

Analysis Tools Overview

Eric & Herb, MicroBooNE Collaboration Meeting, 9-October-2014

Outline

- Reconstruction summary
 - news since last collaboration meeting
- High-level AT news
 - Data Policy
 - MCC6 plans

Not on the agenda

- Tools proper (project.py, SAM, etc.)
 - please see Herb's/Sowjanya's Wednesday talks from dedicated session
- Simulation Summary
 - please see Kazu's talk from Wednesday
- MCC5 analyses
 - again, see talks from yesterday: Mindy, Leon.

Reco update

- Signal Filter
- muon momentum measurements
 - Range
 - Multiple Coulomb Scattering
- Pandora PFParticles
- CTrackMaker
- Calorimetry
- pi0 Showers

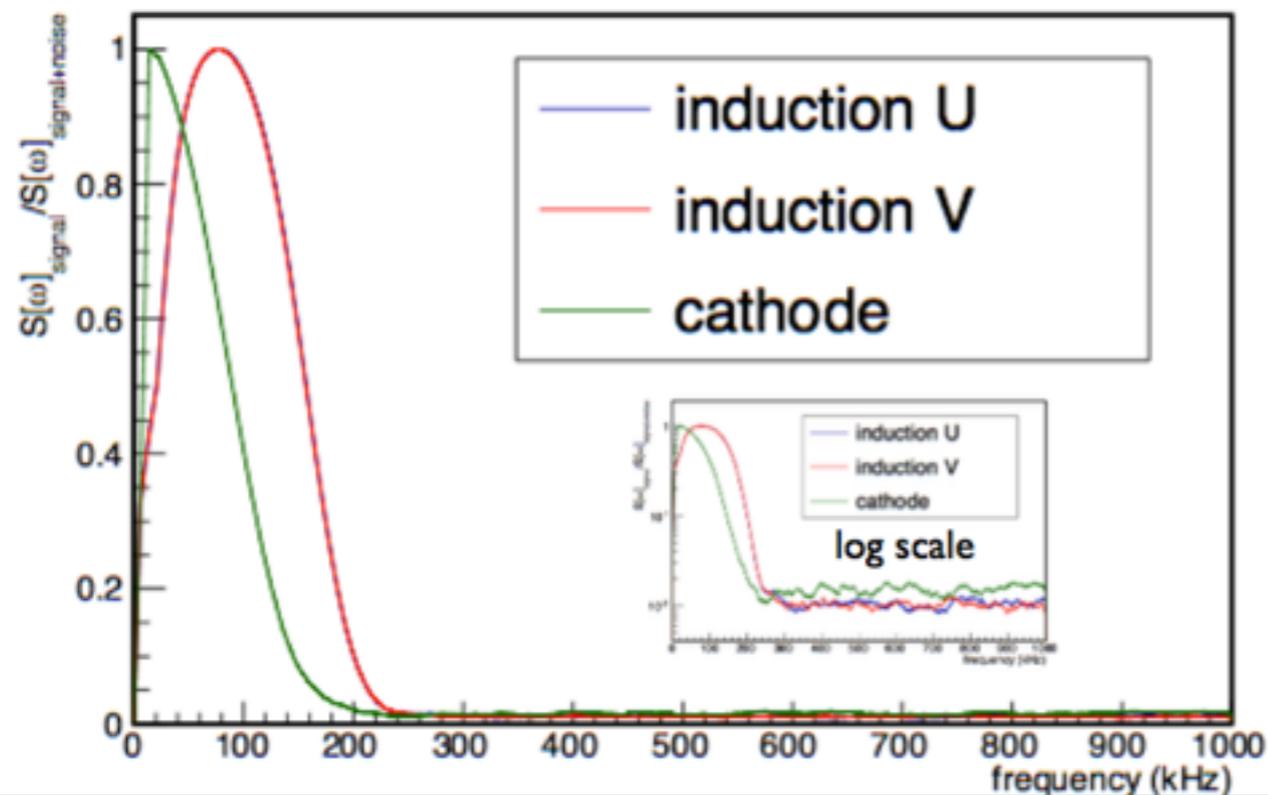
Filter

Post-MCC5, ready
for MCC6

$$\text{Solution: } S^2[g] = S^2[s]/(S^2[s]+S^2[n])$$

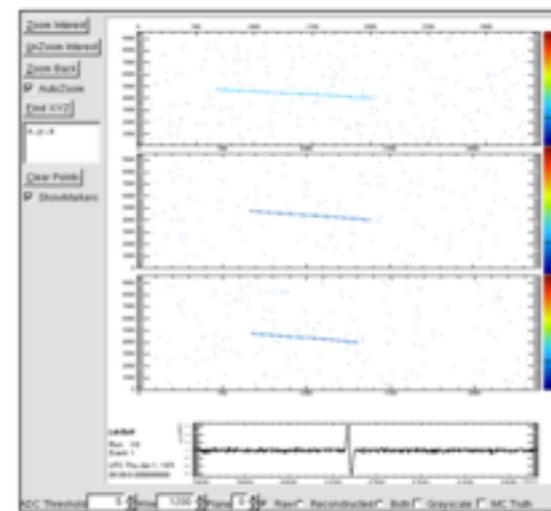
- Generated using 1 GeV muon, 7.8 mV/pC and 3.0 us (Not the chosen, final shaping time) shaping time

Wiener Filter

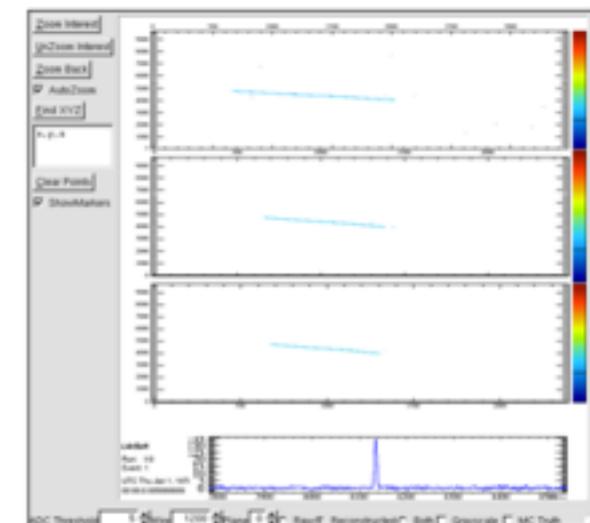


- (Applying filter to data not used for building filter)

Raw Digits



CalWire



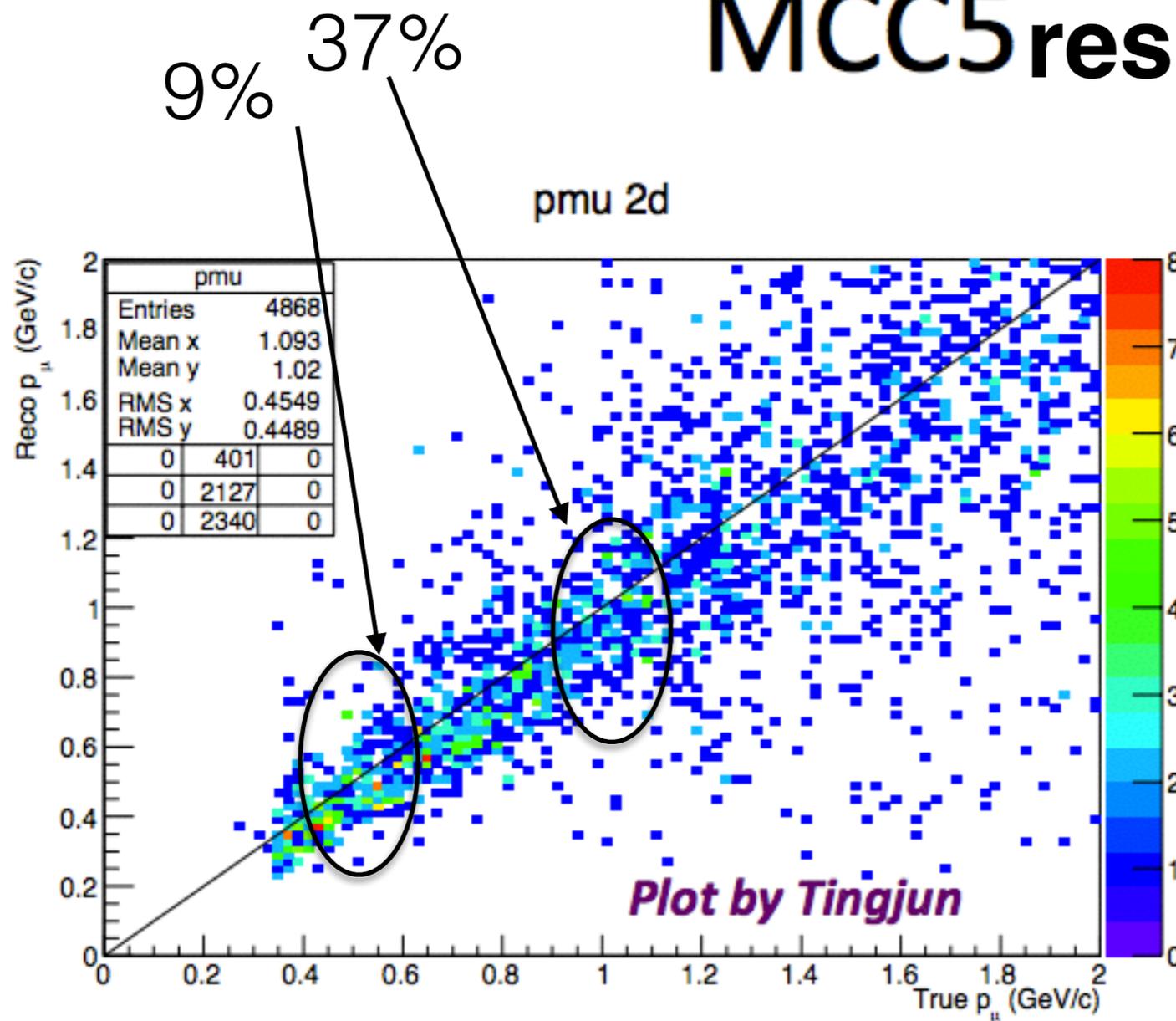
docdb3723 shows more details

After deconvolution: filter. All in CalData module,
first step of the Reco chain.

Taritree Wongjirad w Andrzej

MCS with non-contained tracks (at least 1.5m long)

MCC5 result



Likelihood

$$\Delta\theta_{ij} \longleftrightarrow \begin{cases} f_{ij} = f(\Delta\theta_{ij}, 0.0, \sigma_{ij}) \\ f(x, Q, \sigma) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-Q)^2}{2\sigma^2}} \end{cases}$$

- Energy can be updated along the track, say, $E_i = E_0 - (i \times \Delta s) 2.1 \text{ MeV/cm}$

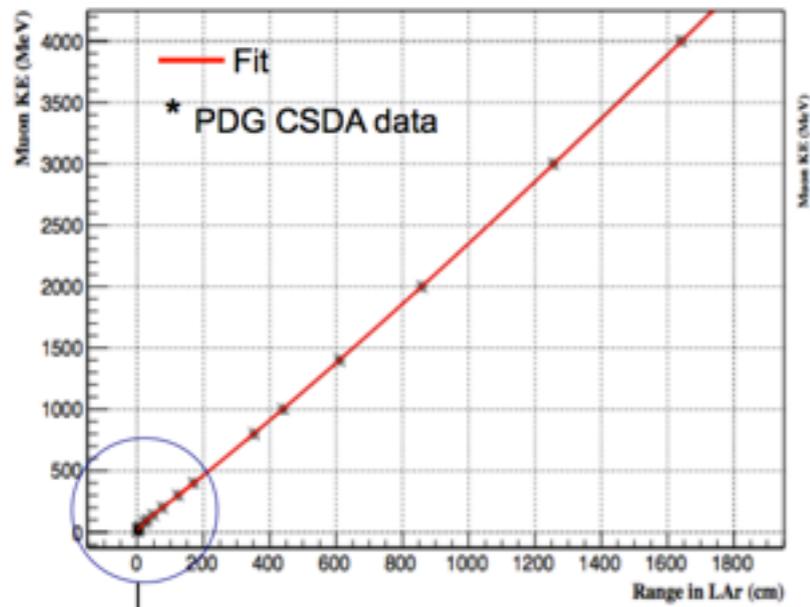
$$\mathcal{L}(E_0, \delta\theta_0) = \prod_{(i,j)} f_{i,j}$$

- Find the E_0 and $\delta\theta_0$ that minimize $-\log \mathcal{L}$

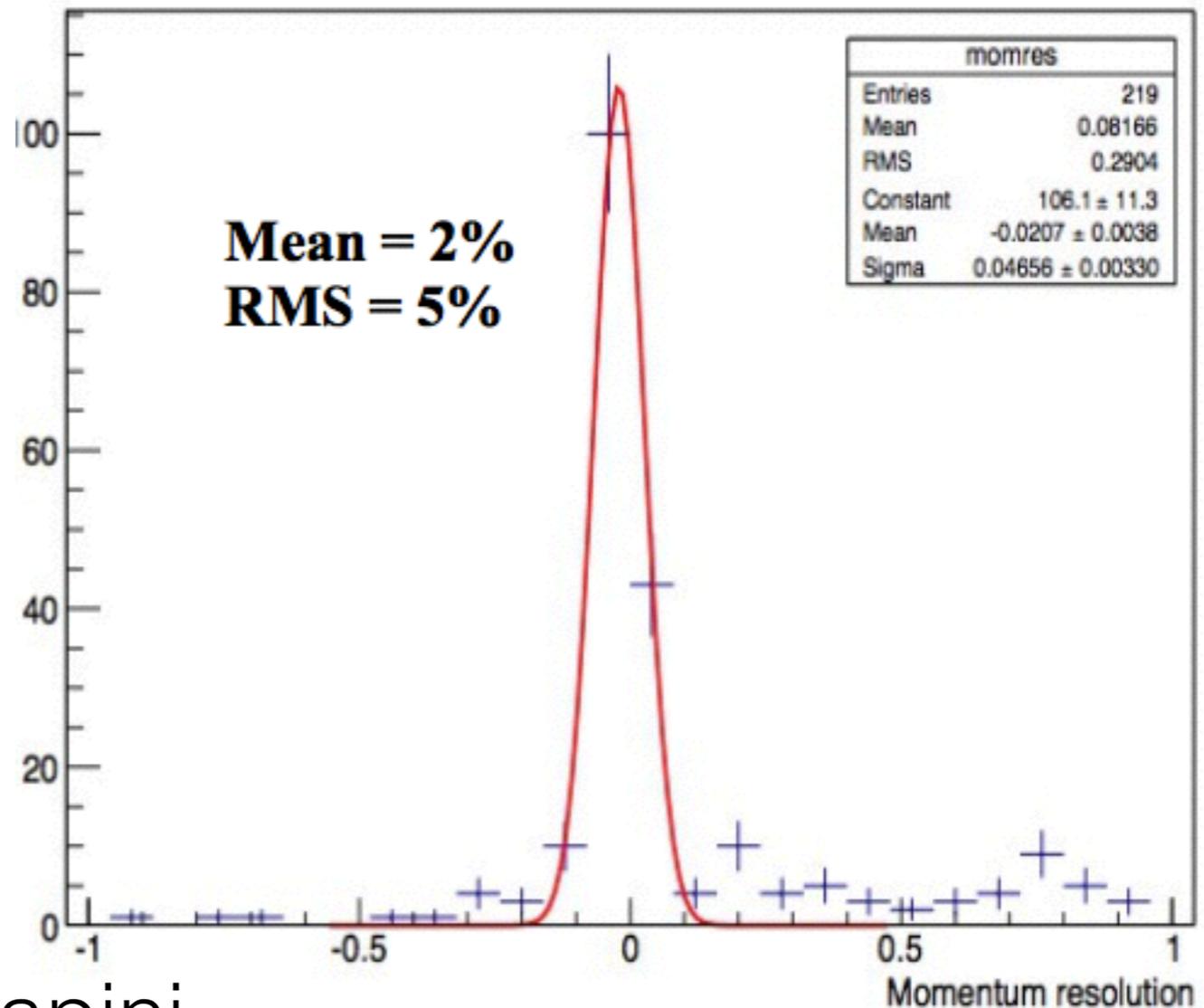
Independently: LK is working also on an ANN method

momentum from range

MUONS



$$\text{Momentum resolution} = (P_{\text{True}} - P_{\text{Reco}}) / P_{\text{True}}$$



Sowjanya Gollapini

Pandora 2-pass

MCC5+

reconstruction

docdb3754

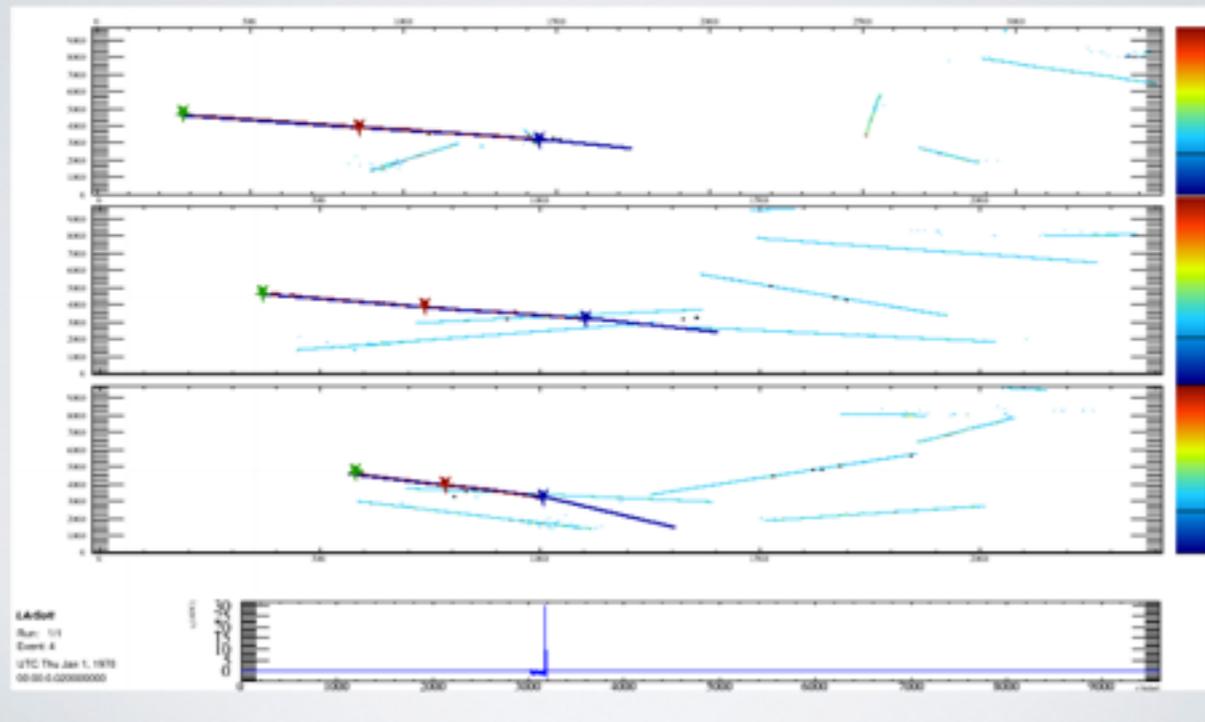
PANDORA TWO-PASS RECONSTRUCTION

- For details refer to Andy Blake's presentation at last week's Analysis Tools meeting - docdb 3734-v1
- Basically...
 - Now able to run two instances of the pandora toolkit in one art job, allowing for a "two-pass" reconstruction:
 - First pass optimized to reconstruct cosmic ray muons
 - Second pass optimized to reconstruct neutrino interactions
 - The output of both passes are PFParticles
 - At the end of the first pass, the resulting candidate CR muon PFParticles can be sent through the normal reconstruction
 - Track fits performed
 - run the CR taggers CosmicTrackTagger and BeamFlashTrackMatch
 - Idea is after the CR taggers run to remove the hits associated to CR muon CRHitRemoval PFParticles before running the second pass neutrino optimized reconstruction

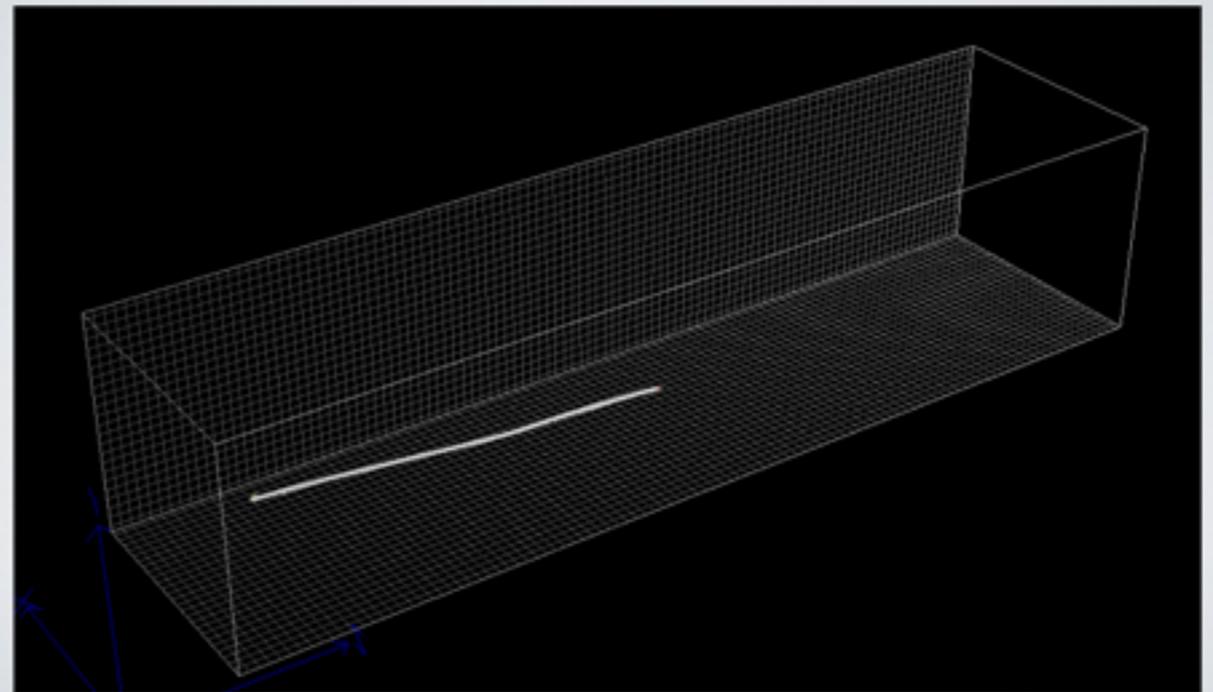
Tracy, Andy, John, Wes, Sarah, Herb, Sowjanya, Ben J, Jonathan

Cosmic tagging 2

“CLEAN” EVENT AFTER CR REMOVAL



“CLEAN” EVENT AFTER CR REMOVAL



9.5/10.5 rejection of CRs in 3 windows. (7.8 of 9.5 are “easy”)

6% rejection of Neutrino evts

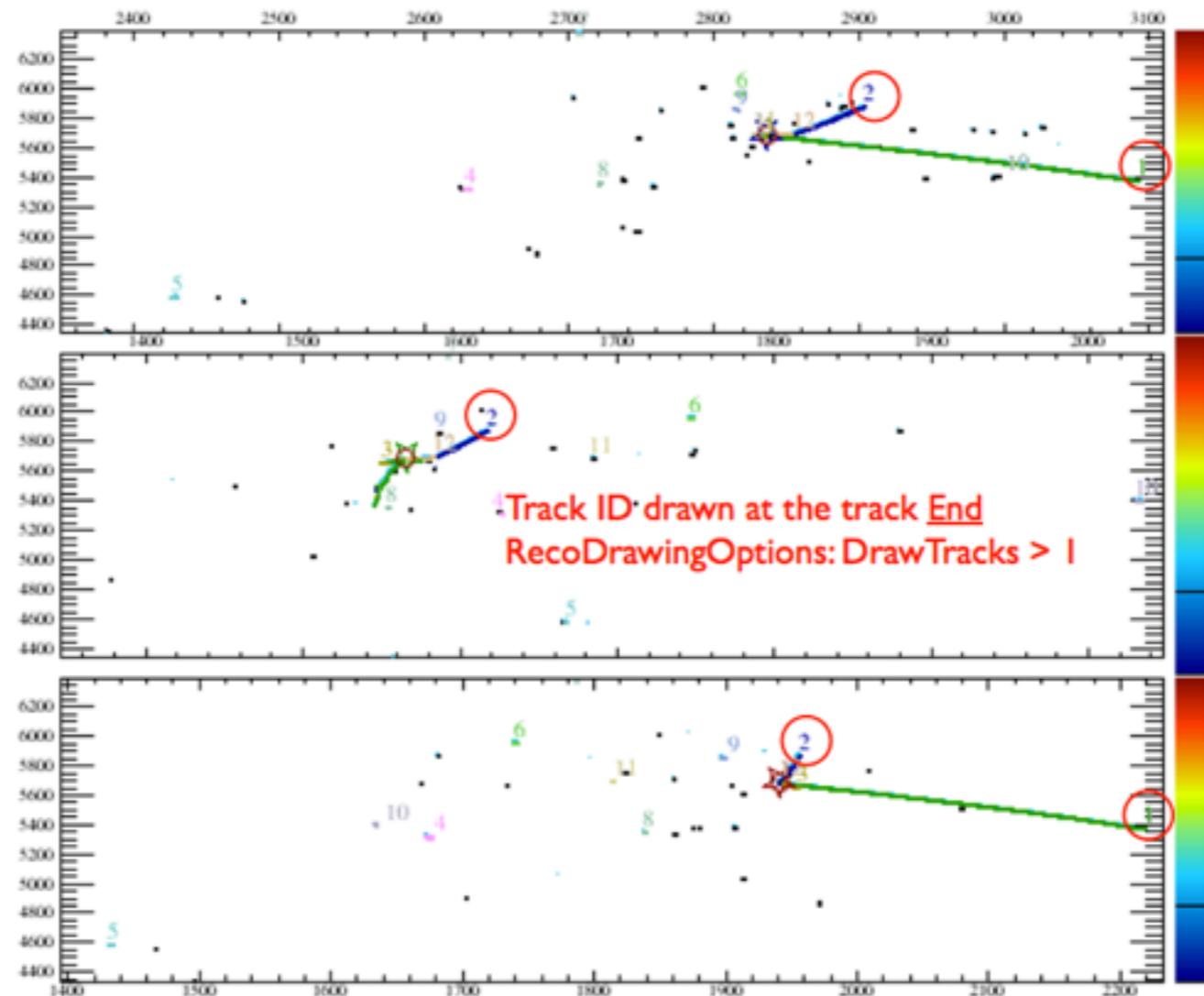
(10.5 is the factor 2-3 low we’ve been talking about today...)

CCTrackMaker

beyond MCC5

Makes tracks from *ClusterCrawler clusters*, vertices. Advertises to determine track direction from charge.

For the crowded environment around the vertex and proton
+ many tracks.
+ ... in its early days



Bruce

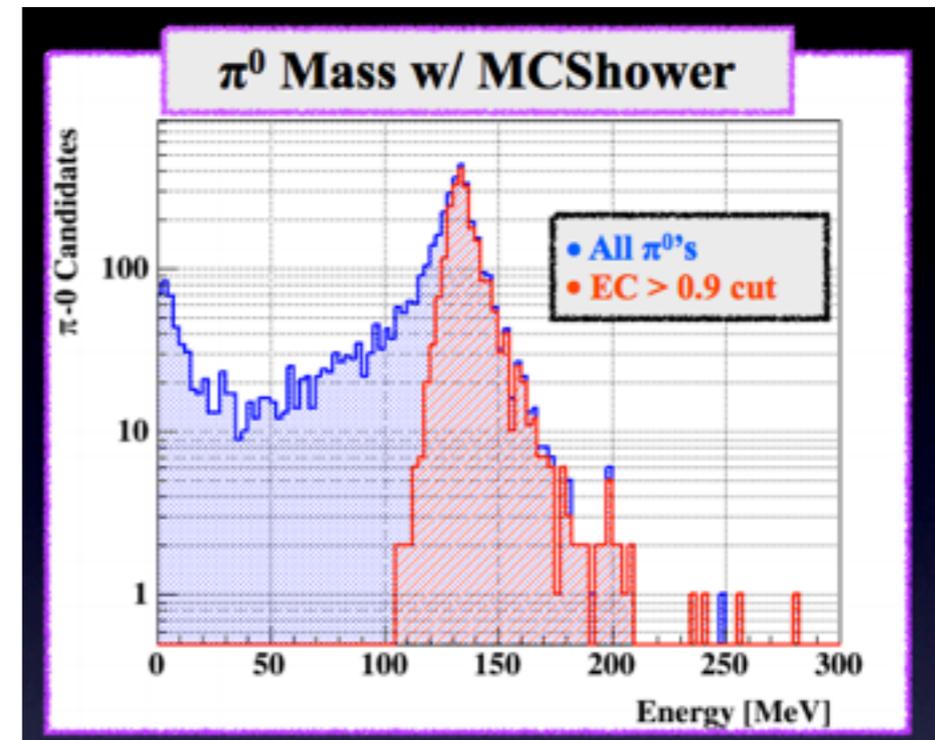
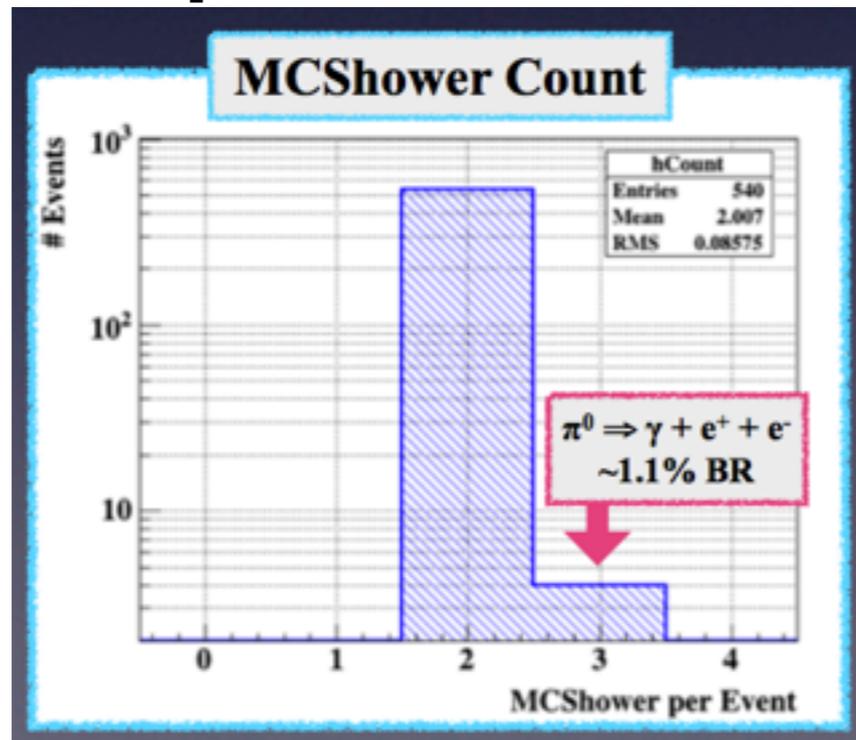
requires new members in `recob::Cluster`

MCC5-era LArLight sample

Much intense effort recently

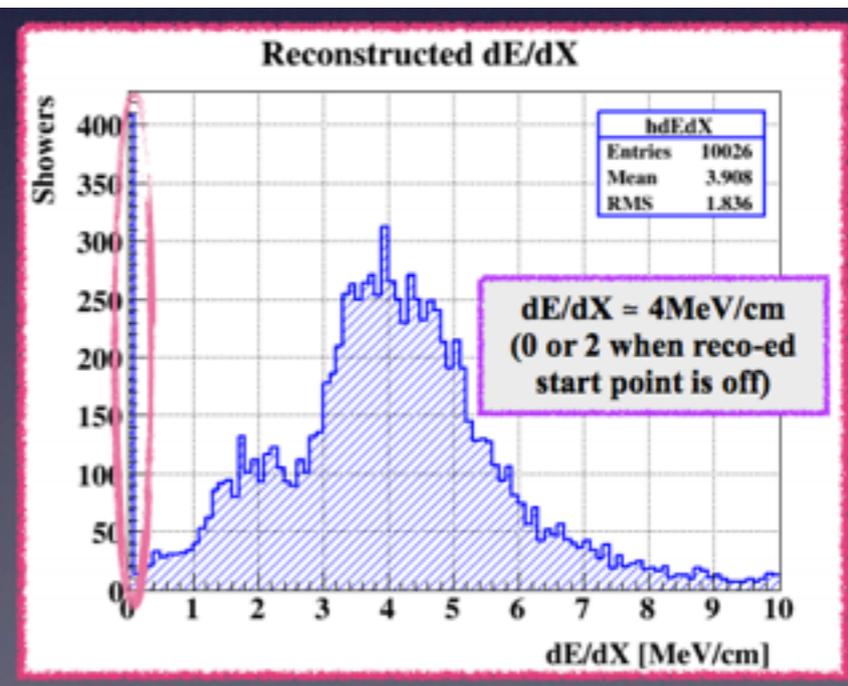
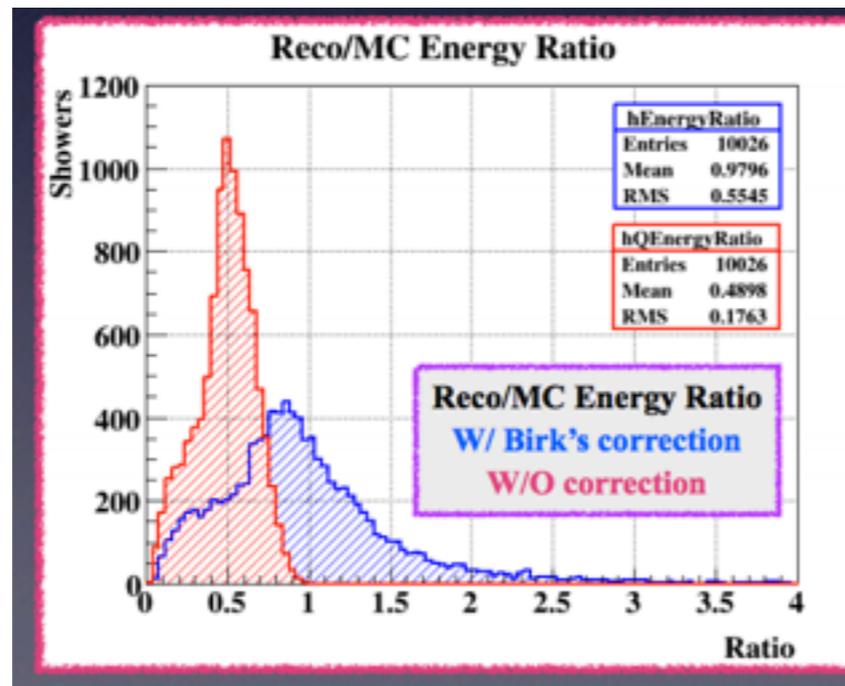
π^0 reconstruction

π^0 s



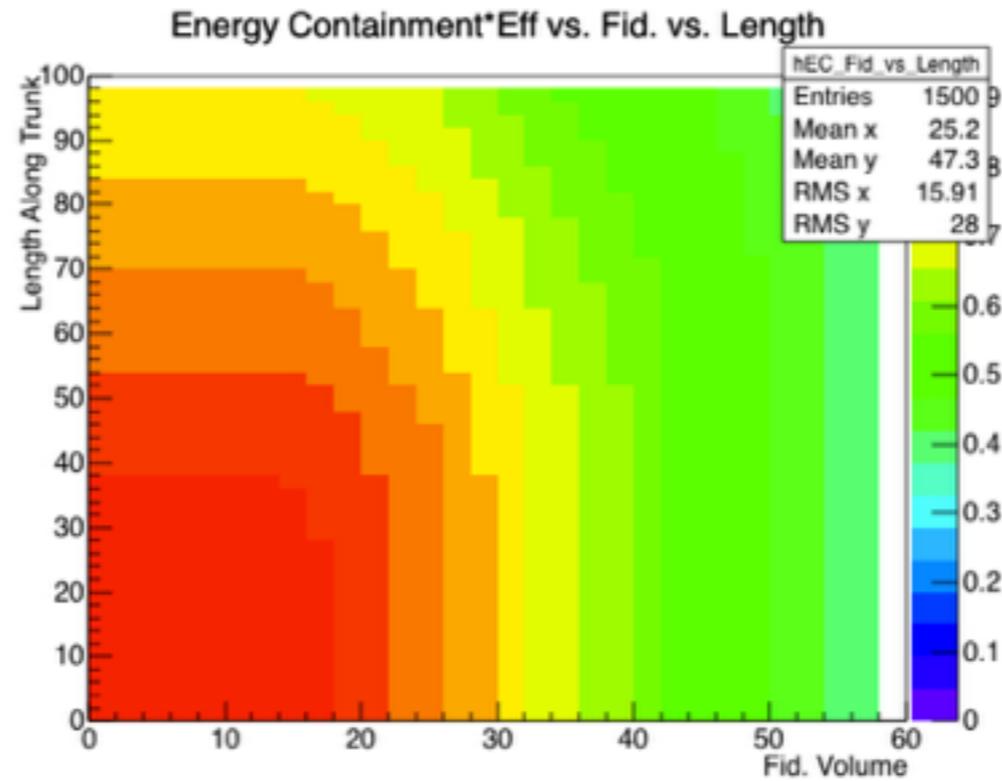
8-9%

gammas

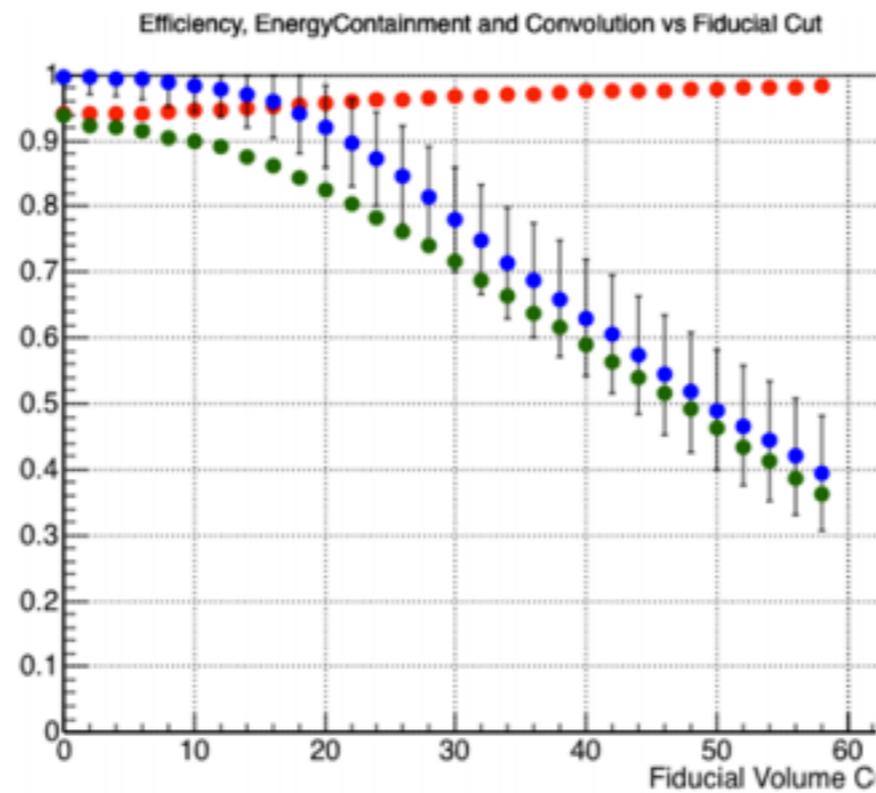


pi0 reco continued

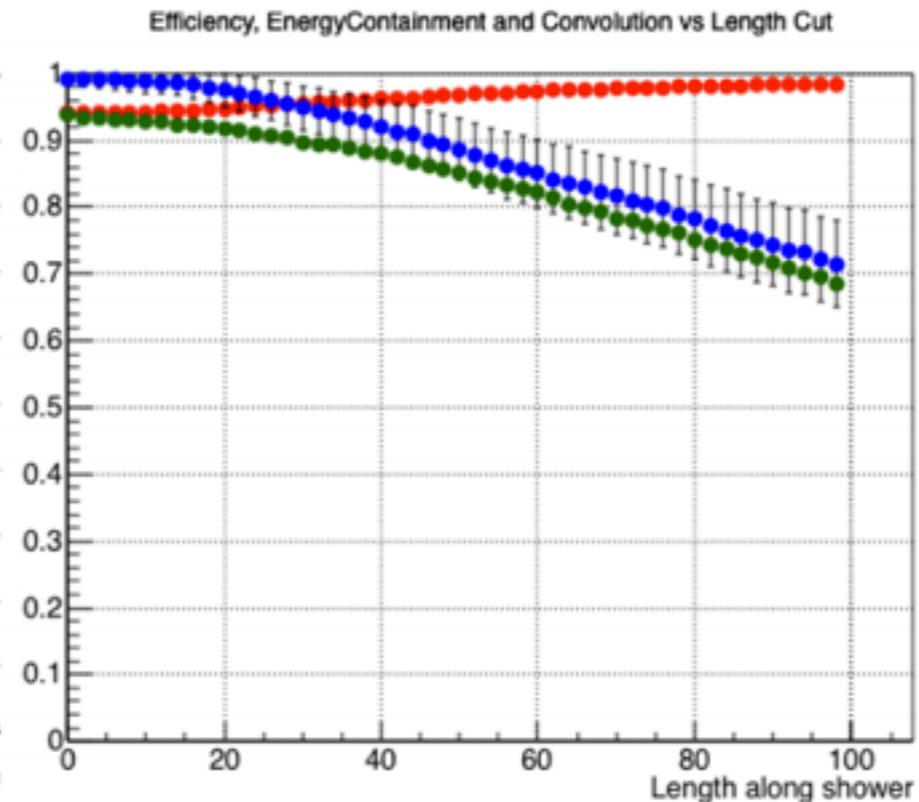
A better cut
than naive FV



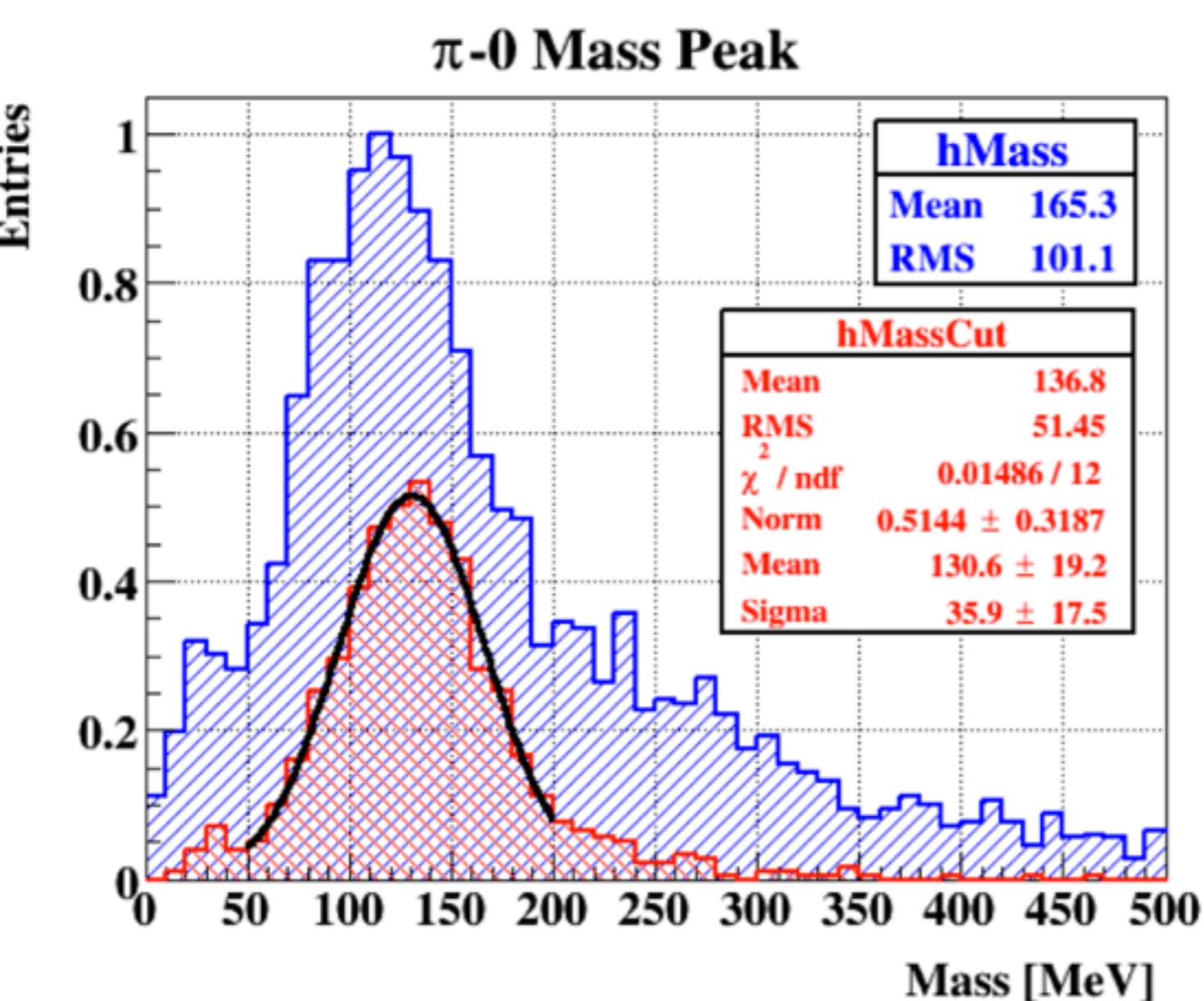
Fiducial Cut



Length Cut



pi0 reco continued

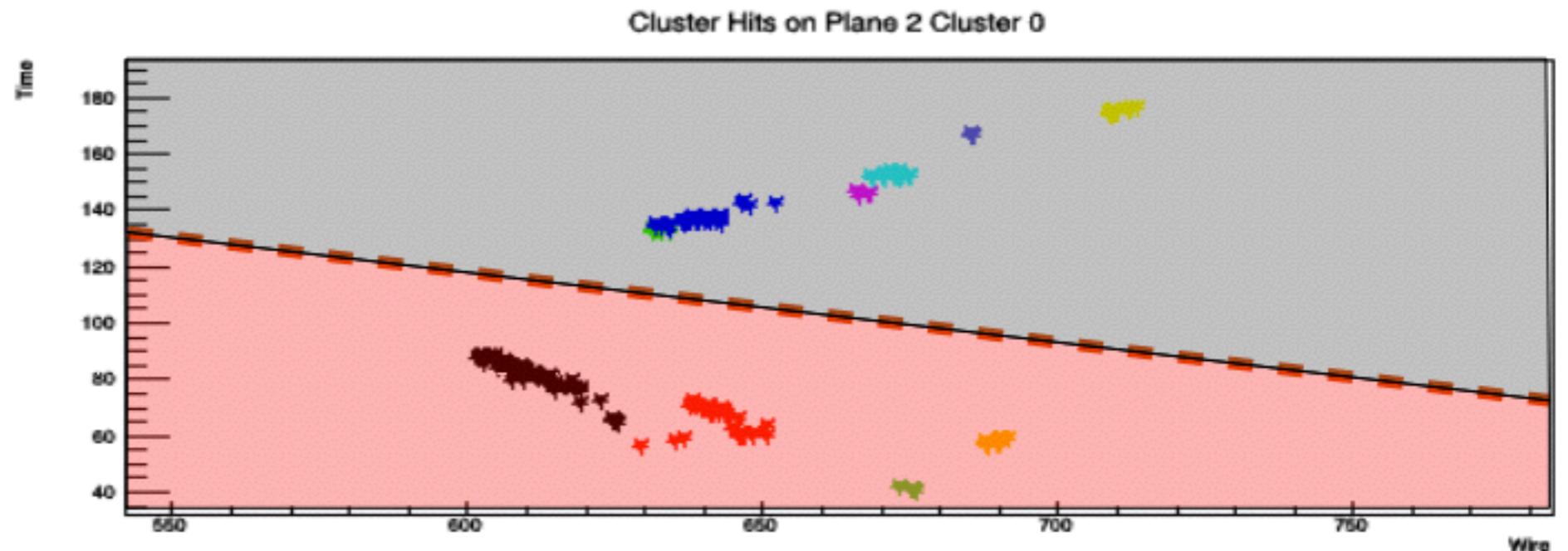


- π^0 Mass Peak
- Using 1e4 single π^0 MC
 - Energy/Angle uses bnb distribution
 - Generated uniformly inside TPC
 - Using Merged-FuzzyCluster
 - w/ Jonathan's GausHit
 - after track/shower separation cut
 - Applied energy correction
 - Known issue
 - Used single e^- for correction
 - **Blue:** ALL events w/ 2 showers
 - **Red:** After analysis cut
 - Only asking opening angle cut
 - Stat reduction $\approx 1/3$

pi0 recon contd 2

Another approach:

In a single pi0 MC sample, force shower separation in at least two planes

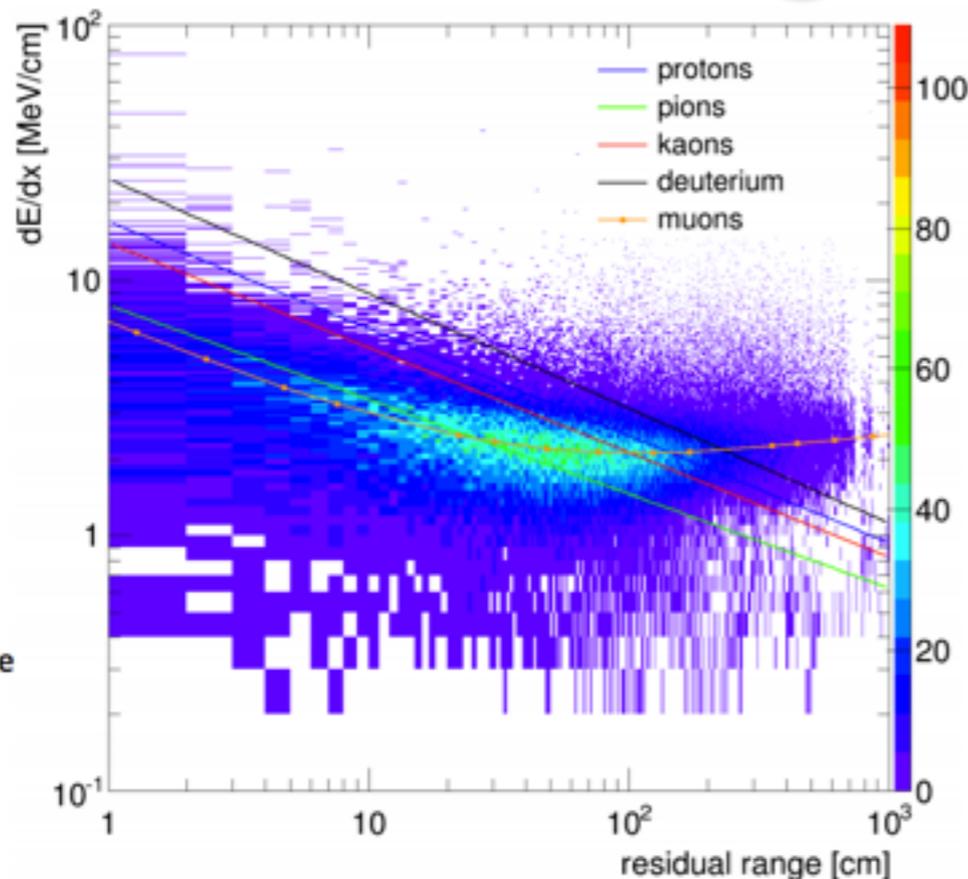


cluster matching in each view is a whole other subject that's received a lot of attention of late.

Calorimetry

The calibrated version: energy loss vs residual range - plane Y

in MCC5



This process took 4 iterations of reconstructing/calibrating to converge

Reached < 0.3% for stability of constants

Calibration constants for area mode:

microboone_calorimetryalgmc.CalAreaConstants: [7.488e-3, 5.110e-3, 1.008e-2]
MeV/ADC

Calibration constants for pulse height mode:

microboone_calorimetryalgmc.CalAmpConstants: [9.573e-4, 6.868e-4, 1.382e-3]
MeV/ADC

These calibration constants are in larana/Calorimetry/calorimetry_microboone.fcl

These constants are derived for the combination of GausHitFinder with trackkalmanhit. The constants have been observed to vary between hit find track reconstruction algorithms by up to 12%.

Anne Schukraft and Tingjun Yang

2nd Part of Talk

- Analysis Tools matters — high level

Data Policy

- Our data from the LArSoft MCCs is output into so-called recob and anab data objects.
 - recob and anab are the namespaces. These persistent data objects, especially in recob::, are considered “sacred,” and changes are to be proposed and reviewed — within the AT group, but also by the LArSoft project.
- The AnalysisTree that emerges from the MCCs is a ROOT TTree.
 - A handy “DST” for use in, say, a (py)ROOT Macro.
 - Wholly owned by MicroBooNE AT. It has not been regulated. Variables output probably due for a review.
- LArLight
 - It has a sizable number of users who now present results in the Osc and Xsection groups, at least
 - Faithfully puts its data into LArSoft recob objects.
 - Supported by LArSoft project now

Data Policy: reliable data

- There has been concern expressed, rightly, that as data arrives we need to be confident that the analysis results as presented are reproducible by multiple people in the collaboration, across time.
- We are in need of a recob data object review. More on this in a bit.
- AnalysisTree should perhaps face similar scrutiny and a high bar for changes.
- LArLight runs should go concurrently with the LArSoft MCC runs.
- Metadata should be attached to AnalysisTree and LArLight objects and data pushed to enstore, which has not yet been done, that diligently records build, geometry, and runtime conditions, etc. This is not so hard; a new body or two here could take this on.

Policy: recob Review

- Separately, a recob data object review is advocated by the MicroBooNE AT, and LArSoft team is taking this on.
- Desires
 - Remove ART objects as members — `art::Ptrs`, `art::PtrVectors`
 - Be sure all needed members are included
 - Consistency of members produced by similar algorithms for interpretability/use

recob example changes

- Cluster objects
 - lose dQdW, totalCharge
 - Add cluster end parameters
- Wire,Hit objects
 - lose the `art::Ptr<RawDigit>` => non-backward compatible: MCC5 recon becomes obsolete.
 - replace with ChannelNum
- Track
 - Need overall χ^2
 - Need to agree on discrete representation of smooth parametrization
 - Should accommodate multiple momentum measurements
- Shower ...

into MCBase

- MCHit
- MCTrack
 - as yet, non-existent
- MCShower
 - truth level G4 track shower membership

MCC6

- We finished MCC5 — always a formidable exercise — just a few weeks ago.
- Data comes soon — say, February
 - any data object changes must be cemented by then
 - MCC6 and data output should correspond to tuned data structure and state of the art reco/sim at that time.
- Yes, objects can be augmented by version number incrementing, but let's avoid as much of this as possible.

MCC6 - continued

- Pandora objects (PFParticles) usage in downstream algo's did not make it into MCC5 — narrowly. It's ready now. e.g., Calorimetry, would use these tracks
- TrackFlash matching improvements
- Shower reco improvements should go in
- New PMT Geometry and corresponding photon lookup library
- Final ASIC settings set, but are hit thresholds optimal, e.g.?
- Garfield-inspired wire signal shaping response perhaps...
- MCShower, MCHit need to be added.
- other changes?
- mid-January, 2015?