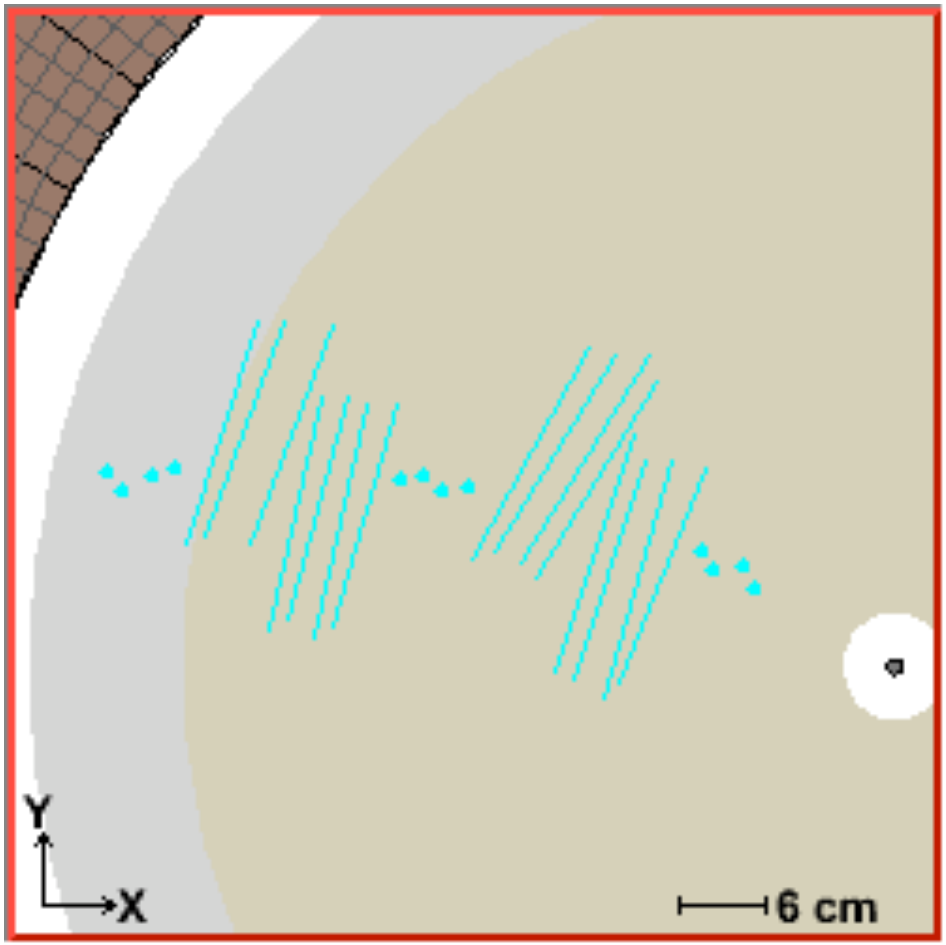
Tracking Efficiency

May, 1, 2009 David Lawrence

Track Finding in CDC



Short refresher on CDC track finding:

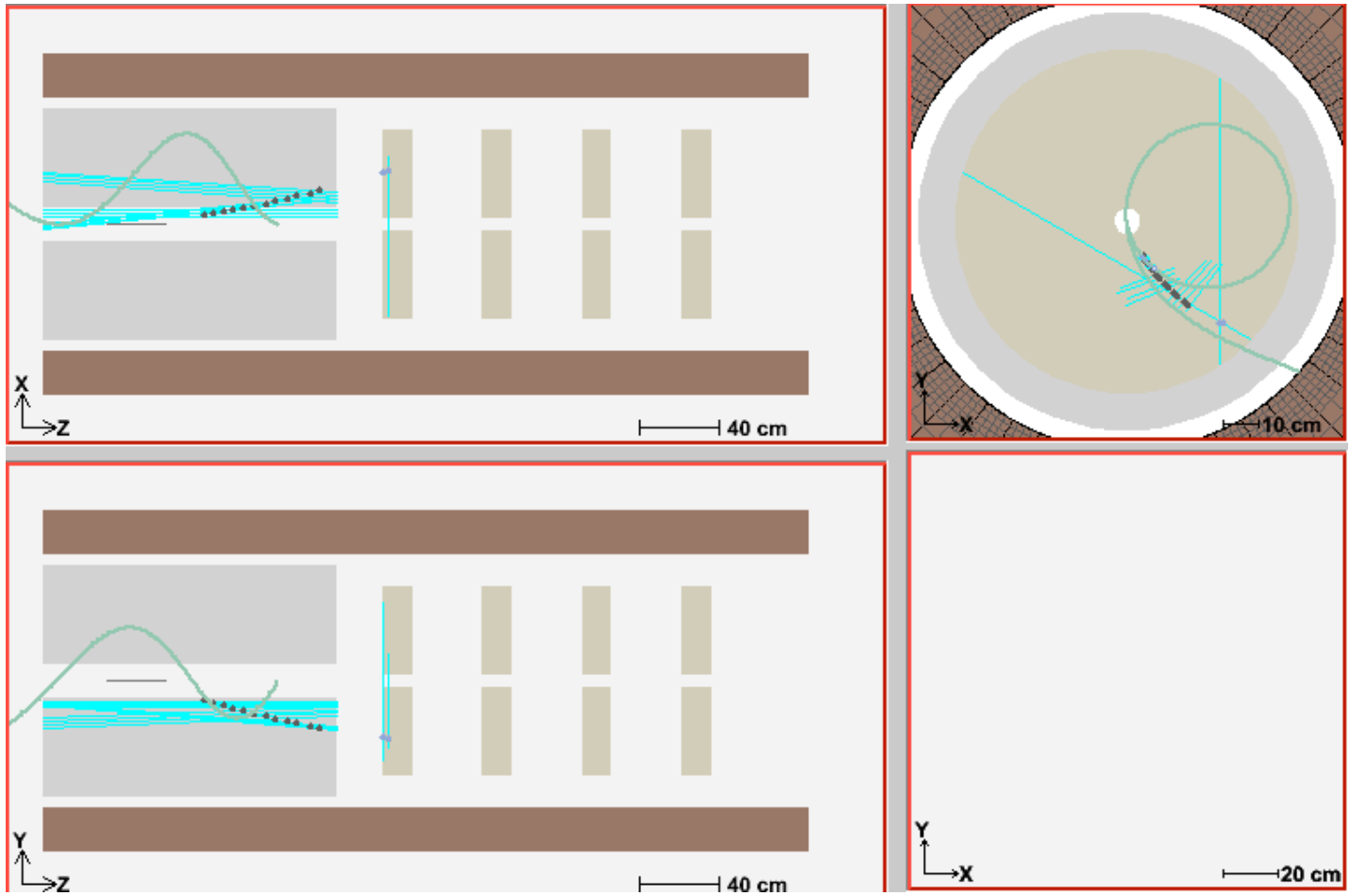
1. Find clusters of hits in adjacent layers for each of the 3 axial superlayers

2. Match “sub-seeds” in axial superlayers to make “seeds”

3. Fit a circle to seed in X/Y plane and use intersections of circle with stereo wires to get 3D space points of hits

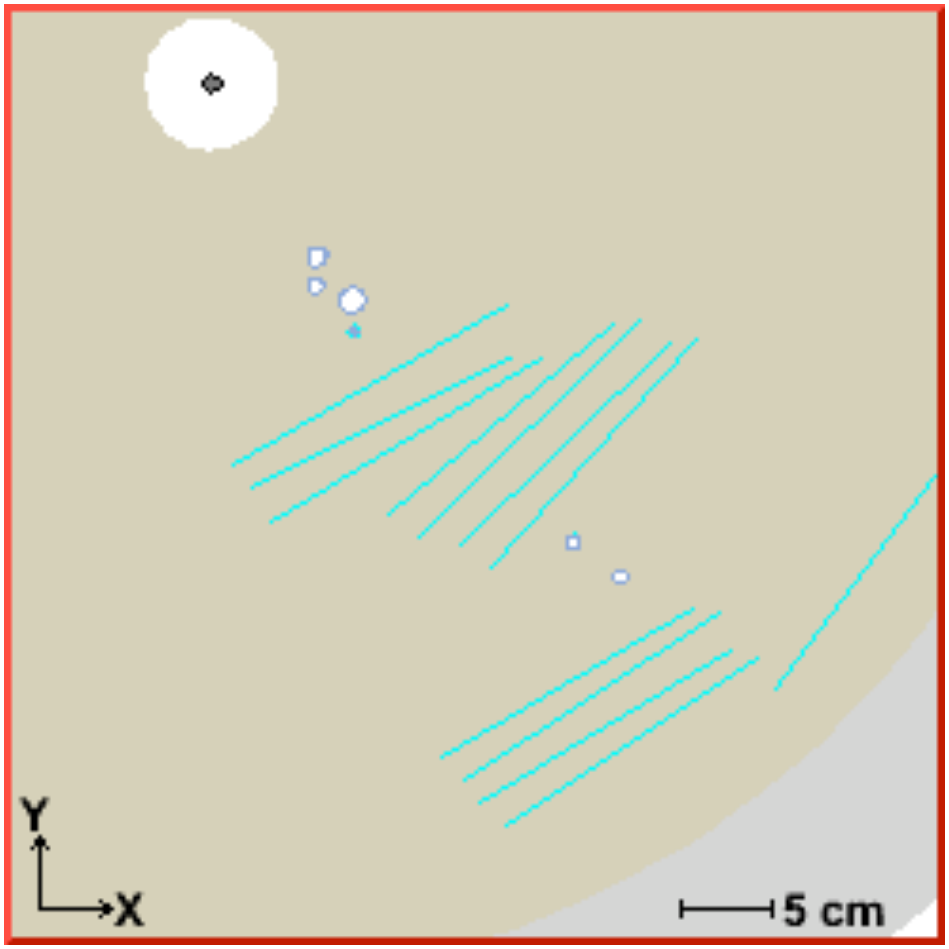
4. Initial track parameters have p_t and ϕ from circle fit and θ and z_vertex from fit to stereo wires

A “missed” candidate



Seed algorithm does not make secondary attempt to extend single layer seeds to another layer

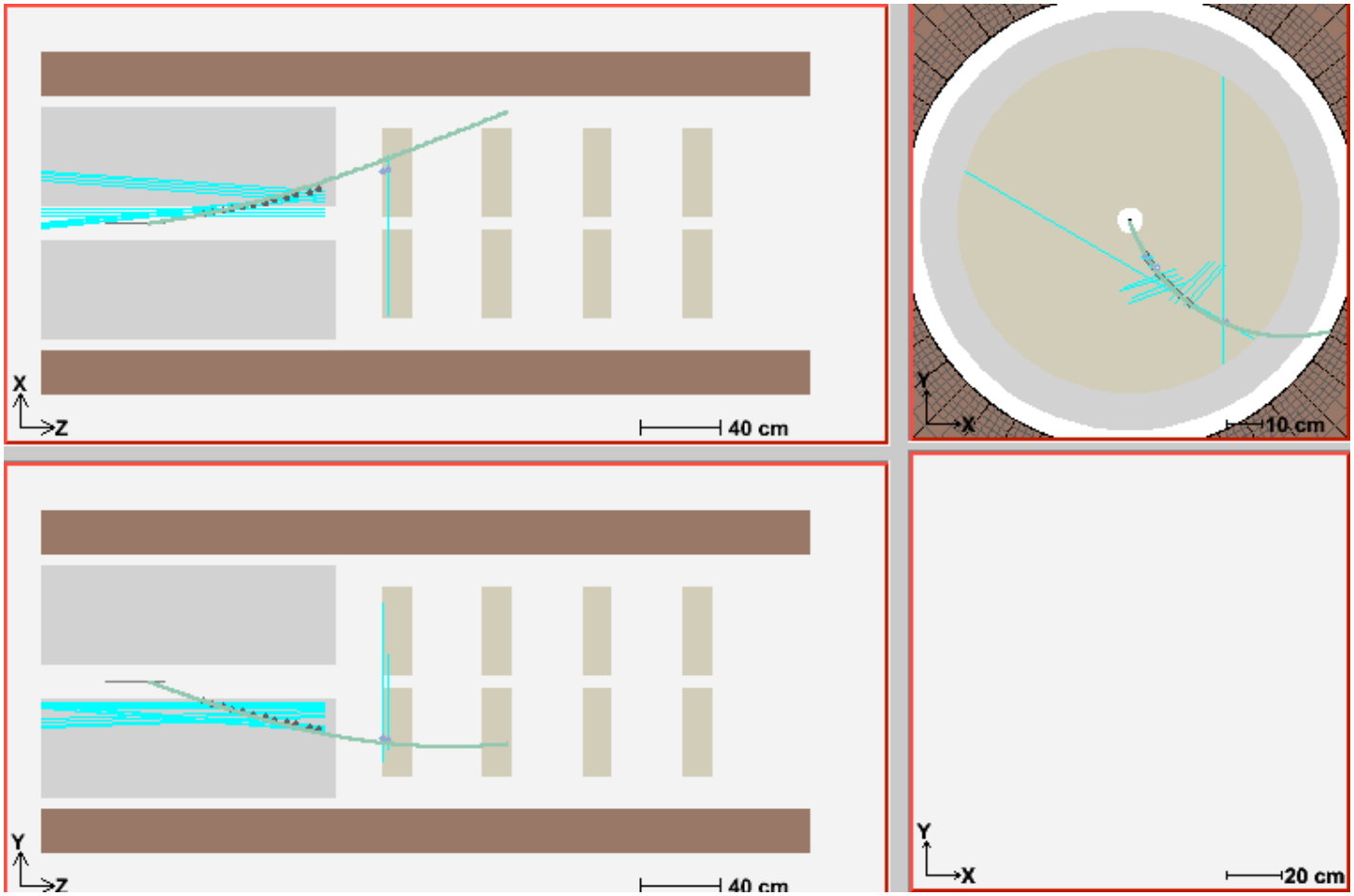
First changes to CDC finder



- Minimum number of hits in a superlayer needed to form a "subseed" reduced from 3 to 2.

- Hits still must be in adjacent layers so no seed was formed from the 2 hits in the middle axial superlayer

Same candidate is now found

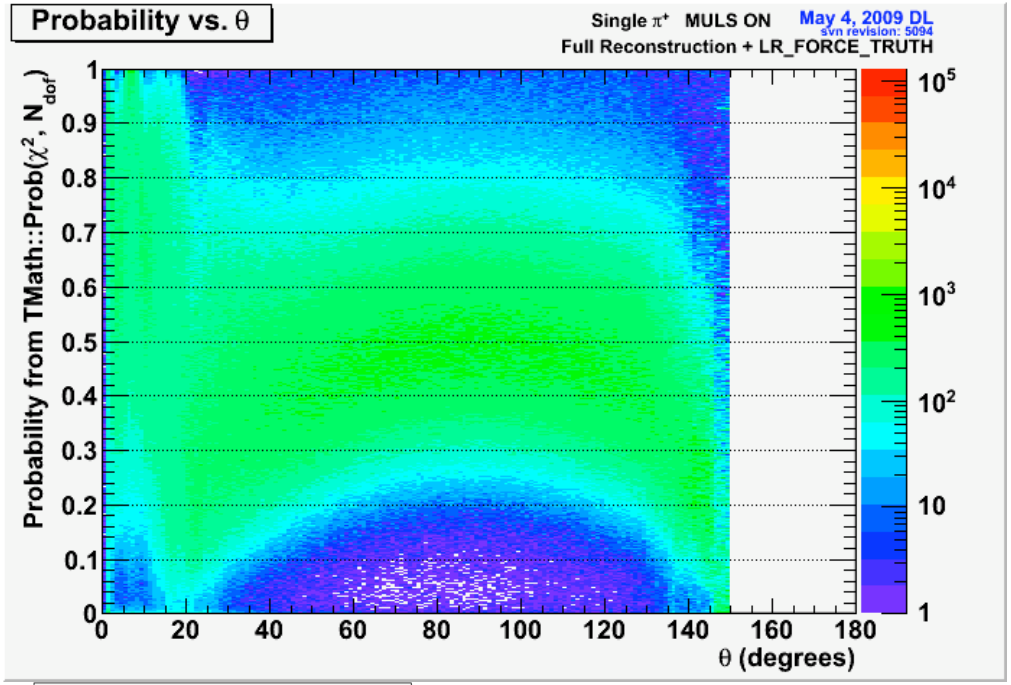


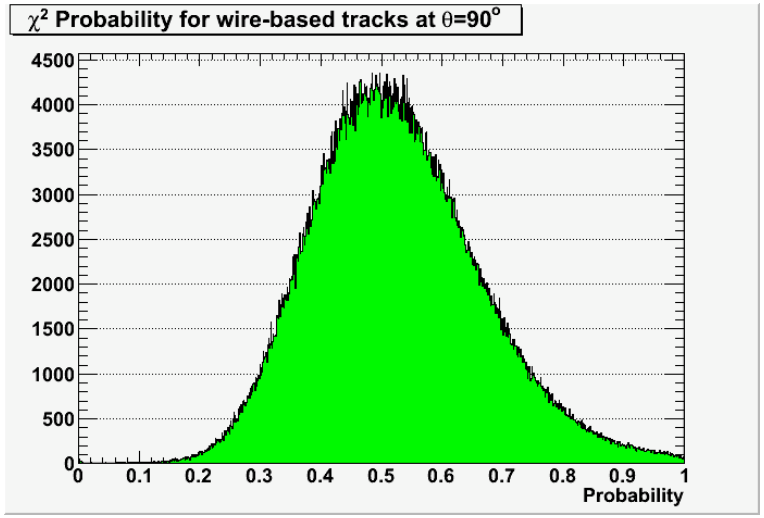
For full seeds which have hits only in SL1, a second attempt is made to find stray, matching hits in SL3 or in the first FDC package.

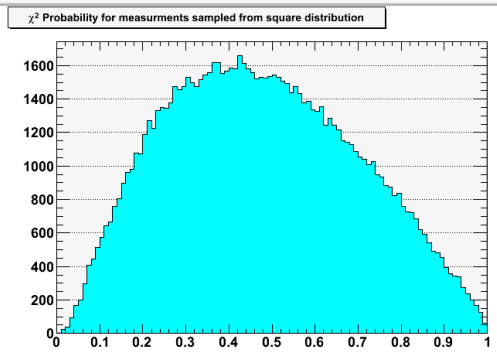
Some modifications made to improve efficiency

- Reduced minimum number of hits in CDC needed to for subseed
- Added secondary pass to add stray hits from CDC SL3 or FDC to CDC SL1-only seeds.
- Check the χ^2 from the Riemann helical fit and try alternative method if it is too large (>20)
- Created new top-level candidate factory that merges candidates from *CDC* and *FDCpseudo* (as opposed to *FDCCathodes*) finders
- Added option to force correct Left-Right choice based on truth information
- Added material integration to swimmer an build proper* covariance matrix for fit

χ^2 probability for Wire-based tracks



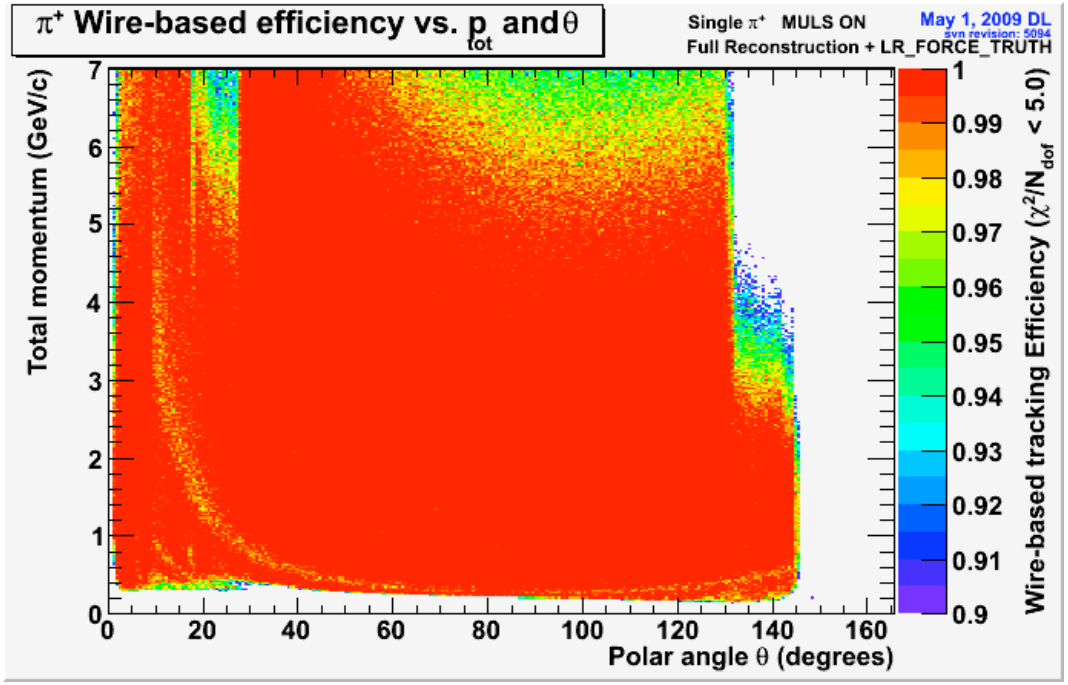




"χ^2 probability" for a square distribution

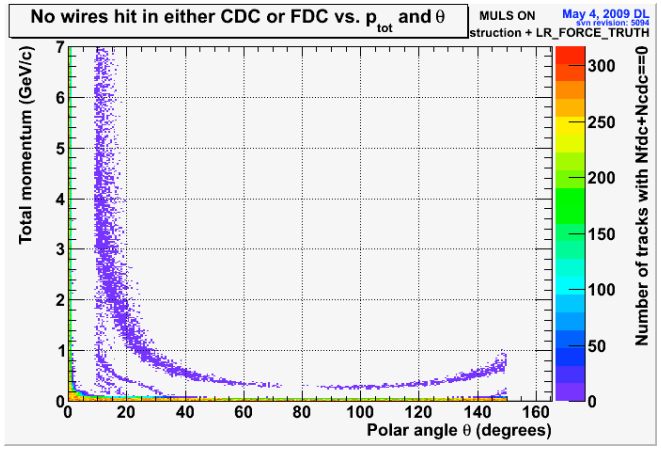
Tracking includes a phase that fits to wire positions only. This avoids L-R issues and gives a better idea of what the ultimate efficiency will be.

Wire-based tracking efficiency

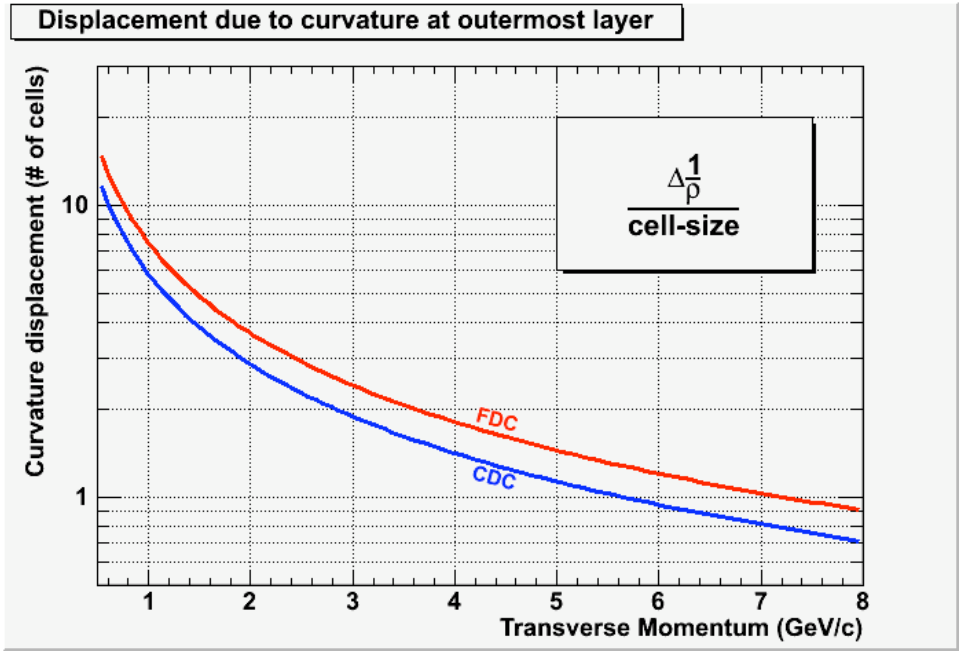


- Single π+ tracks
- no background
- Multiple scattering ON
- Energy Loss ON
- Secondaries OFF
- Full Reconstruction

GEANT tracking bug is still present, though highly suppressed. Plot to right is of events where no CDC and no FDC wires were hit.



Inefficiencies at high momentum



Sign of charge for track is determined at track finding time by checking whether track tends to be curving clockwise or counter-clockwise in X/Y plane.

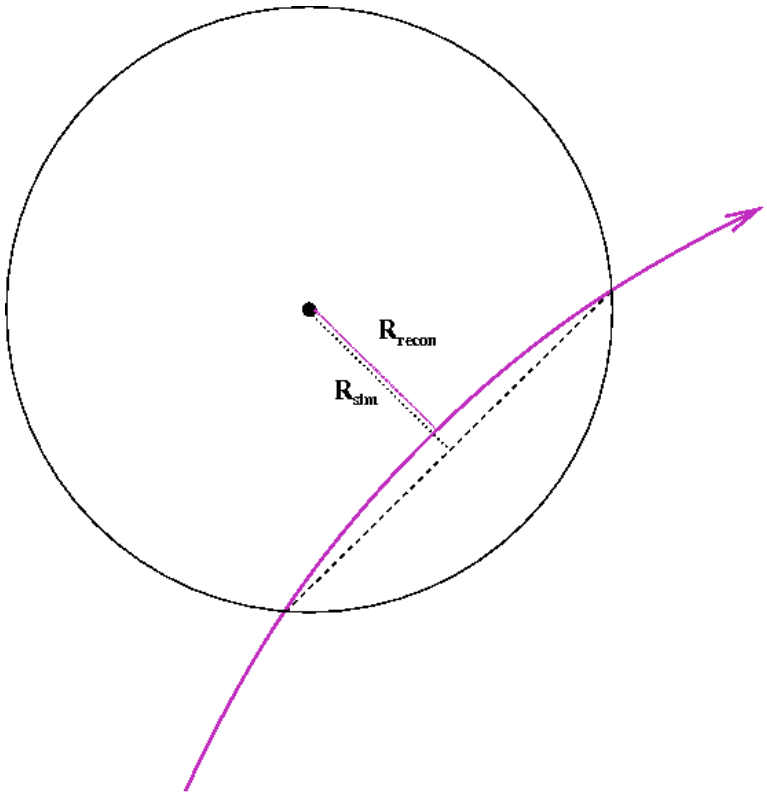
Points used for this are from wire positions which have a resolution that goes like the cell size.

At some point, the largest deviation from a straight line due to curvature at the outermost layer will be comparable to the cell size. The above plot shows this curvature deviation in units of cell size.

Checking the Geometry

Simon showed some plots last time that brought up the question as to whether the wire positions are consistent between the simulation and the reconstruction. The address this …

Why “perfect” isn’t perfect

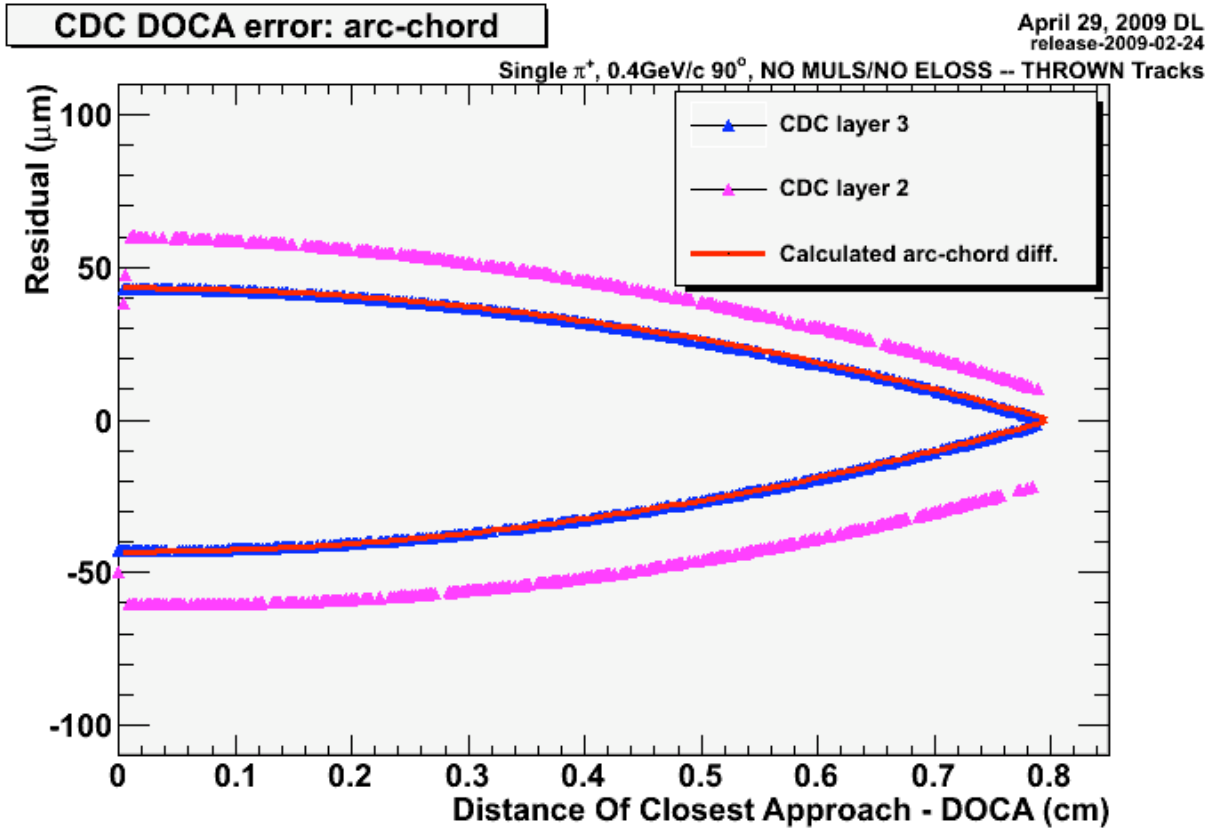


- *hdgeant* estimates the point of closest approach (POCA) to be the midpoint of the entrance and exit points of the tube.

This is true to about 10 μm (systematic)

- Tracking reconstruction approximates trajectory as parabola near wire and calculates POCA from that

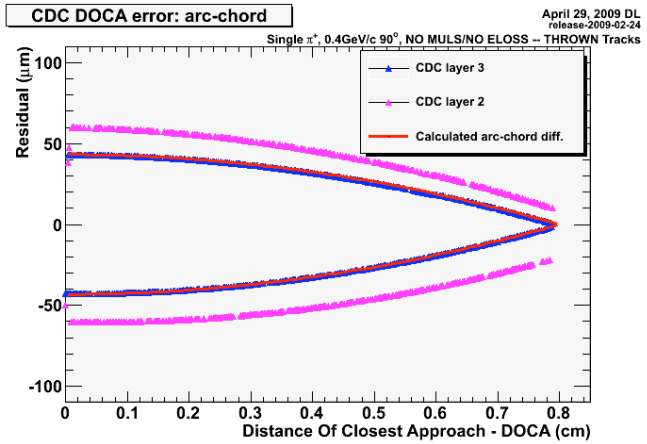
Checking the arc-chord difference



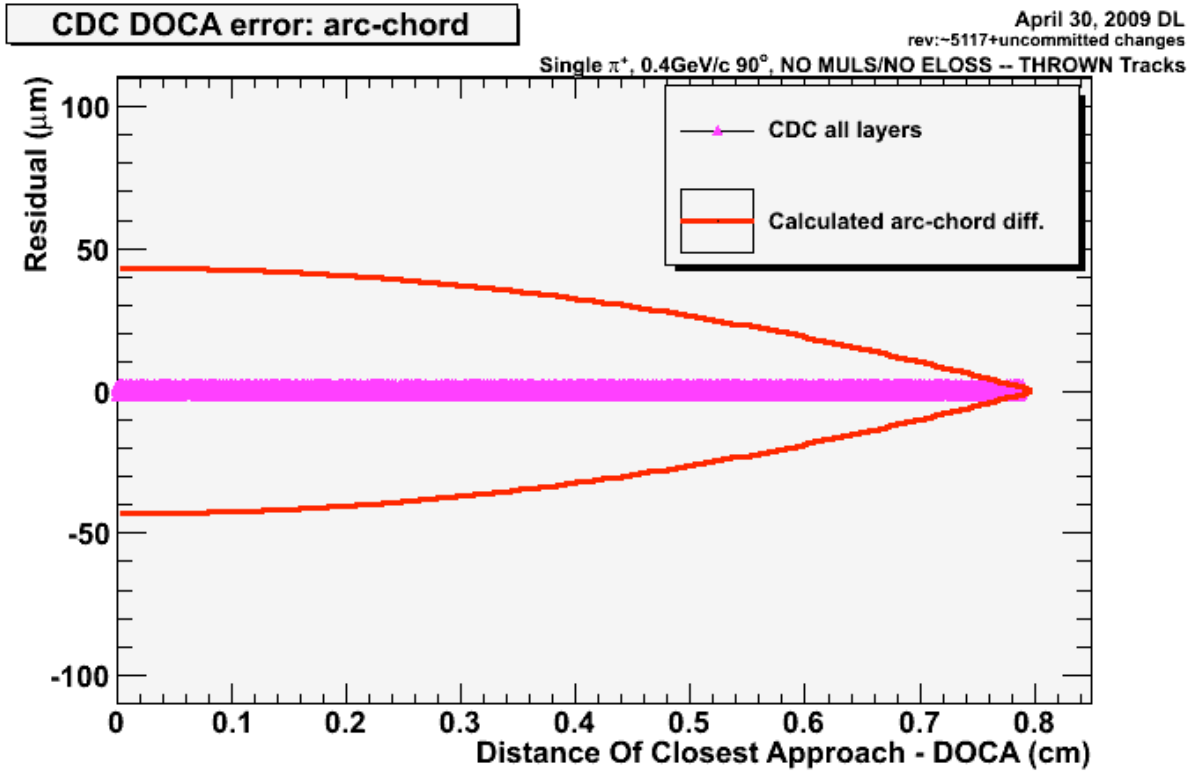
Looking just at the first 4 axial layers, layers 1 and 3 seemed to agree well with the calculation while layers 2 and 4 did not

Verbose print statements about the wire positions from hdgeant and the reconstruction showed they were defined consistently for all layers

hdgeant modified to be more accurate

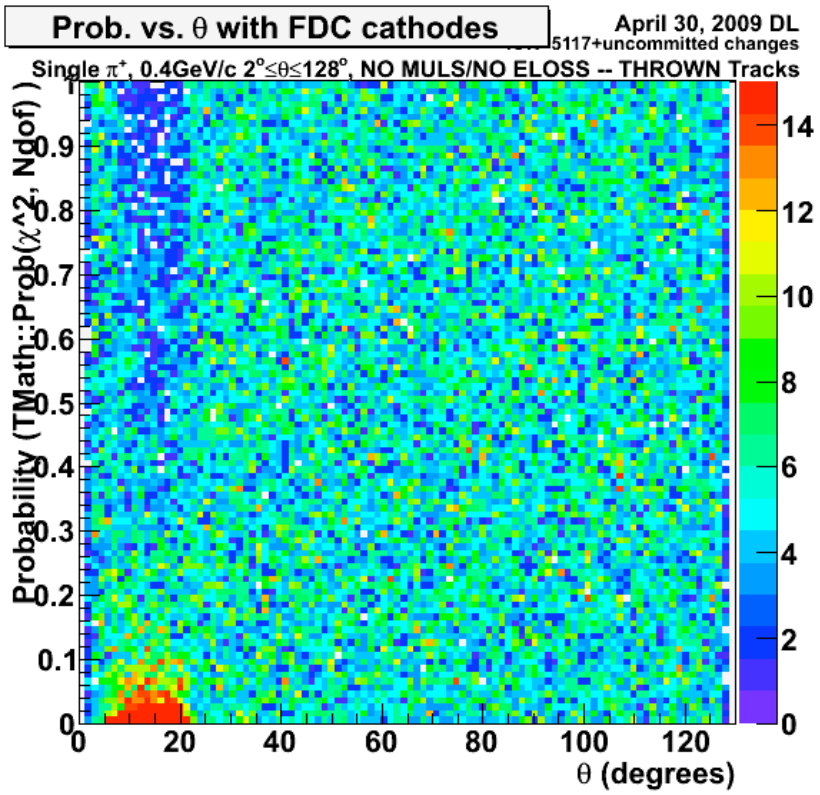


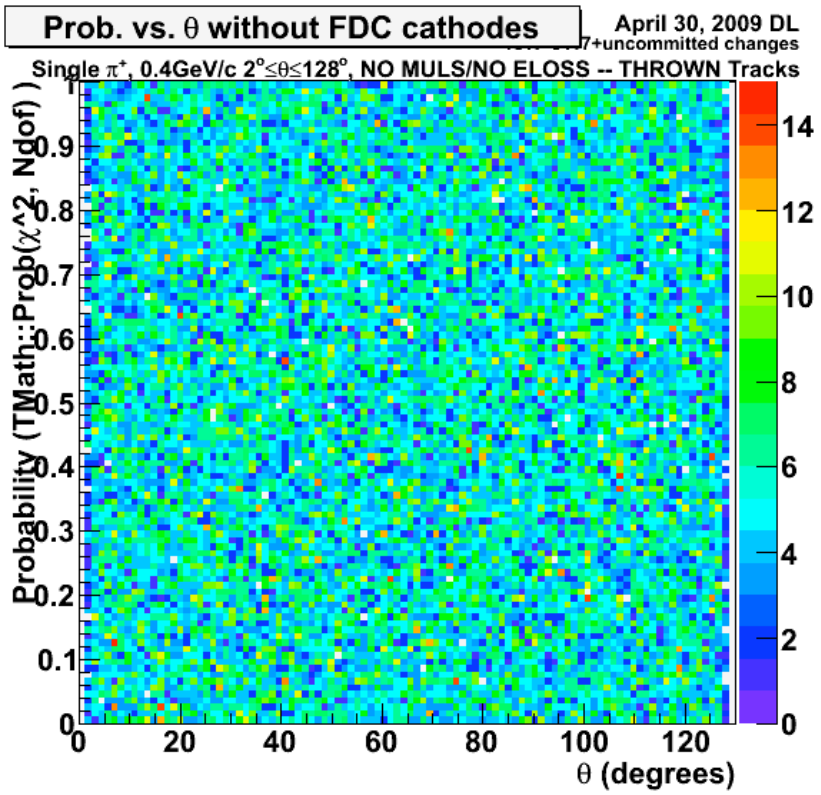
hdgeant now swims the particle from the entrance point of the volume to determine the DOCA. Simulation and reconstruction are consistent within about 2 μm.



Agreement at this level was only reached by modifying swimmer in tracking such that it now goes considerably slower (factor of 4 at minimum)

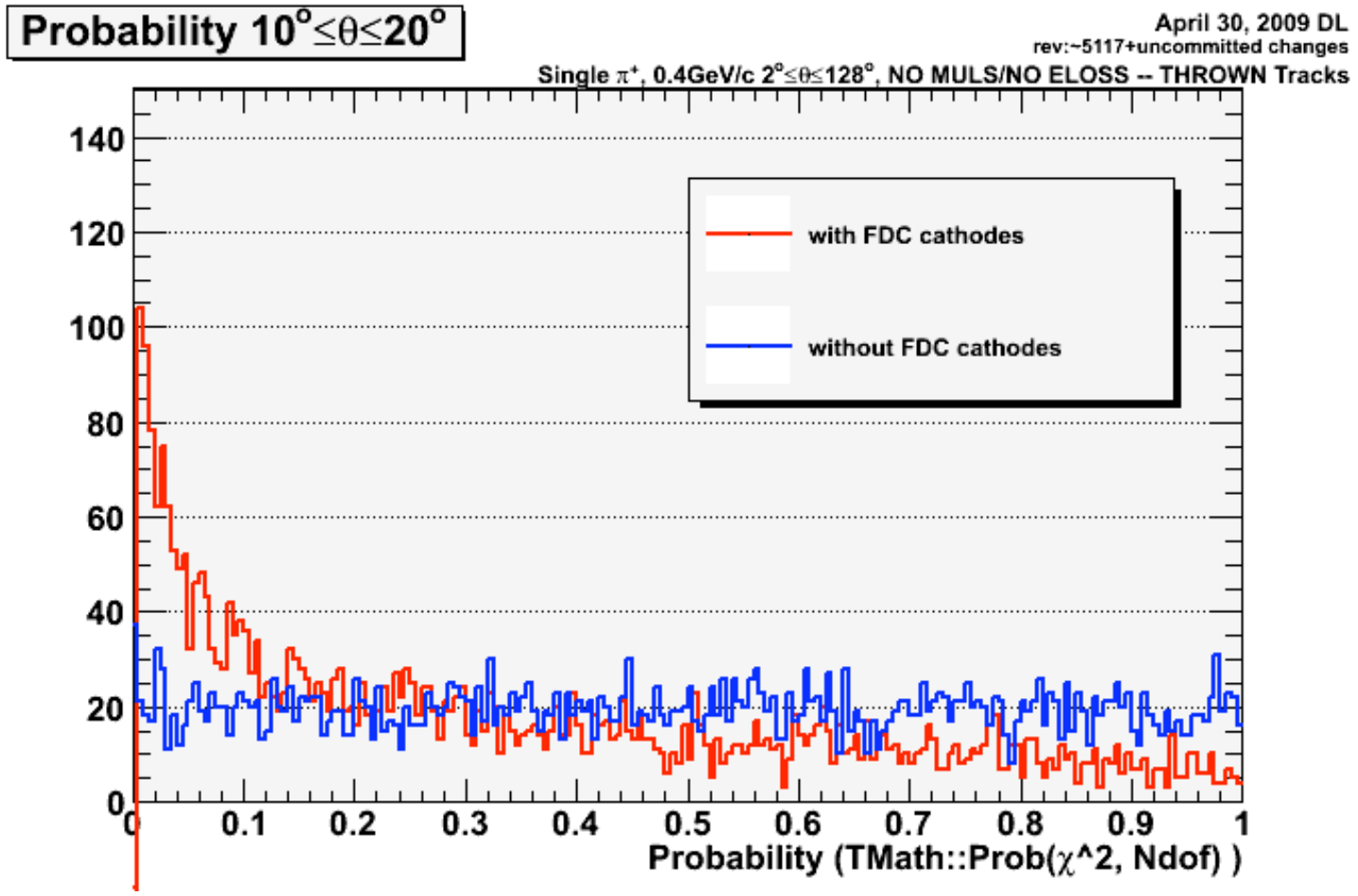
χ^2 probability vs. θ



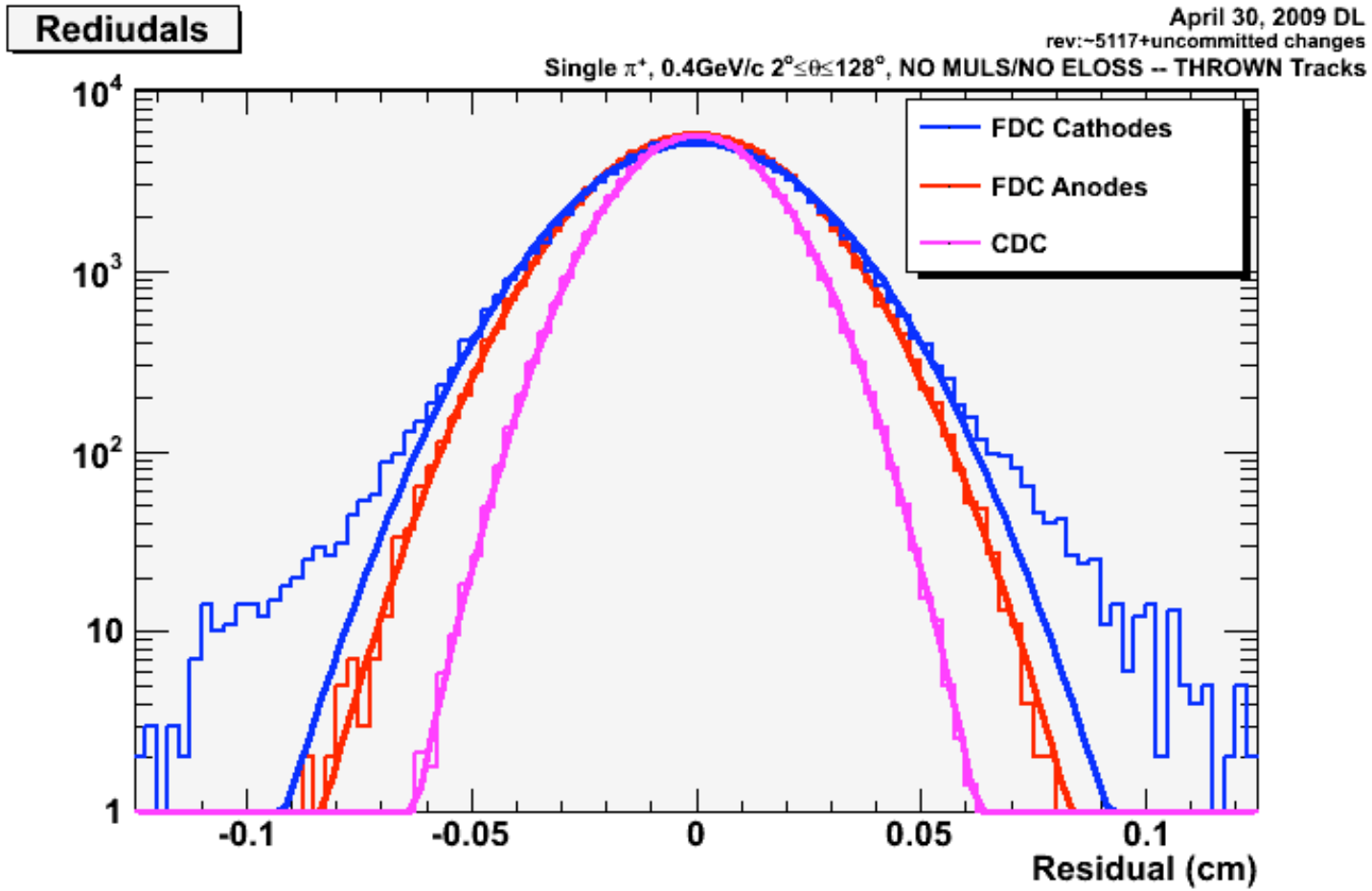


Probability has issues in FDC region when cathodes are included

χ^2 probability in forward region



Residual distributions without fit

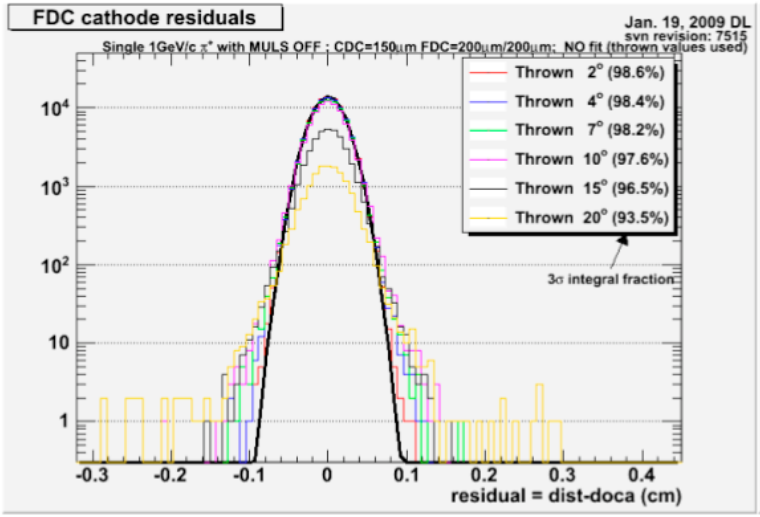


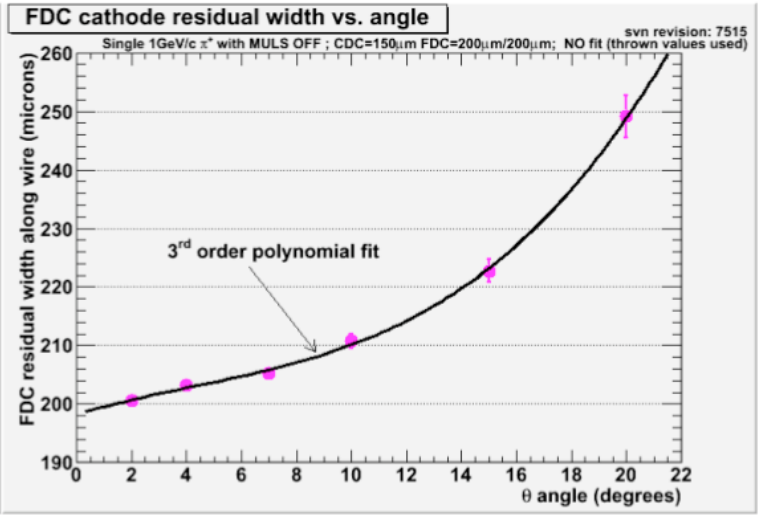
from Jan. 21st …

Angular dependence of FDC residual width along wire

The width of the residual distribution for distance along the wire (from cathode reconstruction) has a dependence on the incident angle.

This dependence was determined as a function of the thrown θ angle of the track by fitting a 3rd order polynomial. The results of the fit were used to determine the error on the measurement along the wires for the FDC as a function of thrown θ.





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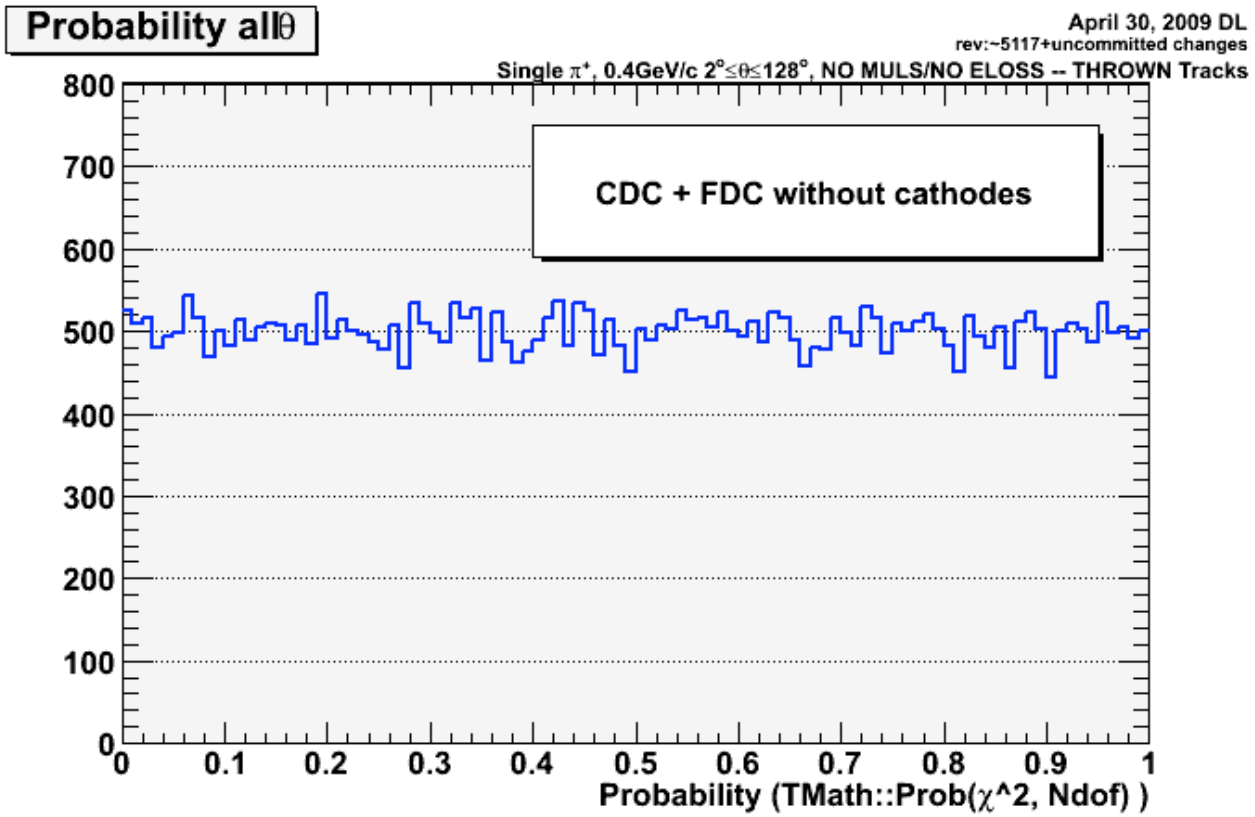
χ^2 probability for CDC and FDC for all θ



- Single tracks
- Multiple scattering OFF
- Energy loss OFF
- Secondaries OFF
- Position Smearing ON
- Thrown track (no fit)

Summary

- Tracking efficiencies from wire-based fits seem to be in pretty good shape
- Efficiencies for time-based fits (not shown) are looking good, but only with truth info used for LR choice
- Wire positions are exactly where they should be
- Tracking is running much slower and optimization for speed will need to be done before any more significant development
- Next steps:
  - Improve speed of ALT1 fitter
  - Complete efficiency optimization for time-based tracks
  - Implement LR decision algorithm so no truth information is used
  - Backgrounds, multiple tracks, …
  - None of this will likely start before June