



# LArSoft/Tools Update

Eric/Herb  
6 Sep, 2012

# Outline

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- LArSoft reconstruction developments since last meeting
- Frozen LArSoft Release
- uBooNE codebase
- tasks

# This Time

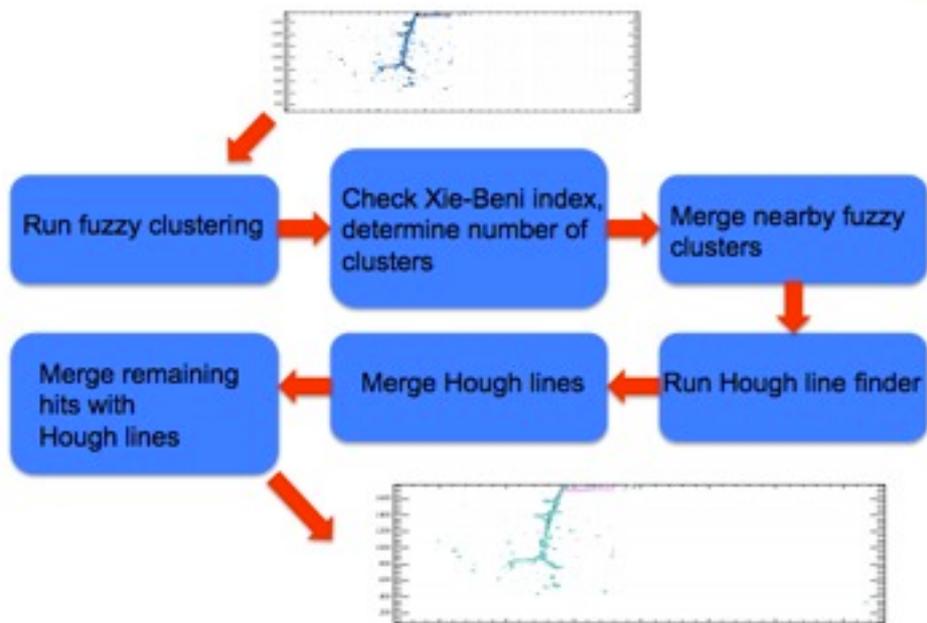
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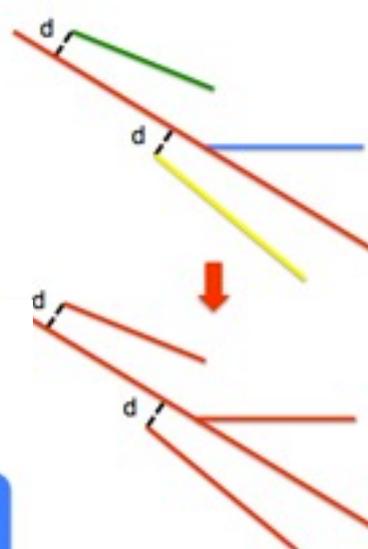


# Fuzzy Clusters

Ben Carl's work



## Showers with Hough lines

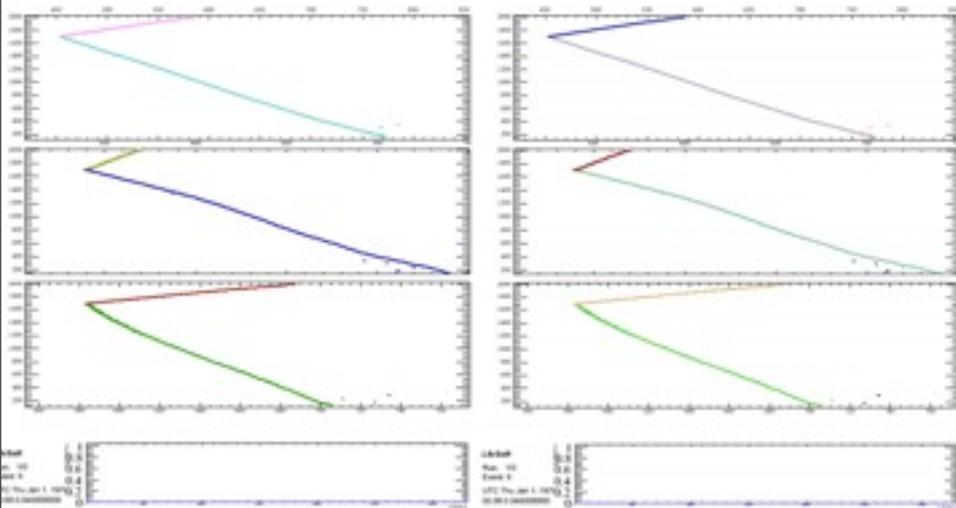


Hough line finder very effective at finding lines in showers

Now aiming to capitalize on this, merging Hough lines together to construct showers

Merge Hough lines using the distance between the line segments and angle between slopes  $< 20^\circ$

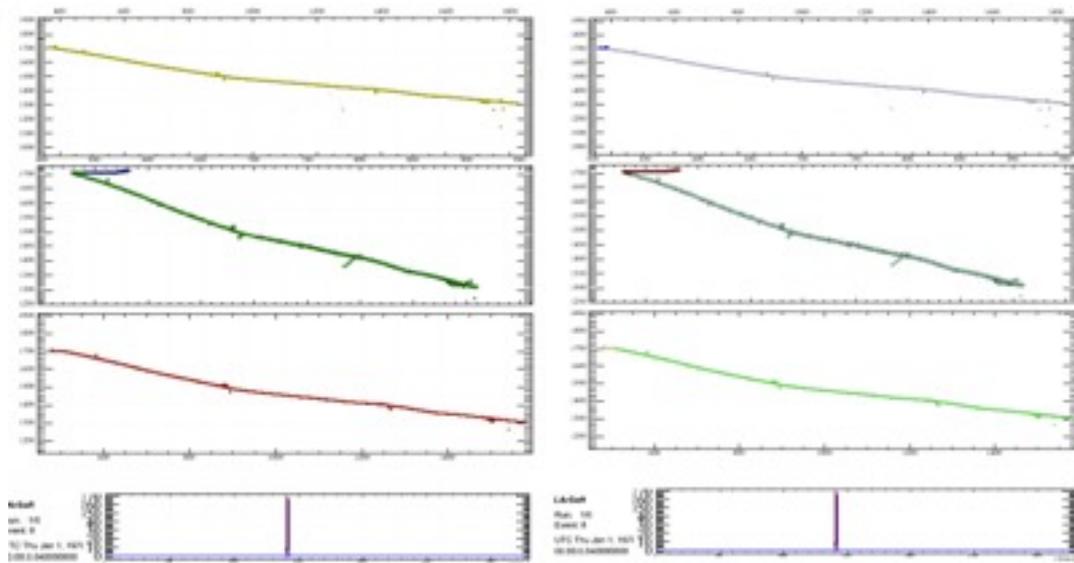
# Fuzzy 2



numu CCQE

Fuzzy and Hough line clustering

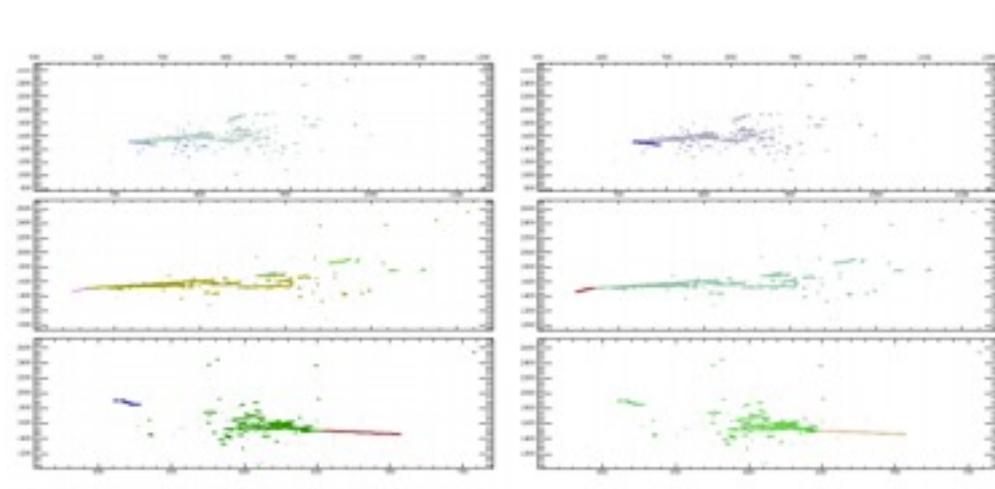
Cluster cheater



Fuzzy and Hough line clustering

Cluster cheater

# Fuzzy 3



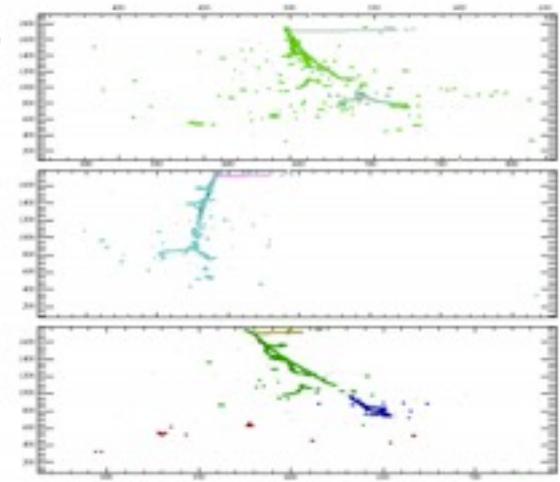
nue CCQE



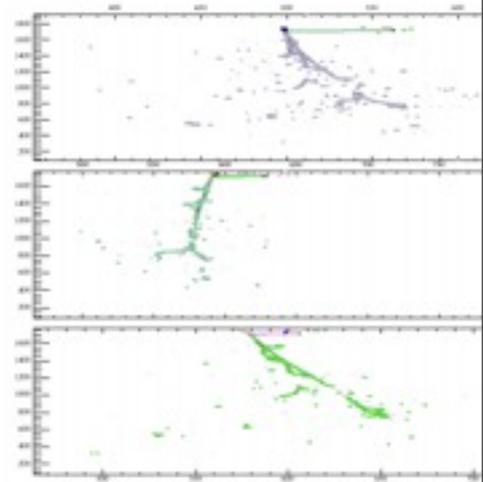
Fuzzy and Hough line clustering



Cluster cheater



Fuzzy and Hough line clustering



Cluster cheater

- Tingjun and Brian R, to hold data from an analysis. So far, Calorimetry and pID

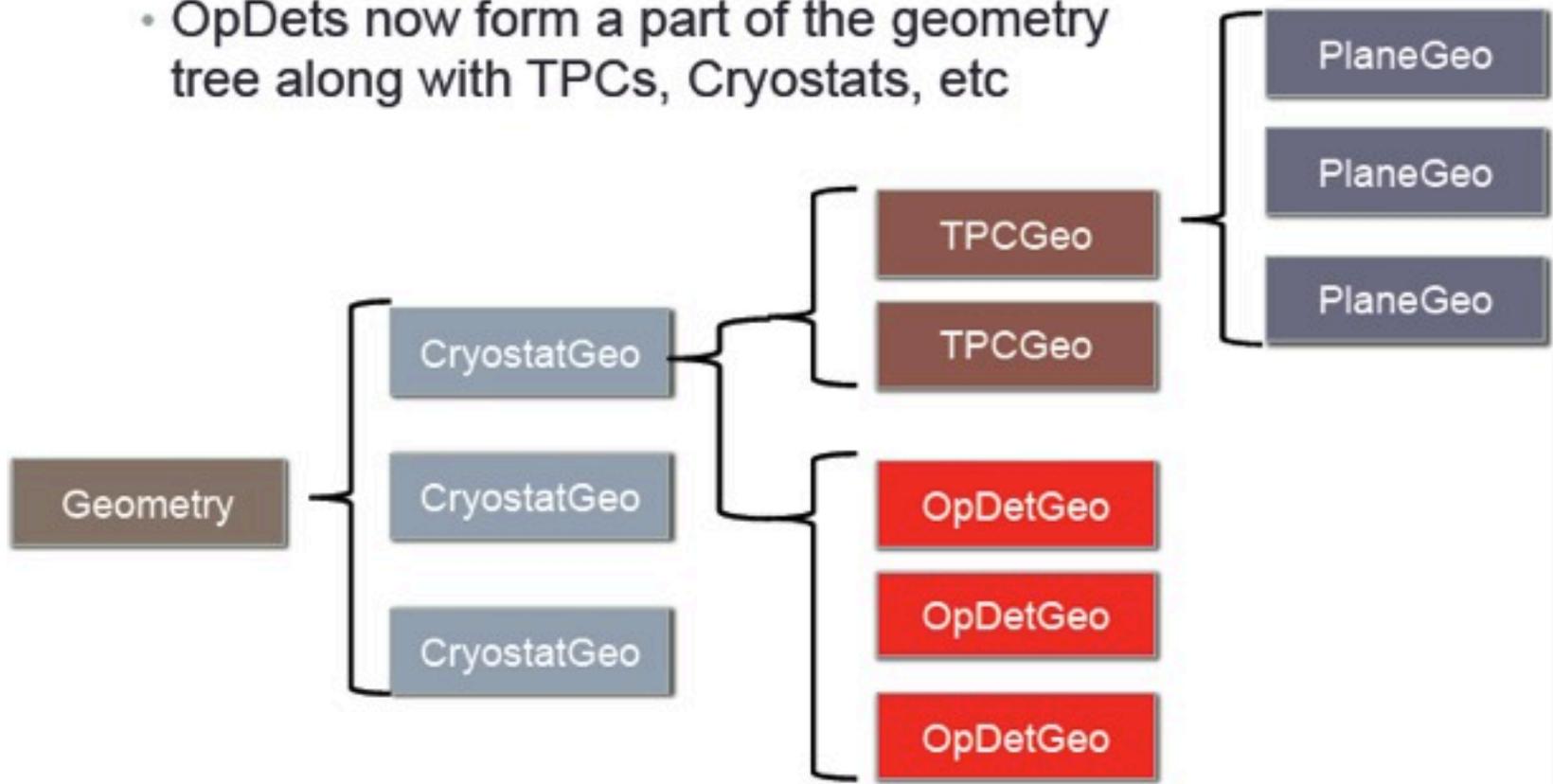
## anab::ParticleID

- A module to save particleID information.
- int **fPdg**; ///< determined particle ID
- int **fNdf**; ///< ndf for chi2 test
- double **fMinChi2**; ///< Minimum reduced chi2
- double **fDeltaChi2**; ///< difference between two lowest reduced chi2's
- double **fChi2Proton**; ///< reduced chi2 using proton template
- double **fChi2Kaon**; ///< reduced chi2 using kaon template
- double **fChi2Pion**; ///< reduced chi2 using pion template
- double **fChi2Muon**; ///< reduced chi2 using muon template
- double **fMissingE**; ///< missing energy for contained particle
- double **fMissingEavg**; ///< missing energy from average of hits
- Added association between anab::ParticleID and recob::track.
- There exists a module ParticleIdentification/Chi2ParticleID that does particle identification based on calorimetry information and saves particleid information to art::event.

# Reorganized Optical Detector Module

## geo::OpDetGeo

- OpDets now form a part of the geometry tree along with TPCs, Cryostats, etc

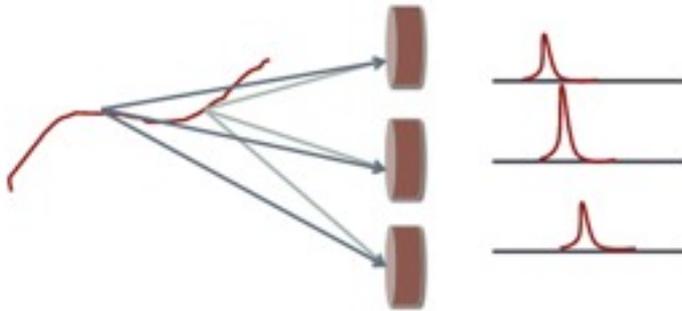


# Optical Detector 2



## TrackTimeAssoc

- Analyzer in the OpticalDetector package
- Make a quick hypothesis for the light from each track in the event per PMT
- Step along a bezier track in uniform intervals, querying the visibility at each point and multiplying by local dQdx.
- Light production can be dropped by quenching function. Visibility and quenching are both controlled by the PhotonVisibilityService

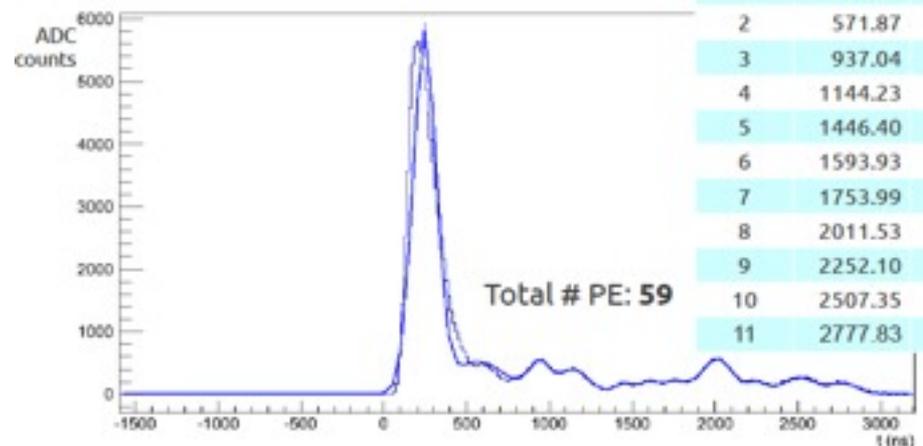


Christie Chu:  
59 pe, and as many  
as 6-7 sub-events  
detected. 7 overlaid  
muons.

BJPJones: On its way. Building  
photon library now.

## Data extraction

Use pulse area to find # of PE



Peak #	Time (ns)	# PE
1	244.57	35
2	571.87	7
3	937.04	3
4	1144.23	3
5	1446.40	1
6	1593.93	1
7	1753.99	1
8	2011.53	4
9	2252.10	1
10	2507.35	2
11	2777.83	1

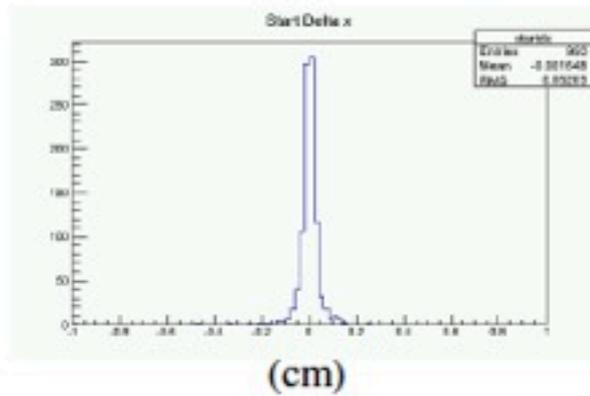
# KalmanHit 1



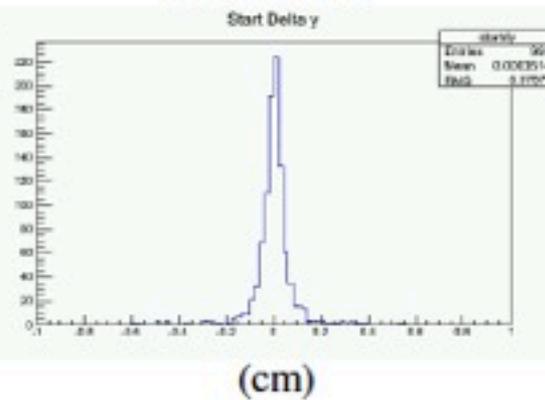
## Track Start Position Resolution

**Herb** gets 0.5–1.5 mm resolution on Track start point.

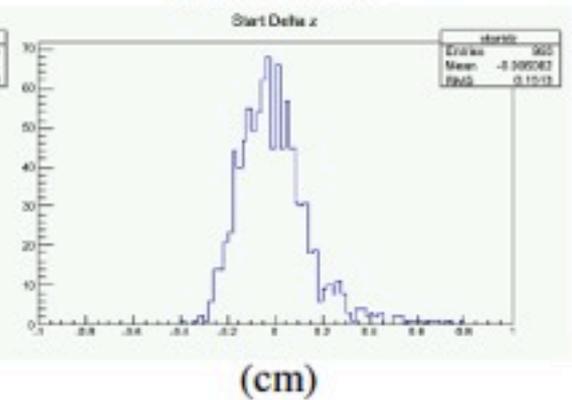
X Resolution



Y Resolution

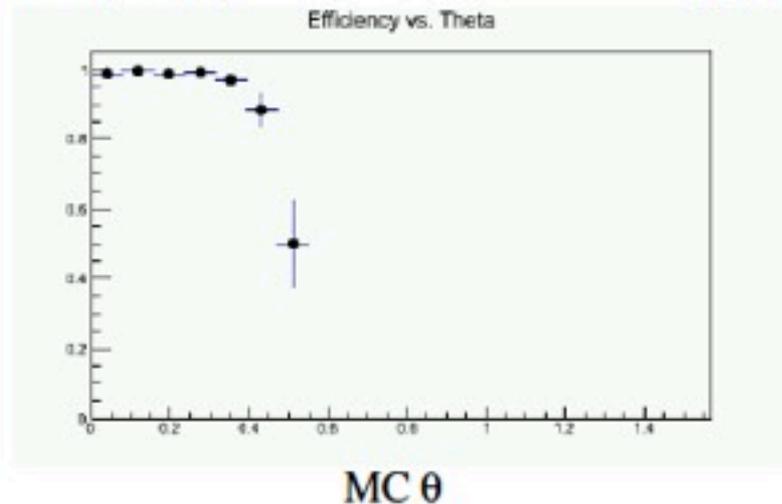
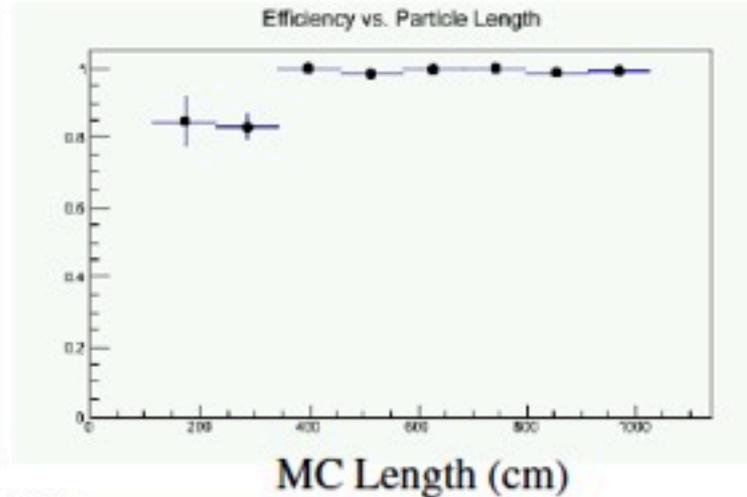
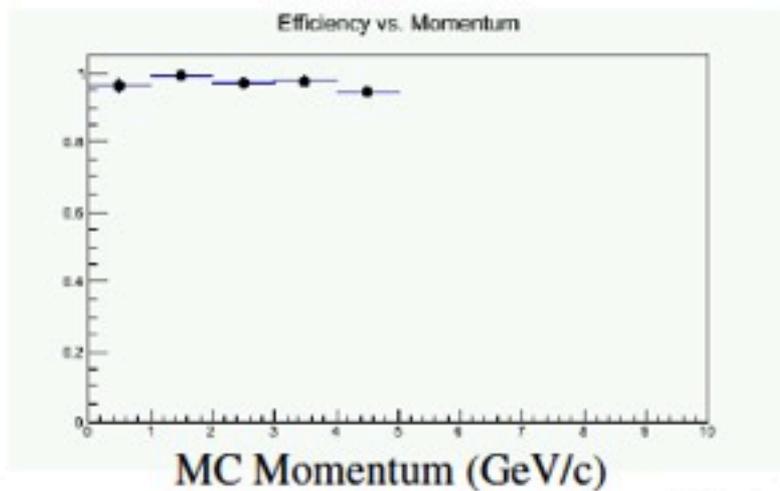


Z Resolution



single muons of varying momenta

## Track Efficiency

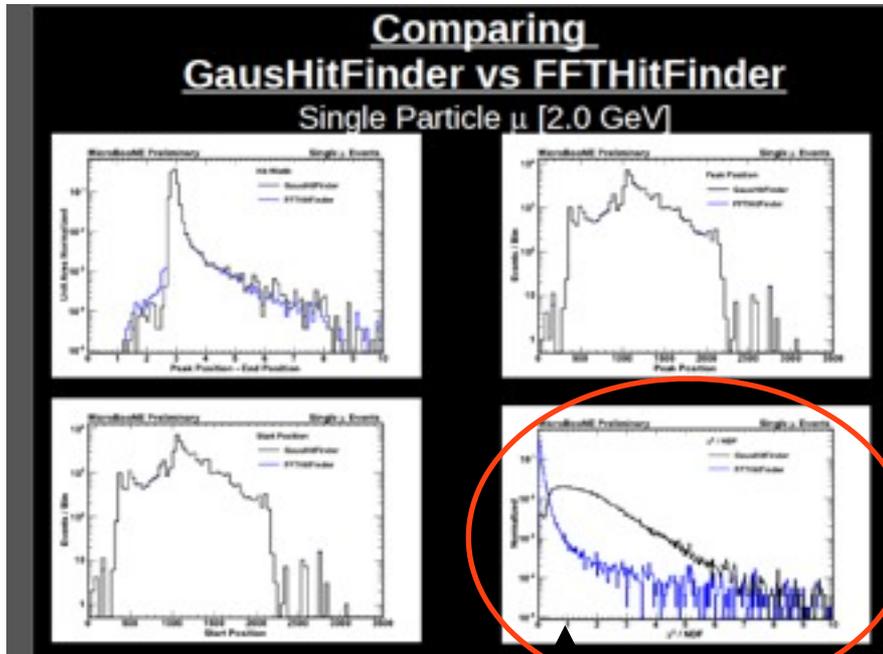


Pulls (not shown here) give results consistent with correct sized measurement errors attributed.

# GausHitFinder (sic)

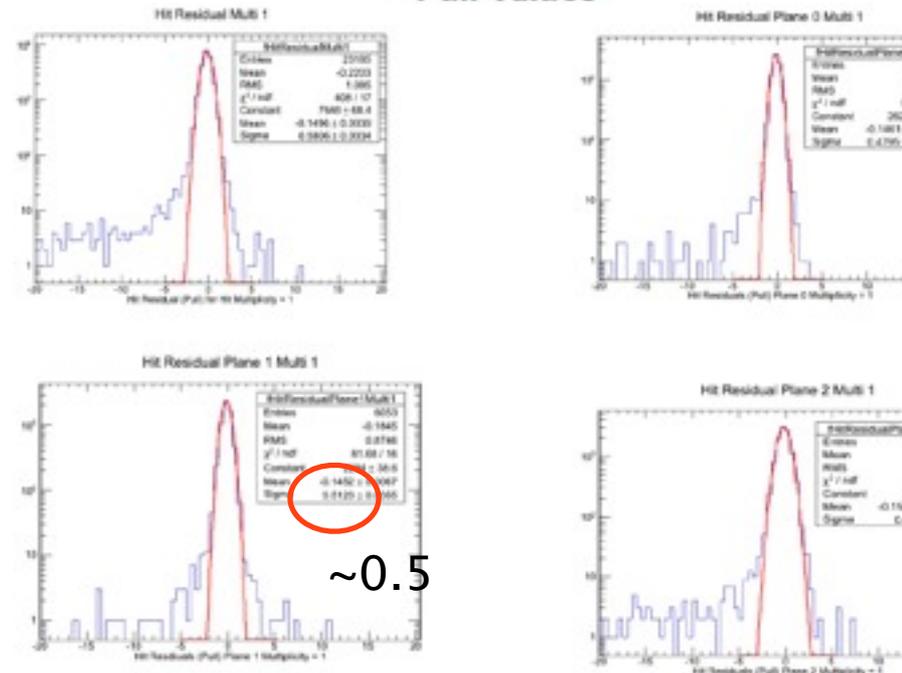


Jonathan's algorithm to properly characterize Gaussian (sic) hit fits. Gives reliable chi2 and hit multiplicity



1.0

## GausHitFinder Pull Values



~0.5

Jonathan has now added Pulls. (In fact, he sees that his currently assigned hit width errors are about 2x too large.) Seems ready for primetime.

# HandScan Tools 1a (Showers)



- Andrzej's EVD Analysis tool: <https://cdcv.s.fnal.gov/redmine/documents/537>

## How it works (Cluster Finding Version)

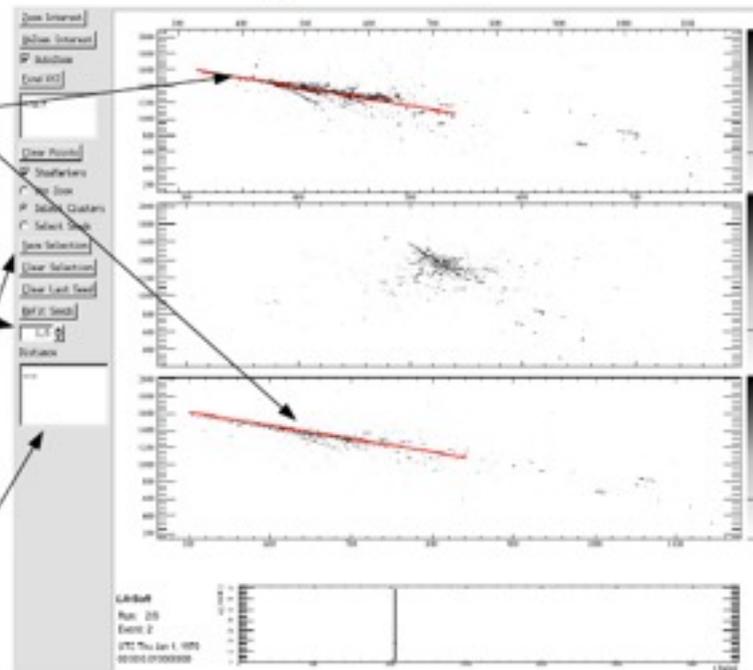
*Draw lines around track or shower axis. It will appear in Red.*

*Set the width of the box if you think it's too big/too small (it's sort of in cm)*

*If you're happy with your selection – Save it.*

*3D angles and estimated length of track will appear here.*

09.05.2012



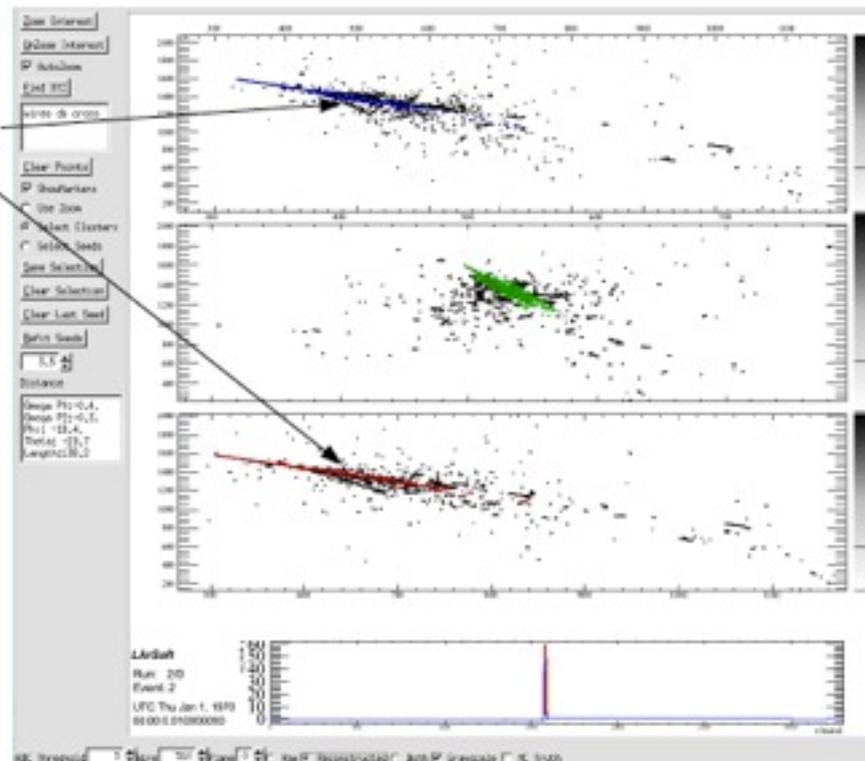
# HandScan Tools 1b



## How it works (Cluster Finding Version)

*The Event has rerun and GraphCluster has produced shiny new Clusters that you can display, if you so choose in RecoDrawingOptions.*

*These clusters could have been passed on to further producer modules down the stream. For an Example, see next slide:*



09.05.2012

# HandScan Tools 2a

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- ❑ Ben Jones' Interactive 3D Tracking: <https://cdcvs.fnal.gov/redmine/documents/535>
- ❑ Describes how to, by-hand, draw track segments in 2 planes, which turns into a 3rd segment in the 3rd plane. And then they connect amongst each other via Bezier, and voila, a 3D track! ....

# HandScan Tools 2b

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- ❑ Cross fingers and click on the link below and the successive one after that.
- ❑ <https://cdcv.s.fnal.gov/redmine/attachments/download/6981/Screen%20Recording%209.mov>

# Thoughts from the Naugehyde swivel chairs of the Tools Conveners ... 1



- I think the following are true:
  - Shower code works to separate gammas/es, as advertised. Is still under development
  - Tracking code -- Bezier and KalmanHits -- are promising and have made great headway
  - Calorimetry dEdx and likelihood pID exist
  - **Most of the above work has been done on single particle MC.**
- Lots of other great work, of course, not necessarily germane to this discussion:
  - HitFinding improvements
  - Vertexing in 2D
  - Electronics simulation/deconvolution, ...

# Thoughts 2: Beyond single particle MC

- ❑ Tracking: We have seen some CCQE mu+proton events thrown at tracking algos. TrackKalmanHits are sensitive to input Seeds. Not yet tackled in yet more complicated neutrino events.
- ❑ I believe we have not seen  $m_{\pi^0}$  tackled yet by putting together two showers' invariant mass. Let alone in a CCQE/Resonant event or DIS neutrino event.
- ❑ We've seen some cosmic muon overlays with GENIE evts. Just EVDs, have not seen any effort at subtracting the cosmics.

# Thoughts 3: Other Ideas for high-level things we can do to make progress toward the big LArSoft questions ....

- ❑ Summing the energy in the hits on a plane for complicated DIS events: how well does that do?
- ❑ Do some resonant events lend themselves to the Delta invariant mass being able to be assembled?
- ❑ Deciding what gets tracked, what gets shower-recon'd and building modules that do both inside one event, as in a CCpi0 event.
- ❑ Generally, can we start bringing our tools to bear on multi-track/shower events?
- ❑ ....

# Slightly more Pedestrian Thoughts from the Tools Conveners' Naugehyde Swivel Chairs ...



- We've been saying we should have a MC Challenge in the Fall. Fall is in 2 wks!
  - Are there samples desired?
  - Is there a code freeze desired?
  - Herb has started writing full-featured, general purpose batch worker and submission scripts with the idea that one never has to touch them again (except for maintenance).
  - There ought to be a MC czar/jefe
- **uBooNE offline repository reminder!**: <https://cdcvs.fnal.gov/redmine/projects/ubooneoffline/wiki>