ROOT-based Event Display for LBNE-35t

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Updates Since Doc-8715

- Renamed the project to RED35
  - https://github.com/czczc/RED35
- Updated the geometry to use lbne35tapa_v3.gdml
- Updated to work with LarSoft v4_01
  - renamed the Module to CTree35t
  - currently in a feature brach feature/chaoz_ctree
- Added more information to the event display
  - wire signals (raw, calibrated, hits)
  - MC tracks (2d, 3d)
  - Reco tracks (3d)

Components of RED35

- There are basically **three components** in RED35
  - **A converter** to convert sim/reco files to a event tree for offline reading *(dependent on LarSoft)*
    - `git flow feature pull origin chaoz_ctree`
    - `lar -c ctree35t.fcl [sim/reco root file]`
  - **A 3D Event Display** *(independent of LarSoft)*
    - based on the ROOT module EVE (invented for the ALICE experiment) https://root.cern.ch/root/htmldoc/GRAF3D_EVE_Index.html
  - **A 2D Event Display** *(independent of LarSoft)*
    - based on the ROOT GUI widgets https://root.cern.ch/root/html/GUI_GUI_Index.html
- How to install and run (on your own computer) https://github.com/czczc/RED35

The Converter

```
lar -c ctree35t.fcl [sim/reco root file]
```

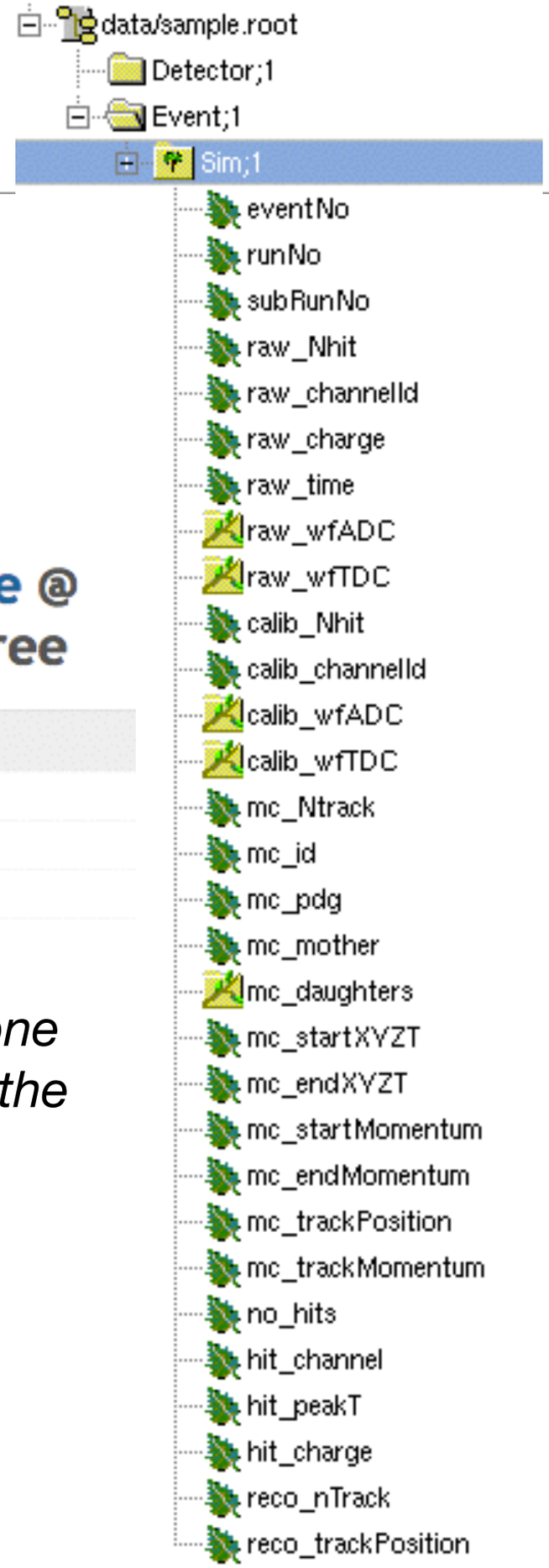
- Currently the following information are stored as branches in the converted TTree
  - MC particles
    - tracks
    - mother/daughter relations
  - raw wire signals
  - calibrated wire signals
  - hits found on each wire
  - 3d reco tracks

root / lbne / CTree @ feature/chaoz_ctree

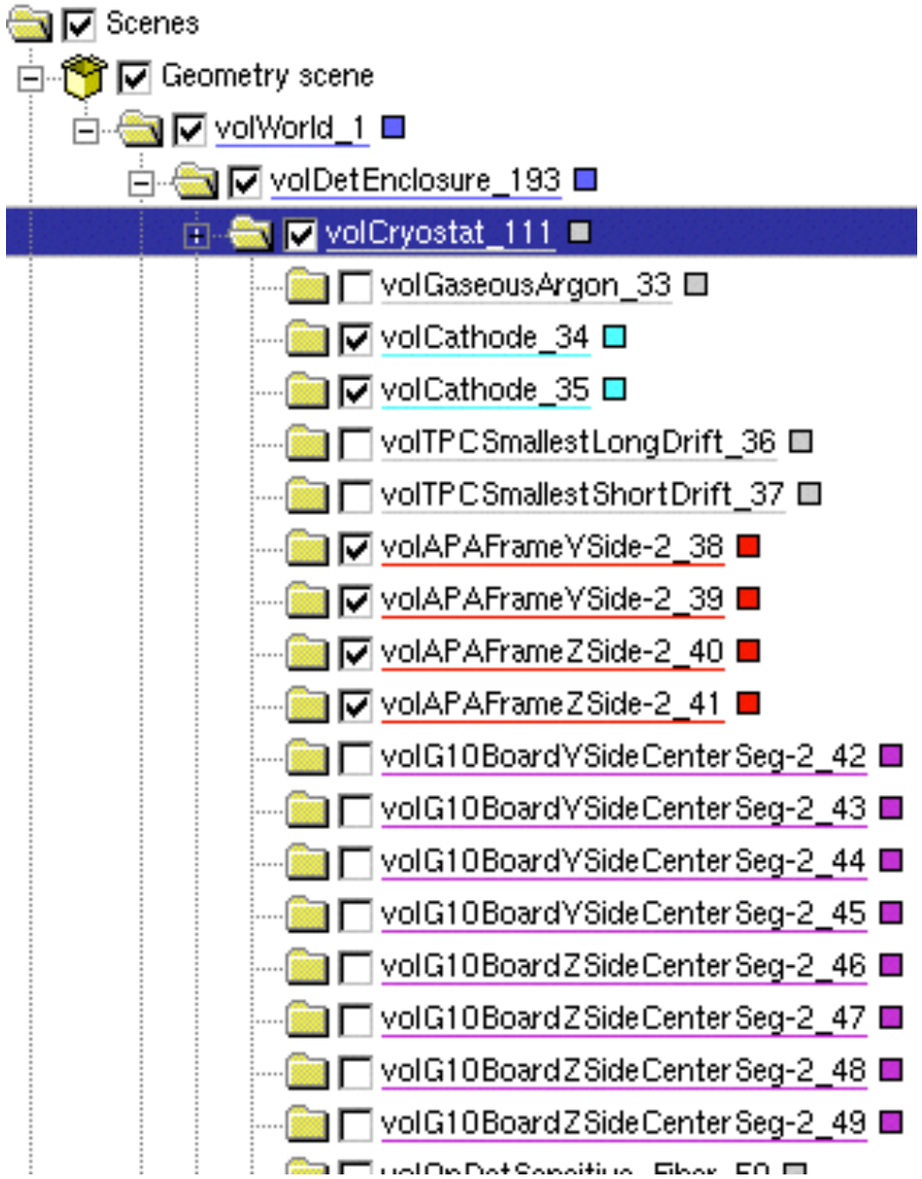
- CMakeLists.txt
- CTree35t_module.cc
- ctree35t.fcl

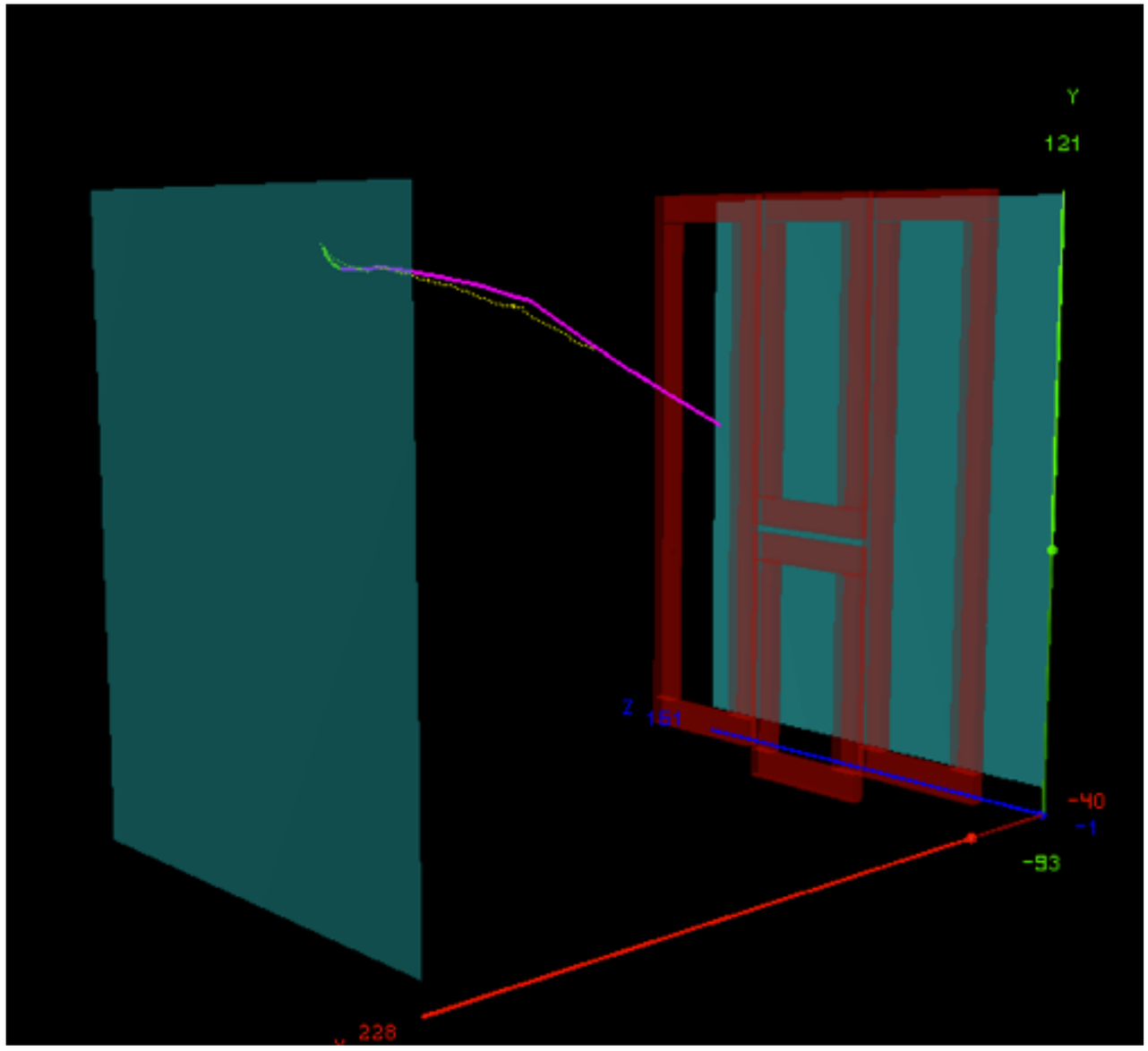
currently only store one algorithm (specify in the .fcl file)

- Currently a factor of ~10 — 50 reduction in data size (can be optimized in the future)



3D Event Display





- By default turned off many detector elements for visual clarity
- Can turn on DEs by hand (or can provide options in the future)

2D projections (next slide)

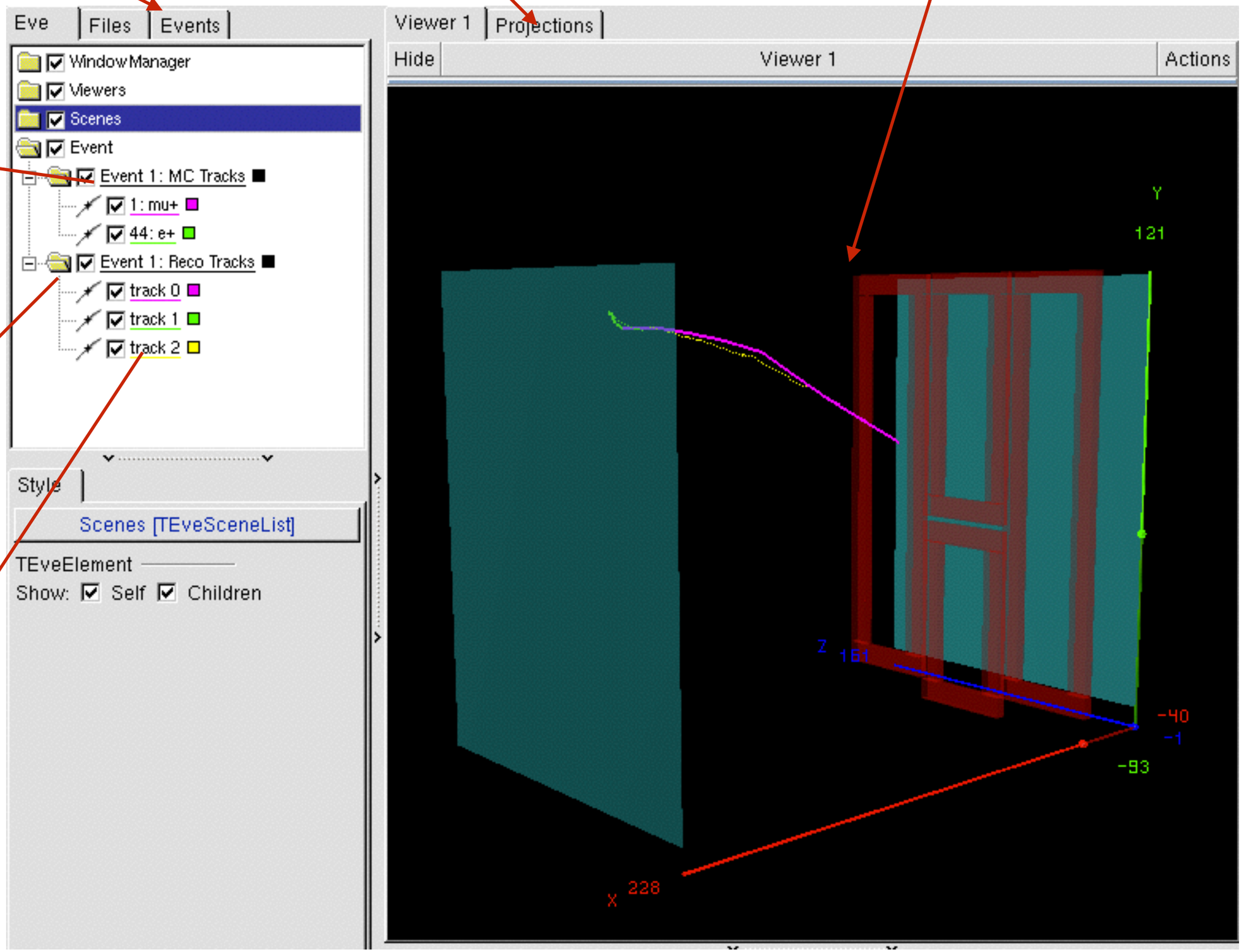
event navigation

can rotate, move, zoom in, zoom out,

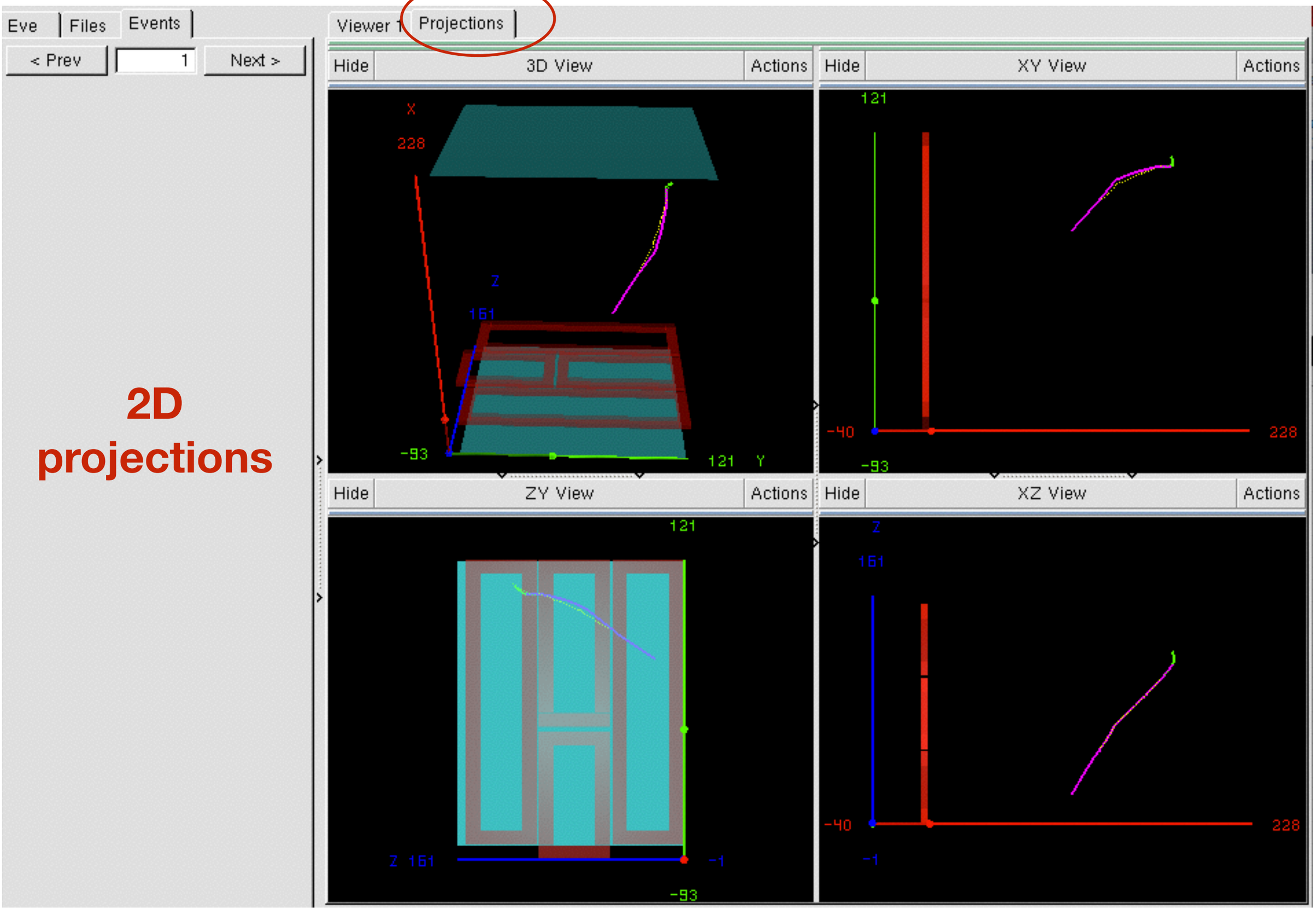
MC tracks in solid lines

reco tracks in dashed lines

hovering over each track will highlight the track in the 3d display

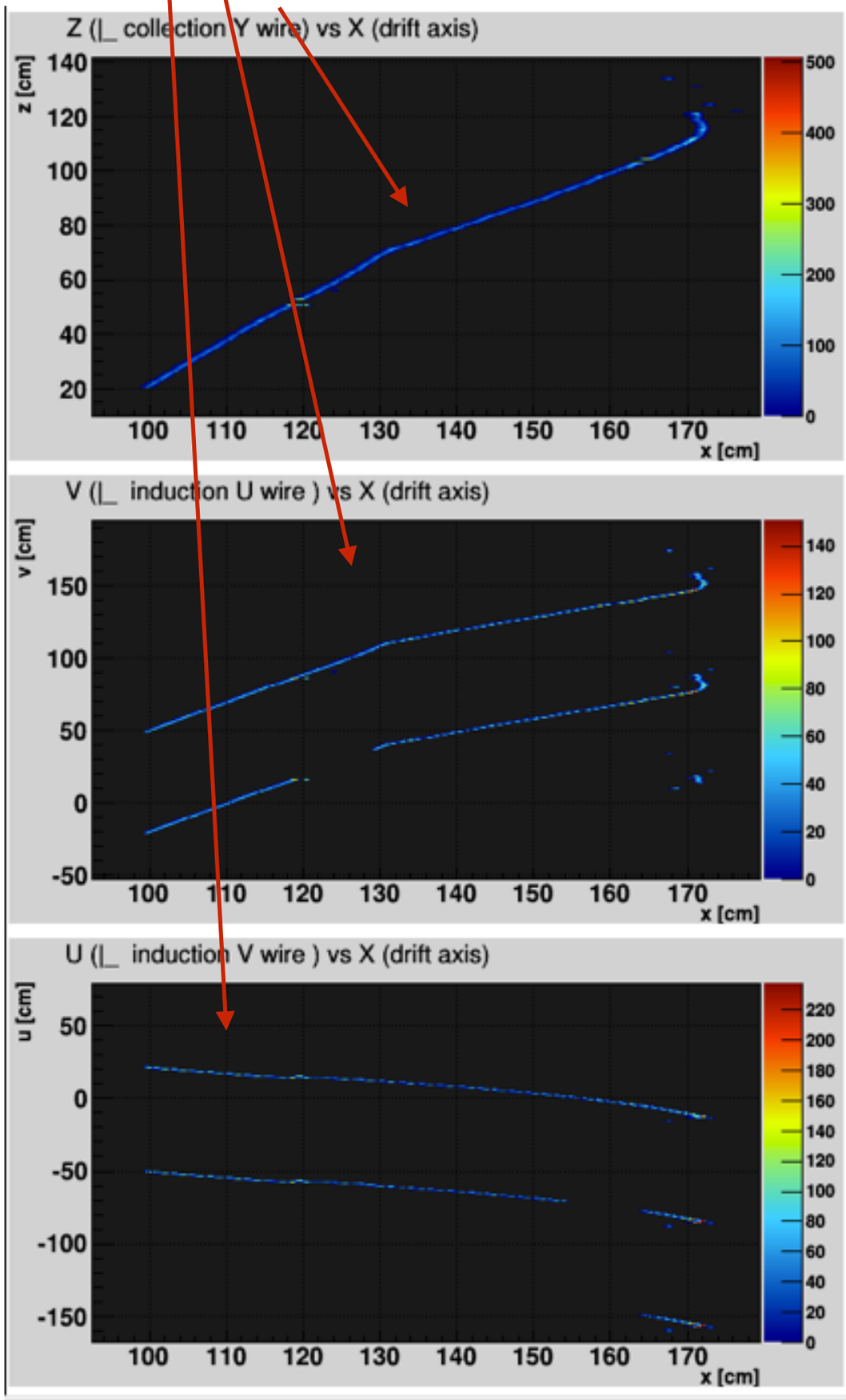


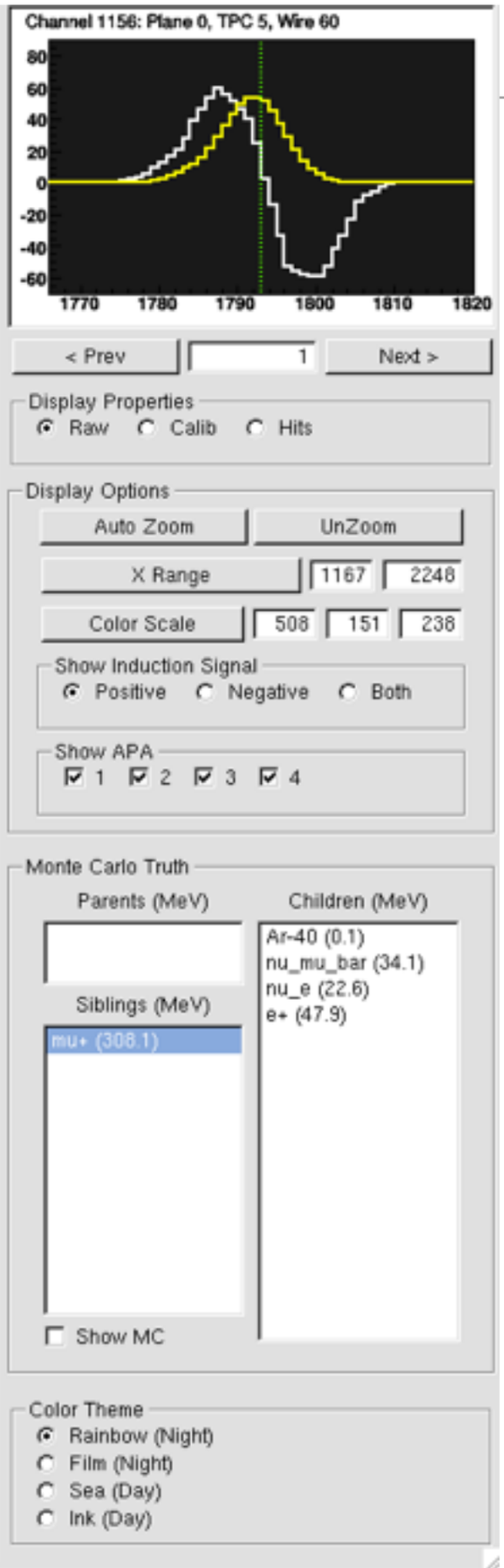
2D projections



2D Event Display

Main window: signals on the 3 wire planes





wire signal
(after click on a wire)

event navigation

toggle raw/calib/hits
in the main window

some more display
controls

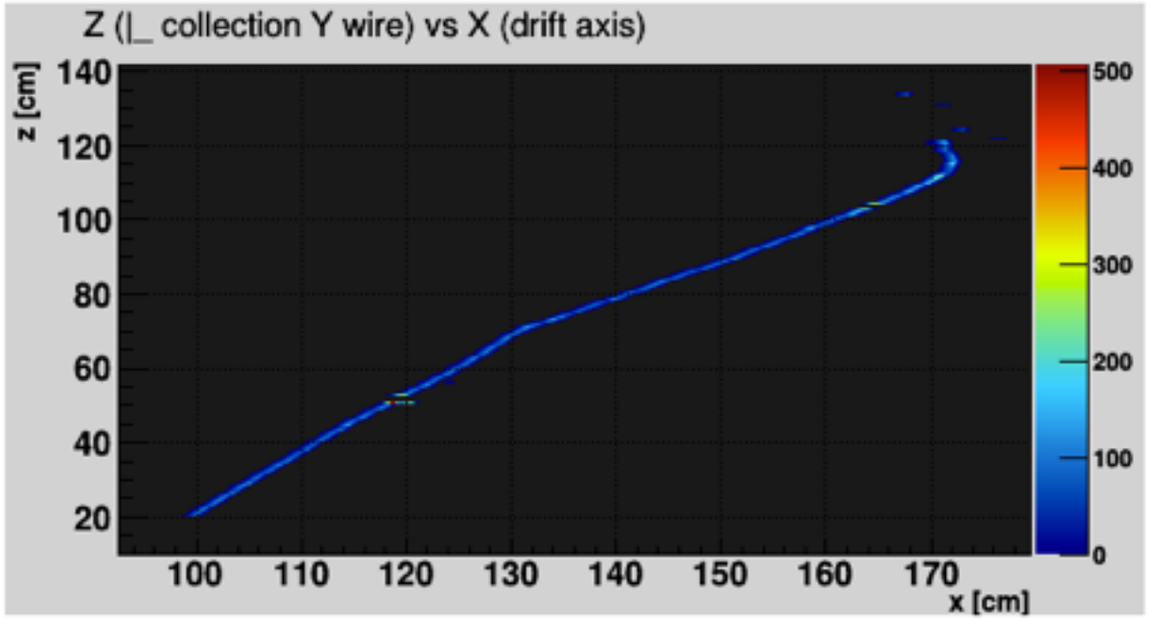
turn on/off APAs

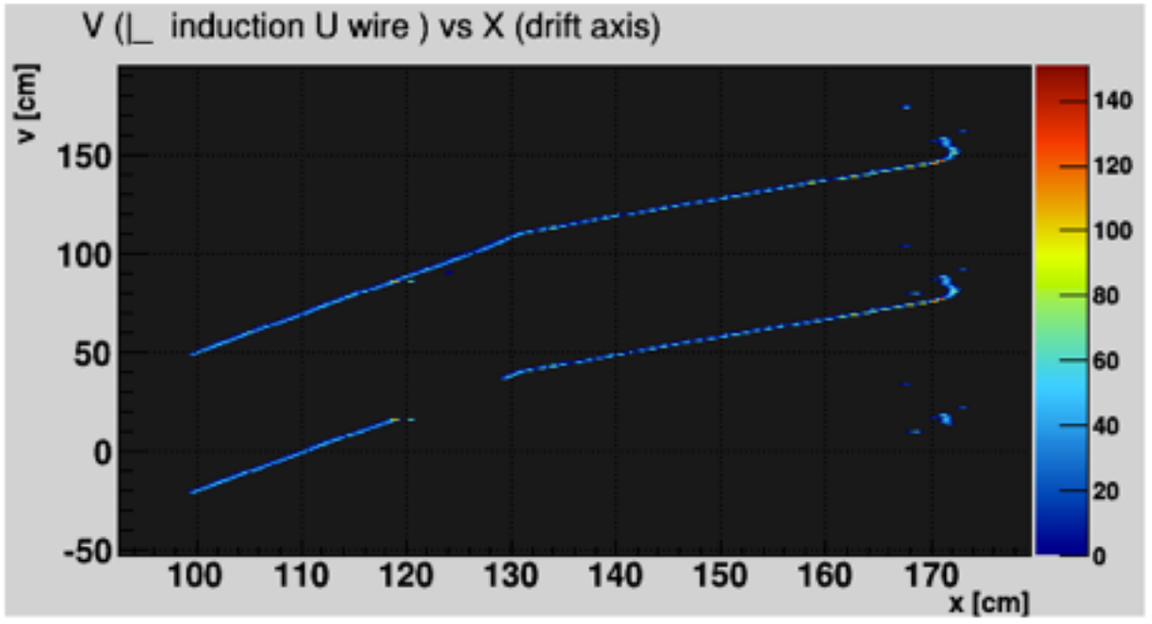
MC track display
control

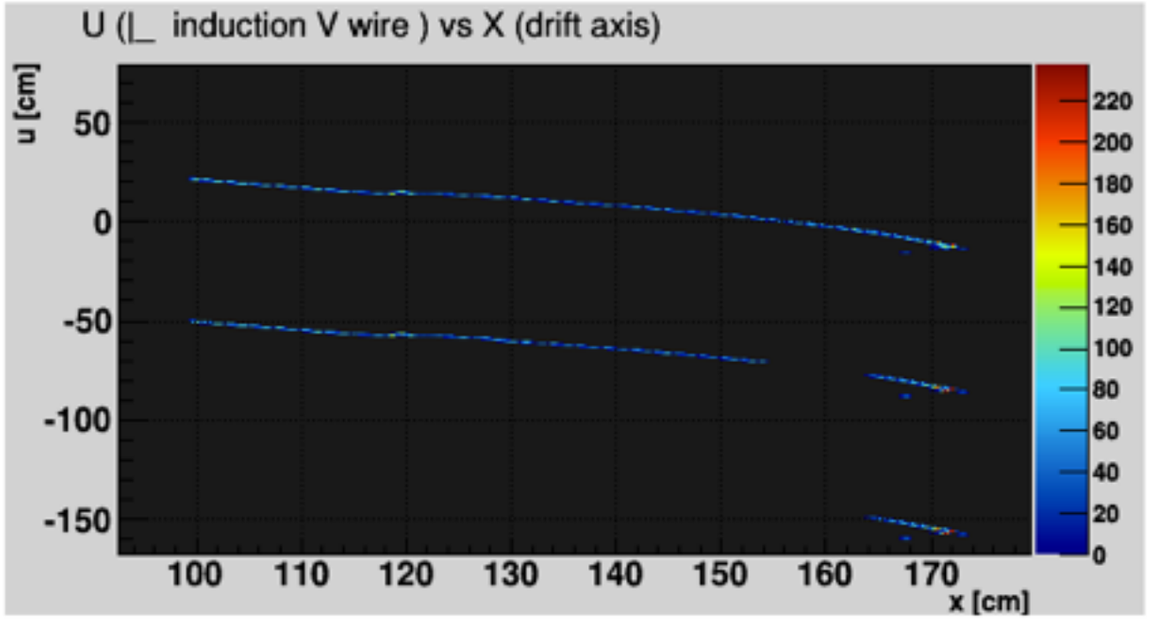
change color scheme

Main Window

- The 3 planes are (from top to bottom)
  - Y (collection)
  - U (induction)
  - V (induction)
- X-axis is the common drift distance (cm) in x direction
  - tdc converted to cm based on drift velocity calculation
  - zoom in/out on x-axis will simultaneously zoom all 3 figures
- Z-axis is the distance (cm) perpendicular to the wires
  - calculated based on wire pitch and orientation
- Color scale/theme can be set from the right control panel



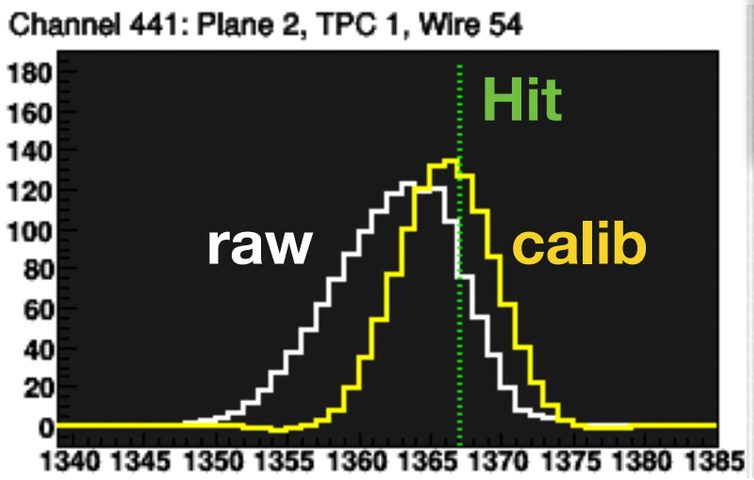




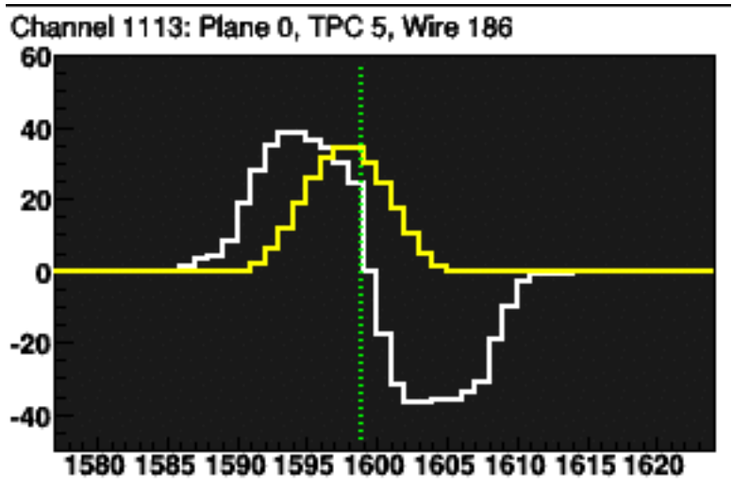
Wire Signal Window

- Click a wire in the main window will show its signal in the wire signal window
  - Raw signal (white)
  - Calibrated signal (yellow)
  - Hits found (green line)
- It will also show the channel#, wire#, tpc#, etc.

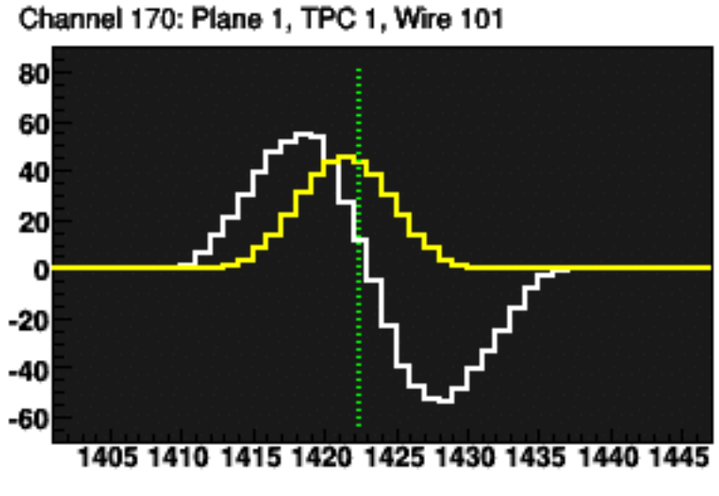
Collection Plane (Y)



Induction Plane (U)



Induction Plane (V)



Signal Processing

Raw Signal

CalWire

Calibrated Signal

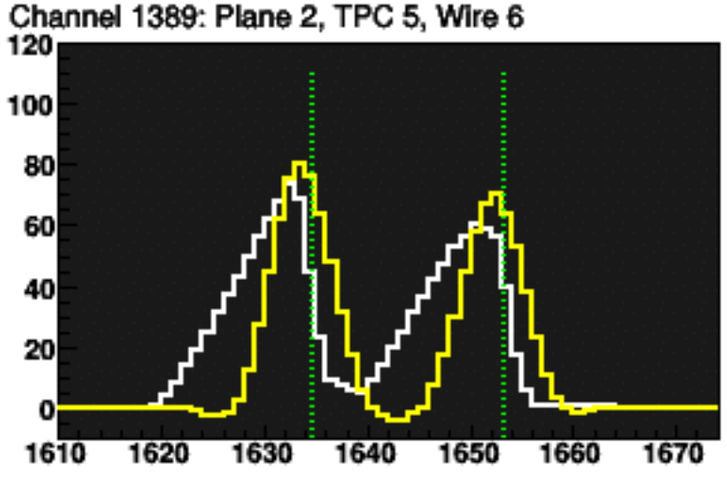
HitFinder

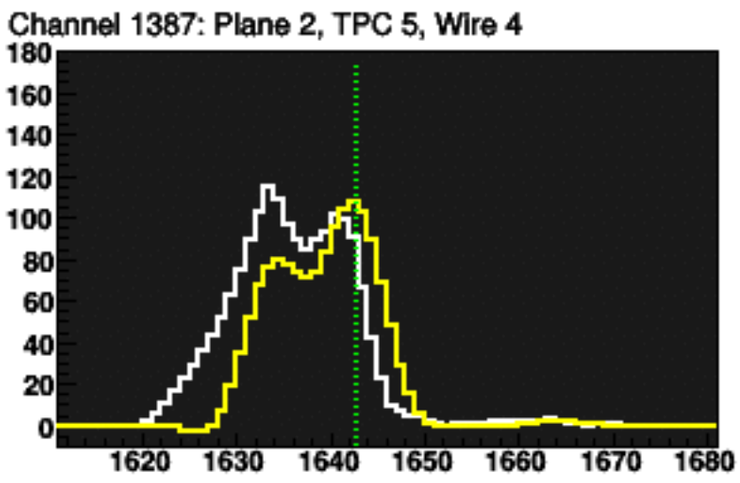
Hits

Hit time
Hit charge

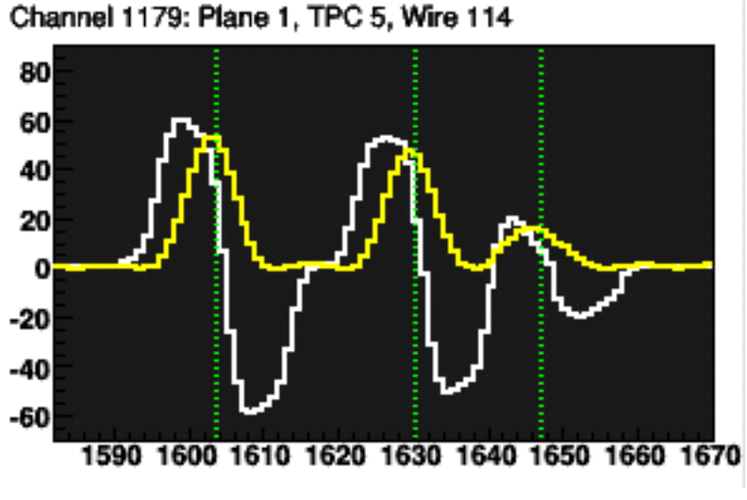
More Examples of Wire Signals

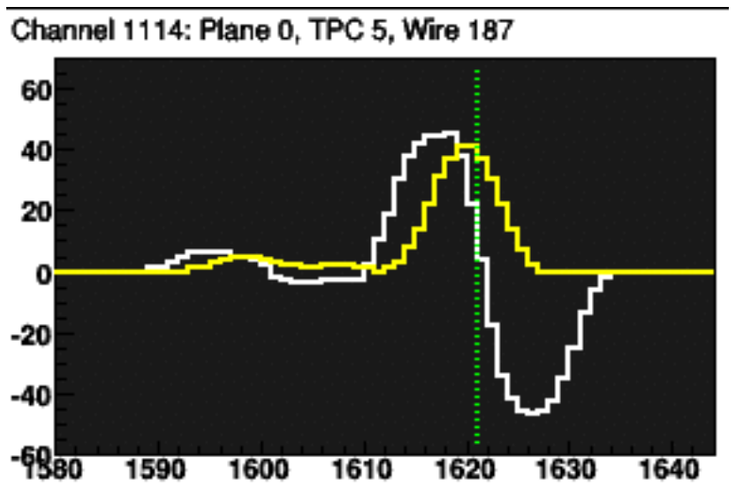
Collection Plane

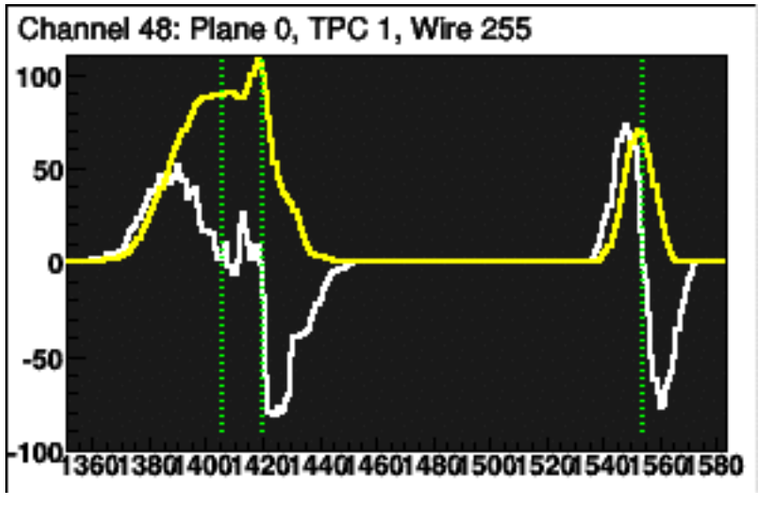


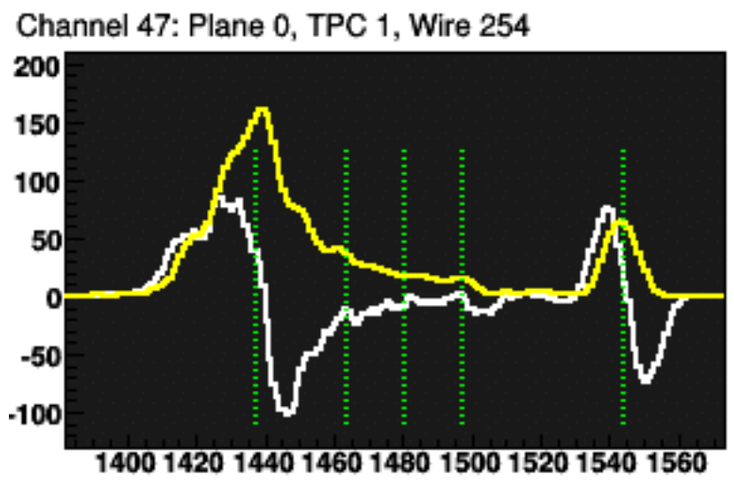


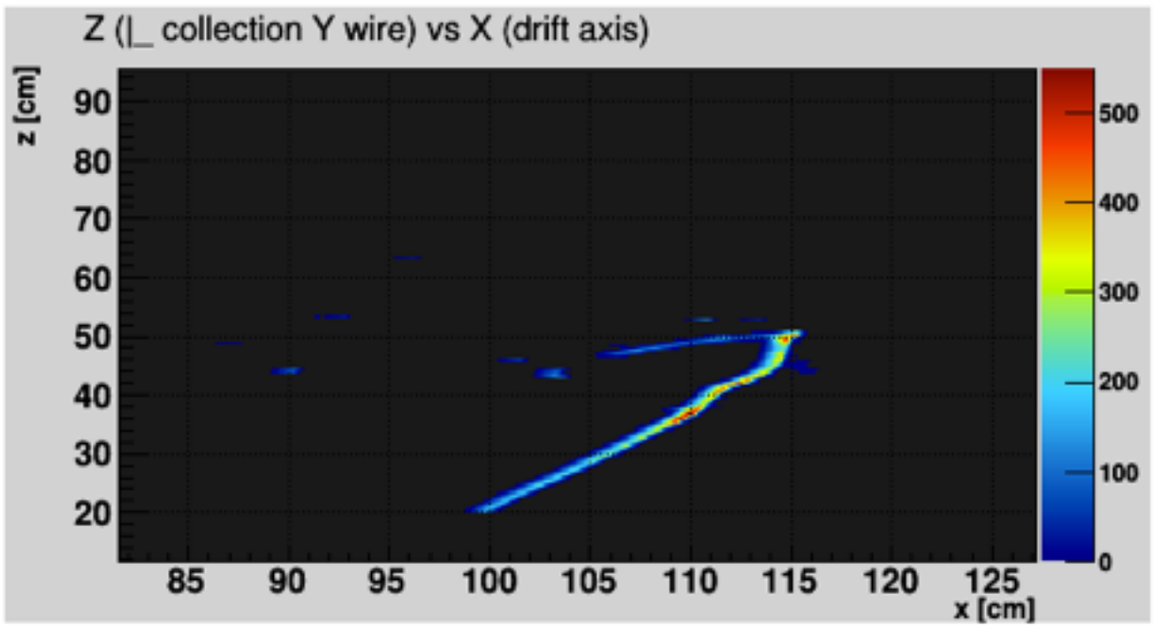
Induction Plane

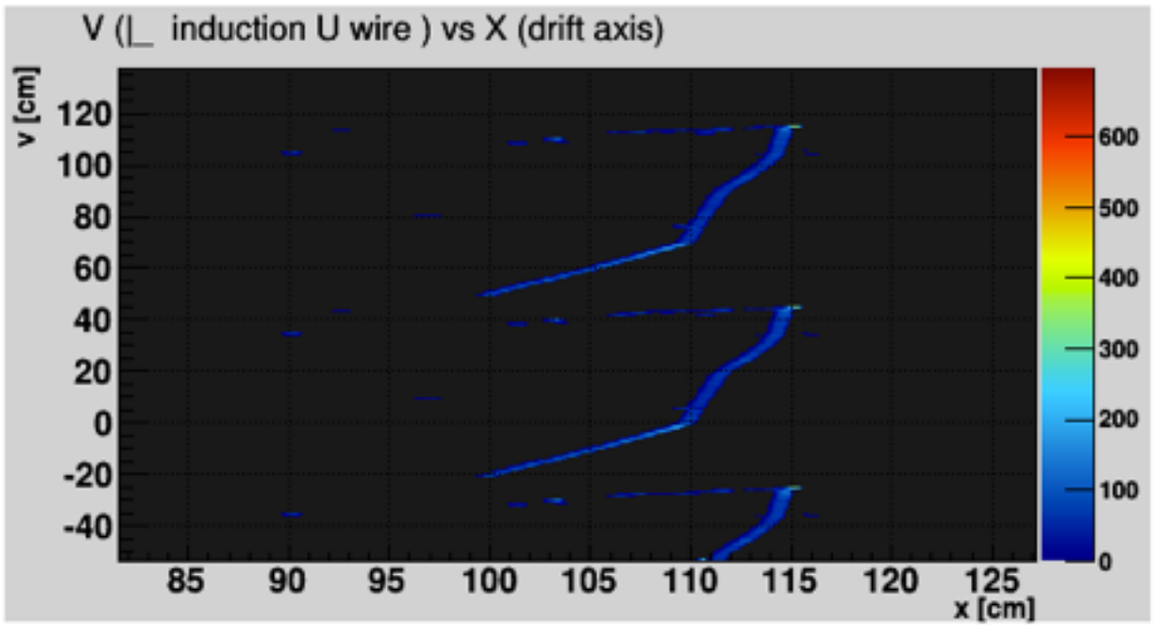


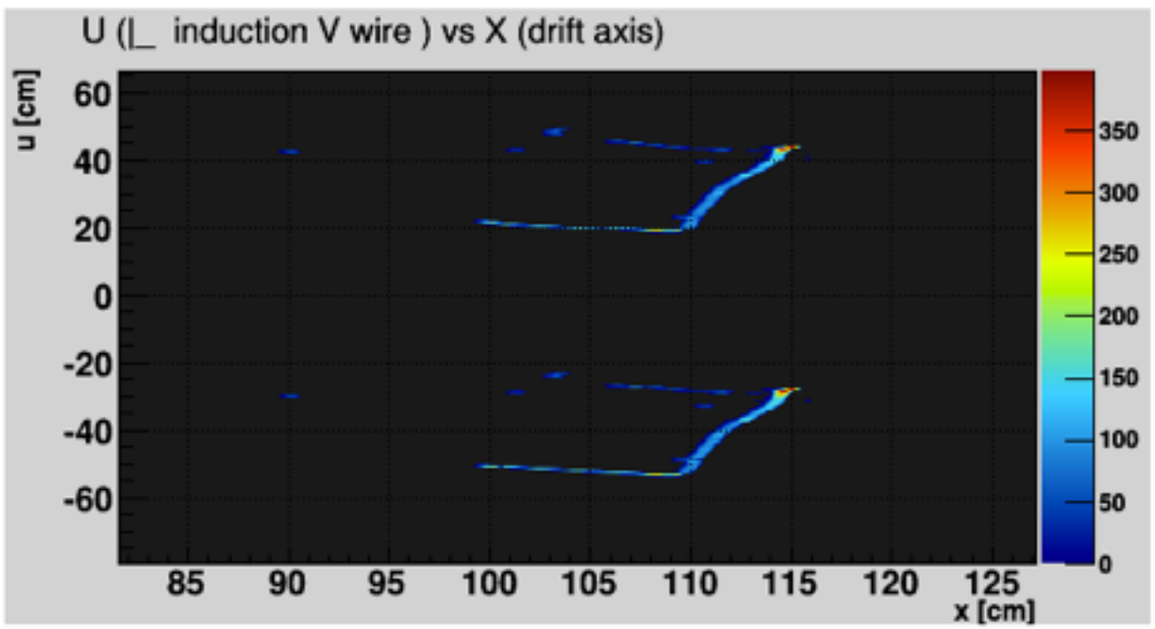


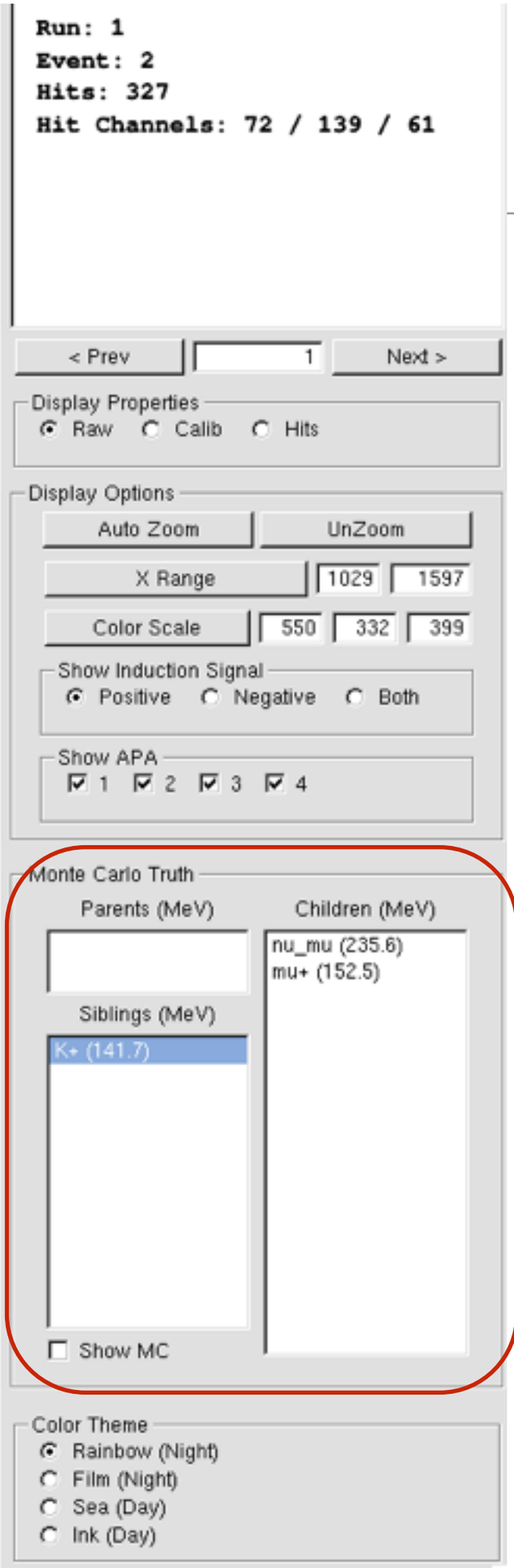






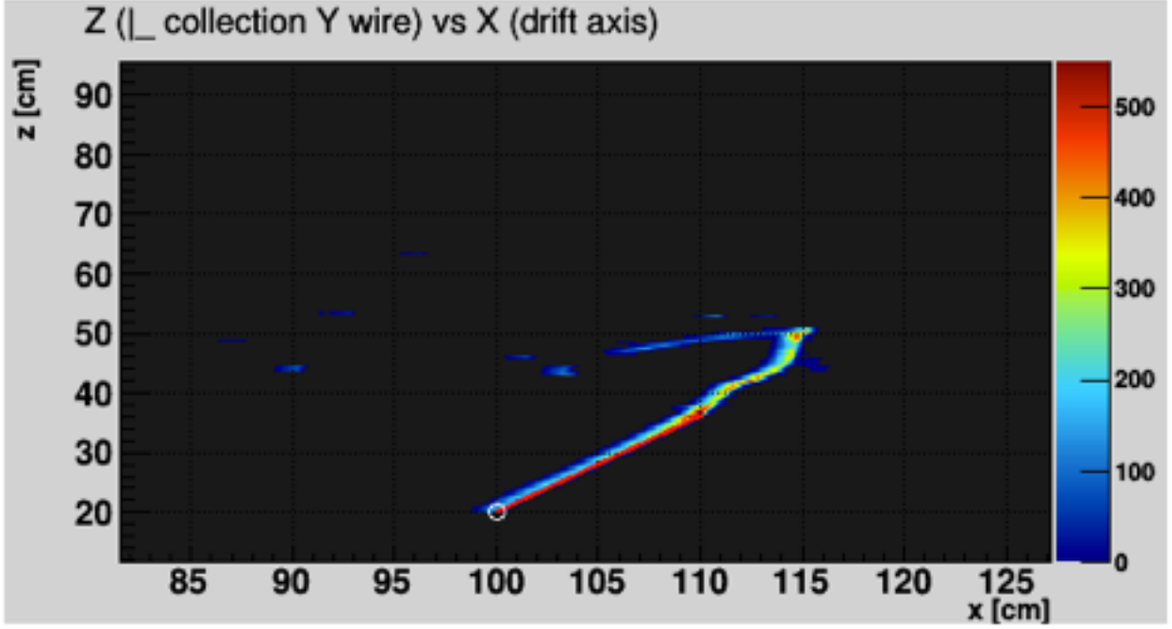


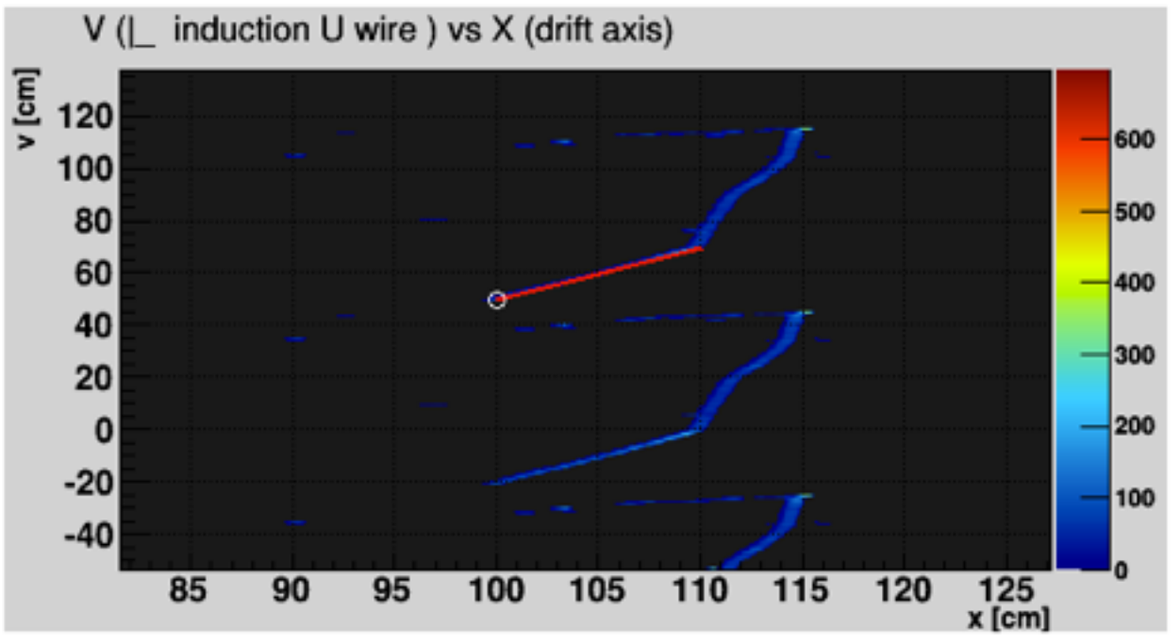


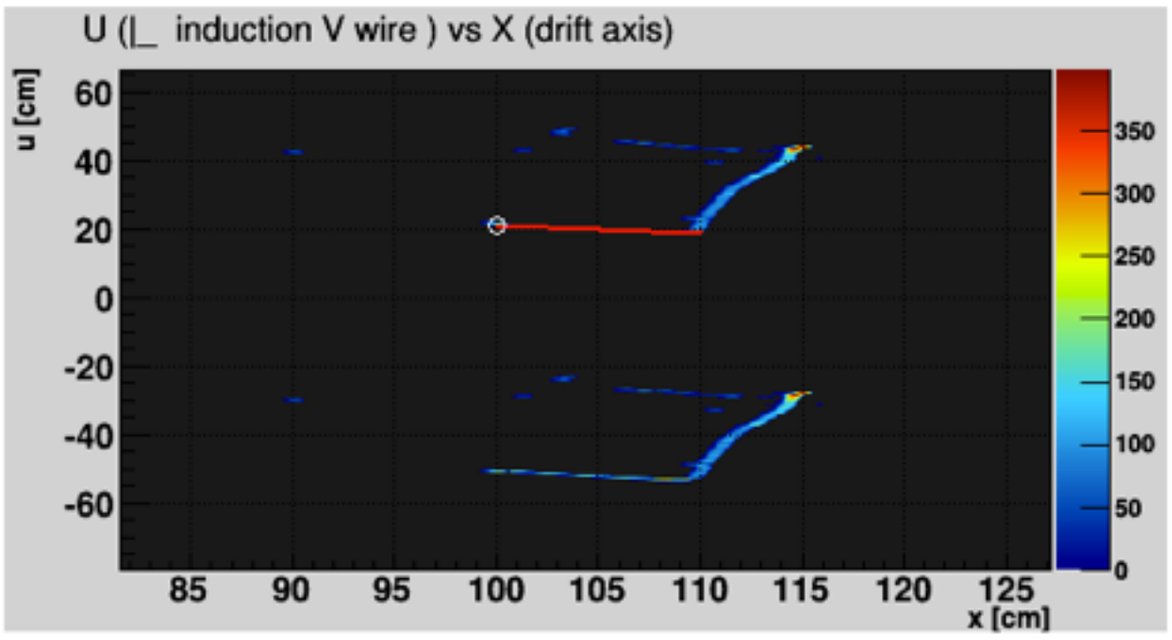


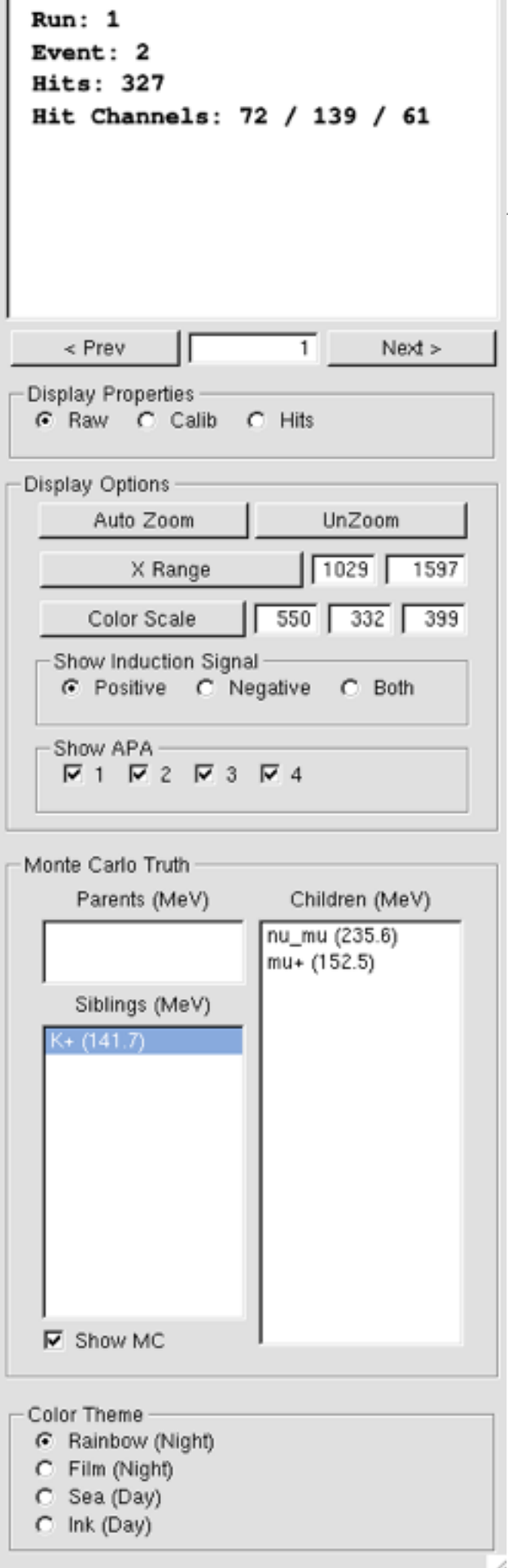
MC Tracks

- This panel controls the navigation of MC tracks
  - click the tracks in the parents/ children listbox to navigate
- current only show a straight line from start to end in each plane.
  (Xiaoyue is working on displaying the whole trajectory)



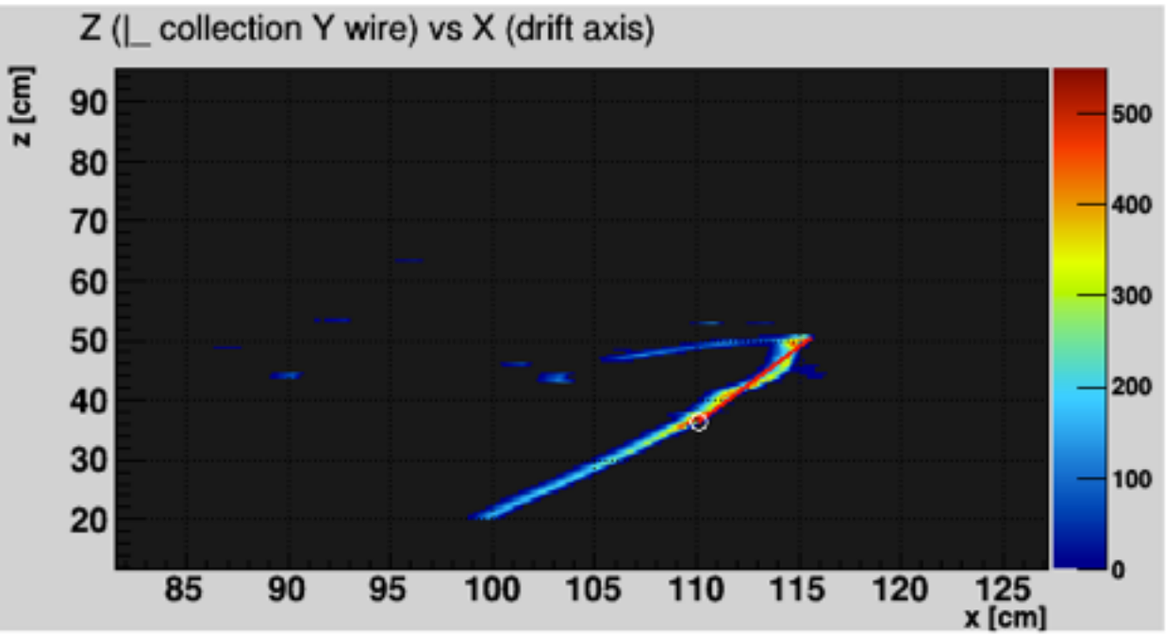


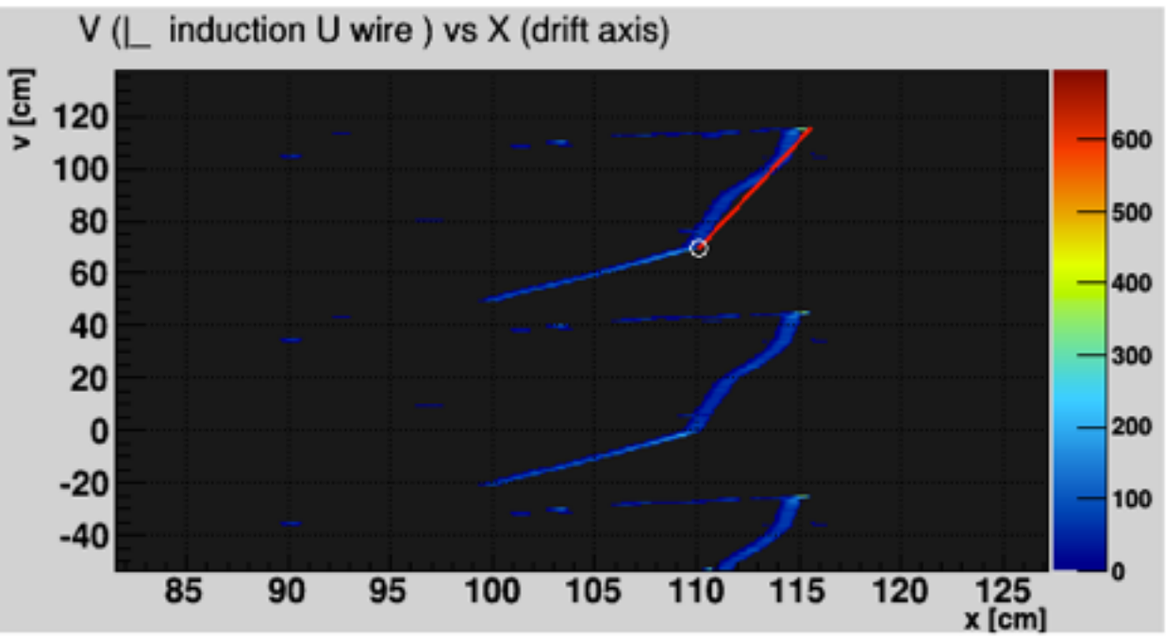


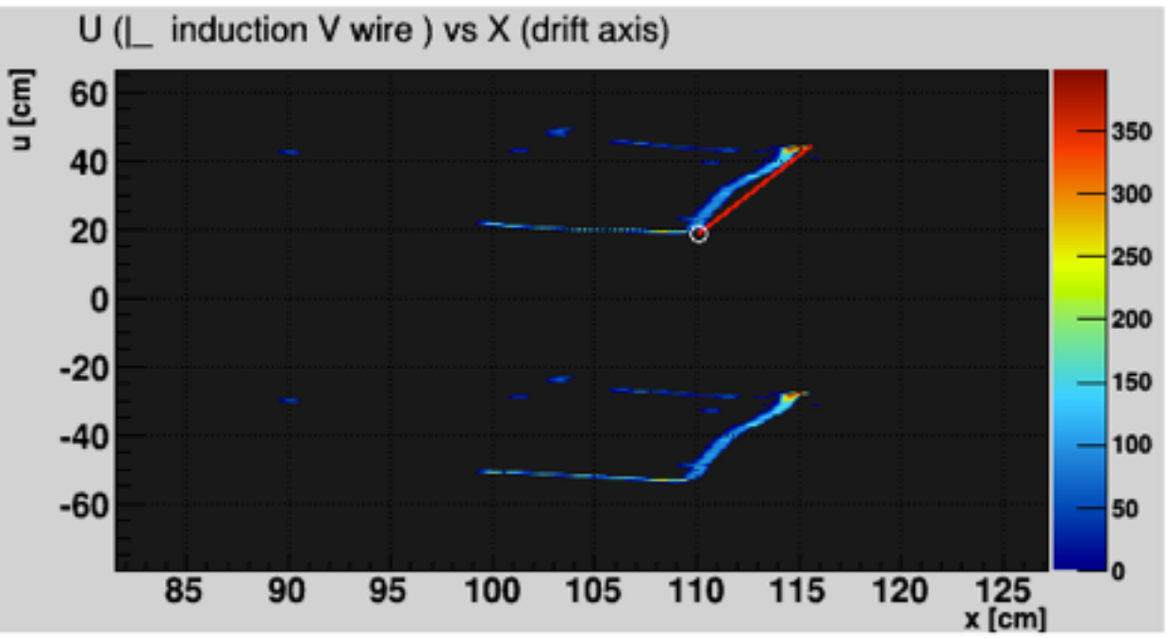


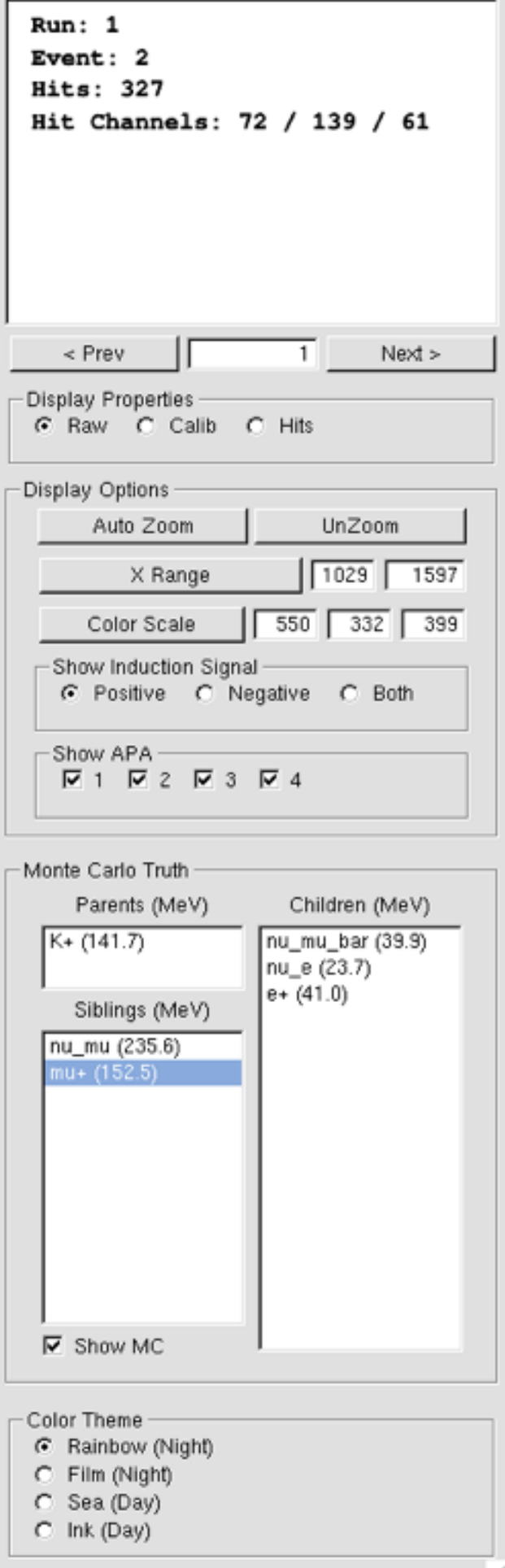
Example:

K^+ -> mu^+ -> e^+



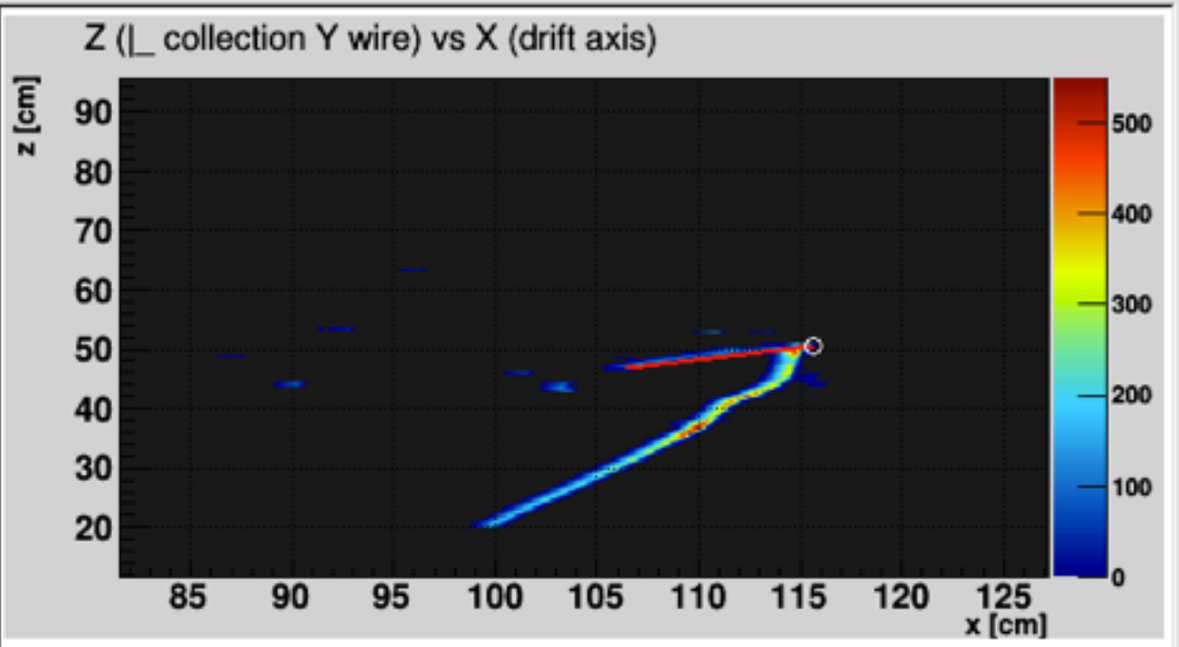


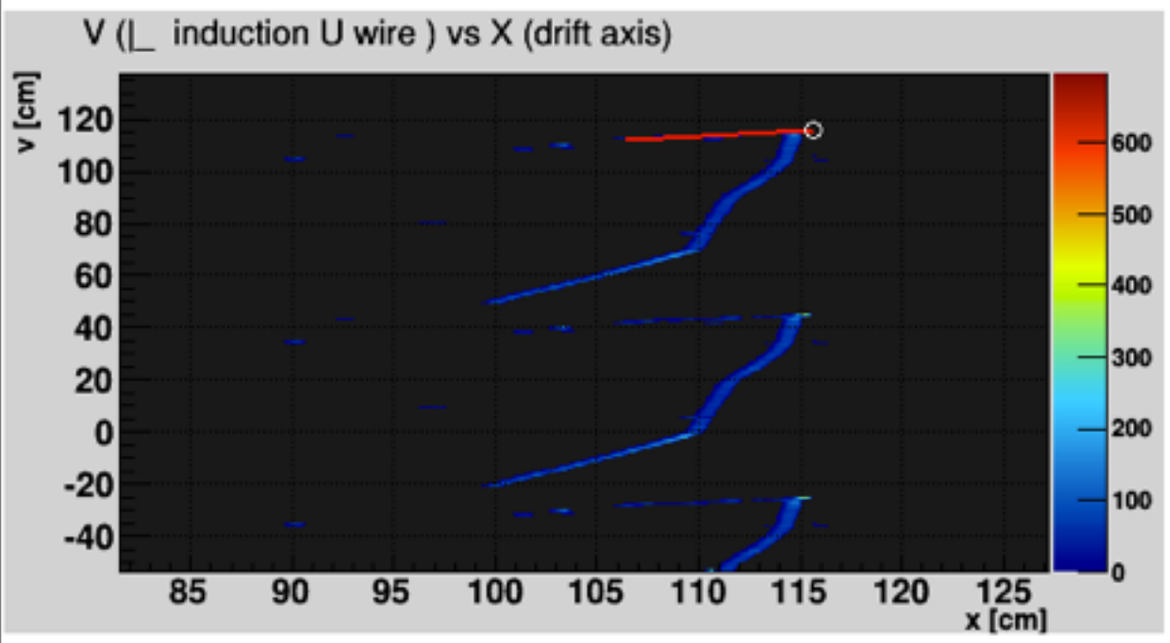


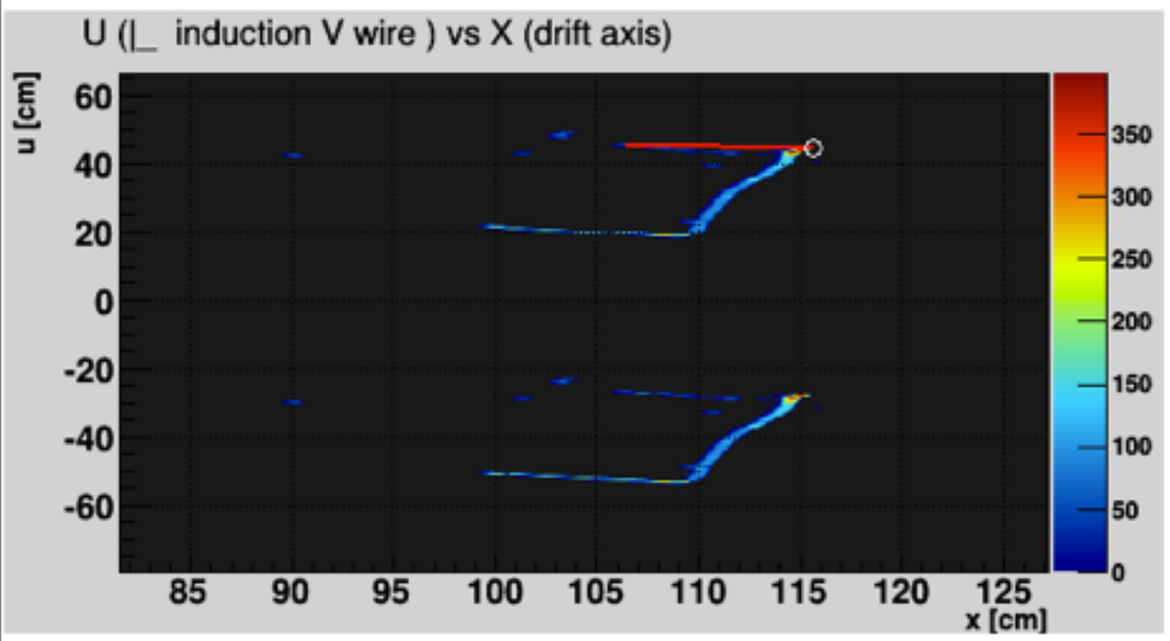


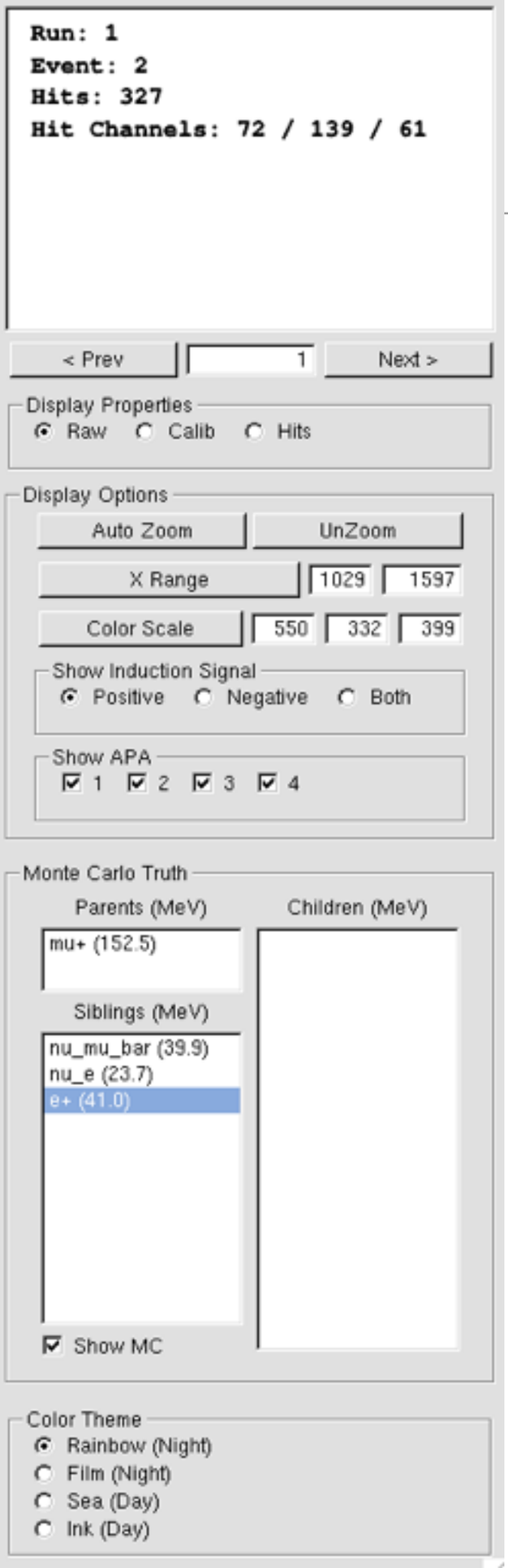
Example:

K^+ -> mu^+ -> e^+









Example:

$K^+ \rightarrow mu^+ \rightarrow e^+$

Planned Future Improvements

- Show the true trajectories (instead of start-end lines) and the reco tracks in the 2D display (already so in the 3D display)
- Add photon detector information
- Add muon paddle information
- Optimize the size/speed
- Many other little touches …
- Any feedback/requests will be welcome