3D Reconstruction Update

M. Antonello

INFN-LNGS

May 10, 2010

Overview

- cluster::LineMerger Module (ClusterFinder Package)
- trkf::Track3Dreco Module (TrackFinder Package)
- Reconstruction procedure Validation with a passing muon sample
- NuMI Beam angle measurement using reconstructed muons
- Reconstruction procedure Test over few multi-prong events
- Cumulative Event Display

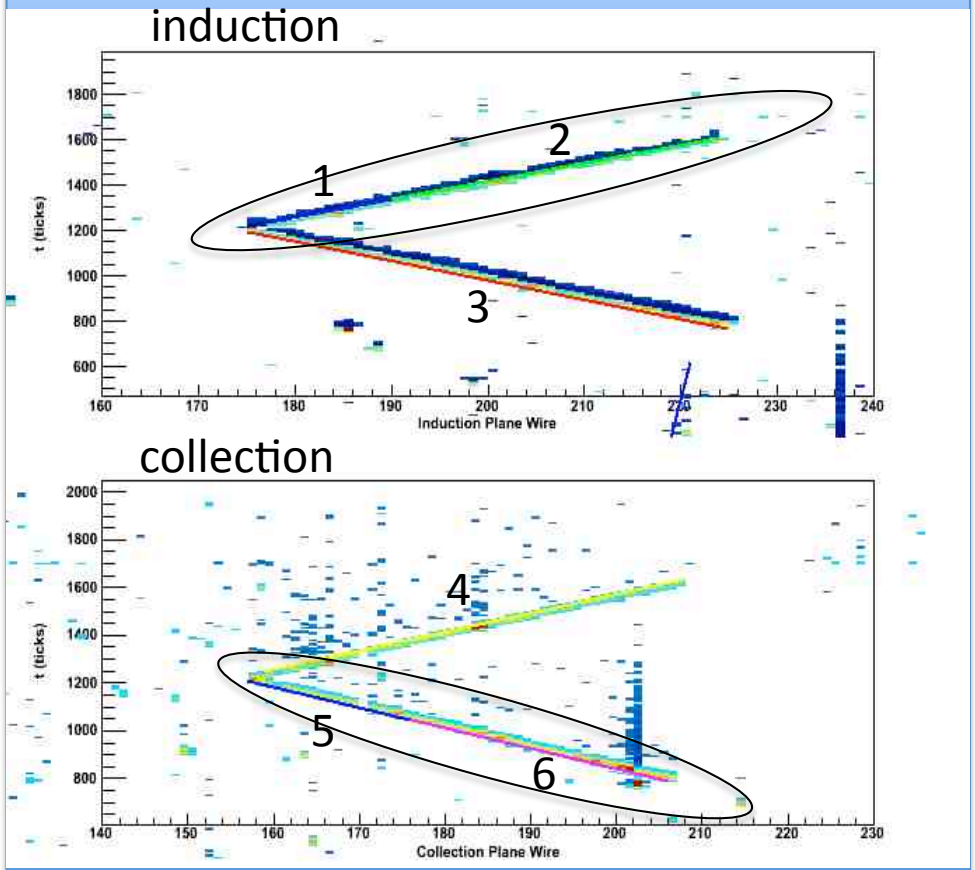
cluster::LineMerger

- A simple module to merge together linear clusters found by HoughLineFinder Module
- Input folder: ./HoughClusters
- Output folder: ./Superclusters
- Two linear clusters are merged together if they have the same slope and intercept within settable tolerances
  - tolerances can be set in linemergerModule.xml

    tslope, tintercept (in time samples)
- In ./Superclusters you can find every cluster that you had in ./Houghclusters, in case merged together
- This module has revealed to be quite useful in the 3D event reconstruction (see later)
- Recently committed to the LArSoft cvs repository
- How to run it : ana -x argoneut.xml –x linemerger.xml filename

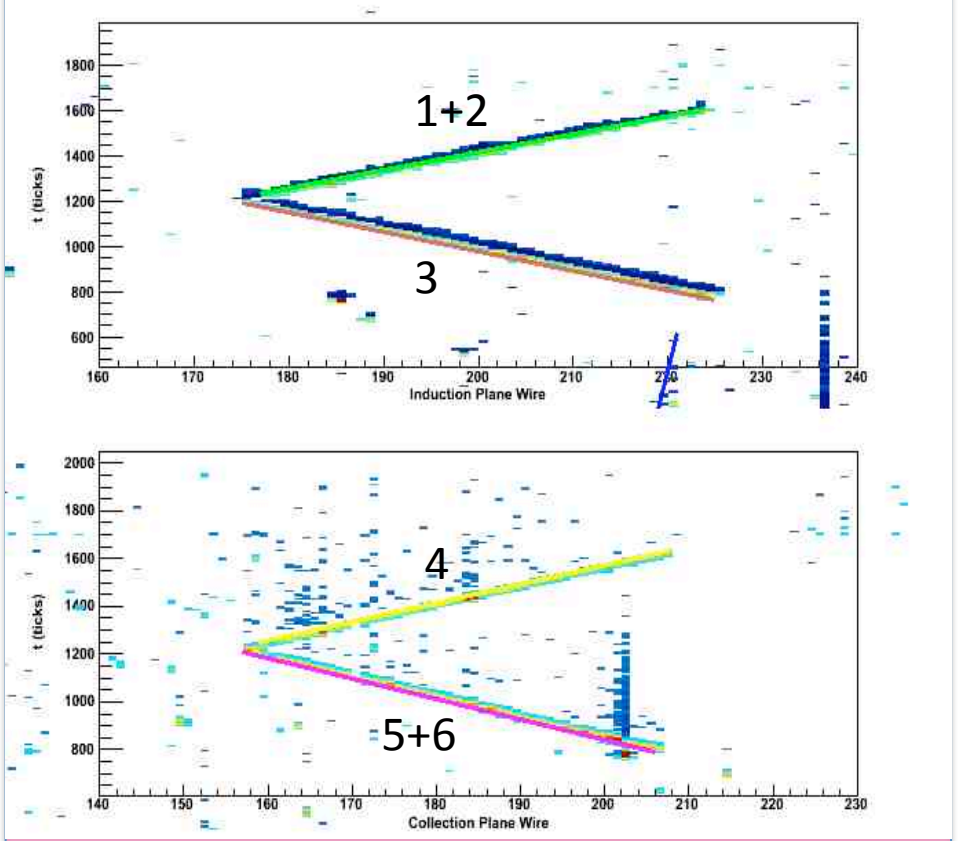
An example Run 628 Event 1798

Houghclusters



6 Houghclusters

Superclusters

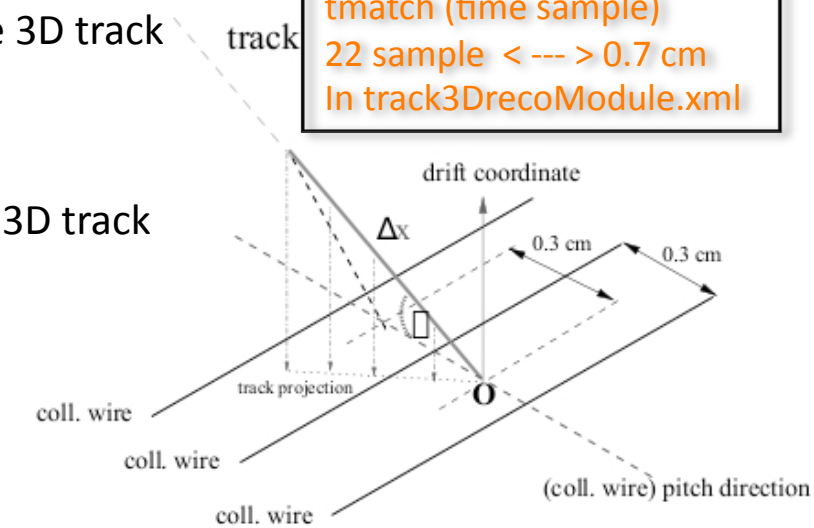


4 Superclusters

trkf::Track3Dreco

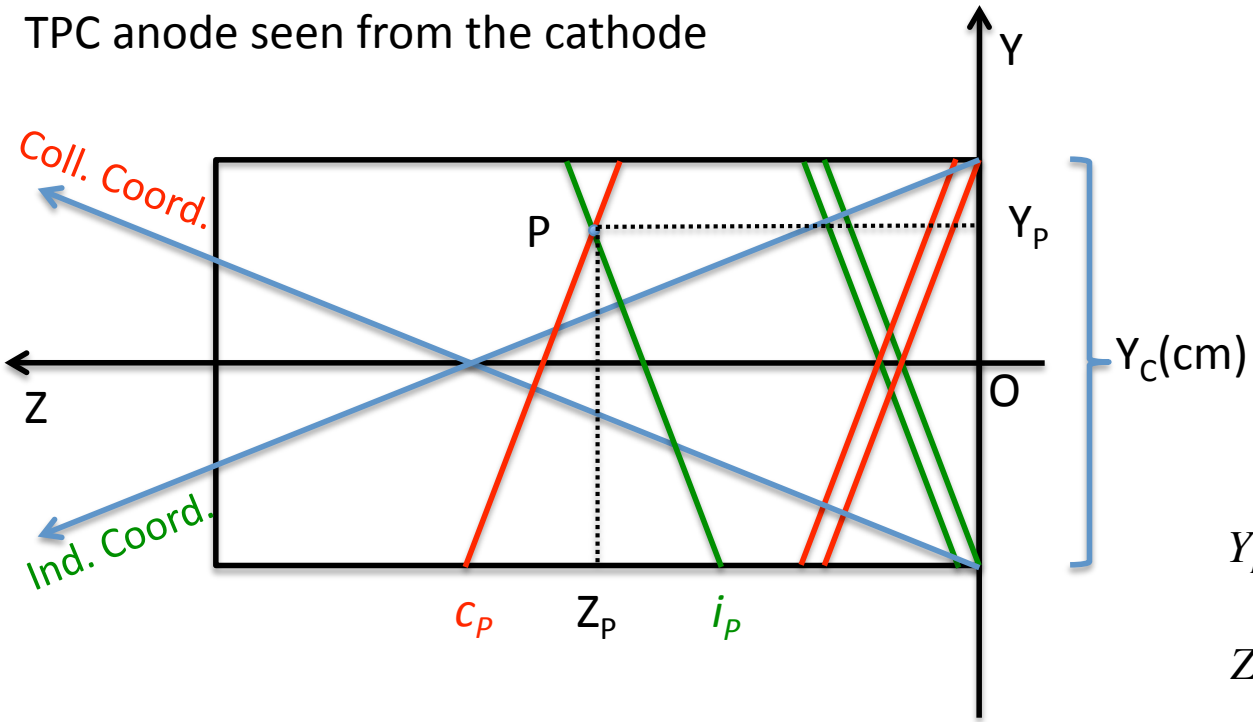
- 3D reco module starts from “Super-clusters” (i.e. from a merging of “Hough-clusters”)
- Input folder: ./Superclusters
- Output folder: ./tracks
- How to run it: ana -x argoneut.xml –x track3Dreco.xml filename
- How to display 3D tracks in evd: go to “Window” → “VolumeView”
- 3D reconstruction take now advantage of three modules besides FFTHitFinder: DBscanFinder, HoughLineFinder and LineMerger
- The core of the 3D reconstruction module is unchanged with respect to trk::SimpleTracker module:
  1. Match 2D tracks between the 2 different views (Collection and Induction); two tracks are matched if both their end-points are matched (i.e. are close in time and have “compatible” wire numbers) → Strict Geometrical condition
  2. Compute 3D coordinates of the track end-points
  3. Compute the direction cosines, ϑ, ϕ, Δx of the 3D track
  4. Match hit by hit the 2D matched tracks (thorugh dedicated algorithm)
  5. Compute 3D coordinate of each hit of the 3D track

Tolerance Parameter:
tmatch (time sample)
22 sample < --- > 0.7 cm
In track3DrecoModule.xml



3D coordinates expression in ArgoNeuT World reference system

TPC anode seen from the cathode



Collection wires
Induction wires

P = projection of a 3D point onto the TPD anode plane

$$Y_P = \frac{c_P - i_P}{2 \cdot \sin 30°} \cdot WirePitch$$

$$Z_P = \frac{c_P + i_P}{2 \cdot \cos 30°} \cdot WirePitch - \frac{Y_C}{2} \cdot tg30°$$

- X coordinate is derived from drift time of the hit (tHit)

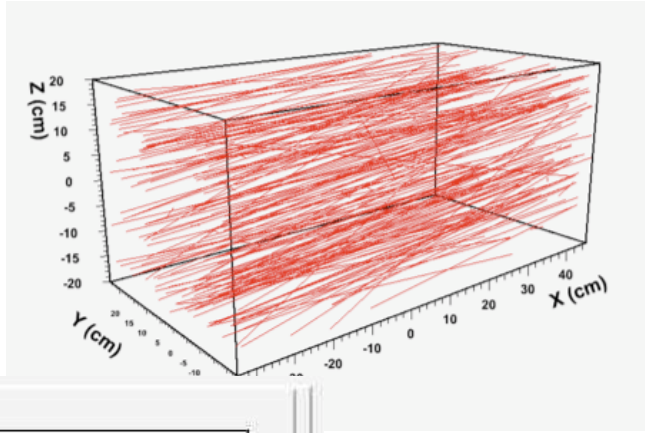
$$X = (tHit - \Delta t) \cdot V_{drift} \cdot TimeSample$$

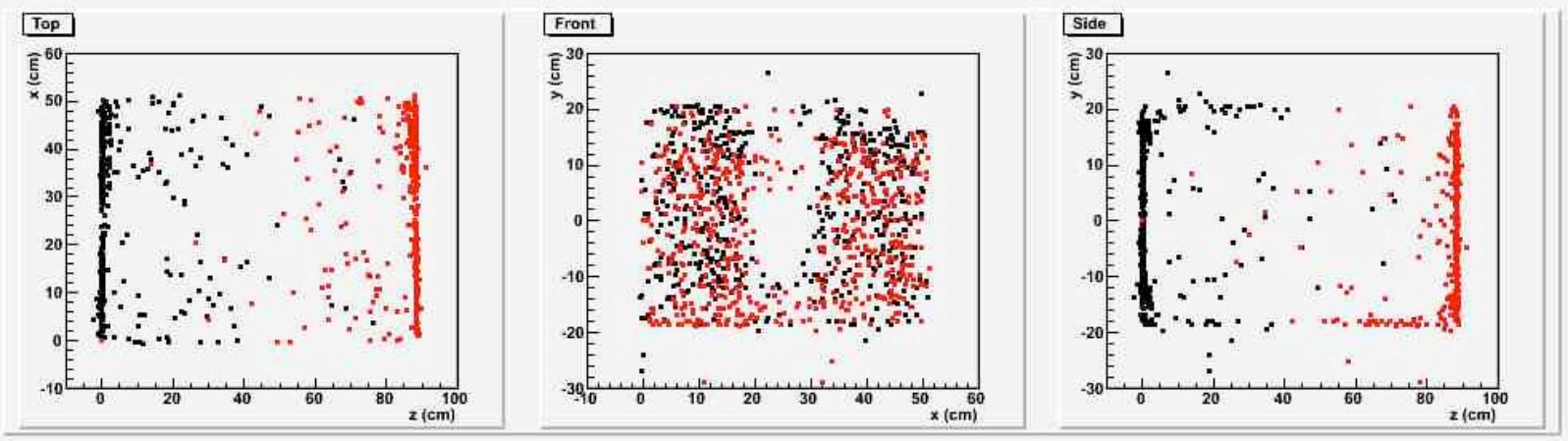
Presamplings already subtracted

Δt → Drift time from Shield to Collection or from Shield to Induction (considering the appropriate E-fileds)

Procedure validation over passing muon sample

- Passing muons from Runs 628 and 634 reconstructed
- X-ray plots of track end-points help us in evaluating the algorithm efficiency:
- If endpoints exceed TPC box boundaries the track is not well reconstructed





For Run 628:

260 muons total

240 reconstructed

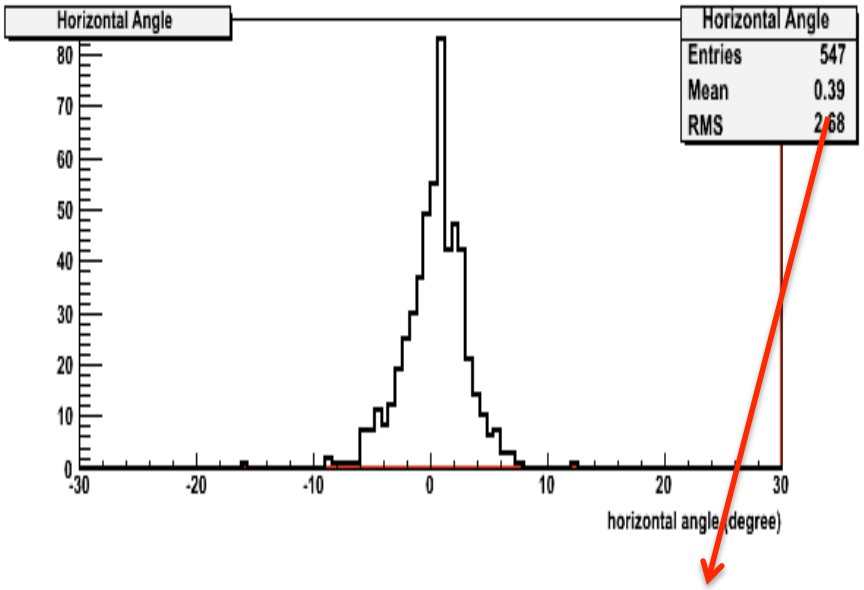
20 have end-points outside the boundaries

9 are recovered through parameters adjustment

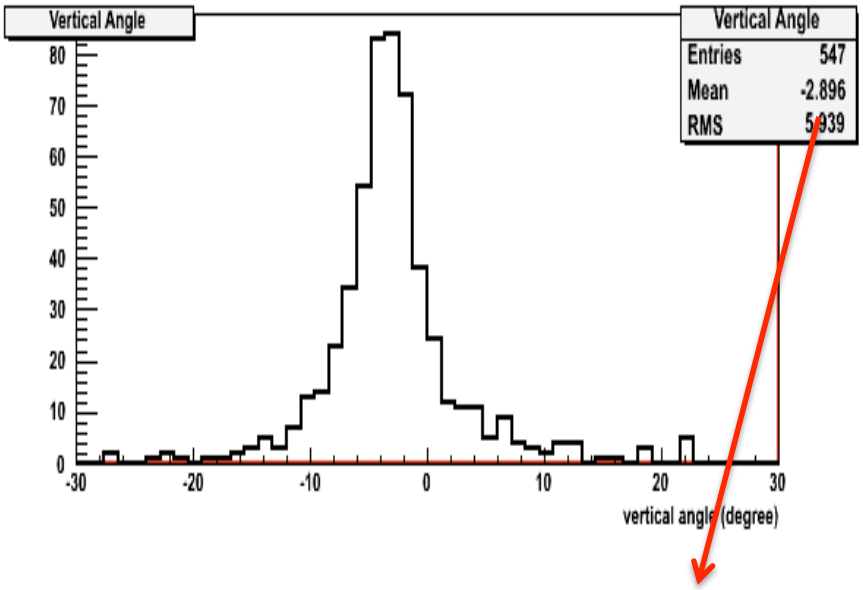
5 miss part of the track only in induction plane (track crossing induction wires but not collection wires)

$$Eff = \frac{240+9}{260-5} \cdot 100 = 97{,}6\%$$

Horizontal and Vertical angles

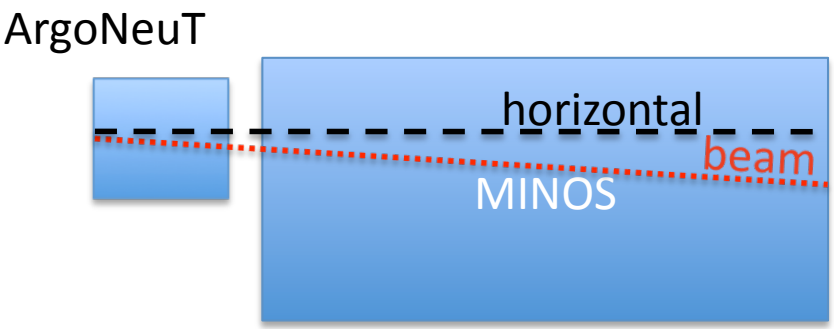


0.4°



-3°

TOP VIEW

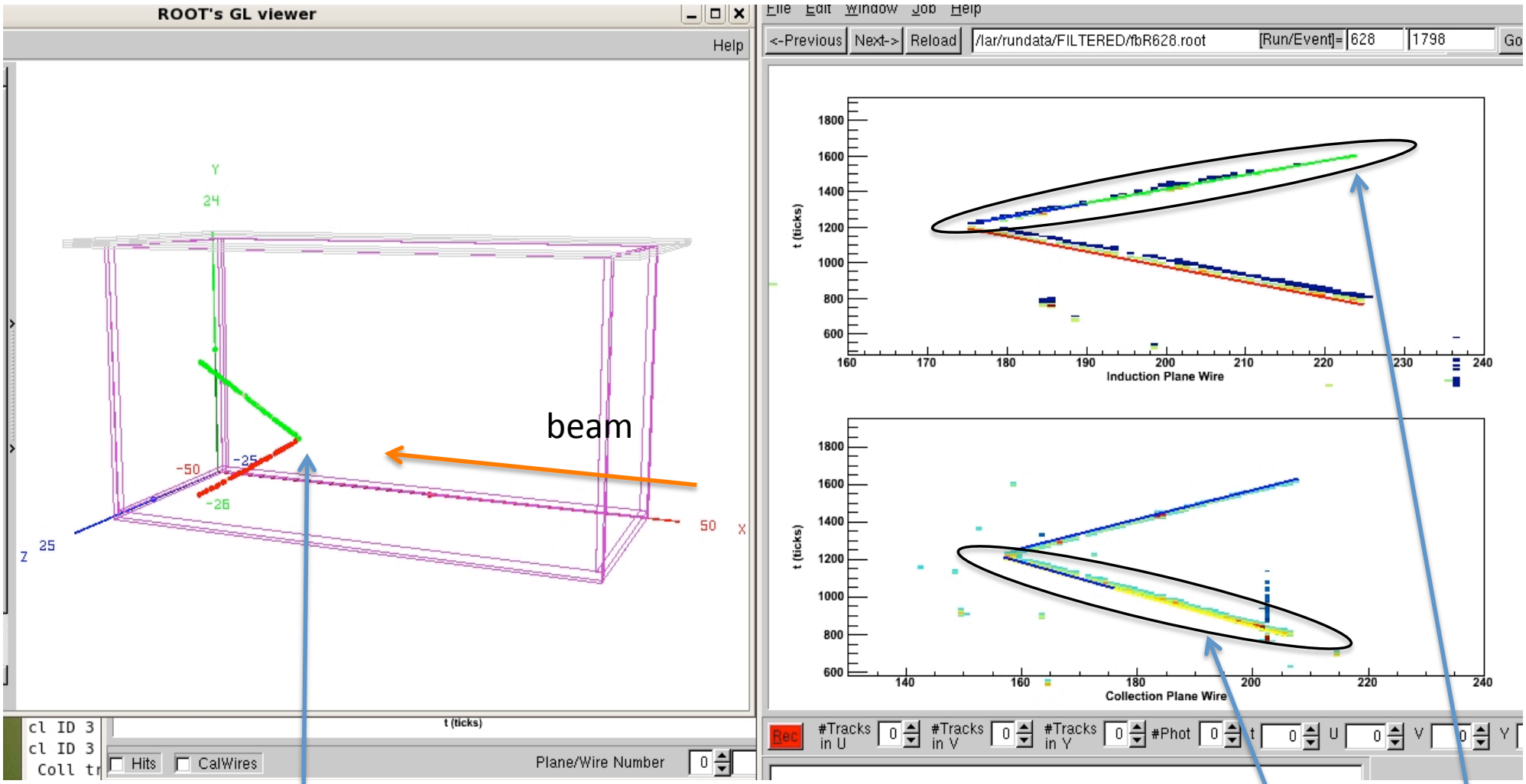


SIDE VIEW

Procedure Test Over Multi-prong events

- The tool has been tested over a little number of multi-prong events with simple topology
- For some events it works pretty well
  - 1 to 3 well visible lines from the vertex
- For other events it works but not yet perfectly → missing some little tracks
  - Many tracks from the vertex, especially not straight
  - If one track or endpoint-hits are missing the 2D track matching algorithm can fail but it can be refined to take into account these possibilities
- Still far away from reconstructed the most complicated events.
- Refinements and further upgrades are possible.

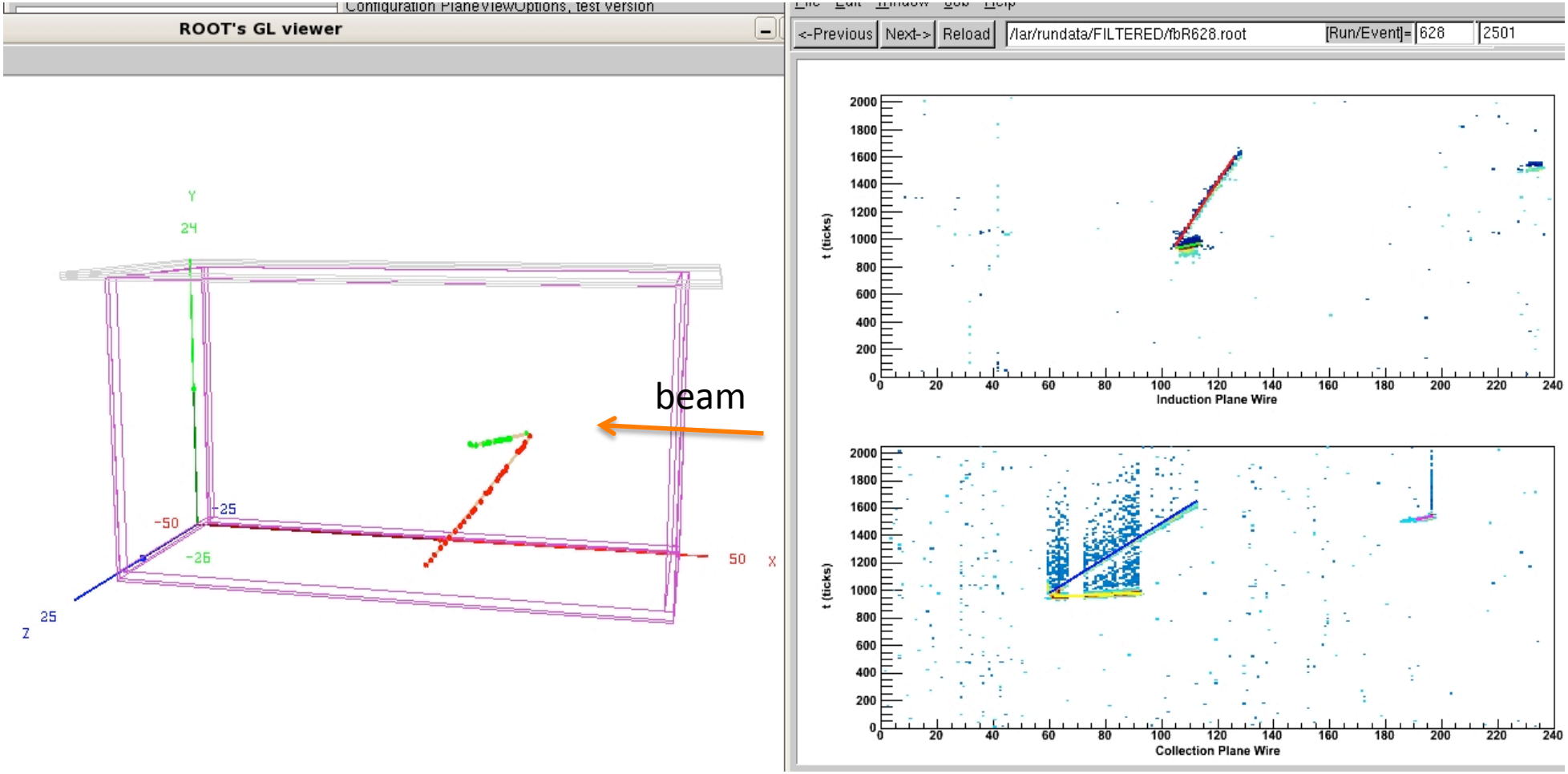
Run 628 Event 1798



Vertex position is precisely reconstructed

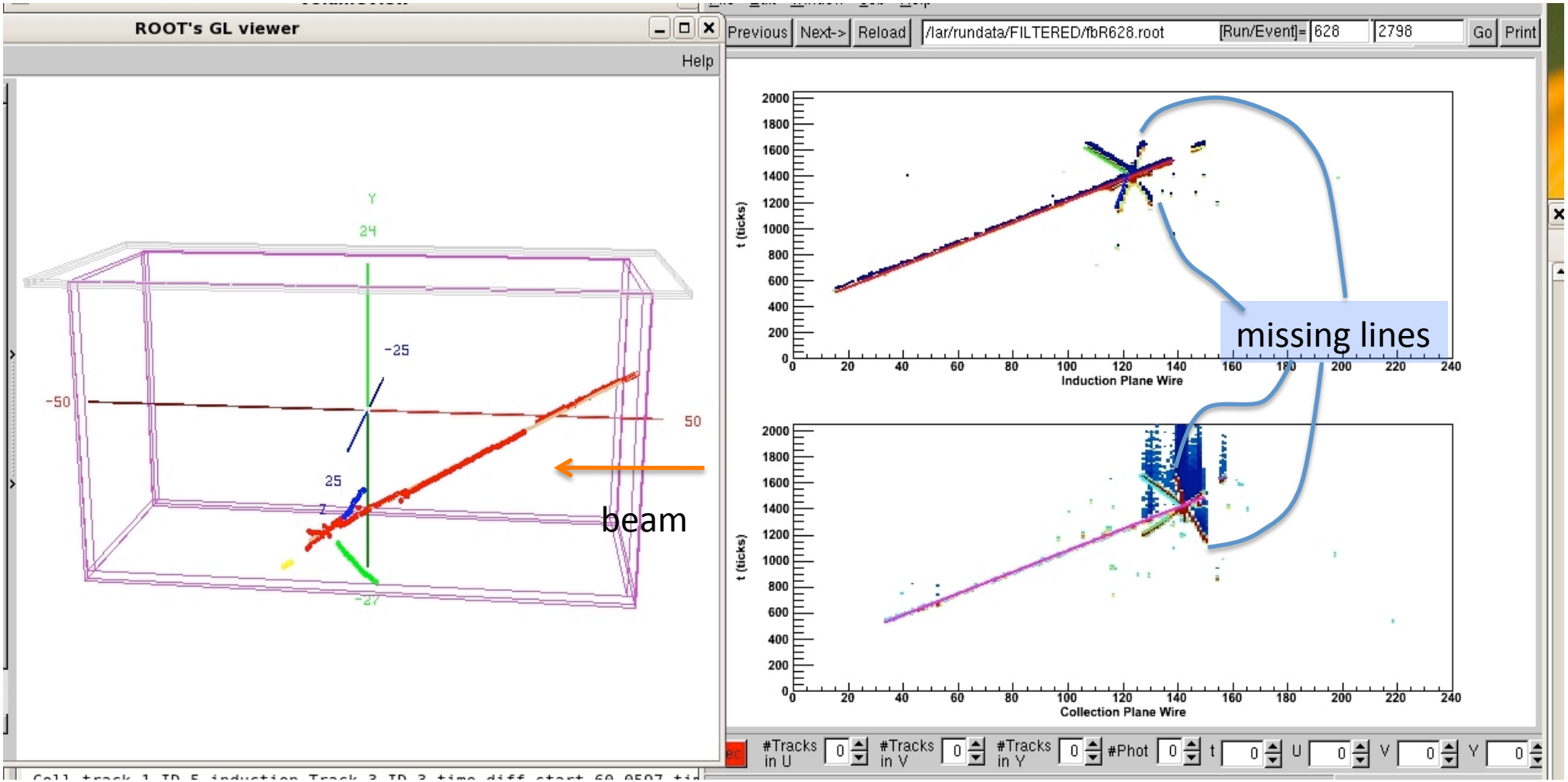
Supertracks are created merging Hough-clusters

Run 628 Event 2501



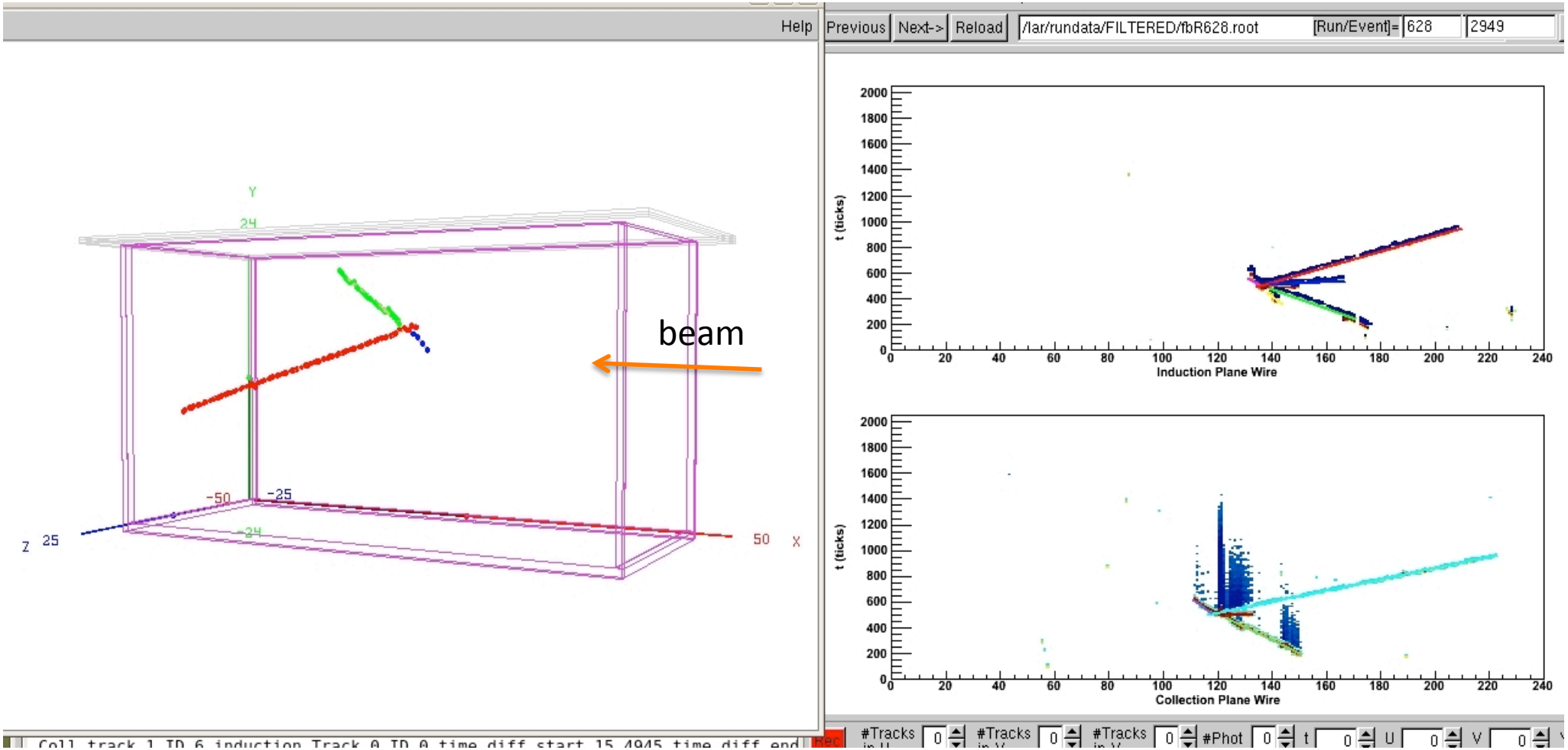
tracks correctly reconstructed. One hole for track can be seen.
It correspond to the blind wires.

Run 628 Event 2798



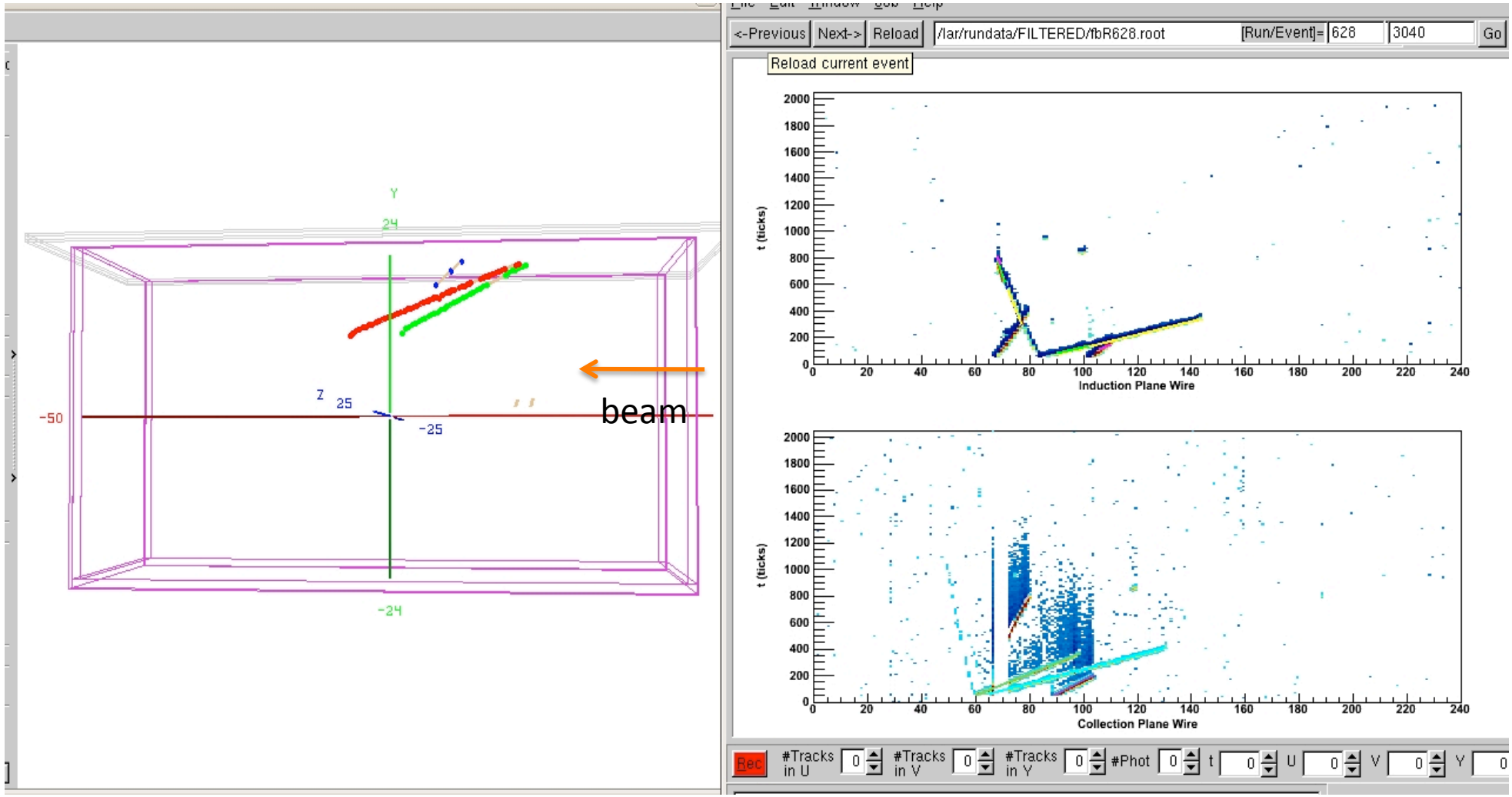
4 out of 7 tracks correctly reconstructed.

Run 628 Event 2949



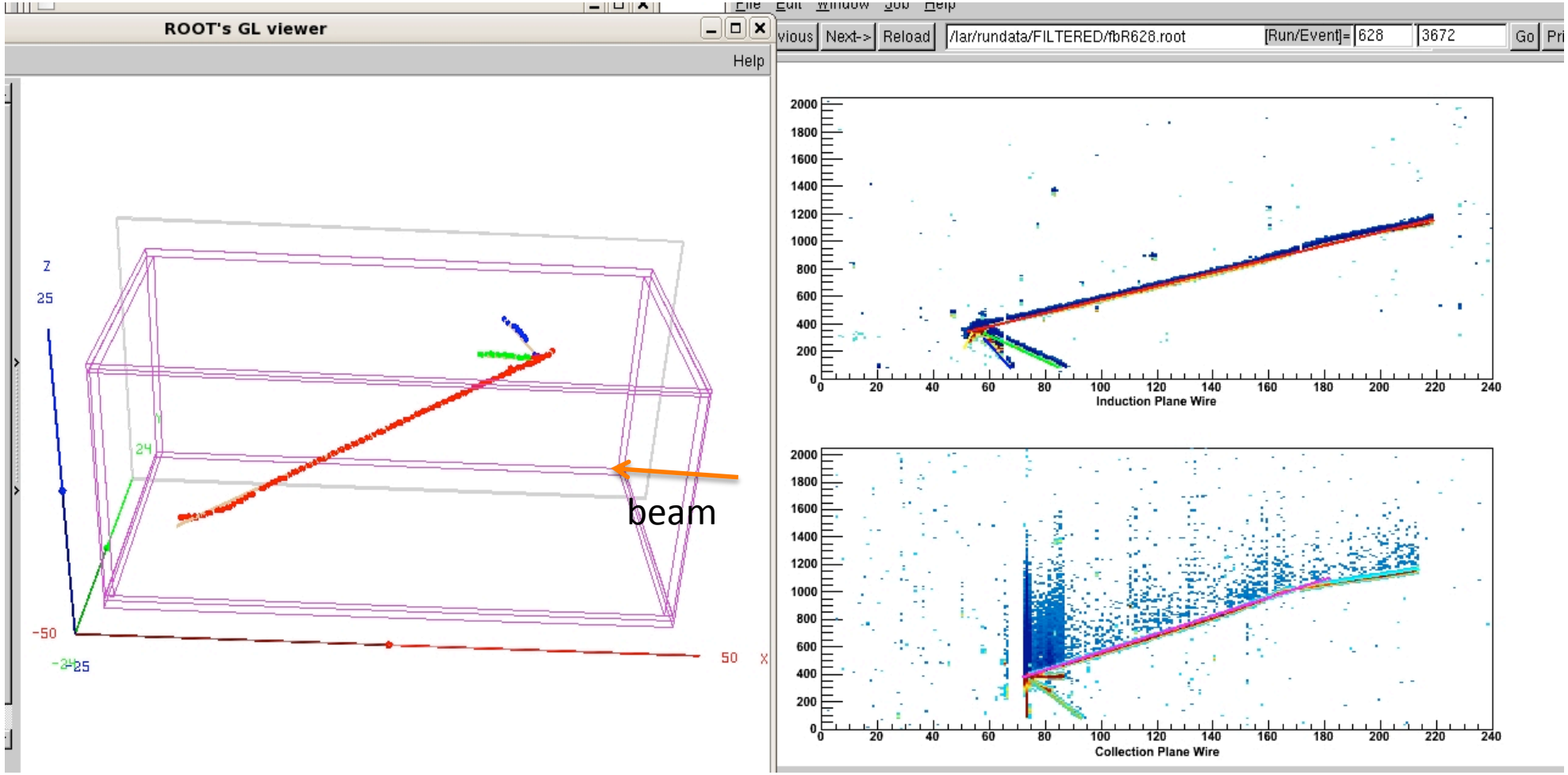
3 out of 4 (possibly 5) tracks reconstructed
A lot of low-energy activity present at vertex.

Run 628 Event 3040



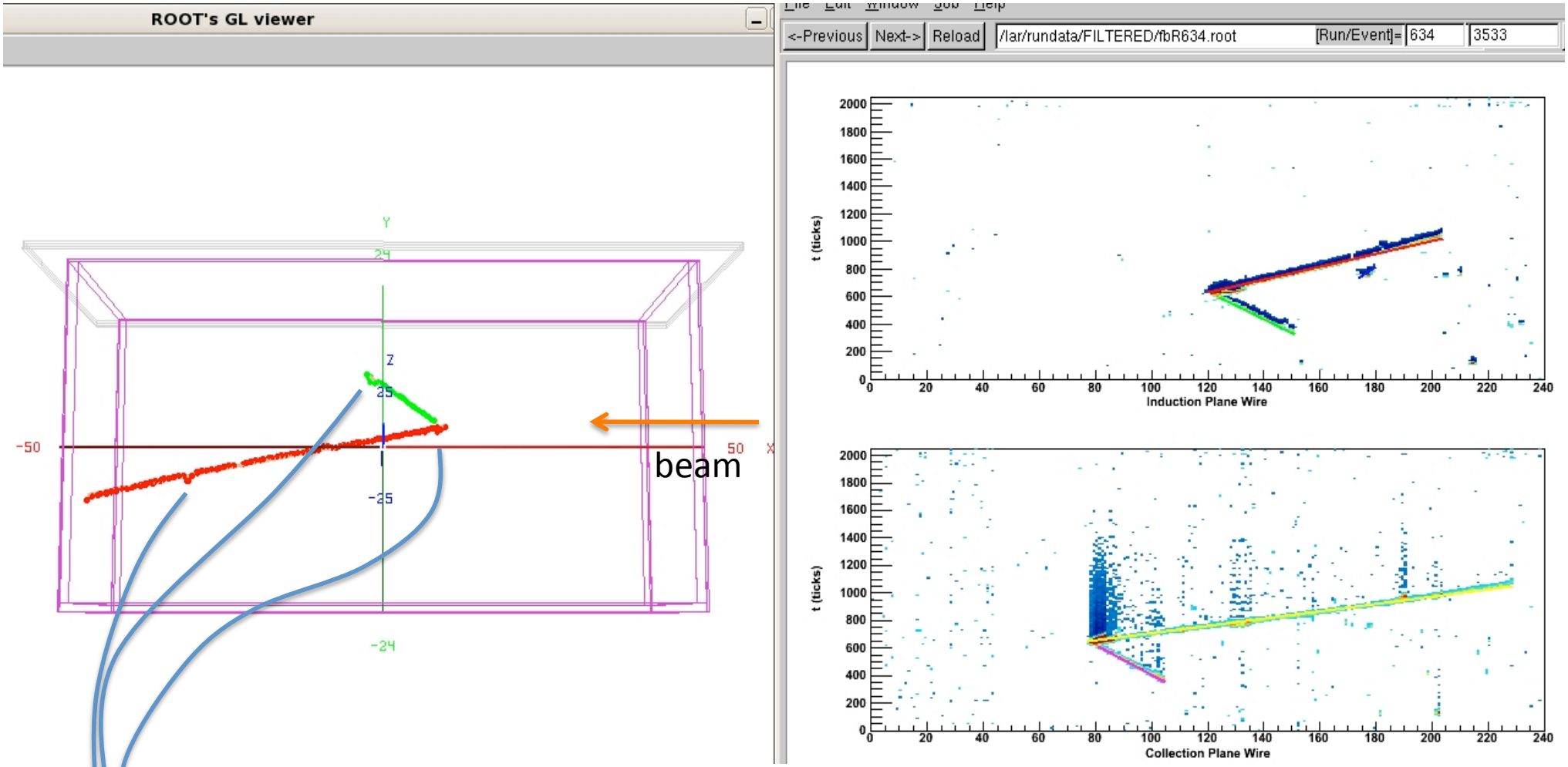
3 out of 4 tracks reconstructed.

Run 628 Event 3672



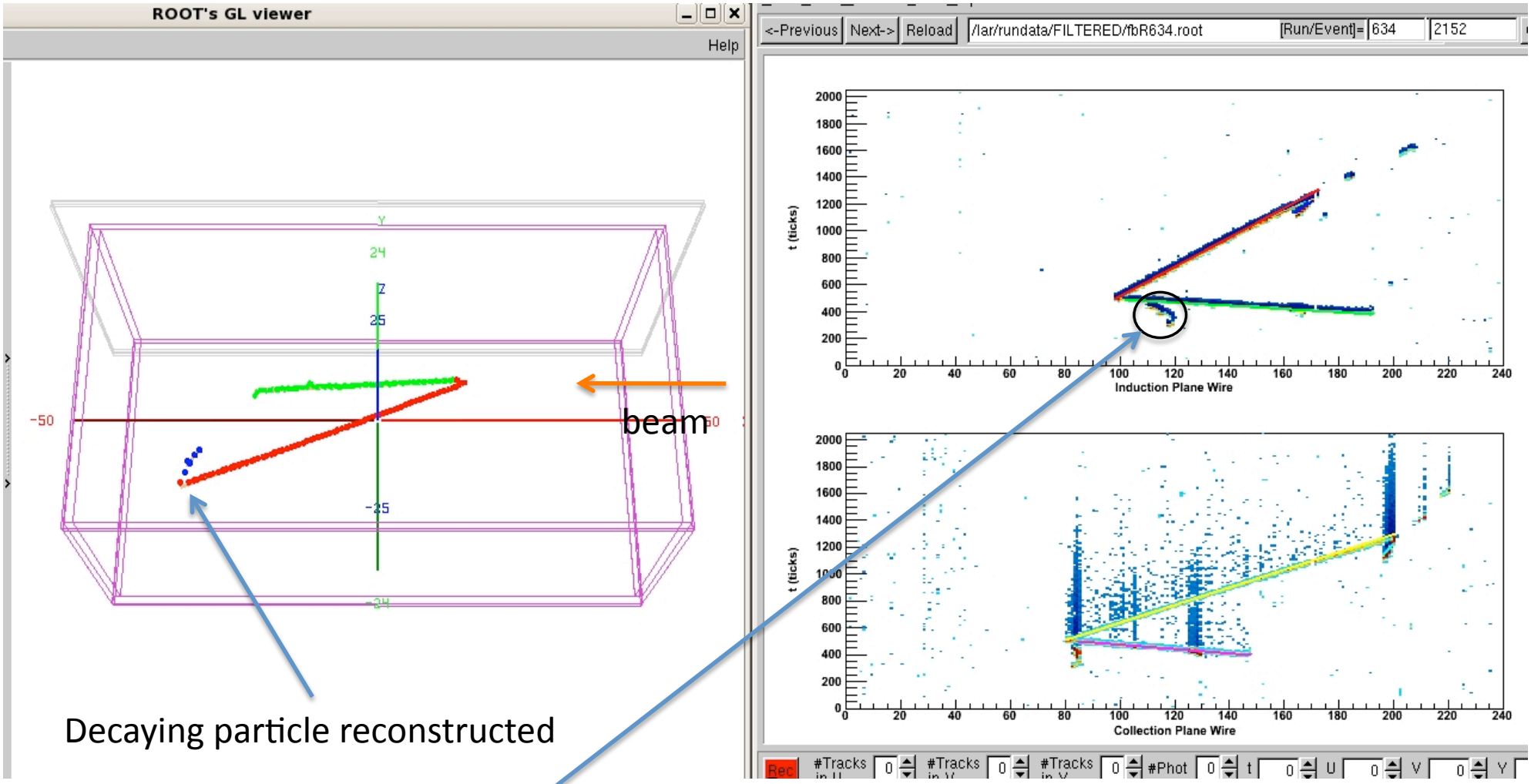
3 reconstructed tracks. 1 incorrect: 2 lines missing, wrong 2D tracks association.
Activity near the vertex.

Run 634 Event 3533



2 tracks reconstructed. Activity near the vertex cannot be reconstructed.
Little deviations of the 2D hits from the line are correctly reconstructed in the 3D view

Run 634 Event 2152

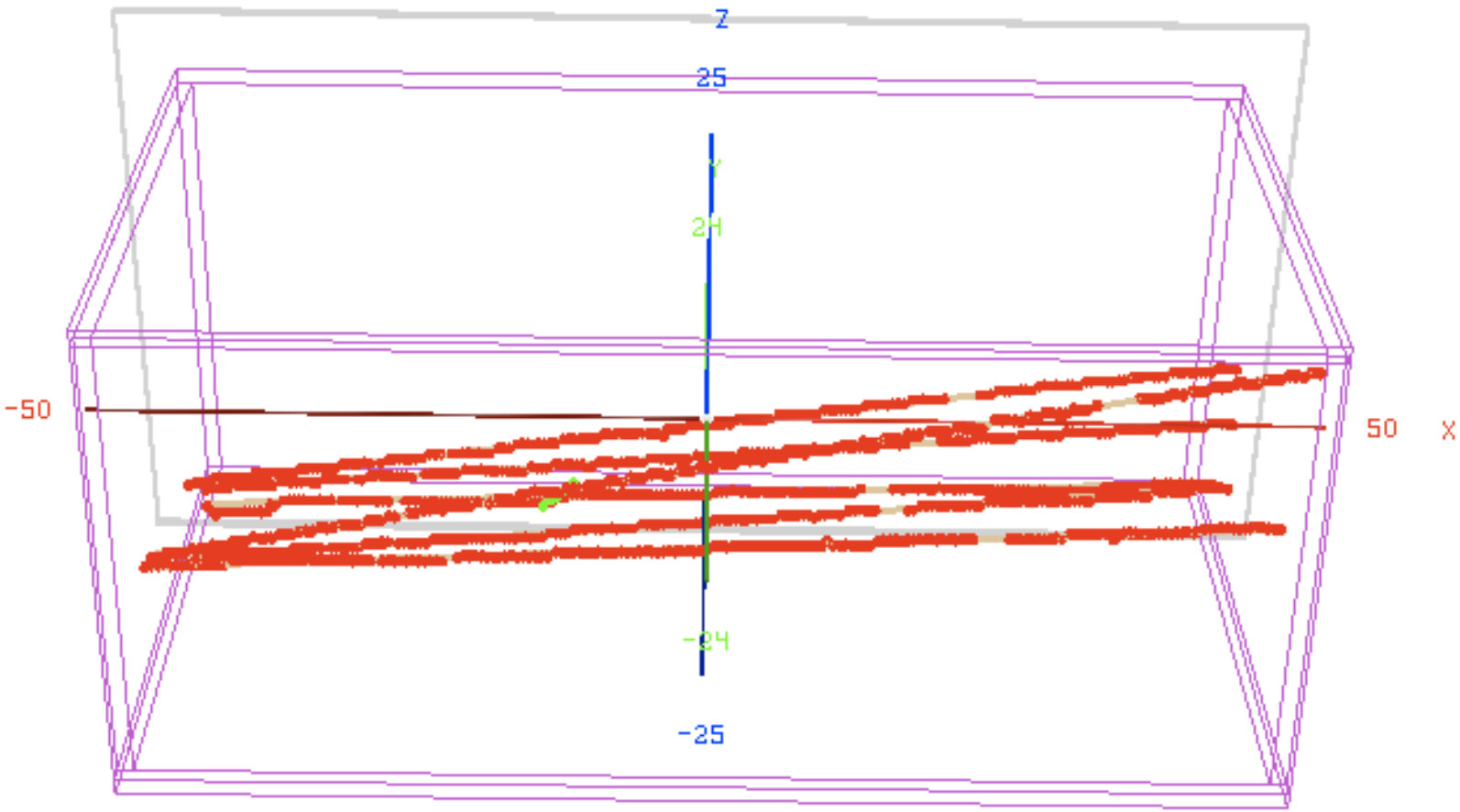


Deposition by neutral particle, spatially separated from other hits.
Not reconstructed since not present in the “Hough–clusters” collection.
Can we recover these hits?

Cumulative Event Display in LArSoft

by B.Rossi from Bern U.

Go to “VolumeViewOptions”
Check the “CumulativeEvents” box



Next Steps

- Refinements:
  - 2D track matching
  - Hits by hit matching
- Upgrades:
  - Recover hits not belonging to “Hough-lines” and try hit by hit matching on this limited number of hits
  - Many events show vertex activity that cannot be reconstructed through the present tool. A dedicated algorithm is needed.