MINERvA Update

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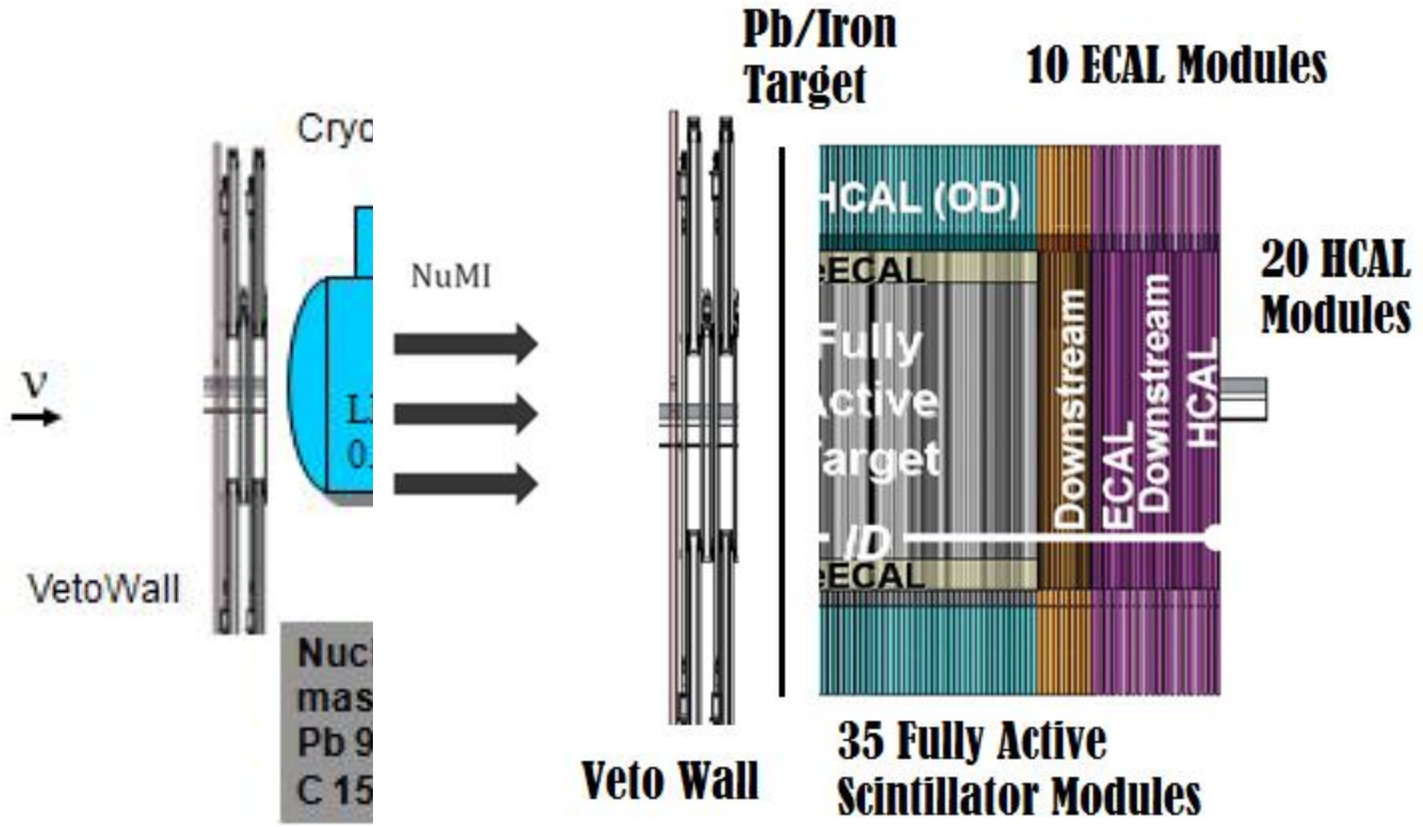
October 7, 2010

Hampton University Nuclear Group Meeting

The Main INjector ExpeRiment ν -A Detector

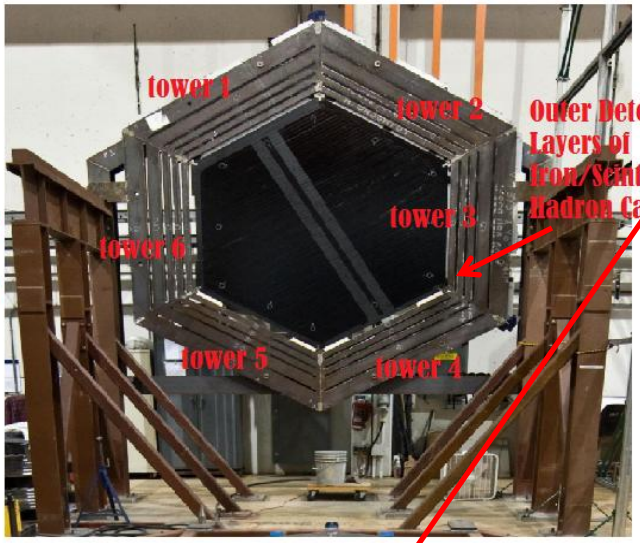


MINOS Near Detector

(muon spectrometer)

Gives the momentum and charge of the muon

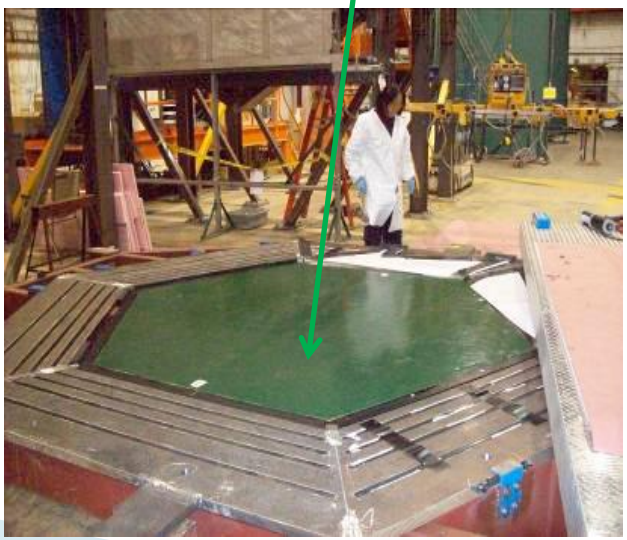
MINERvA Detector Module



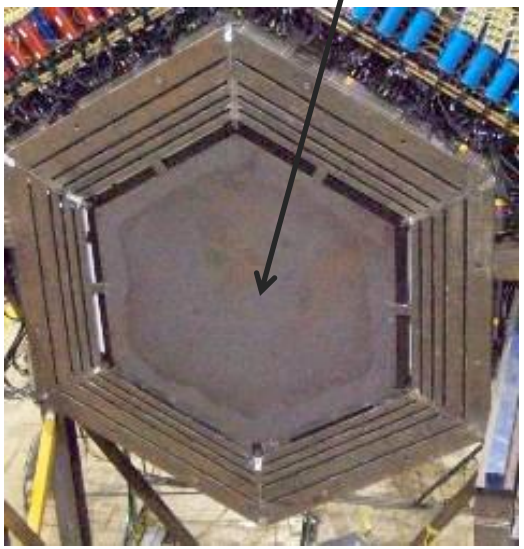
- 32,448 channels
- 80% in inner hexagon
- 20% in Outer detector

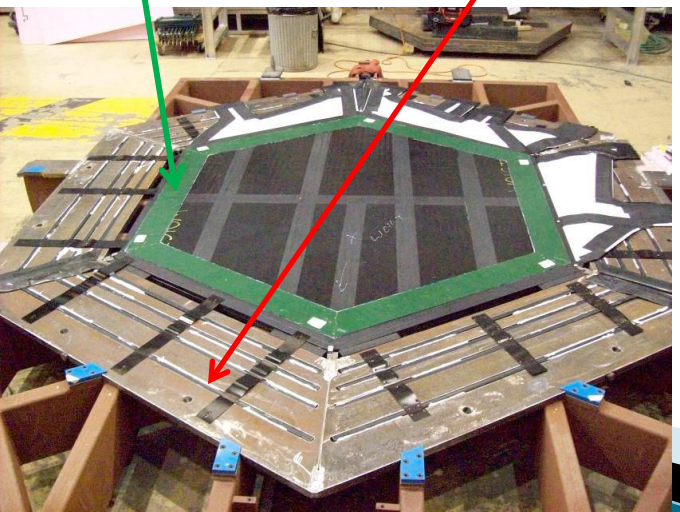
- 507 M-64 PMTs (64 Channels)

ECAL module include 2 scintillator planes each embedded with 2 mm Pb absorbers

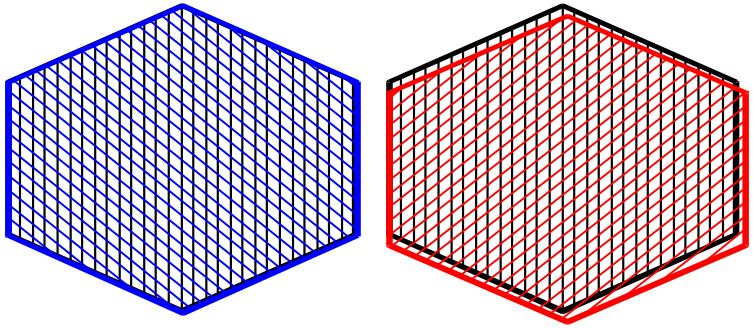


HCAL module include 1" steel plane and one scintillator plane.

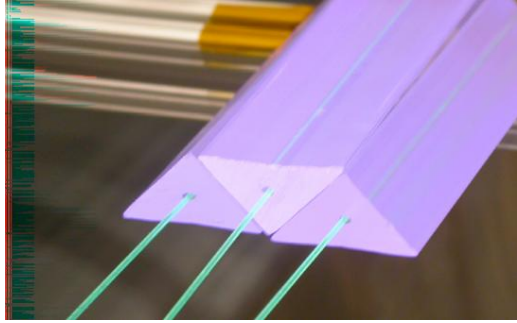




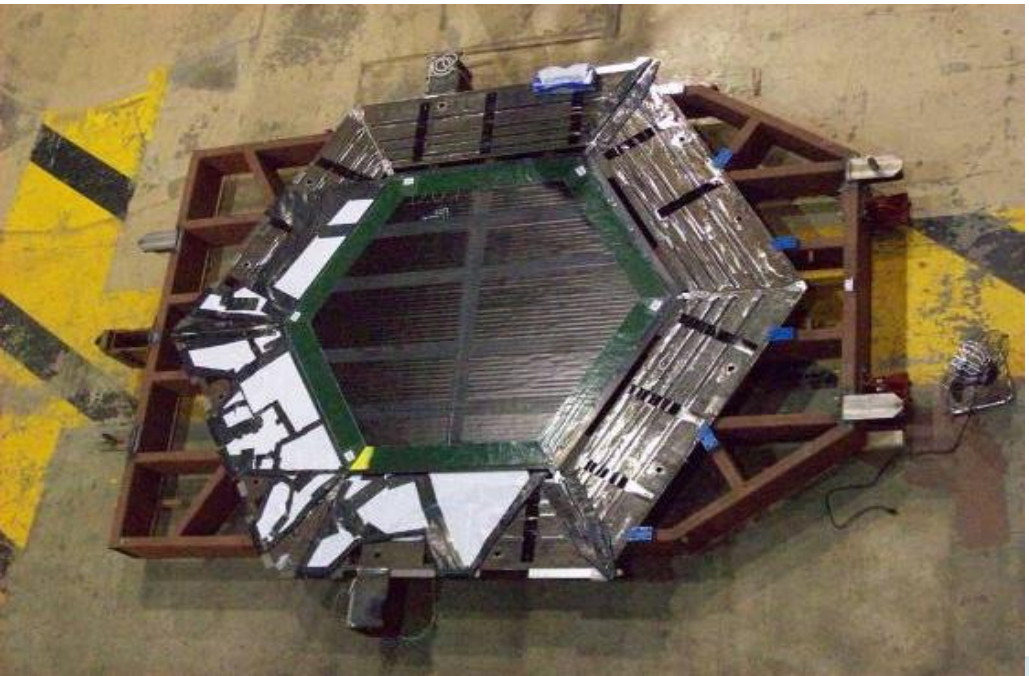
Inner Detector

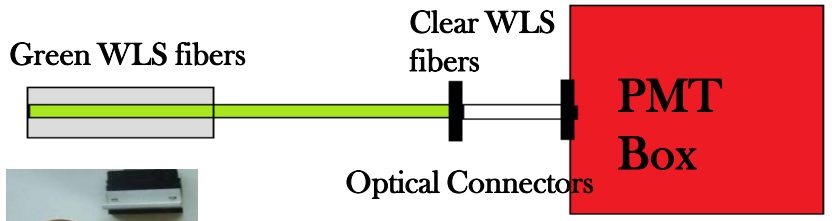


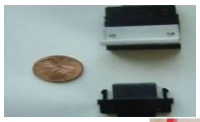
U X VX

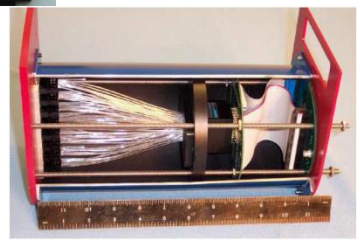


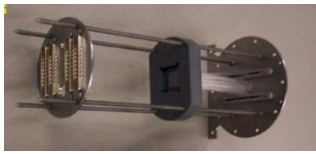
17 mm fiber to fiber
127 strips per plane
2-3.5 mm resolution from charge sharing



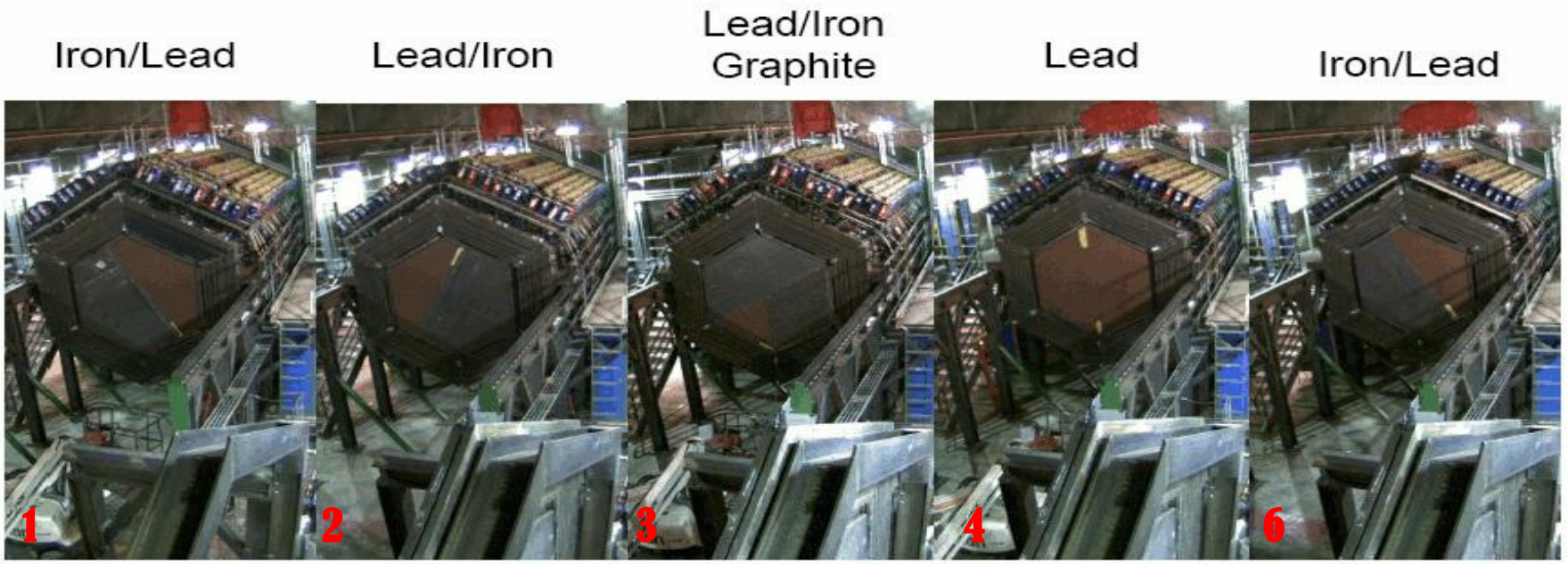








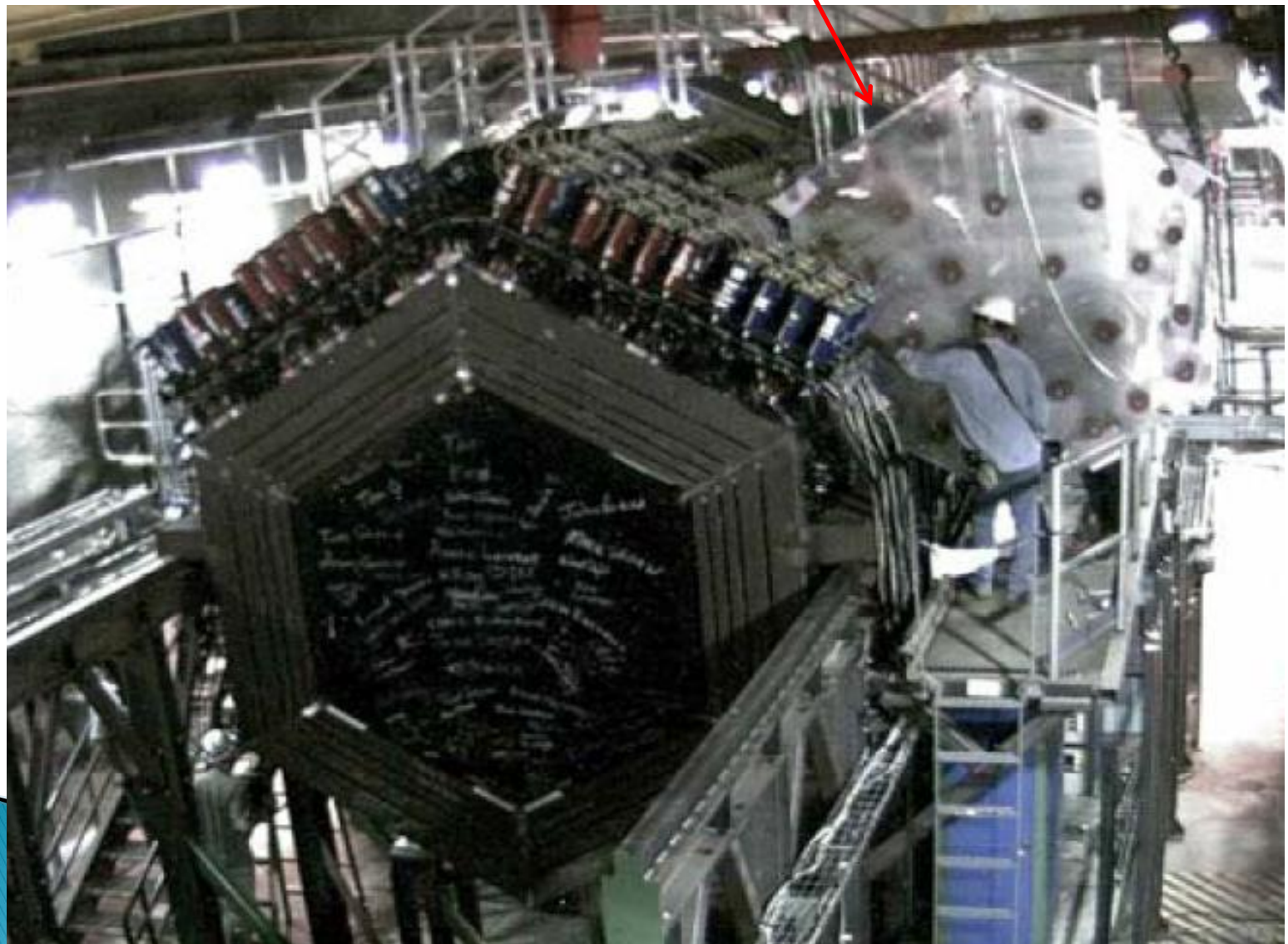
Current Nuclear Targets



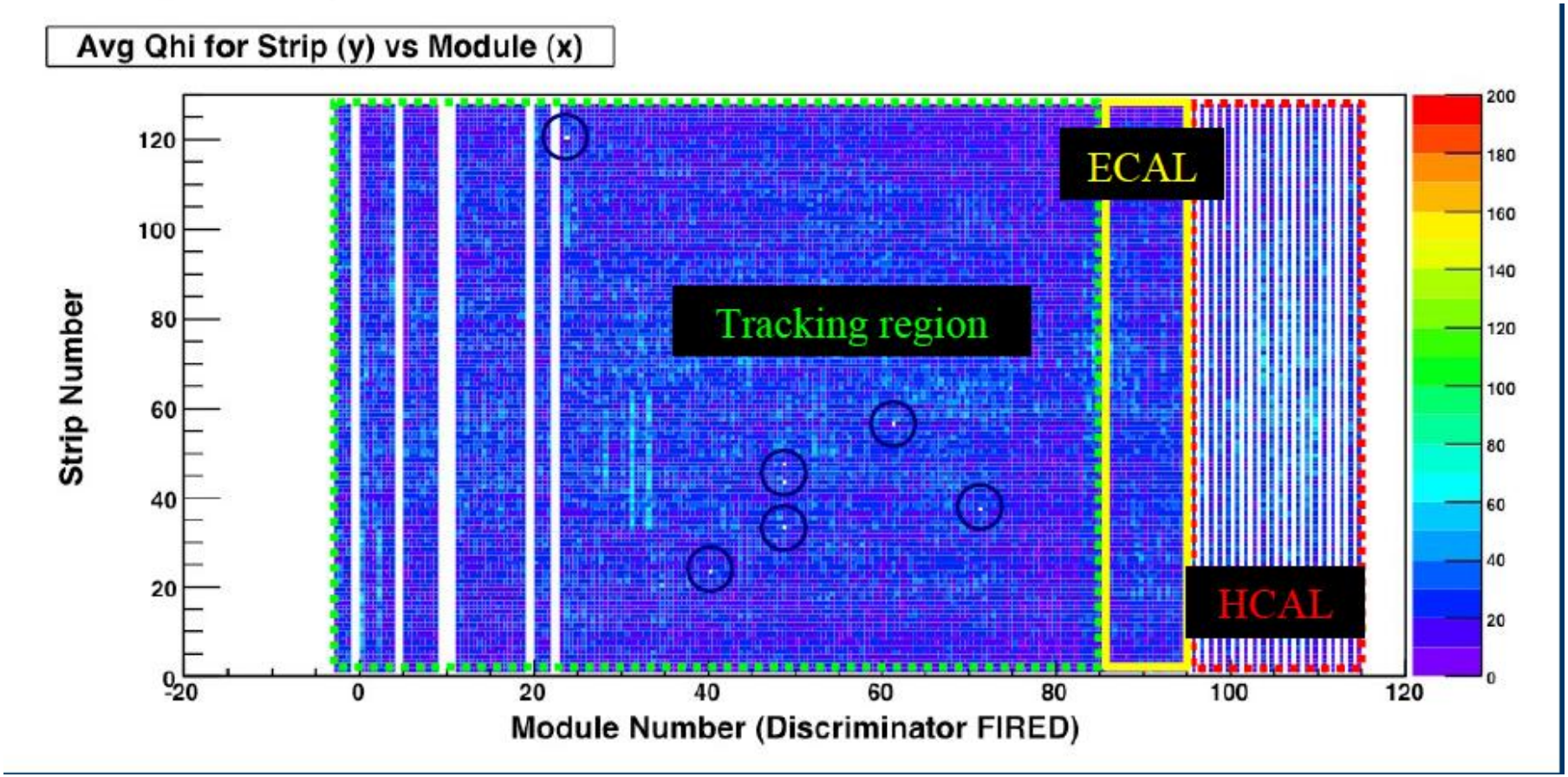
Target	Mass in Tons	Event in Millions
Scintillator	3	8.6
He	0.25	0.6
C (graphite)	0.15	0.4
Fe	0.7	2.0
Pb	0.85	2.5
Water	0.3	0.9

Using the NUGEN Neutrino Event Generator
Expected CC Sample

Installation of the Water Target Frame



Occupancy Plot

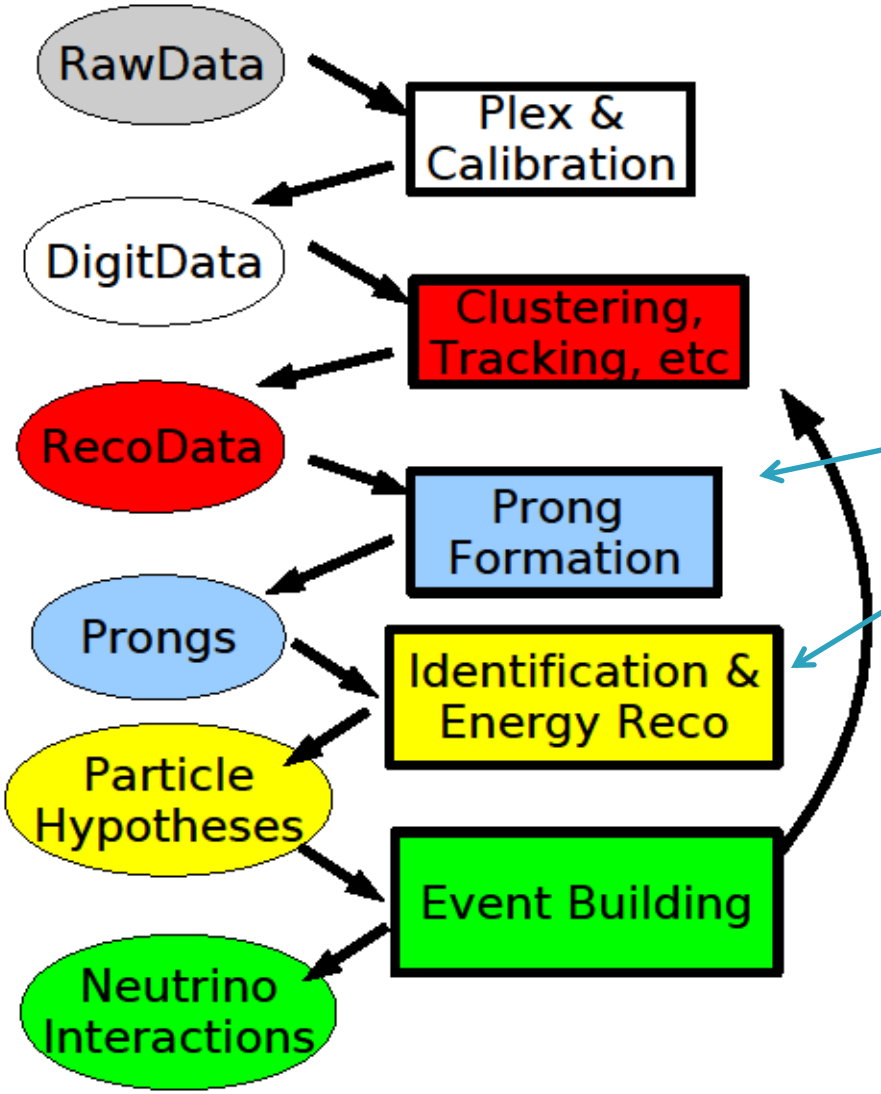


99.9 % of 31k channels working!

my contribution to MINERvA over the pass six months

- Reconstruction development
- Reconstruction analysis

Analysis Scheme



I have been developing the packages, higher level reconstruction objects, and algorithms .

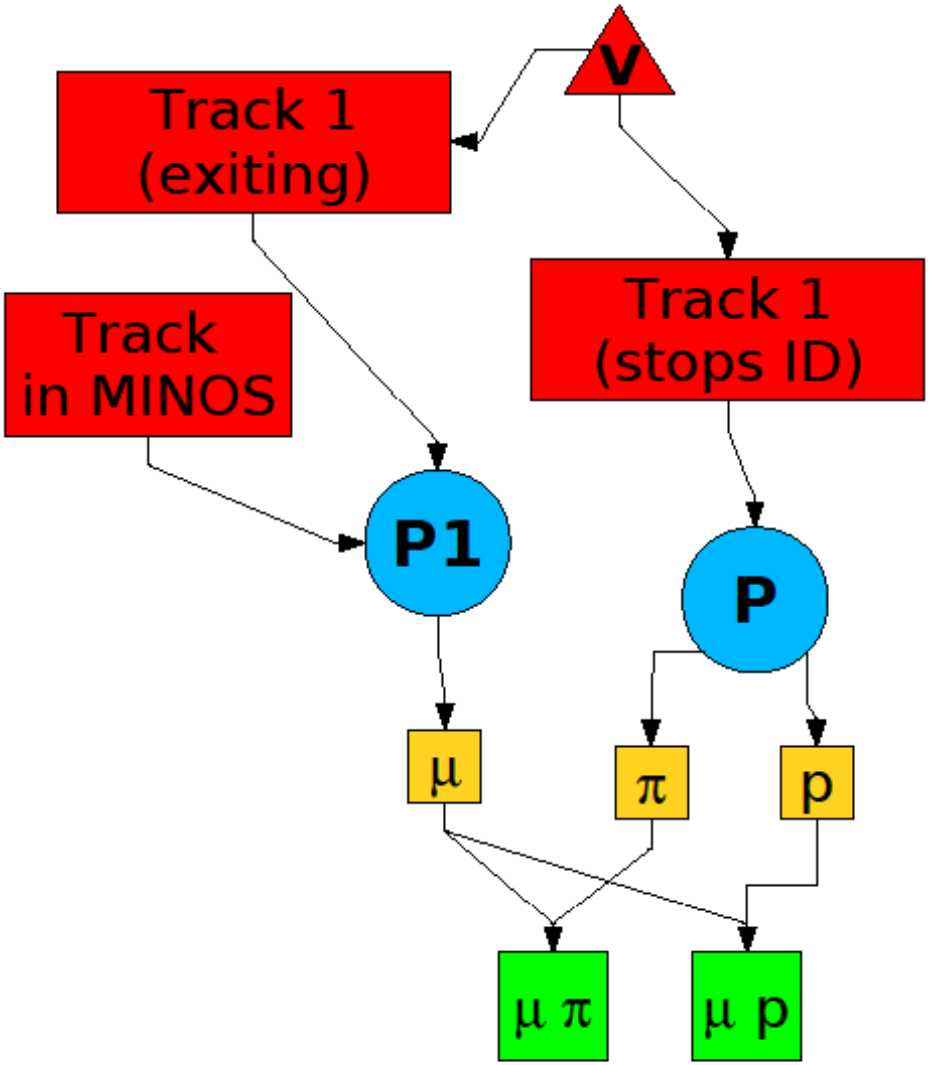
What are the Prongs Objects?

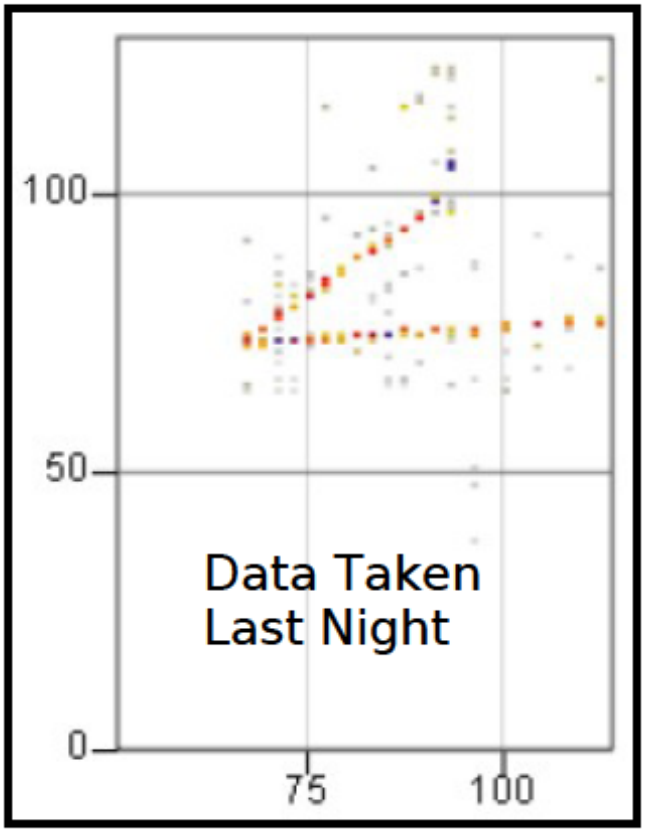
- Prongs are objects created from reconstructed objects, such as tracks, showers, vertices, …
  - Examples of prongs:
    - MINERvA matched MINOS tracks
    - Contained Track
    - Track and hadronic shower
    - Electromagnetic shower
    - Track and kinked track
    - So forth..

After the Prong Formation?

- Energy Reconstruction and Particle Identification
  - Currently, we have only two available tools
    - MuonEnergyRec - reconstructs the kinematics for a muon particle entering our muon spectrometer (MINOS)
    - dEdXTool – reconstructs the kinematics for hadrons (protons and pions) ranging out in the detector.
- What is needed?
  - much more
    - Tool which can distinguished between minimum ionizing particles.
    - Tool which can find energy unassociated with a track (actually someone just started working on this)

Concrete Example





What About Filters?

- Developed a tool, “dEdXPatternRecognition” which analyzes the measured dE/dx profile of a prong.
  - These are prongs which are “Contained”, ranging out in the detector.
  - Tries to find secondary nuclear interactions, selected events with little or no hadronic interactions, feed information back into the Tracker, etc…

    (show some examples later)

- Reconstruction Analysis
  - PID for “Contained” hadrons
  - momentum reconstruction
    - For muons entering MINOS
    - For hadrons ranging out
  - Identifying secondary nuclear interactions

Everything I do depends on tracking.

MINOS match MINERvA muons

I'm currently not doing any analysis to check the performance of these tools, etc.

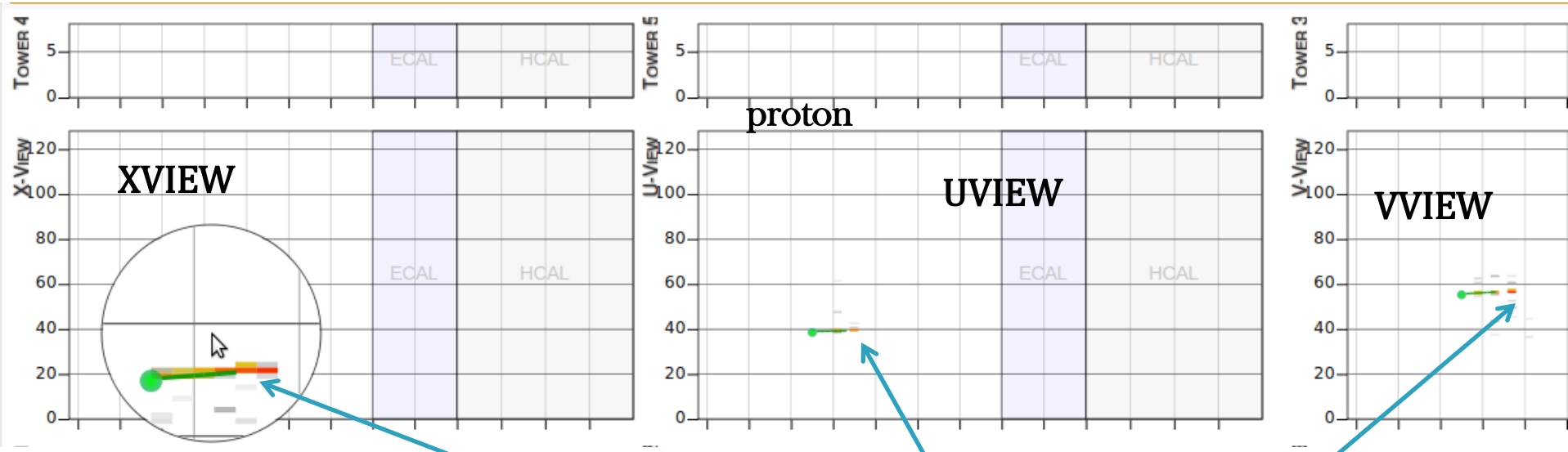
There are people who are, if you wish next time I give a talk I can give an overview of the analysis effort for muons entering MINOS.

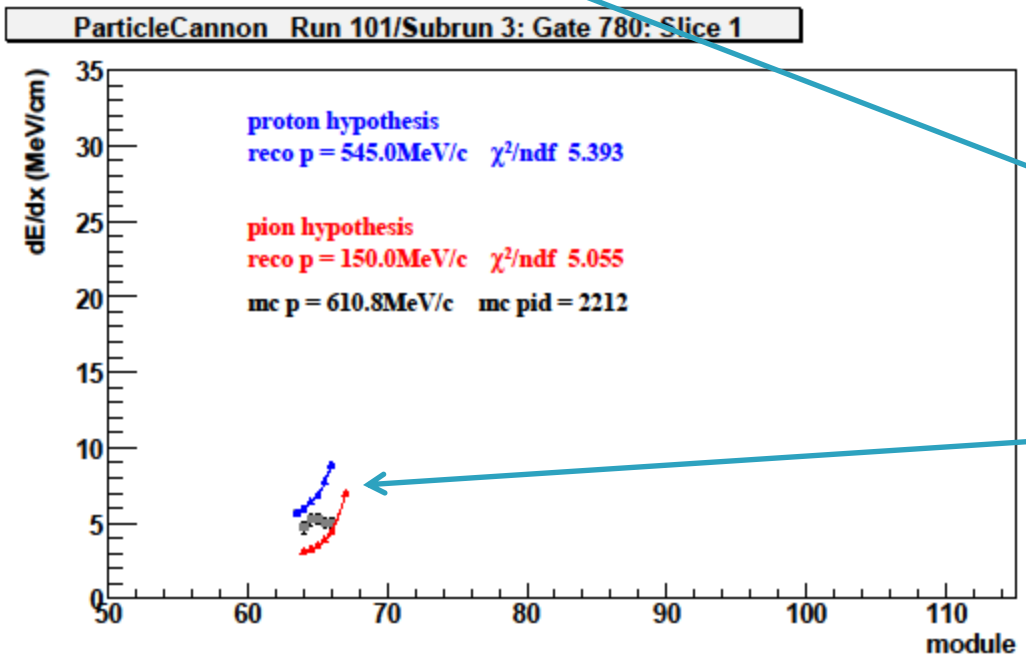
Stopping Hadrons

- We know that the dE/dx fails when dealing with secondaries.
  - study with Hadronic Model turned off/on
  - study the efficiency and purity for finding secondaries

- Before I show some results of momentum distributions and PID efficiency with the Hadronic Model turned off, first I want to give an overview of the "dEdXPatternRecognition" Tool. A filter for finding secondaries and unanalyzable prongs.

Example of finding clusters at end of track.

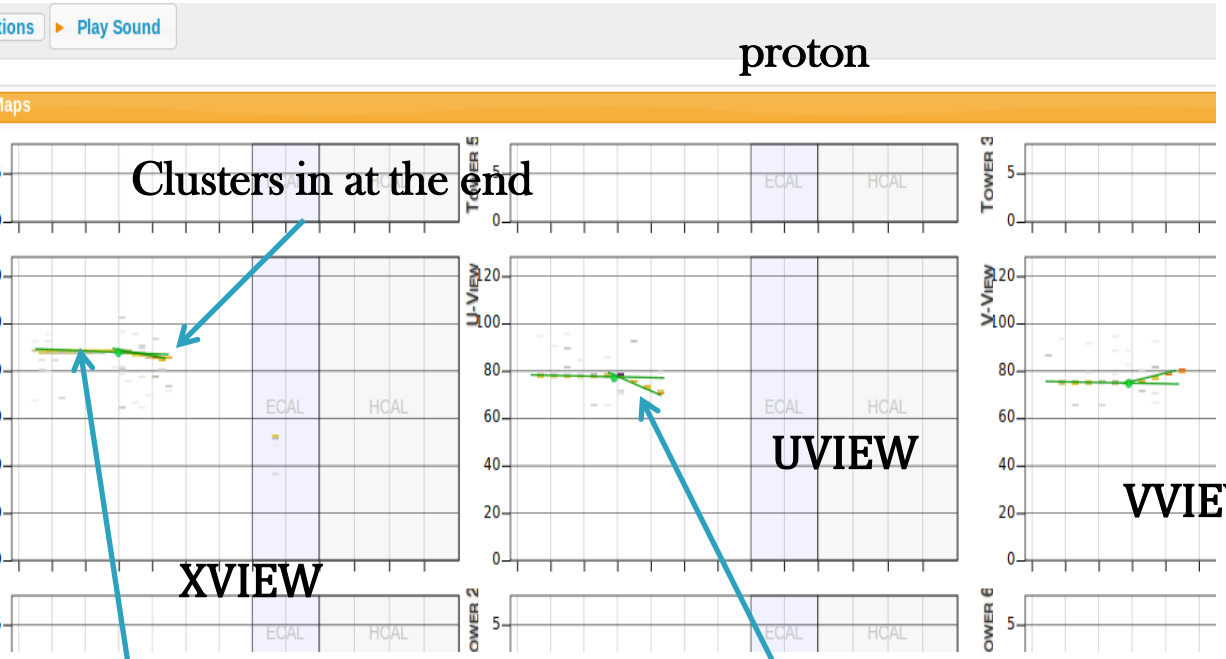




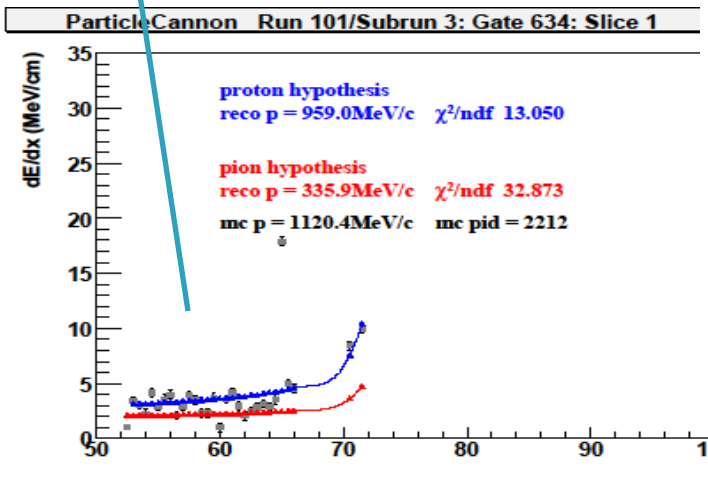
Hits are not on Reconstructed Track

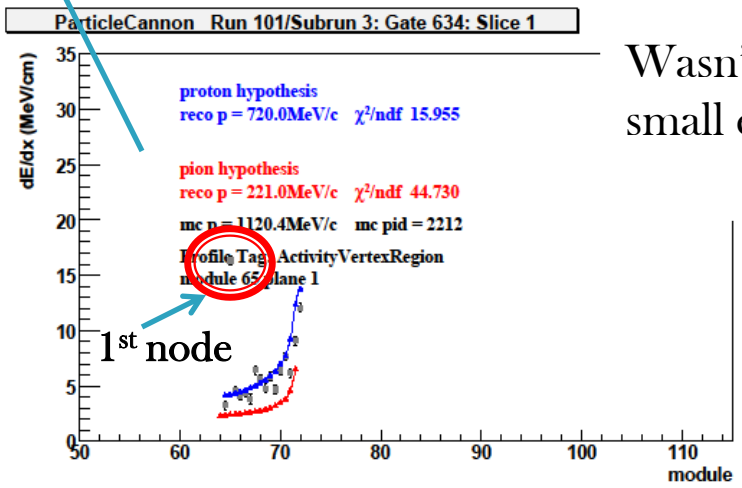
ProfileTag is assigned an integer 200

Example of finding tracks which intersected

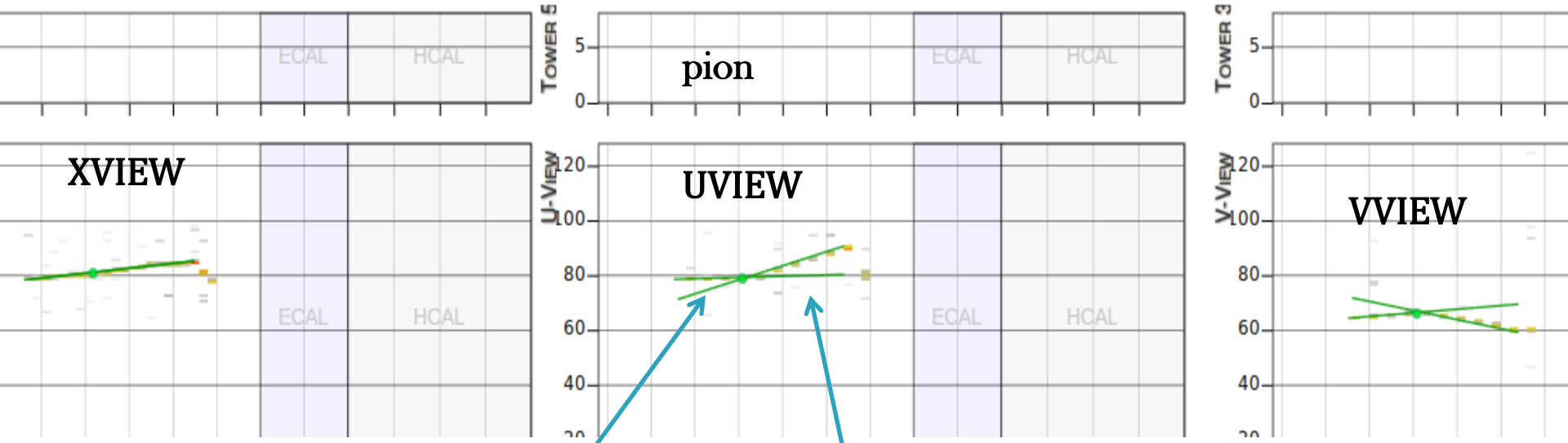


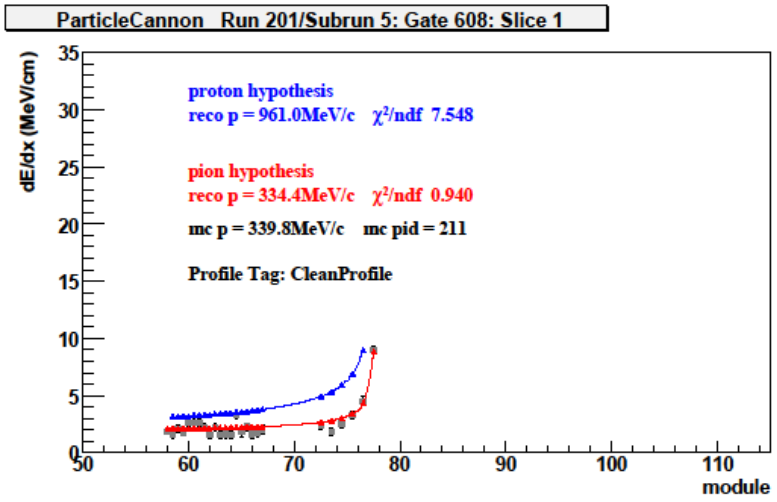
Kinked Tracks
ProfileTag is assigned an integer
300

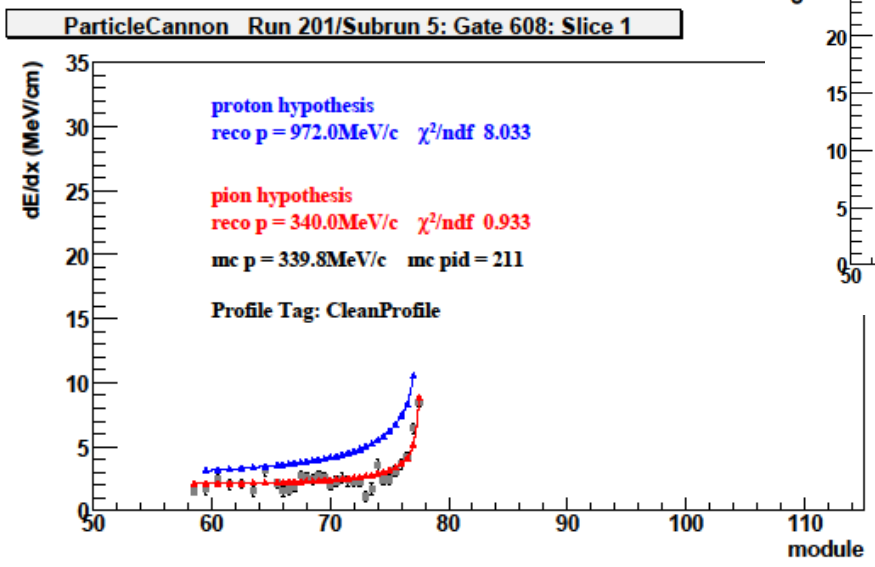




Wasn't tagged due to a small error in the code.



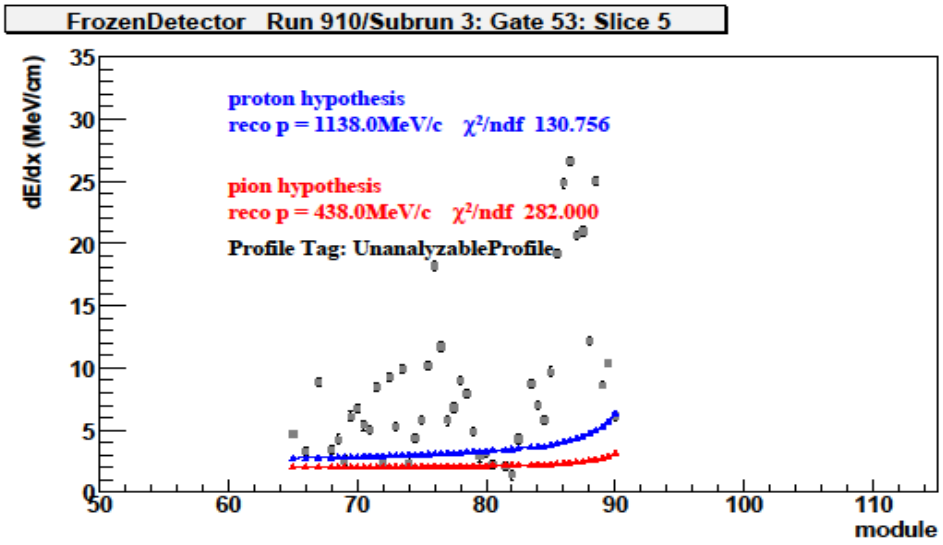


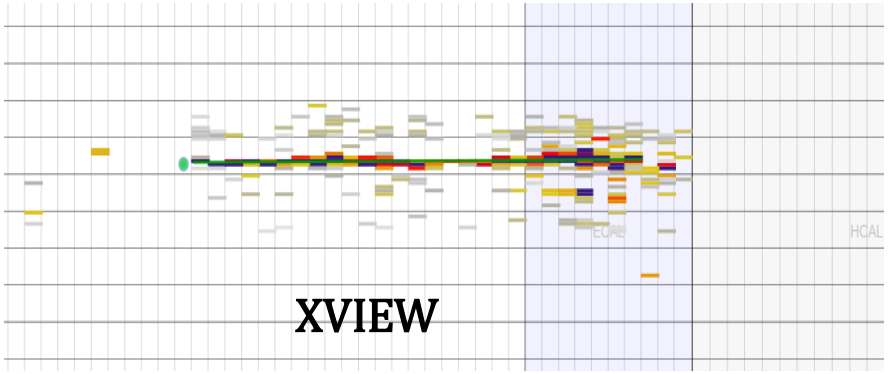


The code doesn't look for overlapping tracks.

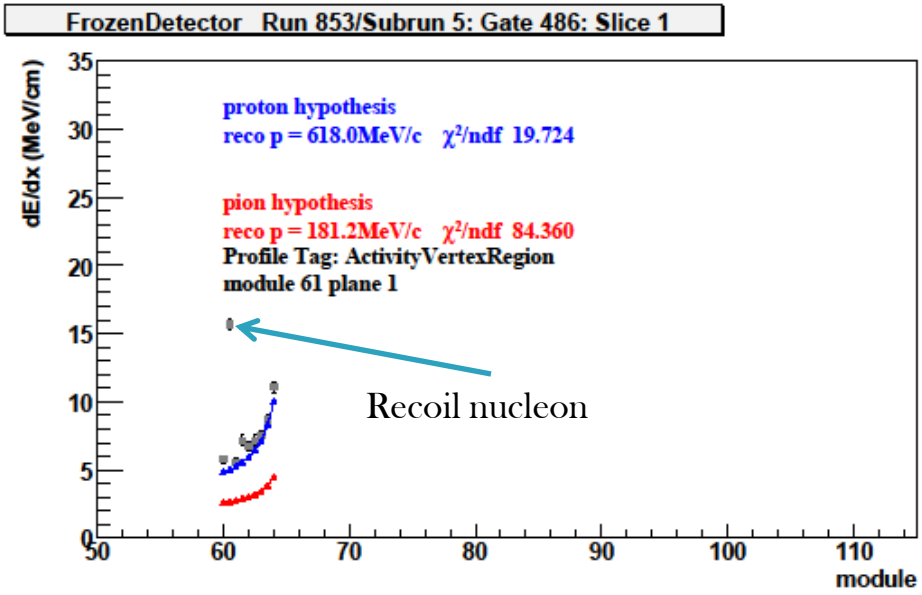
dEdXPatternRecognition -"UnAnalyzableProfile"

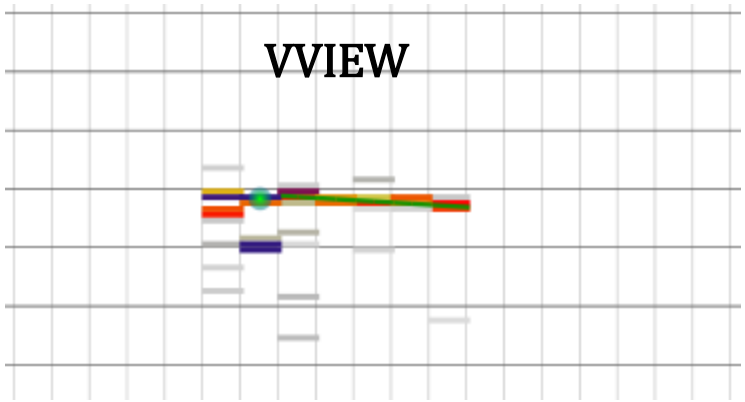
- Selected events which have a large reduced chi^2 for both fits. ReducedChi2 > 50



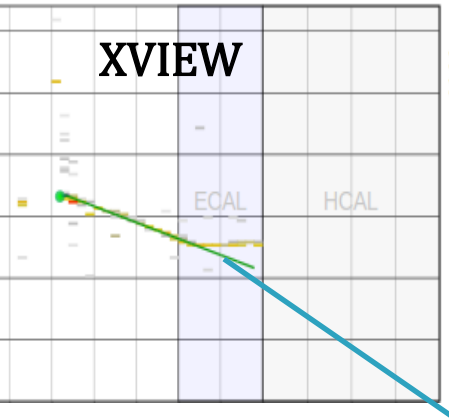


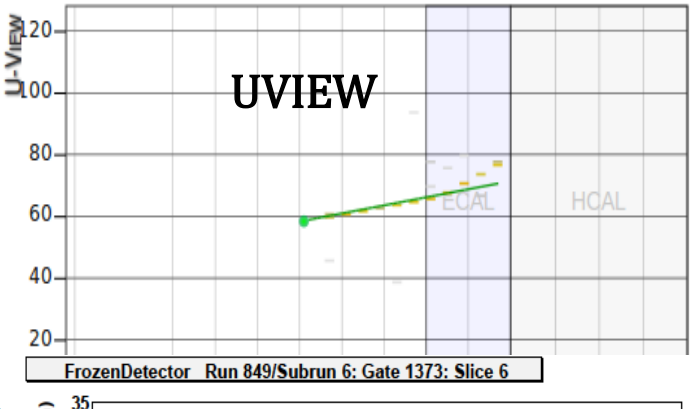
- We need a reasonable cut because we don't want to eliminate events such as:

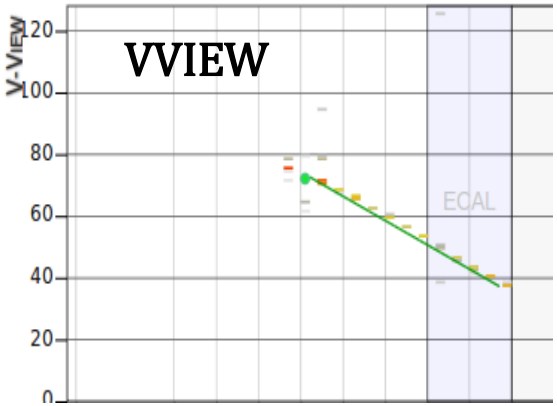


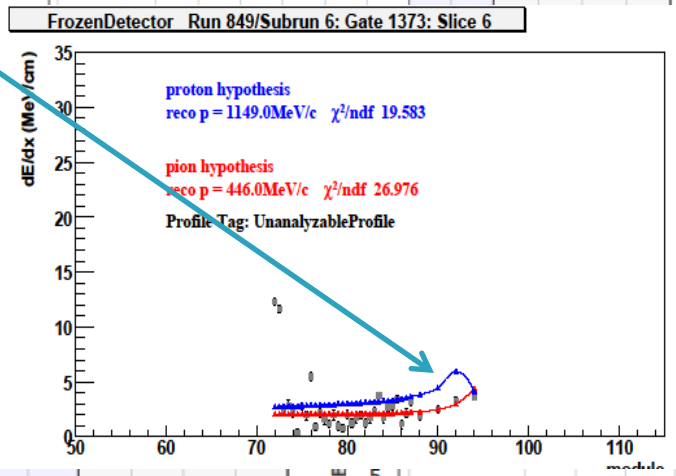


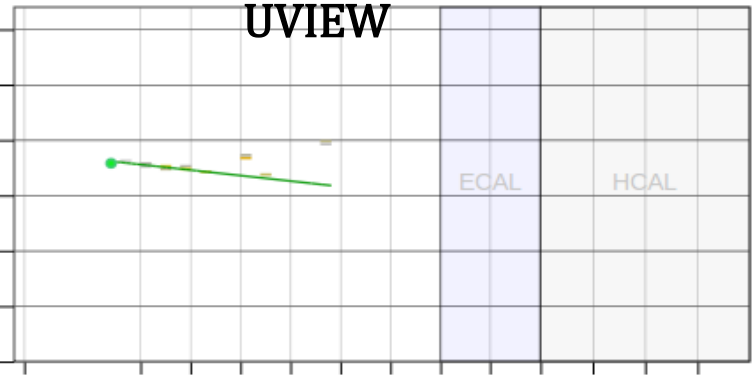
dEdXPatternRecognition -"UnAnalyzable Profile"

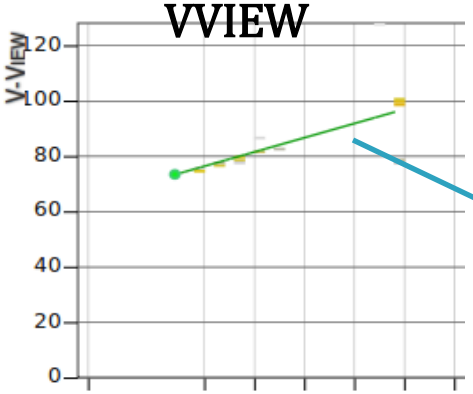


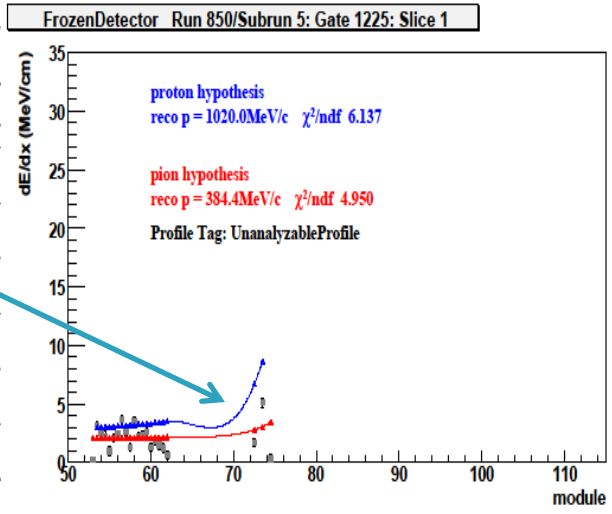




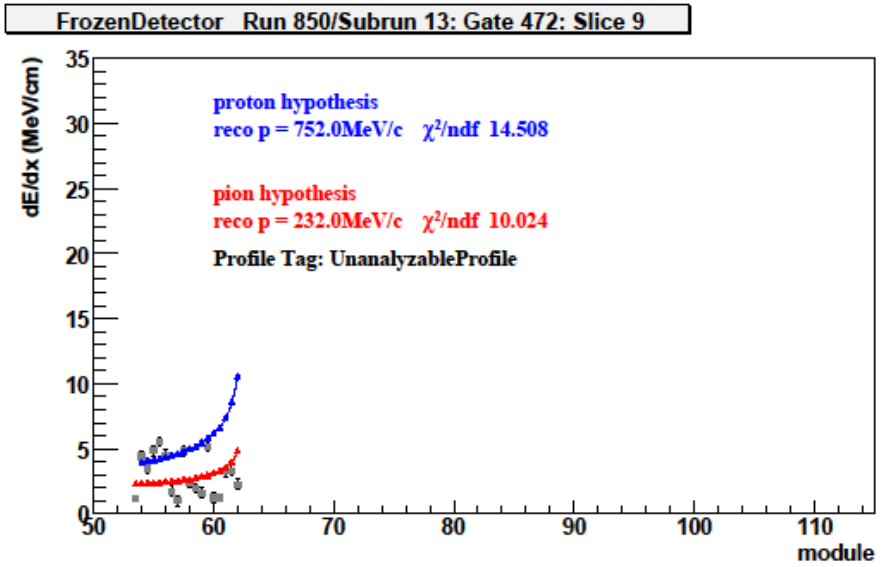


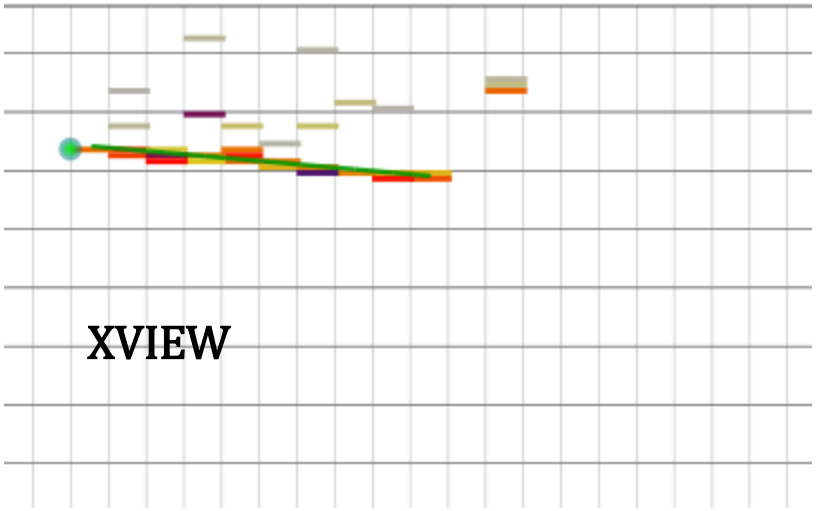


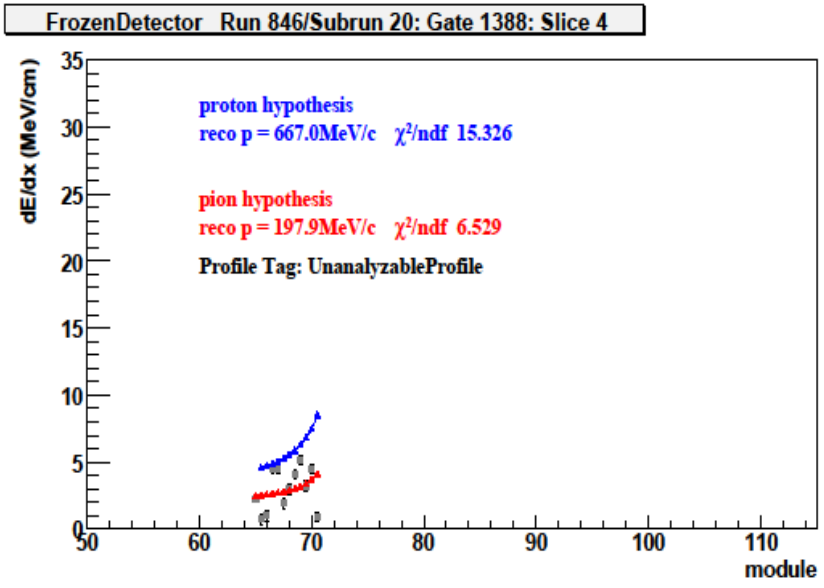


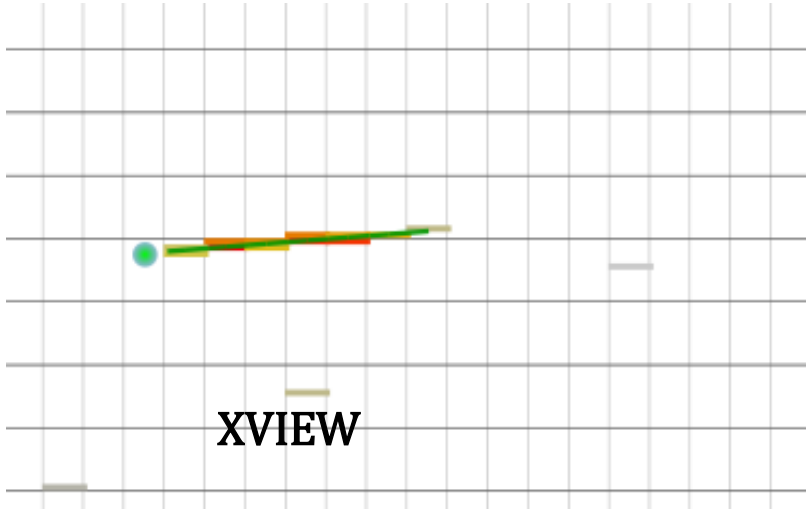


dEdXPatternRecognition – "UnAnalyzableProfile"







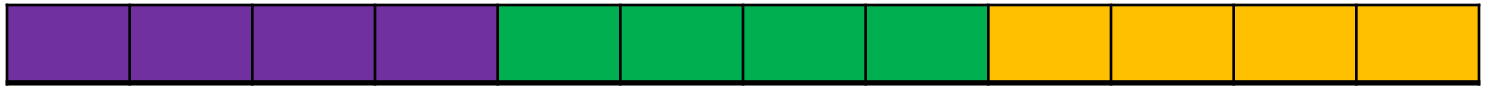


"ActivityVertexRegion", "SecondaryIntMiddleProng", and "SecondaryIntEndProng"

- Using the best fitted particle hypothesis
  - Stored the node's chi^2, where any value above 3 σ is tag as a "red" event and everything else is "blue"

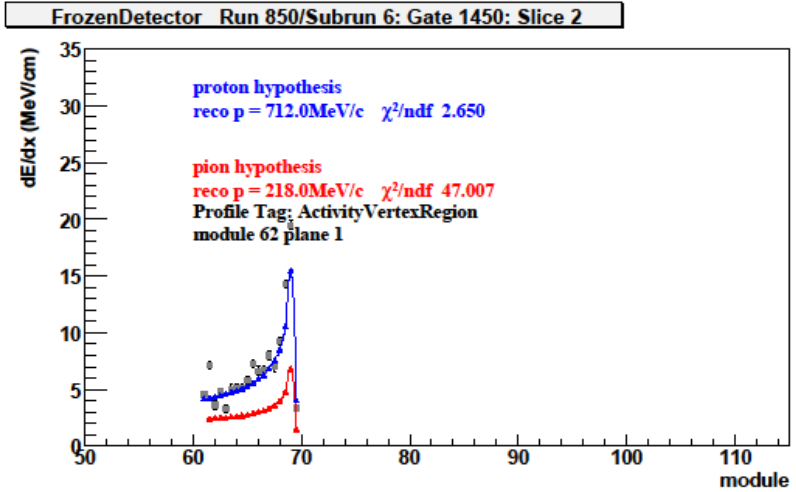
  - Find the node's maximum chi^2 and it's z position

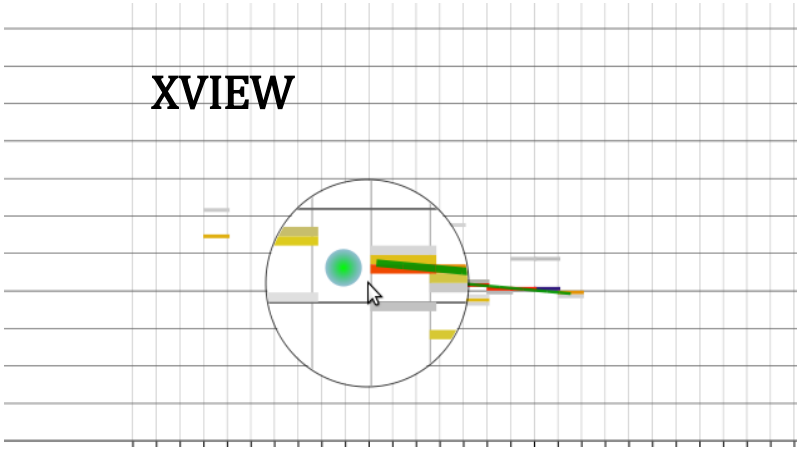
  - Separate into three regions:
    - region 1 ranges from 0 to .33, region 2 ranges from .33 to .66 , region 3 ranges from .66 to 1

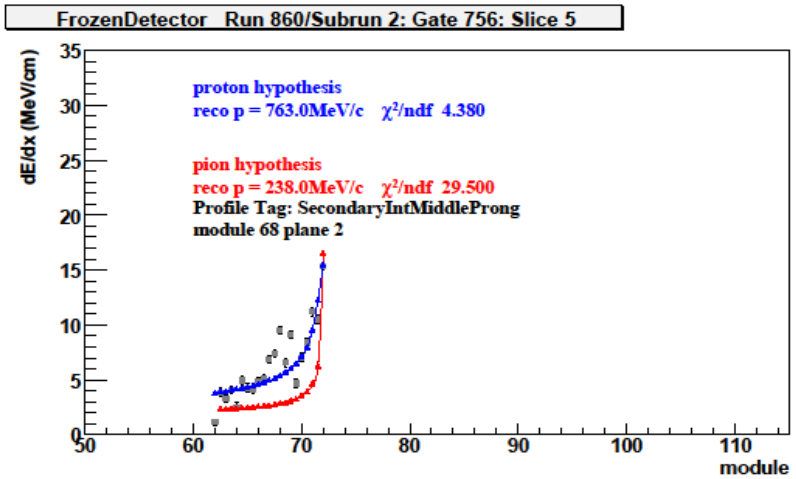


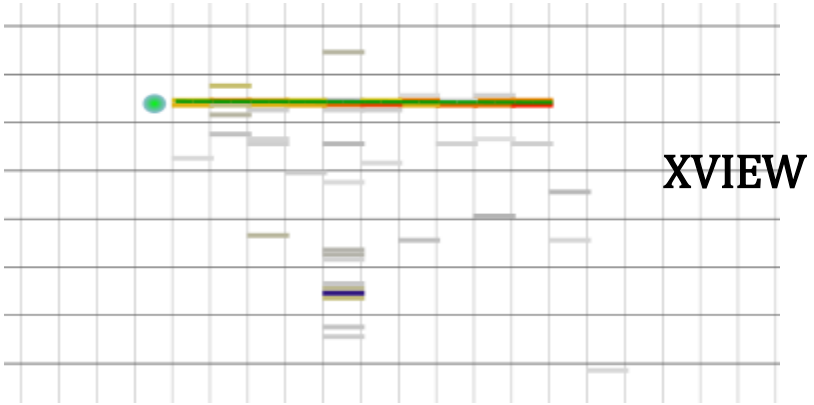
- Prong is Classified as "SecondaryIntEndProng"

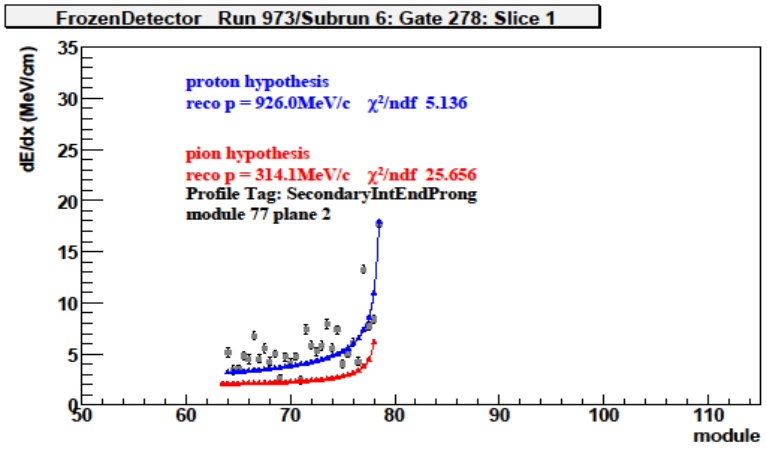
This is the principal ideal with some tweaks here and there

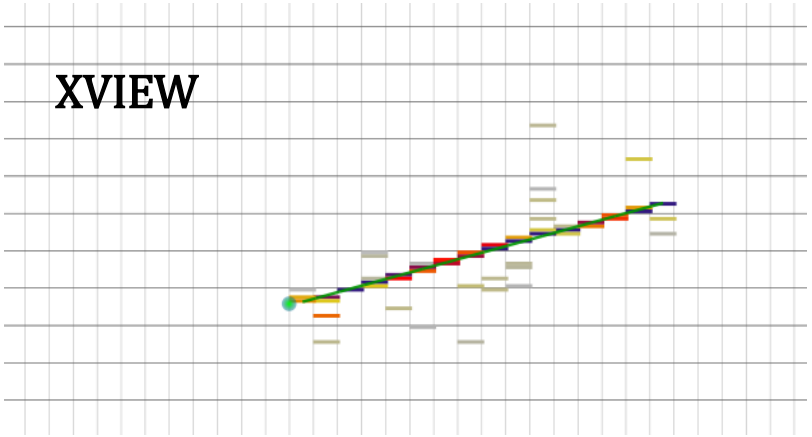

FrozenDetector Run 850/Subrun 6: Gate 1450: Slice 2
proton hypothesis
reco p = 712.0MeV/c χ²/ndf 2.650
pion hypothesis
reco p = 218.0MeV/c χ²/ndf 47.007
Profile Tag: ActivityVertexRegion
module 62 plane 1
dE/dx (MeV/cm)
module


XVIEW

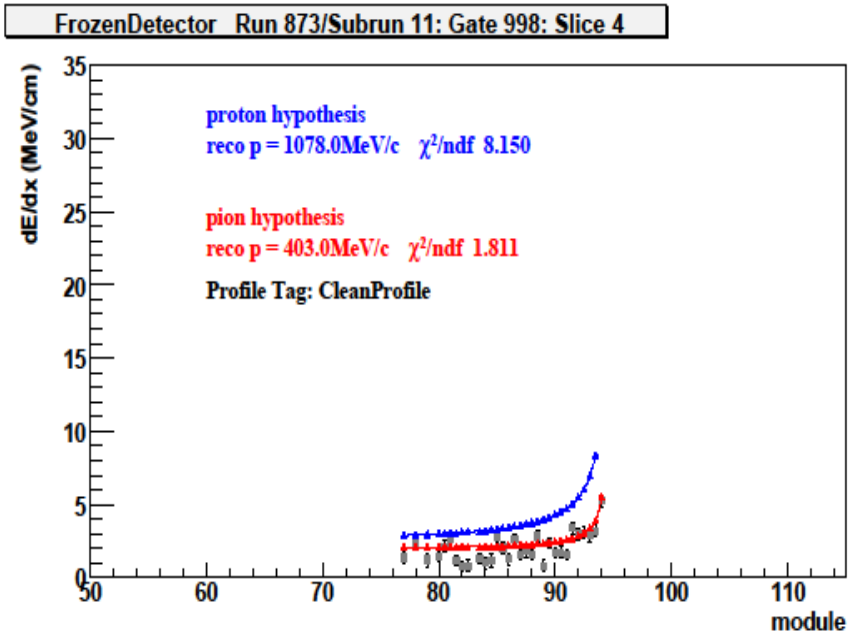

FrozenDetector Run 860/Subrun 2: Gate 756: Slice 5
proton hypothesis
reco p = 763.0MeV/c χ²/ndf 4.380
pion hypothesis
reco p = 238.0MeV/c χ²/ndf 29.500
Profile Tag: SecondaryIntMiddleProng
module 68 plane 2
dE/dx (MeV/cm)
module

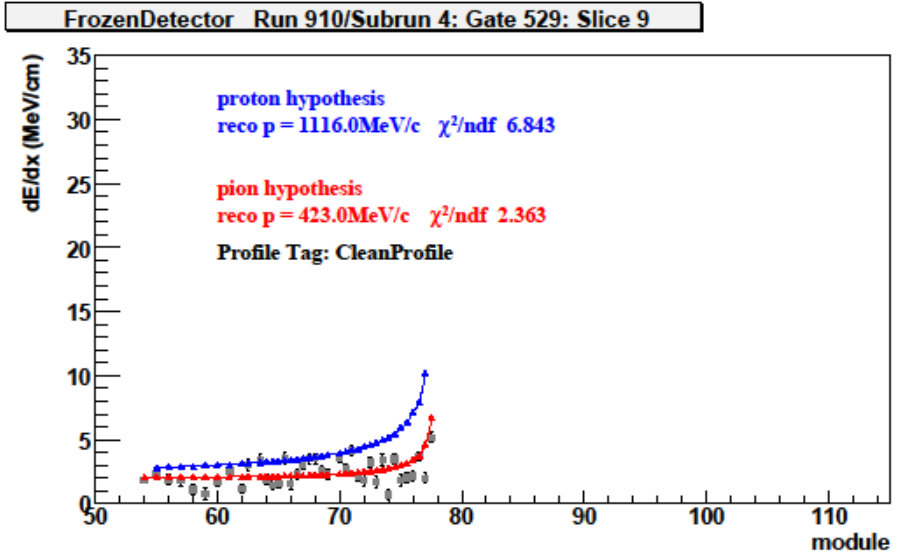

XVIEW

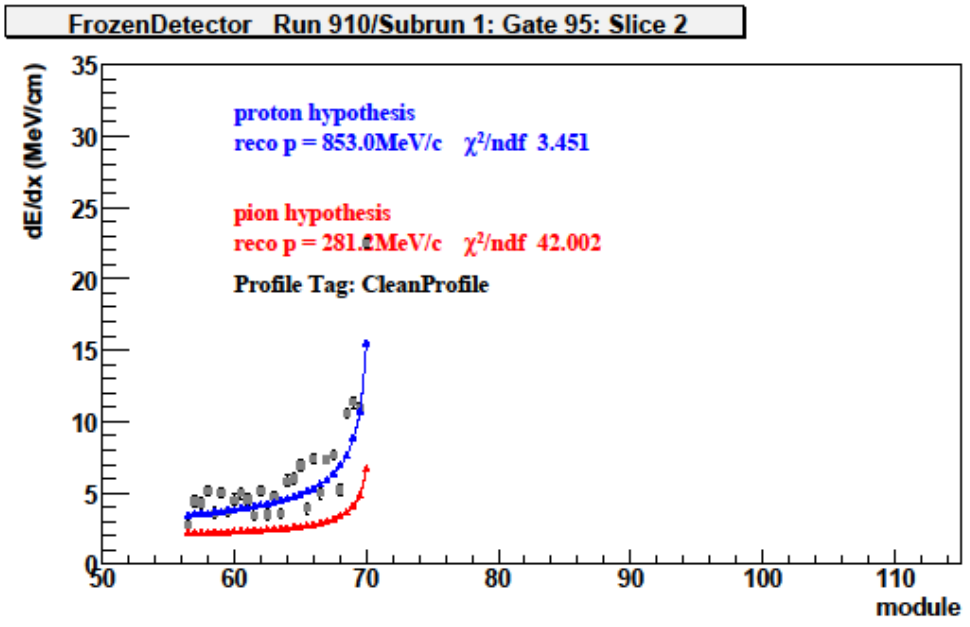

FrozenDetector Run 973/Subrun 6: Gate 278: Slice 1
proton hypothesis
reco p = 926.0MeV/c χ²/ndf 5.136
pion hypothesis
reco p = 314.1MeV/c χ²/ndf 25.656
Profile Tag: SecondaryIntEndProng
module 77 plane 2
dE/dx (MeV/cm)
module


XVIEW

“CleanProfile”

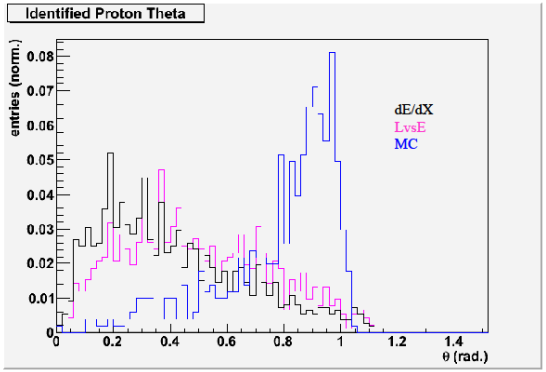


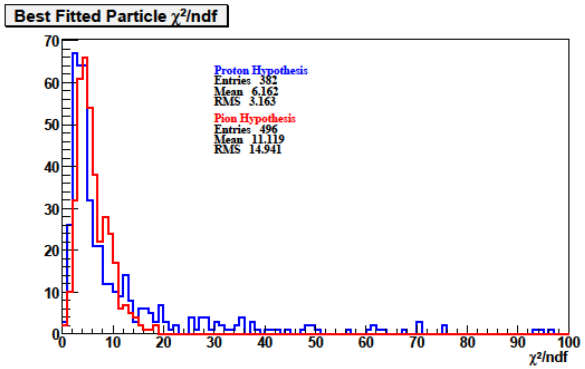


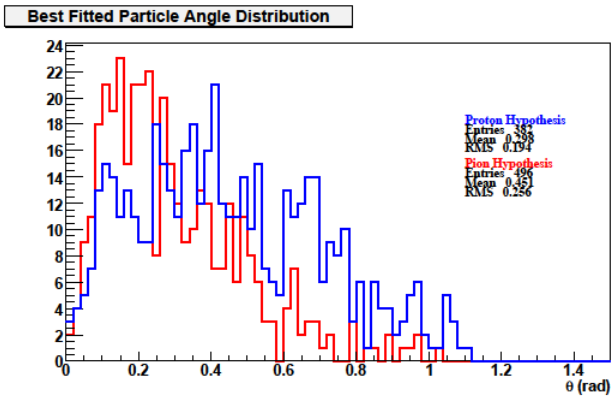


Frozen Detector Single Track Candidates

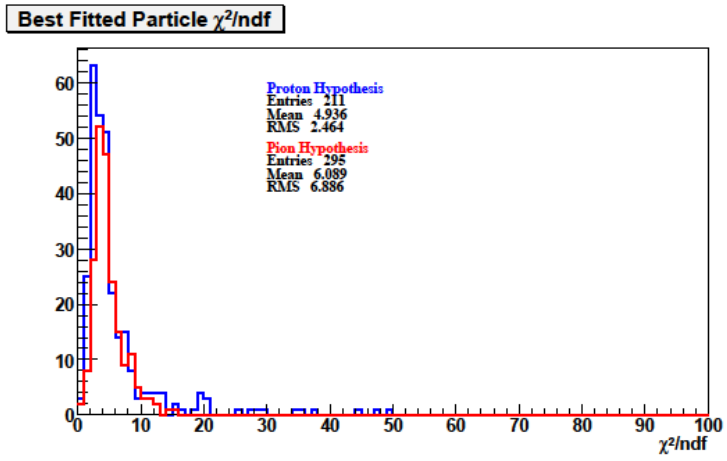
Benjamin's Analysis

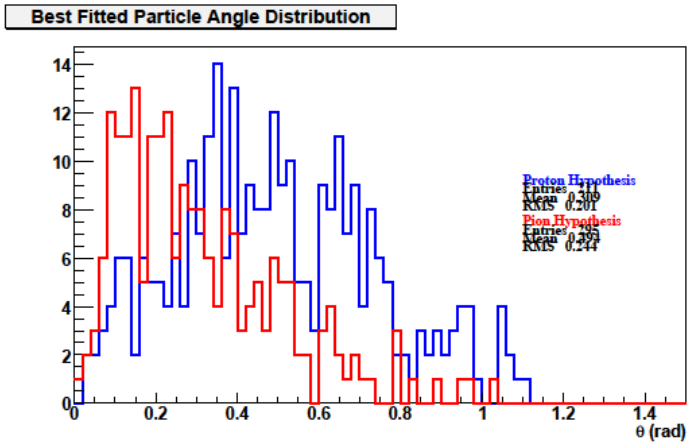




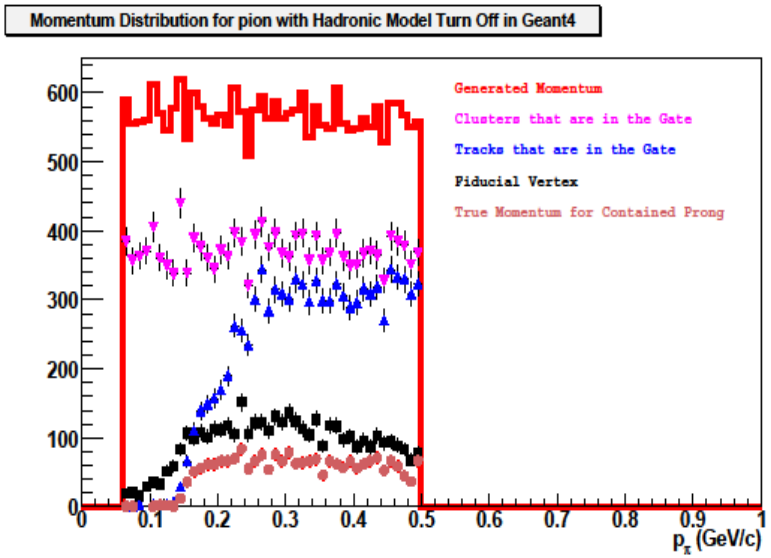


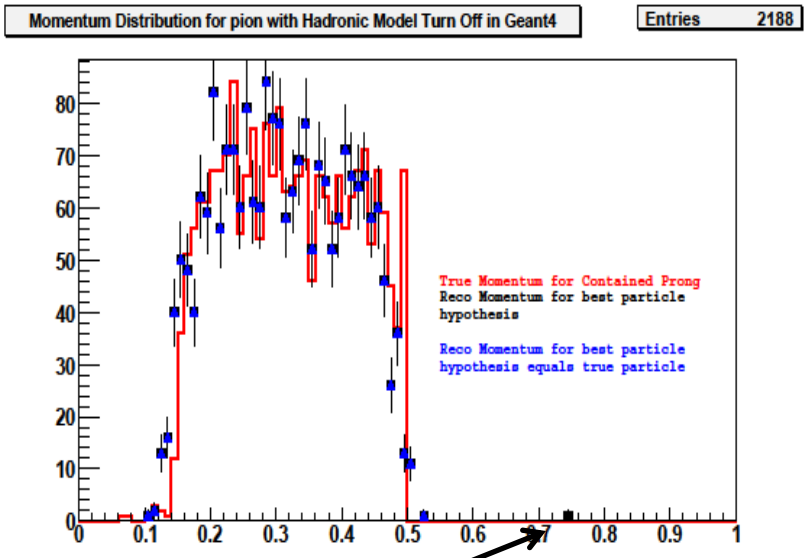
"Contained" Prongs tagged as either "CleanProfile", ActivityVertexRegion, "SecondaryIntMiddleProng", or "SecondaryIntEndProng"



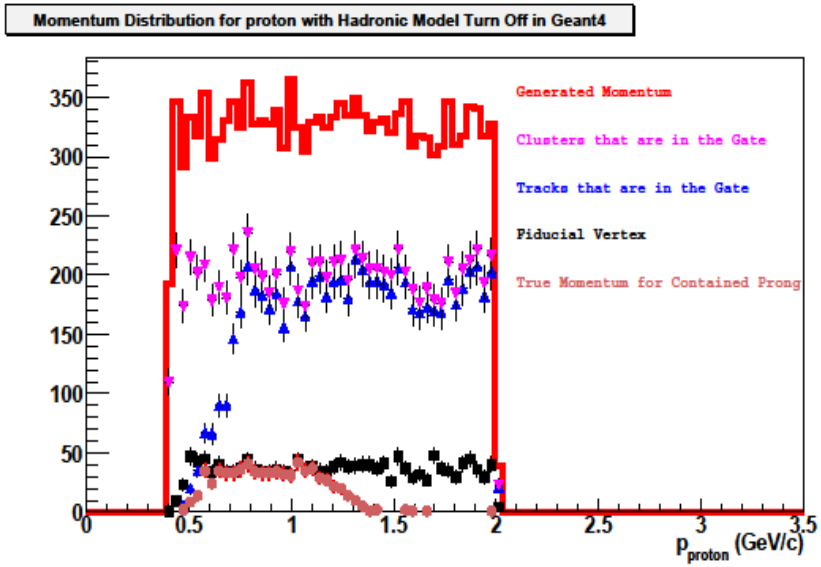


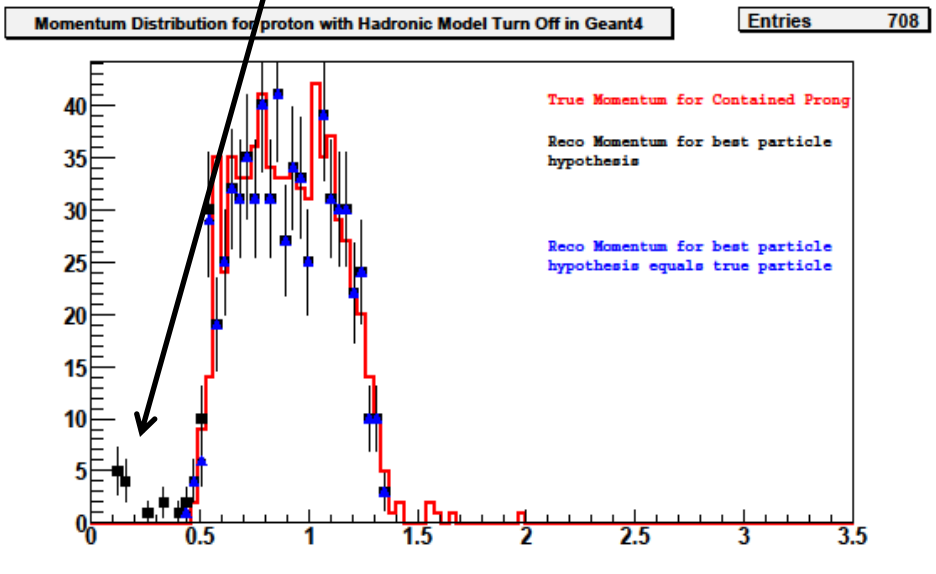
Hadronic Model in Geant4 Turned Off



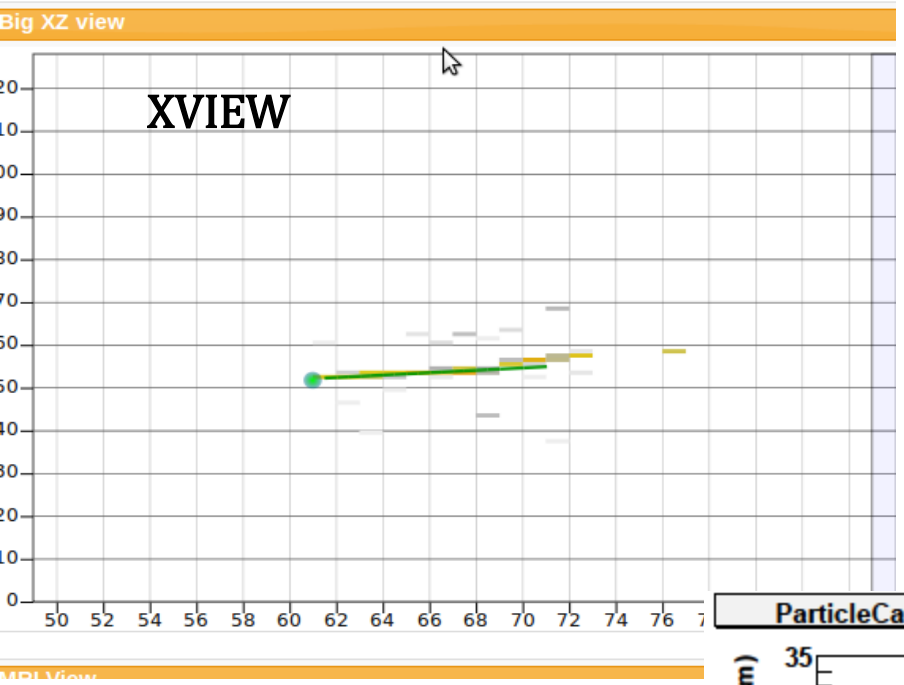


Mis-id events

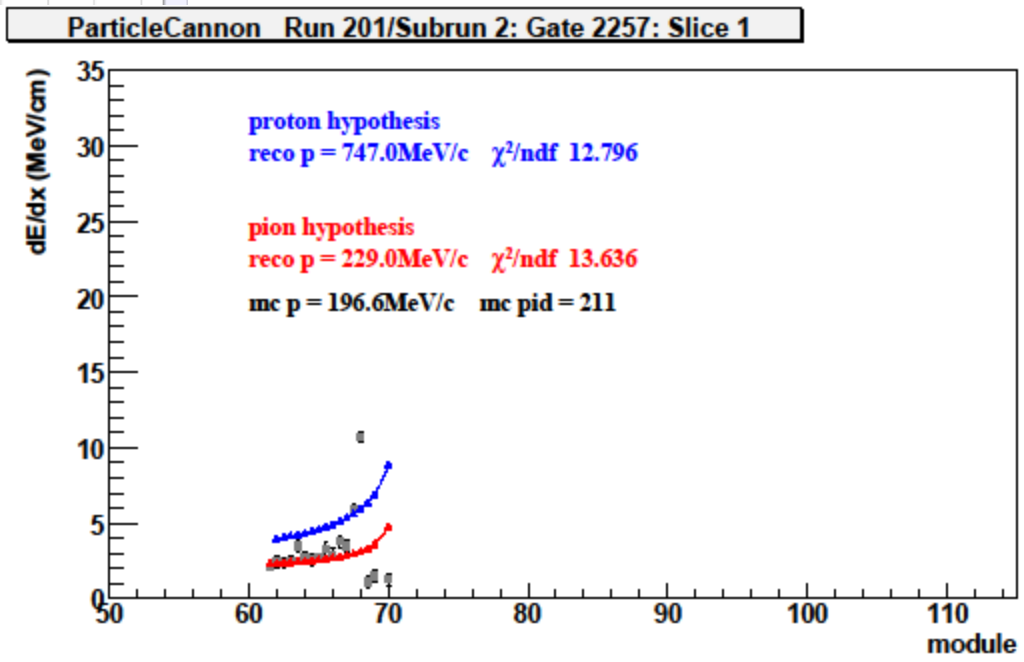




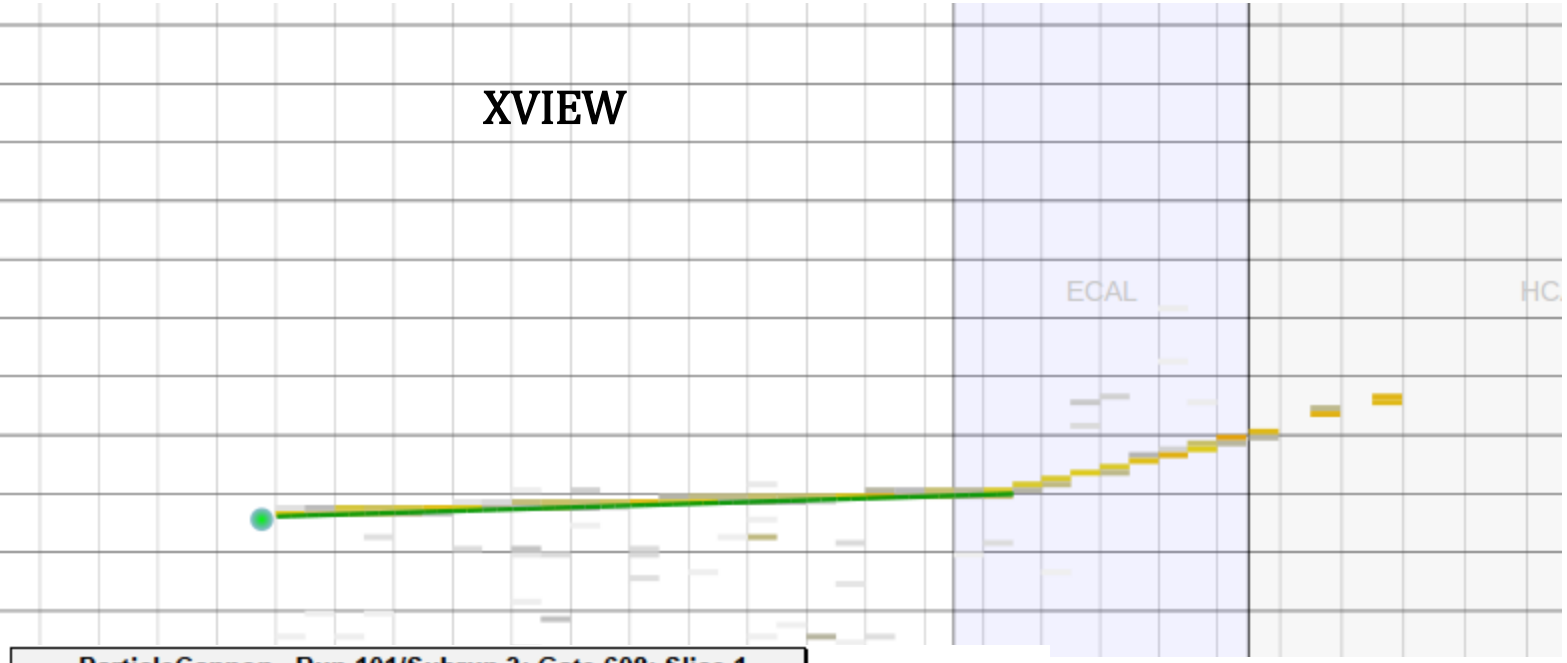
Mis-PID Pion

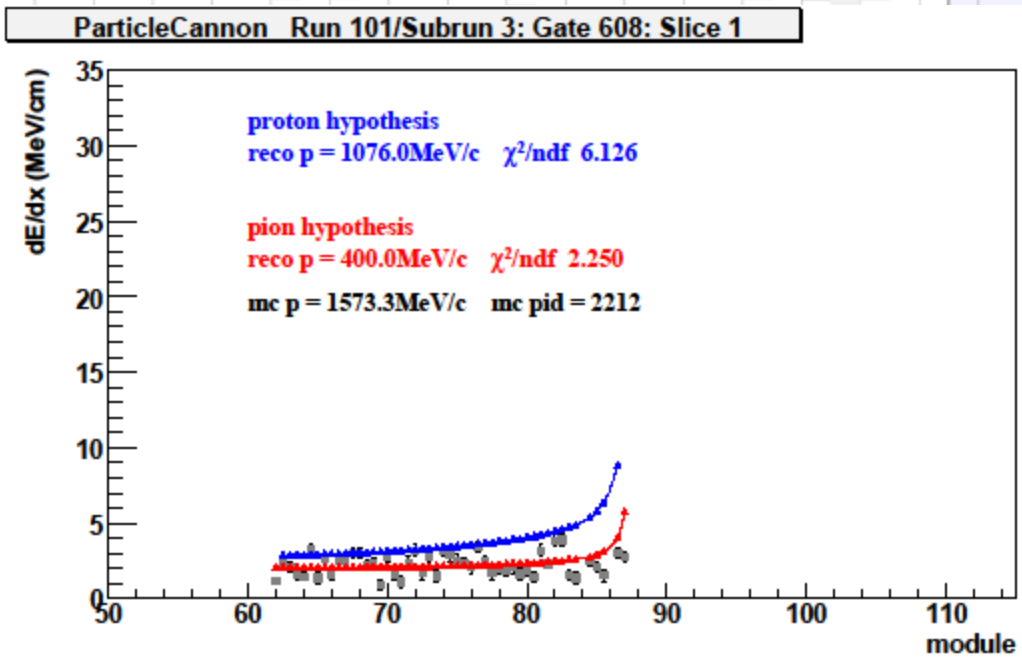


Profile Tag: 200 (Unassociated Clusters at the End of the Track)



Mis-PID Proton





ProfileTag: 200

Conclusions

- We have a lot to do.
- A tracker workshop.
- Reconstruction framework is coming together.
- Need to implement reconstruction iterations

- Currently, tuning this filter.
- Soon, I should have results for PID, momentum reconstruction, secondaries efficiency and purity studies with the Hadronic Model turned on.
- ….