Vertex reconstruction and fill vertex analysis.

Vertex reconstruction.

- Problems with MWPC make necessary to measure the particle position using other methods.

- We have used a fast clustering/fit approach to obtain the particle impact point in the PMT matrix.

- In principle to use the reconstructed vertex in this way biases the velocity reconstruction.

- Fortunately the beam width is small enough to use a fill vertex for each run.

- In addition the vertex reconstruction allows to obtain the matrix rotation angle.

Algorithm: zero angle case

- Take an initial center x0: For the first iteration use the hit with largest number of photoelectrons.

- Fill an 1 cm bin histogram with the distance of all the hits to this center, normalize it and set to zero any bin with an occupancy lower than 5%.

- Look for the rightmost (higher radius) local maximum in the histogram.

- Extend this bin to left and right up to the first bins with zero entries. The resulting bin is the cluster.

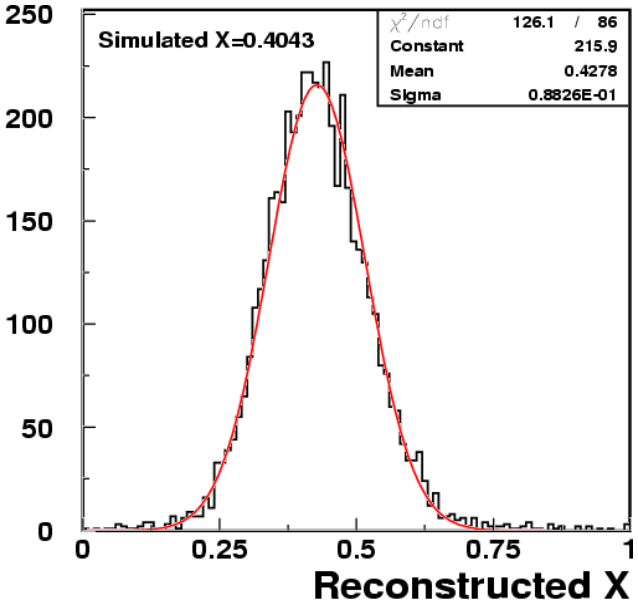
- Take all the hits within this cluster, and use them to (exactly) minimize

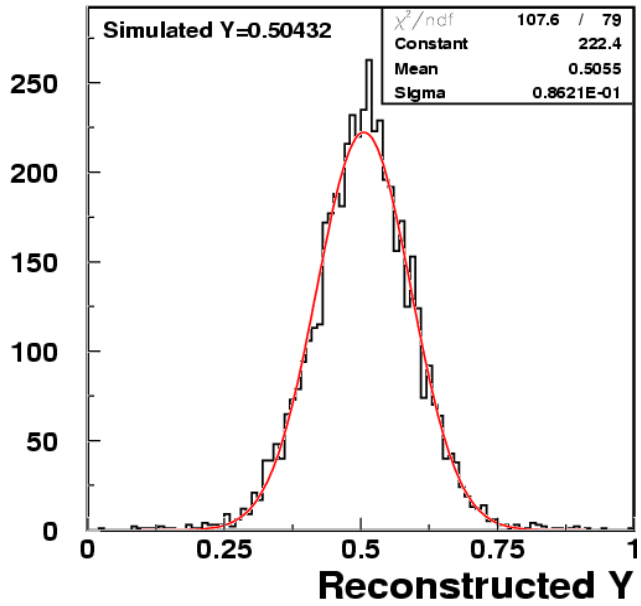
$$F=\sum((x-x0)^2-R^2)$$

respect x0 and R.

- If the new center is close enough to the initial one finish. Otherwise take the new cernter as the initial one go to first point.

Algorithm: zero angle case

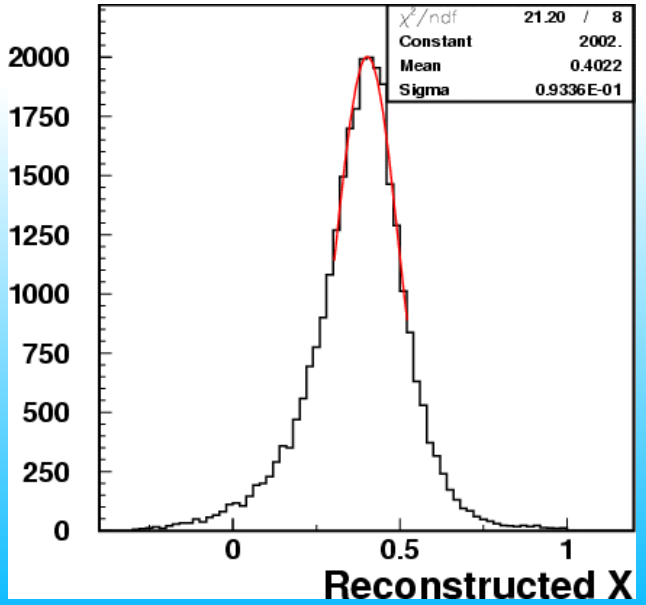


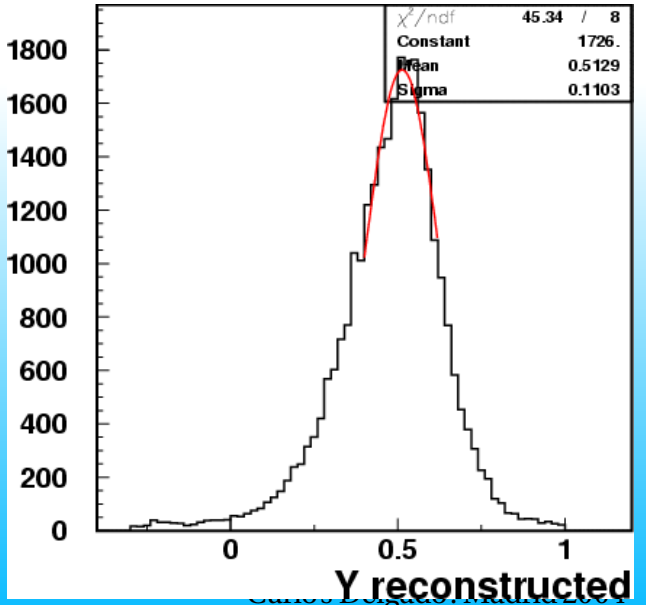


Simulation

Data

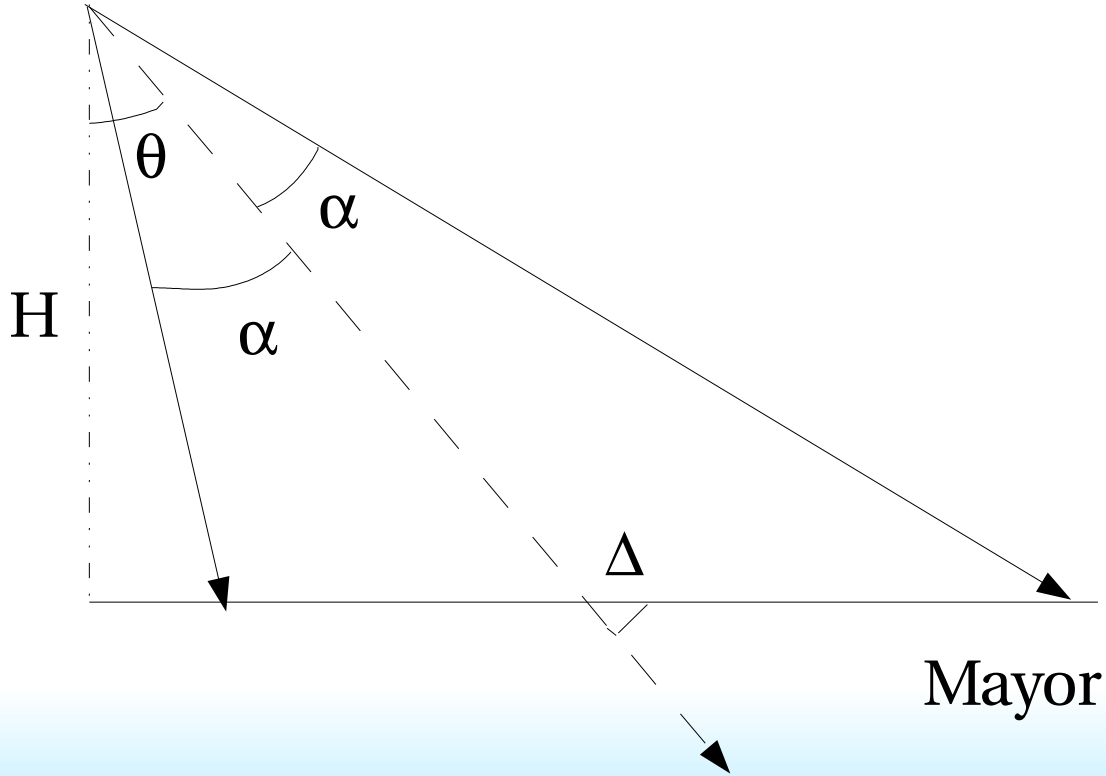
- Tails due to bad reconstruction.
- Resolution compatible withnarrow beam.





Algorithm: non zero angle case

Use the same algorithm, but scale the X and Y axis according to the ellipse semiaxis obtained in the projection of the Cerenkov cone.

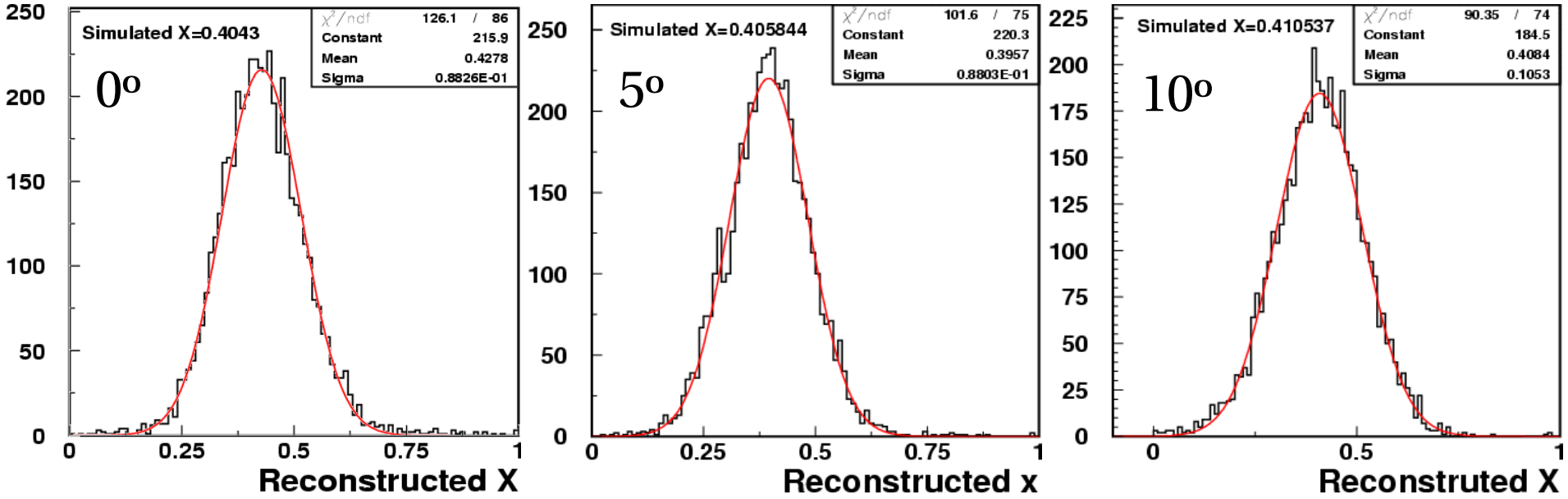


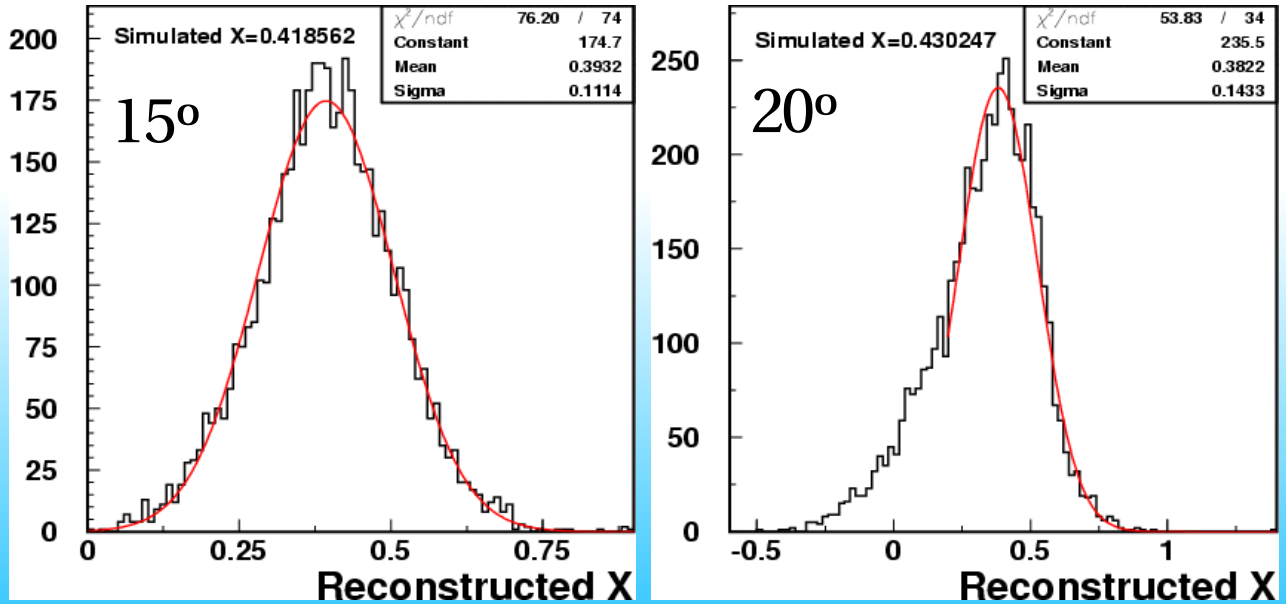
α Cerenkov angle.
θ particle angle.
H – expansion length.
Δ distance from particle impact point to center

Mayor axis=H/2 (tan(θ+α) – tan(θ–α))

- Assume β=1 to compute everything: systematic for large θ.
- Use approximations to deal with different refracted angles and optical path within radiator.
- Finally obtain Mayor axis, Minor axis and Δ.

Algorithm: non zero angle case

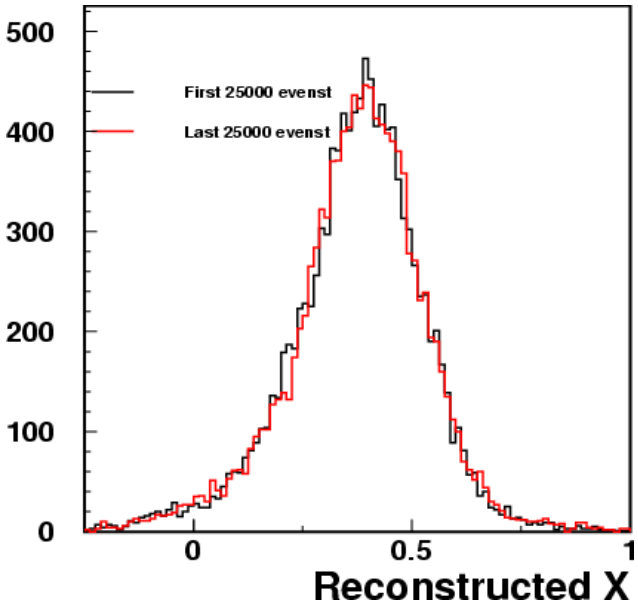




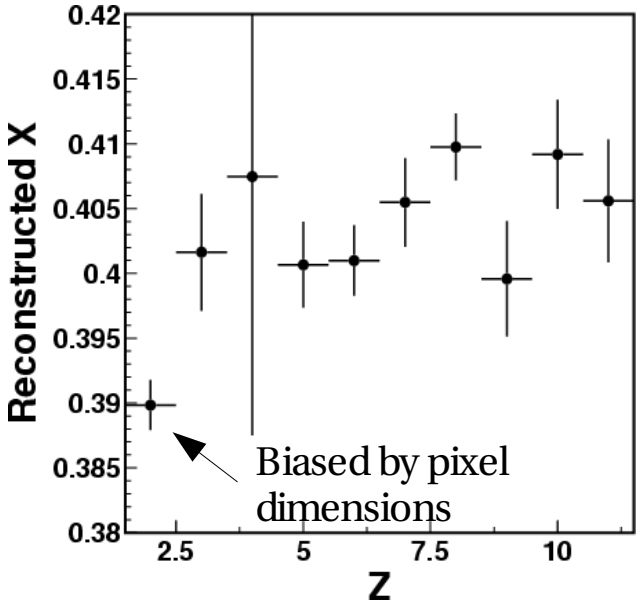
- Resolution degradates with angle.
- Bias is ~3 times smaller than resolution.
- The distribution is not gaussian for high enough angle.

Stability

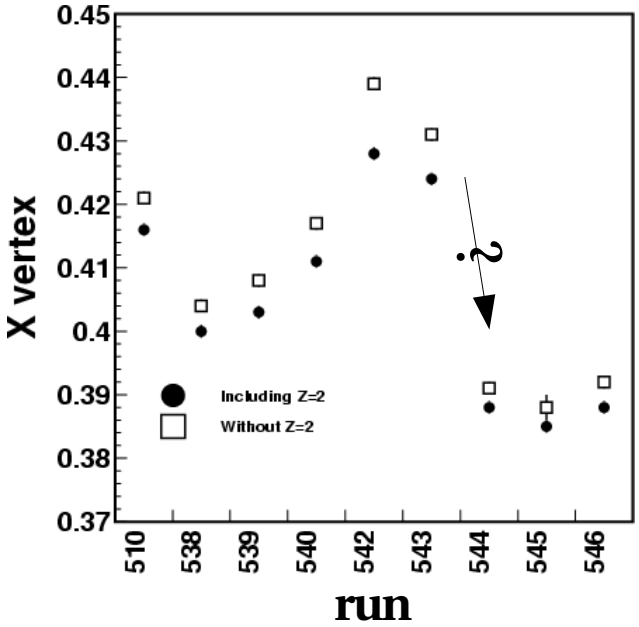
Within a run the reconstructed vertex is stable.



Small, but not zero, dependence with Z (another systematic).



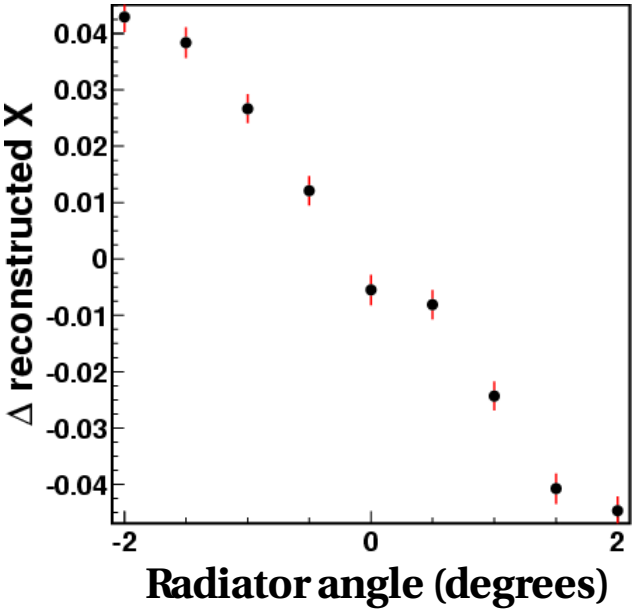
Clear run dependence.



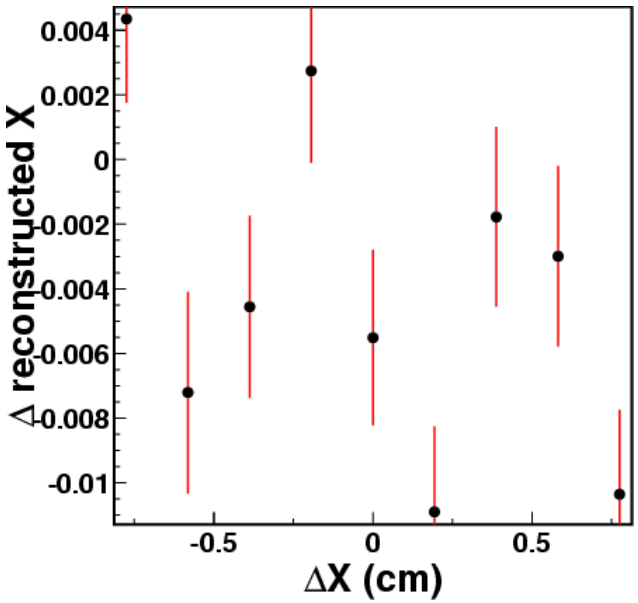
- No straight forward implementation of the vertex reconstruction for special runs (radiator turned or mirror present).
- Analysis using a fill vertex per run is a good option, but care with systematics has to be taken.

Systematics

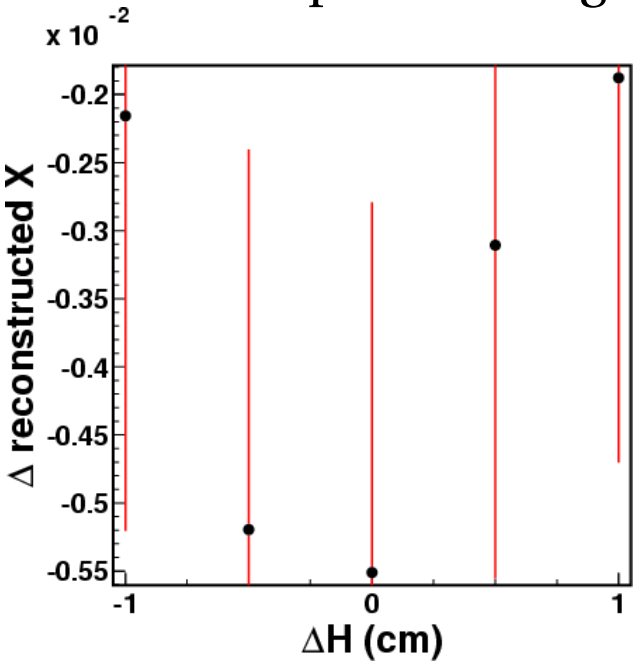
Angle of the radiator respect the PMT matrix.

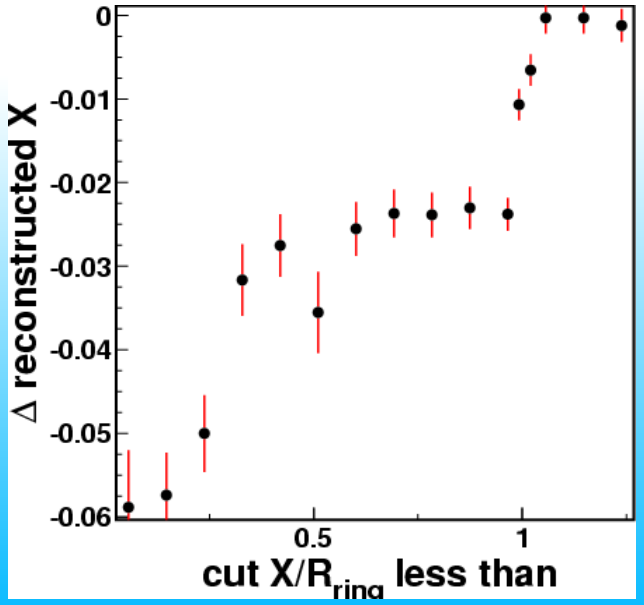


Real vertex position



Error in expansion length.



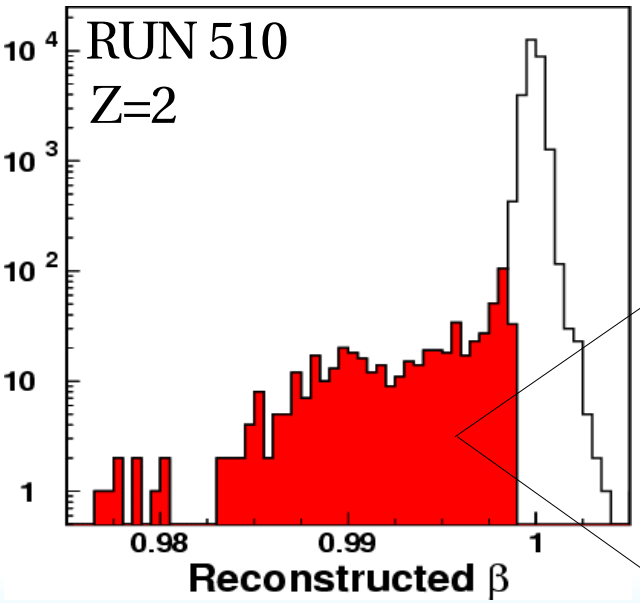


- The important systematic errors:
  - Matrix-radiator alignment.
  - Fraction of ring lost.

Vertex reconstruction
and ***fill vertex analysis.***

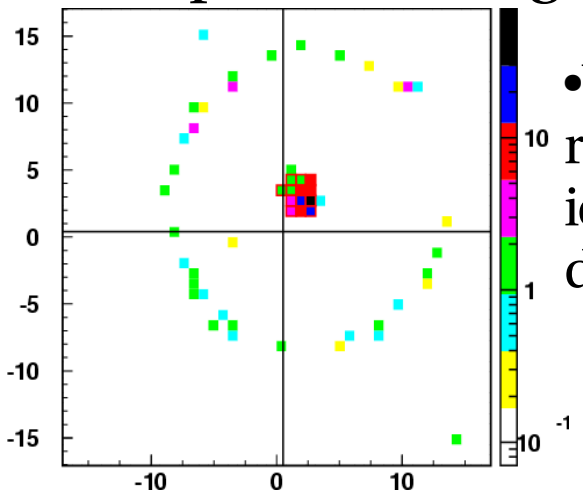
Selection

- Assume a single vertex for all the events of one run.
- First glance: run 510, Z=2:



~75%

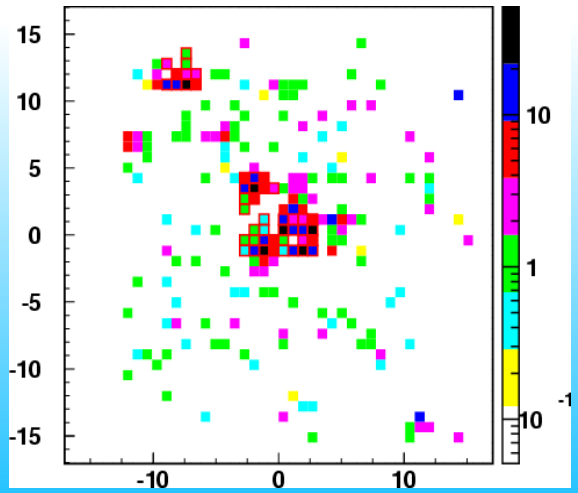
"Halo" events
(multiple scattering?)



- We can use the vertex reconstruction to identify them.. but we do not want to do so

~25%

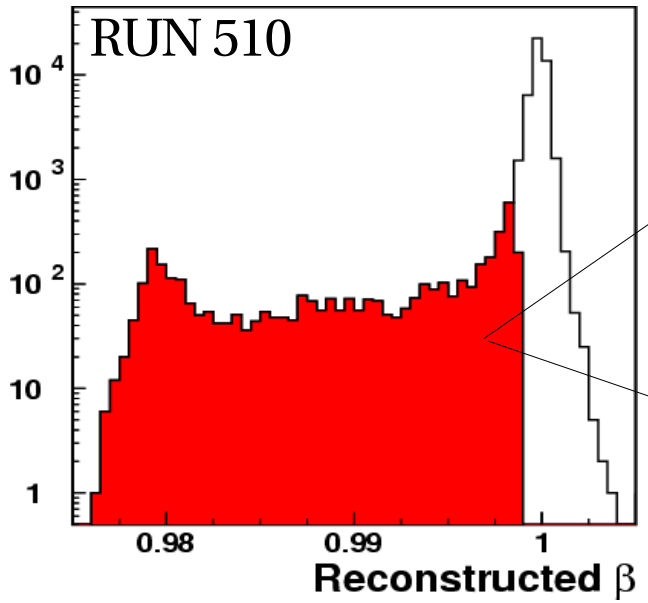
Fragmentation(?)



- How can we identify them without using the vertex-beta reconstruction?

Selection

And it gets worse if we do not select Z.



~15% "Halo" events (multiple scattering?)

~85% Fragmentation(?)

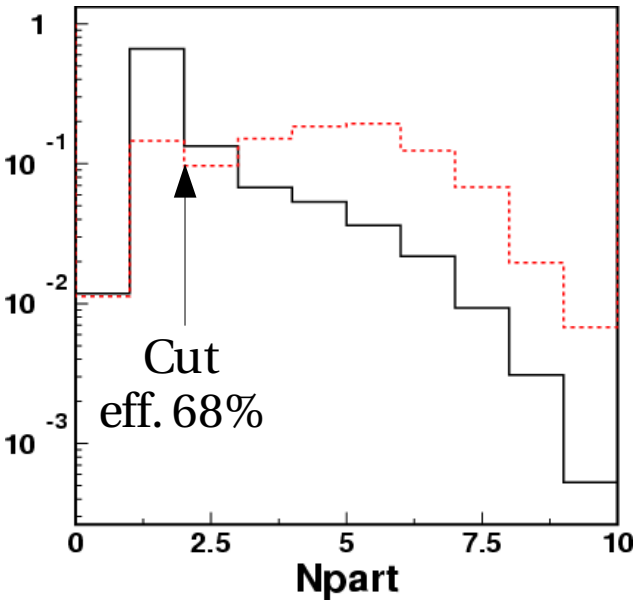
Cook-book:

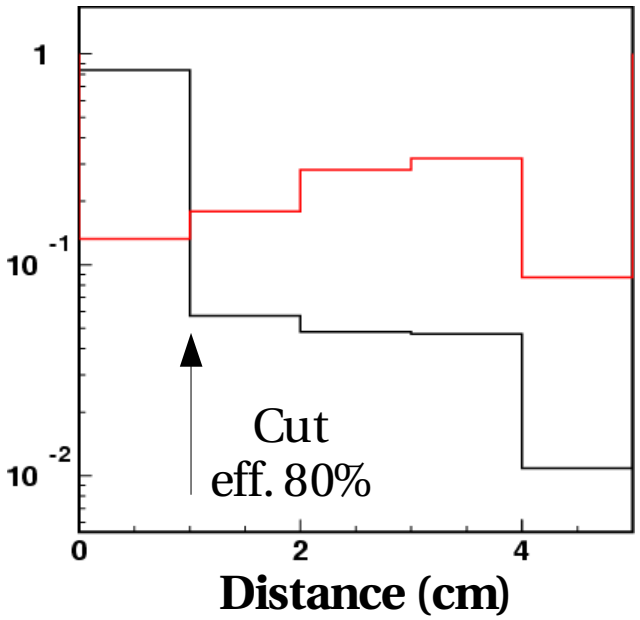
- Deal with fragmentation counting how many particles crossed the PMT array and selecting those with a small number (less than two). Used particle number estimator implementer in ntuple (NPART word)

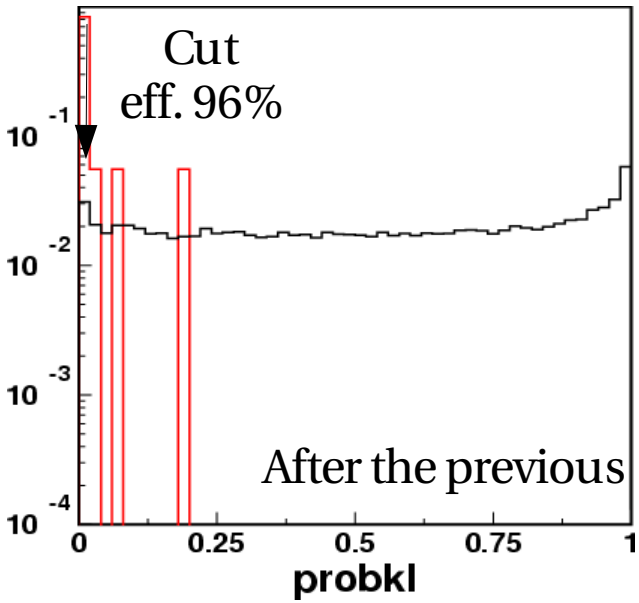
- Deal with "halo" by selecting events with a particle matching the fill vertex.

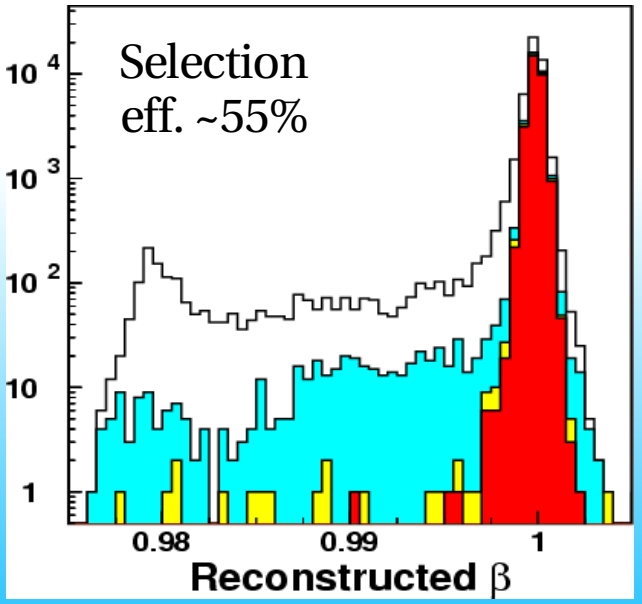
- Use a soft selection on probkl to remove the remaining fragmentation events: only cut depending in reconstruction.

Selection



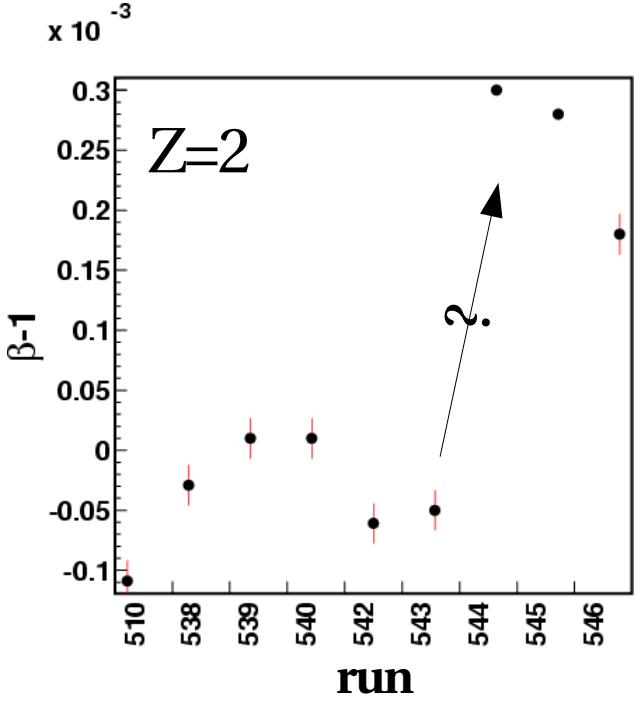


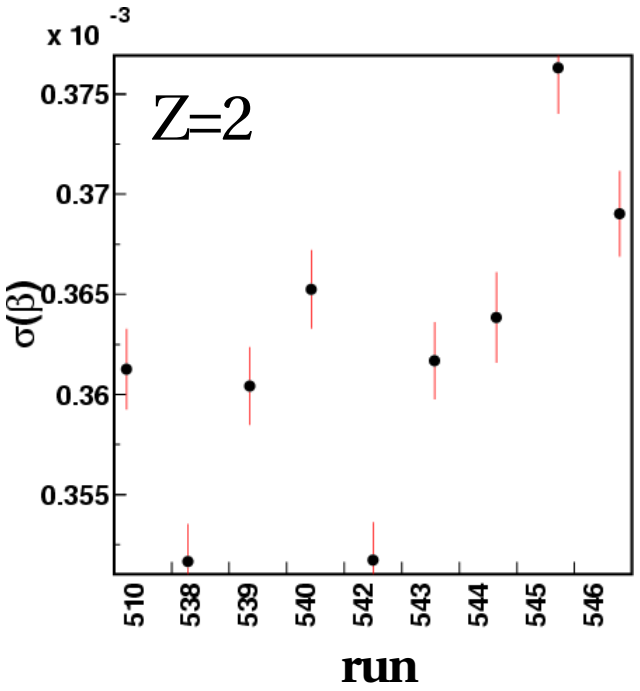


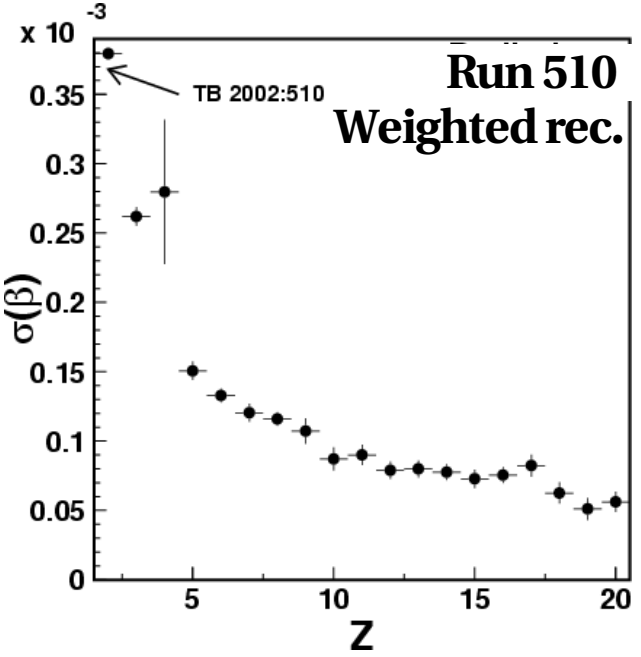


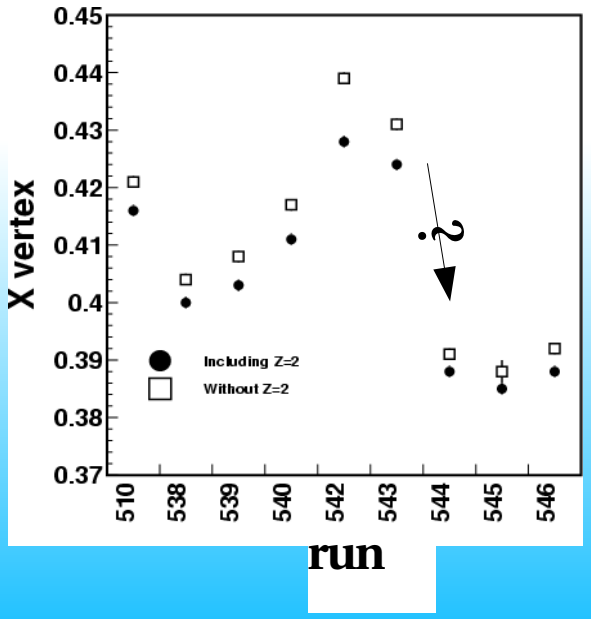
- Final sample with ~0.01% of background (for current analysed runs).

Results: scanning N.103G





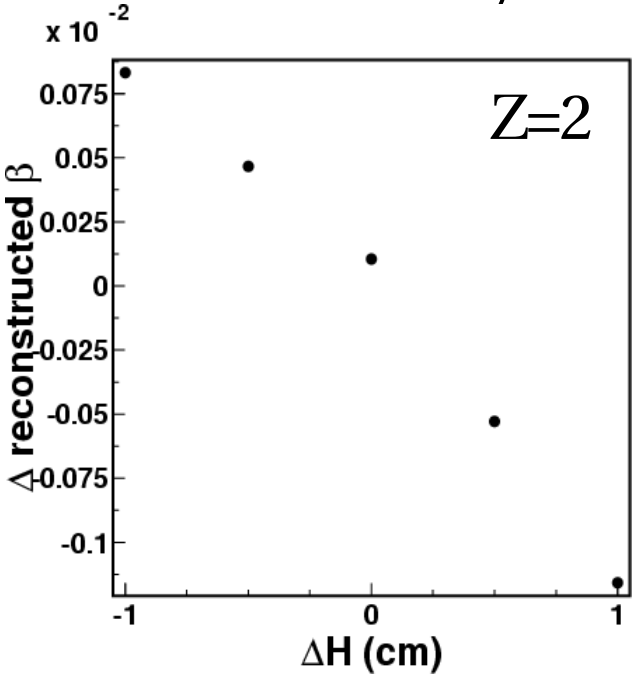


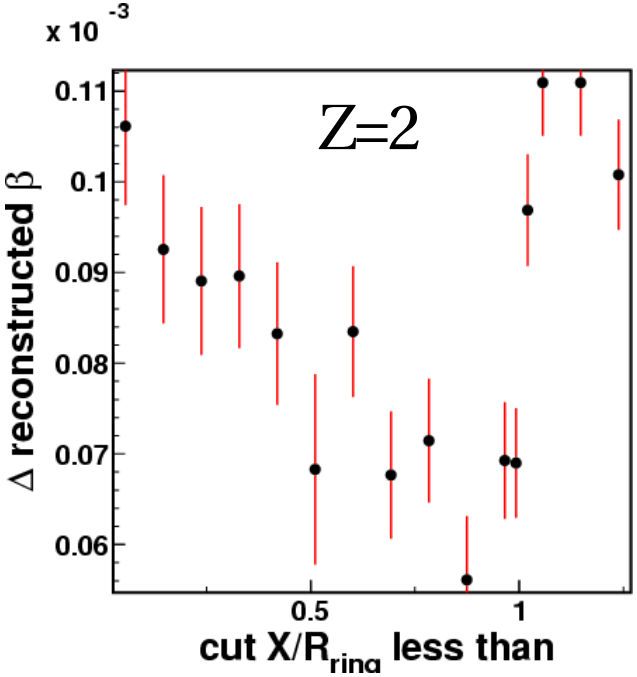


538	539	540
542	510	543
544	545	546

- Resolution behaves as expected with Z.
- Resolution value is compatible with 2002.
- R. index homogeneity at the 10^{-4} level.
- What is going on with bottom part of tile? Need systematics study.

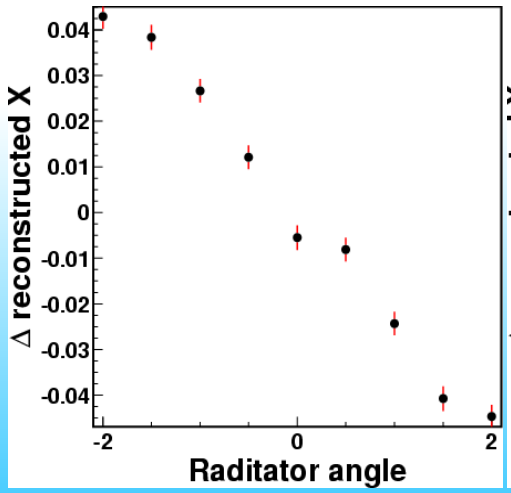
Results: systematics for N.103G

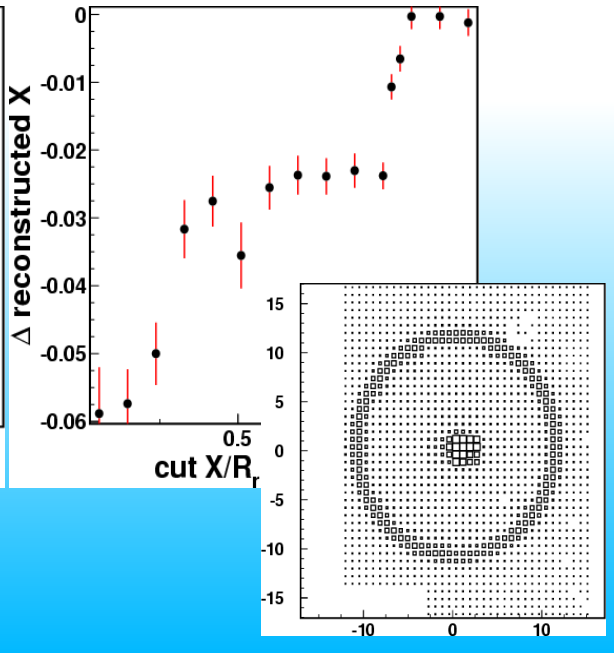


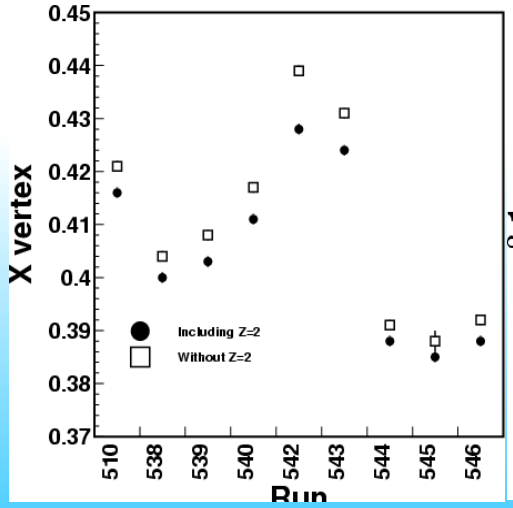


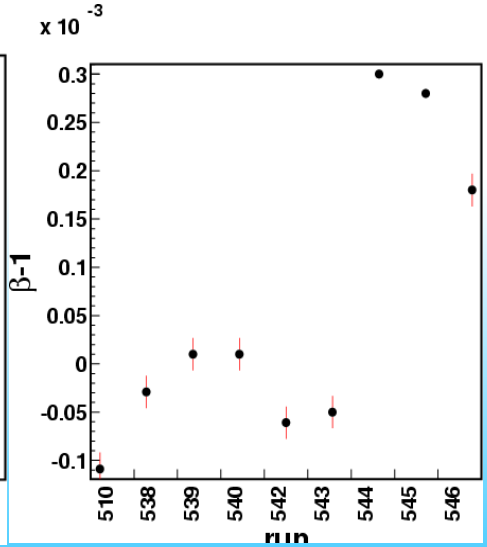
- Bottom side effect could be due to
  - Bad radiator positioning (few mm).

    and
  - Misalignment (<1 degree).

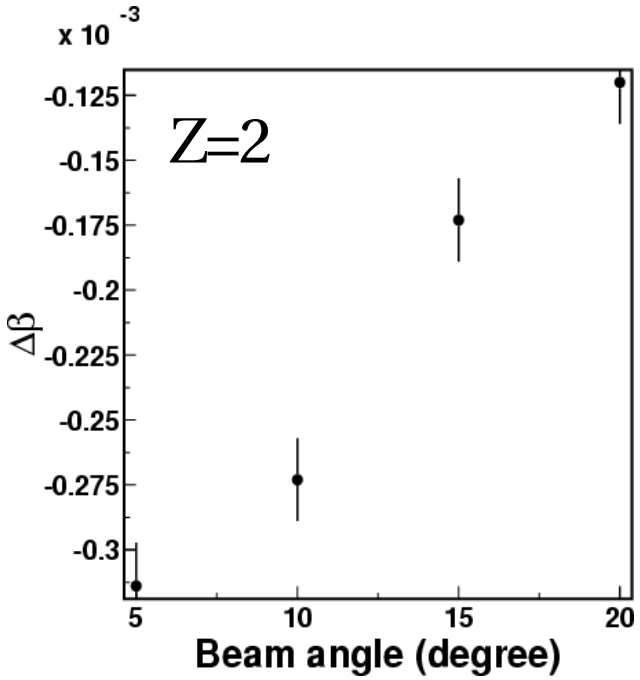


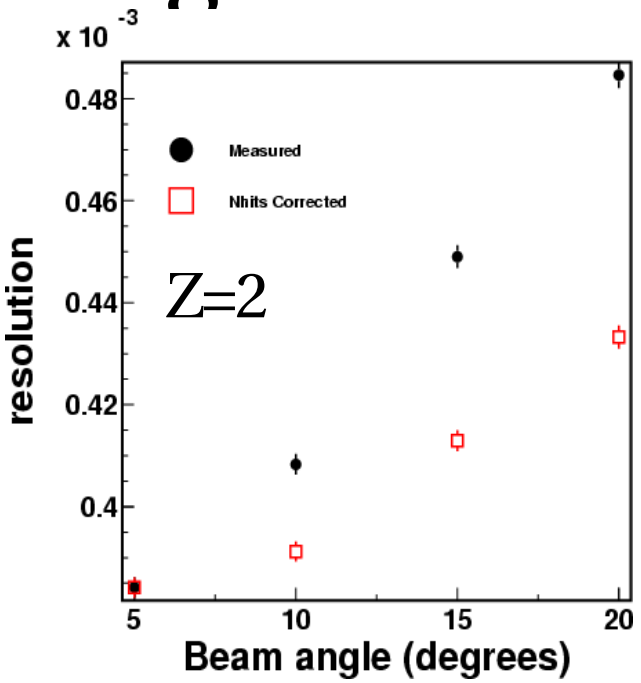


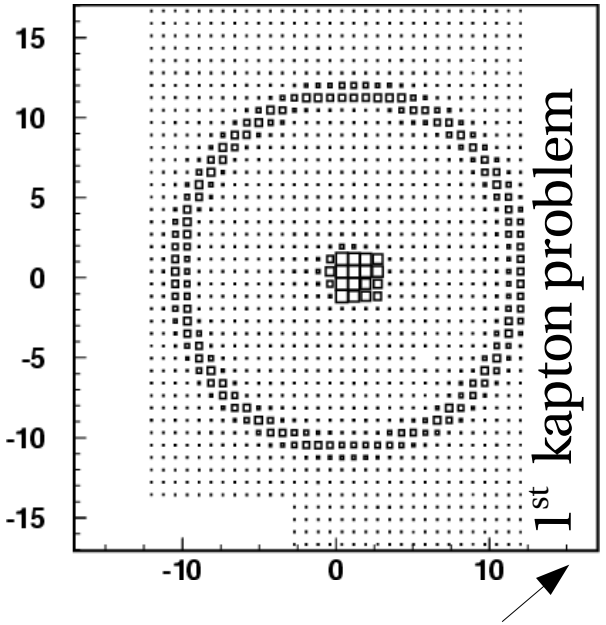




Results: beam angle runs for N103G

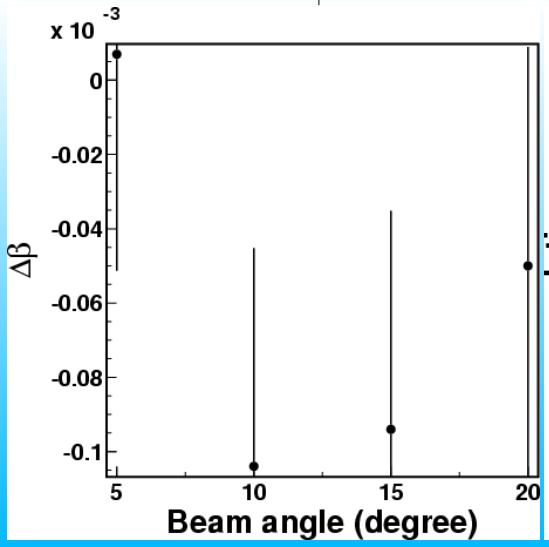


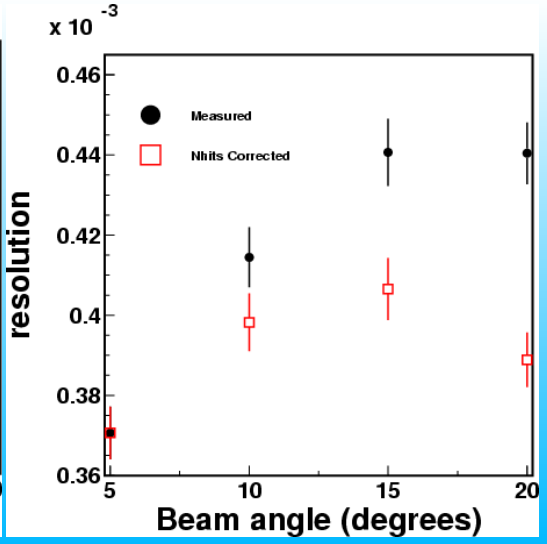




More hits are lost here for larger angles, Thus correction is necessary.

2.





MC with the next ingredients

- Forward scattering
- First kapton problem