pi0 Reconstruction in 35t

Mike Wallbank
Thanks as always to Tingjun!
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Since Last Update...

- Improved the BlurredCluster reconstruction method and re-tuned — won't touch this much now.

- Written a shower finding algorithm, EMShower, which uses clusters as input to create 3D shower objects.

- Used this shower reconstruction to have a first look at reconstructed pi0s.

Blurred Clustering

- Cluster technique which uses a 2D Gaussian function to 'blur' a hit map and allow formation of more complete clusters.
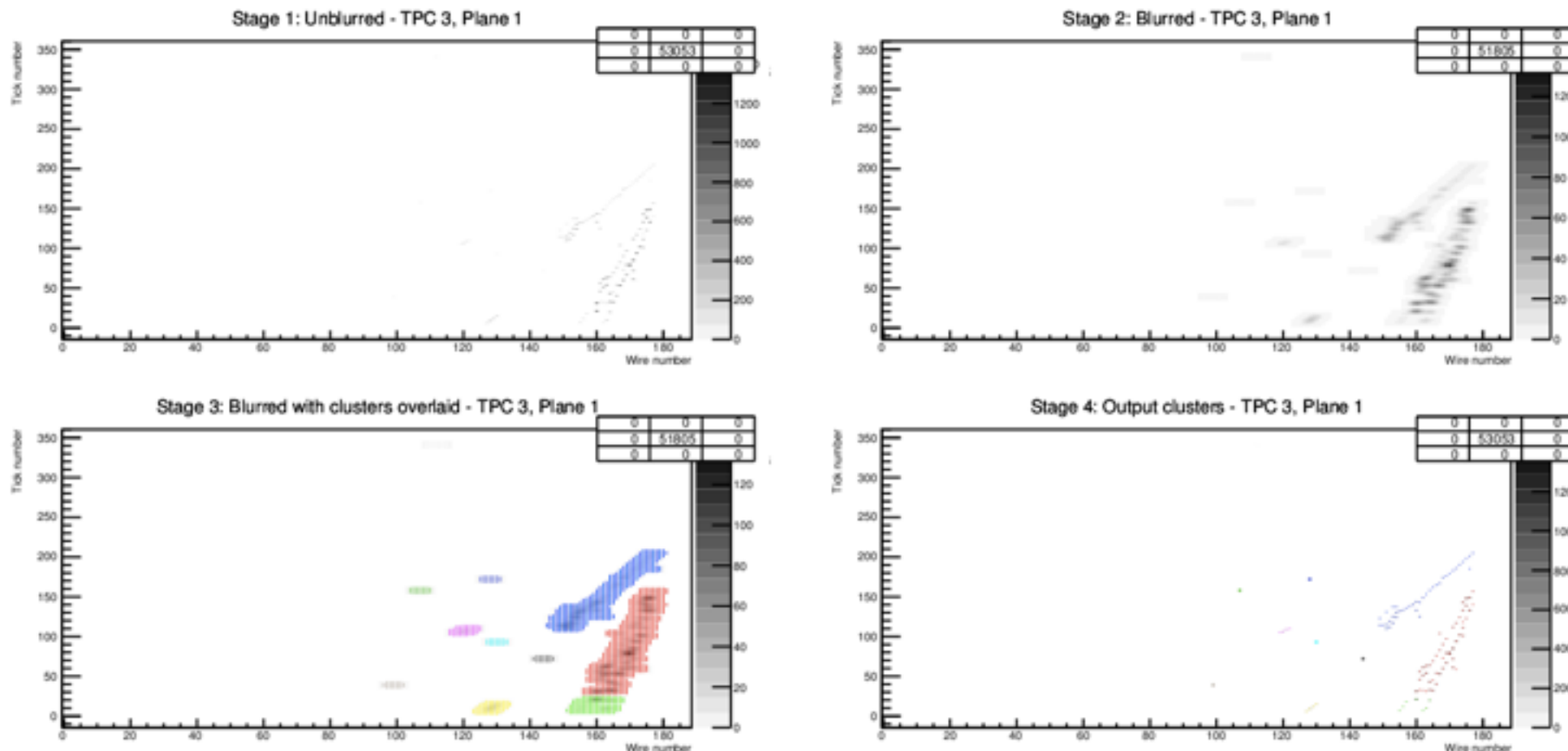
- Use 'Dynamic Blurring' to use an initial guess at the direction of the particle trajectories to apply the appropriate blur.

- Clustering proceeds using a simple nearest neighbour-style algorithm on hits above charge threshold.

BlurredCluster Updates

- Improved 'Dynamic Blurring' so that it sets the sigma of the Gaussian kernel individually as well as the blurring distances.

- Also improved the initial determination of the rough direction of the particle trajectories.

- The idea: shape the Gaussian function to match the hits for a particular particle as much as possible, and then blur the hits according to the distribution of the charge deposits.
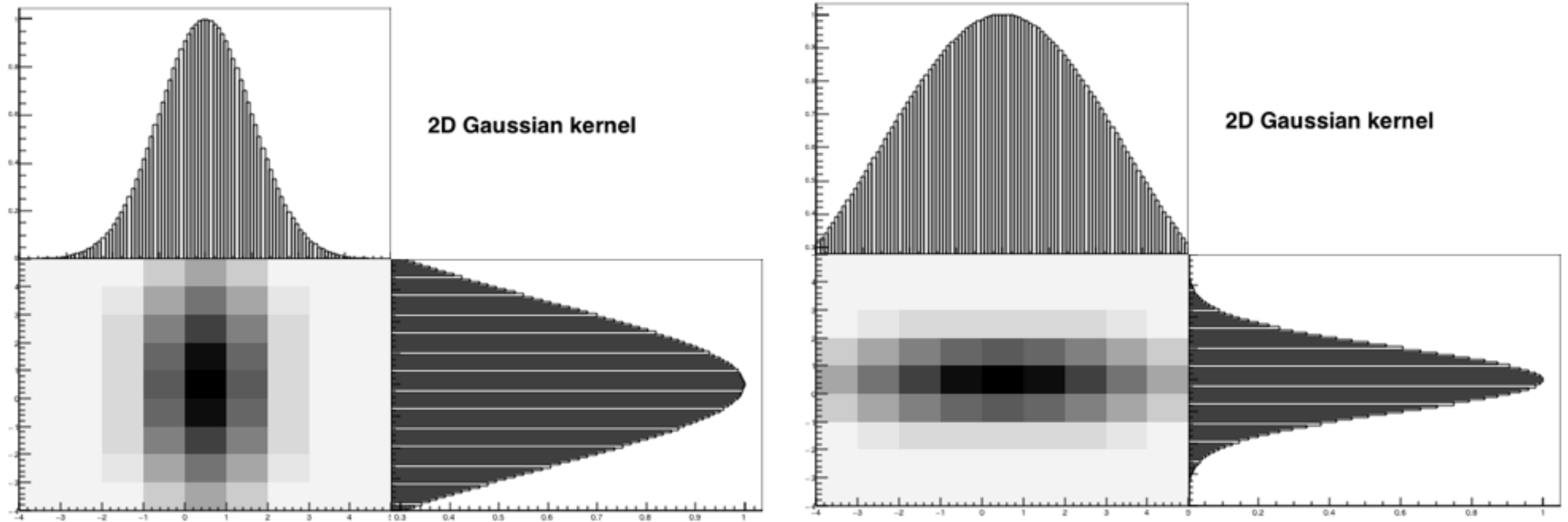
Controlling Parameters

- Gaussian kernel:

$$\frac{1}{\sqrt{2\pi}\sigma_{wire}} \frac{1}{\sqrt{2\pi}\sigma_{tick}} e^{-\frac{r_{wire}^2}{2\sigma_{wire}^2}} e^{-\frac{r_{tick}^2}{2\sigma_{tick}^2}}$$

- Parameters to fix are the **blur radius** (r) and the **Gaussian sigma.**

- Other defining parameters are the **clustering distance** (how far from a seed to cluster) and the **charge threshold**.
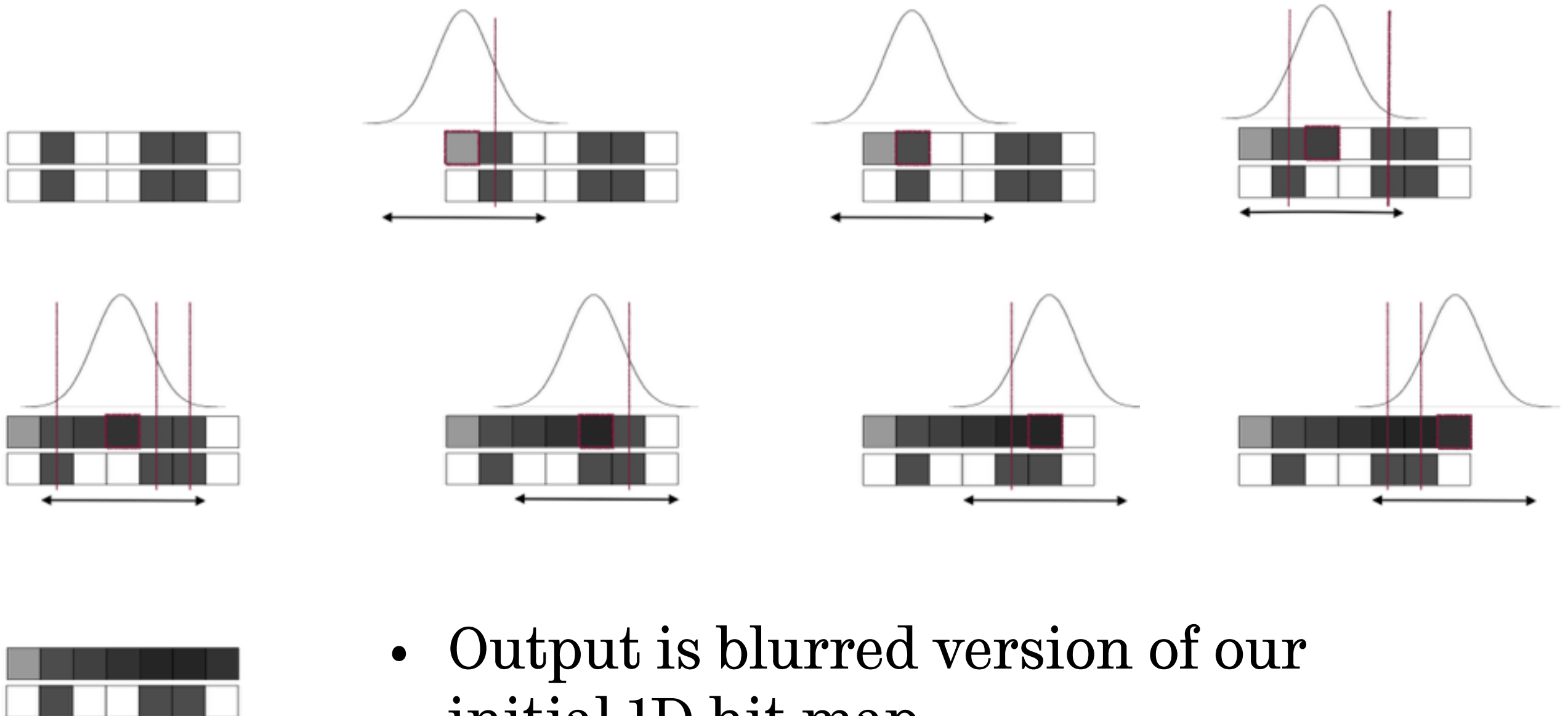
Demonstration: 2D Gaussian Kernel

- Left: more effect in tick direction (sigmax = 1, sigmay = 2.6)

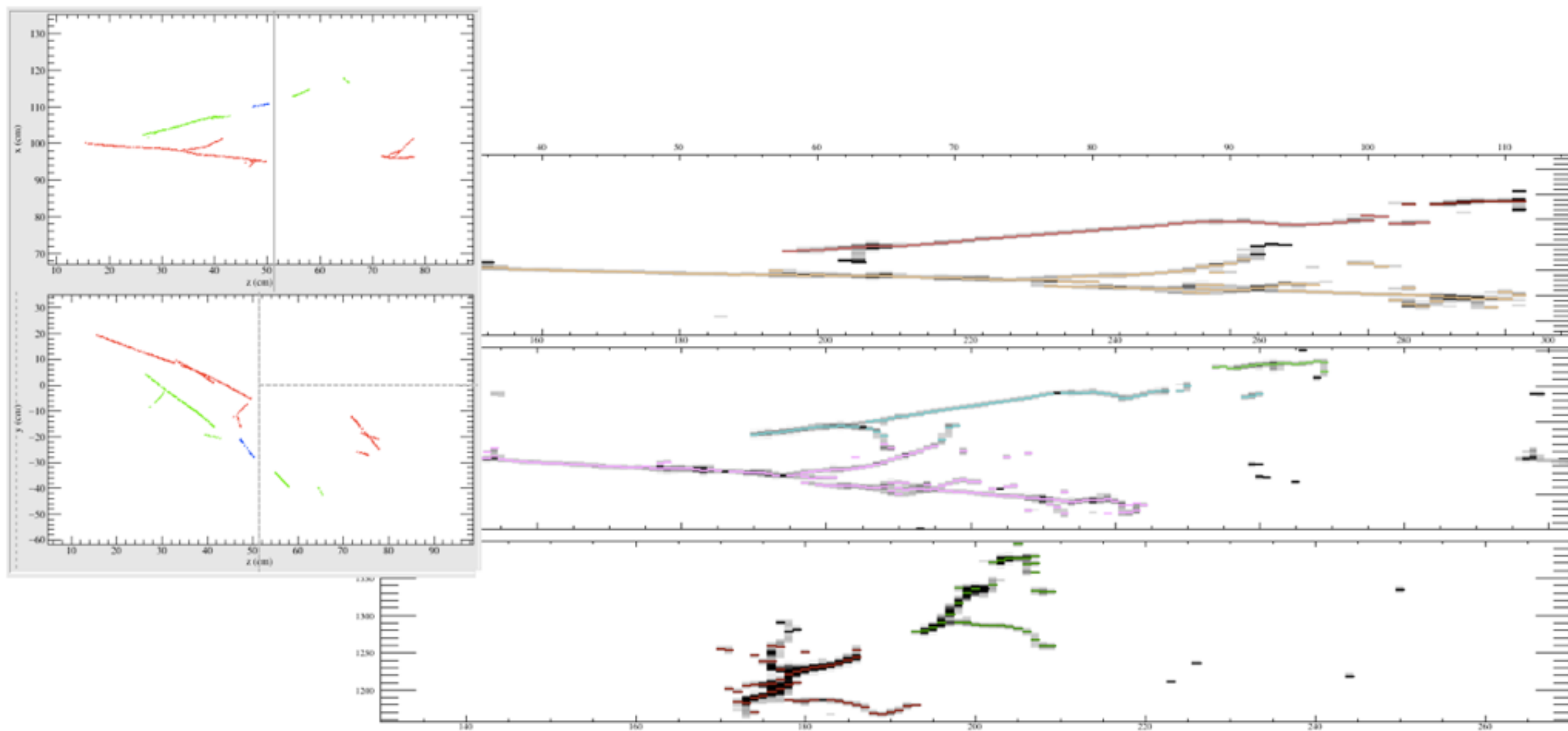- Right more effect in wire direction (sigmax = 2.6, sigmay = 1)

Demonstration: Blurring Radii

- How far to blur in each particular direction (demo in 1D with blur radius of 2):

- Output is blurred version of our initial 1D hit map.

# Effect of BlurredCluster Improvements

Example pi0 event after running BlurredCluster. Complicated hit pattern was
reconstructed very well after the recent improvements.
(Inset shows the resulting 3D showers — more next!)

Extension To EMShower

- Original idea: take these well-formed 2D clusters and simply match between the views to form 3D shower objects.

  - i.e. No more reconstruction in 3D, do everything in 2D.

- Also added option to BlurredCluster to cluster only hits not tagged (by PMTrack) as track-like [help with hadron track/EM shower in, e.g. FD nueCC event].

- Still early in the development but initial results and progress looks promising.

Algorithm Details

- The shower reconstruction runs on the output of clustering and tracking on the events.

- Each cluster is associated with a track and, by using the 3D nature of tracks, means that clusters across multiple views can be matched to forms showers:
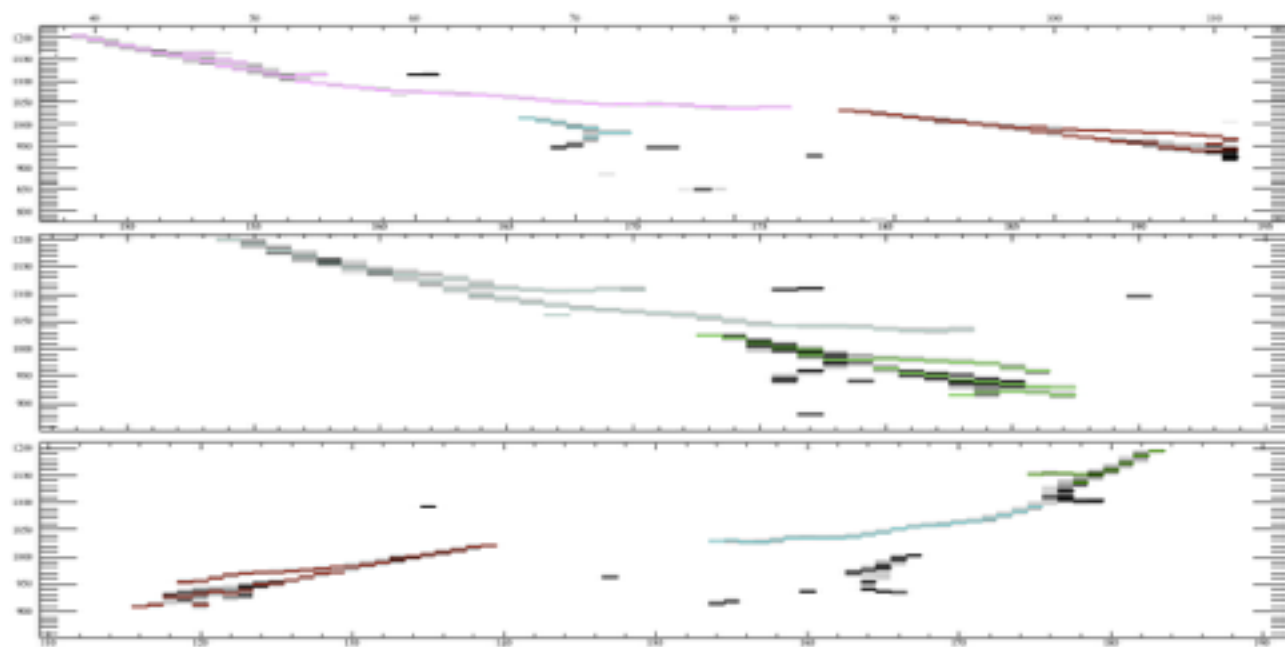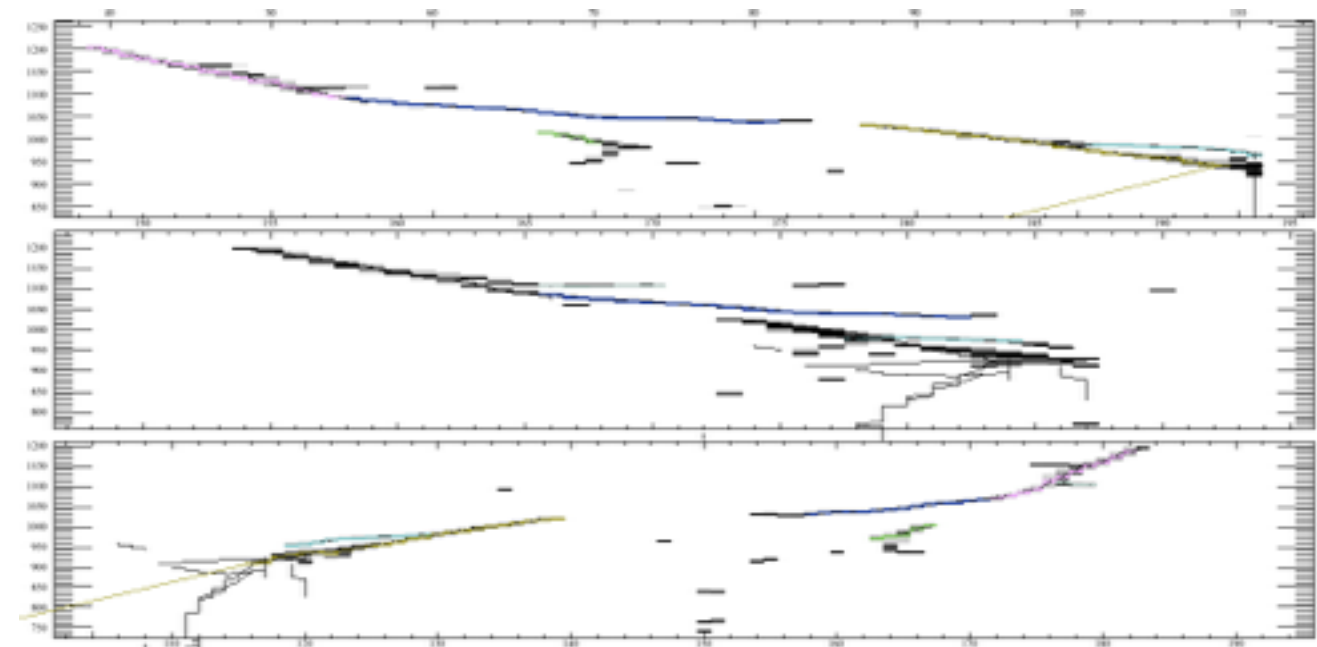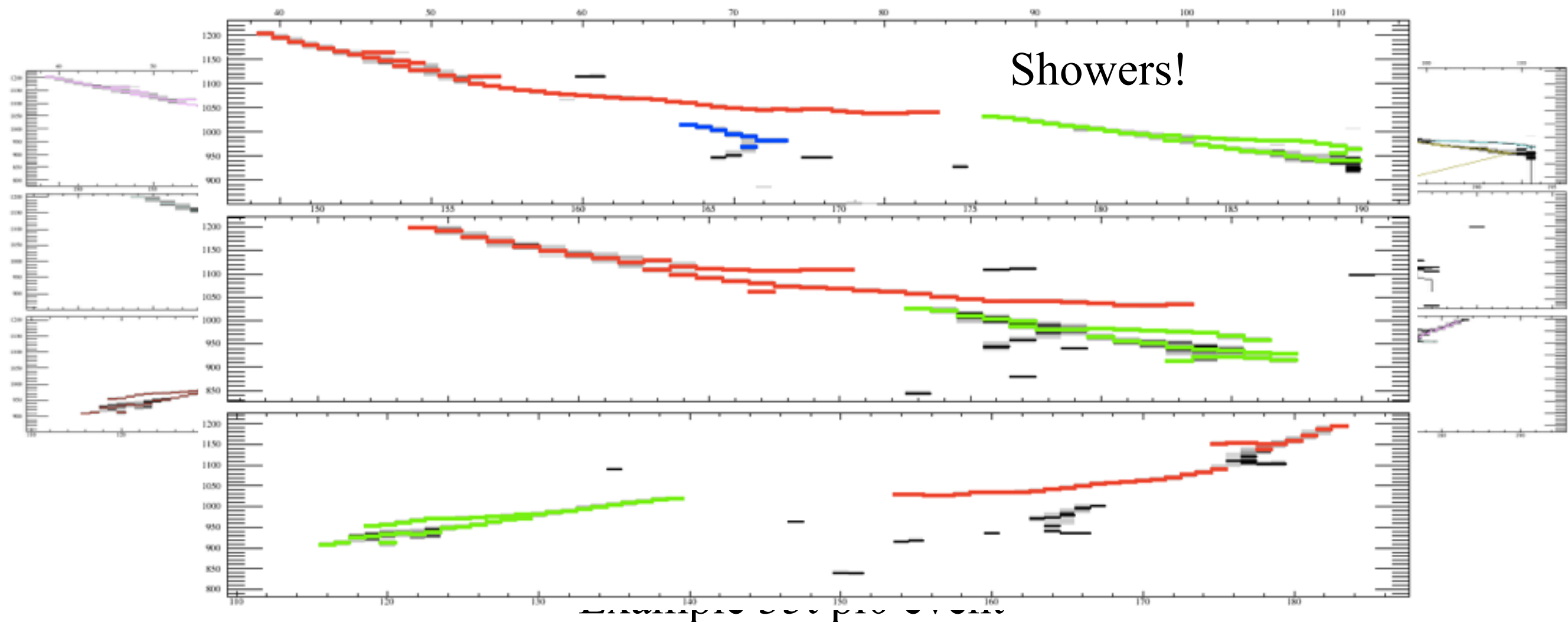
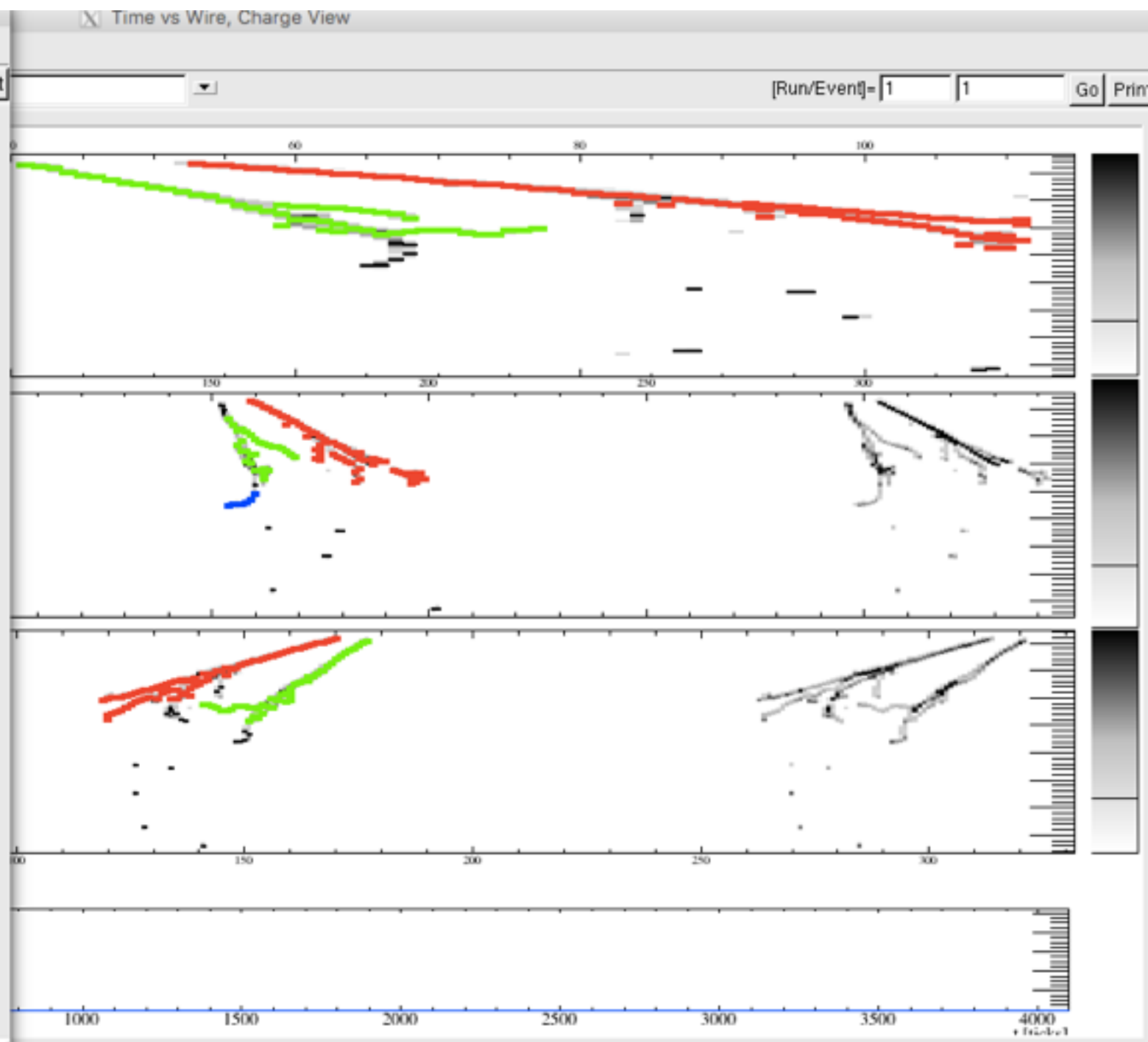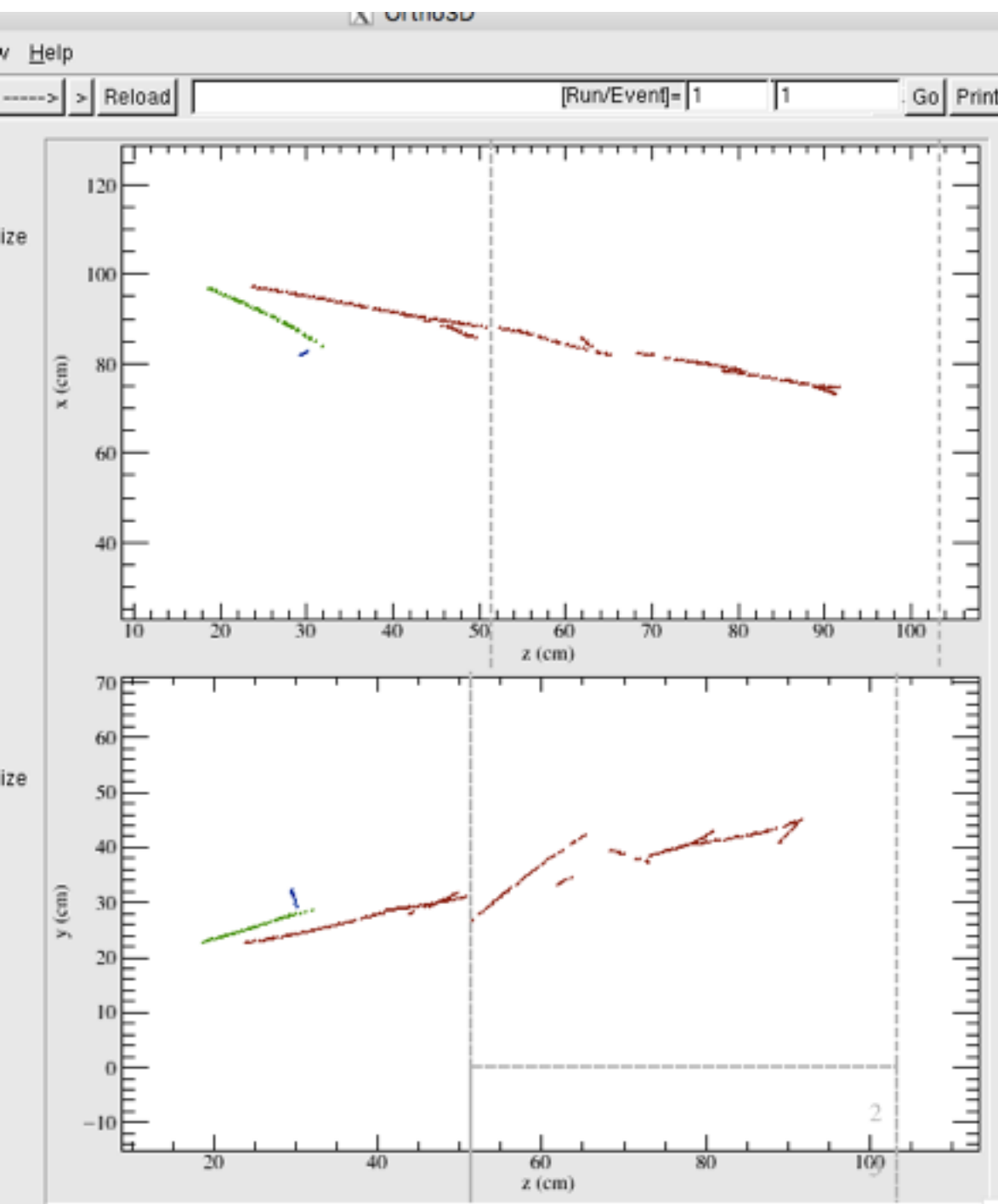

BlurredCluster   PMTrack

Example 35t pi0 event

Algorithm Details

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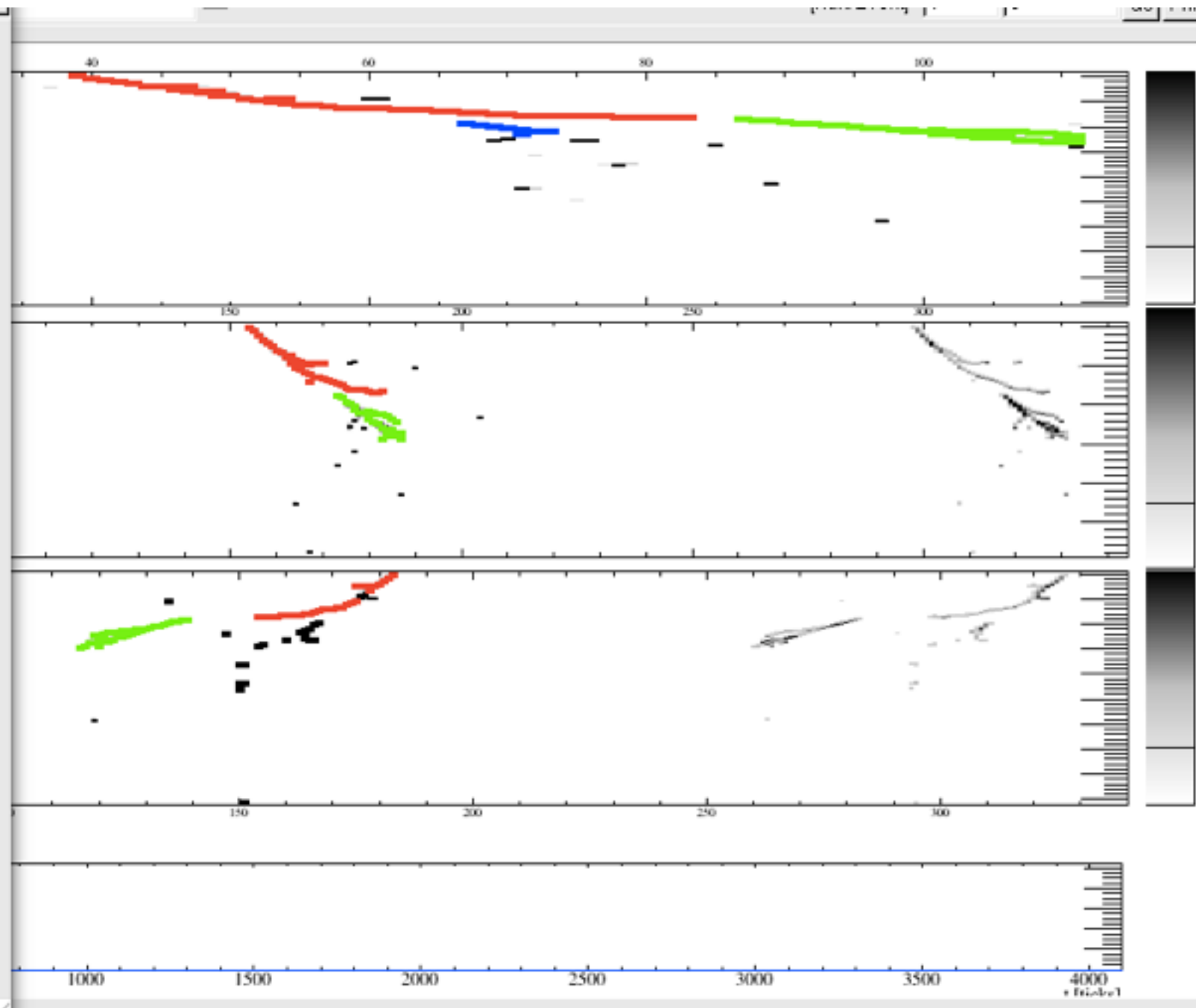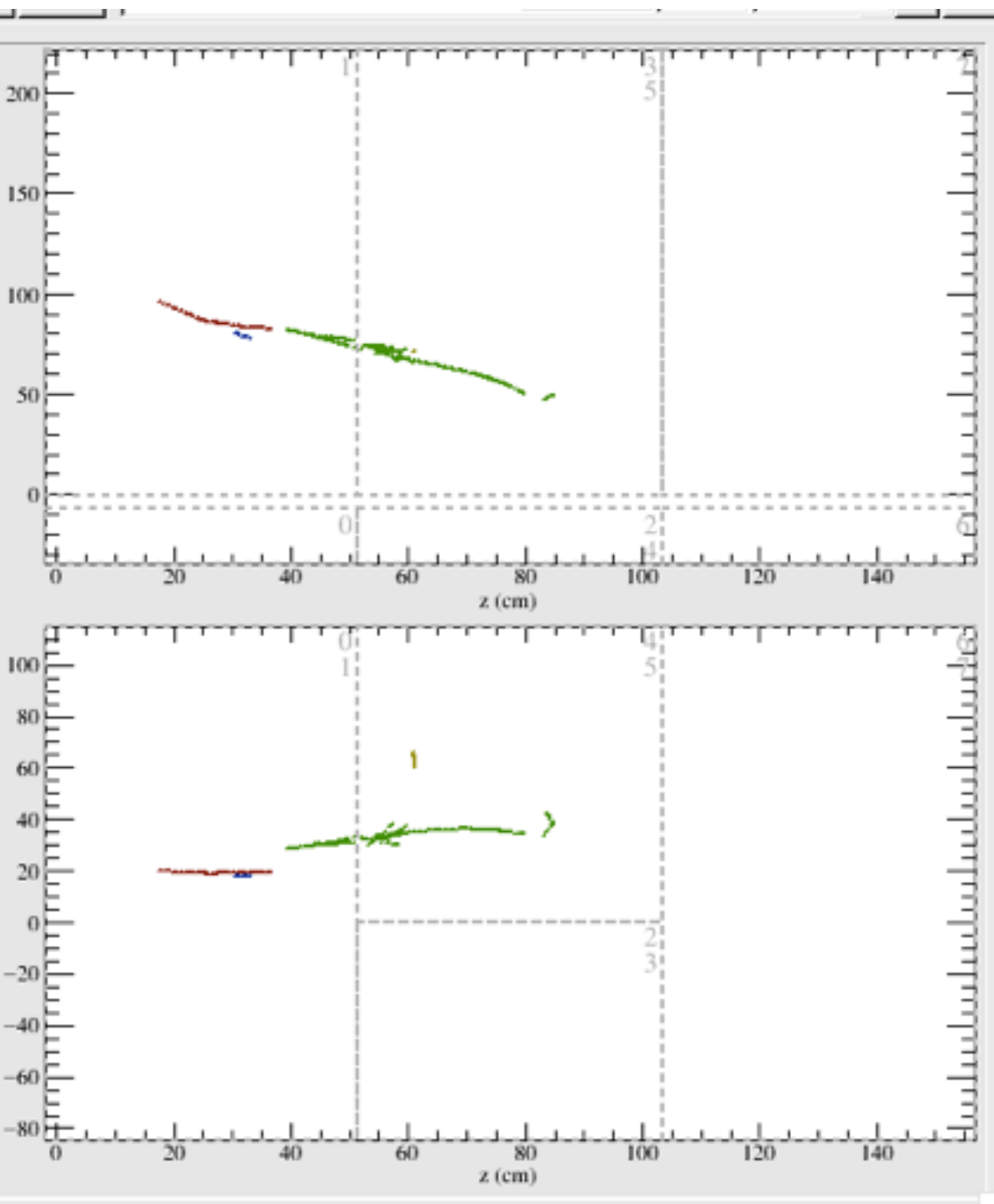

Showers!

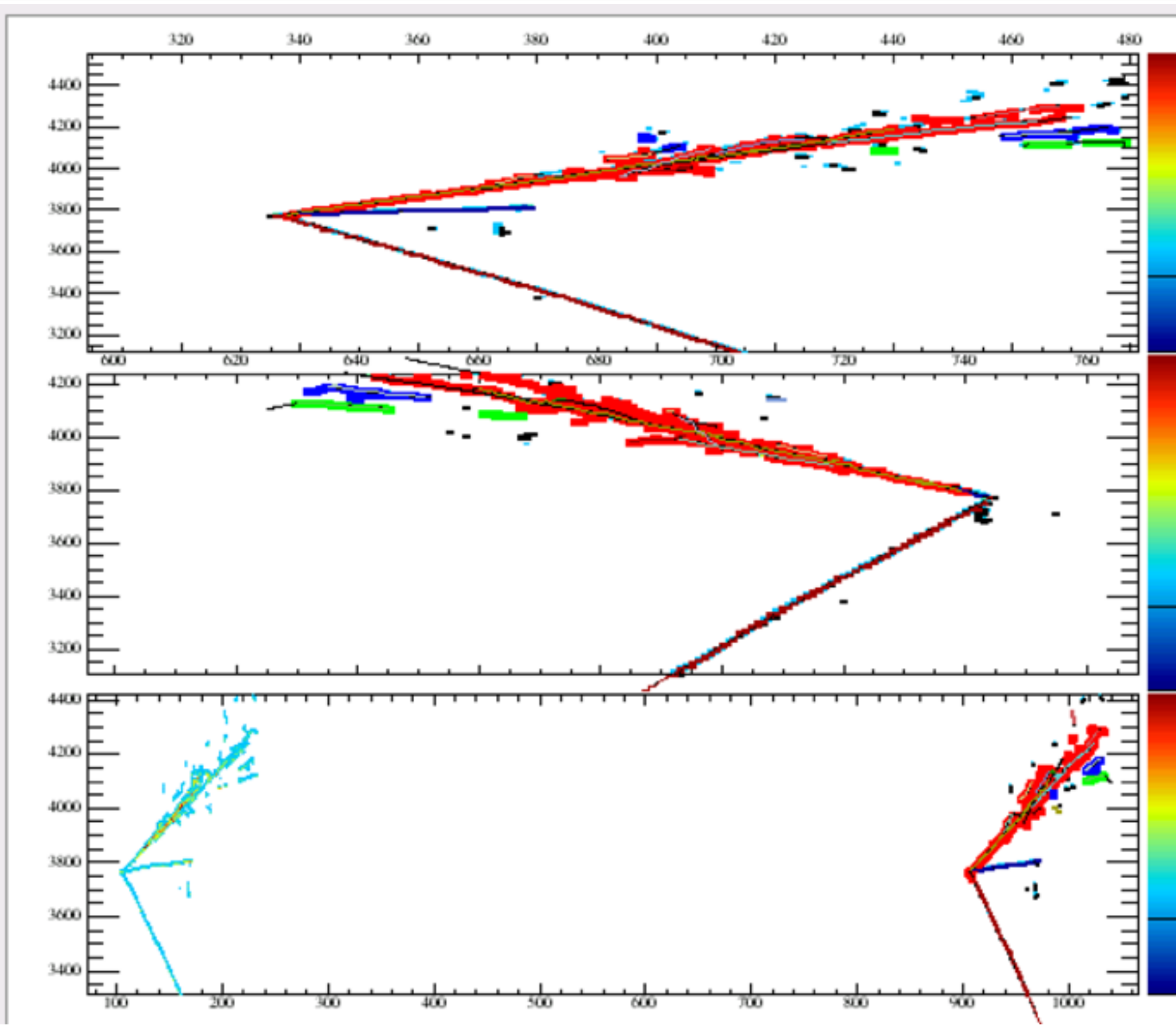Example CC1pi0 event

Example Events

35t pi0

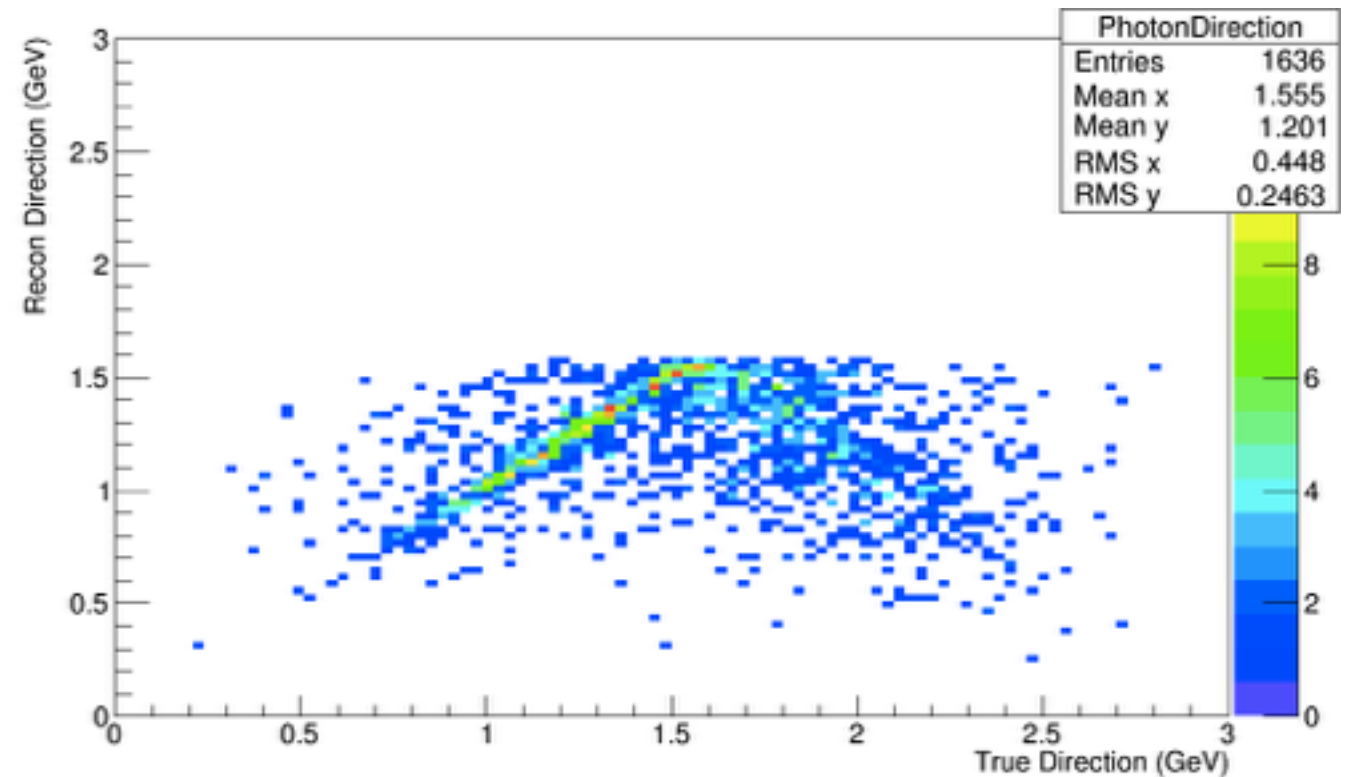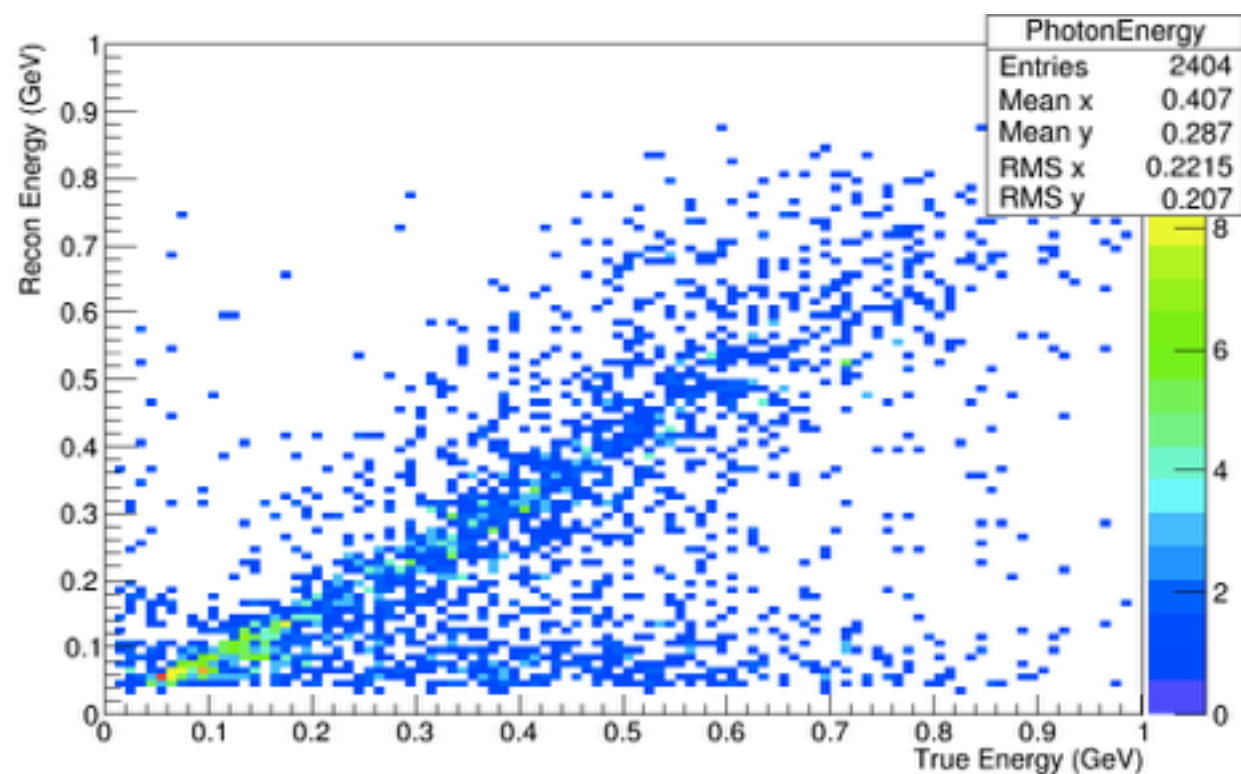# Example Events

35t pi0

Example Events

FD nueCC

Tingjun Yang

Shower Properties

- Still working on improving the properties of the showers.

- Important quantities: conversion, direction, energy, dE/dx.

- Energy (left) looks ok. Strange features at <0.1 GeV E_{recon}

- Direction is a bit strange. sin(recondir) = sin(truedir), but over ~pi/2 it's a lot messier!

Reconstructing pi0s

- Eventual aim is to develop selection to pick out pi0s from cosmic events — right now I'm just looking at pi0 particle gun!

- Very straight forward selection:

  - Exactly two separate showers of at least 50 hits.

  - These are taken to be the two photons.

- Using this, can reconstruct the pi0 mass peak!…

First Mass Peak
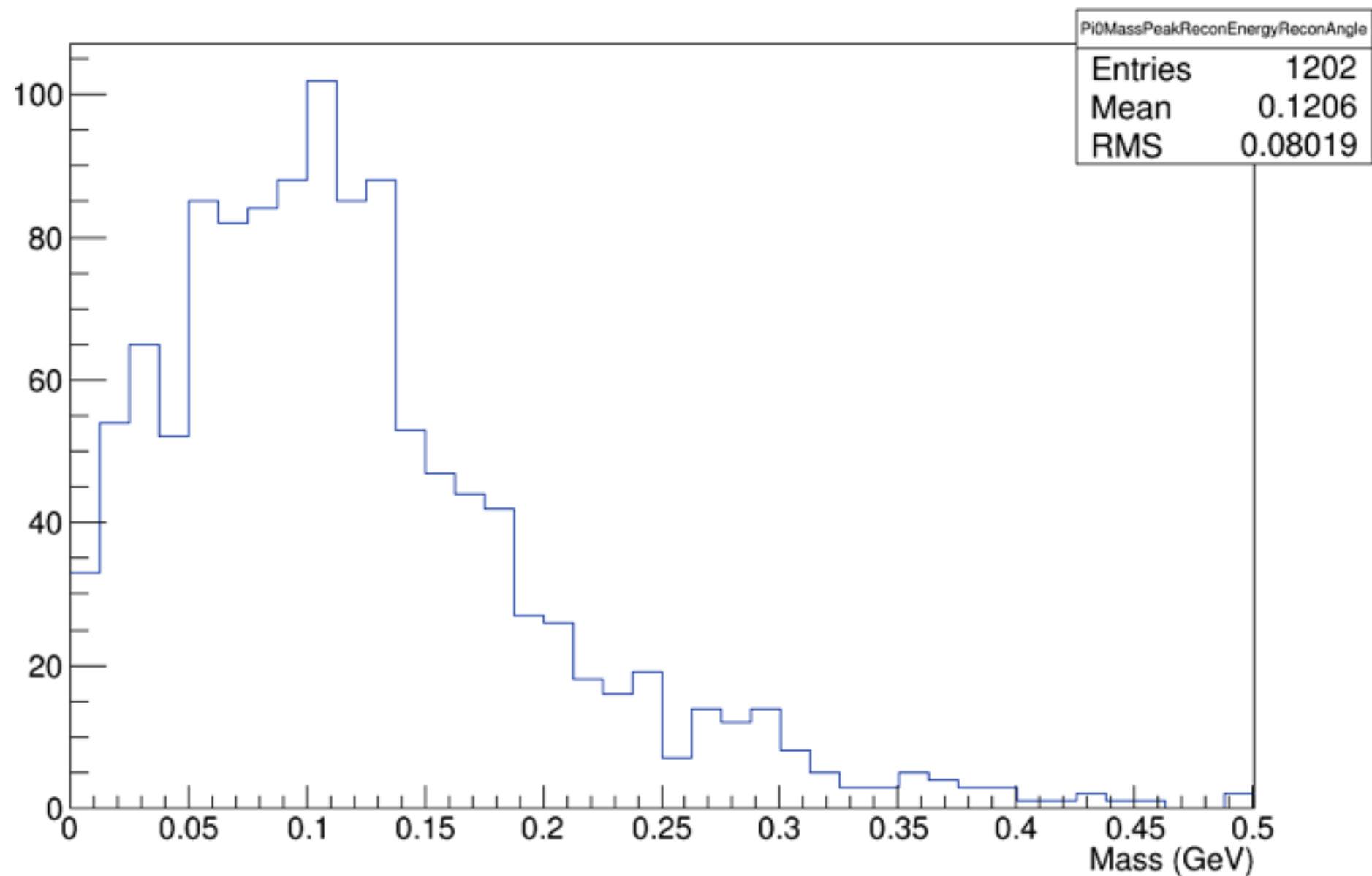
- Not bad! A bit wide… And peaks a bit low.
  See next slide for investigation.

Subtle Use of Truth
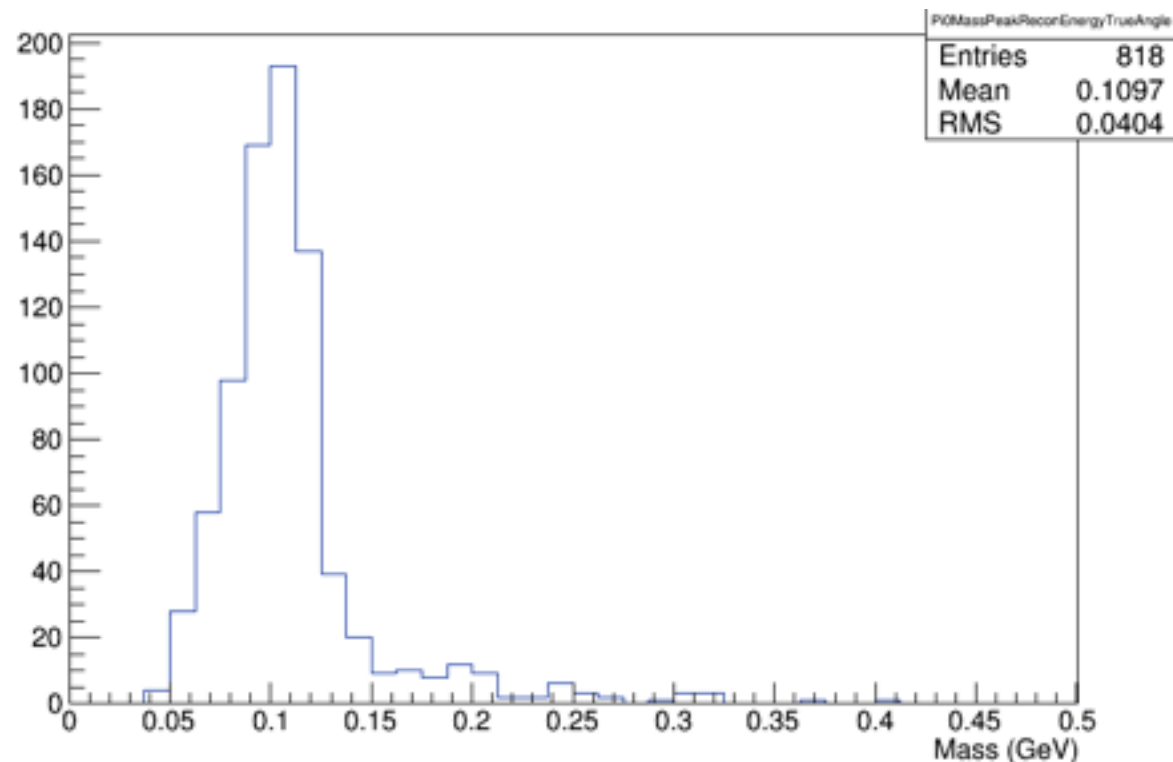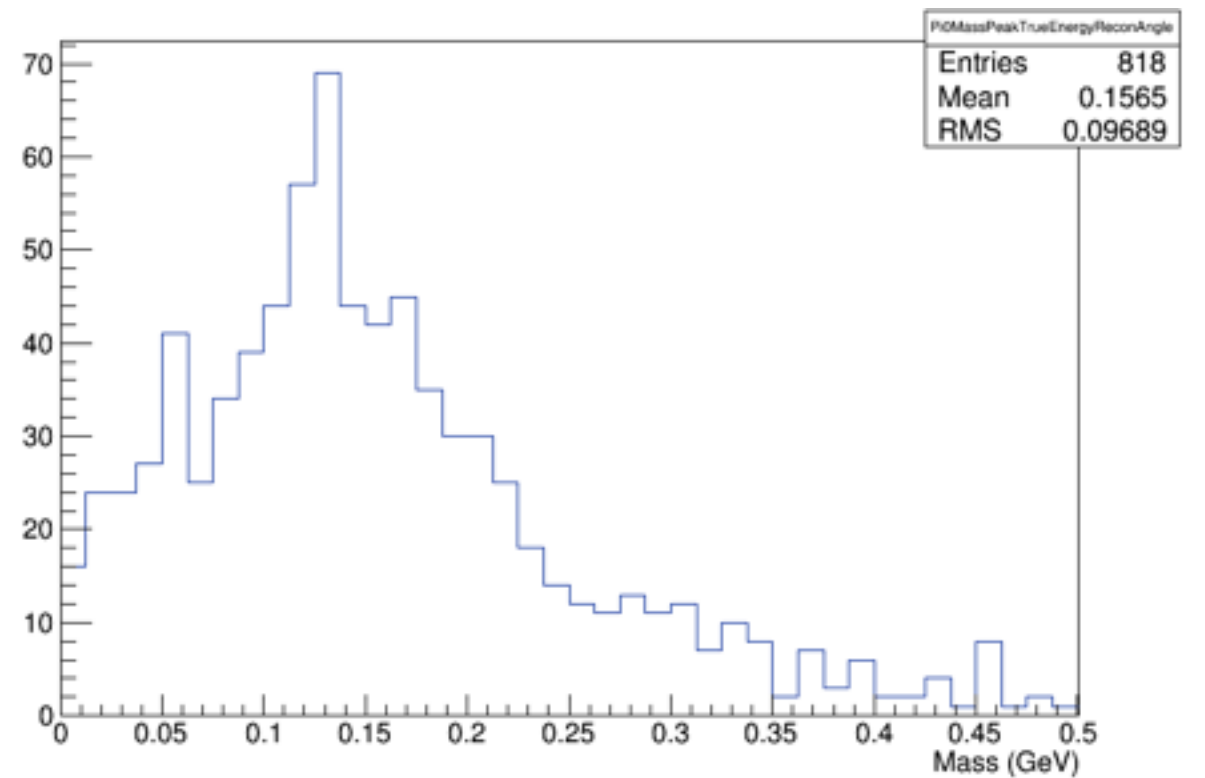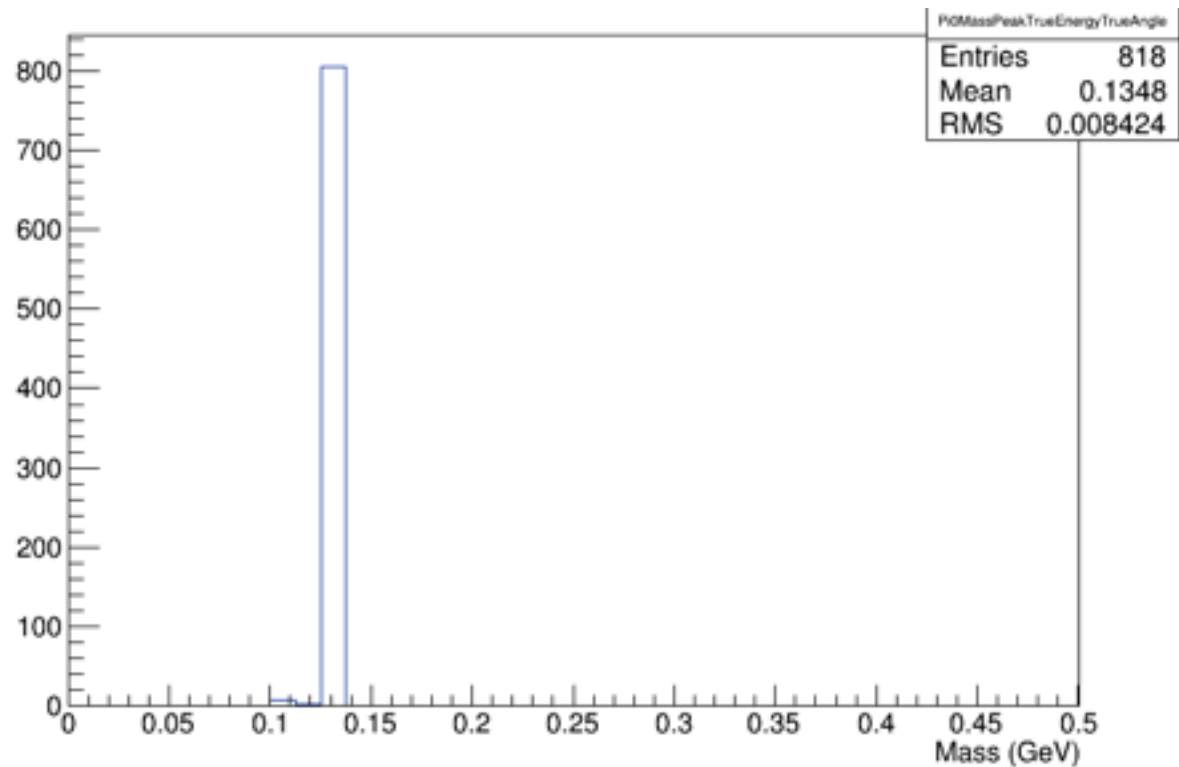
- Top left: true energy, true angle.

- Top right: true energy, recon angle.

- Bottom left: recon energy, true angle.

Notes

- Not a bad start — loads of improvements to be made!

- Looks like the reconstructed angle is the quantity that most needs to be sorted here.

- Also a problem of fragmented showers.

  - I haven't turned on cluster merging yet with the shower algorithm so will work on this next.

- All reconstructed quantities need improvements so will carry on development.

- More improvements to the showering algorithm also needed — right now if one view is bad then it breaks the whole event.

Summary

- Made improvements to BlurredCluster to even better deal with complicated pi0 decays.

  - Looks good, probably won't change much now…

- New showering algorithm, EMShower.

- First results look promising, much more development needed.

- Further validation and improved shower properties for the next meeting!

Backup

Pi0MassPeakReconEnergyReconAngle	
Entries	818
Mean	0.1223
RMS	0.07679
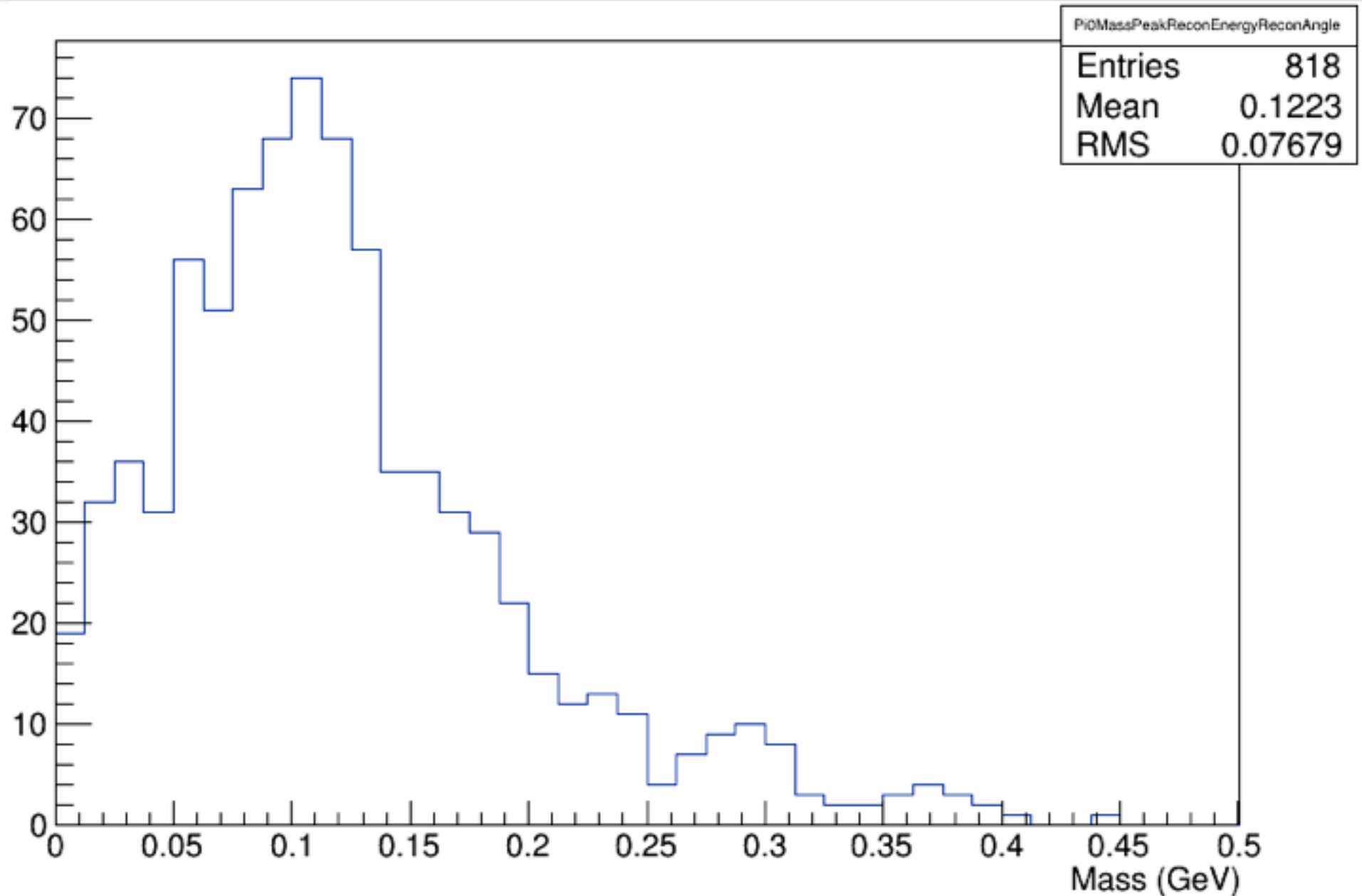
- Using truth info to neglect pi0s were both photons were identified as the same photon!