

RECONSTRUCTION REPORT

AND PLANNING FOR THE IIT WORKSHOP

WESLEY KETCHUM (LANL)
TRACY USHER (SLAC)

OUTLINE

Wires/Hits

Tracking

Holistic packages

- Pandora and ClusterCrawler

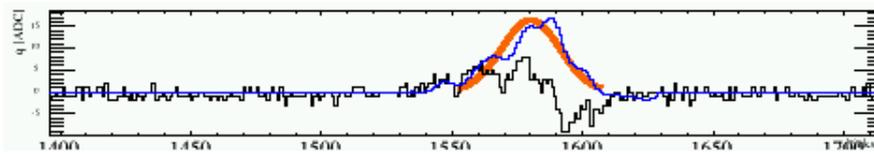
Shower reconstruction

Looking ahead to IIT

DECONVOLUTION

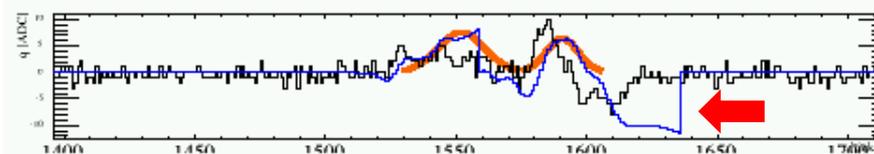
Problems uncovered with current scheme

- Lower gain + noise + insufficient ROI padding → very bad features in deconvolution
- Modify deconvolution kernel? Better noise filter? Implement baseline subtraction?



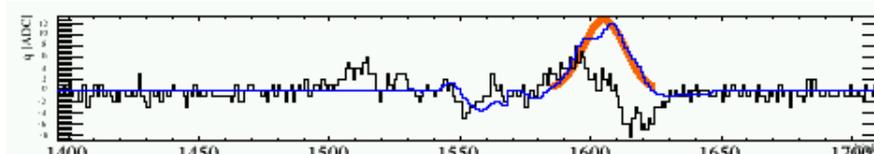
Wire 1117

From Bruce
(docdb 3963)

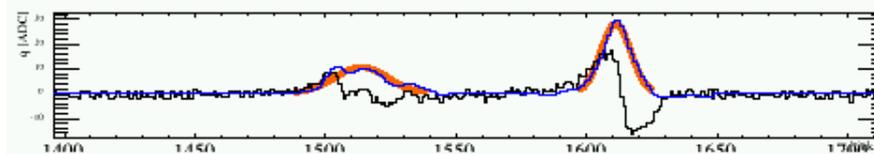


Wire 1118 - Yikes!

Raw
Deconvoluted



Wire 1119



Wire 1120

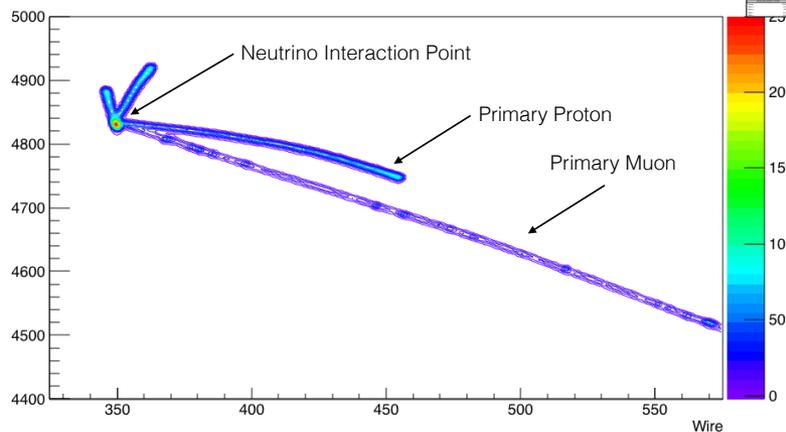
ALTERNATIVE HIT-FINDING TECHNIQUE

...or, forget signal deconvolution altogether

- Make hits based on raw waveform
- Use image-processing techniques (Canny filter) to define regions of interest

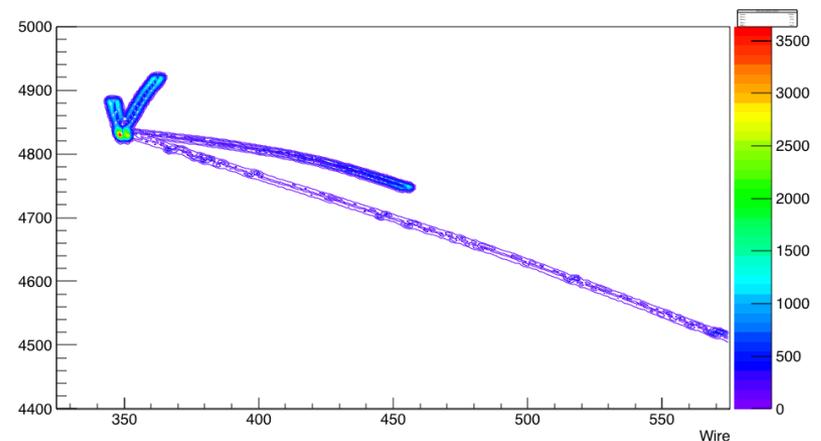
From Tracy
(docdb 3939)

RawDigit ADC Values Less Pedestals



W plane Contour plot

Image Gradient

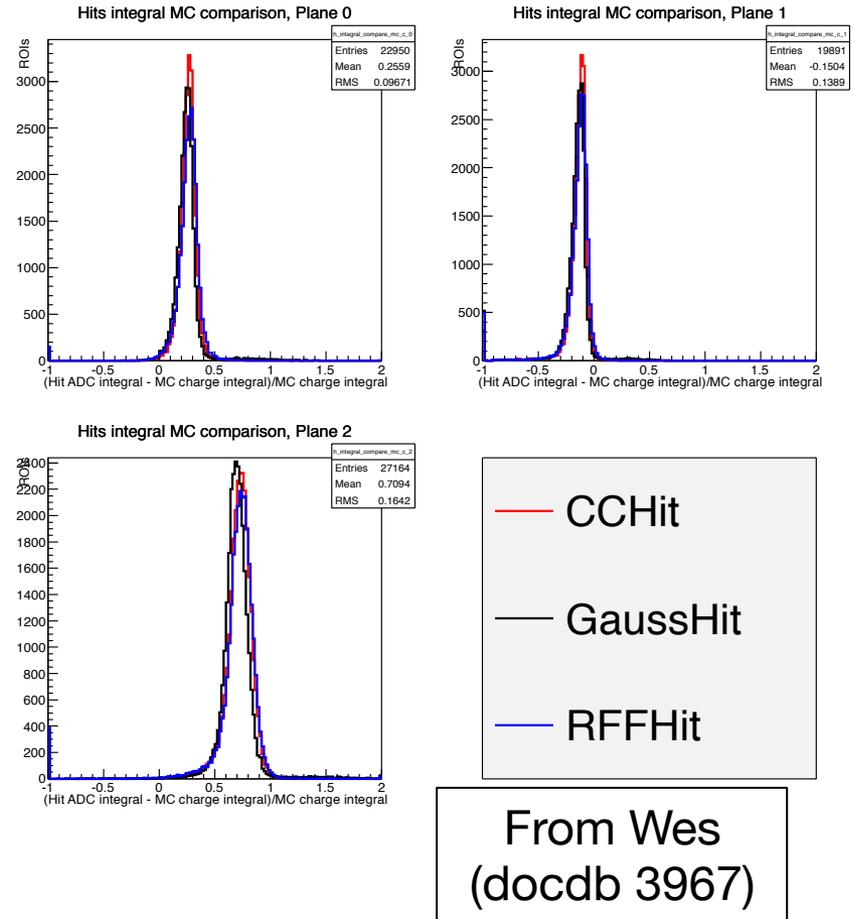


"Gradient" of Blurred ADC less Pedestals - W plane

HIT VALIDATION

New HitAnaAlg

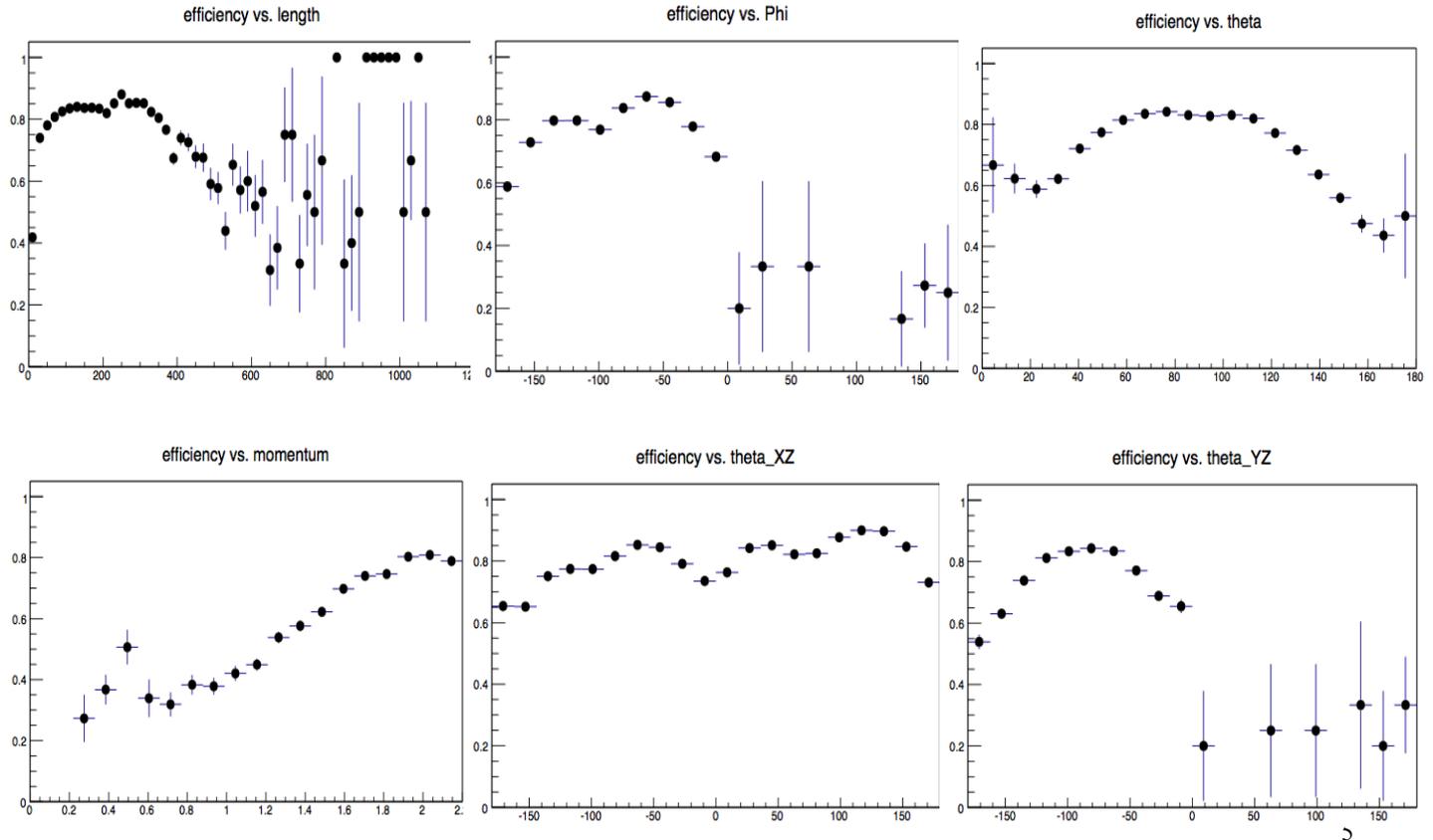
- Compare hit-finders to wires and MC truth
- Also offers comparisons between wires and MC truth
- Start of broader comparison package to be developed at IIT



TRACKING PERFORMANCE IN MCC5

From Sowjanya
(docdb 3969)

KalmanHit Tracker – Cosmic sample
Efficiency with: Fuzzy clustering = 81%



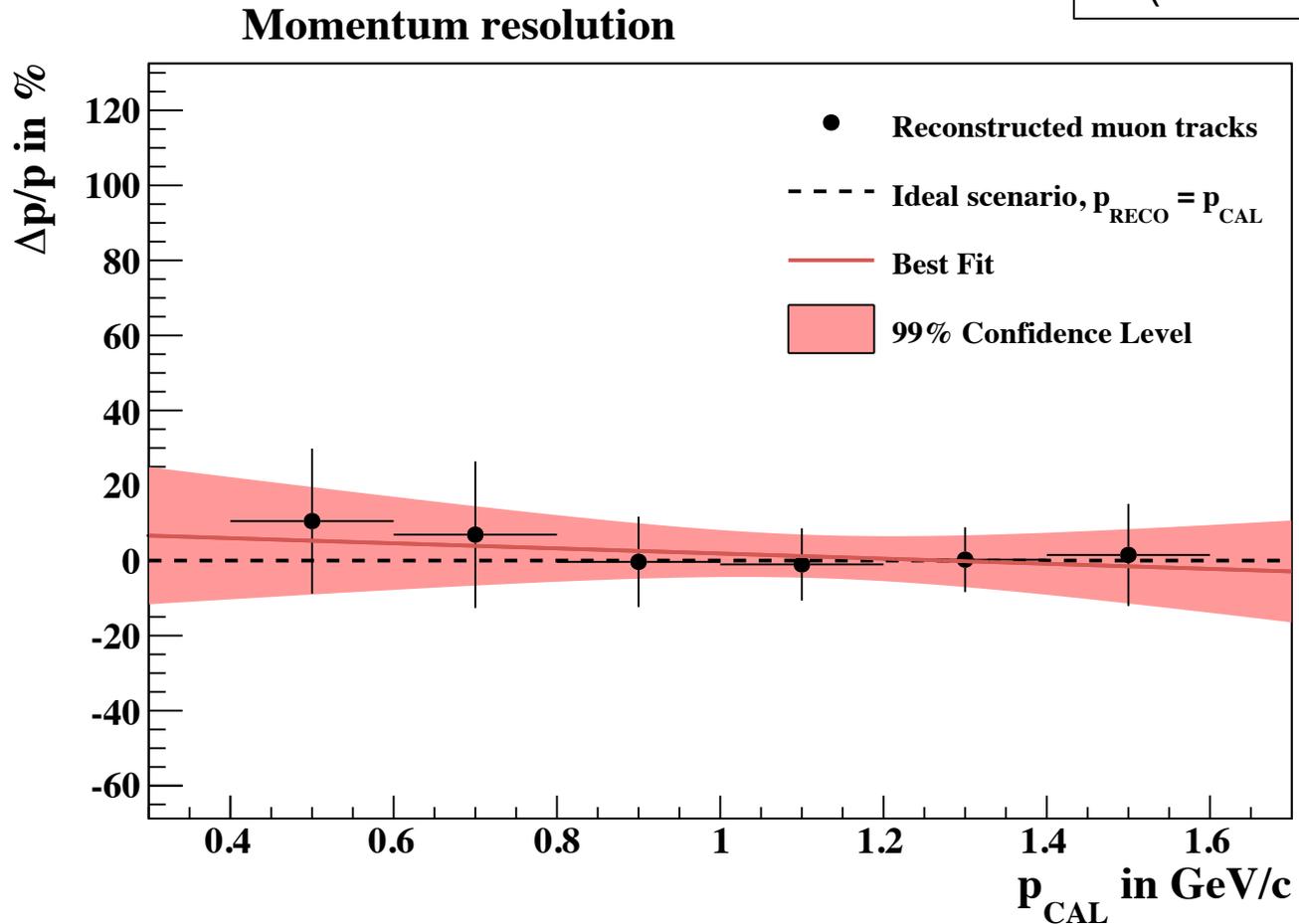
TRACKING PERFORMANCE

Improved performance + maturing downstream reco/analysis → need more detailed comparisons

- Selection
 - Previous plot likely undercounts our efficiencies in some areas
 - ...and perhaps overcount in others, but think it's more the other way...
- Metrics
 - Need more than “did we see track”: length, angles, start points, etc.
 - And other related elements
 - Like associated charge, and momentum...

MOMENTUM DETERMINATION: MCS

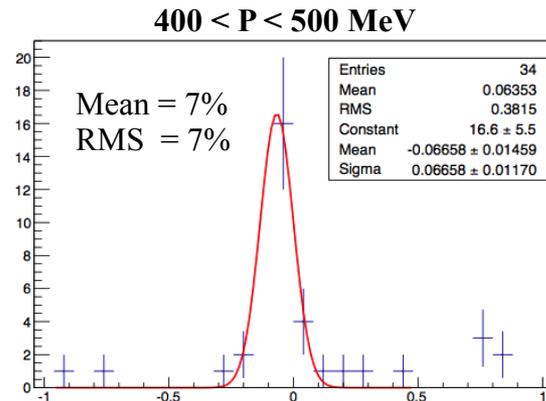
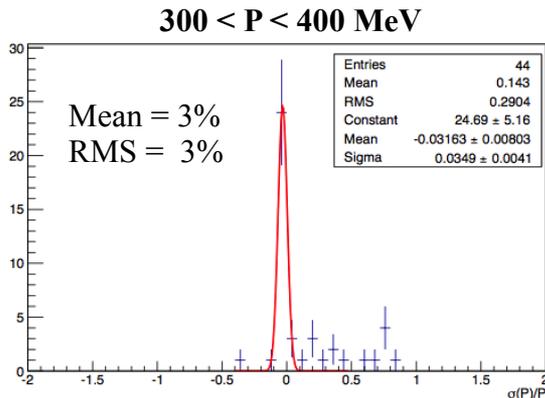
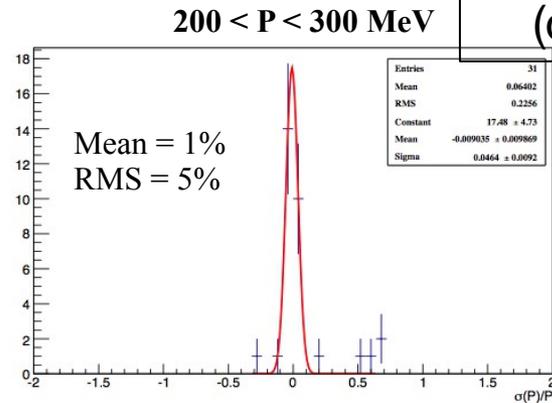
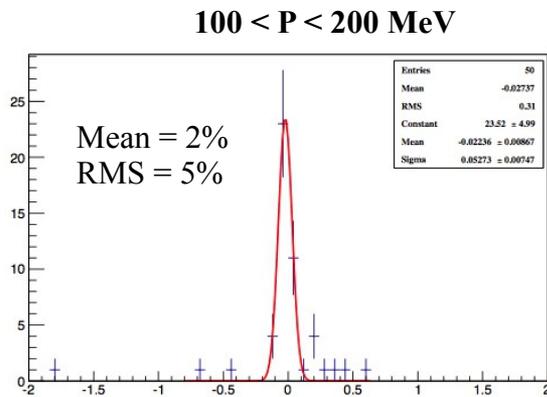
From Leonidas
(docdb 3891)



MOMENTUM DETERMINATION: RANGE

Momentum resolution for statistically populated bins

From Sowjanya
(docdb 3662)

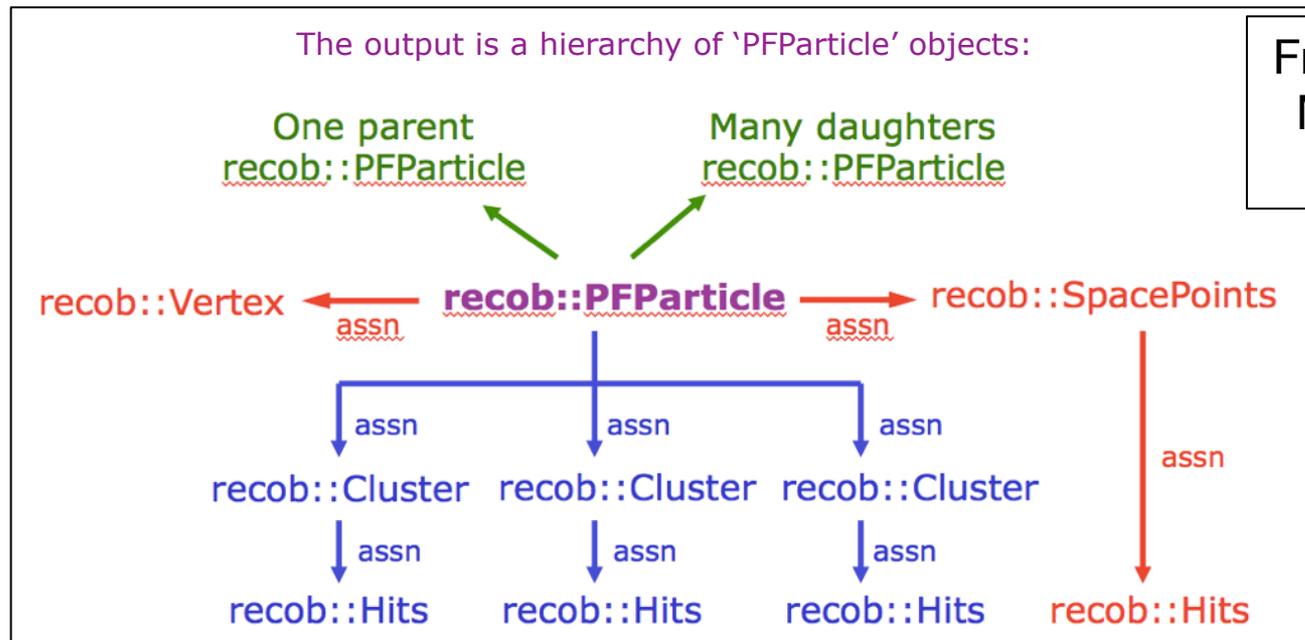


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PFPARTICLE

We have full-formed pattern recognition algs

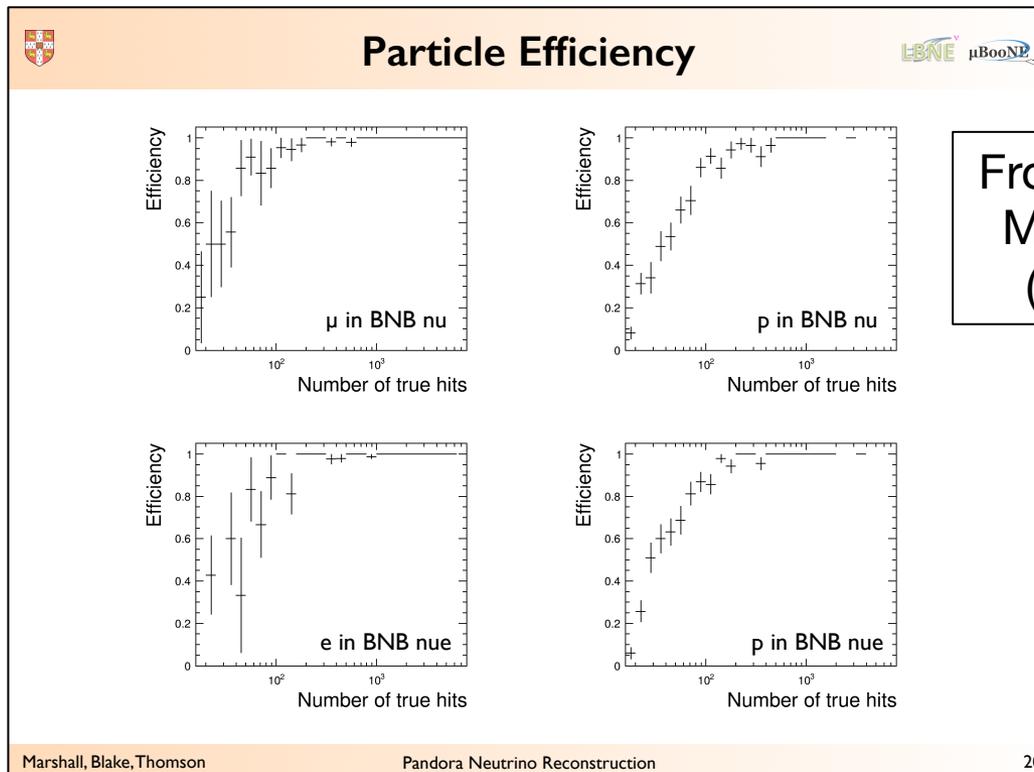
- Pandora and ClusterCrawler provide reconstructed objects and the relationships between them
- Output structure is PFParticle hierarchy
 - Need common analyzer for these objects



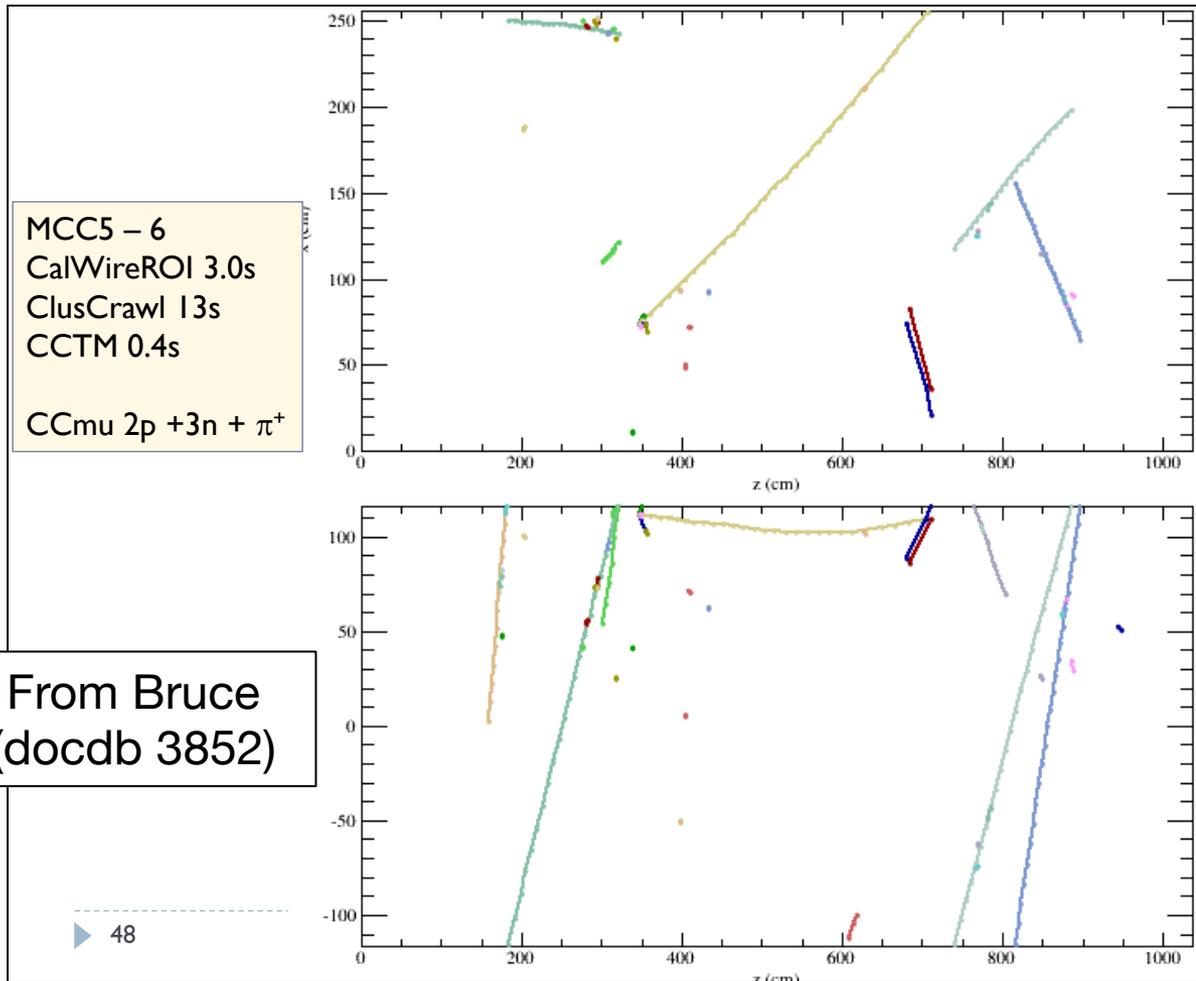
From John, Andy,
Mark, and Tracy
(docdb 3569)

PANDORA

- Two-pass reconstruction
 - “Cosmic” reco, remove hits tagged as cosmic, “neutrino” reco
- Input: hits. Output: everything!
 - Clusters, tracks, showers, vertices, and all the associations
- Very excellent improvements since MCC5



CLUSTERCRAWLER



- Now includes CTrackMaker, which does cluster matching across planes and creates tracks and vertices
- Recent updates put output in PFParticle structure

SHOWER RECONSTRUCTION

See talk from Wednesday ...

What Has Been Done?

π^0 Reconstruction ... Ryan, Kazu, Kaleko

- Ryan continued to work on π^0 filter ... trying cc/fuzzy cluster & 3D information

Tool Development ... Ryan, Kazu, Kaleko

- Successful reconstruction metric now applicable to both shower & track
 - MCShower & MCTrack became official data products
 - Agreed to standardizing @ IIT workshop in reco validation group

Analysis ... Caratelli., Ariana, Andrzej on BG, Bobby, Kazu, Kaleko, Corey, Jeremy on SG

Signal selection & BG rejection

- Cosmic related BG rejection @ last workshop ... see [DocDB 3978](#)
- Signal selection effort started @ last workshop ... work in progress

More Tool Development ... Jeremy, Kazu, and Caratelli

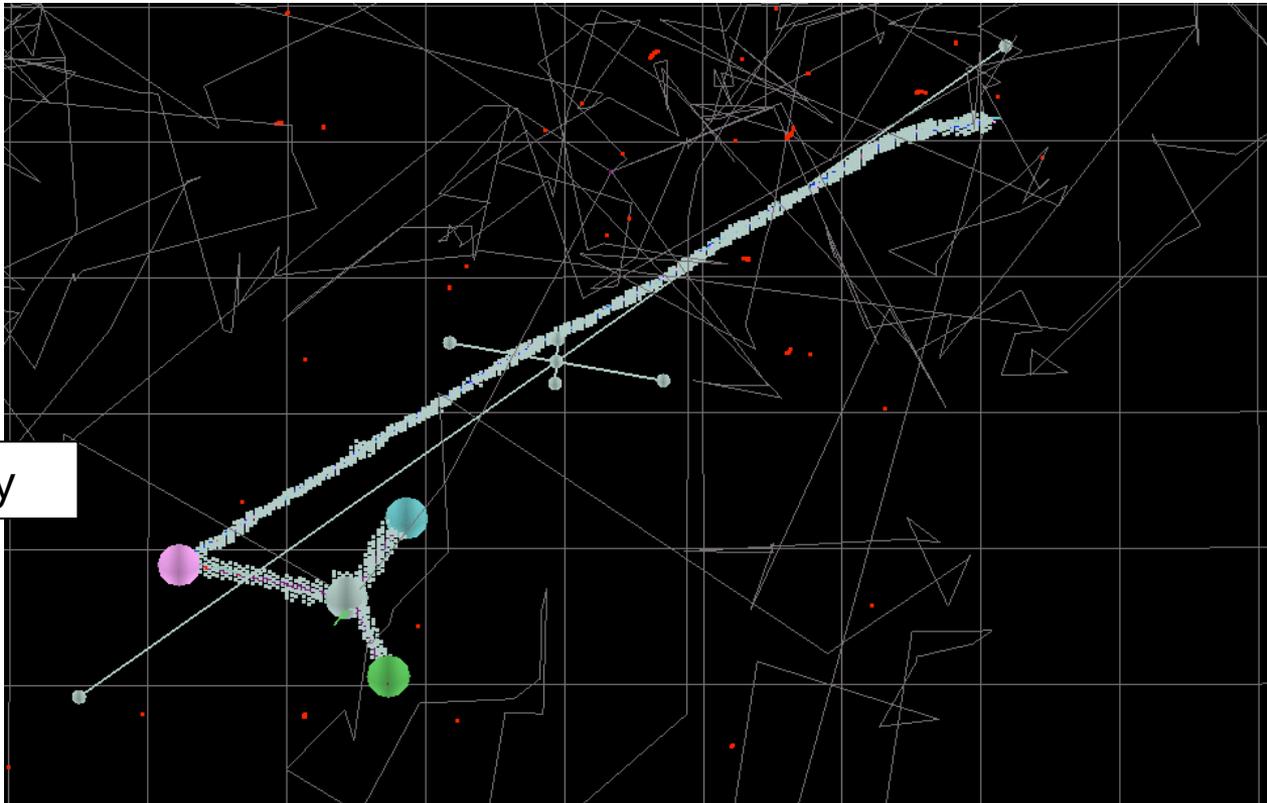
- Two major code framework development
 - **GeoAlgo** ... analysis package for 3D geometrical objects' collision detection
 - **ShowerPdfTool** ... toolkit designed for an "event reconstruction"

I focus on these items in the rest

From Kazu
(docdb 3982)

3D CLUSTERING

- Lots of recent progress: combining hits from each plane and clustering in 3D directly



From Tracy

NOW FOR IIT

CHARGE → HIT SIM AND RECO

Four major comparison tasks

- Deposited energy → charge on wire
- Charge on wire → detected “raw” waveform
- Raw waveform → calibrated wire signal*
- Wire signal* → reconstructed hit objects

Goals

- Develop the software tools for each of the above four categories, validating our hit reconstruction with respect to initial particle energy
- Determine performance of current reconstruction techniques and compare to alternative paths for going from waveform to hit

Group organizer: Leon Rochester

CHARGE → HIT: SELLING POINTS

Some pieces exist, but much to be done too

- Wire → Hit and MC energy → charge on wire mostly defined
 - Good place to play around and get a good feel for things
- Charge → raw waveform and waveform → wires tools exist/being finished up, but comparison software undefined
 - Lots of opportunity to make an impact

Highly tied to early calibration work

- IF we understand our hits/waveforms, the rest of the reconstruction proceeds with confidence
- Working at the low-level now will prepare you for the

RECONSTRUCTION VALIDATION

Particularly focusing on three reconstructed objects

- Clusters (2D)
 - Possibly 3D too...
- Tracks (3D)
- EM Showers (3D)
- Vertices too!

Goals

- Develop the software tools to compare reconstructed objects against MC truth
- Determine the most relevant figures of merit for “general-purpose” reconstruction
- Evaluate performance of current reconstruction algorithms, and determine best-path-forward for standard reconstruction chain

Group organizer: Tracy Usher

RECONSTRUCTION VALIDATION: SELLING POINTS

A lot of utilities exist!

- Current track and cluster comparison software
- MCTrack/MCShower

Help decide the metrics!

- What is a “well-defined” track/cluster/shower? How best to quantify that?

Early start on understanding reco efficiency

- Develop tools with truth, then all you need are relatively pure datasets...

COSMIC TAGGING AND OPTICAL SIM&RECO

Major points of study

- Using TPC reconstruction to exclude cosmic-ray objects
- Comparing optical and TPC reconstruction to enhance cosmic-removal
- Implementing best-practices for cosmic removal and two-pass reconstruction

Goals

- Extend the existing TPC geometry-based algorithms to reject clusters and reconstructed showers
- Validate and improve the flash \leftrightarrow TPC matching
- Develop tools and a reconstruction chain for effectively ignoring objects tagged as “cosmic rays”

Group organizer: Wesley Ketchum

COSMIC TAGGING: SELLING POINTS

Really cool organizer

Lots of tools exist!

- The main goal is to validate what we have, and better understand the inner workings of the optical sim and reco

***Essential* to most everything we will do**

- Need to reliably identify charge depositions from cosmics/and other non-neutrino interactions
- Need to develop robust framework for removing that charge

EVENT RECONSTRUCTION AND ANALYSIS

Little bit of a catch-all for 3D reconstruction and analysis

- Track/shower event reconstruction
- Single- and multi-shower event selection
- Contained muon selection
- Anyone else thinking directly about an analysis!

Utilities available

- Base toolkit for I/O and working with truth and reco
- Support for framework-independent development
- See docdb 3955 EventReco document for more

Group organizer: Kazu Terao

EVENT RECONSTRUCTION: SELLING POINTS

Event Reconstruction (Kazu & Andrzej)

- 3D reco getting into a good shape... onto event reconstruction!
- Come join us if you are interested in...
 - Event reconstruction & selection
 - Writing a probability distribution function (PDF) based algorithm
 - C++ & python coding
- We got a base toolkit!
 - It takes care of I/O. You focus on writing an algorithm
 - Fmwk independent: you can use input of your choice (larsoft, larlite, or tuple)
 - Supports PDF approach (also designed for both selection & training)
 - Works w/ both MC and Reco information
- Our primary goals
 - background filter (cosmics, etc)
 - track/shower event reconstruction
 - single shower event selection
 - multi-shower selection (π^0 , nbar)

