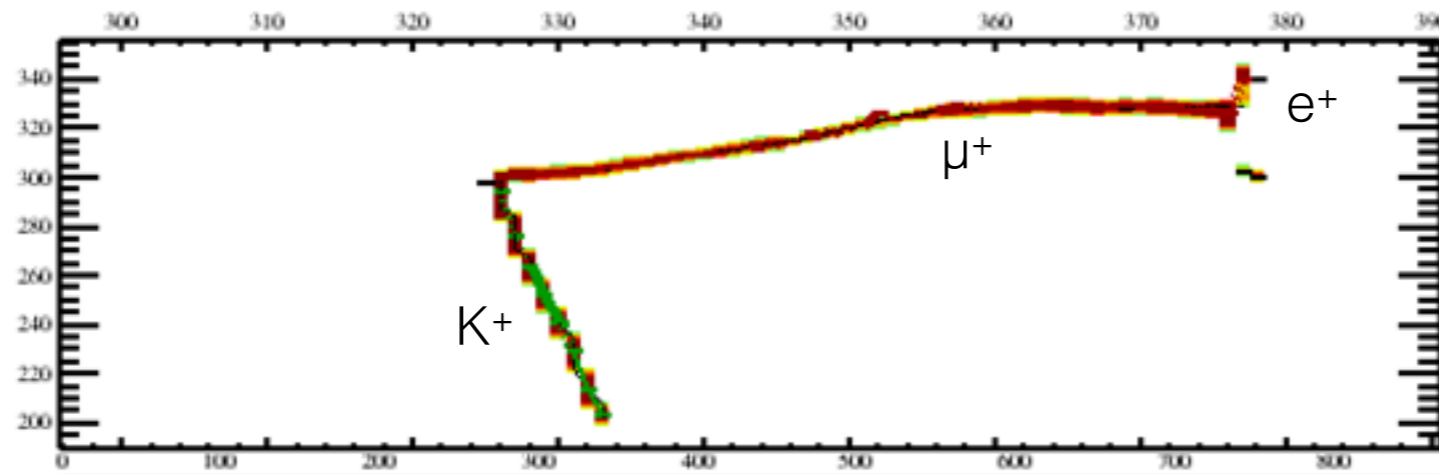
Efrac = 1.0, if all hits in the track come from the same particle

Proton Decay

Proton decay, golden channel $p \rightarrow \bar{\nu} + K$ (sample generated by Gabriel 1K events)

Workspace geometry (4APA 5 mm wire pitch & wire angle 36 degrees)

Looking at two tracking reconstruction algs **PANDORA** and **PMA** (Projection Matching Alg)



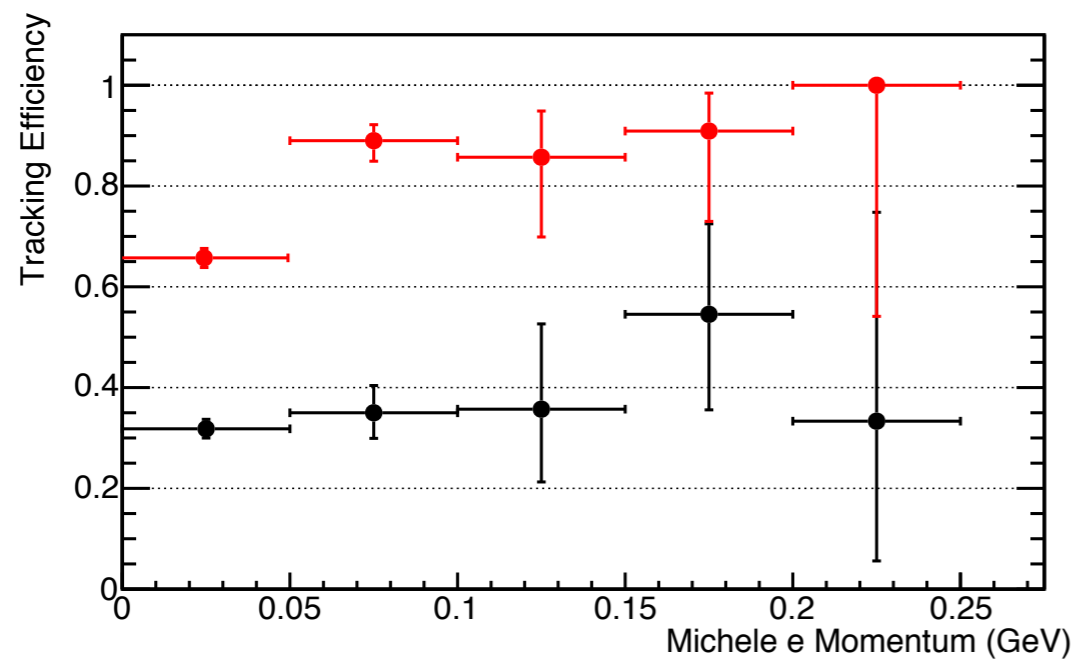
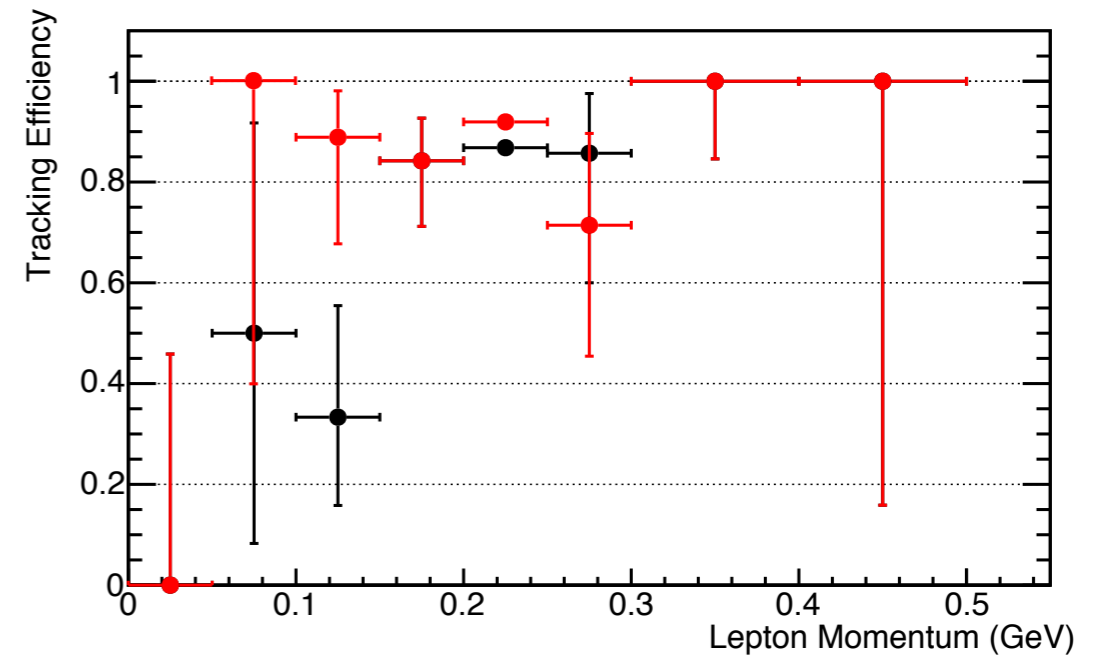
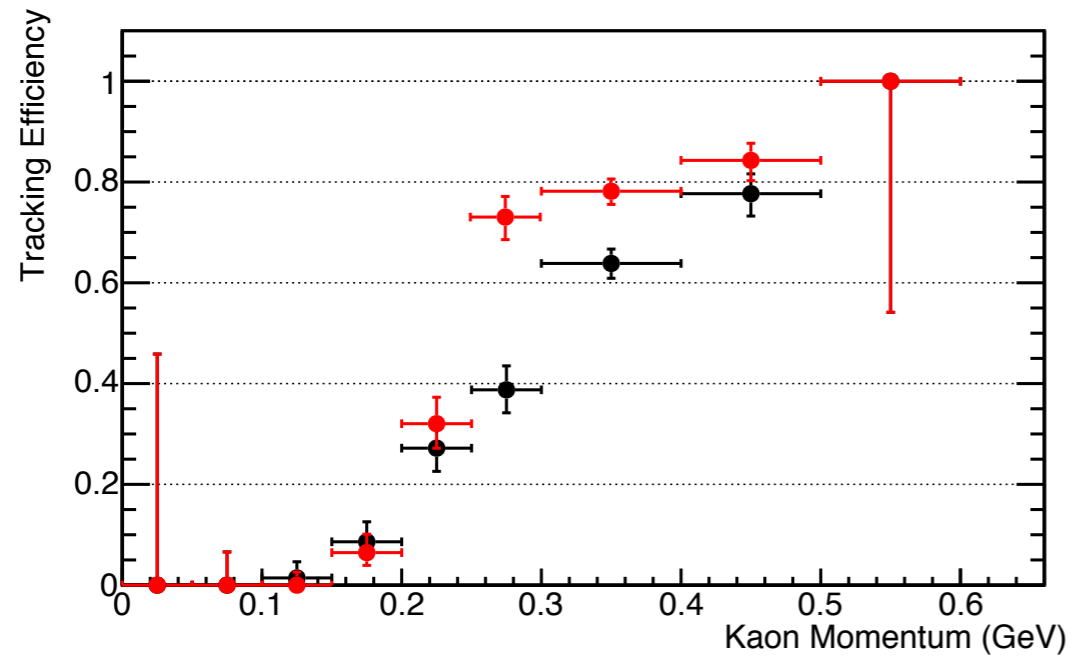
K tracking efficiencies, residuals and track purity

μ tracking efficiencies, residuals and track purity

Michel electron tracking efficiencies, residuals and track purity

$$\text{Efficiency} = \frac{K, \mu, e \text{ within FV w/reconstructed track}}{K, \mu, e \text{ within FV}}$$

Proton Decay Tracking Efficiencies

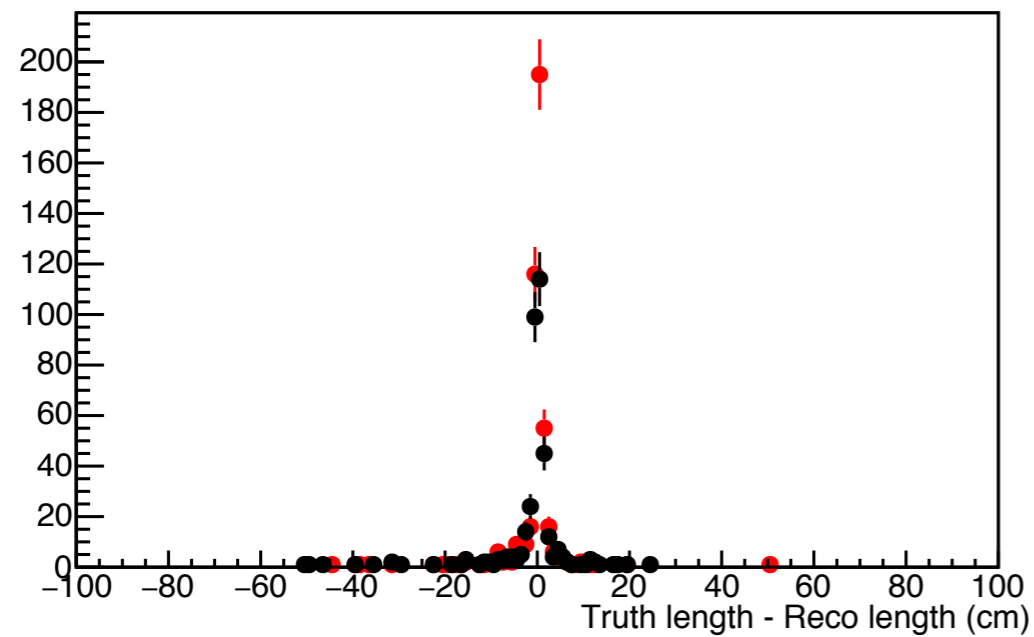


PANDORA

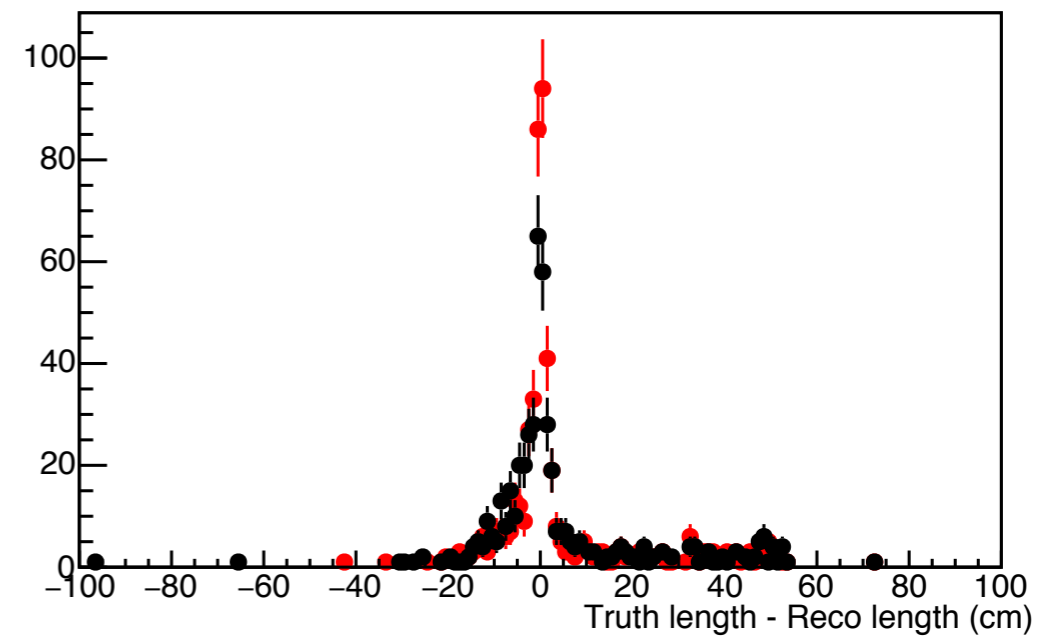
PMA

Proton Decay Tracking Residuals

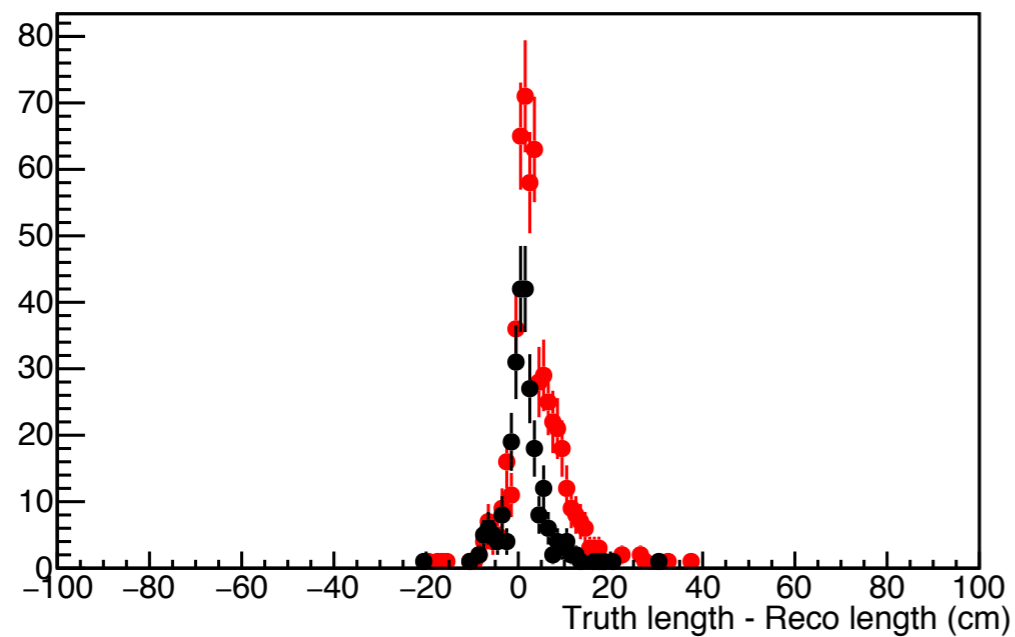
Kaon Residual



Muon Residual



Michel Residual

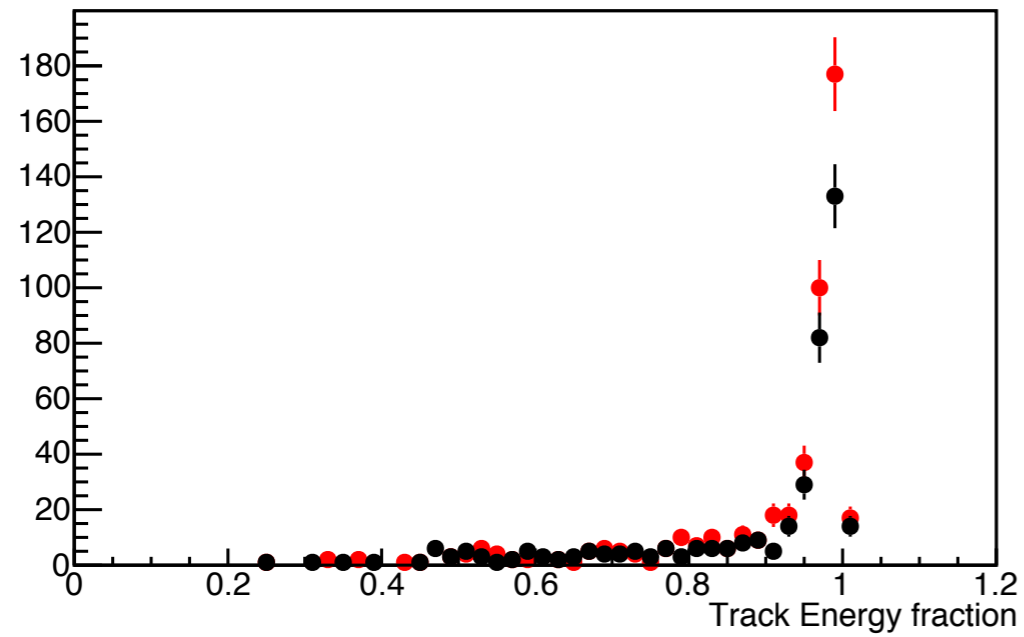


PANDORA

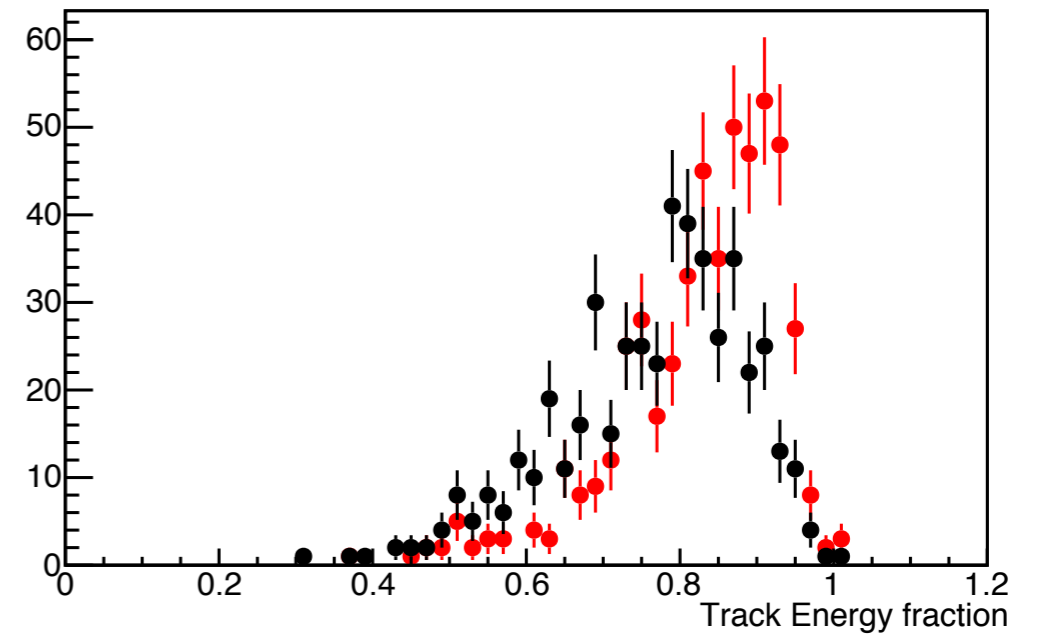
PMA

Proton Decay Track Purity

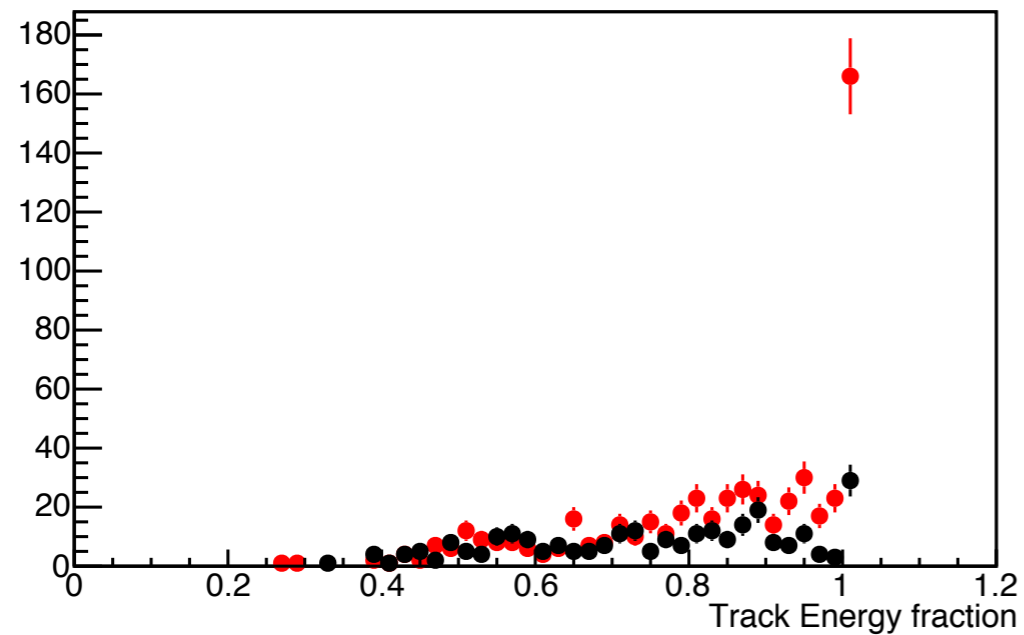
Efrac Kaon



Efrac Lepton



Efrac Michel



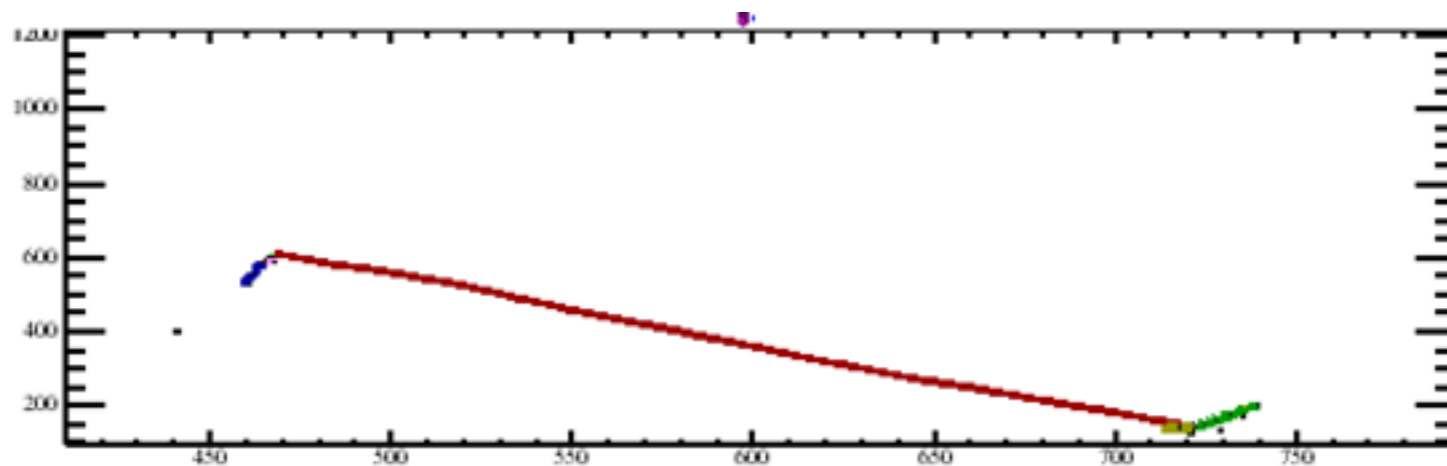
PANDORA

PMA

Atmospheric Neutrinos

Analysis of CC from atmospheric ν_μ within FV volume

Workspace geometry (12APA 5 mm wire pitch & wire angle 36 degrees) generated by Tingjun Yang
Looking at two tracking reconstruction algs **PANDORA** and **PMA** (Projection Matching Alg)

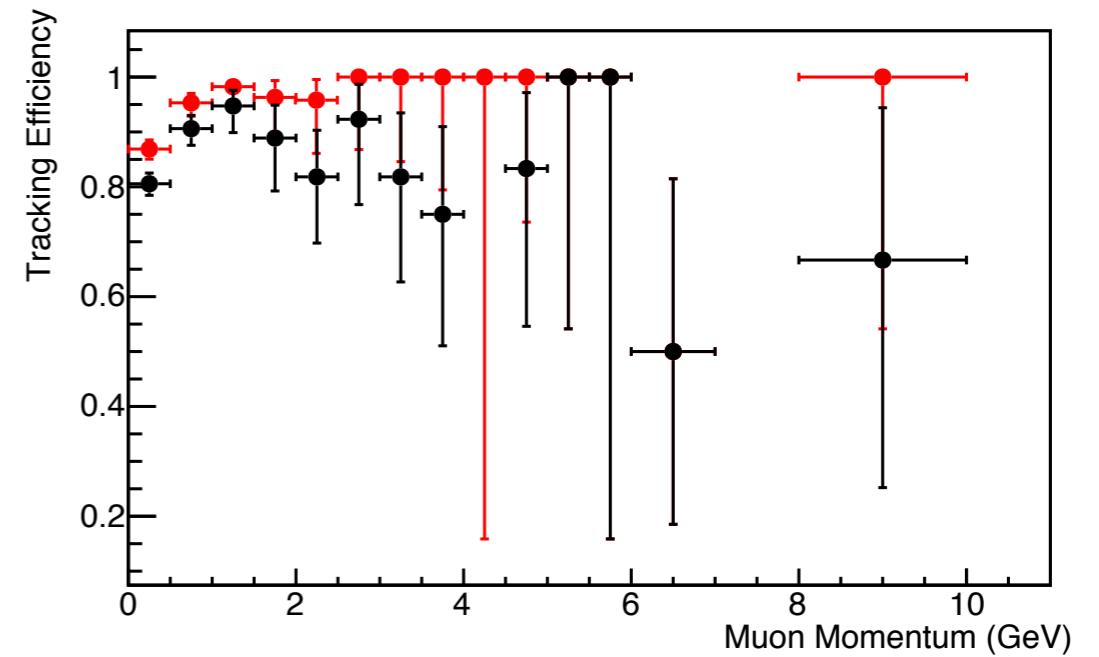
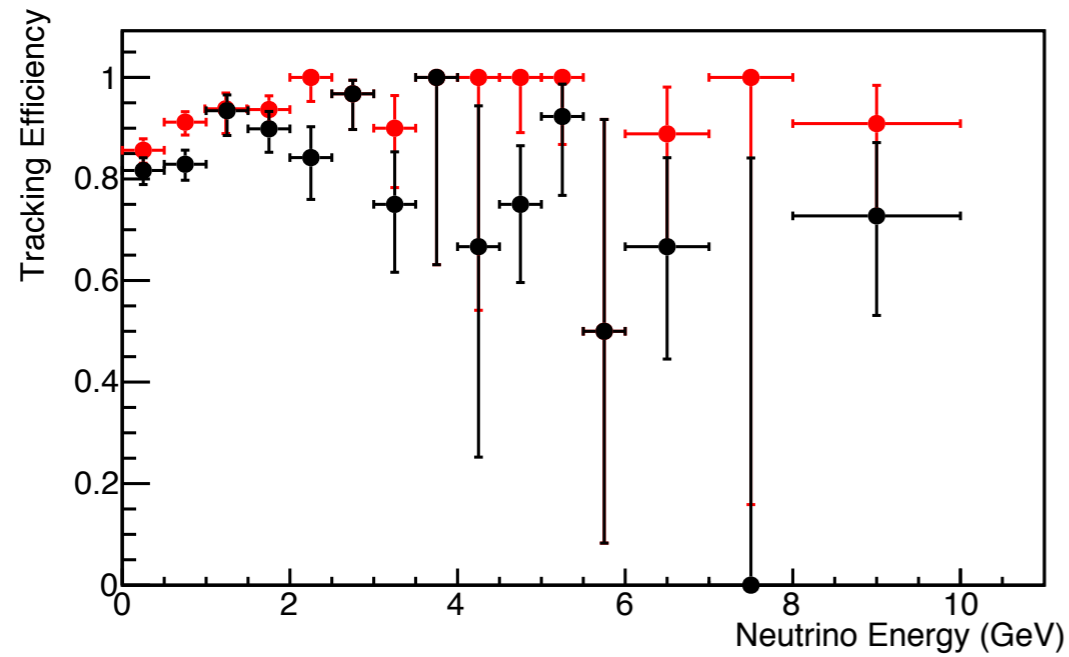


μ tracking efficiencies, residuals and track purity

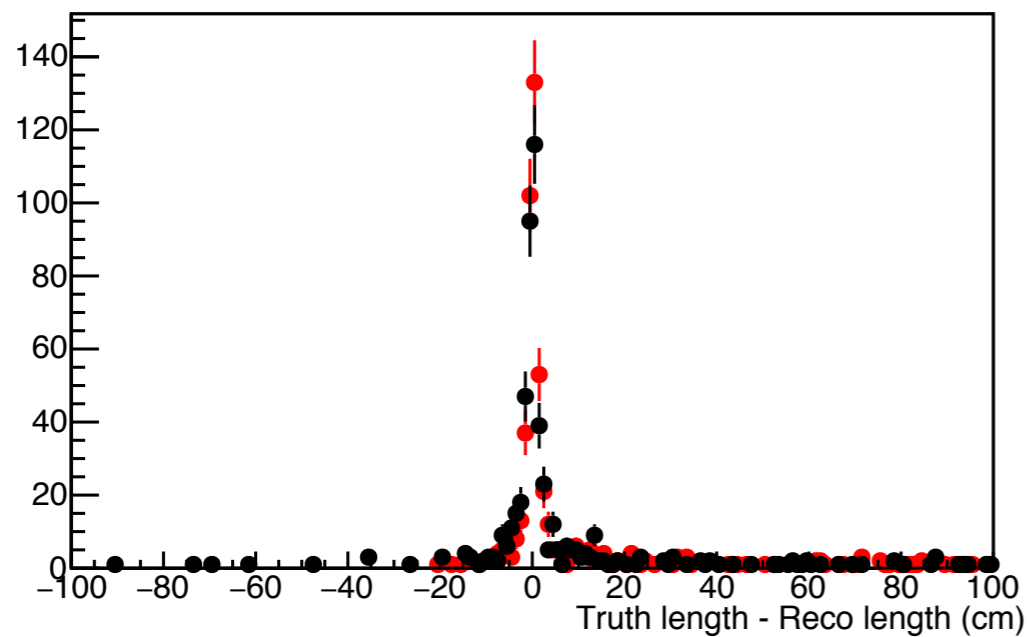
$$\text{Efficiency} = \frac{\text{CC } \nu_\mu \text{ within FV with a } \mu \text{ reconstructed track}}{\text{CC } \nu_\mu \text{ within FV}}$$

Atmospheric Neutrinos, μ^- Tracking

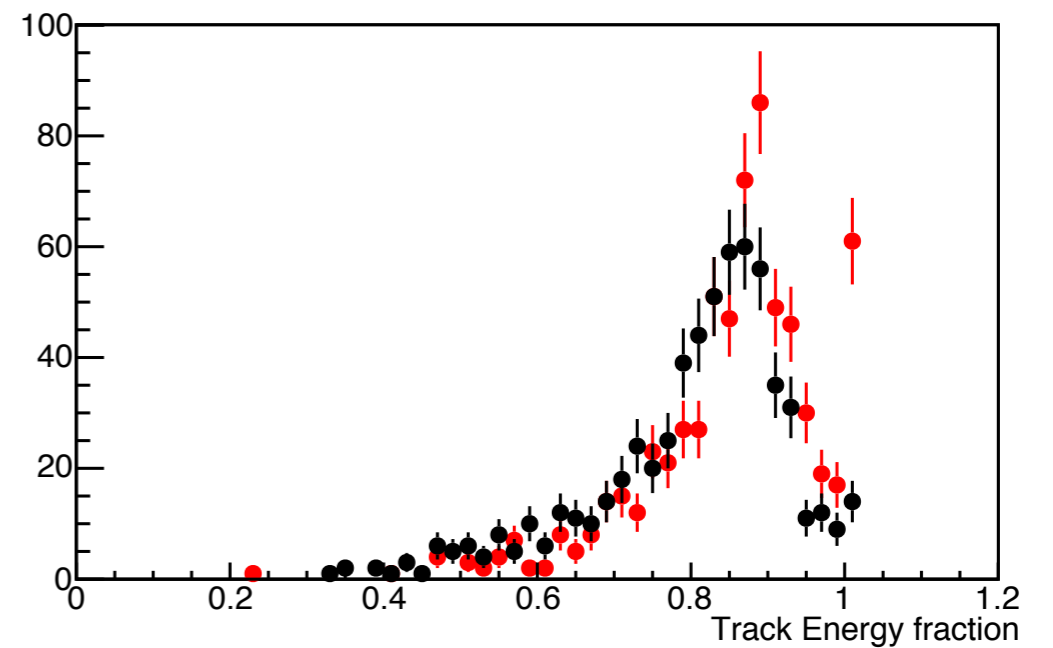
PANDORA
PMA



Muon Residual

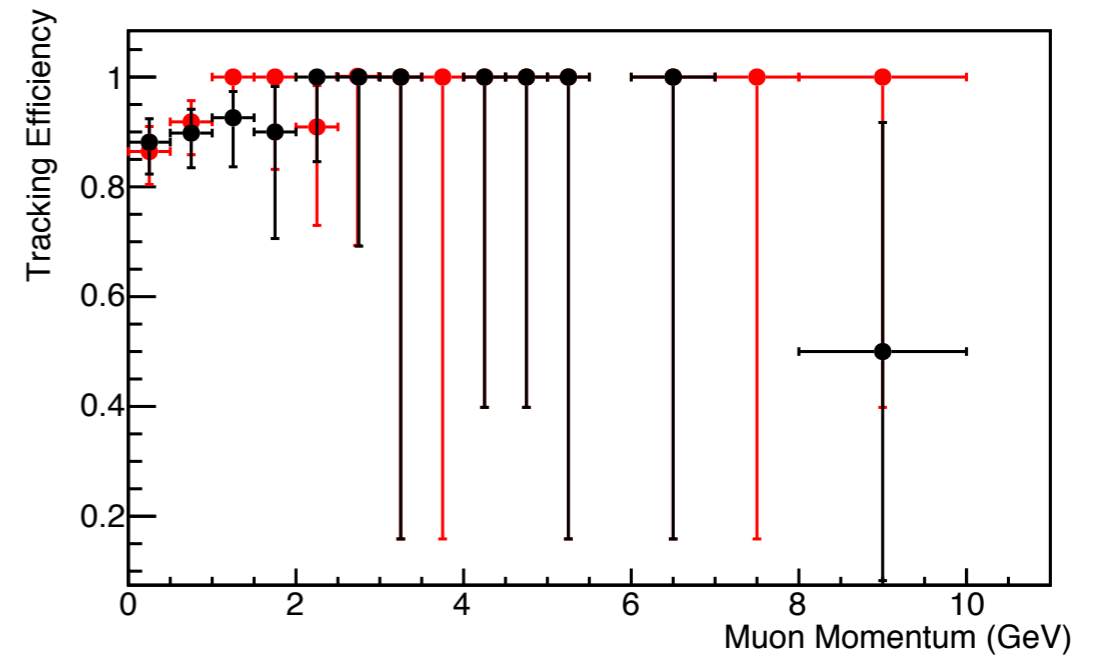
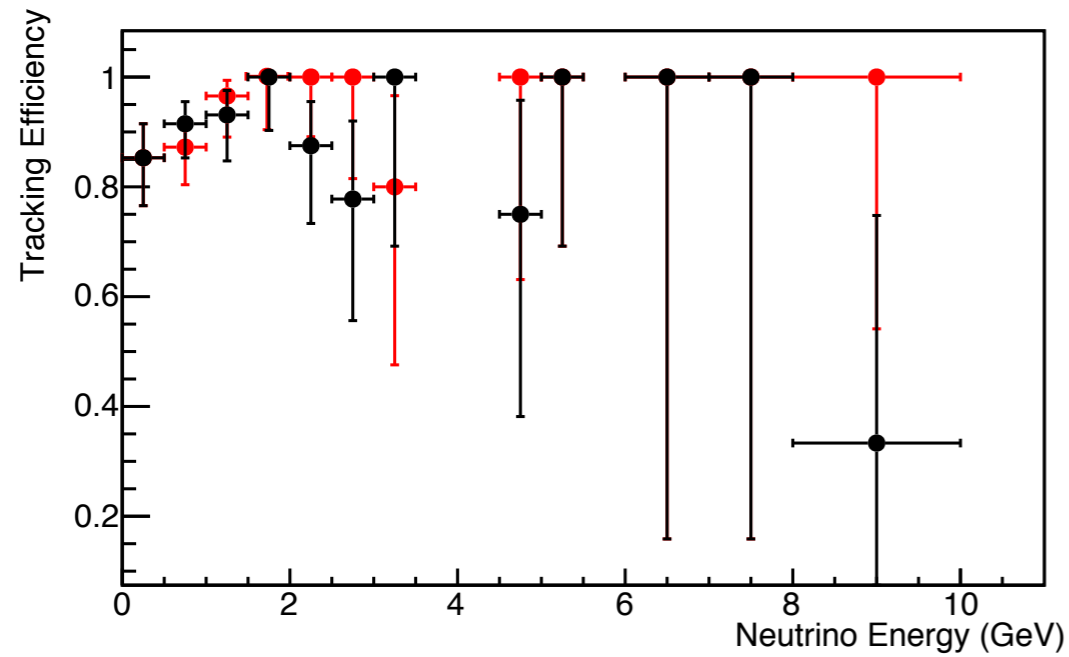


Efrac Lepton

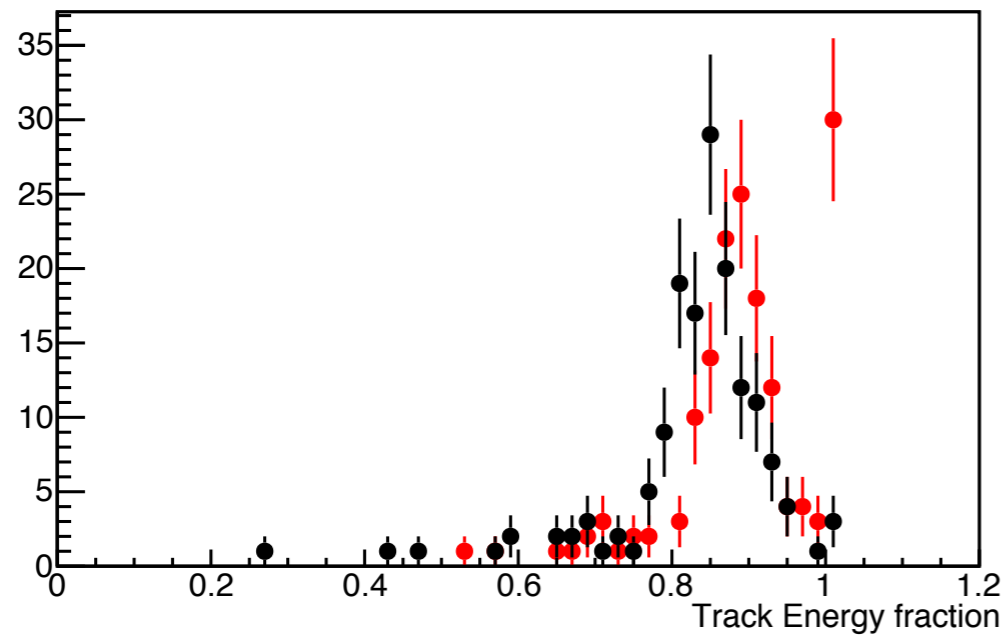


Atmospheric Neutrinos, μ^+ Tracking

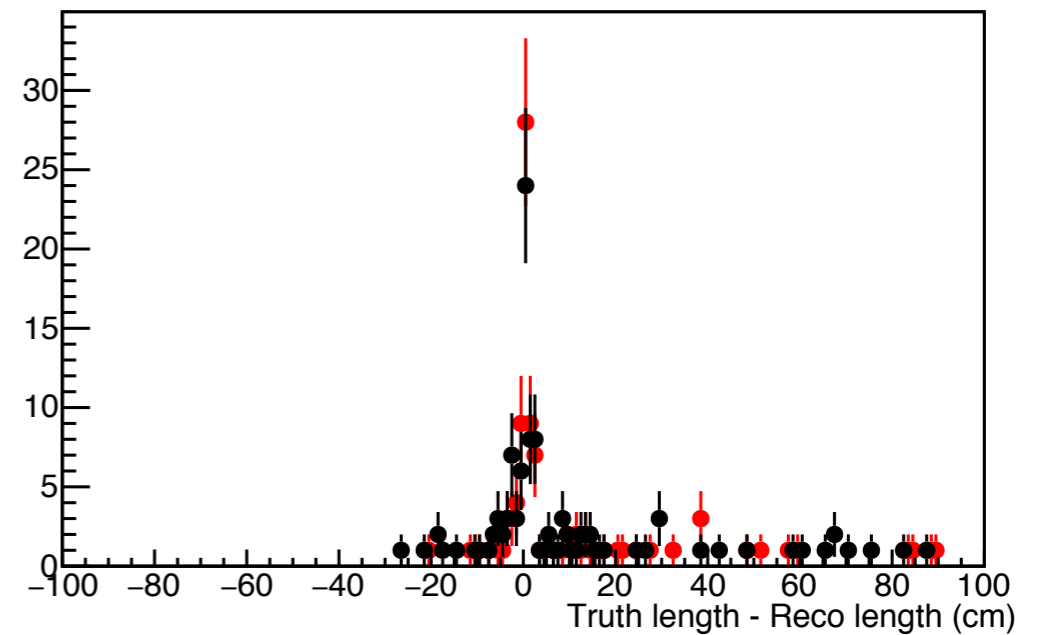
PANDORA
PMA



Efrac Lepton



Muon Residual



Comments

NeutrinoTrackingEff_module.cc, is a useful tool to look reconstruction performance

Capable of analyze CC ν_μ interactions (beam or atmospheric) it also looks at pion $^\pm$ and proton tracking performance from neutrino interactions

Capable of analyze $p \rightarrow \nu + K$ tracking performance for K, μ and michel electron

The End