

# STATUS OF EVENT RECONSTRUCTION IN MICROBOONE

WESLEY KETCHUM (LANL)

# MICROBOONE'S PHYSICS GOALS

**Resolve the source of MiniBooNE's "low- $E_\nu$  excess"**

**Perform precision measurements of neutrino interaction cross sections on Argon**

**Expand the capabilities of LArTPCs to search for physics beyond the Standard Model**

# MICROBOONE'S RECONSTRUCTION GOALS

## “low- $E_\nu$ excess”

- Identify  $\nu_e$ -like neutrino interactions
- Reconstruct incoming neutrino energy
- Strongly discriminate between electrons and photons

## Cross sections

- Reconstruct all kinds of neutrino interactions
- Positively identify all kinds of particles
  - Muons, charged pions, neutral pions, protons, kaons, electrons, photons, neutrons, ... something else obvious

## Expanding capabilities

- Fully-automated reconstruction in a surface LArTPC
- And be ready for anything

# RECONSTRUCTION SOFTWARE

## MicroBooNE is a key member of the LArSoft collaboration

- LArSoft: a common simulation, reconstruction, and analysis software package for LArTPCs
- Also used by ArgoNeut, LBNE, LArIAT, LAr1-ND, and others
- Managed and supported by dedicated team at FNAL, but developed by the experiments

## We all benefit by working together where possible

- MicroBooNE owes much to the outstanding work done by others, especially ArgoNeut
- We hope future experiments will benefit ***directly*** from our efforts

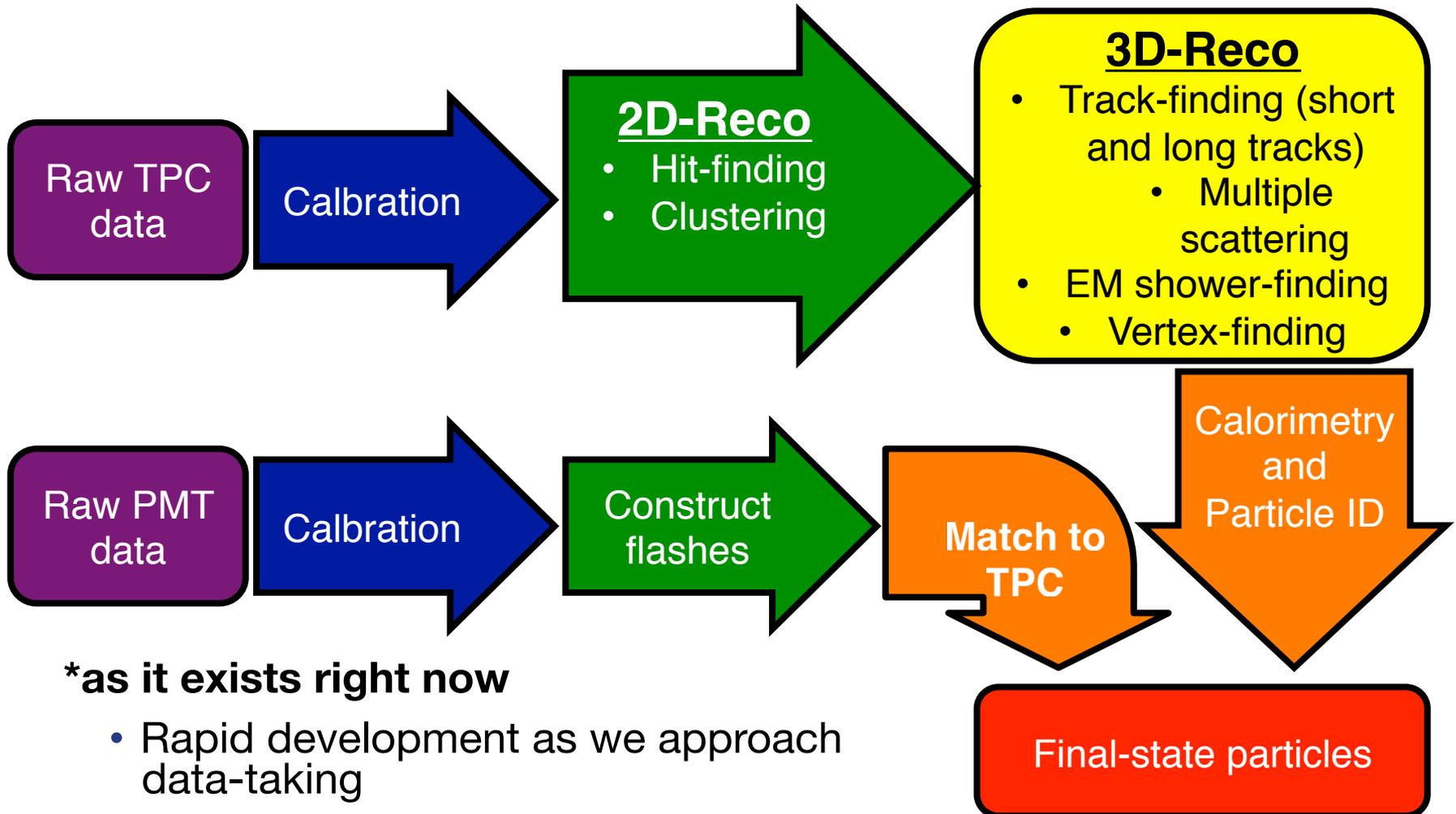
# MONTE CARLO CHALLENGE

## **MicroBooNE has periodic “Monte Carlo Production Challenges”**

- Simulate hundreds of thousands of interactions in the detector
  - Combination of single particle and various neutrino interaction samples
- Run through entire simulation and reconstruction chain

**These samples allow us to monitor improvements in performance, and give us the simulated events needed to improve our reconstruction**

# THE RECONSTRUCTION CHAIN\*: A GROSS SIMPLIFICATION



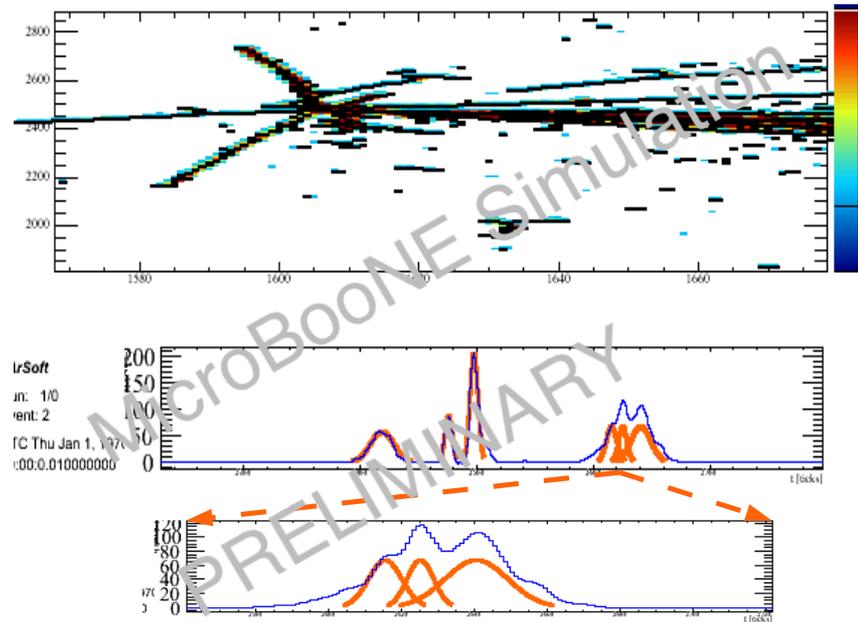
**\*as it exists right now**

- Rapid development as we approach data-taking

# HIT-FINDING AND CLUSTERING

- Deconvolute raw signals from wires
  - **Extensive** effort to understand field and electronics response
- Identify regions above threshold and fit to Gaussian
- Cluster nearby hits believed to be from same particle
  - Geometrical
  - Physics-based (looks at charge deposition)

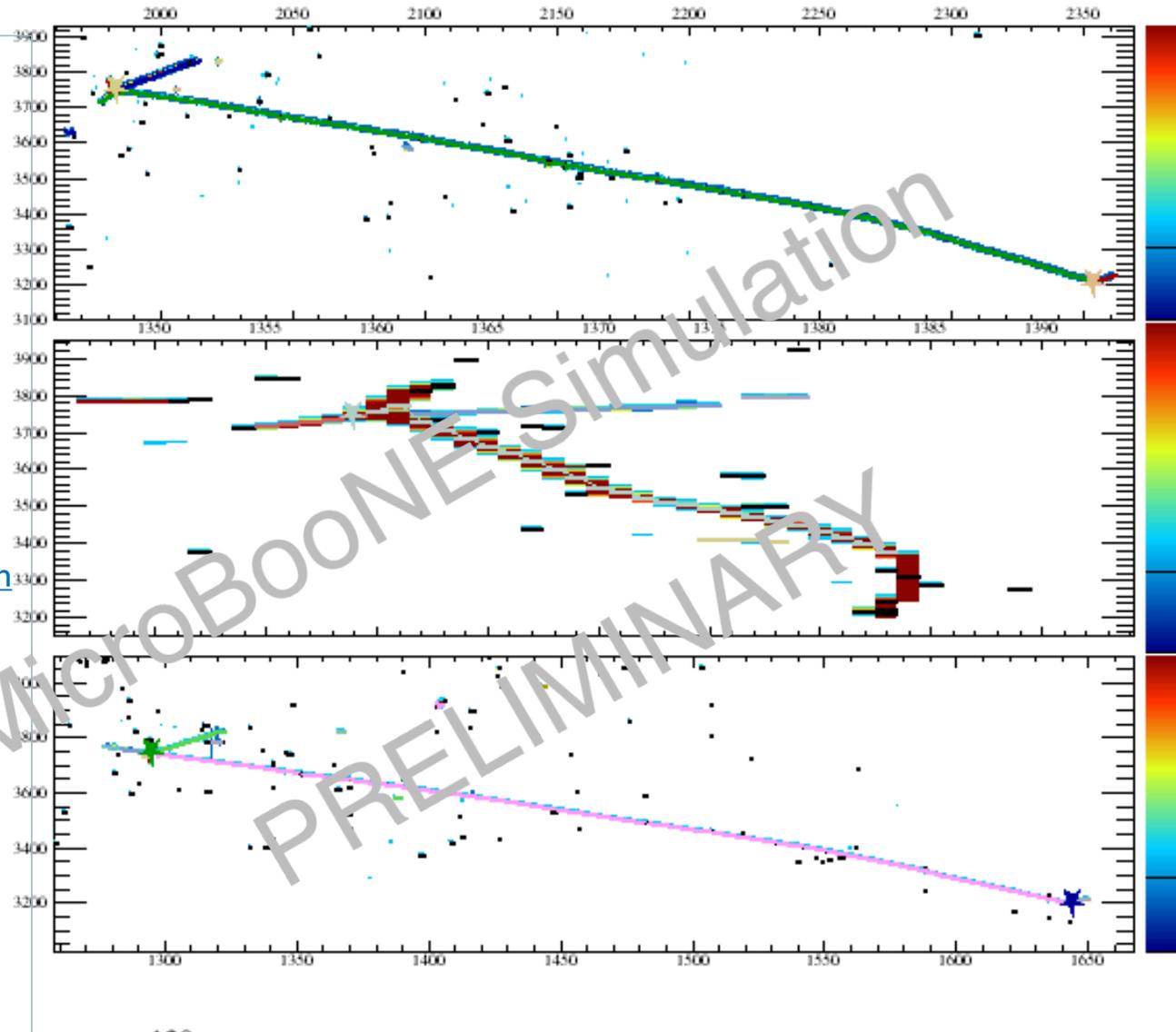
Jonathan Asaadi



# “CLUSTER CRAWLER” EXAMPLE

Bruce Baller

RES  
Enu 1102 MeV  
**386 MeV muon**  
EP2 = 0.94  
E = 0.95  
P = 0.99  
Plane 0  
61 MeV proton  
EP2 = 0.83  
E = 0.83  
P = 1.0  
Plane 1  
128 MeV proton  
EP2 = 0.85  
E = 0.85  
P = 1.0  
Plane 2  
85 MeV proton  
EP2 = 0.80  
E = 1.0  
P = 0.8  
Plane 2  
▶ 38



# 3D RECONSTRUCTION

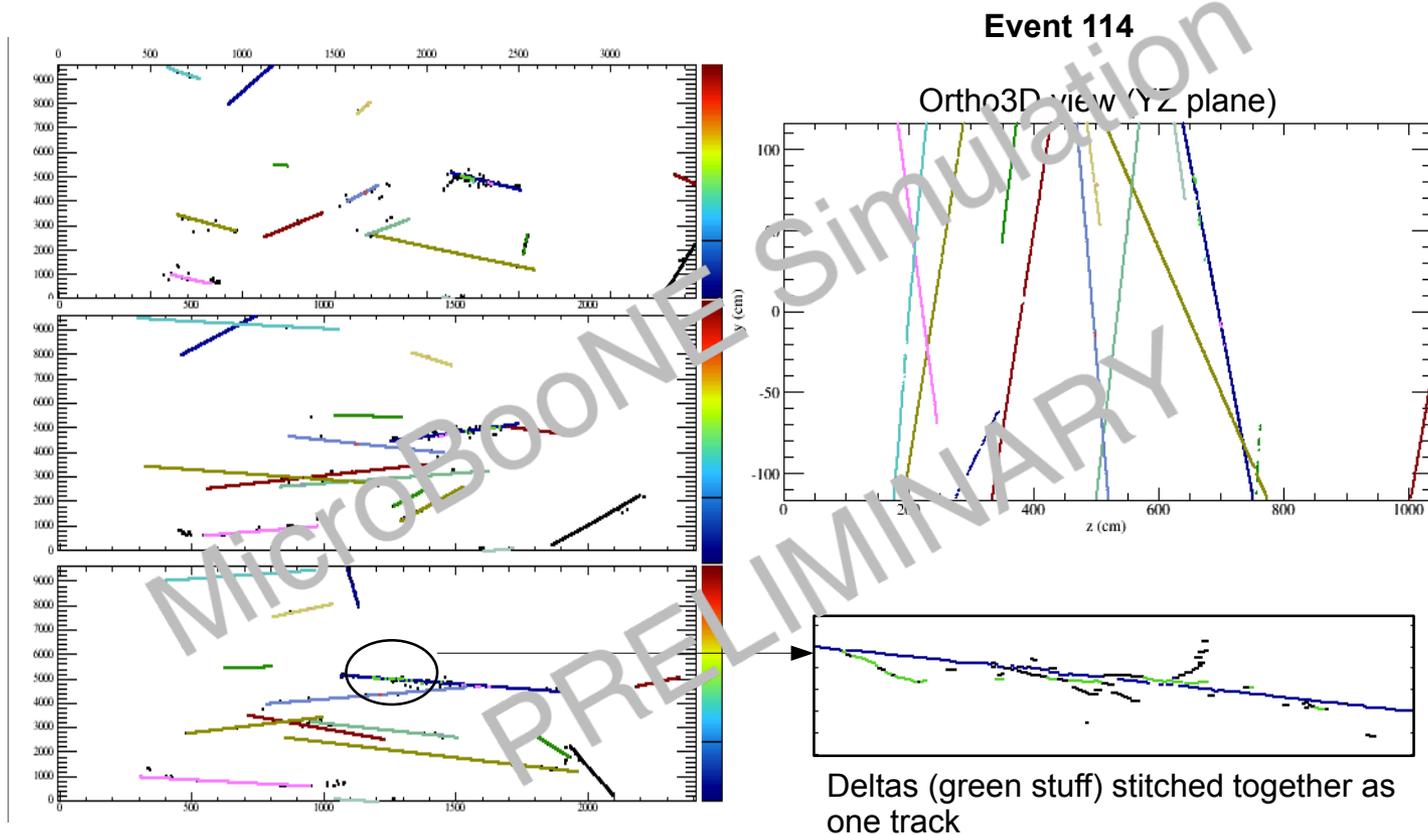
## Crucial component: matching features between planes

- Clusters/hits with similar times, and compatible locations in each planes' wires
- Track reconstruction relies on finding line-like objects in 3D
  - Must handle crossing cases, not perfectly straight tracks, and delta-rays
- Shower reconstruction more difficult due to segmented nature of EM showers
  - Need clusters to include significant portion of shower (merging)
  - Need clusters be consistent across planes (matching)

# 3D-TRACKING EXAMPLE

Herb Greenlee and Sowjanya Gollapinni

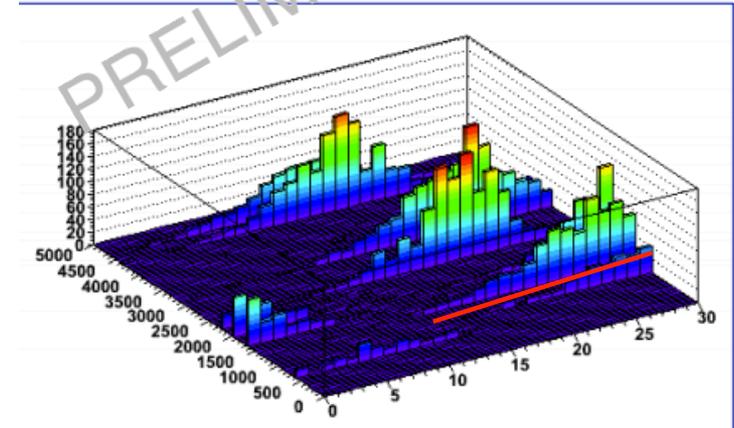
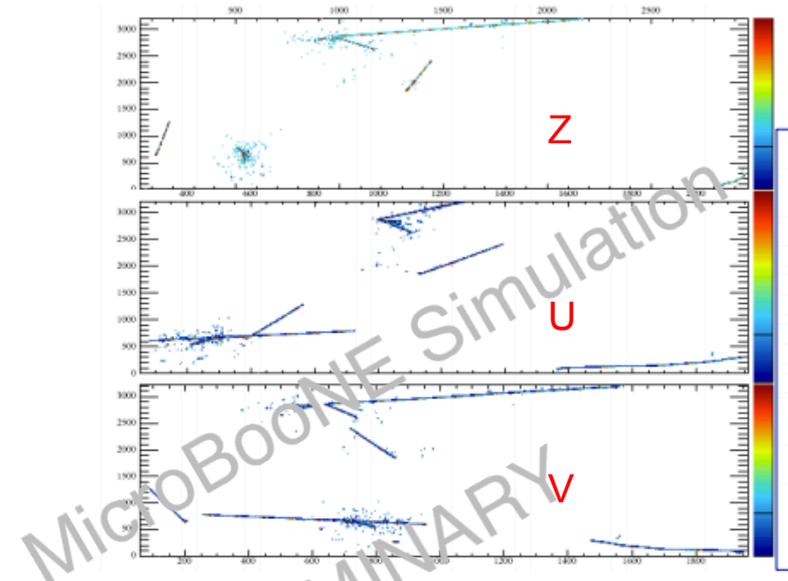
**KalmanHit:** A very busy event – very well reconstructed!



# OPTICAL RECONSTRUCTION

Benjamin Jones

- Combine signals in PMT array to produce “flash”
  - Position in  $y$  and  $z$  (height and location along beam axis)
  - Time of ionization
- Compare with TPC and beam information
  - Find flash in time with beam spill
  - “Reject” tracks with hypothesized flashes not compatible with beam flash

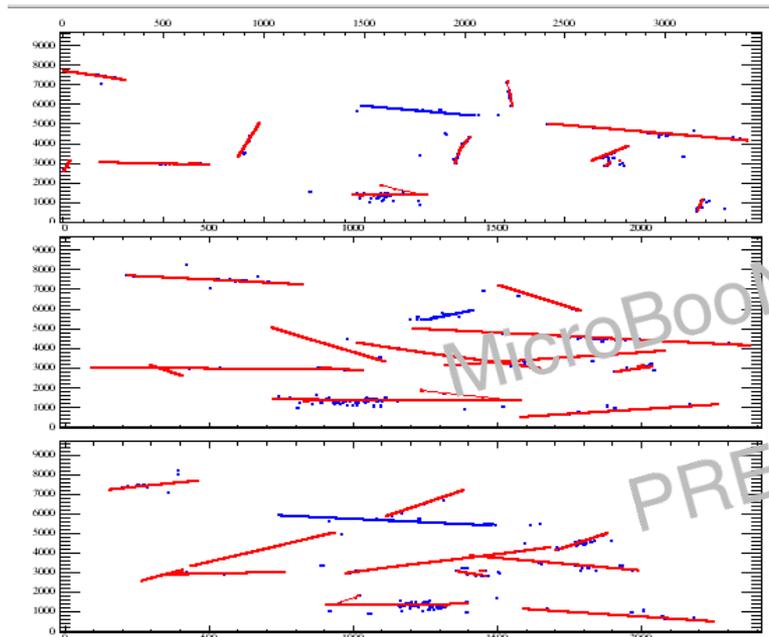


# COSMIC REJECTION

## Crucial component of any analysis for MicroBooNE

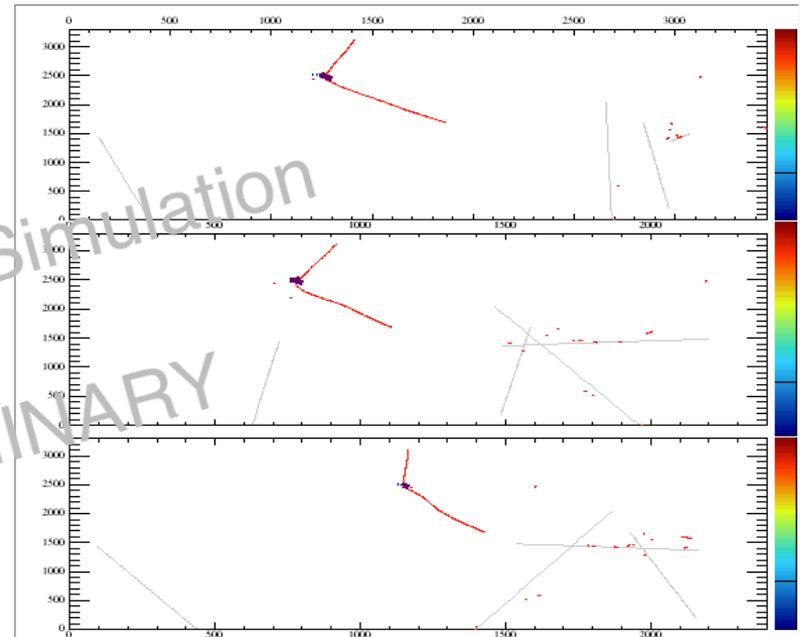
- Use both geometry of tracks and matching to flashes to reject cosmic rays

Geometry: endpoint checks



Sarah Lockwitz and Sowjanya Gollapinni

Flash-based



Benjamin Jones and Wes Ketchum

# OUR EFFORT

**A key point to MicroBooNE's reconstruction effort is that there is no one way to do reconstruction**

- Reconstruction algorithms are highly modularized
- Many different hit-finders, clustering algs, trackers, etc.
- Incorporated the PANDORA pattern-recognition software framework
- We expect to have multiple passes of reconstruction, improving at each step

***This is all possible because we have a large, vibrant, and dedicated group of people determined to have a fully-automated reconstruction chain for MicroBooNE***