

Neutrinos in the Near Detector (This time they are real, not MC)

FERMILAB 01-27-05

Outline

- Runs used
- Data processing
- Preliminary results :
 - Event characteristics
 - Track characteristics &
 - Numbers
- Neutrino event displays.
- Summary

Neutrino Runs

- Took data during 01-21-05 & 01-22-05.
- Various runs with different run configurations (for specific studies, details in the MINOS logbook) and different POTs.
- Runs 6067_0000 6067_0001 6068_0000 6068_0001 6068_0002 & 6068_0003 are SGATE runs, taken with the beam on target in the pseudo medium configuration with $\sim 2.5 \times 10^{12}$ POTs per pulse and a total of 263 pulses (1 spill every 1 minute with 1 batch per spill).
- All (preliminary) results presented are from these Runs.

Data processing

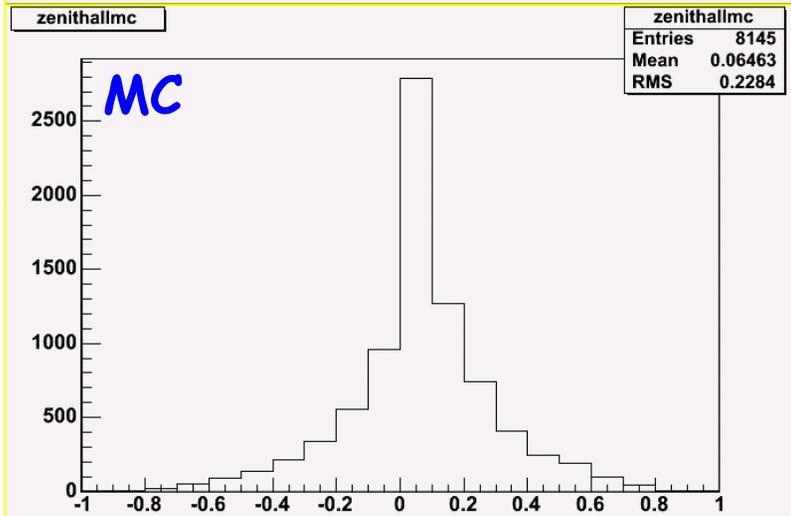
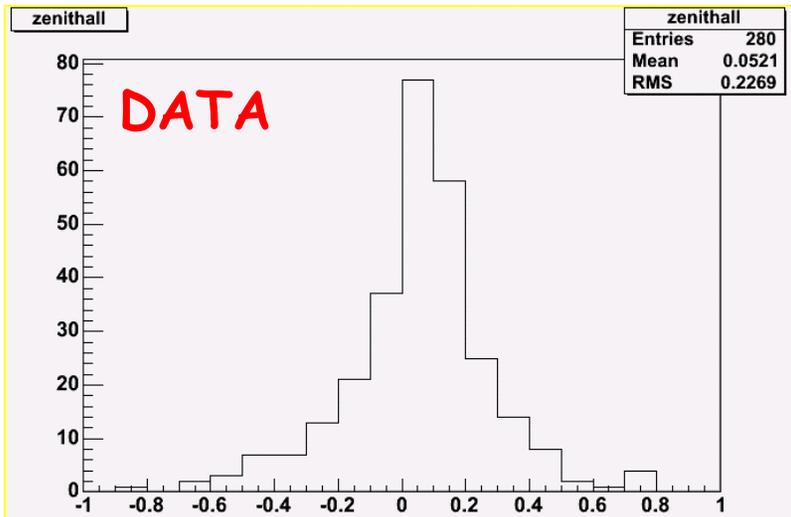
- Magnet off BUT residual magnetic field present (there was no proper degauss procedure, power supply died suddenly). Reconstructing assuming either zero or nominal magnetic field is not 100% correct...
- Processed events with :
 - Nominal field map for the reconstruction
 - Development release
 - ASAP slicer (due to a bug that Rustem & Tom found in the Strip Sorting, SR slicer gave strange results before yesterdays fixes by Robert and we could not use it).

CUTS USED :

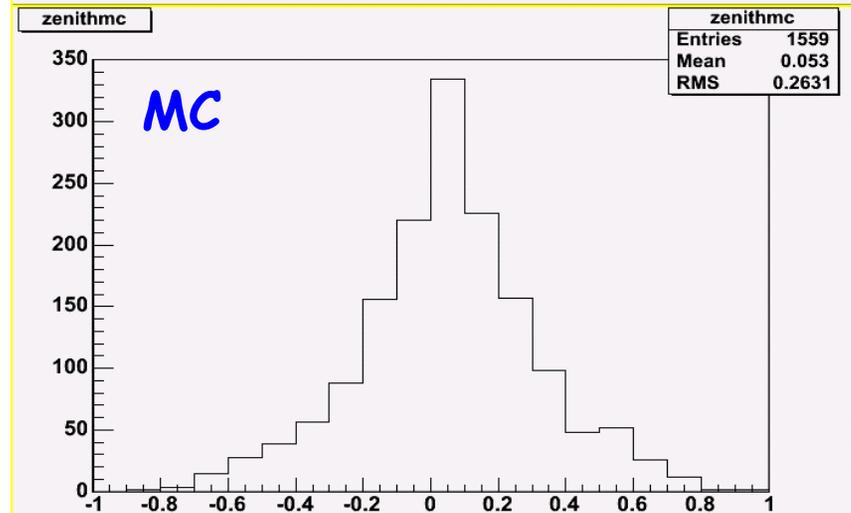
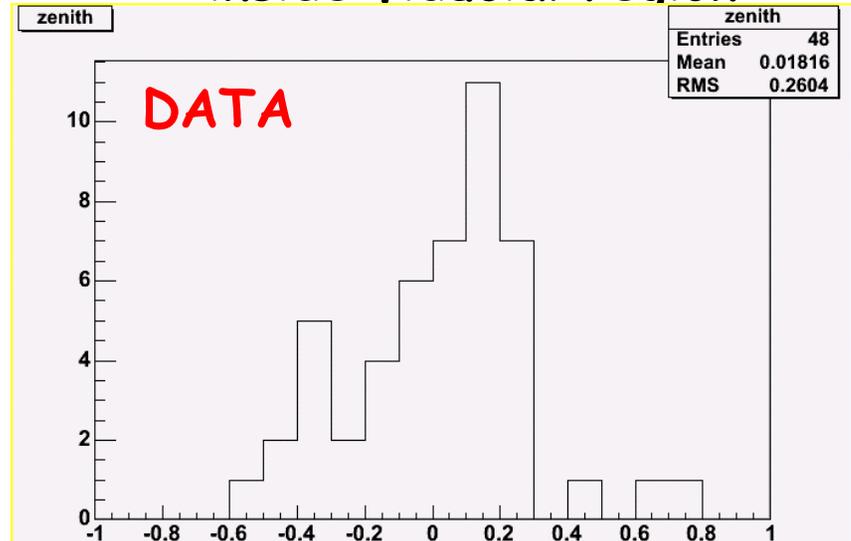
- At least one track in the event
- Track starting position 1m around beam center, $z > 1$ && $z < 6.2$

Event characteristics : Direction

Cosine zenith angle:
All tracks

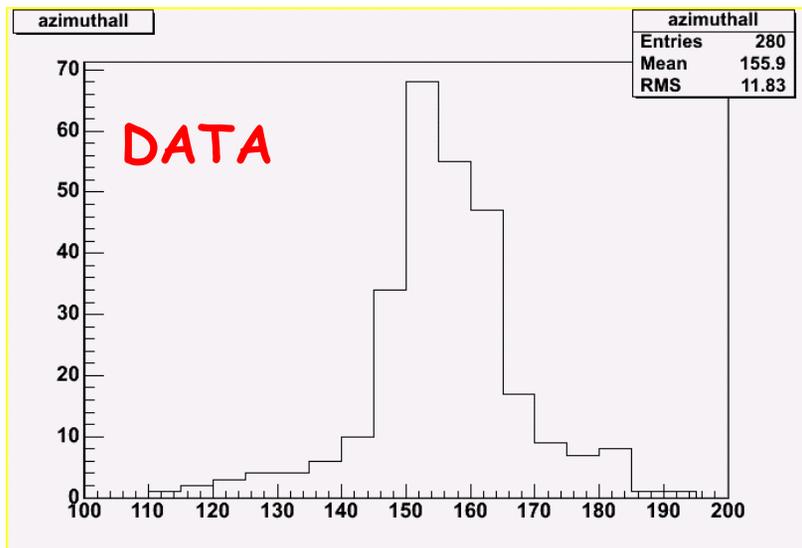


Cosine Zenith angle: tracks
inside fiducial region

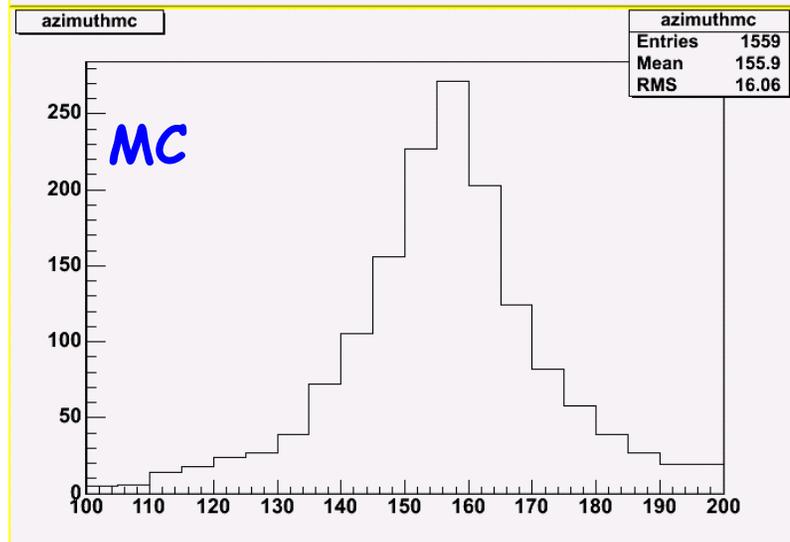
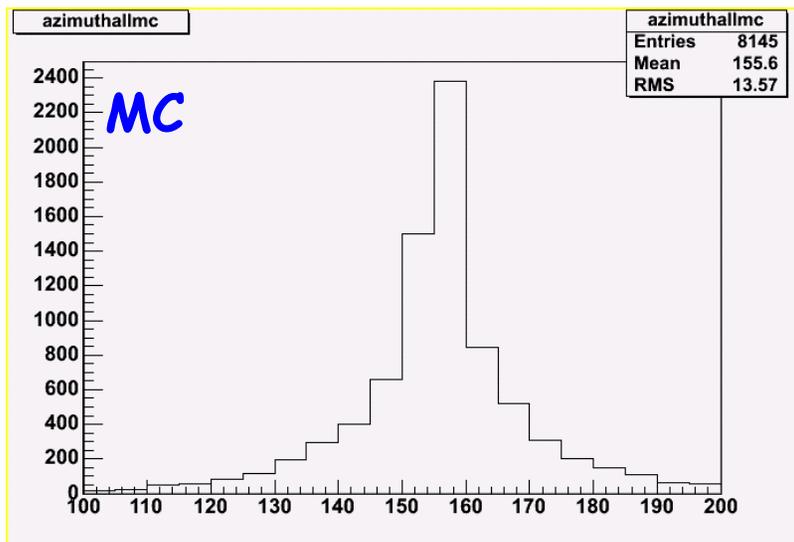
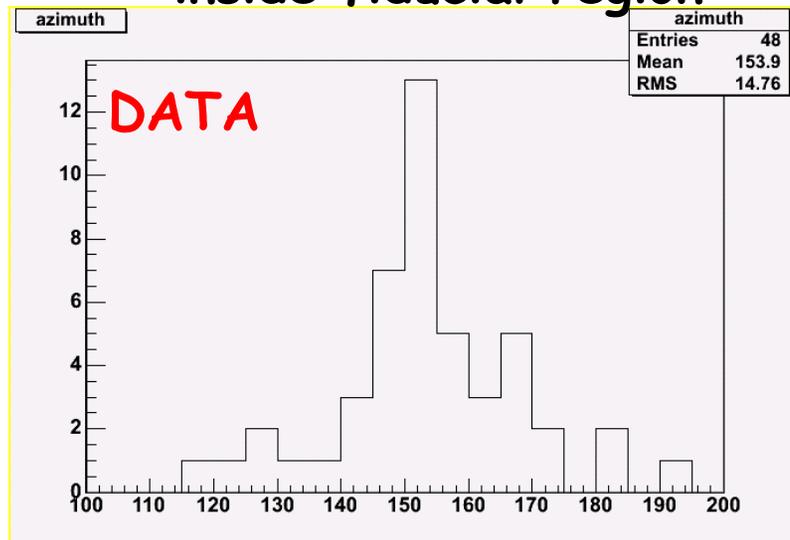


Event characteristics : Direction con't

Azimuth angle All tracks

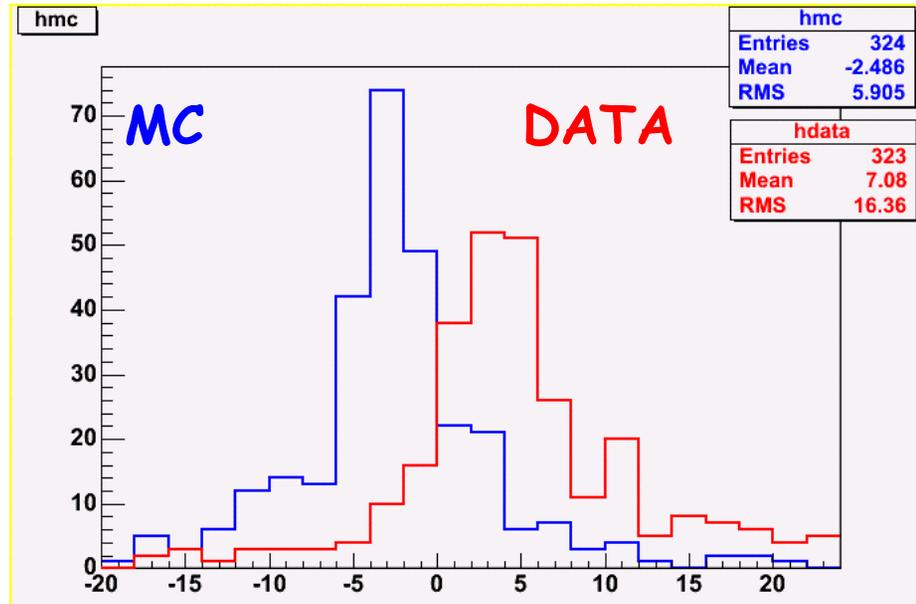


Azimuth angle tracks inside fiducial region



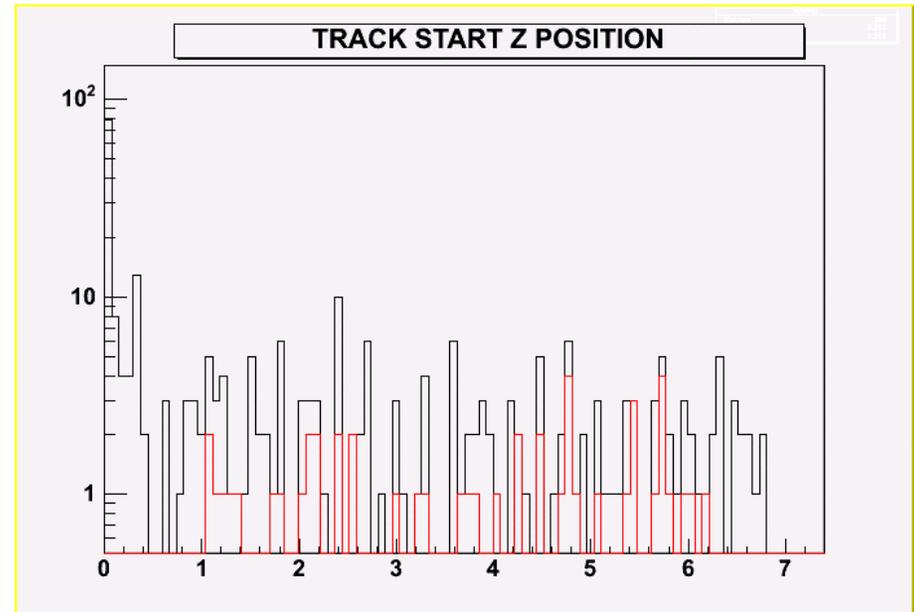
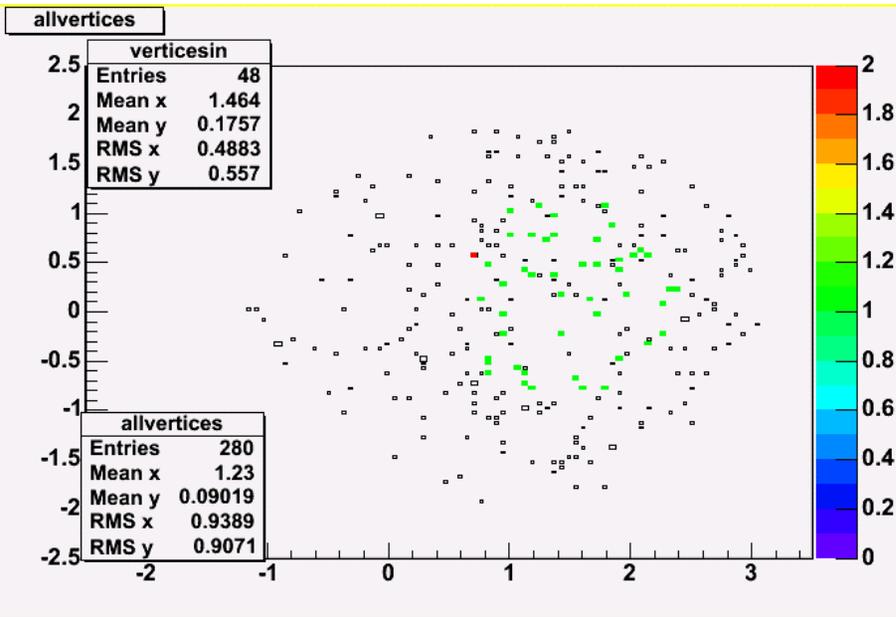
Event characteristics : Magnetic Field

- Although we were not running with the “nominal” magnetic field, the residual field allowed us to do some important sanity tests:



- The estimated momentum from curvature was mostly positive (than negative as we expect from neutrino interactions).
- However (as you will see later) the tracks were really focused as negative particles towards the coil.
- Rob P. and Cat performed tests to verify the magnetic field orientation, and Robert H. found the problem (in software) and fixed it.

Event characteristics : x y z position of selected events

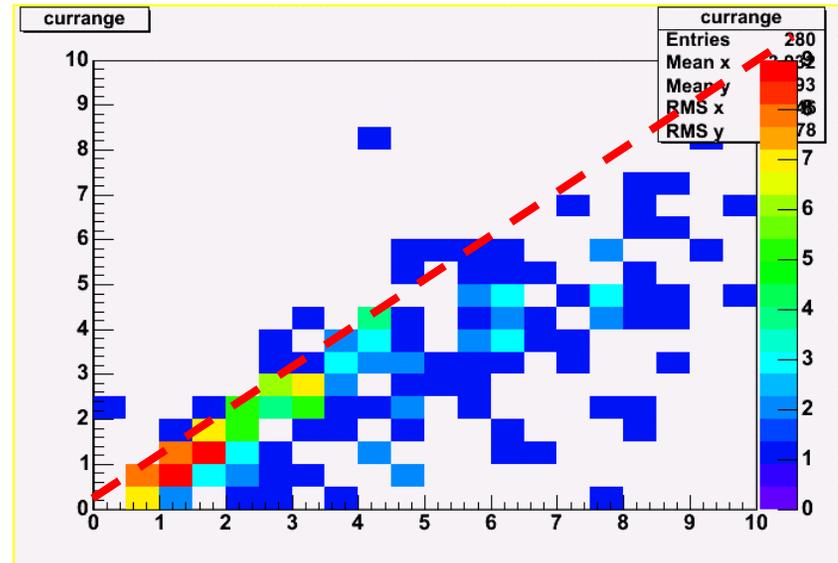
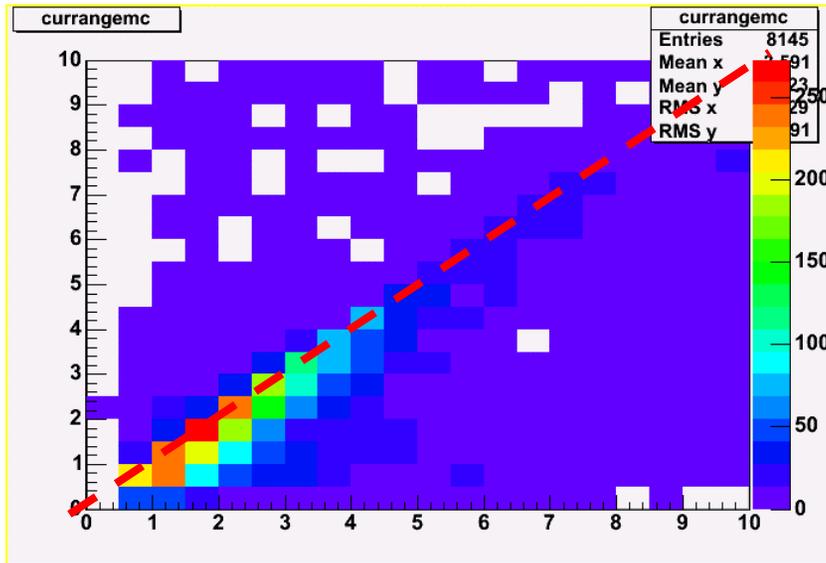


Y vs X position of all tracks (box) and the ones in the fiducial region (color)

Z position of all tracks (blacks) and the ones in the fiducial region (red)

- So far we saw that events are coming from the beam and there is nothing unusual with the distribution of vertices in x y and z.

Event characteristics : Track momentum (All tracks)

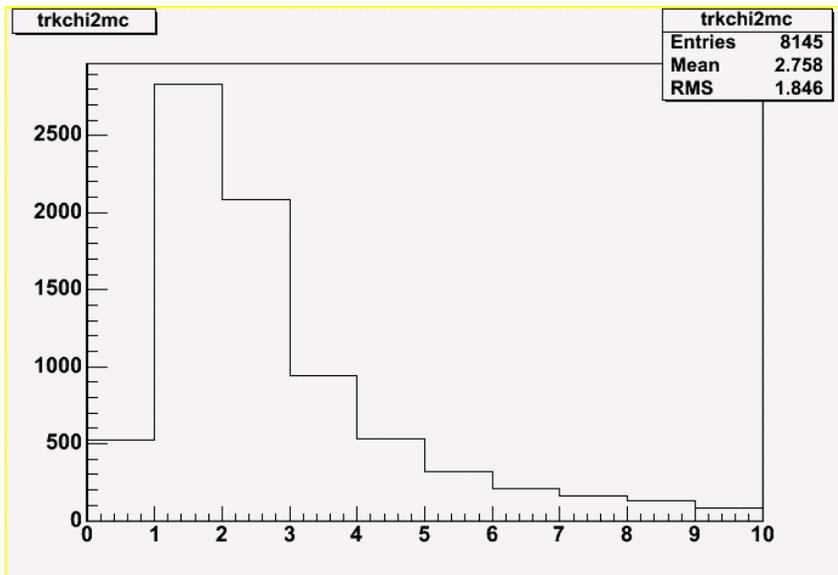


Range vs curvature MC

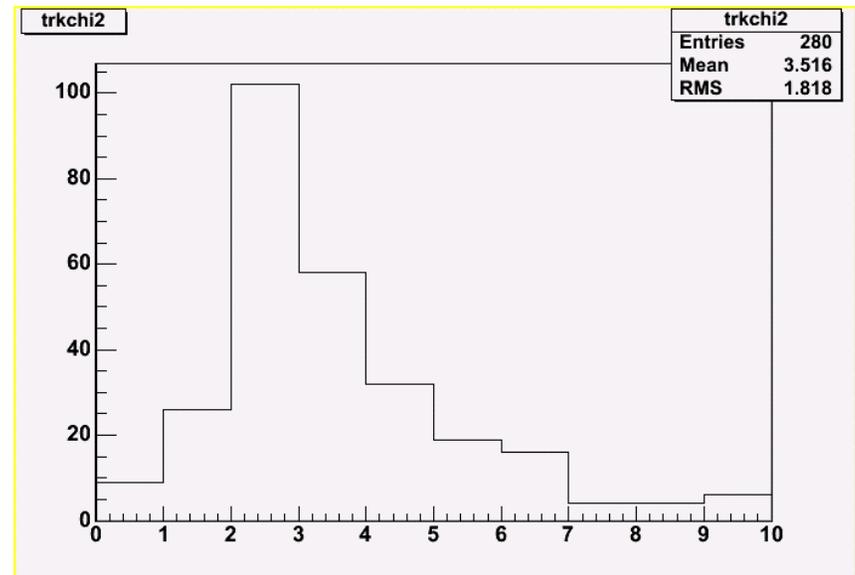
Range vs curvature DATA

- We know momentum from curvature is not right.
- It is hard to define stopping tracks due to complicated ND geometry.
- So we compared momentum from curvature and momentum from range as a basic sanity test.
- They are not that far apart...

Event characteristics : Track Chi-square (All tracks)



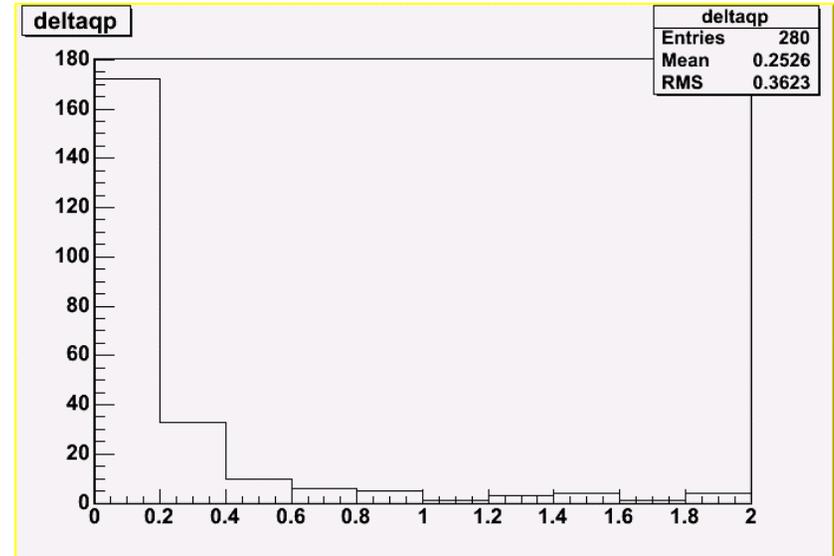
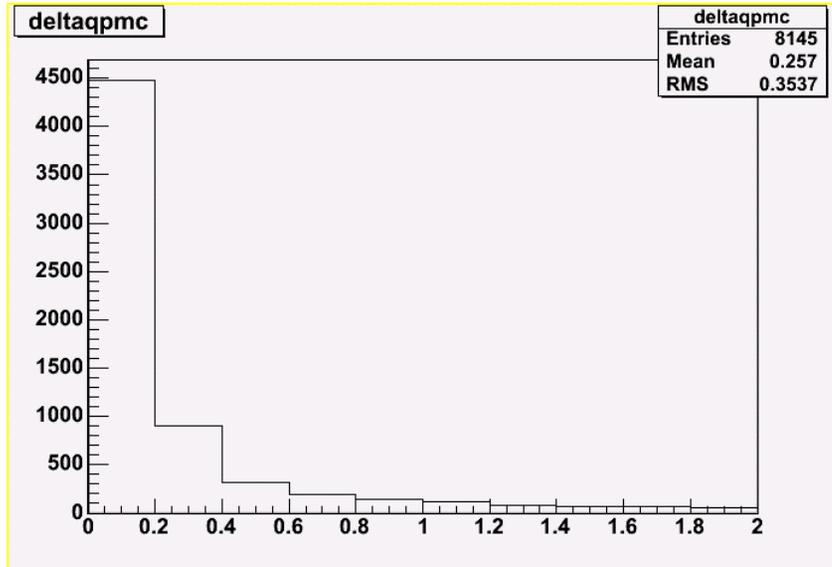
Track chi-square: *MC*



Track chi-square : *DATA*

- Track chi-square for DATA larger than MC as expected. The magnetic field we are using to reconstruct is the nominal one but the true magnetic field is not the nominal one.

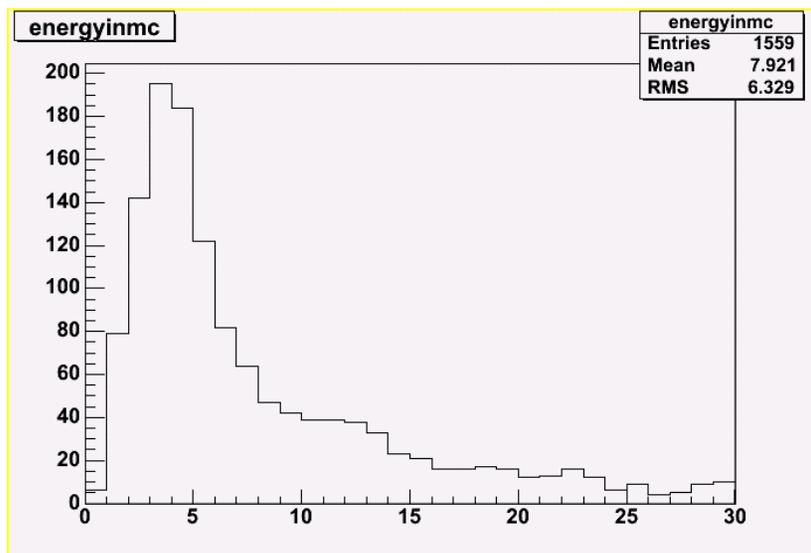
Event characteristics : Track $\sigma(q/p)/(q/p)$ (All tracks)



Track $\sigma(q/p)/(q/p)$: MC Track $\sigma(q/p)/(q/p)$: DATA

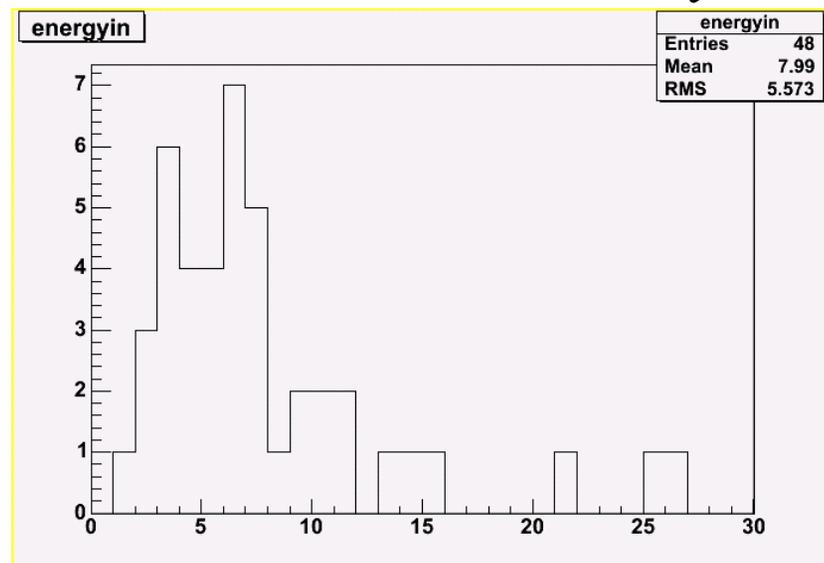
• Track $\sigma(q/p)/(q/p)$ is similar between data and MC although we are not using the correct field map...

Event characteristics : Neutrino energy (VERY PRELIMINARY AND MAYBE MEANINGLESS AT THIS POINT)

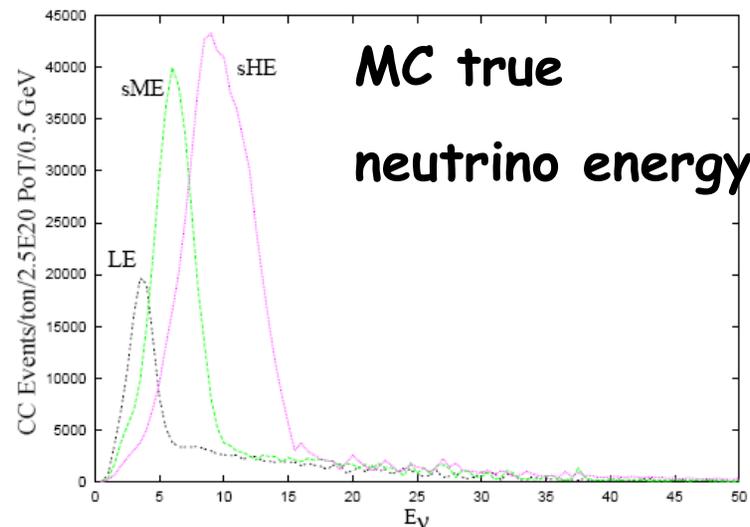


Reco Neutrino energy : MC
low energy beam

Reconstructed spectrum shows a tendency for higher neutrino energies compatible with the sME beam



Reco Neutrino energy : DATA



Event Numbers PRELIMINARY

- Used the number of events (total per snarl & satisfying our criteria) from the LOW energy MC with an intensity of 2.5×10^{13} POTs.
- First counted the number of events per spill for the LOW energy MC
 - 1 Total number of reconstructed events per spill and
 - 2 Total number of reconstructed events per spill that satisfy our cuts).
- Then divided by 10 to correct for the data intensity that is $\sim 2.5 \times 10^{12}$ for the runs we are using.
- Finally multiplied by 2 which the factor that scales low energy to pseudo medium energy neutrino interactions.

Event Numbers PRELIMINARY : expectations

1 Total number of reconstructed events per spill for LOW energy

MC:

-10462 MC Reco events for 1650 spills = 6.3 events/spill

-Scaling for the 2.5×10^{12} = $6.3/10 = 0.63$ events/spill

-Scaling for the 2 times more neutrino events with the sME beam, vs Low energy = $0.6 \times 2 = 1.26$ events/spill (including rock muons) and a total of 1.26×263 spills = 331 events

2 Total number of reconstructed events per spill that satisfy our cuts for LOW energy MC:

-1559 MC Reco events in the fiducial region with a track for 1650 spill = 0.94 events/spill

-Scaling for the 2.5×10^{12} = $0.94/10 = 0.094$ events/spill

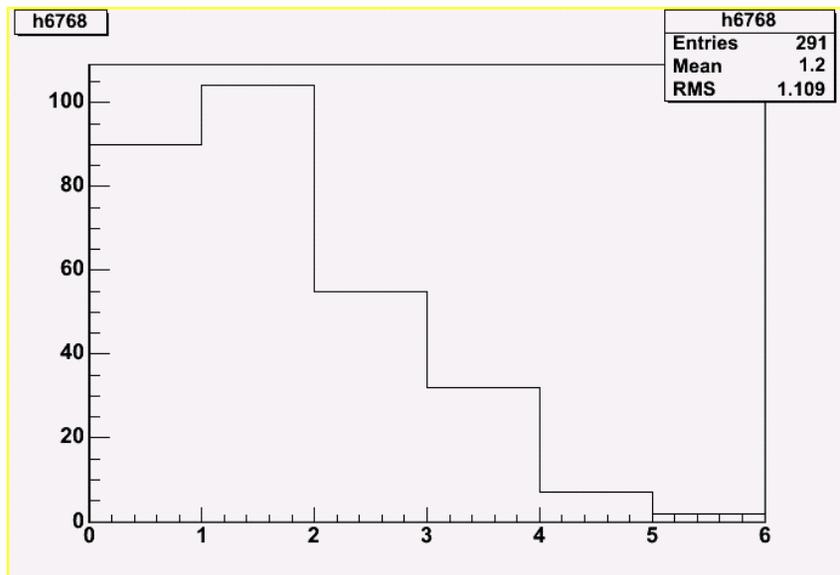
-Scaling for the 2 times more neutrino events with the sME beam, vs Low energy = $0.094 \times 2 = 0.189$ events/spill inside the fiducial region that also have a track and a total of 0.189×263 spills = 50 events

Event Numbers PRELIMINARY : observed events

1.26 events/spill (including rock muons) and a total of 1.26×263 spills = 331 events expected 354 : Observed

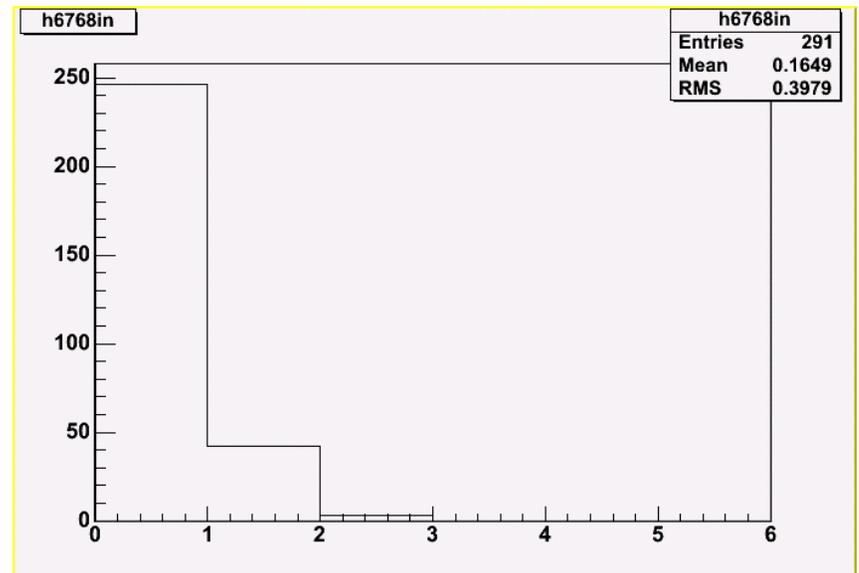
0.189 events/spill inside the fiducial region that also have a track and a total of

0.189×263 spills = 50 events expected 48 : Observed



Total events per spill, mean at 1.2, ~1.3 expected

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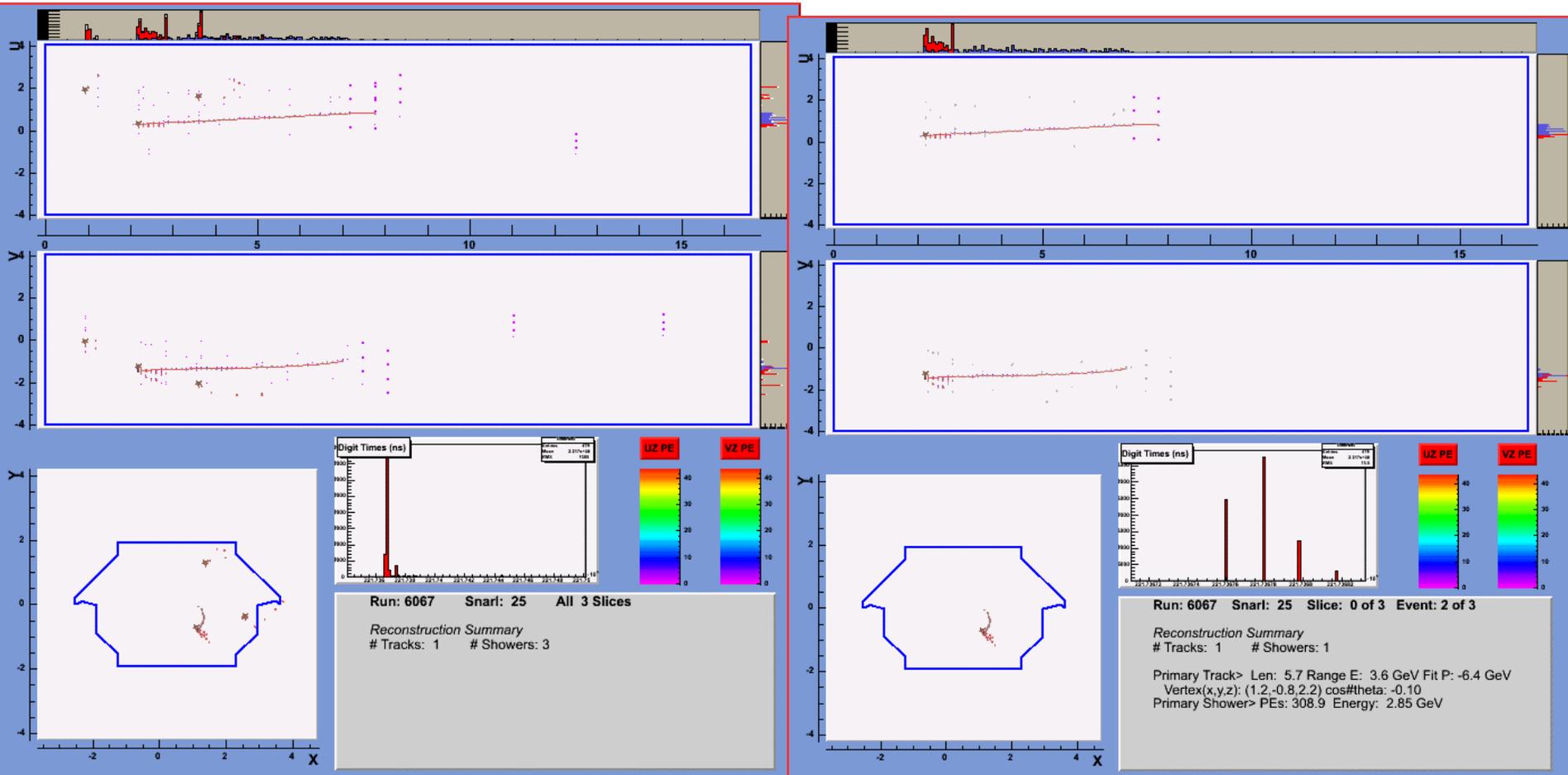


Total events per spill satisfying track and fiducial cuts, mean at 0.17 ~ 0.19 expected

Visual Scan of the Events

- So far what we see is close to what we expect...(preliminary results that are going to be checked and studied again).
- From a visual scan of many events and in particular here the first 10-15 which satisfy the fiducial cuts the reconstruction seems to be doing a quite decent job with a few failures of course that need to be checked more carefully and in detail.
- I just show in the next page these first 10-15 events...

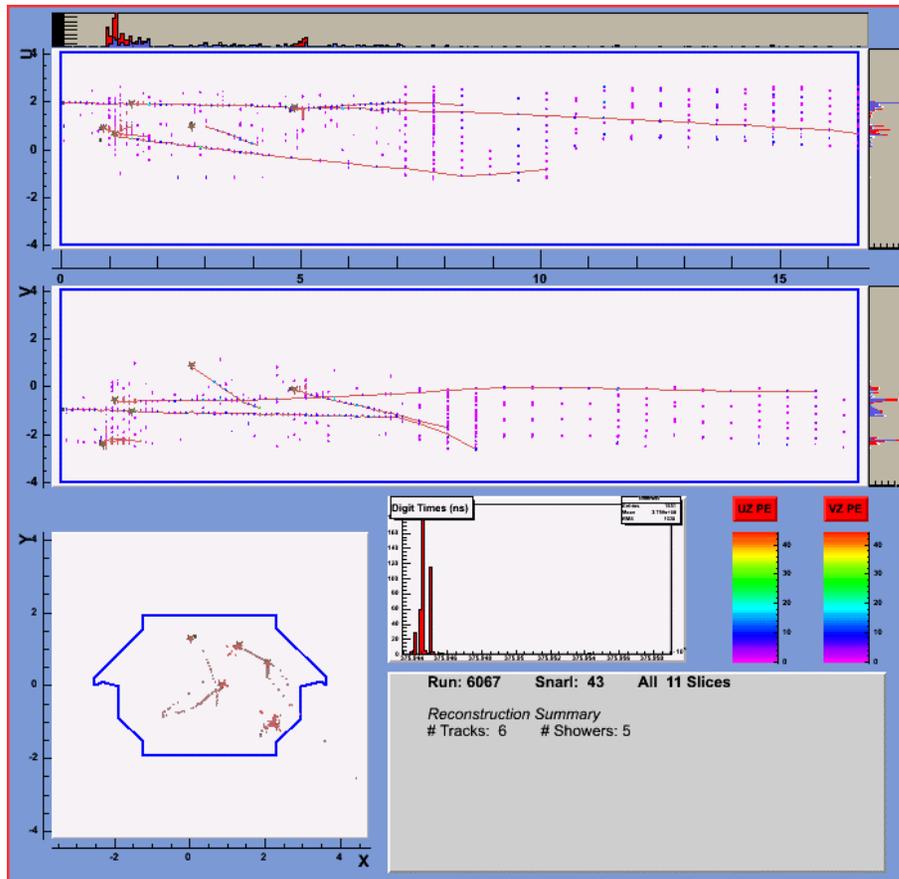
Run 6067 Snarl 25 Event 1



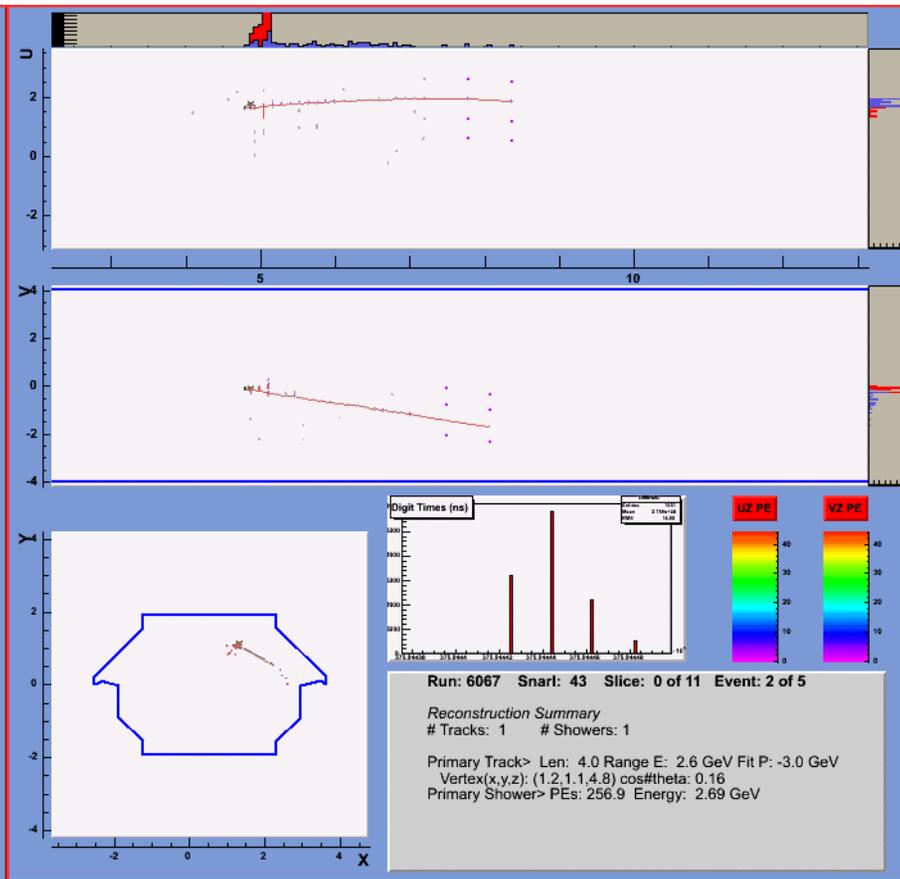
SPILL

EVENT

Run 6067 Snarl 43 Event 1

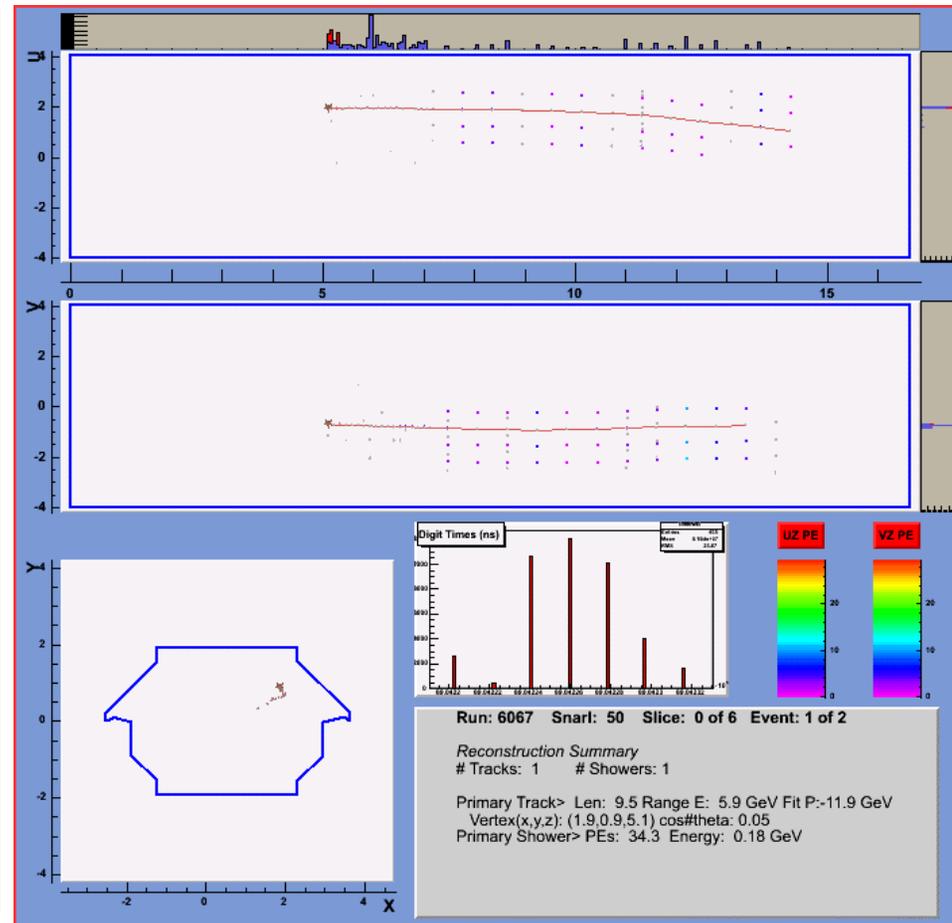
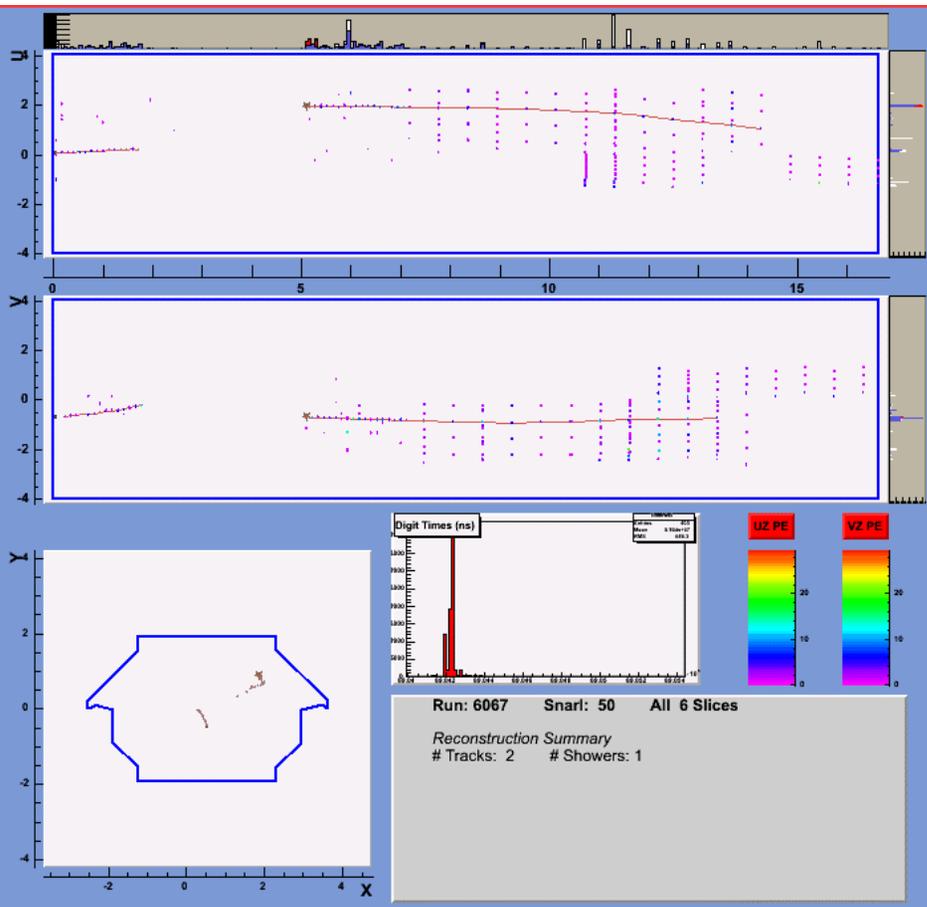


SPILL



EVENT

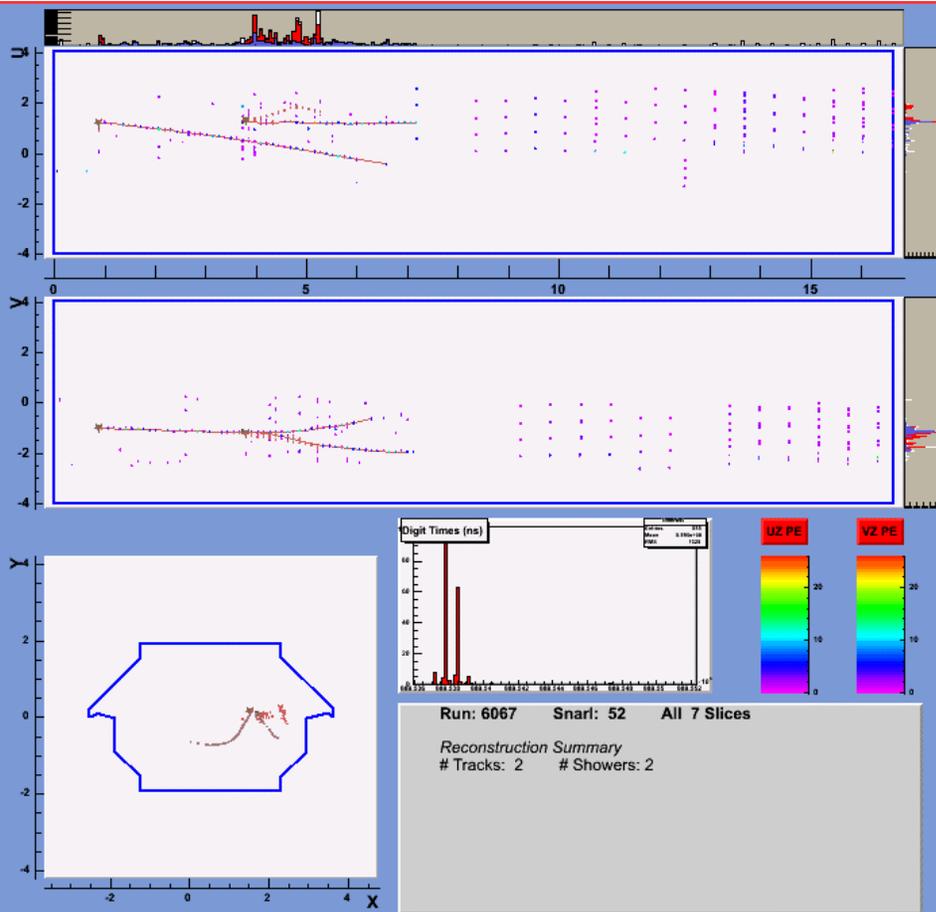
Run 6067 Snarl 50 Event 0



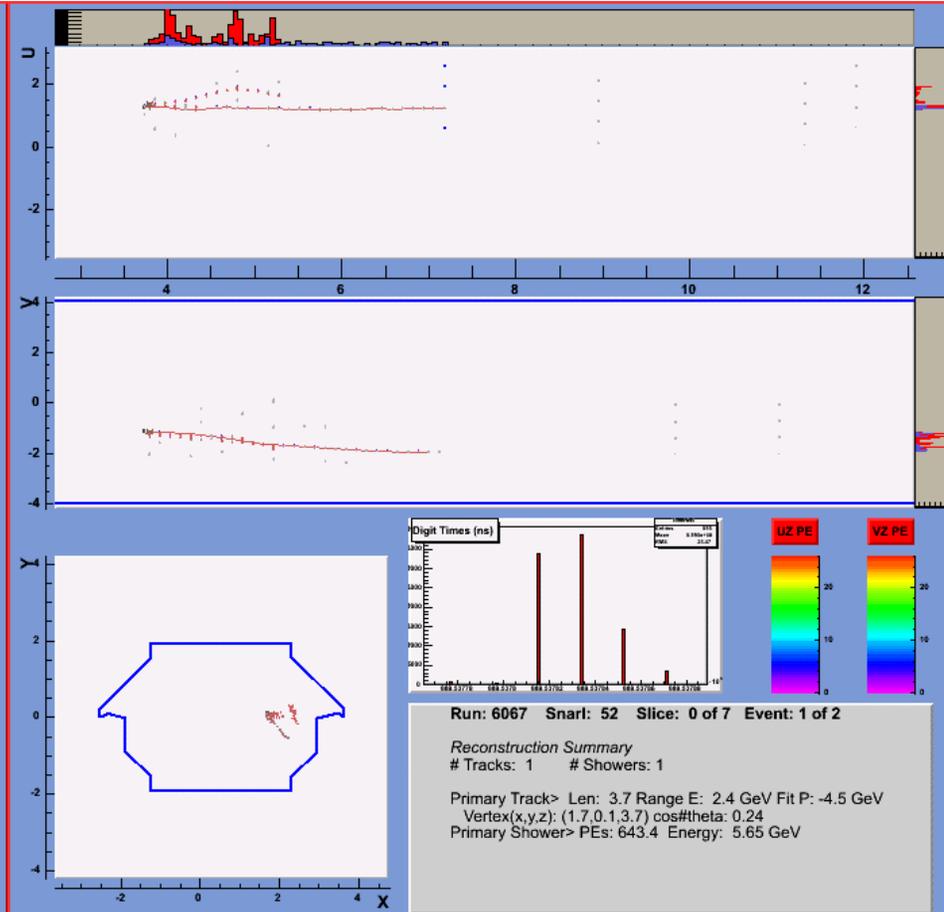
SPILL

EVENT

Run 6067 Snarl 52 Event 0

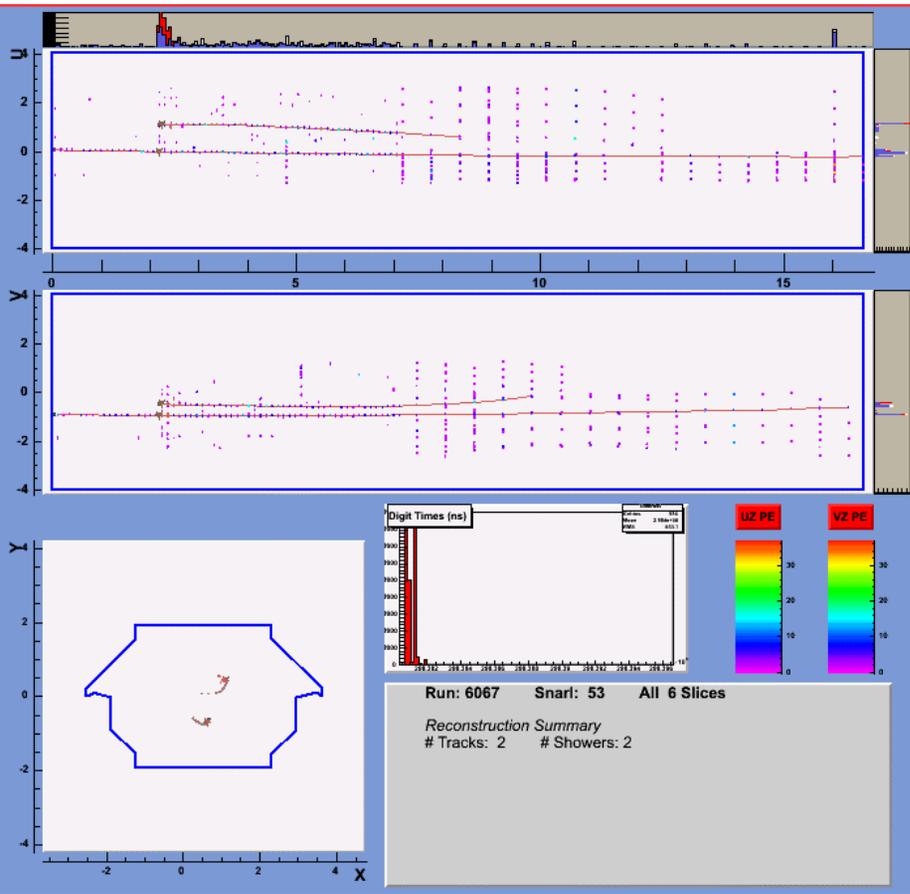


SPILL

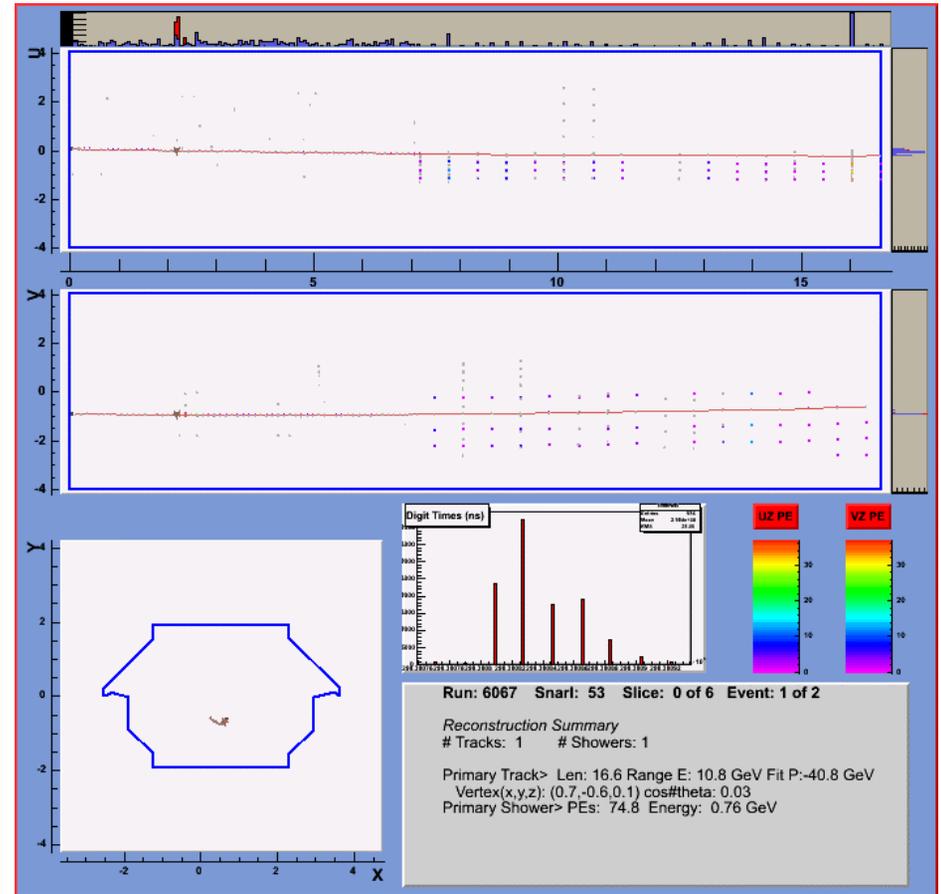


EVENT

Run 6067 Snarl 53 Event 1 (ROCK Event)

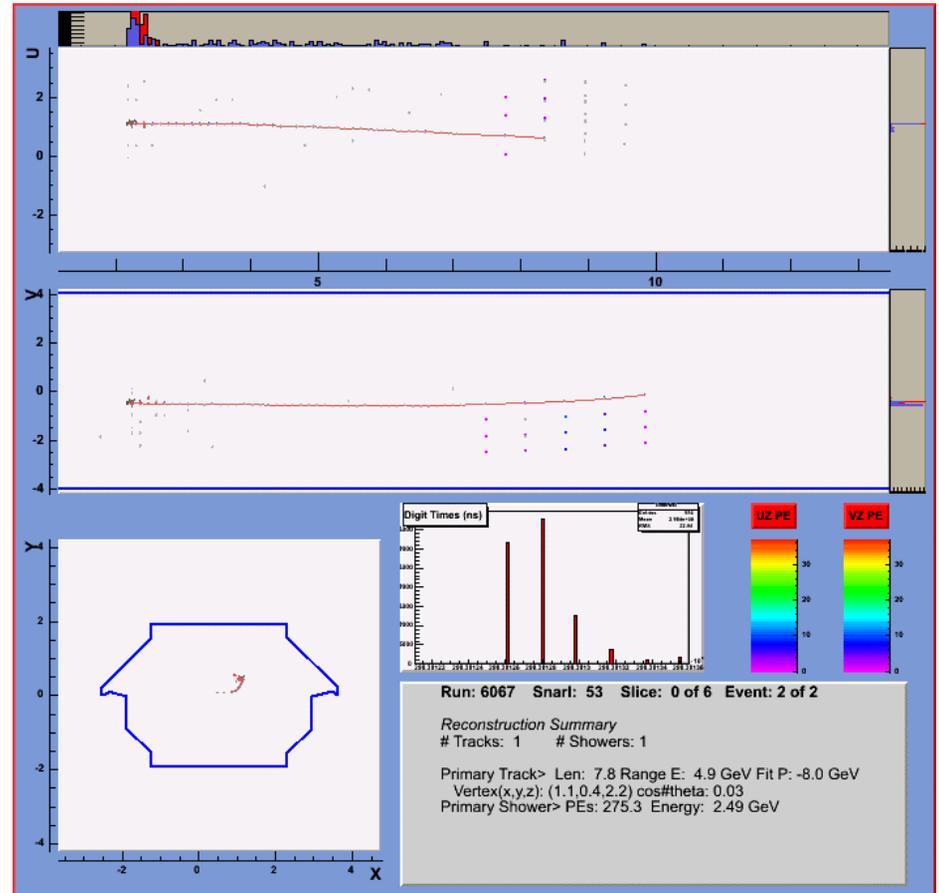
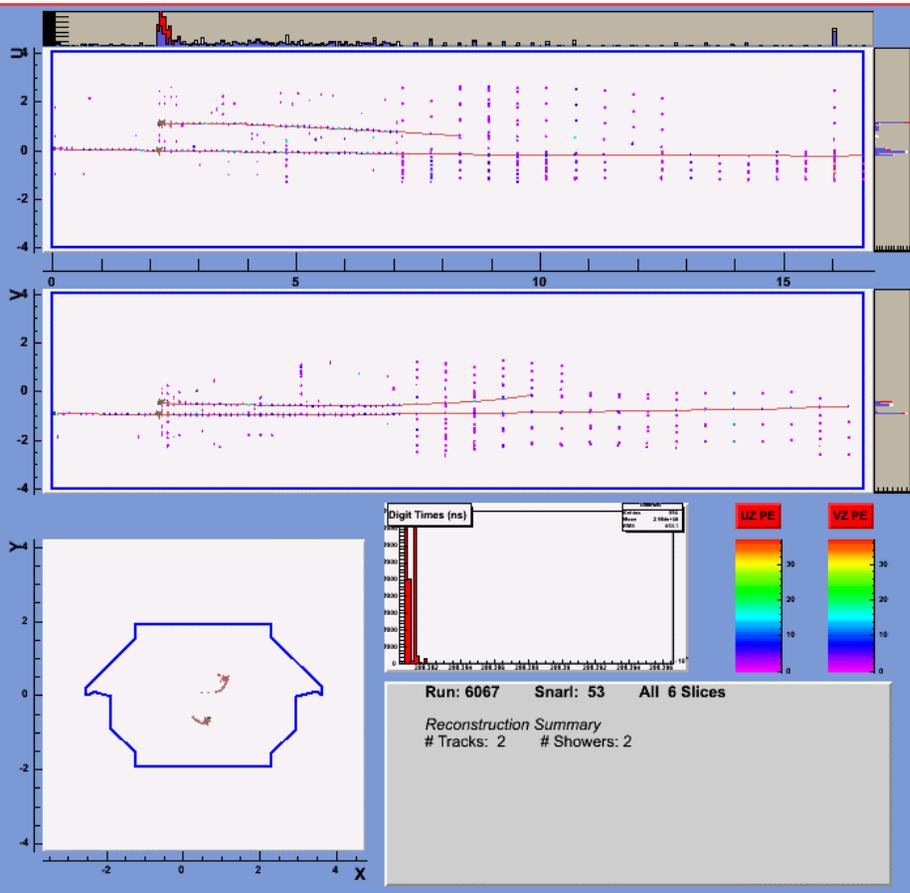


SPILL



EVENT

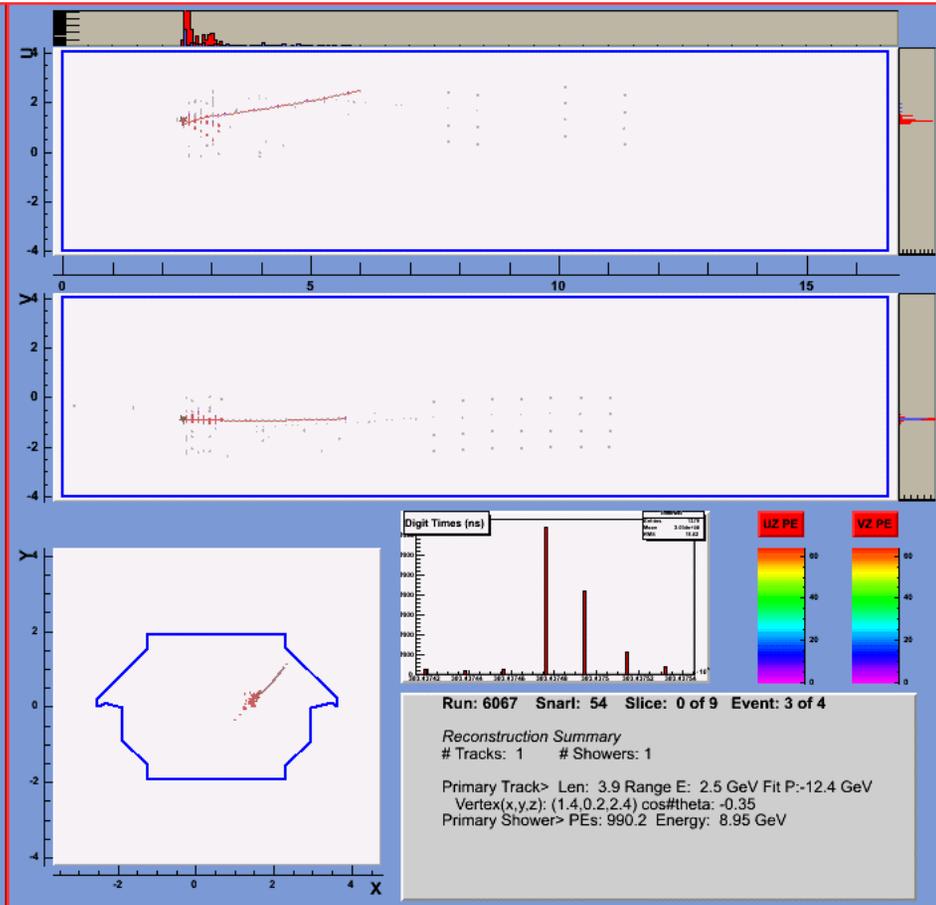
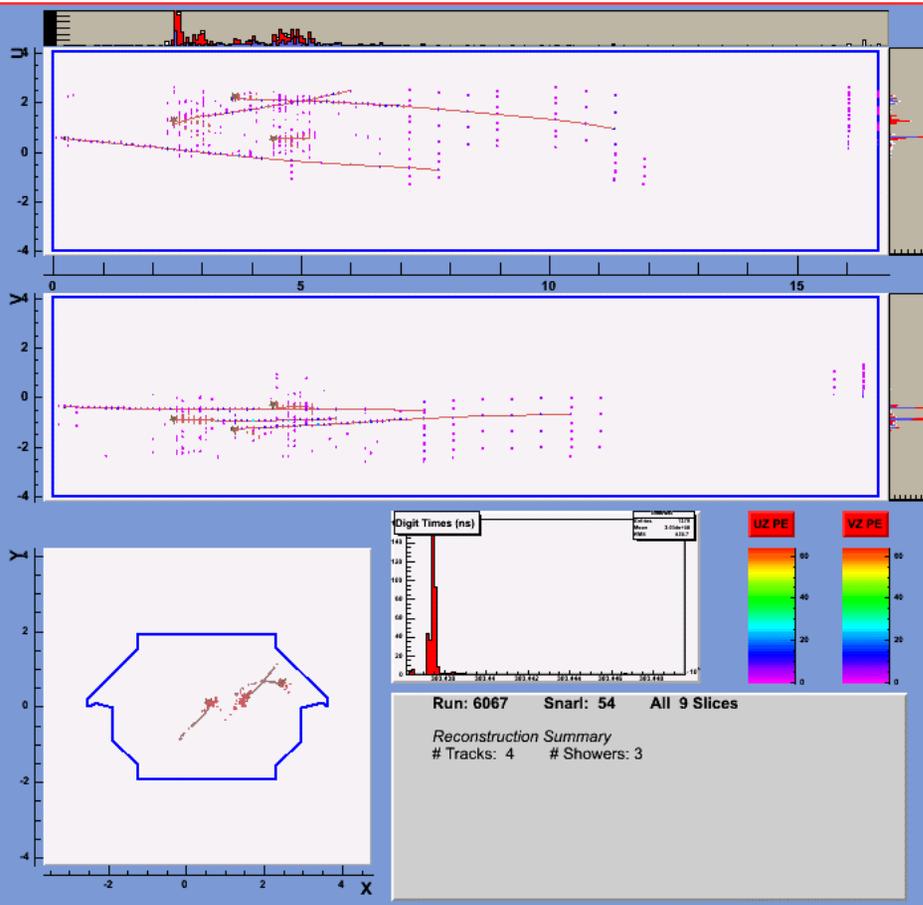
Run 6067 Snarl 53 Event 0



SPILL

EVENT

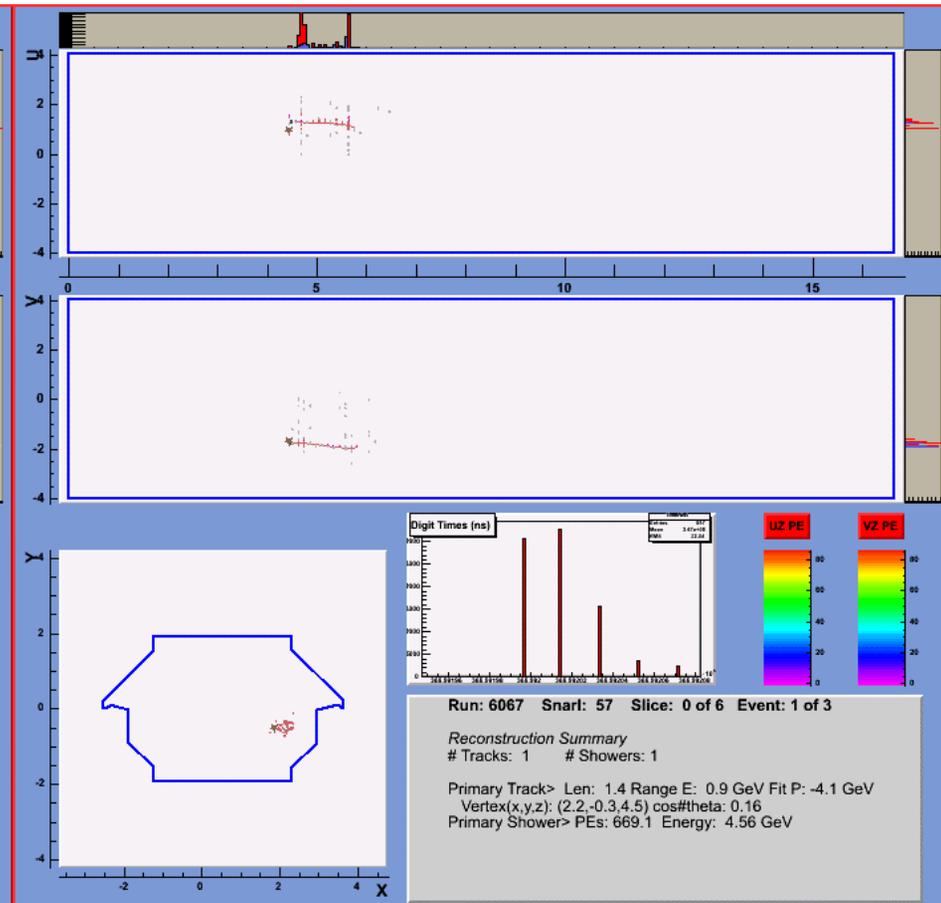
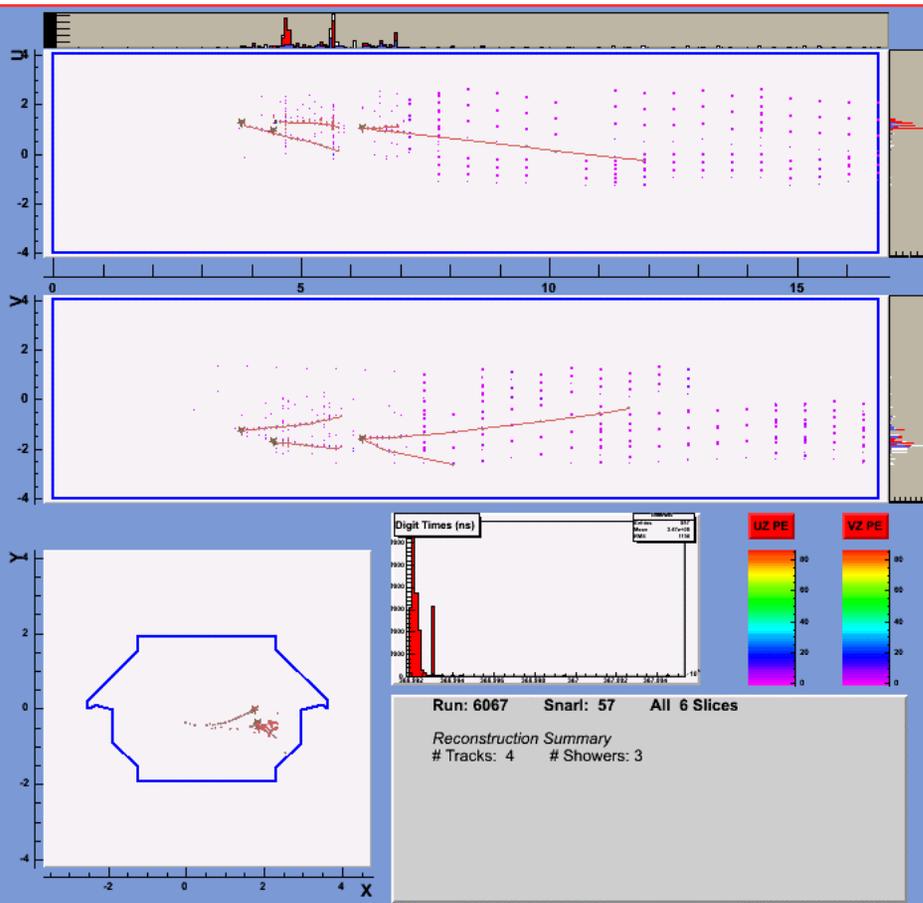
Run 6067 Snarl 54 Event 2



SPILL

EVENT

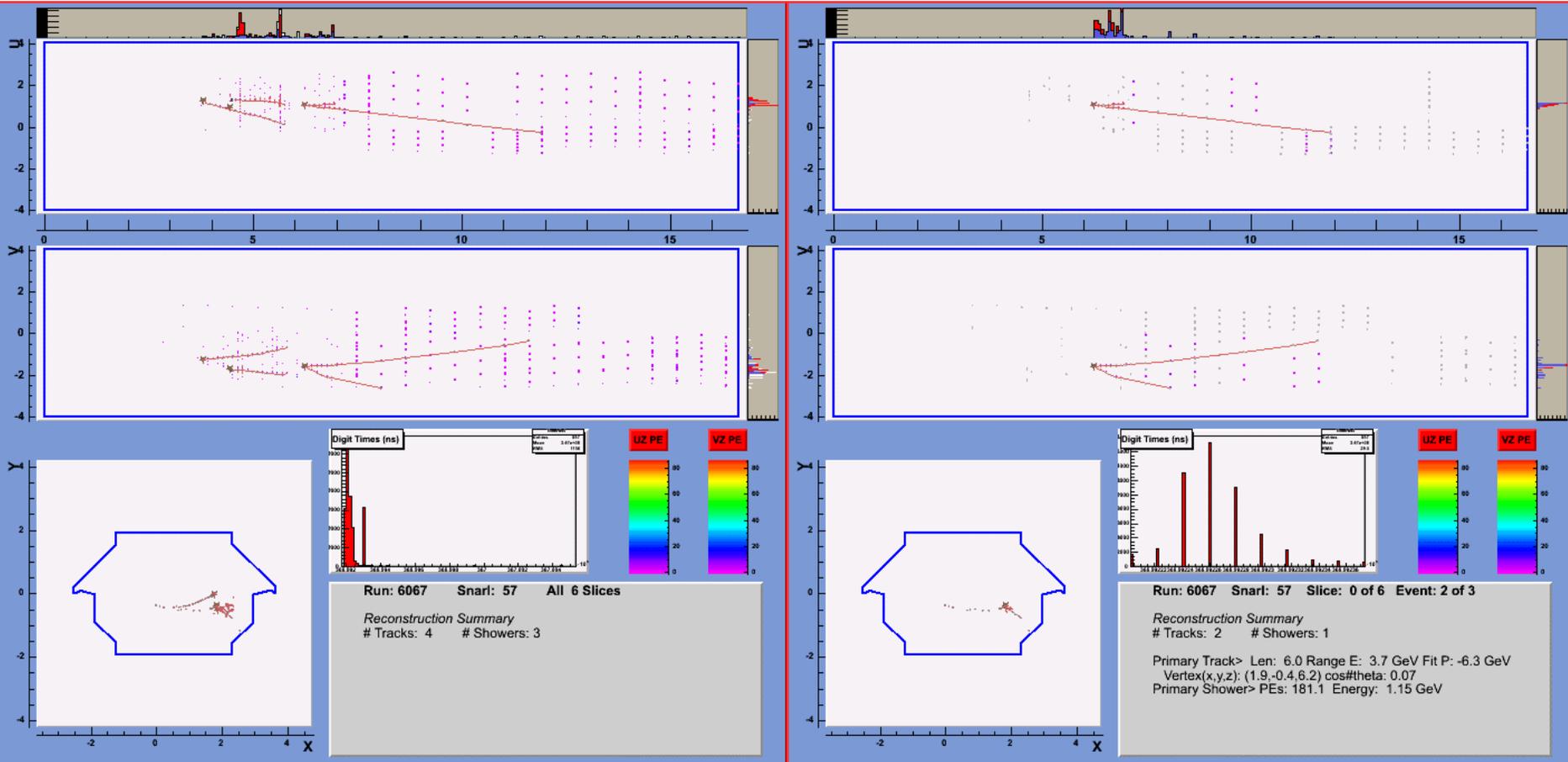
Run 6067 Snarl 57 Event 0



SPILL

EVENT

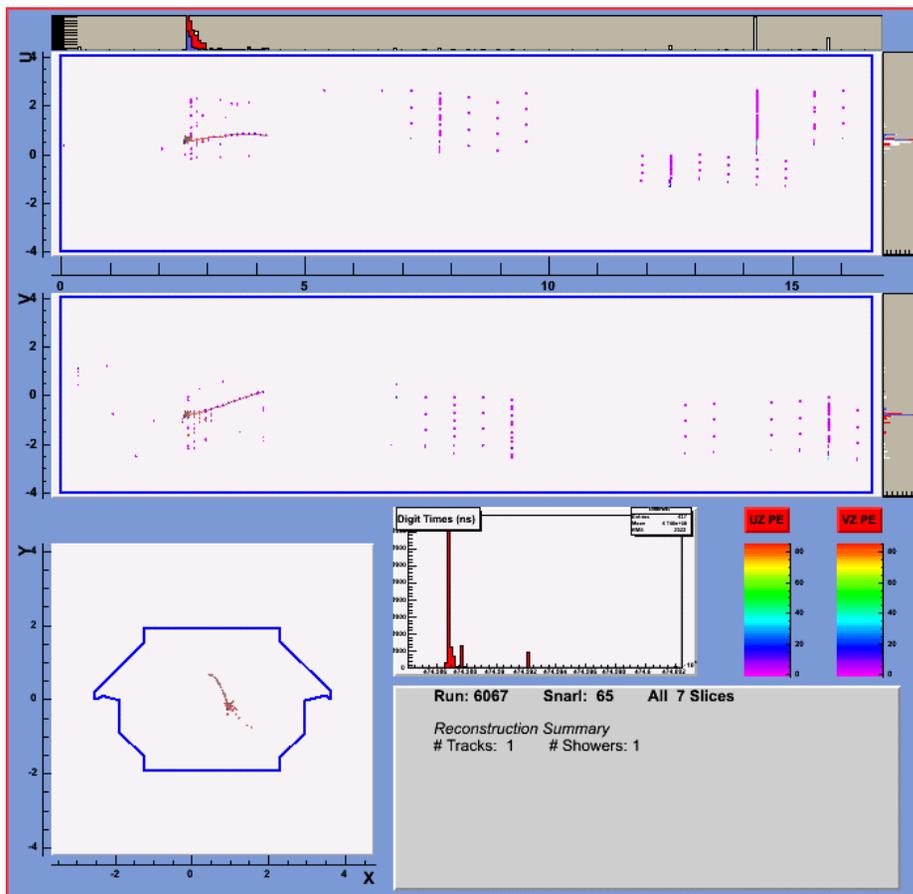
Run 6067 Snarl 57 Event 1



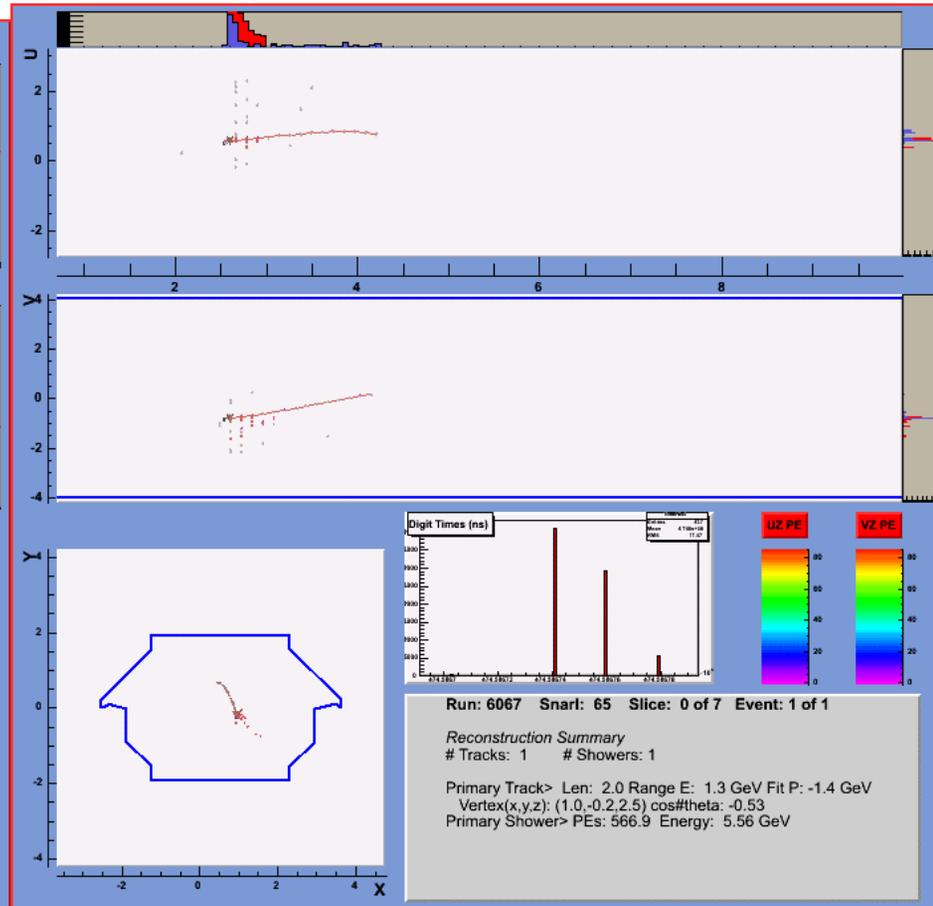
SPILL

EVENT

Run 6067 Snarl 64 Event 0

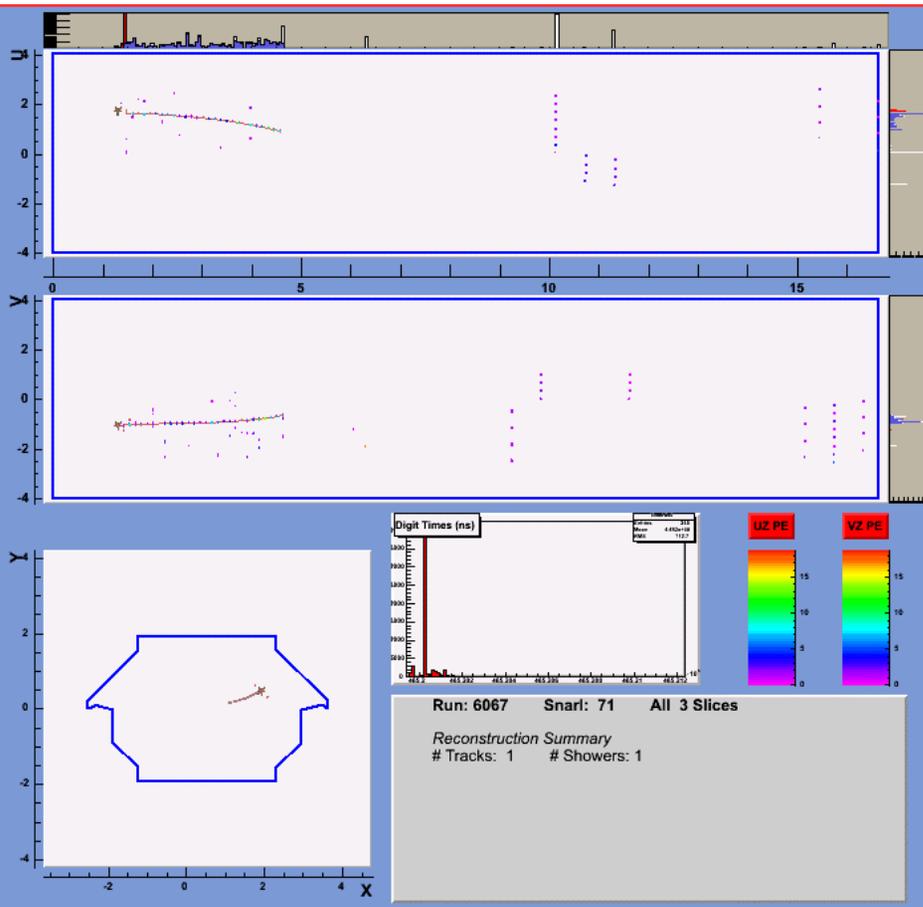


SPILL

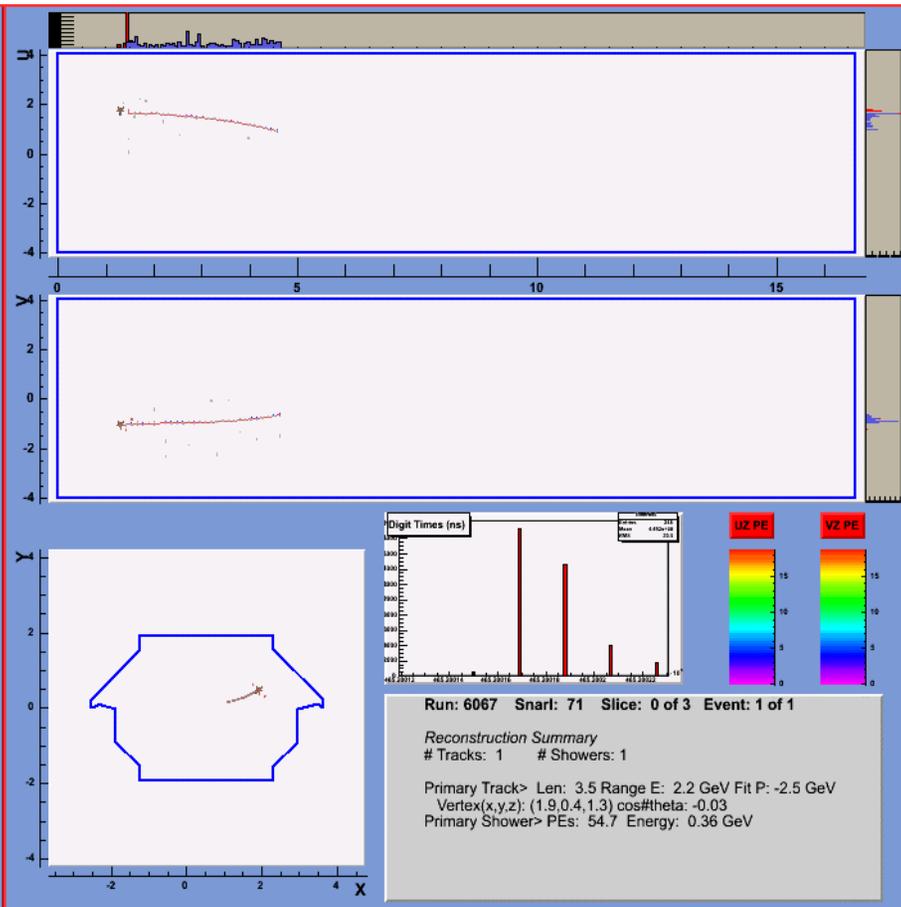


EVENT

Run 6067 Snarl 71 Event 0



SPILL



EVENT

Summary / On going work

- The reconstruction seems to be performing on data similar to MC (on a first quick look) with some failures that need to be fixed but overall with no dramatic problems (given the unknown but nonzero magnetic field).
- What we expect and what we see from this first neutrino running are in quite good agreement (preliminary results that need to be checked again).
- Real neutrino events look **MUCH MUCH MORE BEAUTIFUL** than MC!!!
- The work just started....!!