HPS Tracking Simulation & Reconstruction

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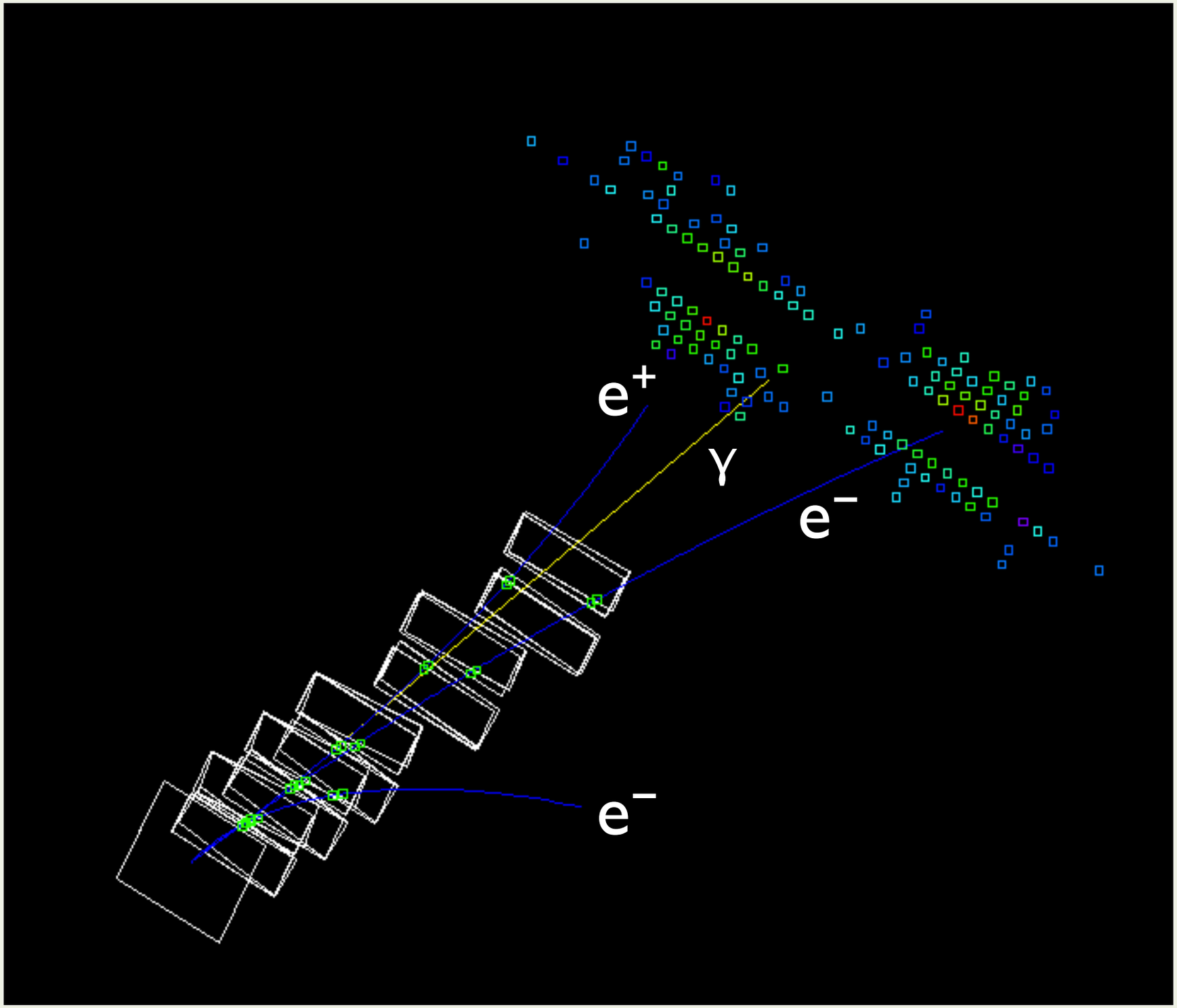
Tracking Simulation

- We use the GEANT4 based slic framework to simulate events
  - signal and trident background events are simulated using MadGraph
  - beam is generated by passing "beam electrons" through target/detector using GEANT single particle gun

Tracker Simulation



Tracking Simulation

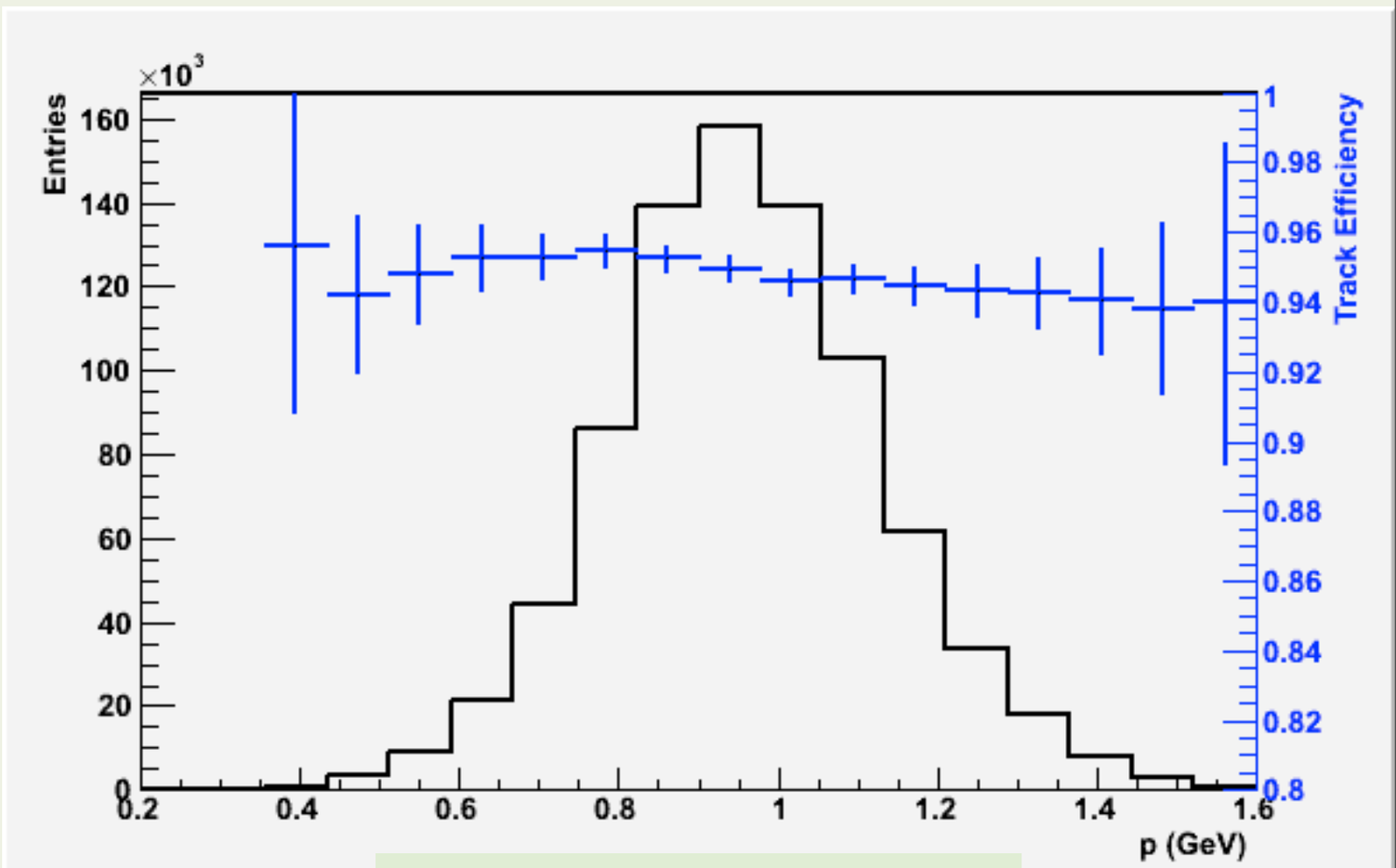
- We use the GEANT4 based slic framework to simulate events
  - signal and trident background events are simulated using MadGraph
  - beam is generated by passing "beam electrons" through target/detector using GEANT single particle gun
- We then use lcsim (+ hps-java) to:
  - take GEANT energy deposits in Si and convert to charge collected on Si strips
  - simulate the response of the readout chip to that charge (not quite complete yet...still need to implement time response of APV25)
  - make clusters, reconstruct tracks, vertex

Setup & track efficiency

Everything I'll show is:

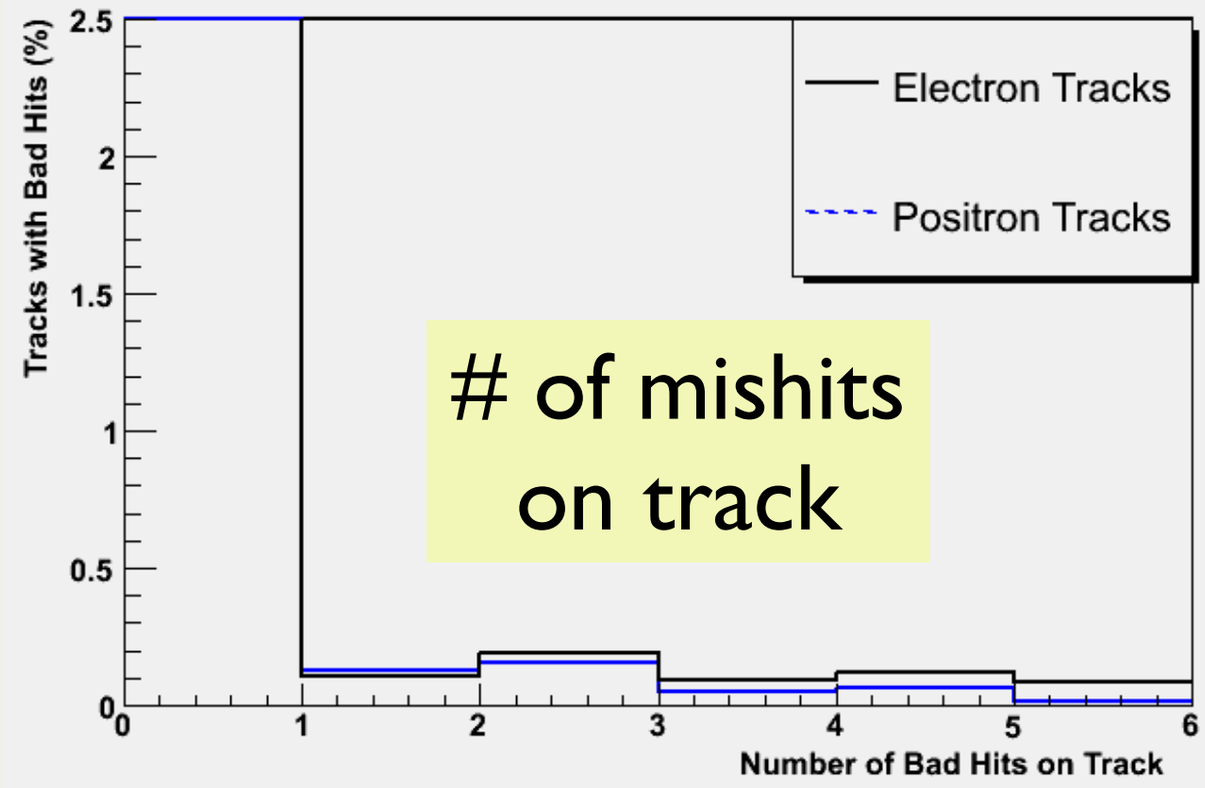
- *2.2GeV, 200nA beam*
- *beam spot=20μ × 200μ*
- *integrated over 7.5ns*
- *X_0=0.125% W target*
- *B=0.5T (uniform)*

For the test detector, require hits in all 10 layers to recon. track



We can find tracks!

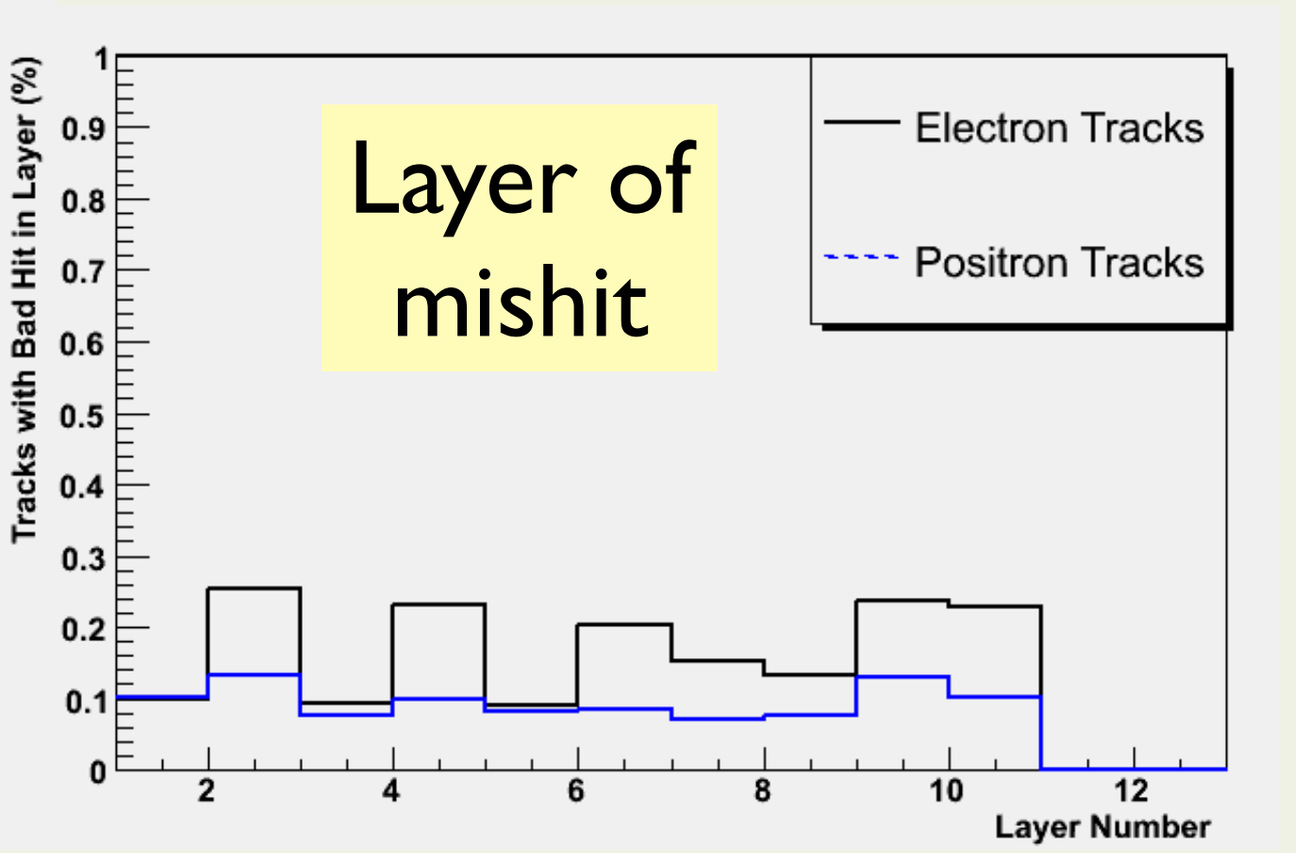
Mis-assigned hits on tracks



# of mishits on track

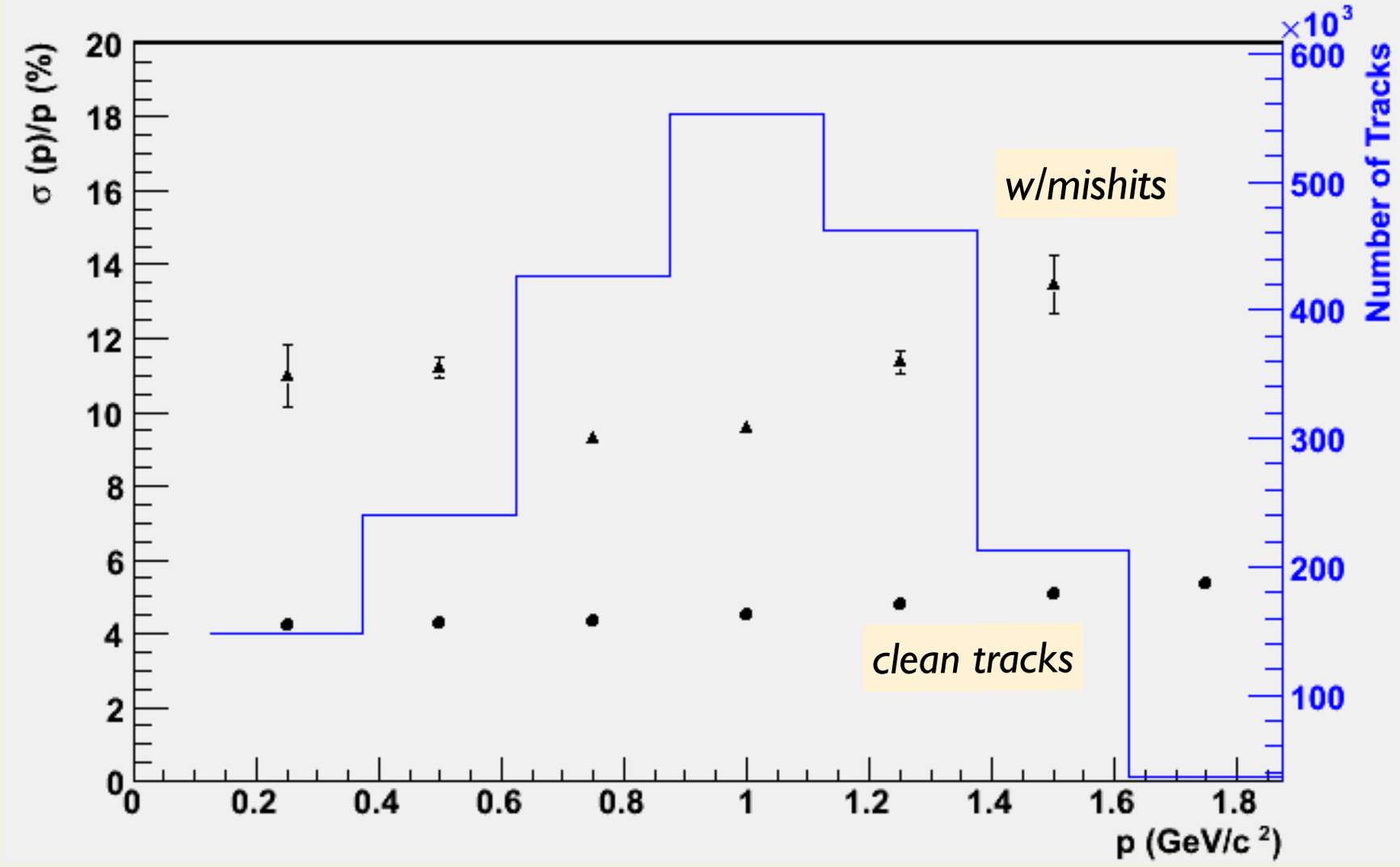
By most measures, tracks are very pure... <1% of all tracks have mishit

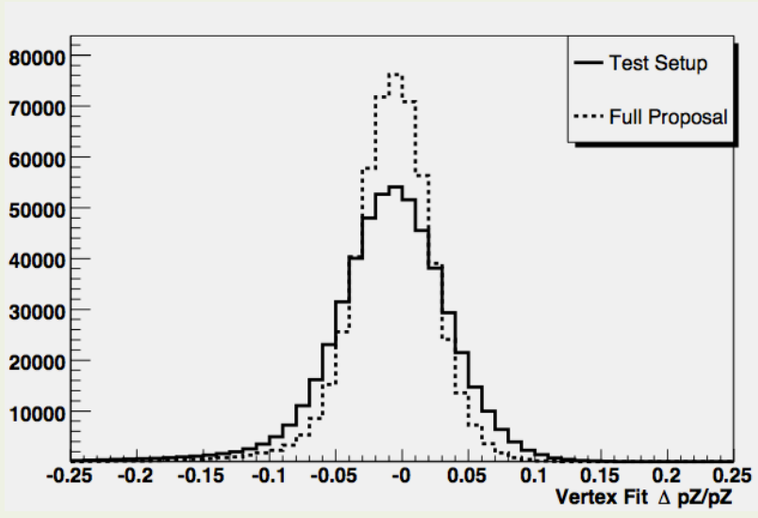
the layer of the mishit spread through tracker...different from full detector where mishits mostly in layer #1



Layer of mishit

Momentum resolution





➪momentum res ~ 4%

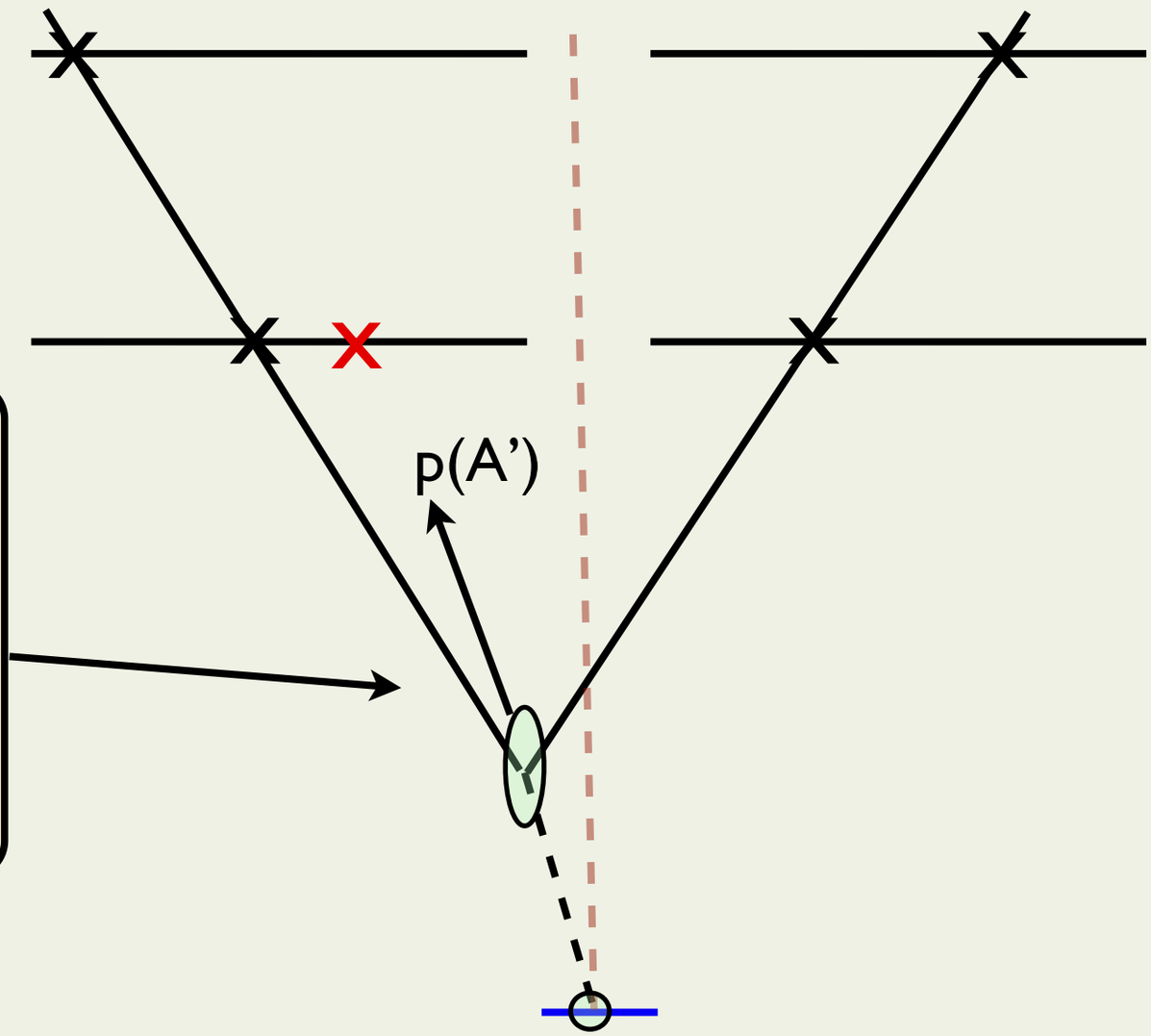
...as expected, worse than in full detector

Vertexing

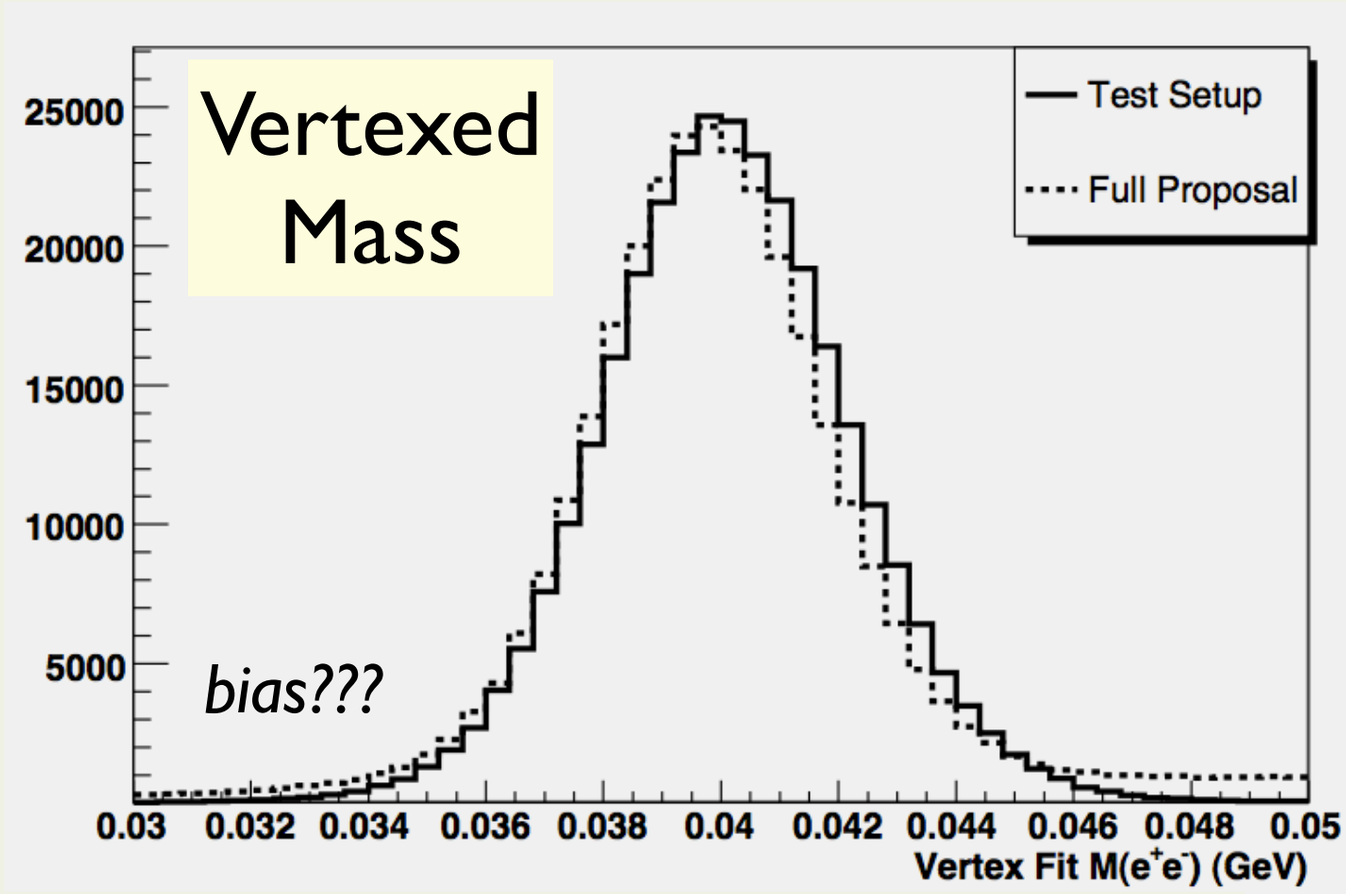
- All oppositely charged tracks combined to form an A' candidate

- Use the measured track parameters to create a vertex where the A´ candidate is constrained to point back to the beamspot (*A´ constrained*)

- Also perform a fit where the vertex is constrained to originate from the beamspot at the target (*BS constrained*)

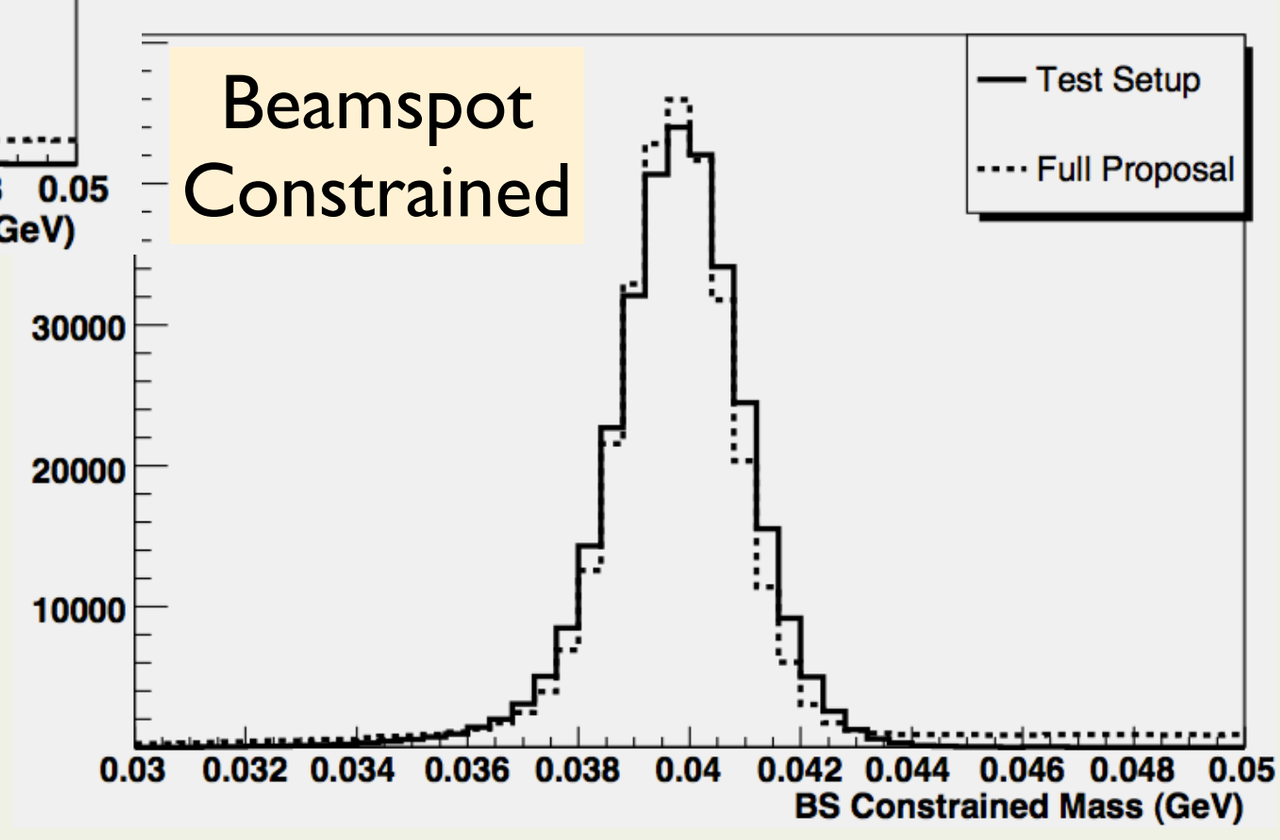


Mass Resolution

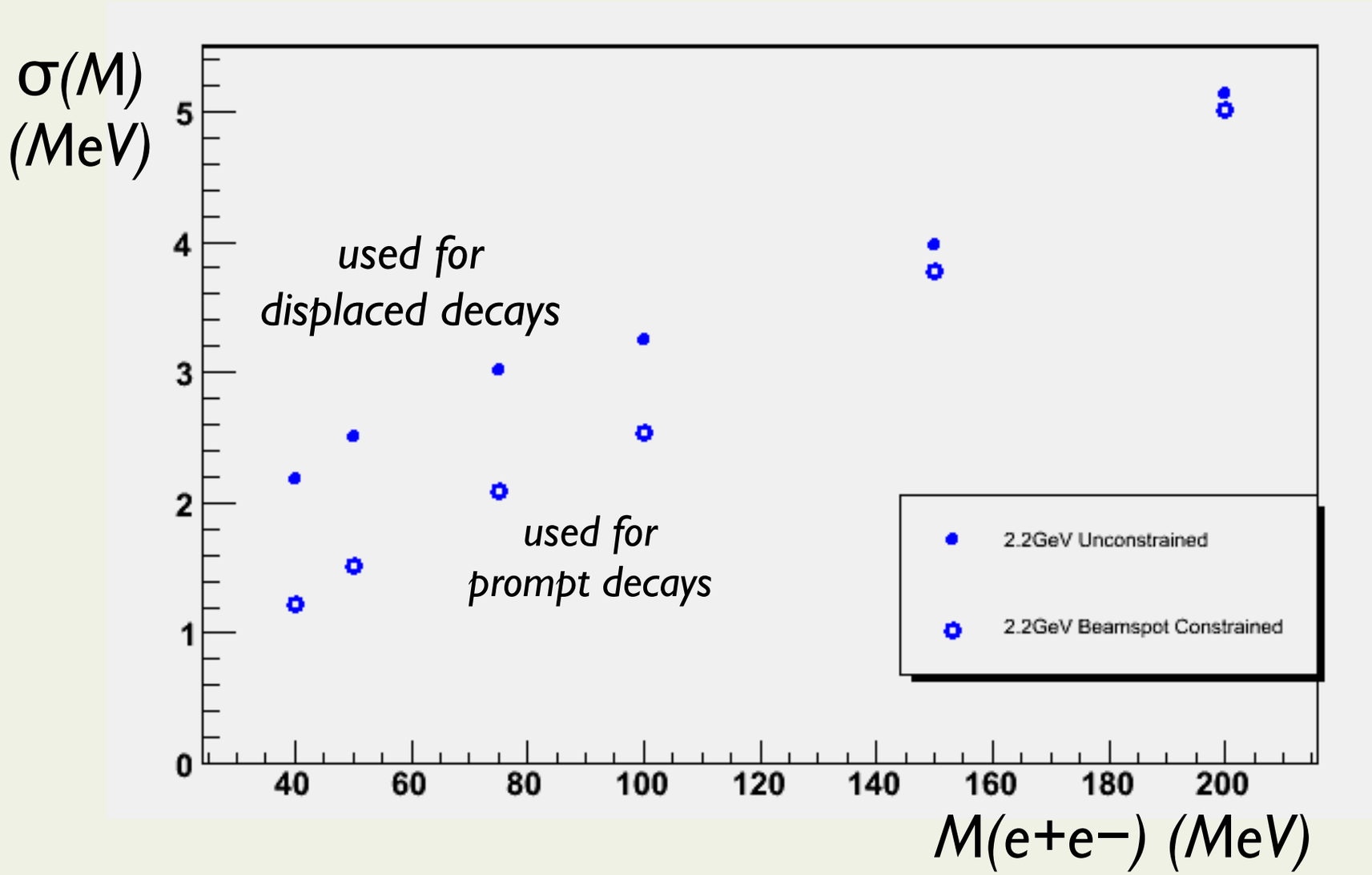


...but the mass resolution is comparable between test & full detectors...mainly depends on angular resolution.

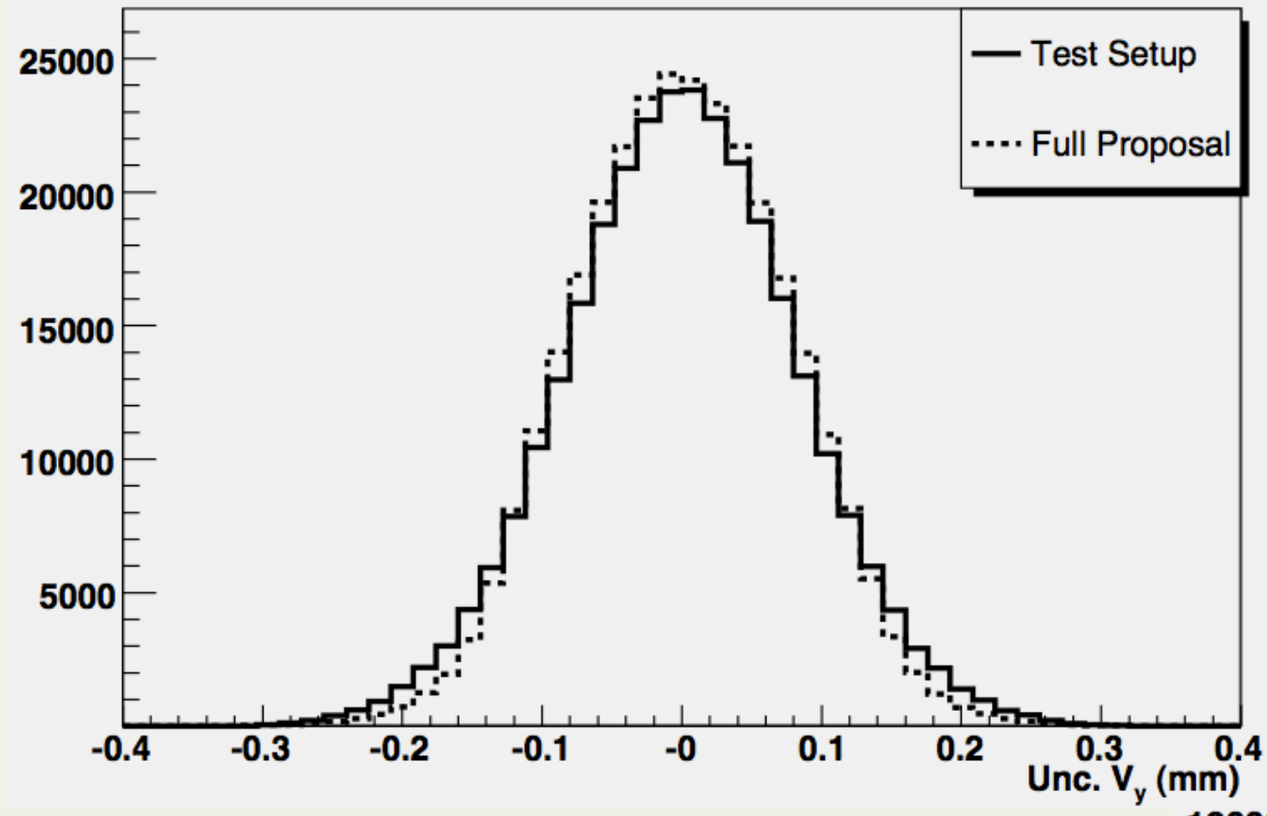
Even constraining to (larger) beamspot, resolution ~same... decays are almost completely vertical.



Mass resolution vs mass

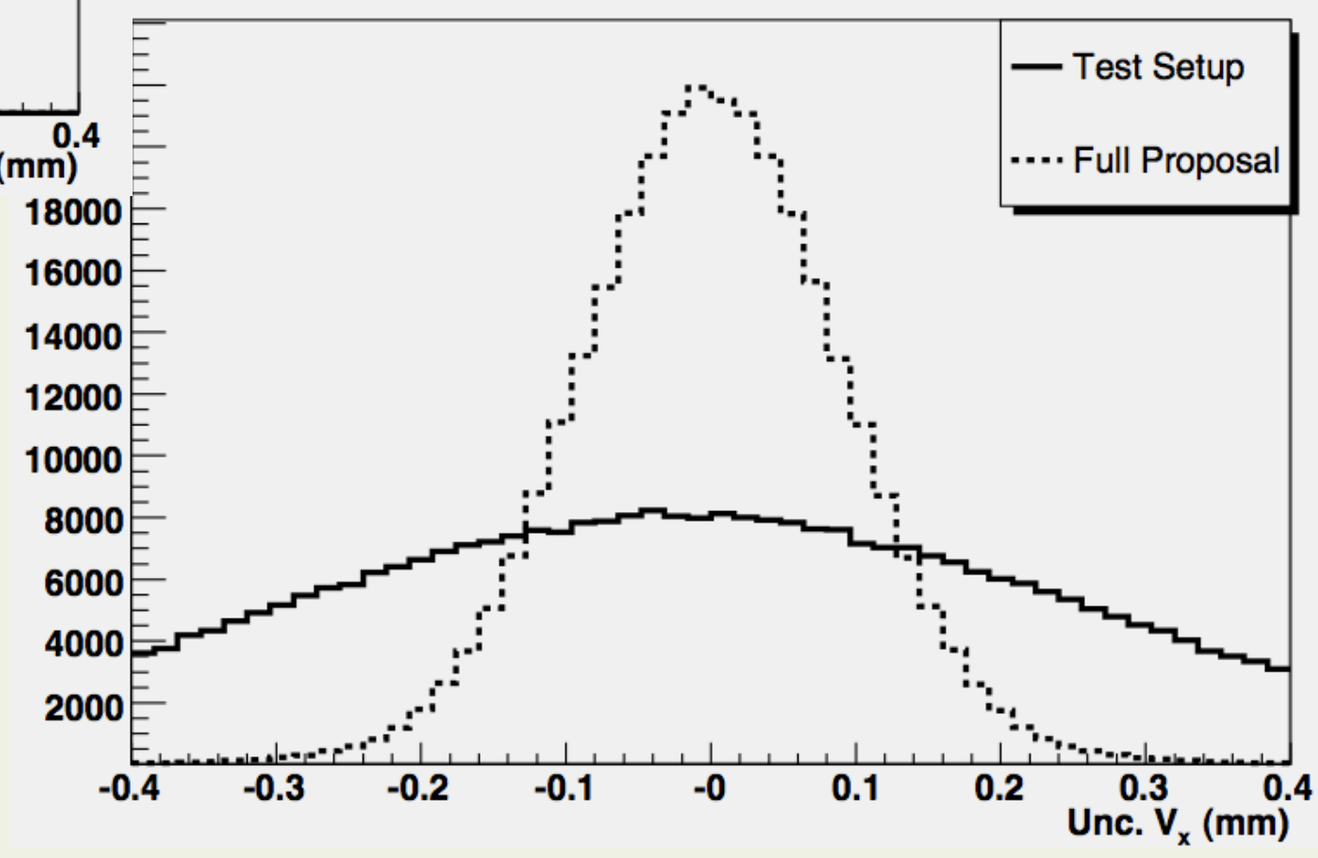


Vertex position resolutions

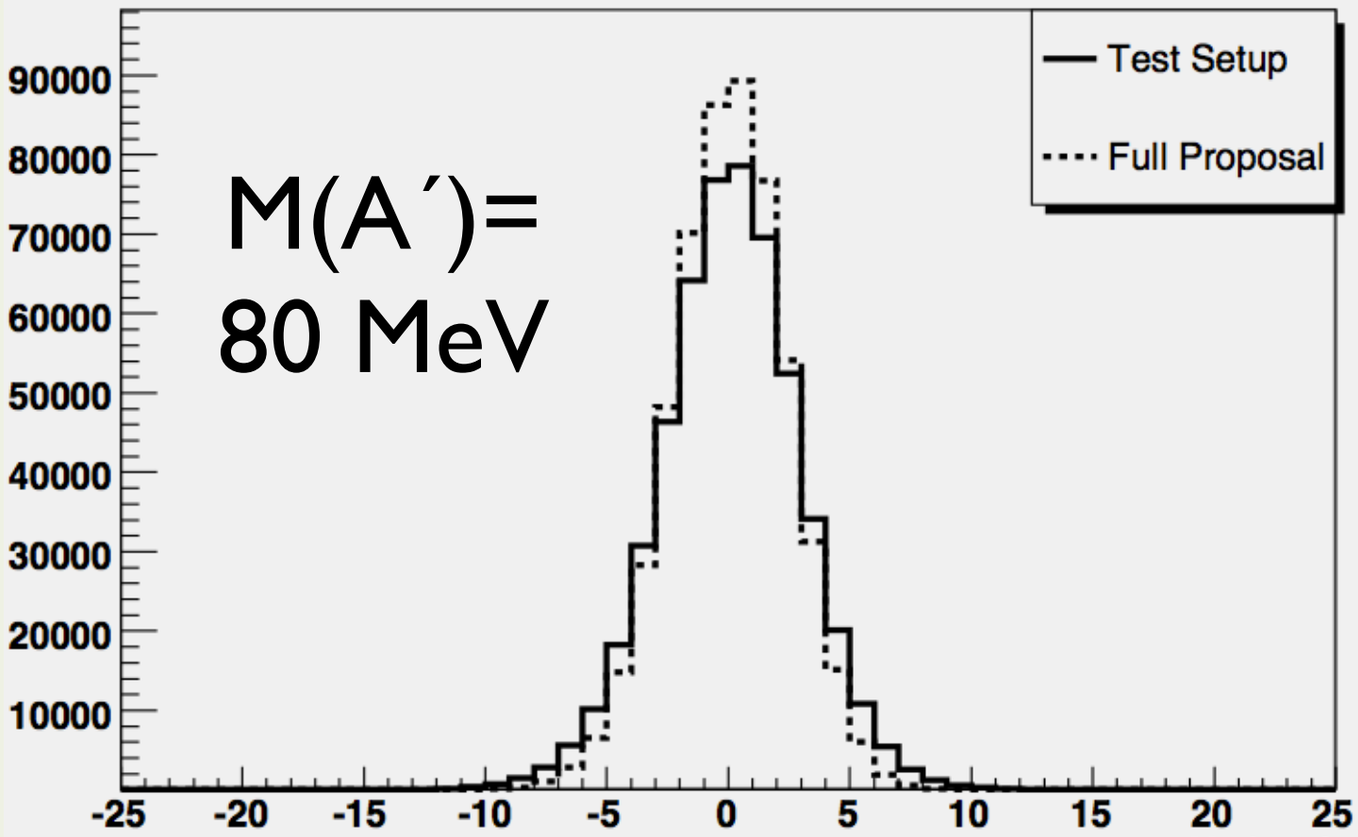


Resolution of the vertex position ~ same in the non-bend direction...

...but much worse in bend direction .

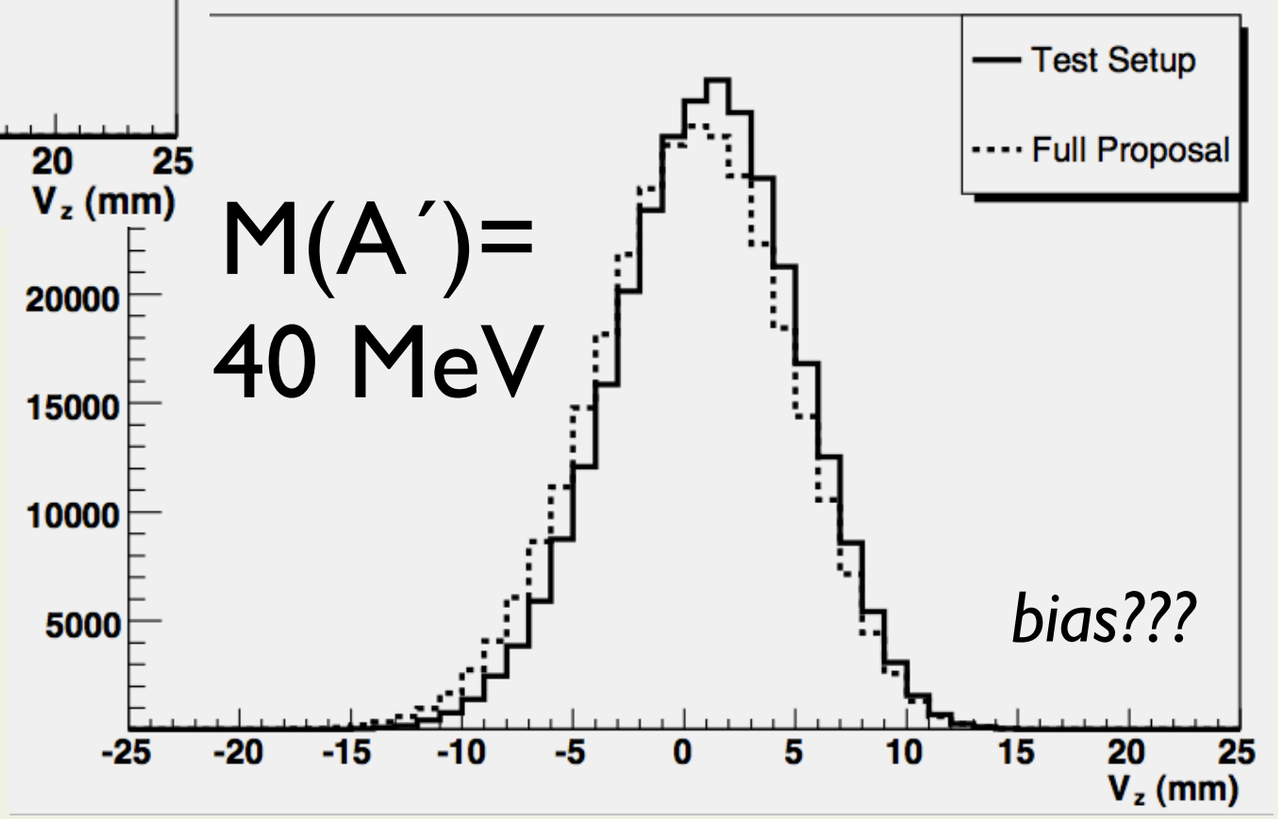


Decay length resolutions

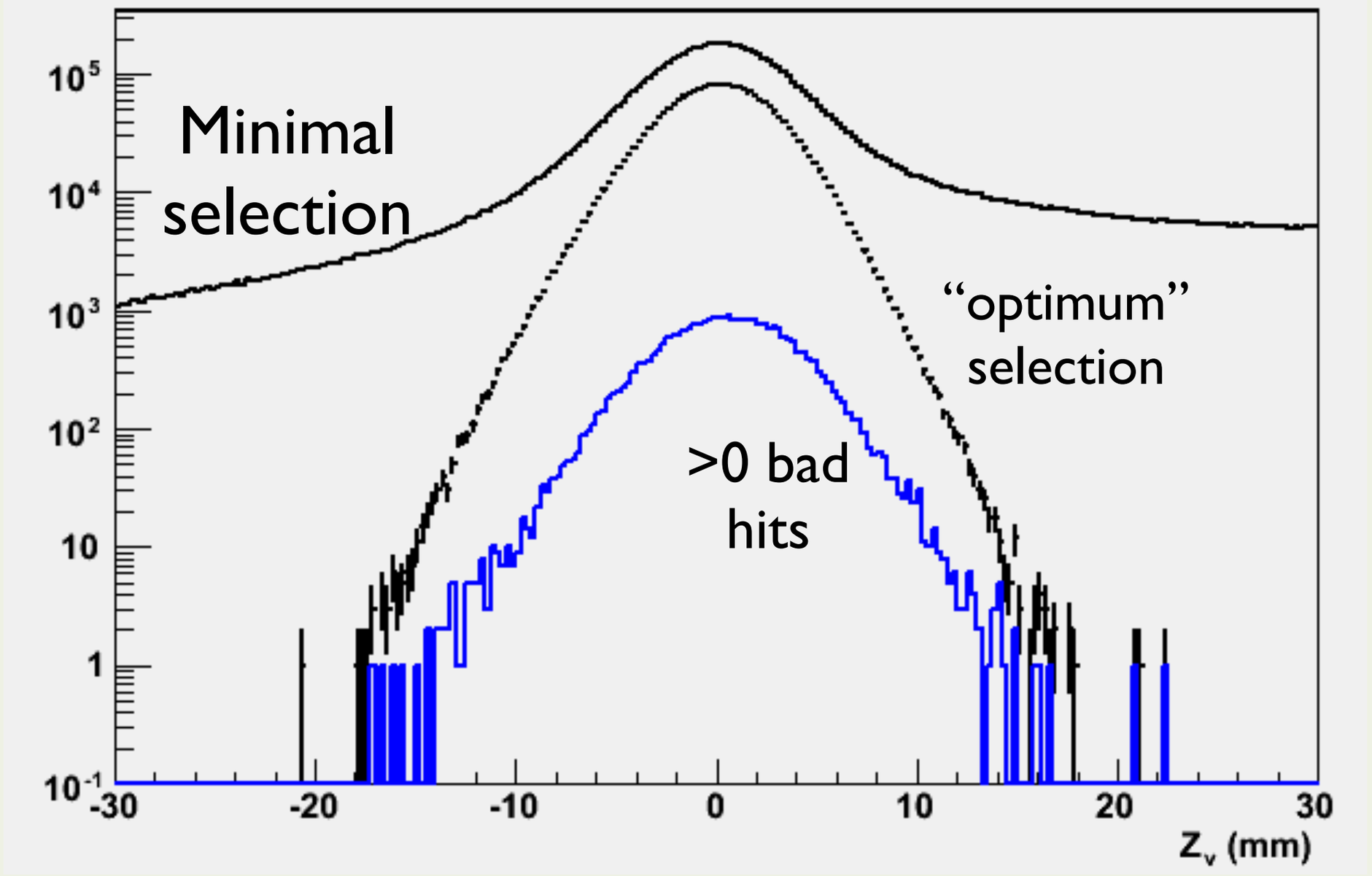


Z-resolutions are somewhat worse than in dedicated detector...particularly for higher masses

these plots don't include it, *but*...can be improved by selecting very vertical decays (better yet, use DPN dependent resolution)

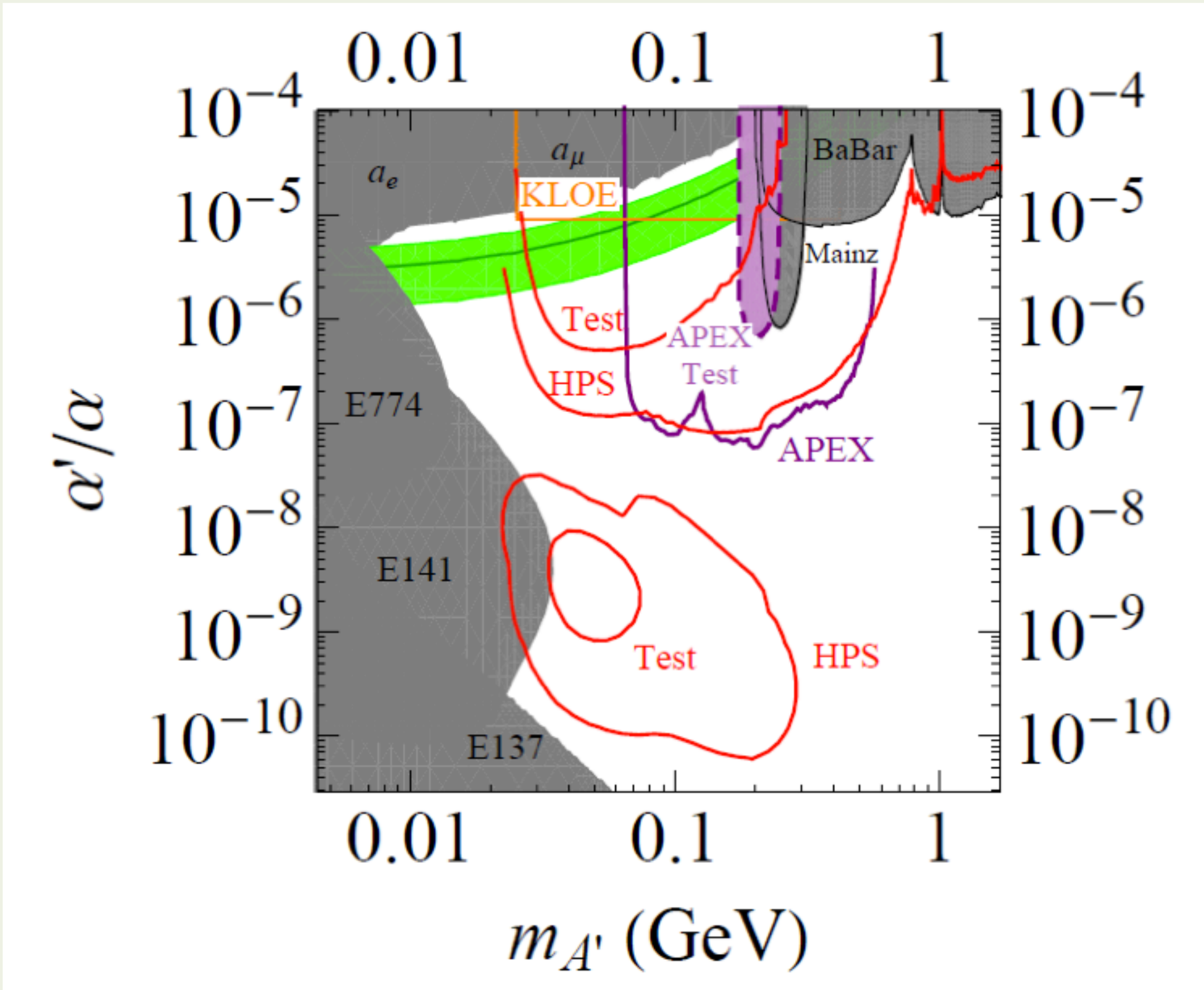


Decay length resolutions



...just a log-scale plot of 80MeV from last page.
Tails are "enriched" in tracks with bad hits...s

Obligatory reach plot



Conclusions

- Simulation tools are in good shape; still need:
  - include correct time structure to event
  - include sampling for APV25 the chip readout
  - magnet and other dead material
- Studies still to be done:
  - estimate the effects of misalignment
  - ...or non-uniform B-field...
- Much to be done to improve the tracking performance
  - I've just included some very simple/crude cuts...we can do better!
- Test run will be vital in order to verify that we understand the tails in the decay length distribution