Update on Tracking Efficiency Studies

Michael Young UCSC

July 1, 2005

Where we left off

- Many questions asked last time (thanks for all the input). Here are three we've focused on:
  - Are we sure reconstructed tracks are correctly being matched with MC truth?
  - Is fitting being done correctly?
  - How trustworthy is that 99.75% efficiency value?

Code Details

- Fitting is turned on by default in VXDBasedReco (N. Sinev) so results last time did include track fitting. (The fitter is declared explicitly now to prevent further confusion).
- Full CCD simulation is not - studies with it will be forthcoming in the next week or so.

- getMCParticle() method tells us which track is reconstructed from which MC truth particle.
- How it matches hits found on the track with hits from the MC truth particle still remains a mystery since this method is all but undocumented, and all attempts at finding the source code defining it have failed.
- Regardless, the fit success can be determined using other LCD methods, and brute force calculation (eventually what we opted for).

Recall: The Events

- $e^+ e^- \rightarrow$ qqbar (uds only)
- 10,000 events at 500 GeV CME
- No beam- or bremsstrahlung
- 80% electron polarization
- ILC500 configuration

For now, we focus only on the 5 layer geometry

Central region is strictly enforced for jet thrust axis and individual MC truth particles: $\cos(\theta) < 0.5$

Two-jet events only: thrust axis magnitude > 0.94

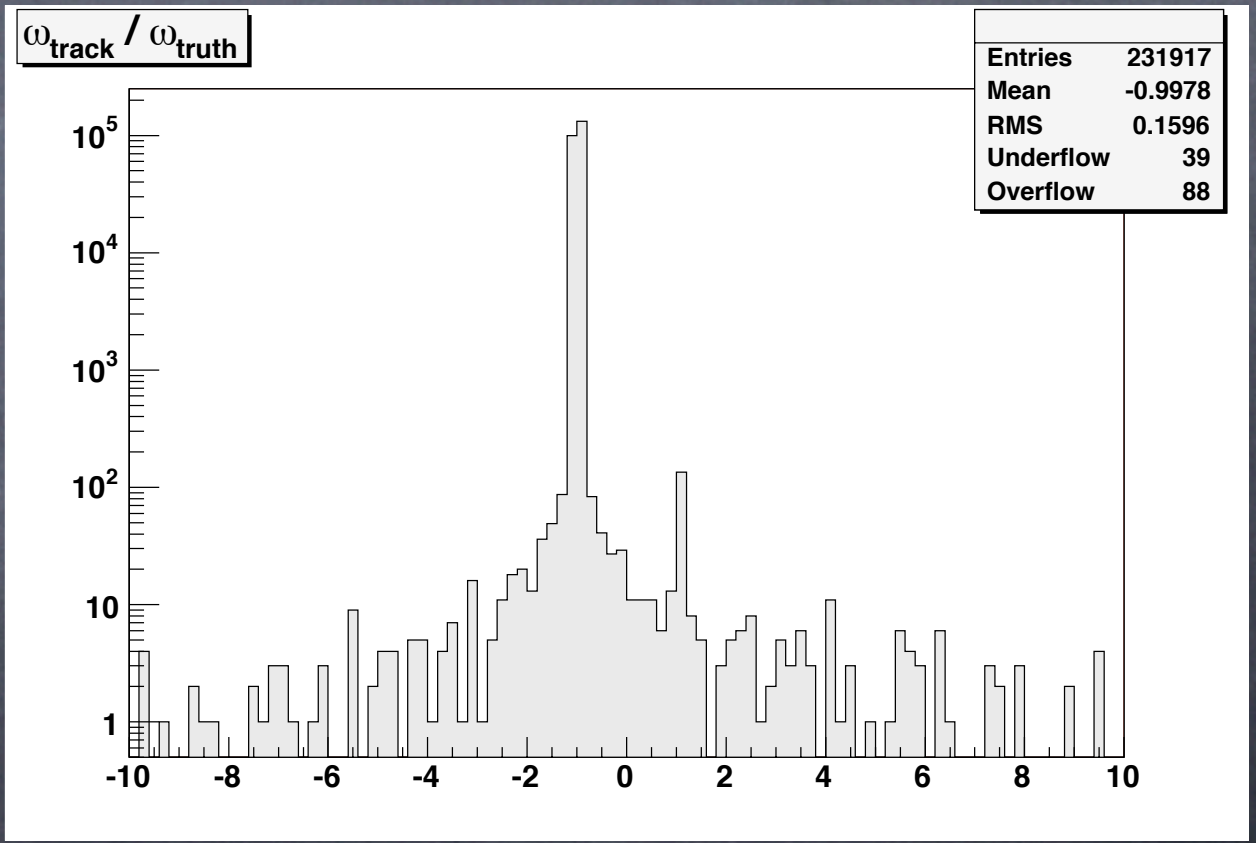
Maximum radial origin = 1 cm

Exploring Fitting

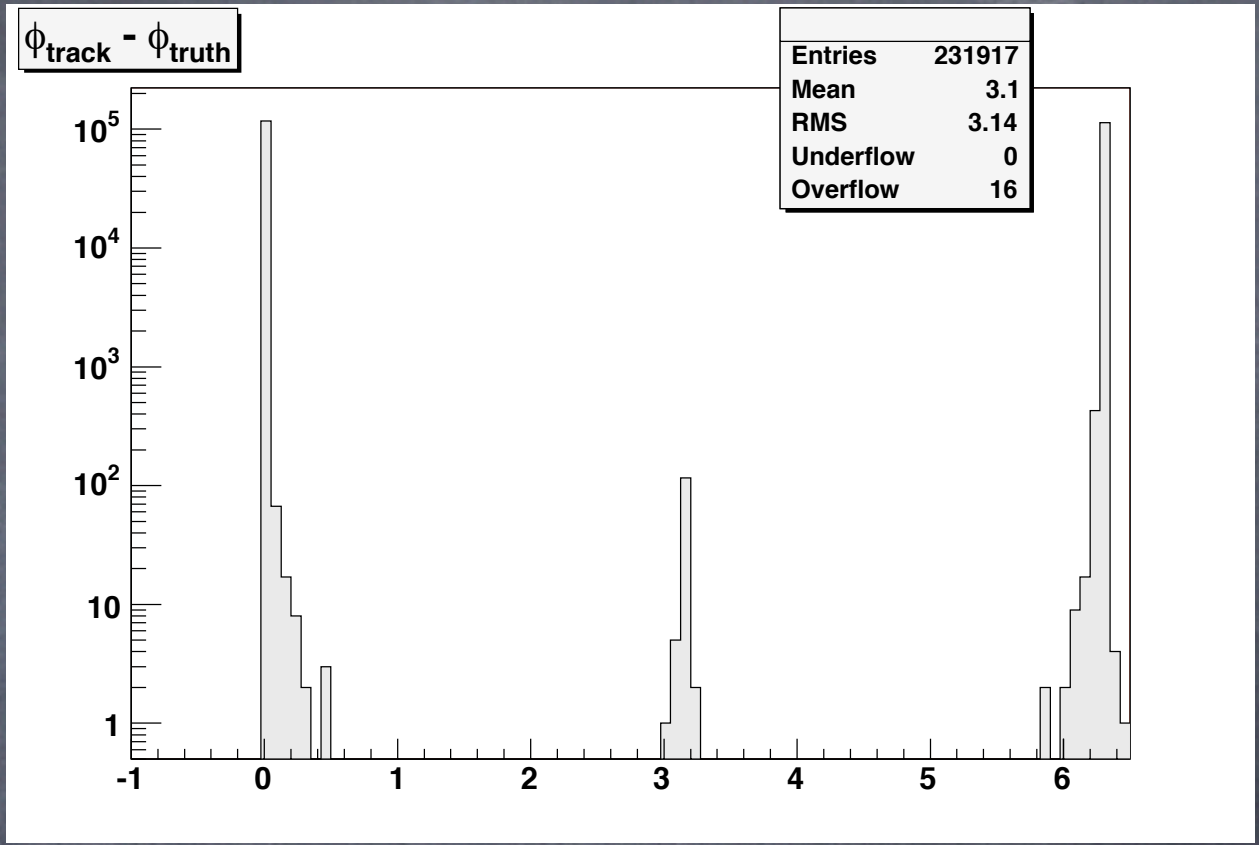
- We now ask how close are the track parameters to the respective MC truth values between a reconstructed track, and the MC particle it's matched to.
  - Curvature: $\omega = 0.015/pT$
  - Φ
  - $\tan(\lambda)$, where λ is the dip angle.
- The "track" values minus the "truth" values are then scaled by the square-root of the appropriate error matrix element.

A couple stumbling blocks...

- As it turns out, there is a sign mismatch in the code somewhere that flips the sign of ω between the track and the MC truth particle.



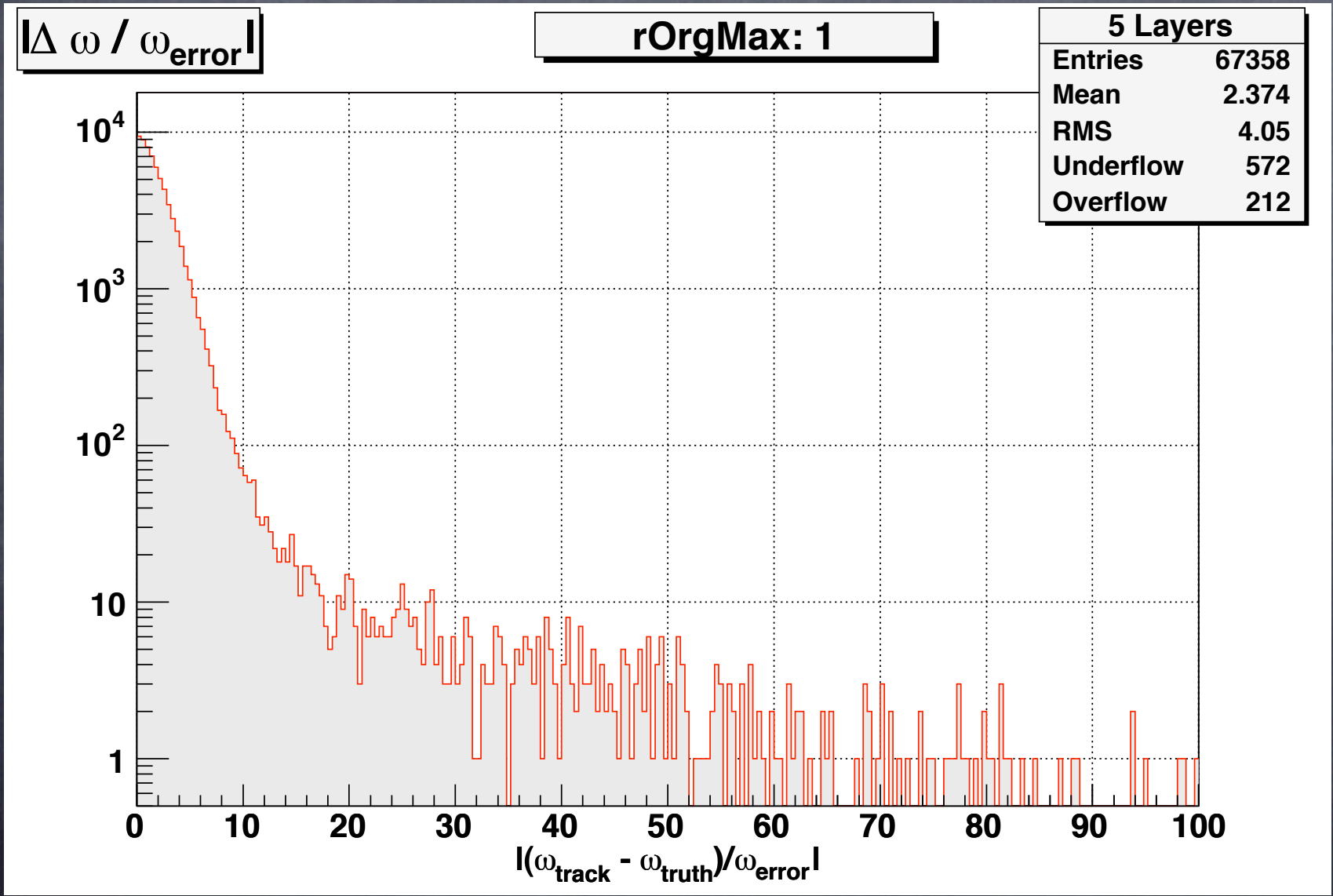
- Also, it appears Φ is calculated slightly differently for the track and the MC truth particle.



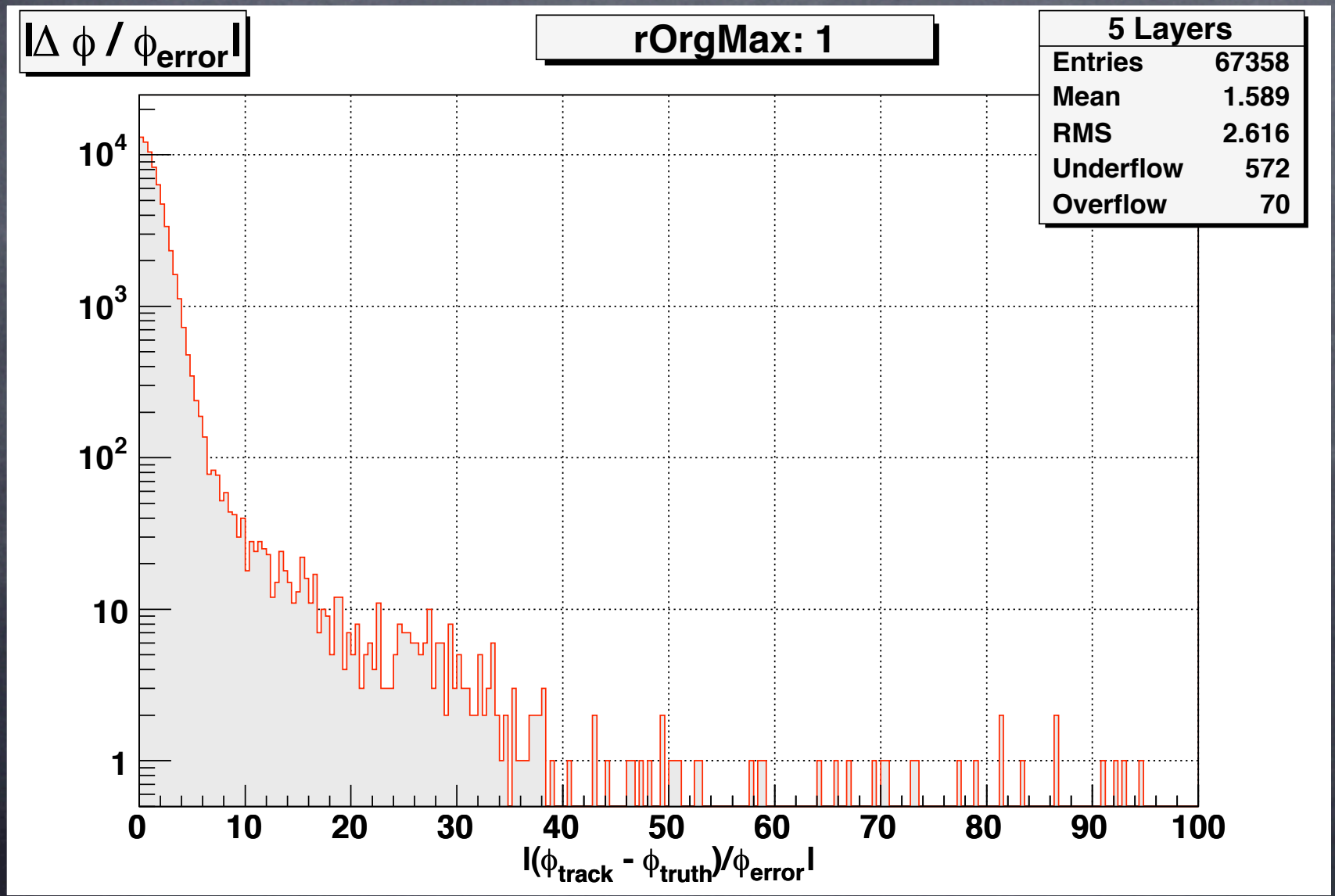
Both of these issues are now corrected manually in the tracking efficiency code.

On to the results:

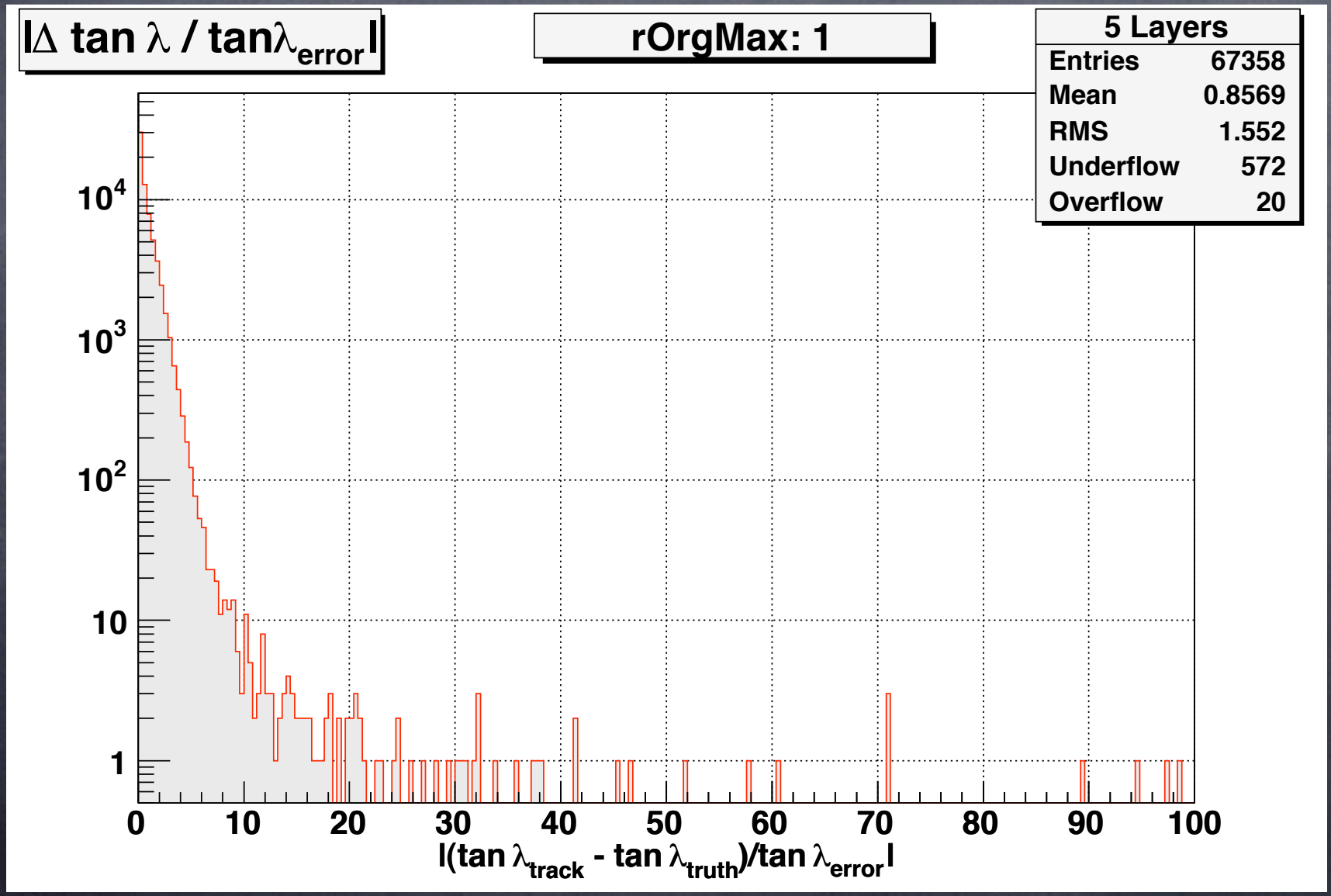
ω residual scaled to √(ω error matrix element)



Φ residual scaled to √(Φ error matrix element)

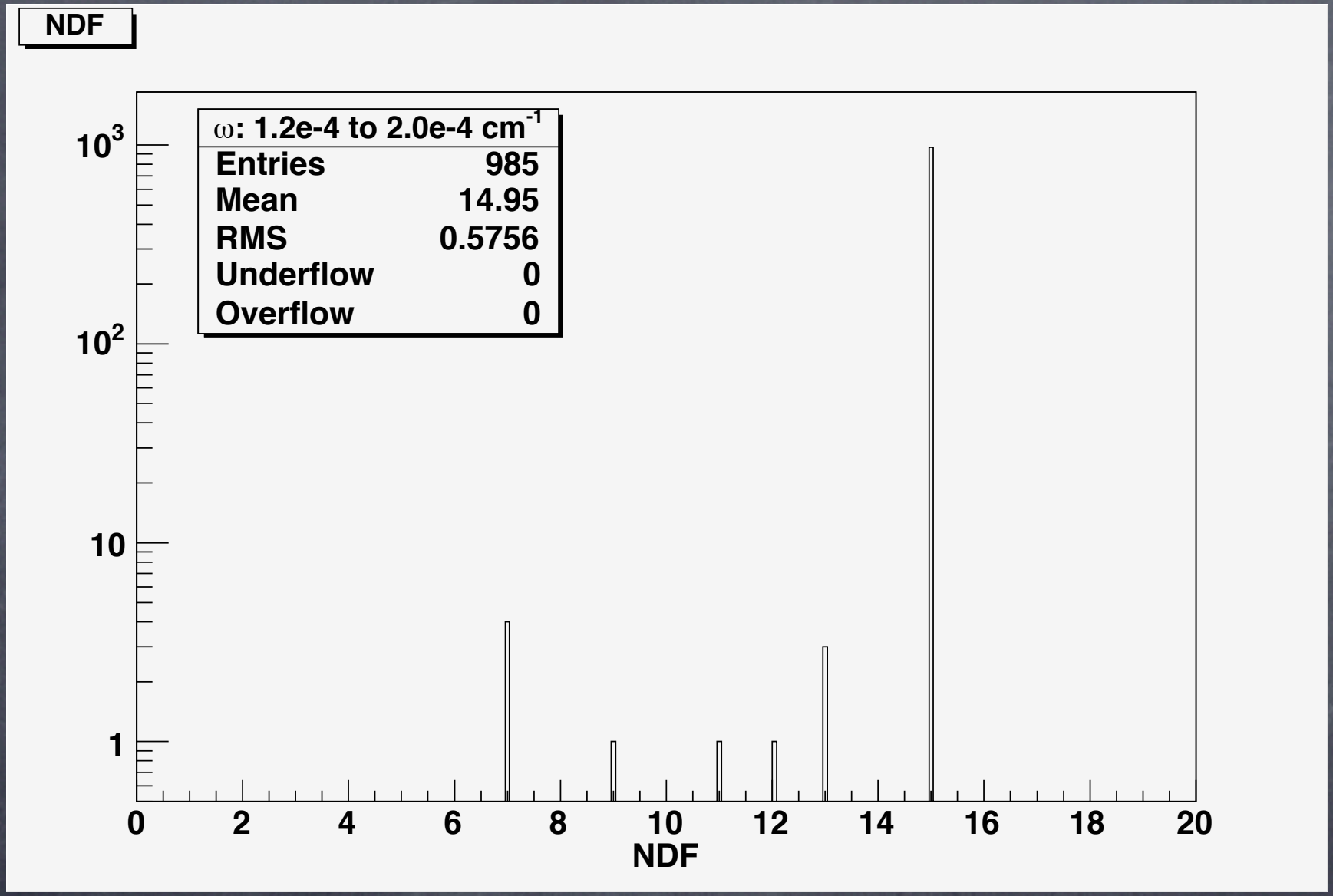


tan(λ) residual scaled to √(tan(λ) error matrix element)



Something fishy with the track parameters...

- Consider the χ^2 and number of degrees of freedom for the track fitting...
  - NDF reflects number of layers (5 vertex and 10 central tracking layers)
  - Why 10 layers present in the central tracker? (Double sided?)

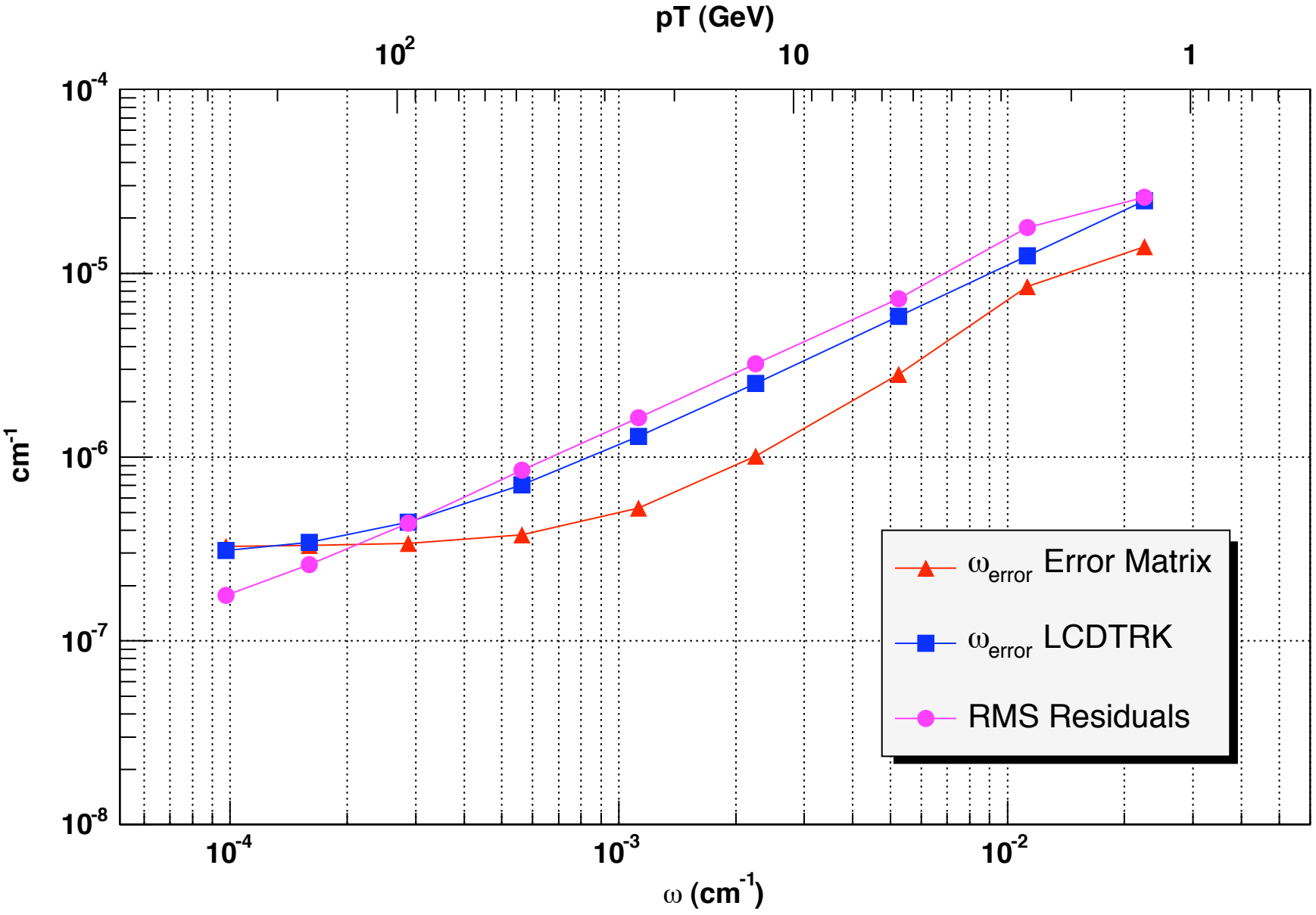


We are motivated to cut on events for which there are all 15 degrees of freedom.

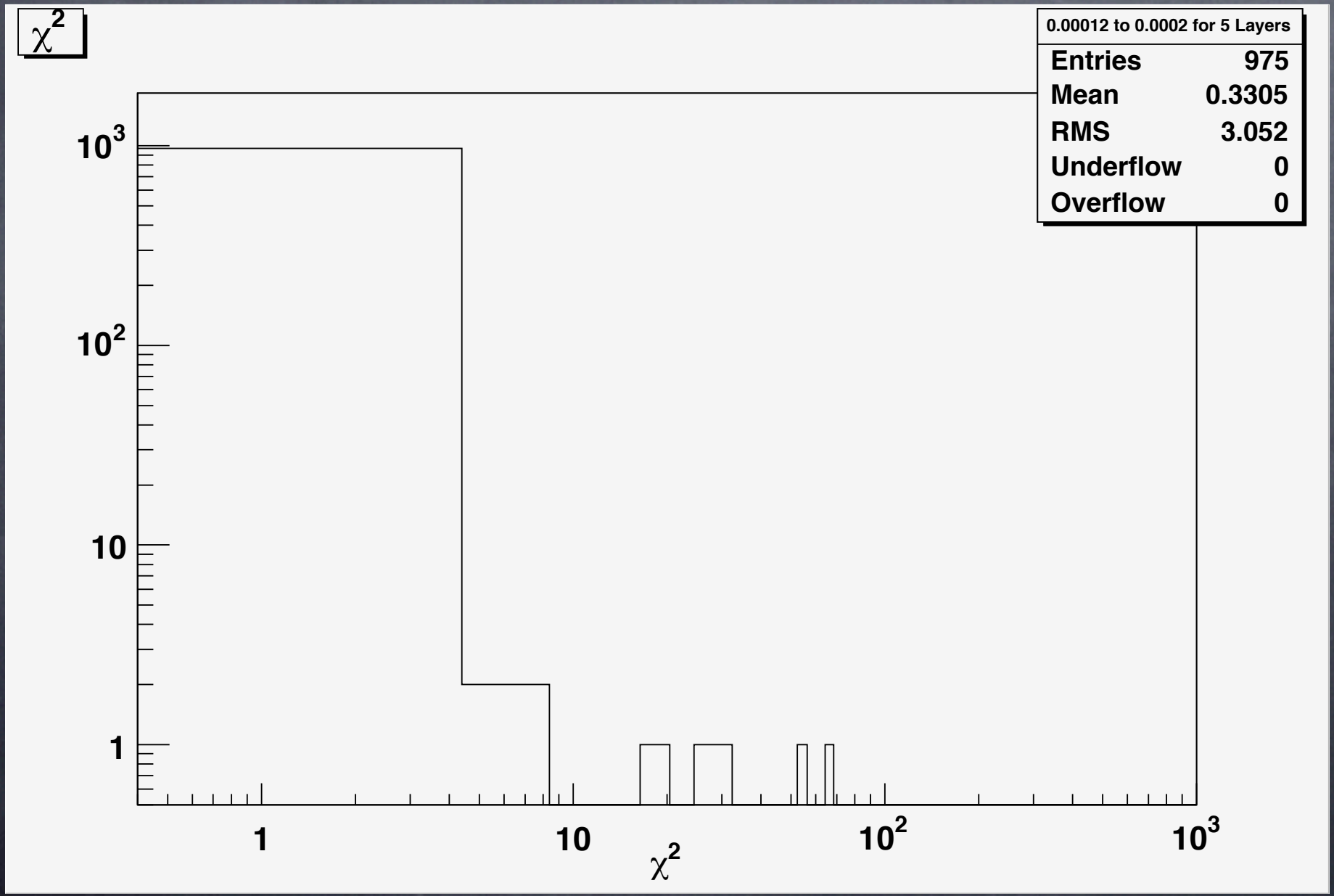
Measuring the error in ω

- Plot the square-root of the curvature matrix element along with the RMS of the curvature residual, and the predicted error from LCDTRK (B. Schumm) as a function of curvature.
  - Residual fitting done in bins of curvature corresponding to pT ranging from 0.5 to 200 GeV
  - LCDTRK values averaged over $\cos(\theta) = 0$ to 0.5

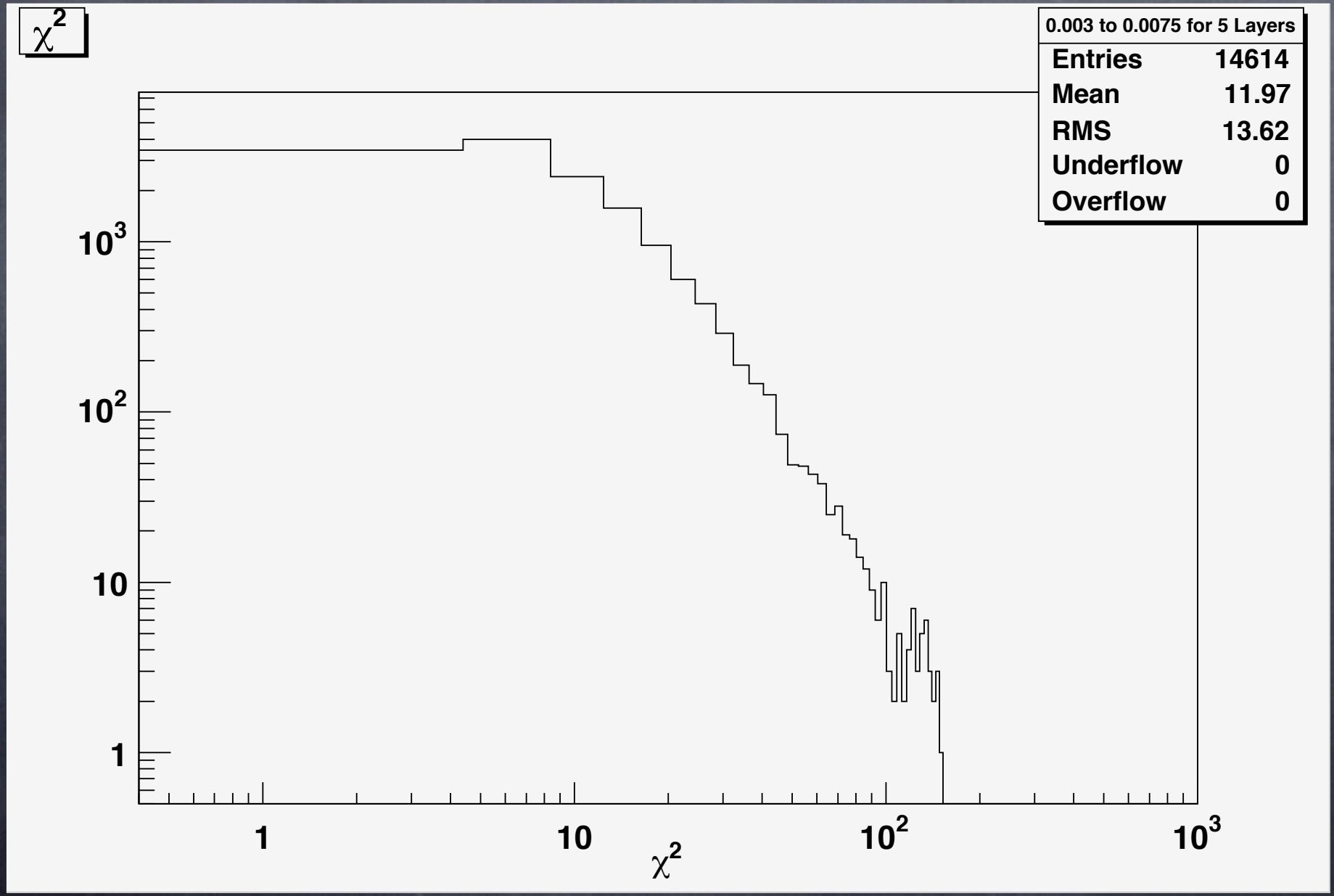
Cut on 15 Degrees of Freedom



High pT:


χ^2
0.00012 to 0.0002 for 5 Layers
Entries 975
Mean 0.3305
RMS 3.052
Underflow 0
Overflow 0
10^3
10^2
10
1
1
10
10^2
10^3
χ^2

Low pT:


χ^2
0.003 to 0.0075 for 5 Layers
Entries 14614
Mean 11.97
RMS 13.62
Underflow 0
Overflow 0
10^3
10^2
10
1
1
10
10^2
10^3
χ^2

Further Questions

- What's going on with the track fit?
- Information about the ECAL entrance
- Effects of turning on the full CCD simulation.
- Longer-term: Outside in tracking.