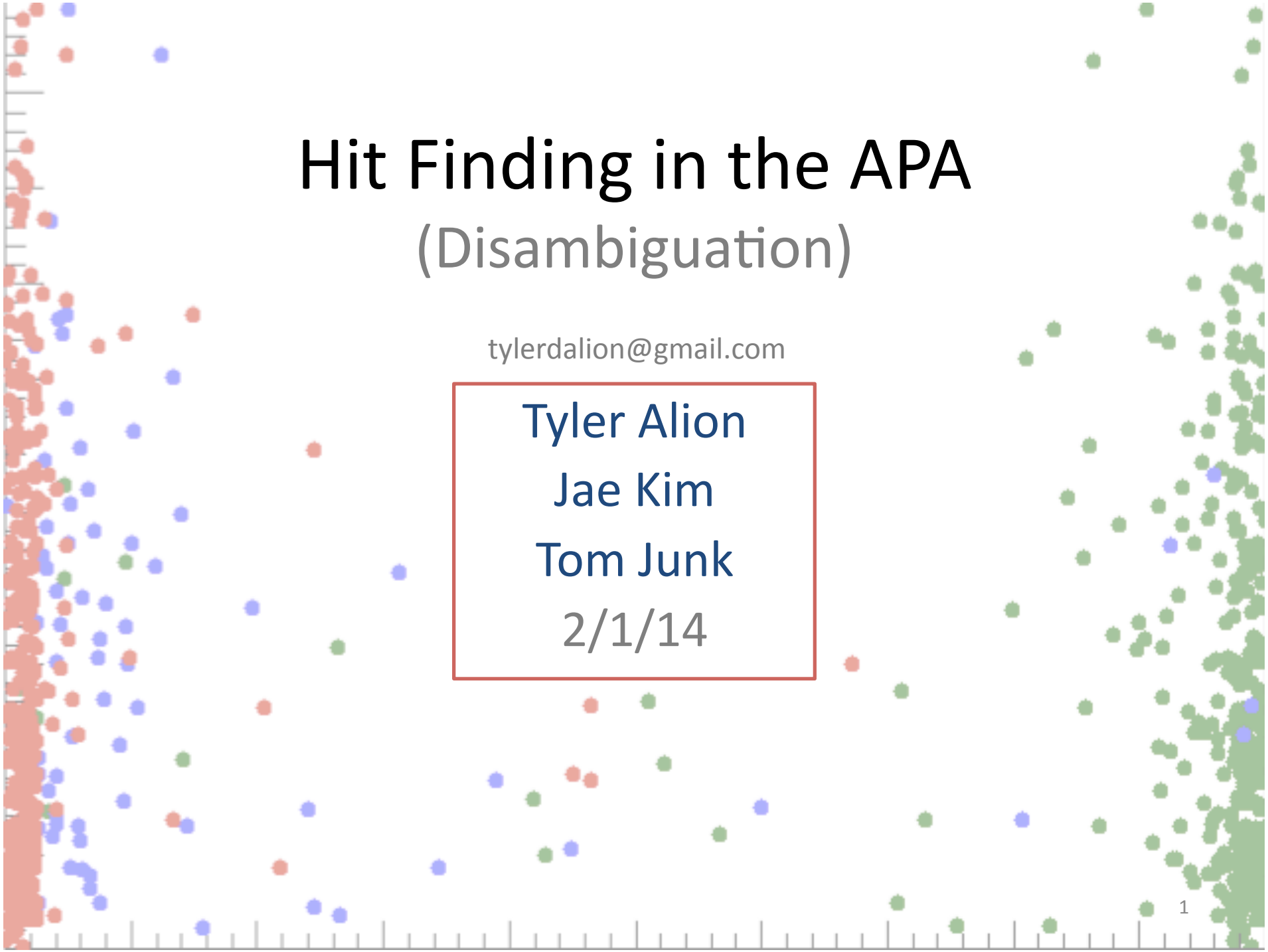

Hit Finding in the APA

(Disambiguation)

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Tyler Alion

Jae Kim

Tom Junk

2/1/14

Outline

- Brief Algorithm Overview (very little new)
- Test Samples (36° and 45°)
  - 350 GENIE Nue events in reduced geometry
  - Locations, corresponding wiki pages
- Some disambiguation displays
  - promising and problematic
  - Some words on the display used
- Hit and Disambiguation Analysis

Current State of Algorithms

Controlled by DisambigAlg::RunDisambig();

- Run "Trivial Alg" first always
  - If a hit is disambiguated by this algorithm, it is virtually never wrong. (wrong observed in only one event)
  - Then grow the disambiguations with "Crawl"
- If less than some % disambiguated (configurable)
  - Run a simple endpoint finder and match points across views for 3D info
  - Then "crawl" from there
- If one view much less disambiguated than other, run "CompareViews"
- Developing: Alg to run after all others, designed to regain the scattered fringe of showers

"Trivial"

"Crawl"

"EndPoint"

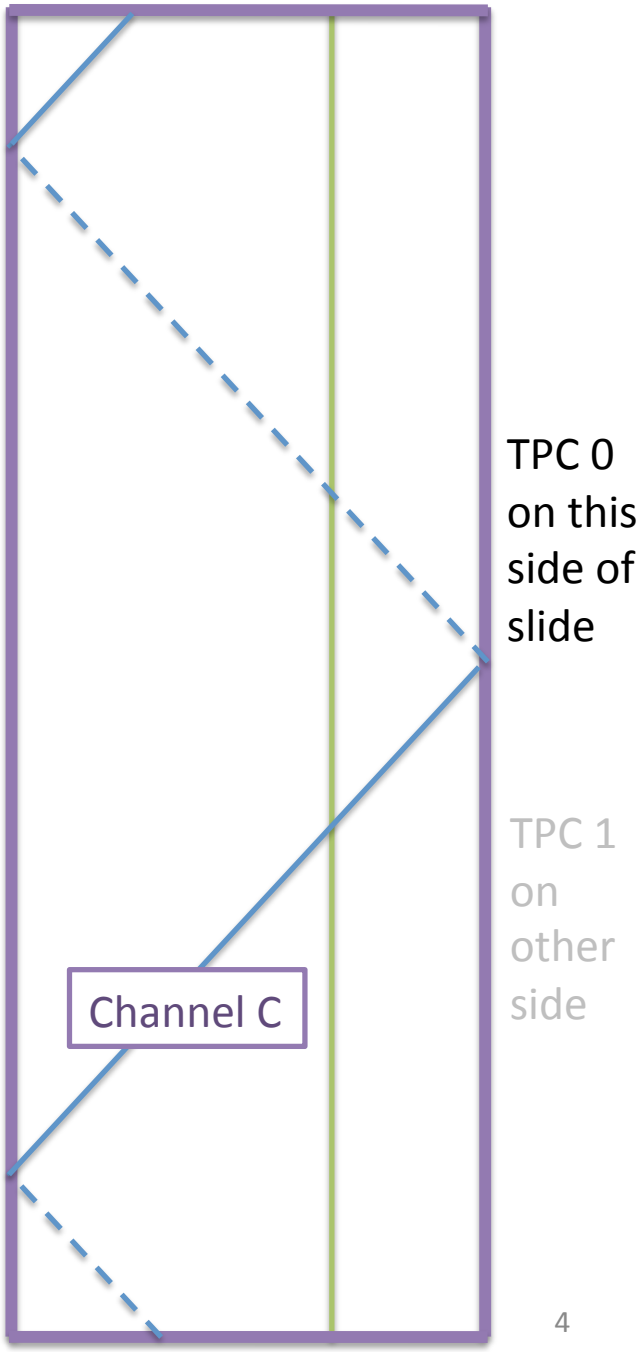
"CompareViews"

"GatherFringe"

"Trivial" Method

For every ambiguous hit at a certain time:

- Get channel
- For every wire segment possibility:
  - -- look at collection channels overlapping the wire segment
  - -- If one of these Z channels has a hit overlapping the ambiguous hit in time, this wire segment is a potential candidate.
- If *only one* candidate → disambiguate!



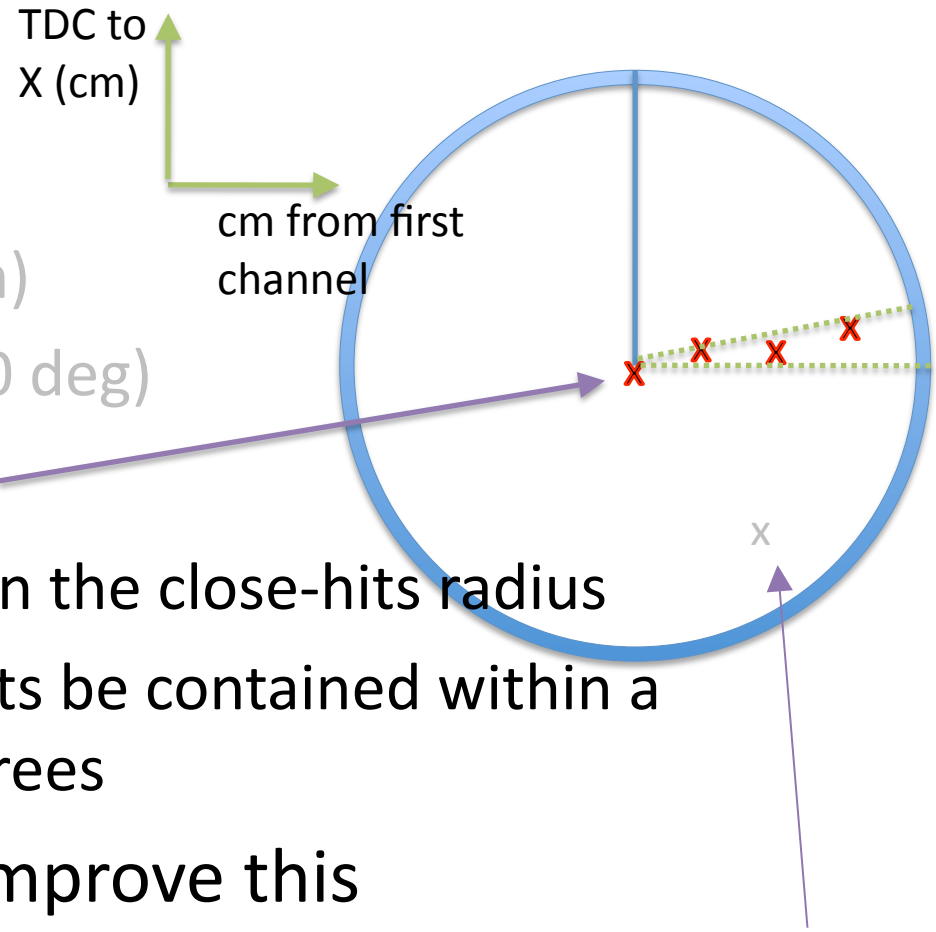
Crawling from *Certain* Disambiguation

- After any algorithm (typically the trivial one), extend disambiguation to neighboring channels close in time.
  - fMaxChanJumps (= 5 right now)

1) Find a Disambiguated hit
2) Look n<=fMaxChanJumps channels away for hits close in time
3) If found, give it the neighboring wireID
4) Repeat while new wire hits are being found

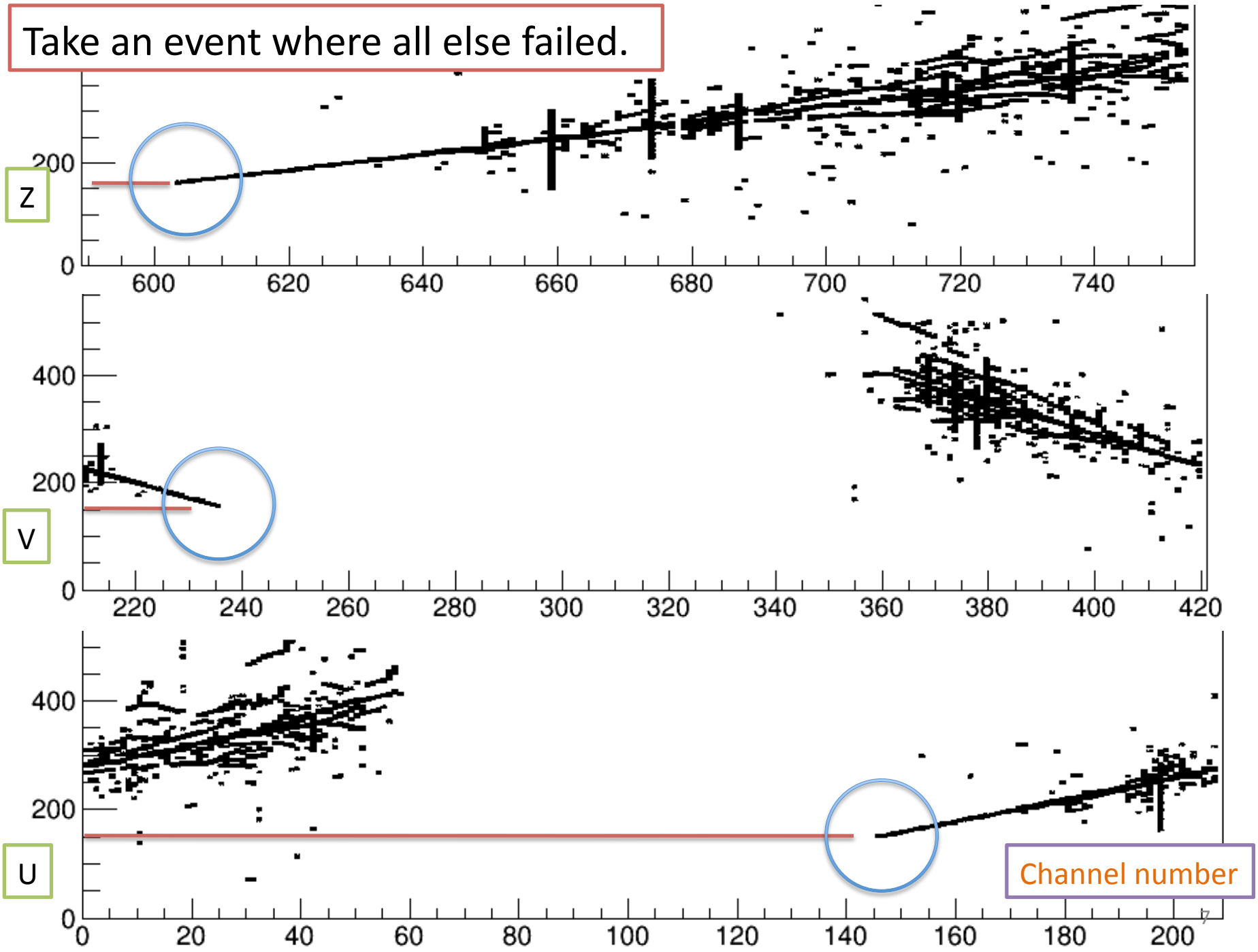
- Two outstanding dangers:
  - Starting from a bad hit grows bad assignments
    - Use it carefully
  - Steps into hits with signal from multiple wire segments
    - Impose a constraint based on amount of activity and Z hit information

Simple Endpoint-Hit Finder



- Two fcl parameters:
  - fCloseHitsRadius (6 cm)
  - fMaxEndPDegRange (10 deg)
- For every channel hit:
  - Find all of the hits within the close-hits radius
  - Require that all close hits be contained within a maximum range of degrees
- Much can be done to improve this
  - Works best on single particles, or *very* clean neutrino events (which are generally already taken car of)

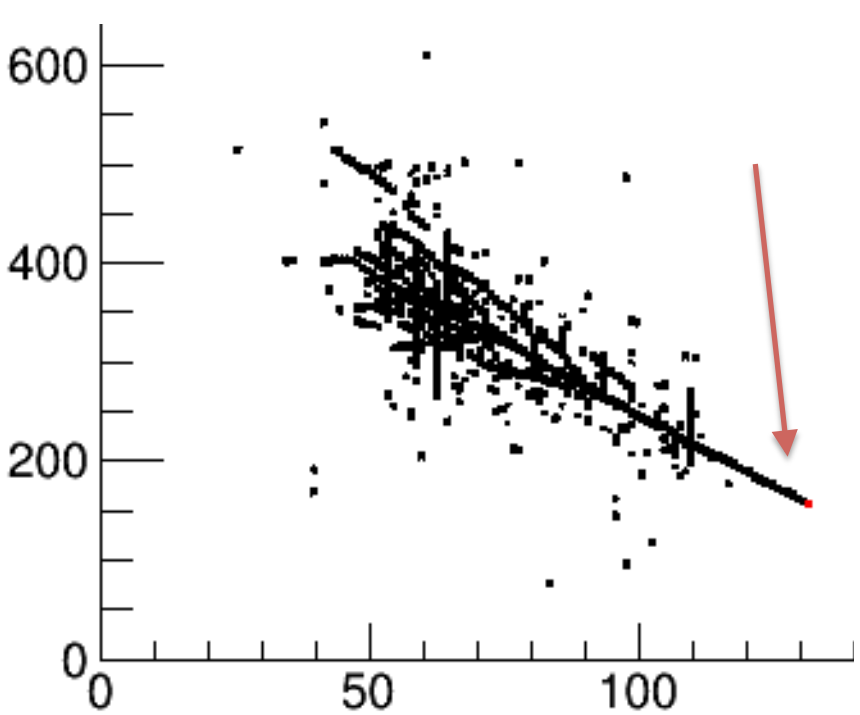
Take an event where all else failed.

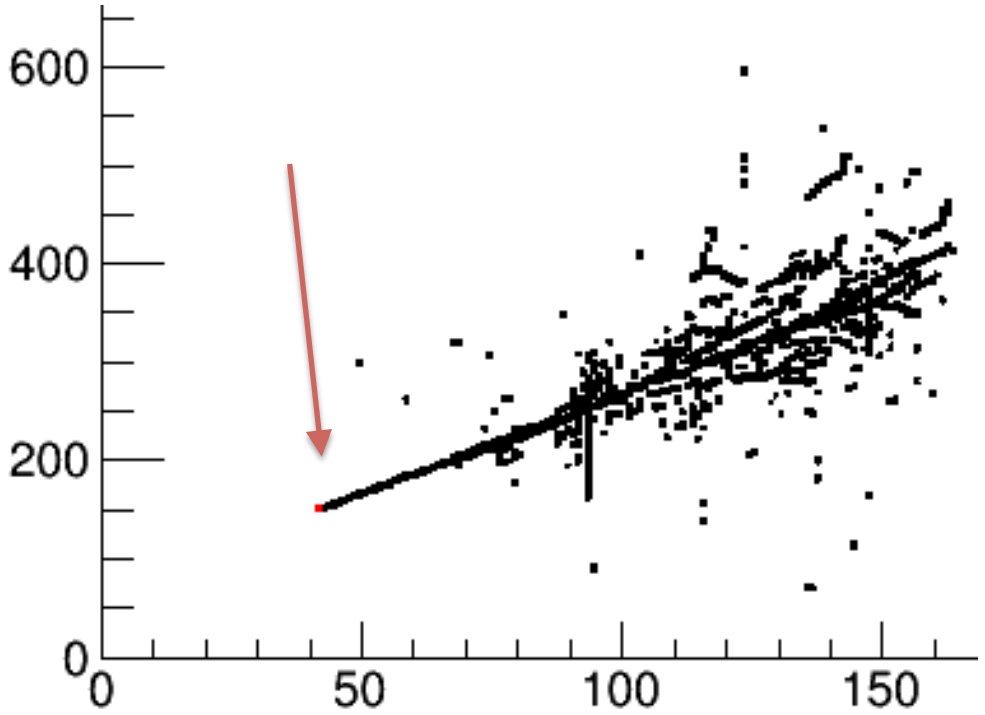


Endpoint Matching

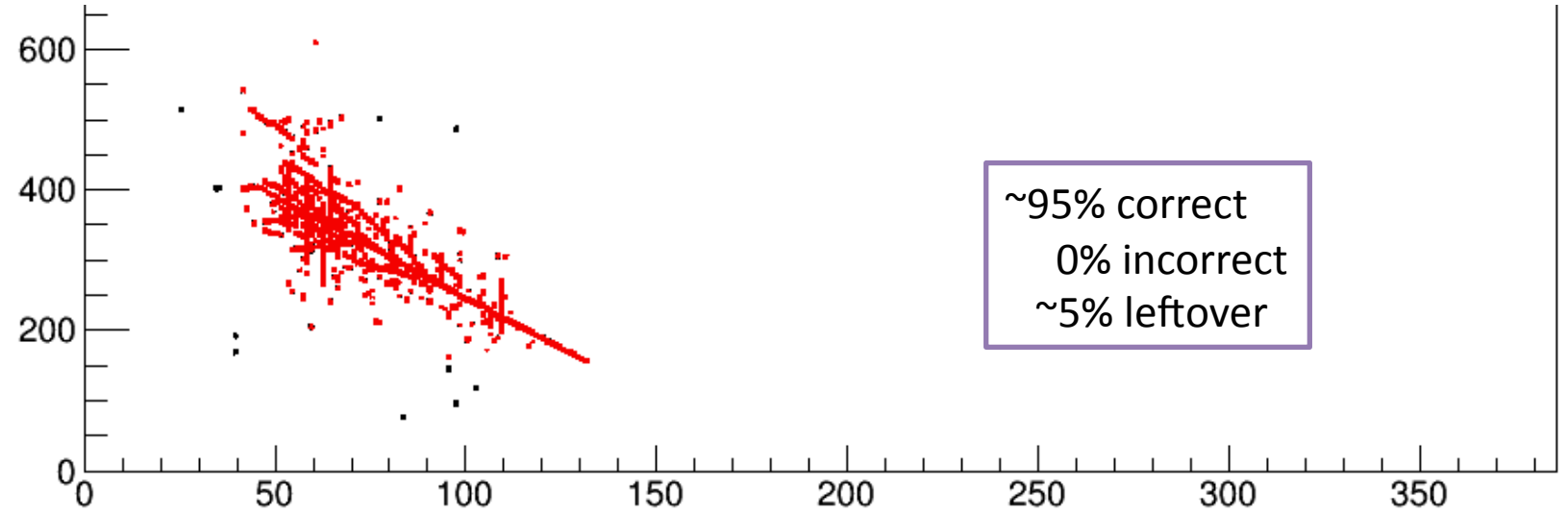
If endpoints from different views overlap in time uniquely, find the 3D position with intersection functions. Use that to disambiguate matched endpoint hits.

APAGeometryAlg heavily applied here

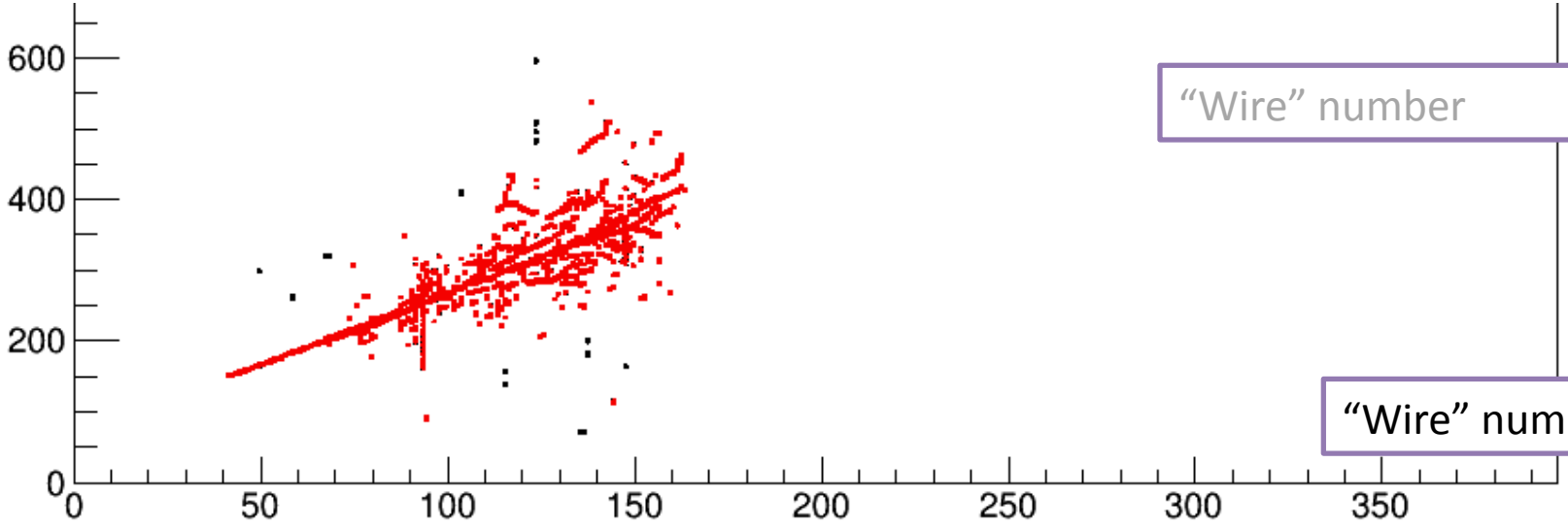




… and then crawl!



~95% correct
0% incorrect
~5% leftover



"Wire" number

"Wire" number

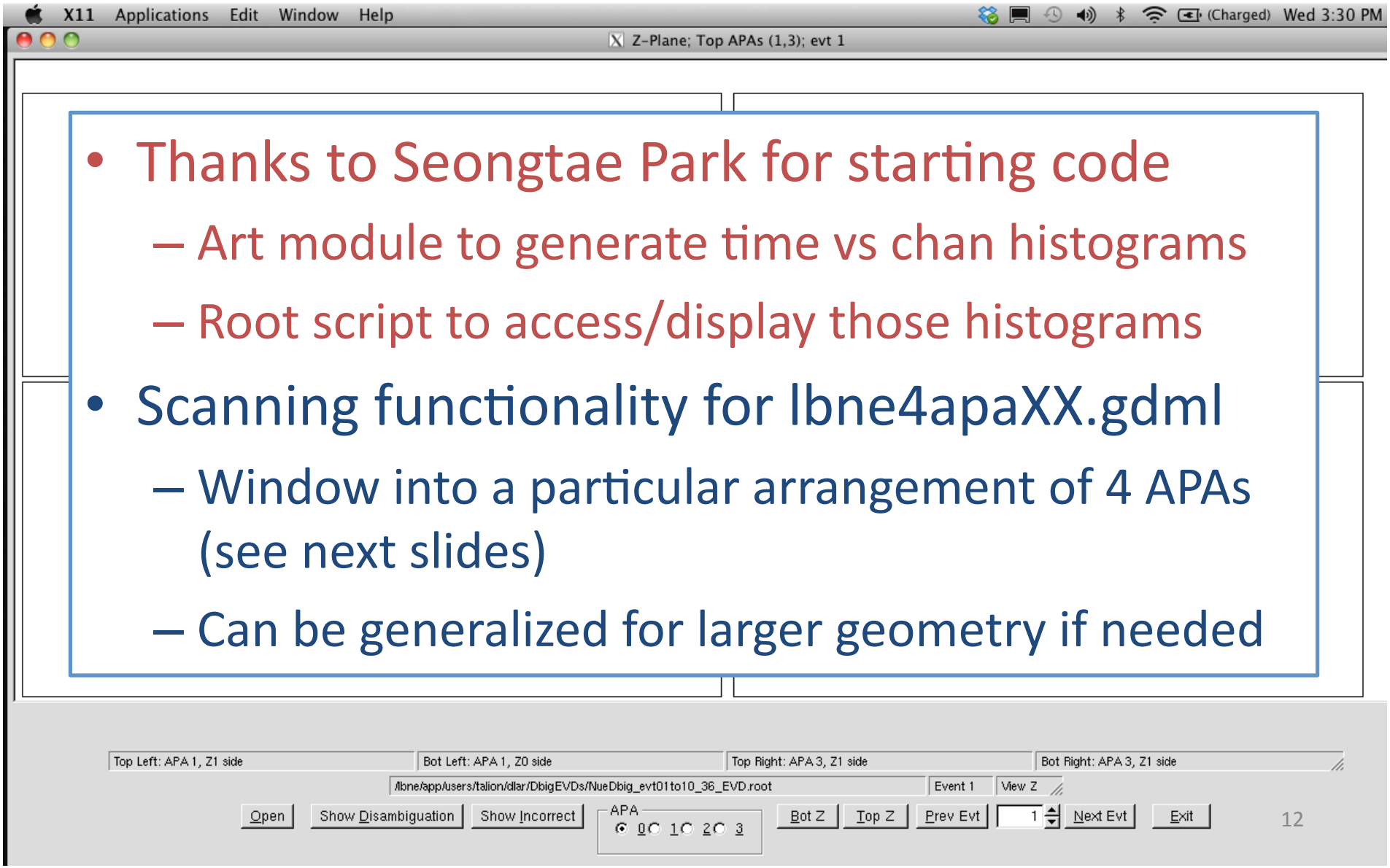
Comparing Views Algorithm

- For every still ambiguous hit:
  - Find all hits in the other view that overlap in time
  - For the disambiguated overlapping hits, see which wireID they cross on the ambiguous channel
  - See if there are any ambiguous hits on channels that intersect the current ambiguous channel
- If only disambiguated intersections, choose intersected wireIDs
- Good When: one of U or V is thoroughly disambiguated, and the other is not

Disambiguated Samples

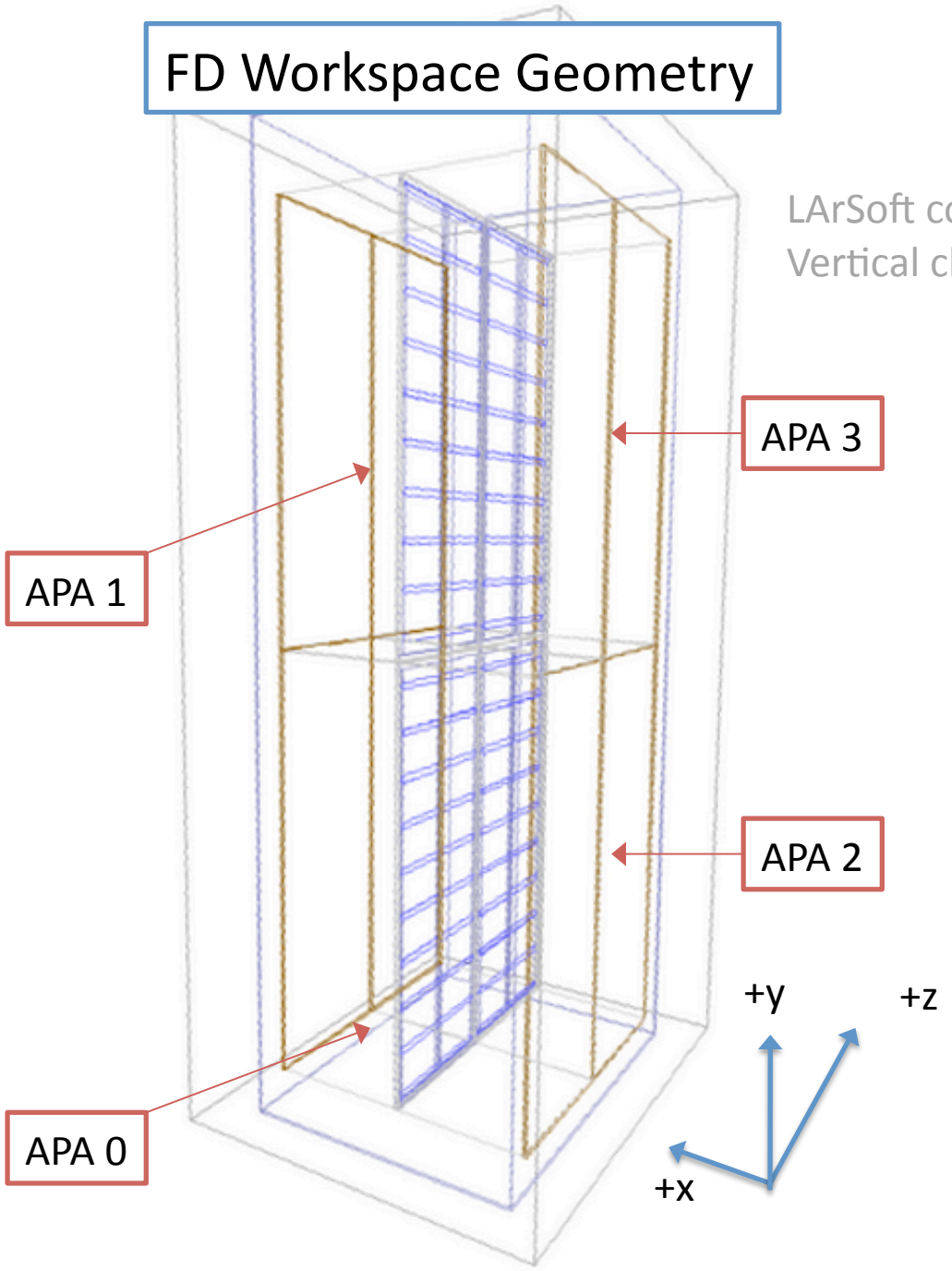
- Geometry: lbne4apa36/45.gdml
- Used: v1_01_03 -q+e4:+prof (final svn)
- /lbne/data2/users/talion/DisambigSamples
- Files:
  - <name> (50 Nue GENIE events in 45°)
  - <name> (…in 36°)
    - Suggest using this one– many cohesive events after disambiguation
  - standard_reco_lbnefd.fcl (job script used)
- DisambigEVD folder
  - Histogram files
  - Root GUI to scan through events
  - Invitation: Come check out the disambiguated events!
  - There is a README, let me know if you have suggestions!

Disambiguation Display

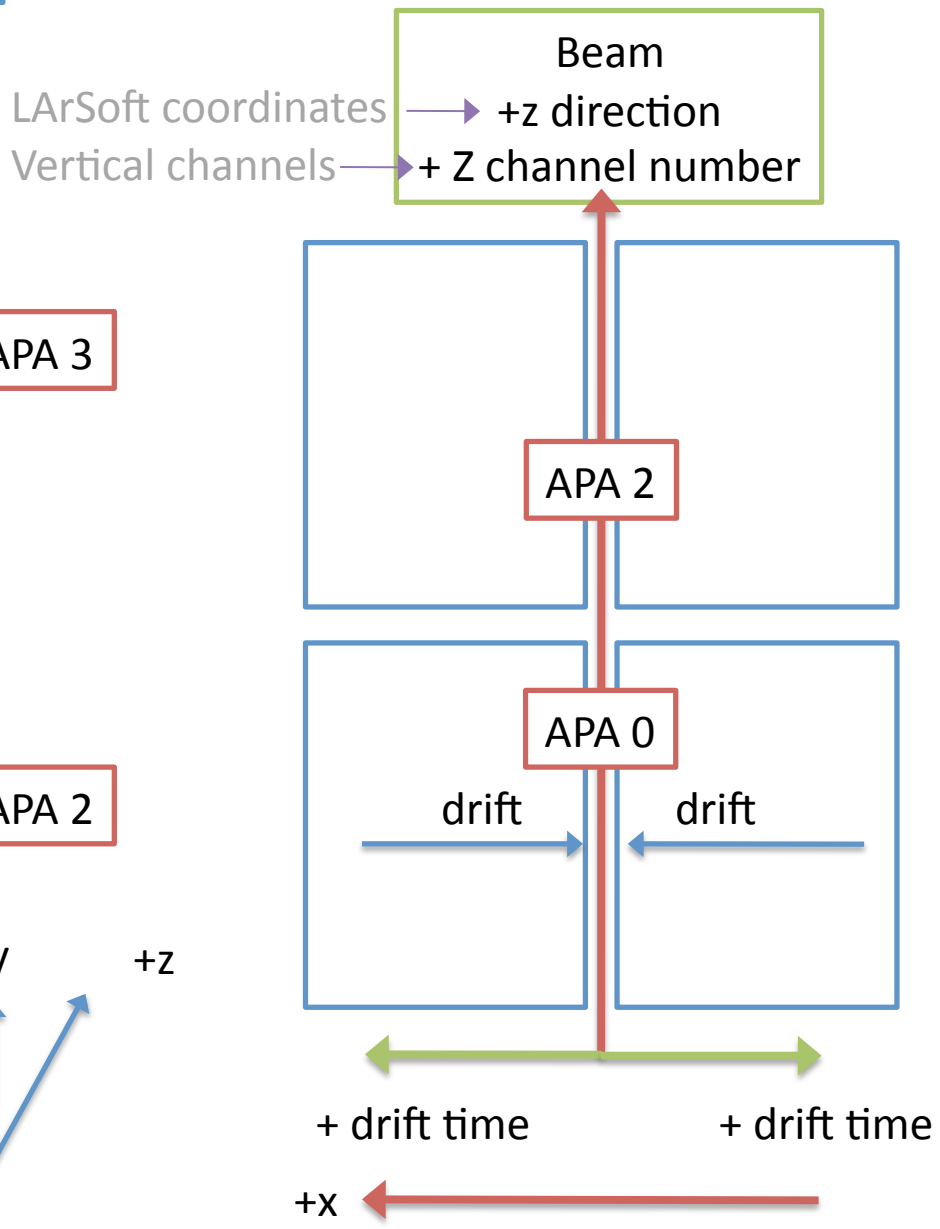


- Thanks to Seongtae Park for starting code
  - Art module to generate time vs chan histograms
  - Root script to access/display those histograms
- Scanning functionality for lbne4apaXX.gdml
  - Window into a particular arrangement of 4 APAs (see next slides)
  - Can be generalized for larger geometry if needed

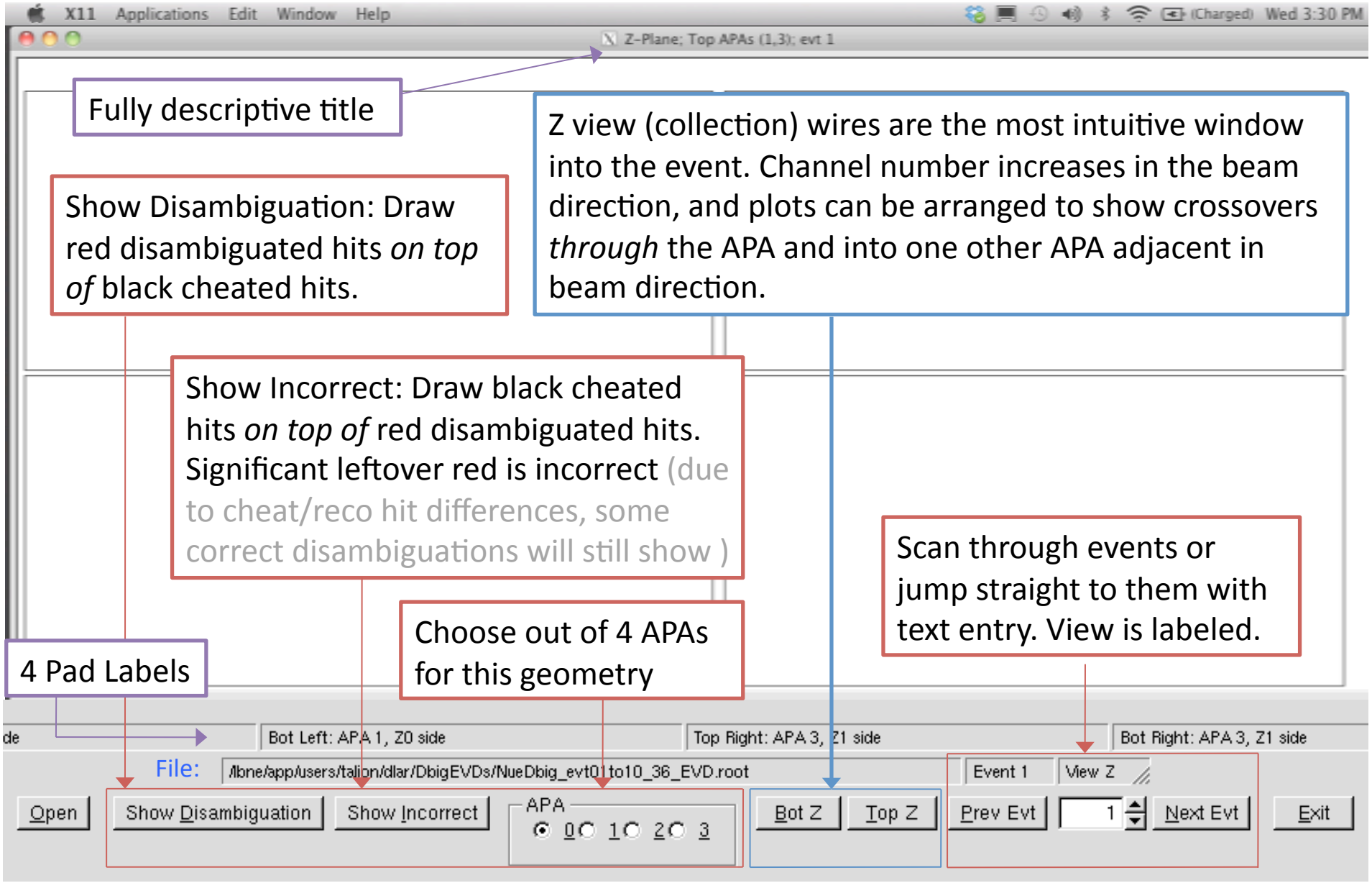
FD Workspace Geometry



Bird's Eye View



Disambiguation Display



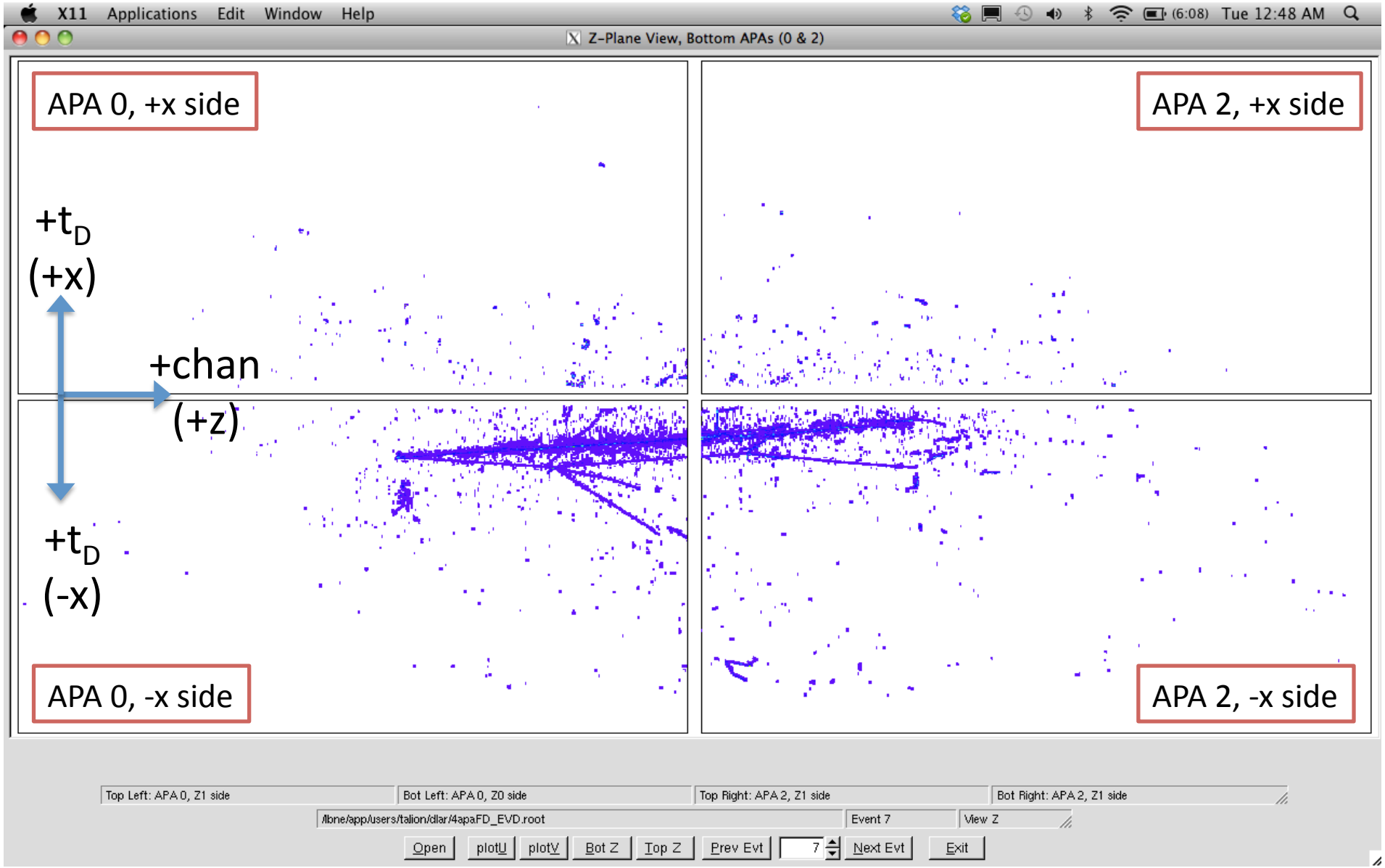
Display Disclaimer

- This is bootstrapped for development
- Drawbacks
  - Many histograms, large files
  - Histograms could be better organized for quicker access
  - Have to pre-generate plots instead of drawing straight from data
- Can be incorporated into LArSoft's EVD to avoid all of those drawbacks
- Can be generalized for other people to plug in
  - Talk on this later

EVT 17

Z view (bottom APAs)

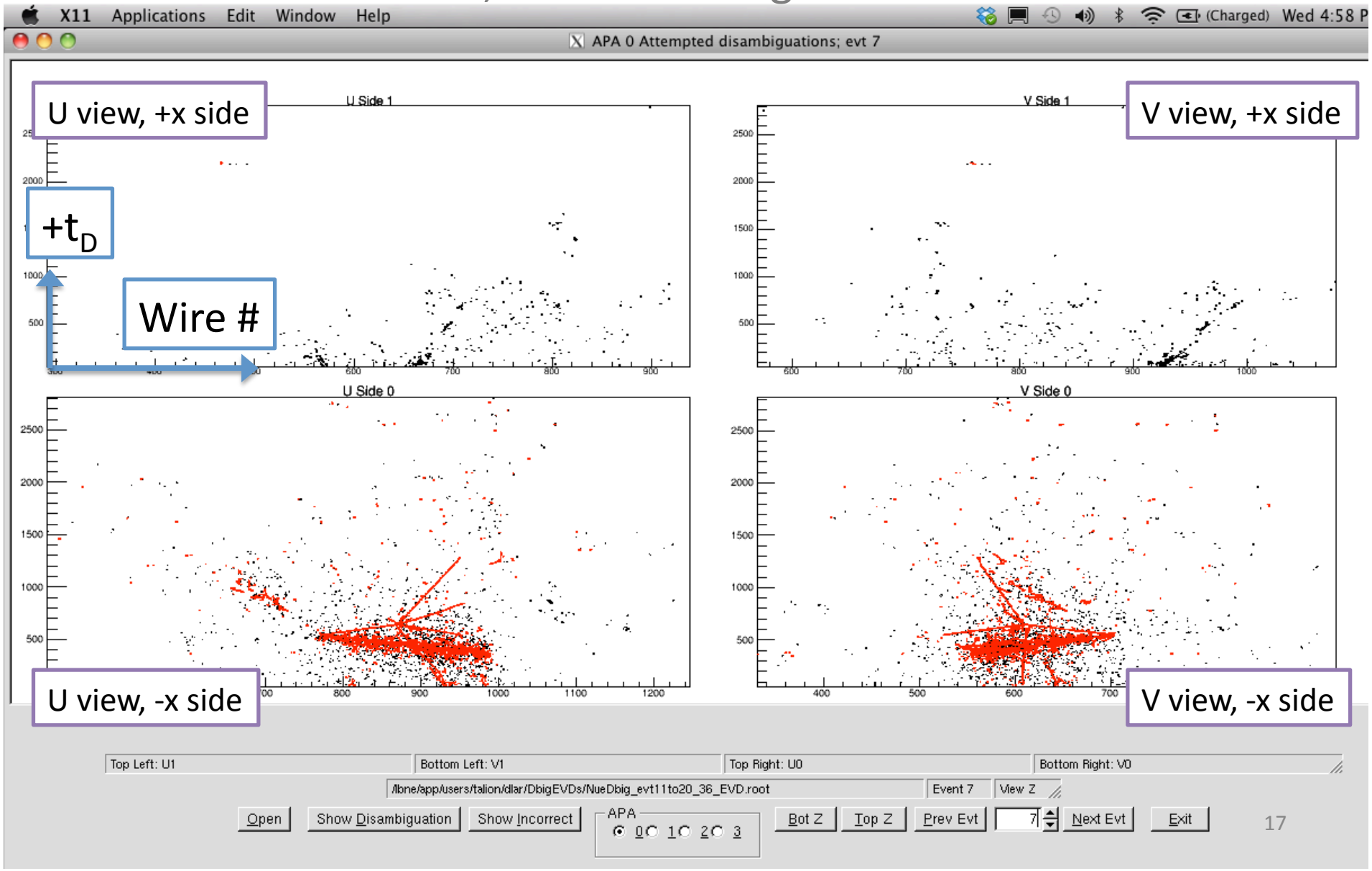
Drift time (x) vs. collection channel (z)



EVT 17

Disambiguated Hits (APA 0)

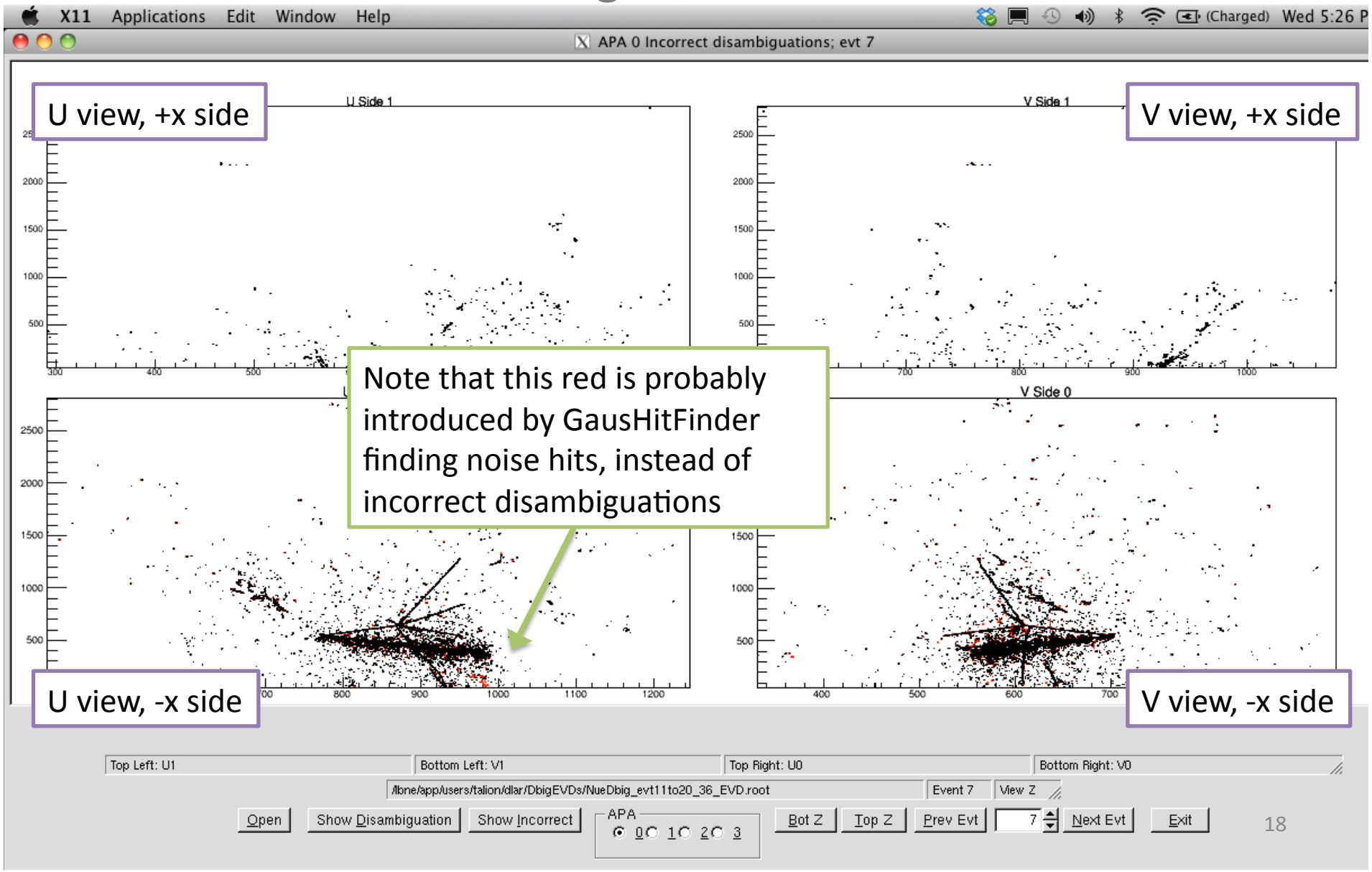
On a WireID, drift time vs. geo::WireID::Wire



EVT 17

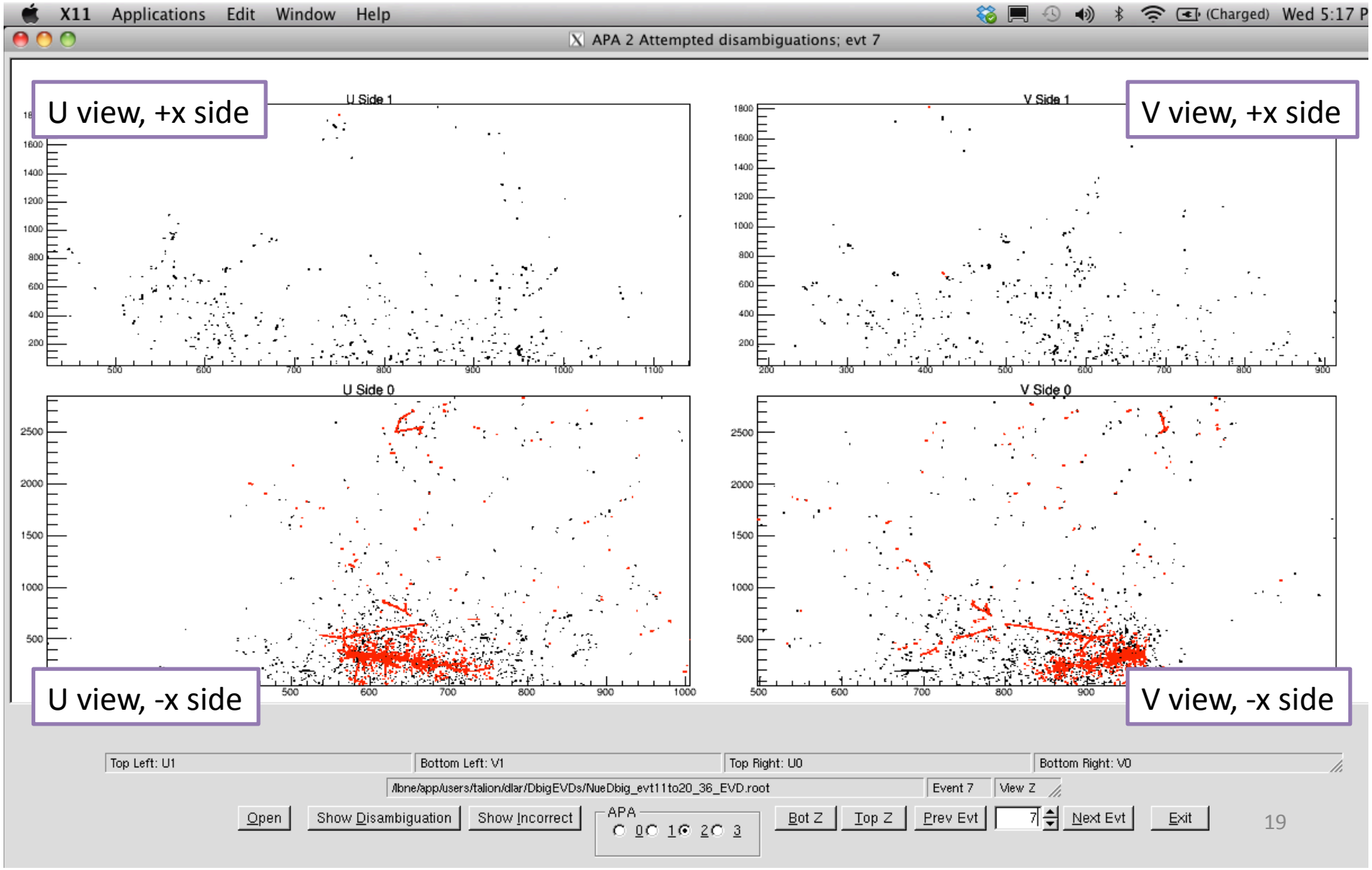
"Incorrect" (APA 0)

Incorrect hit finding or Incorrect WireID choice?



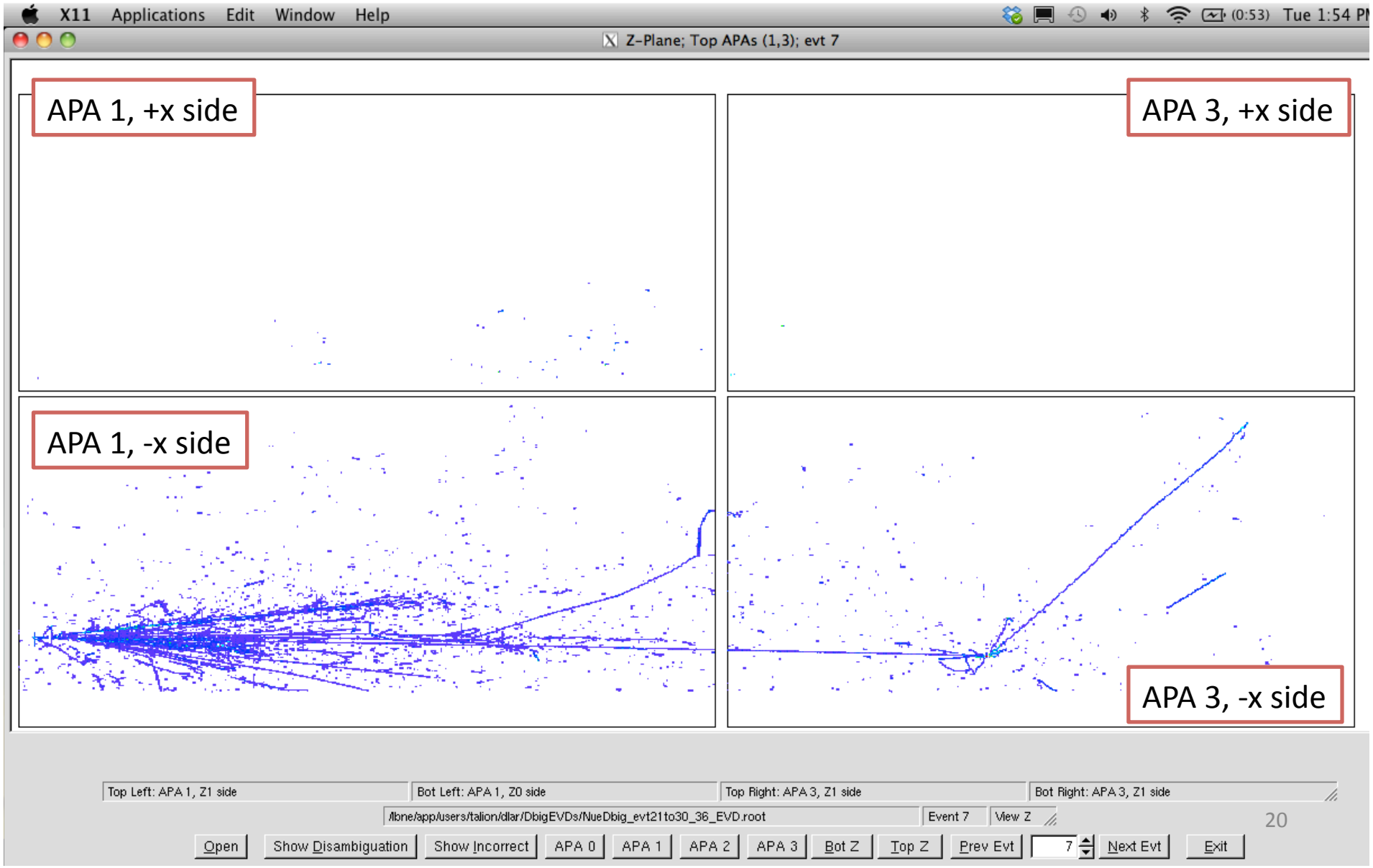
EVT 17

Disambiguated (APA 2)



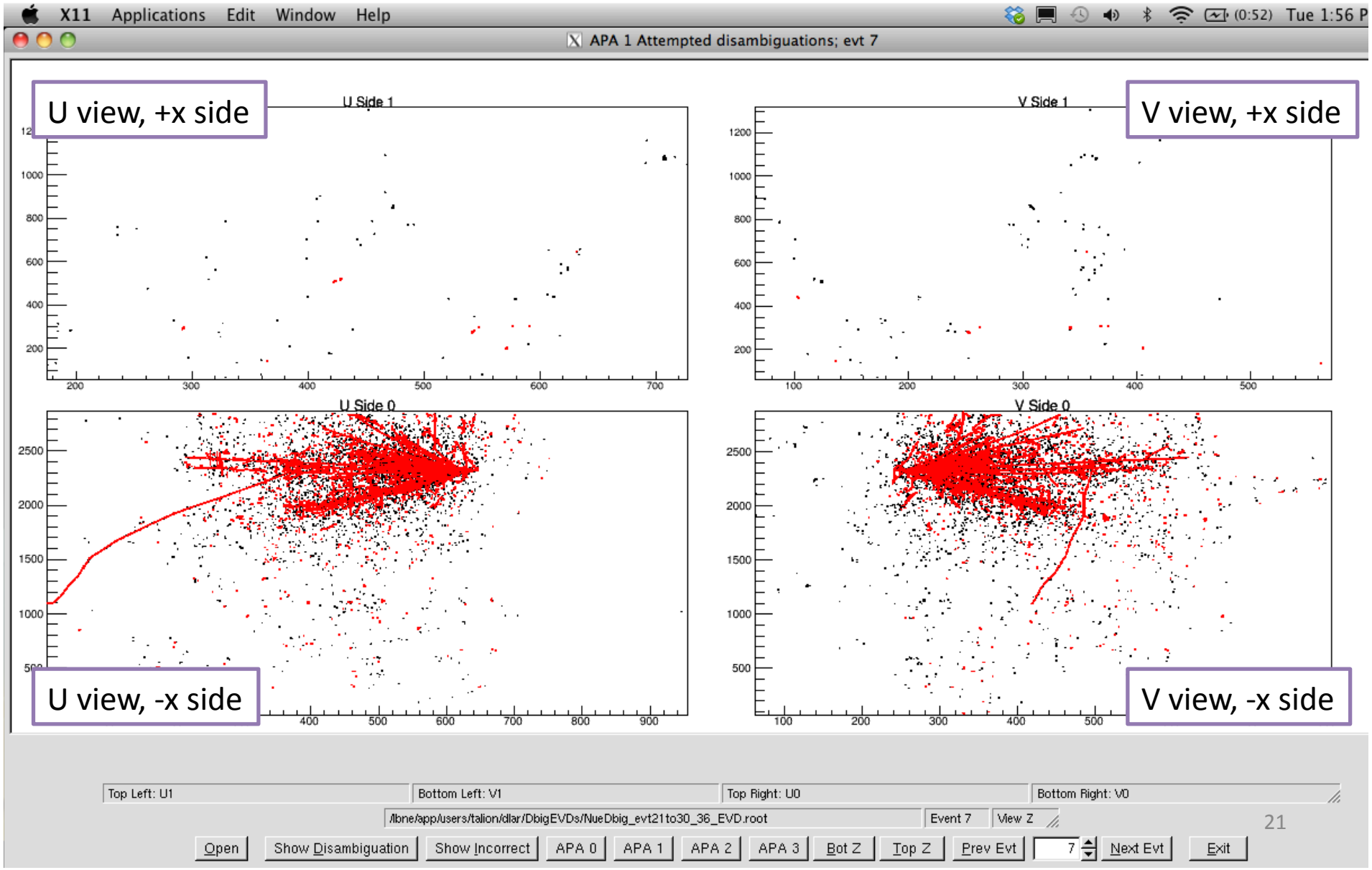
EVT 27

Z view (top APAs)



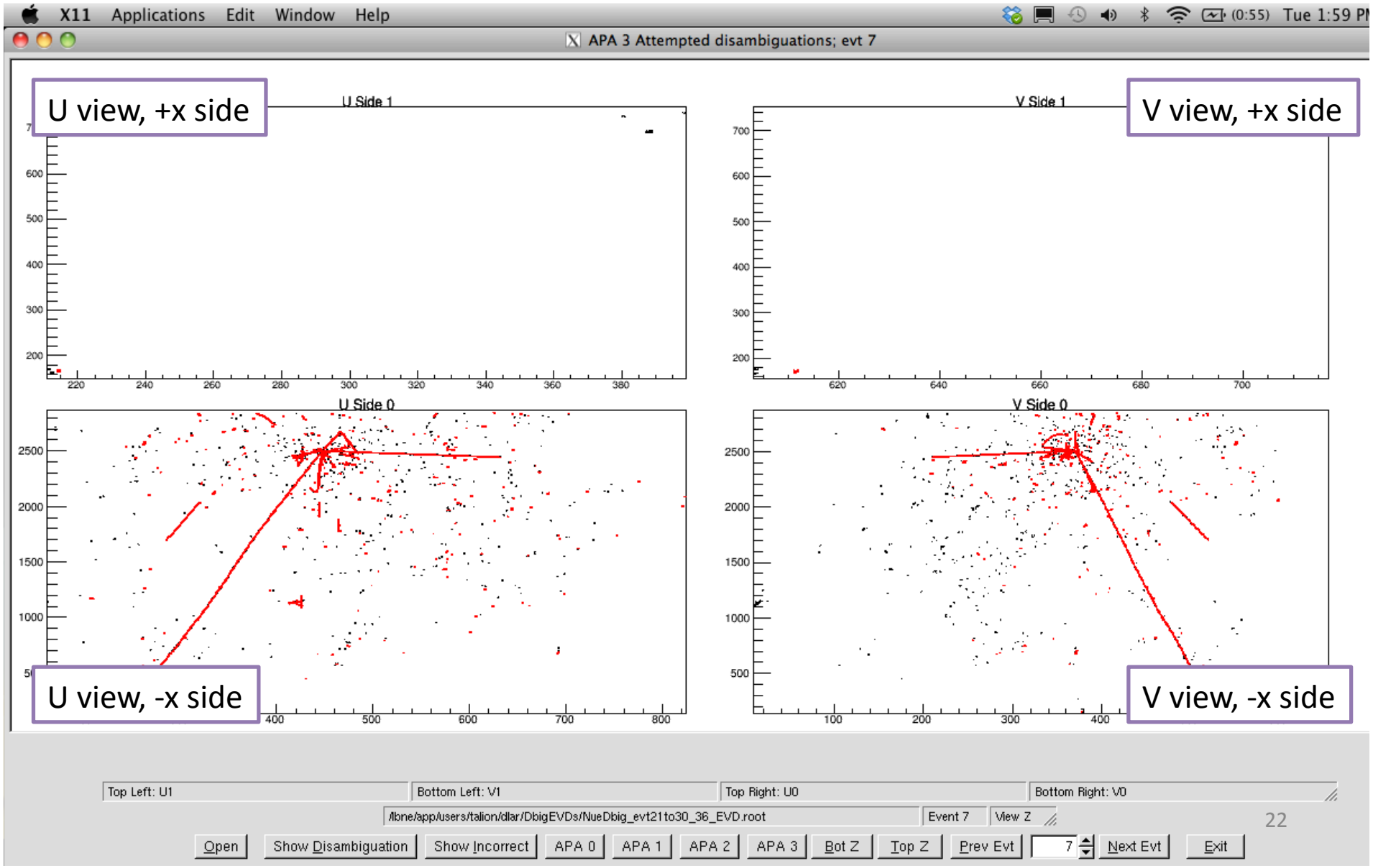
EVT 27

Disambiguated (APA 1)



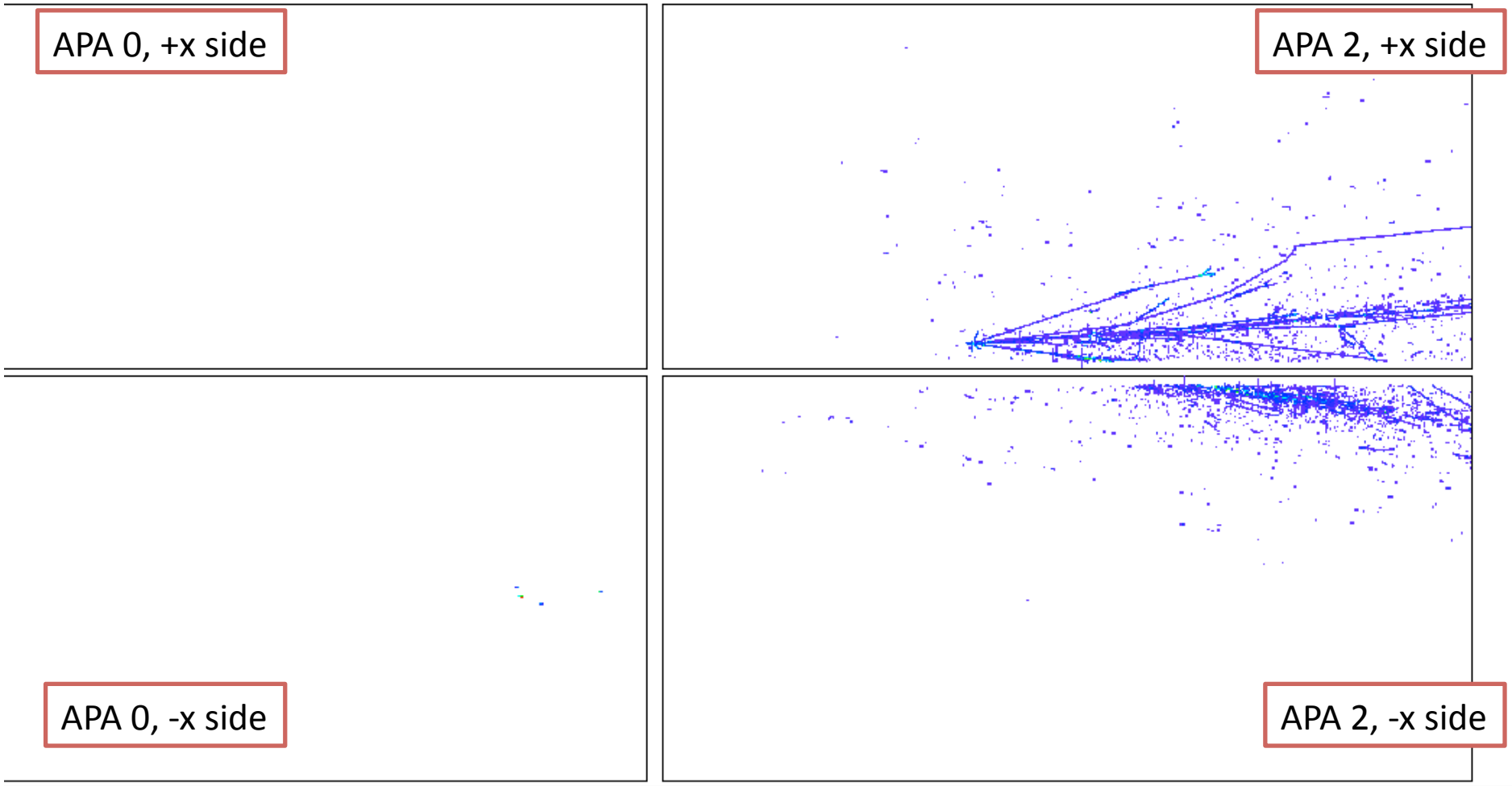
EVT 27

Disambiguated (APA 3)



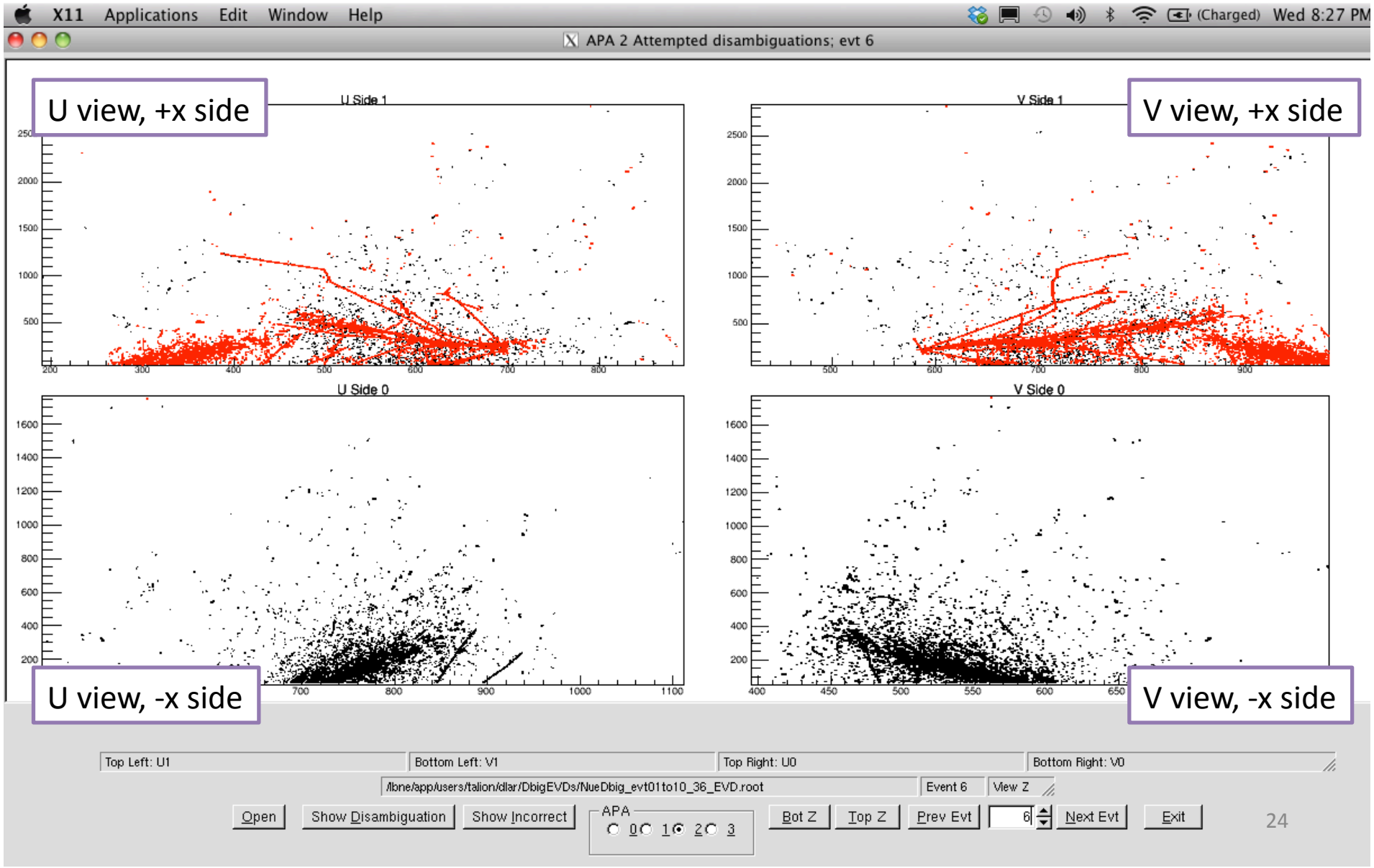
EVT 6

Z view (bottom APAs)



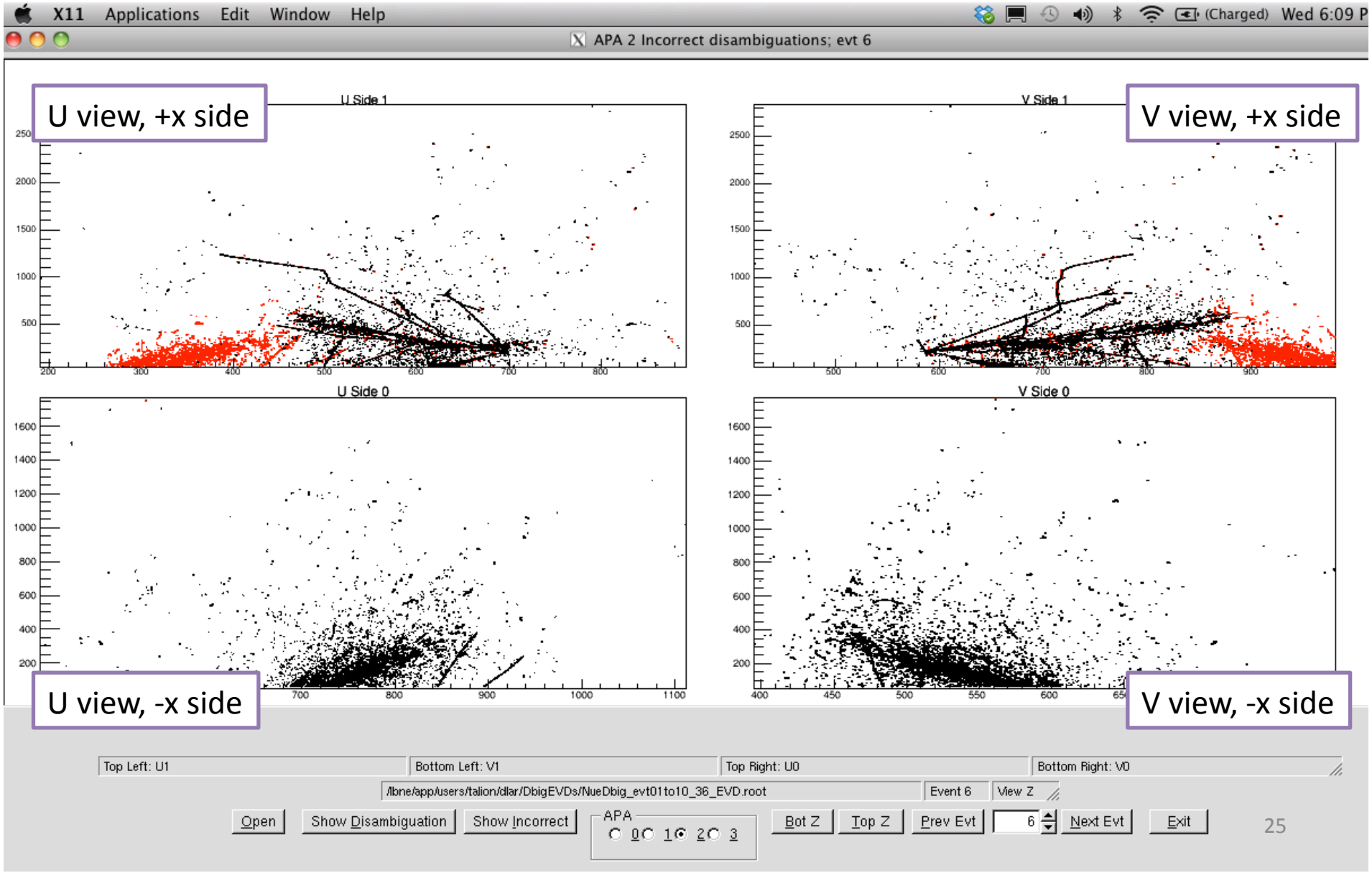
EVT 27

Attempted Disambiguation (APA 1)



EVT 27

Incorrect (APA 3)



Cheaters

- DisambigCheater
  - Input: ambiguous reconstructed hits
  - Output: “perfect” disambiguation
  - Good for moving down the reconstruction chain without assuming unrealistic hit finding
- HitCheater
  - Input: simulated deposition (sim::IDE)
  - Output: best hit finding, perfect disambiguation
- DisambigHitAna
  - Uses the same underlying methods as the above algorithms (but does not take the output from them for customization reasons)

Hit and Disambiguation Analysis

- Need to decouple problems introduced in hit finding from those introduced in disambiguation.
- Hit Ana: (channel hits vs. cheated hits)
  1. Does the hit-finder fail to separate hits from multiple wireIDs? …
  2. Are there regions of much noise? …
- Disambig Ana: (wireID hits vs. channel hits)
  1. … In such cases, how much charge is displaced to what wire?
  2. … If so, what risks do they impose when using the crawling algorithm

Disambig Ana Overview

Given a hit on a channel, did we find the segment(s)?

- Correctly Disambiguated:
  - D-hit which matches simulated deposition on the chosen segment, but not on any other segment
- Incorrectly Disambiguated:
  - D-hit which does not match simulated deposition on the chosen segment, but another segment on the same channel (Noise Hit: matches no segment at all)
- "Multi-hit":
  - D-hit which matches simulated deposition on
- Missed Hits:
  - Hits still remaining ambiguous after disambiguation (prefer this over incorrect)

Disambig Ana Overview

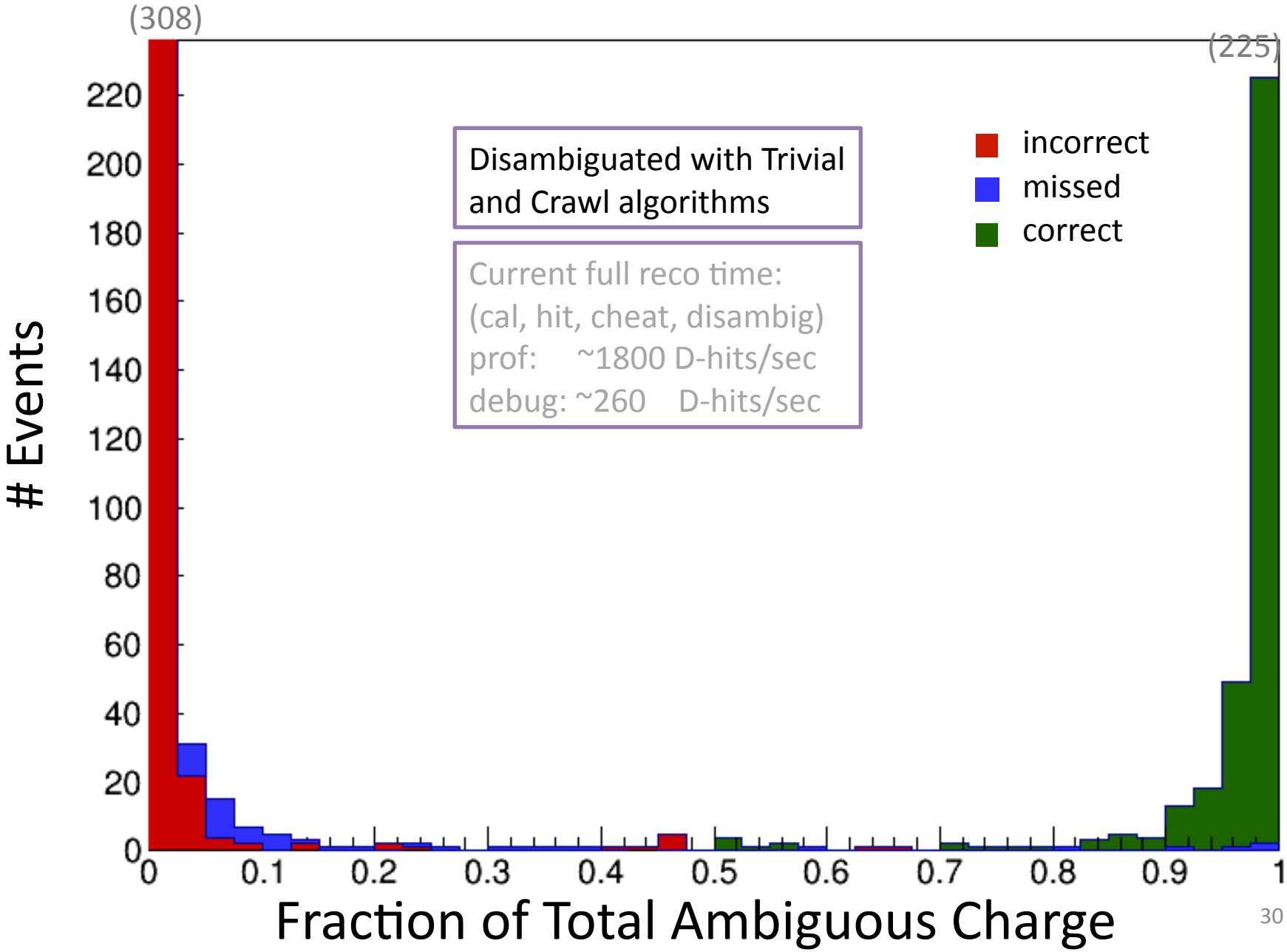
Given a hit on a channel, did we find the segment(s)?

- Total:
  - Number of initially ambiguous hits
  - Amount of initially ambiguous charge

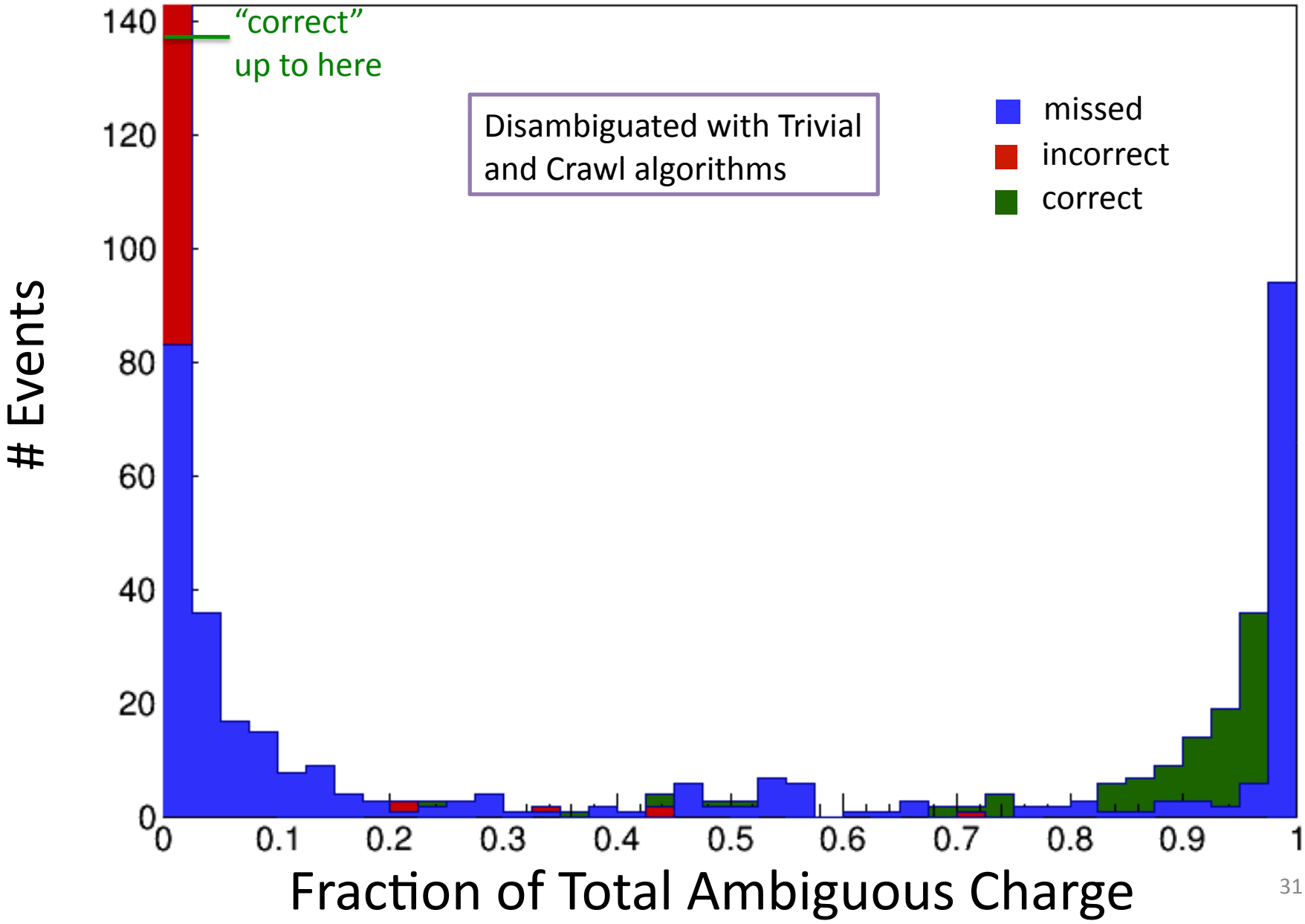
    In terms of reconstructed charge in order to decouple from hit finding quality/analysis

- Efficiency: Correct / Total
- Incorrect: Incorrect / Total
- Missed: Leftover / Total

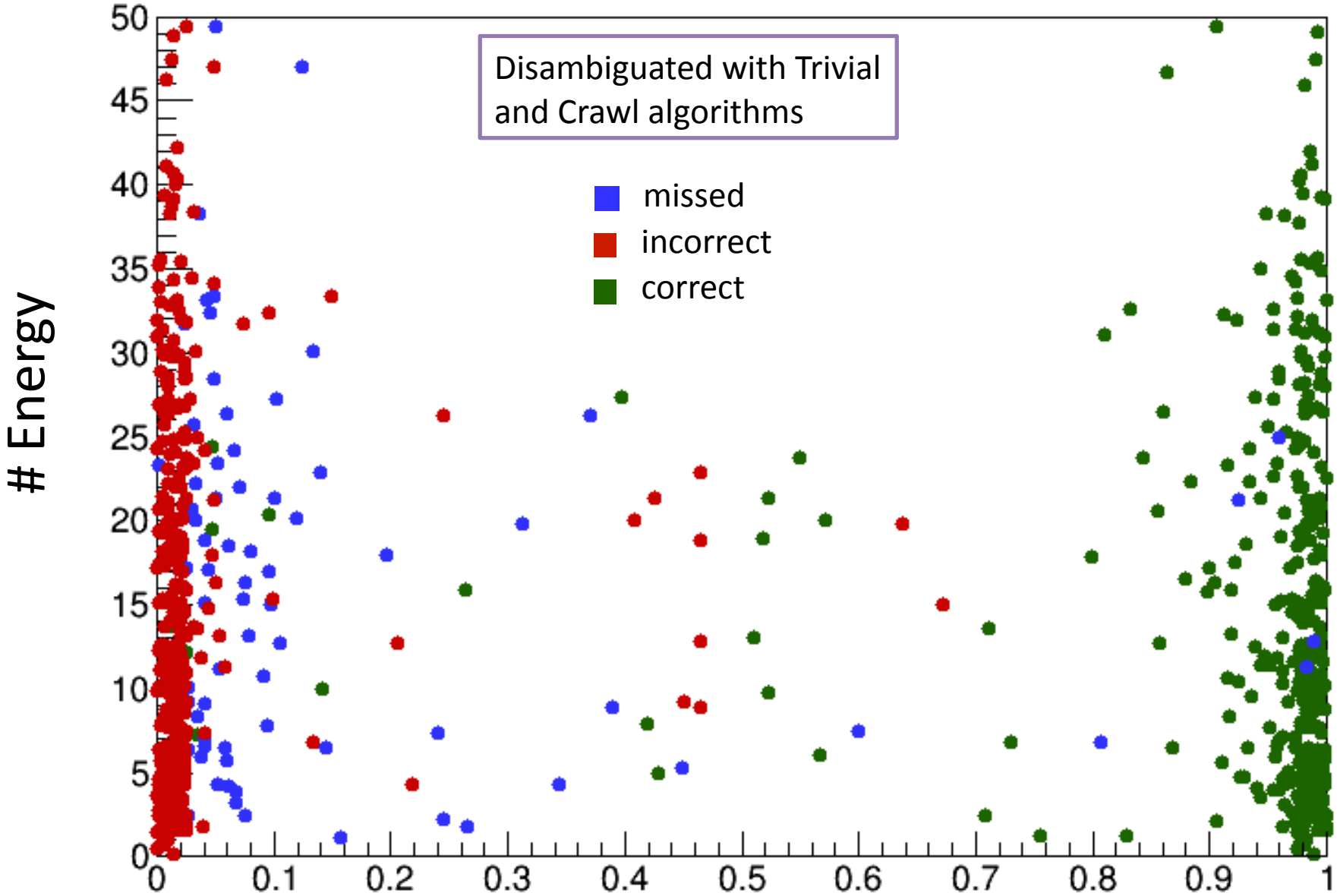
350 Nue events in 36°



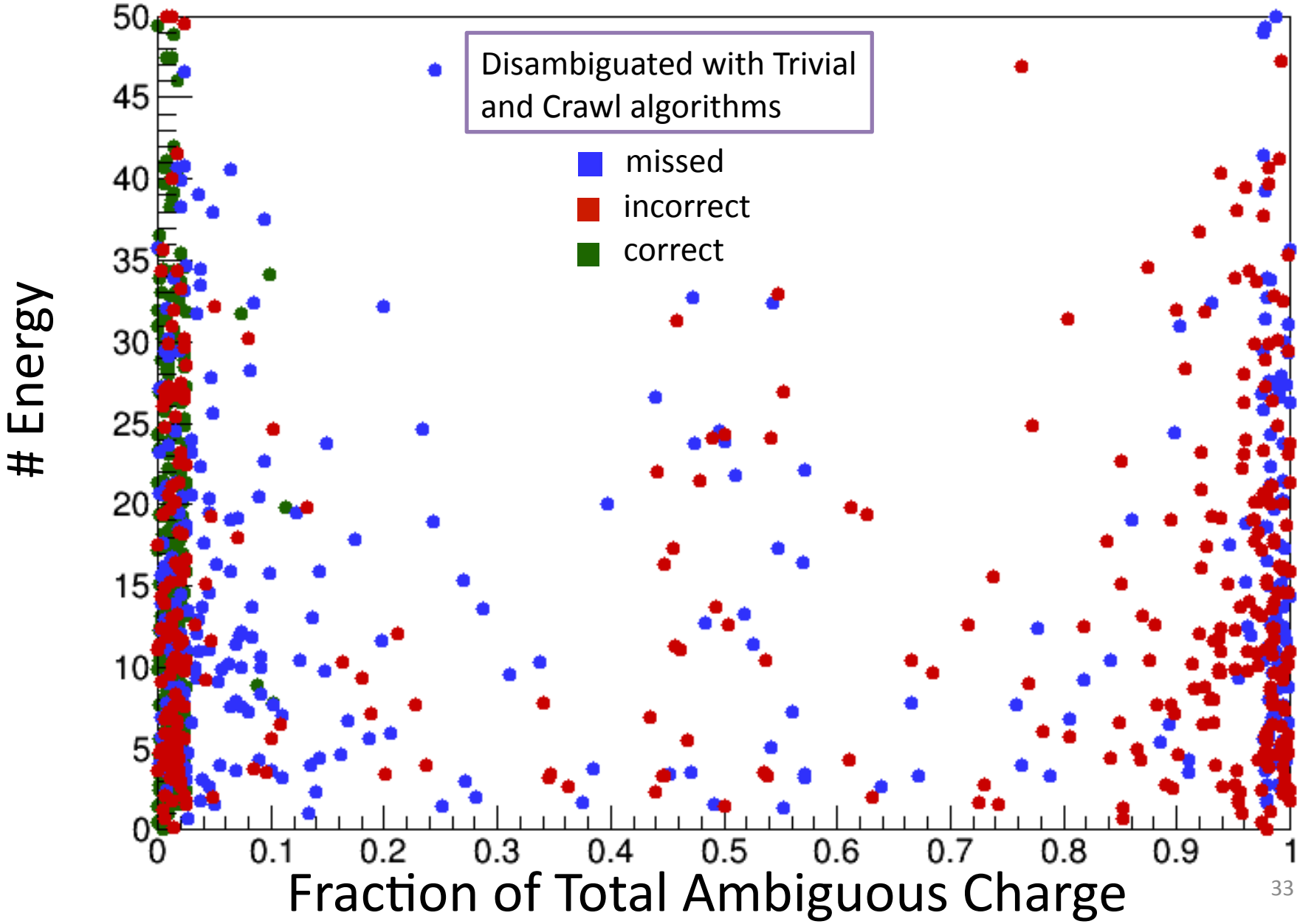
350 Nue events in 45°



350 Nue events in 36°



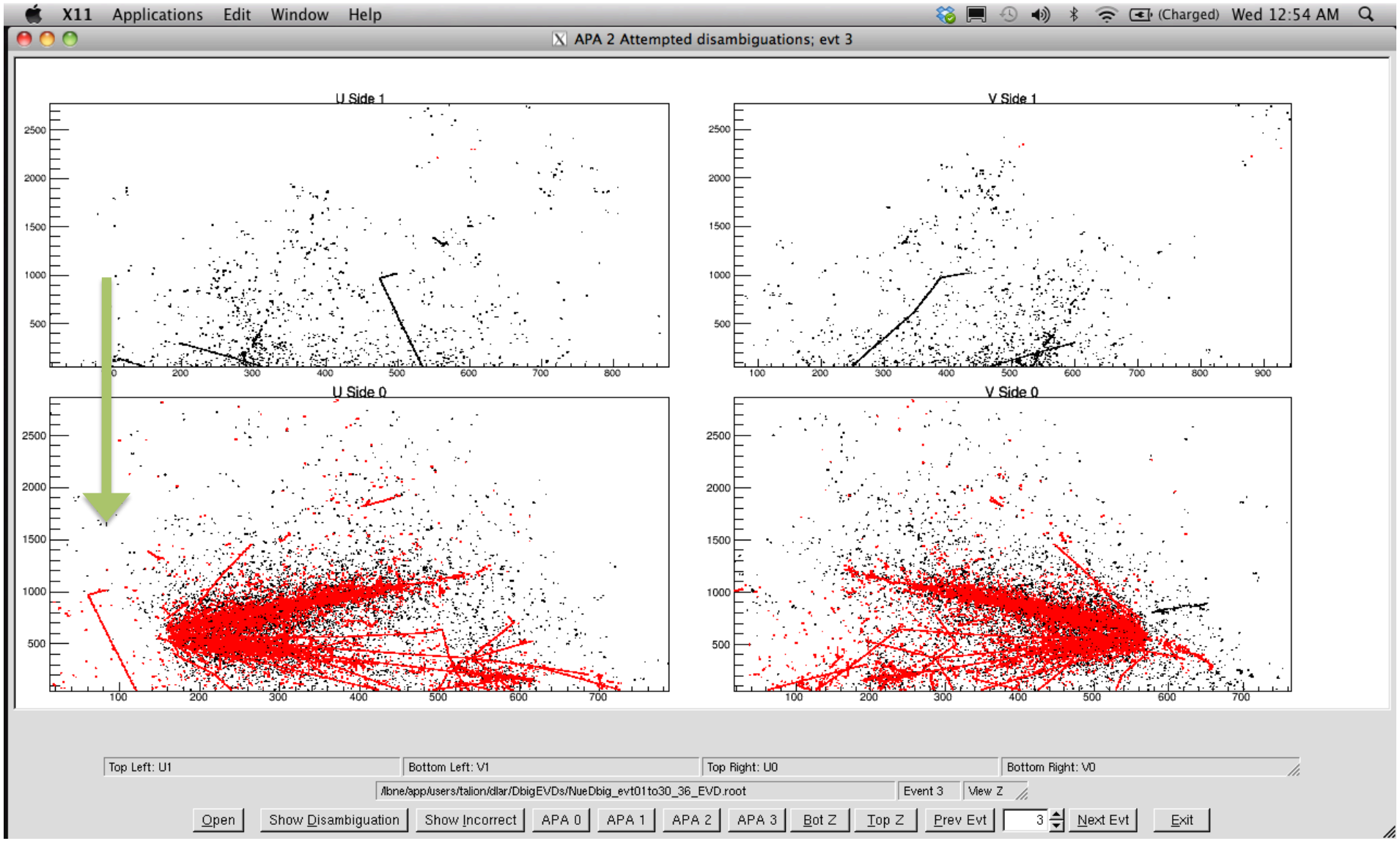
350 Nue events in 45°



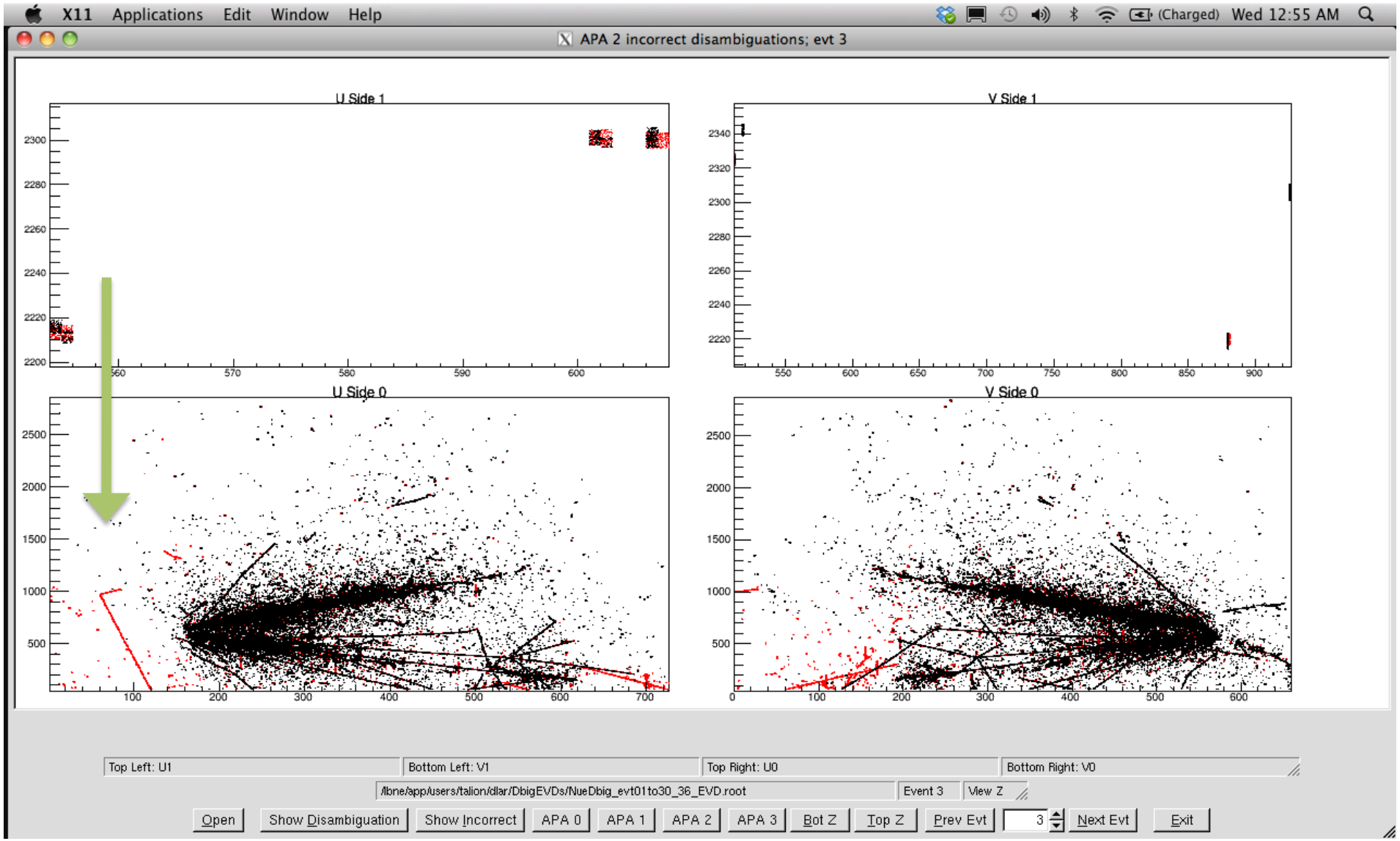
Moving Forward:

- Different Geometry:
  - U angle: 36, V angle: 45
  - Use “CompareViews” algorithm to translate easily disambiguated U information to V
  - Generation and reconstruction has been done, however LArG4 only tracks every 10 or so events
- More samples for others to reconstruct off of
  - PANDORA, Bezier Tracker, etc…
- Optimize current algorithms, add measures of caution so that we can be more aggressive in desirable cases
- 35t 4apa disambiguation:
  - Run disambiguation…. Up to tracking in easier center APAs
  - Use the gained 3D information to step into the taller APAs
  - There are 5 segments, but current algorithms supplemented with this 3D information is a solid start

… and implement Jae Kim's ghost track correction work on events like this!



… and implement Jae Kim's ghost track correction work on events like this!



Thank You!
Questions?

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