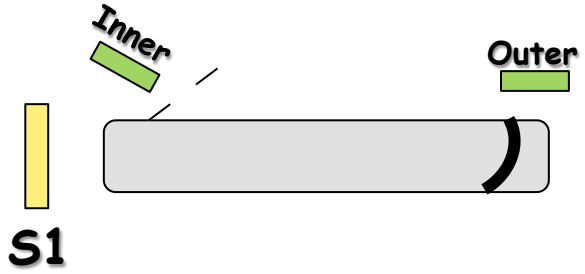
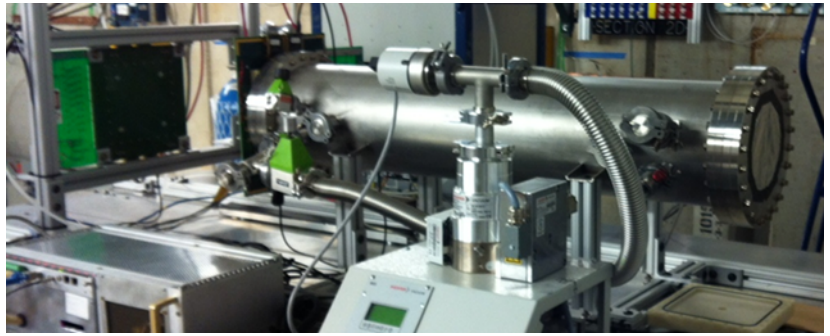
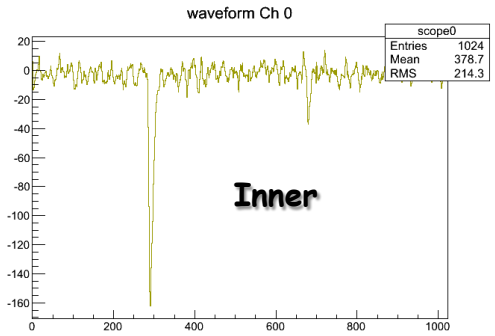
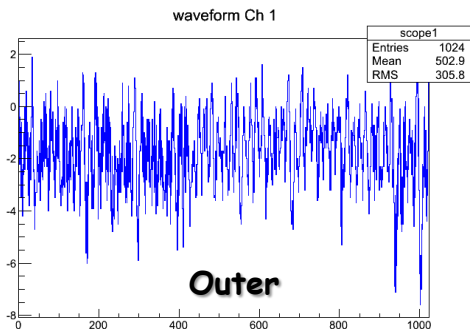
Defining Beam:

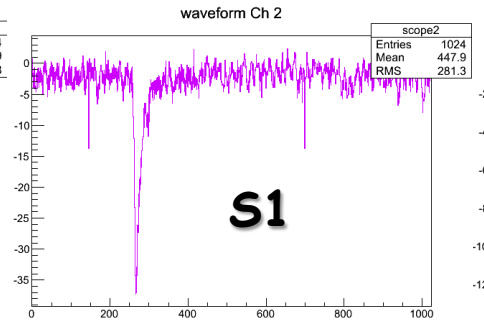


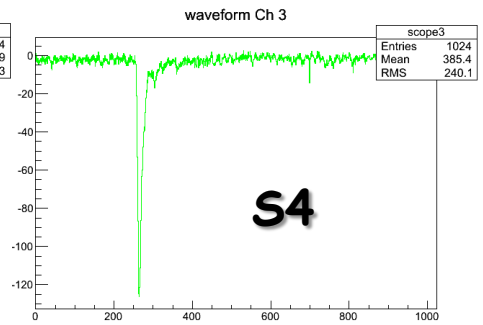


S4





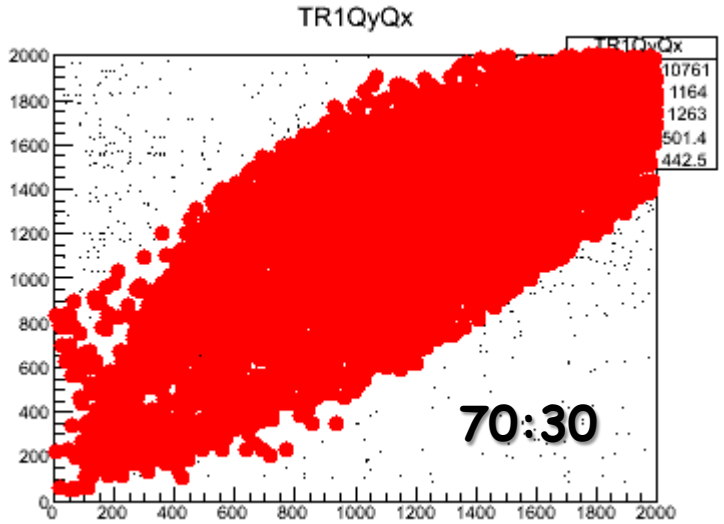


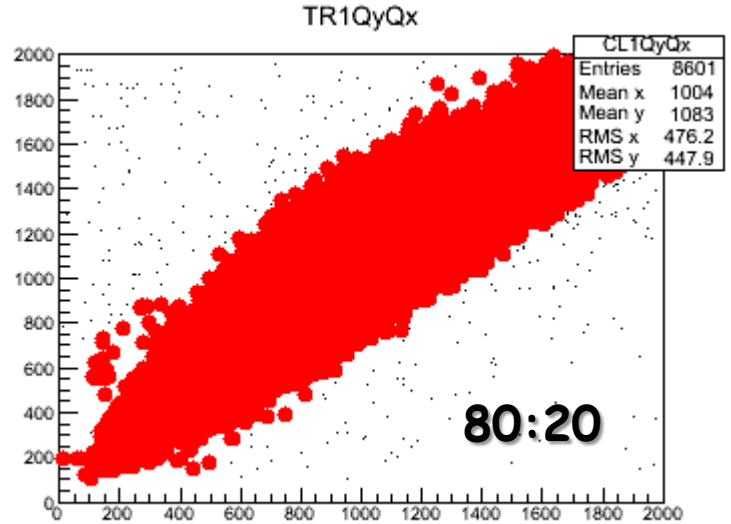


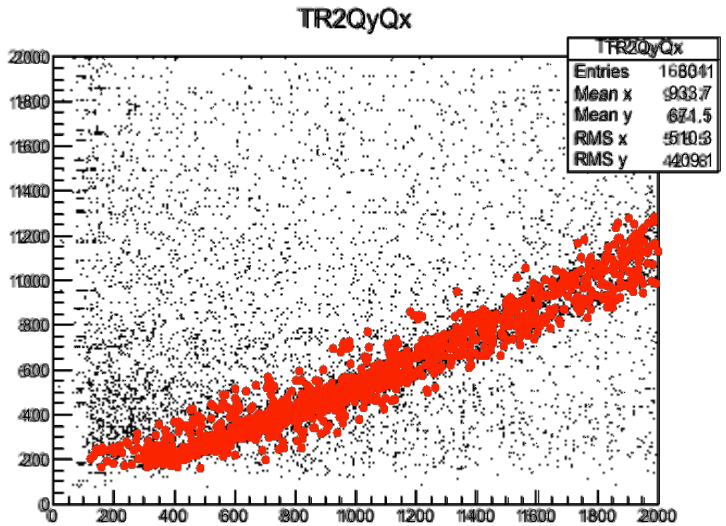
- Each Counter:
  - Must have only one hit in window.
  - Must have proper time of hit
  - Must have proper pulse height

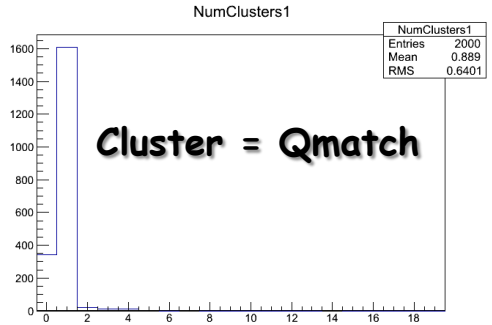
- Beam: S1 && S4
- Pion: Beam && !Inner && Outer
- Kaon: Beam && Inner && !Outer
- Proton: Beam && !Inner && !Outer

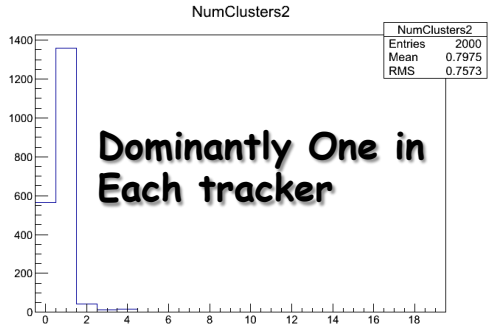
Charge Matching





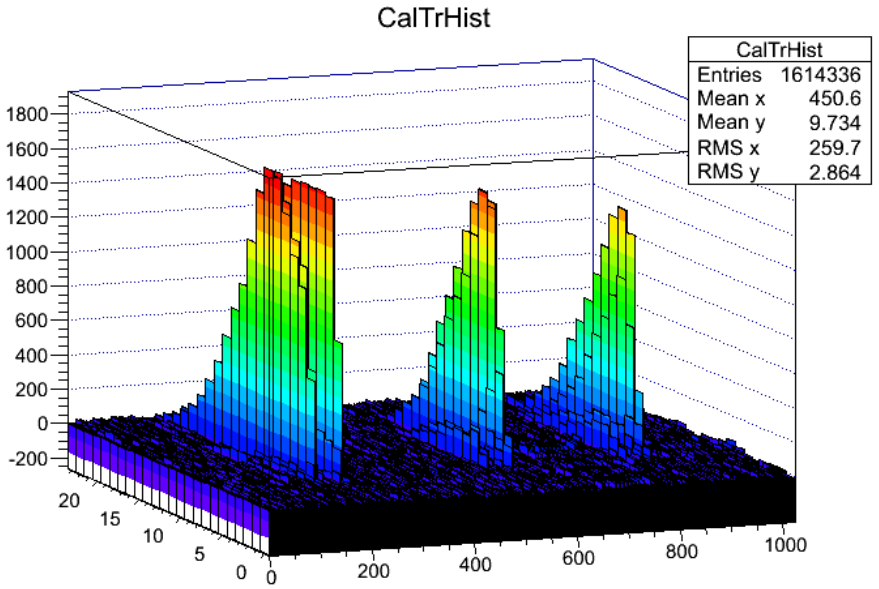


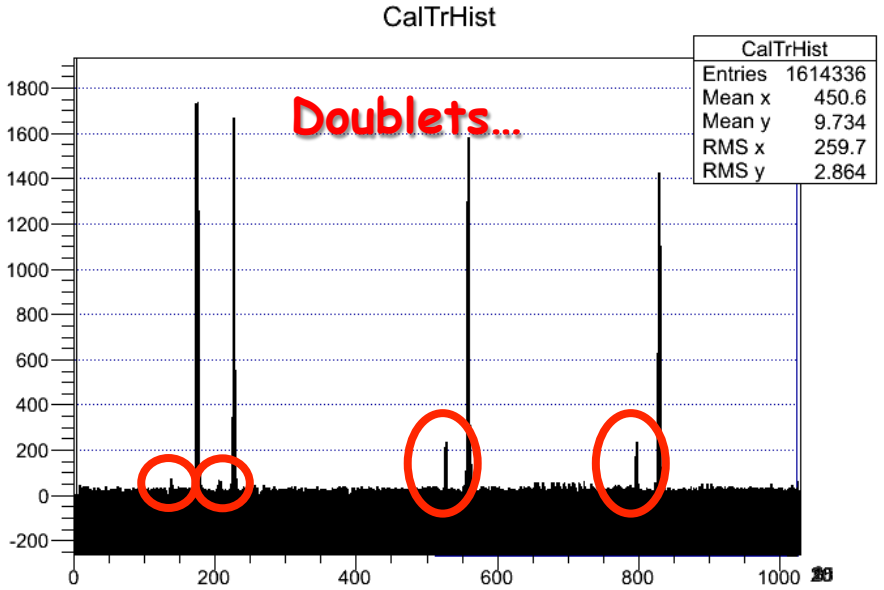


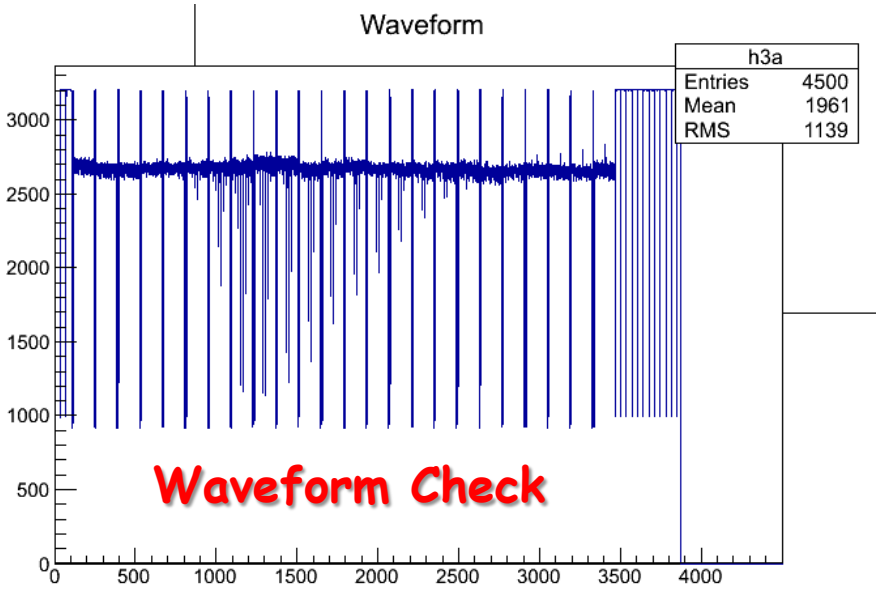


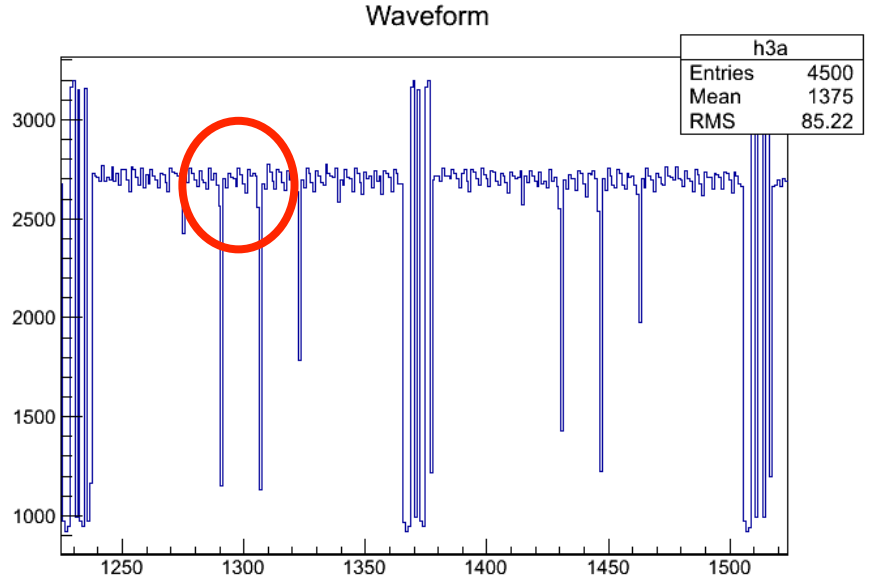
- TR1 800 mm pitch
- TR2 400 mm pitch
- 80:20 gas fixes charge TR1.
- Cluster = Charge Match
- Mostly 1 Cluster in each

Shadow Clusters…



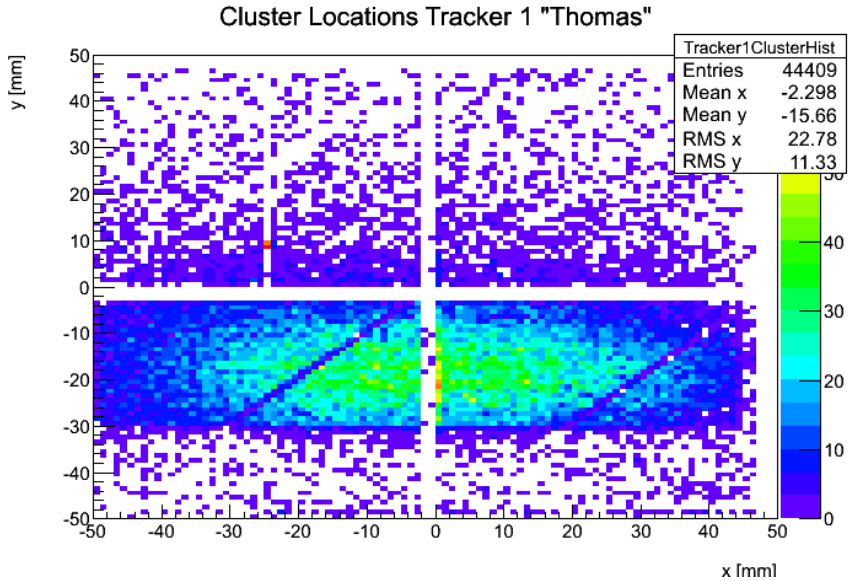


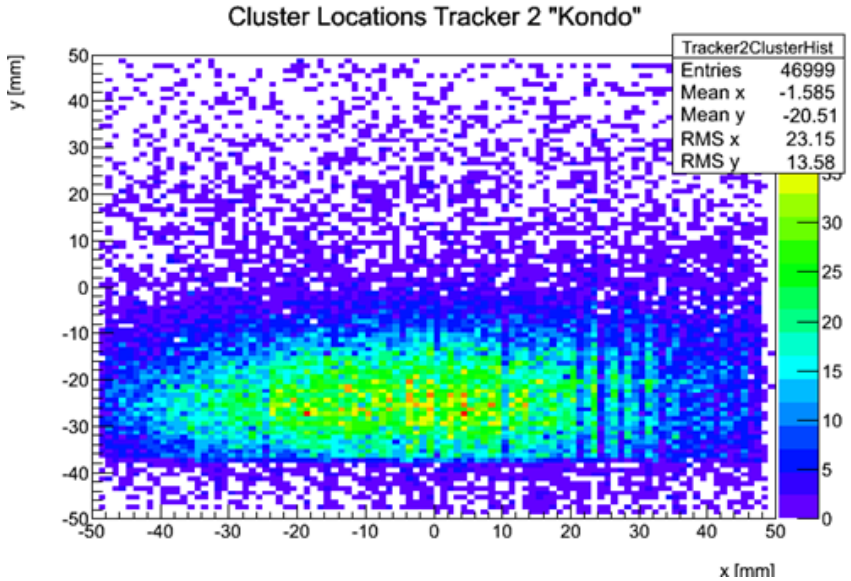




Bad Clock Phase Adjustment?

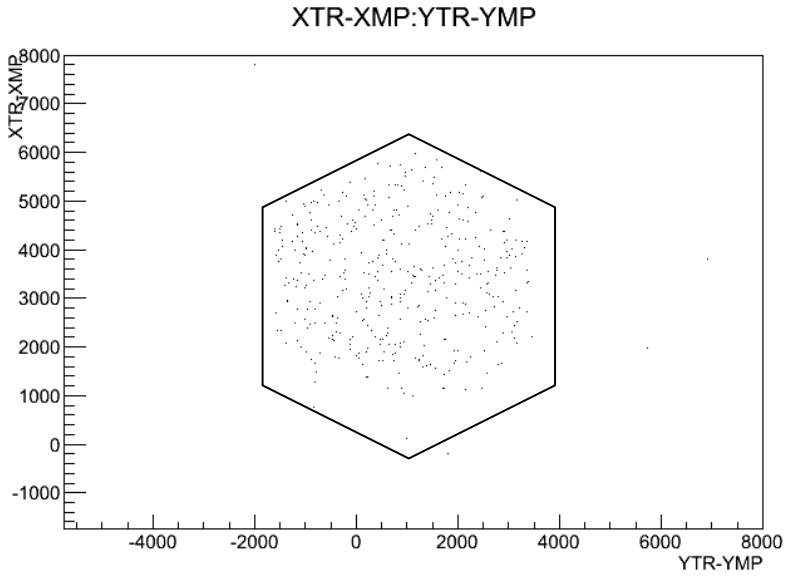
Beam Spots from Trackers





- Secondary Beam Focus near UVA/FIT Station.
- Diverges through SBU Station.
- Missing Diagonal from Shadow Cut (don't care…)
- Ready to Find the Ring using the Trackers…

Killing the "MIP" Pad:



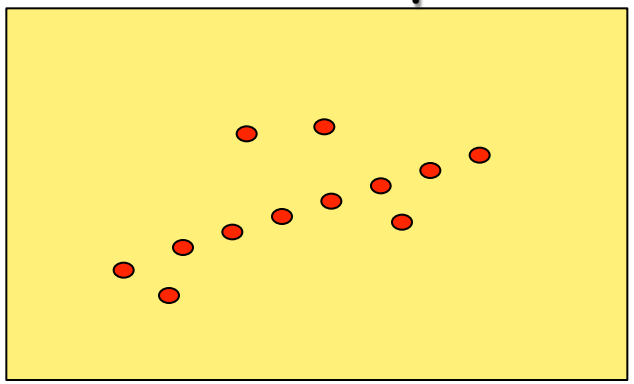
- Find the position of the MIP pad:
  - Take low gain events (MIP = highest pad).
- Plot difference in track crossing vs highest pad.
  - Result shows hexagon shape of a single pad.
  - Center offset makes alignment.

How to define Ring Center

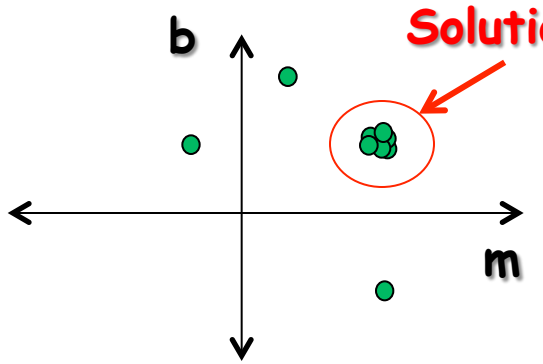
- Ring is NOT centered on the maximum pad!
- Spherical Mirror means that the Ring center varies with the direction vector of the track.
- To align best we should:
  - Find the ring without knowing the center.
    - Combinatorial Hough Transform to make road.
    - Robust Fit to determine center and radius.
  - Compare the ring center to the direction vectors of the track.
    - Use empirical fit to determine correlation.
- Once correlation is known, ignore the ring's free fit and use instead the tracker vectors to predict the ring's center on a subsequent pass of the data.

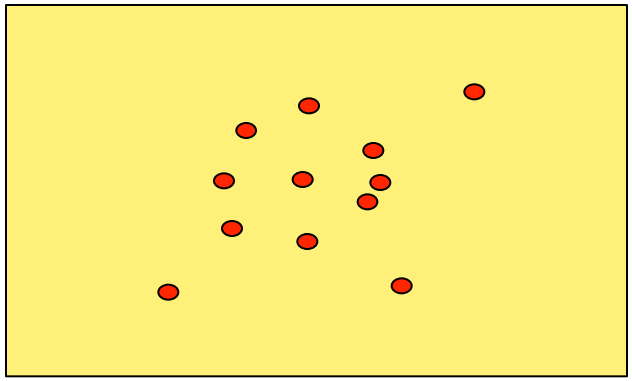
Combinatorial Hough Transform: Concept.

Coordinate Space

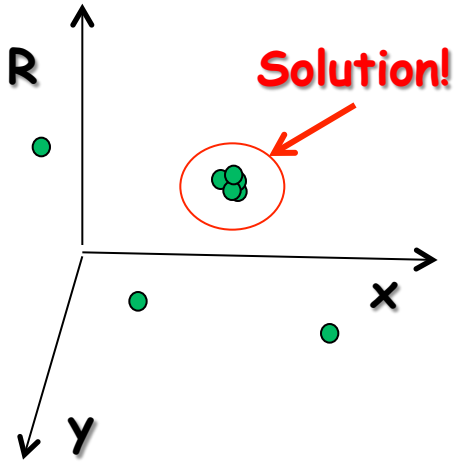


Line = 2 parameters
Two points define line
EACH pair = one vote



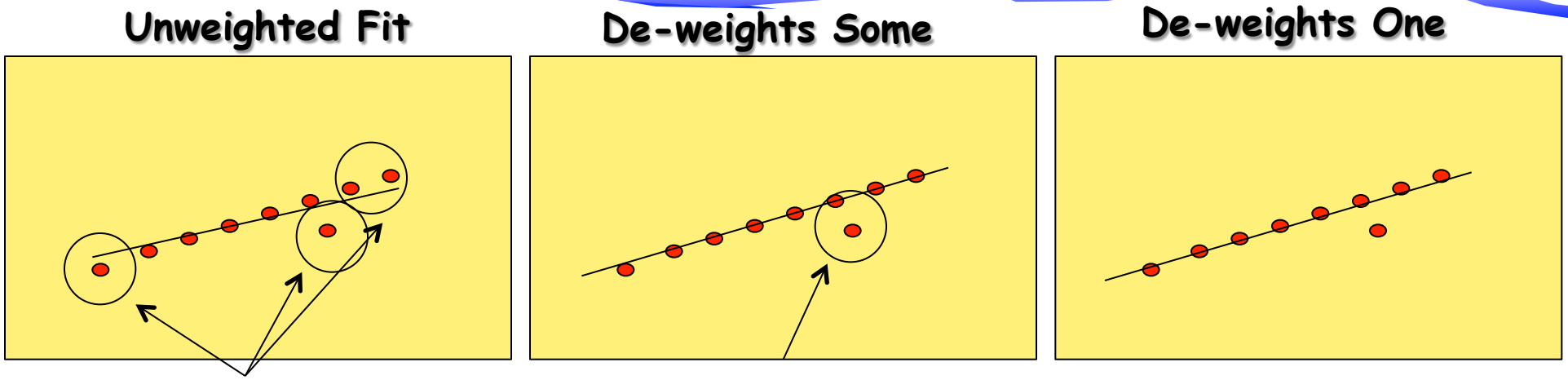


Circle = 3 parameters
3 points define circle
EACH triplet = one vote

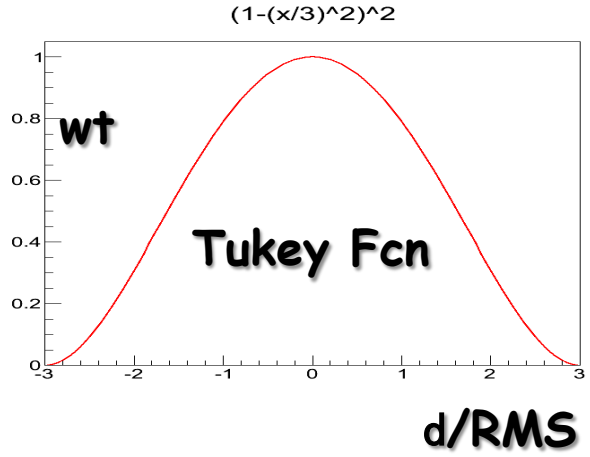


- Technique used for PHENIX DCH Tracking.
- Use 3D histogram in (x,y,r).
- Max in 3D space tells ROUGHLY where the ring is!

Robust Fit Procedure:

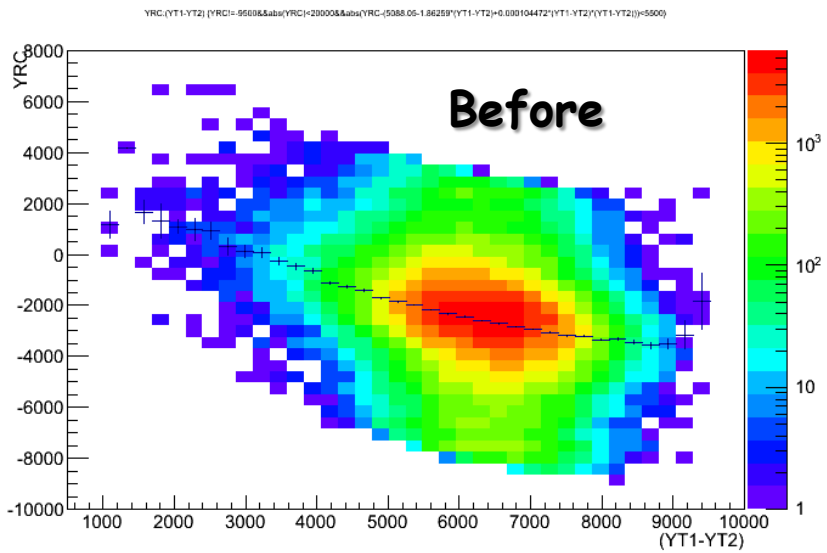


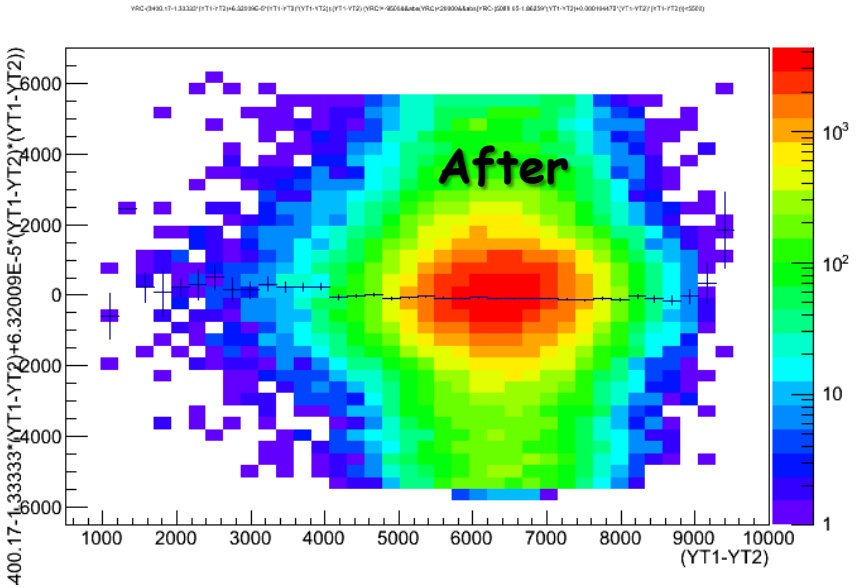
- Add/Drop of outliers is unstable.
- Robust Fitting is gradual de-weighting
- STEPS:
  - Equal Weighting Fit.
  - Calculate RMS deviation (>1-pt error!)
  - Re-weight with Tukey Function.
  - Repeat until convergence.



PHENIX: Convergence Criterion typically met in 3 iterations
RICH: Just do 10 iterations (CPU time not a concern).

Ring Center and Track Vector

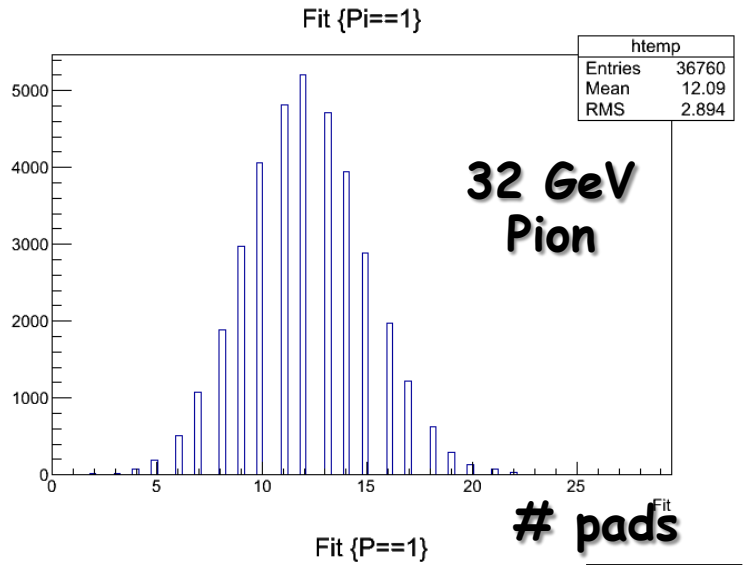


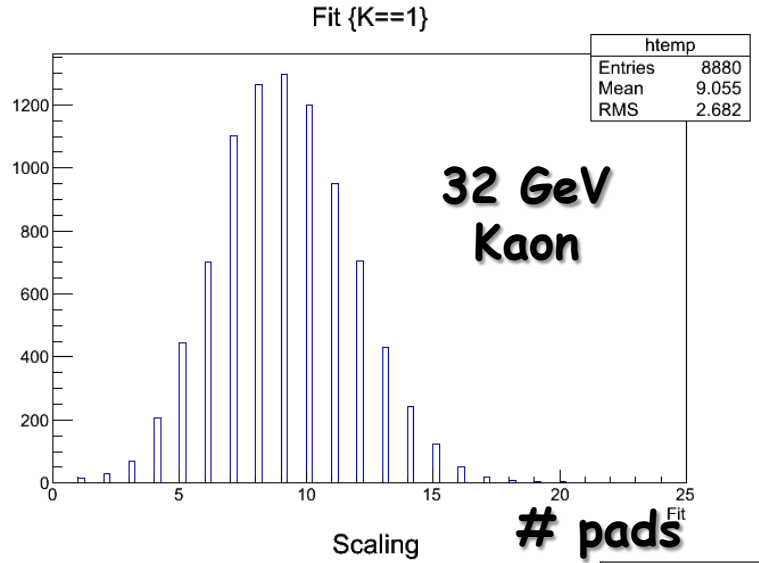


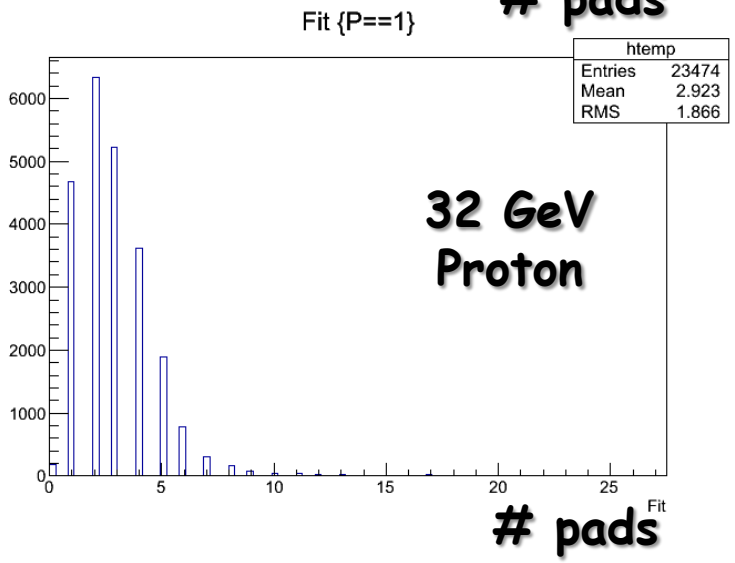
- Correlation between free fit ring center and slope of track in the y direction.
- Crosses on plot show the "Profile" histogram following the peak of the correlation.
- Fit the peak curve to a polynomial and subtract.
- Same for x…

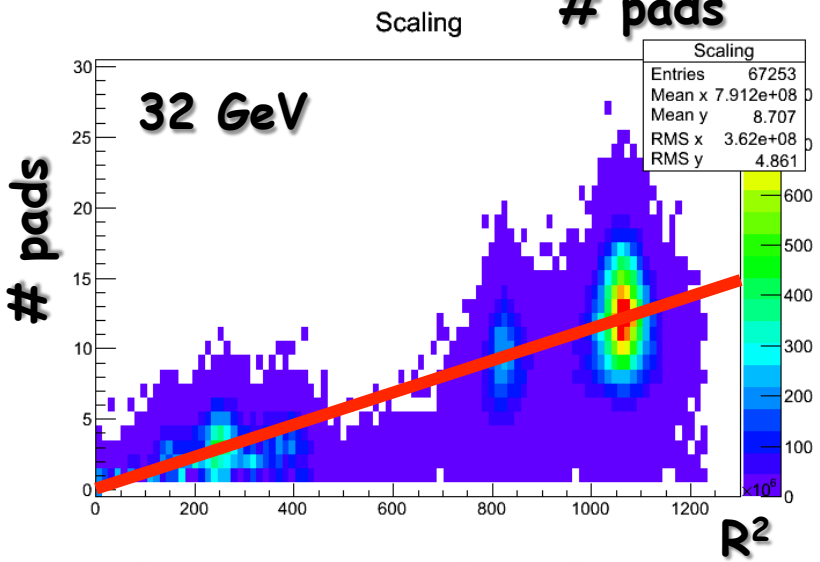
Why is the line curved?

Number of Pads Included in the Fit:



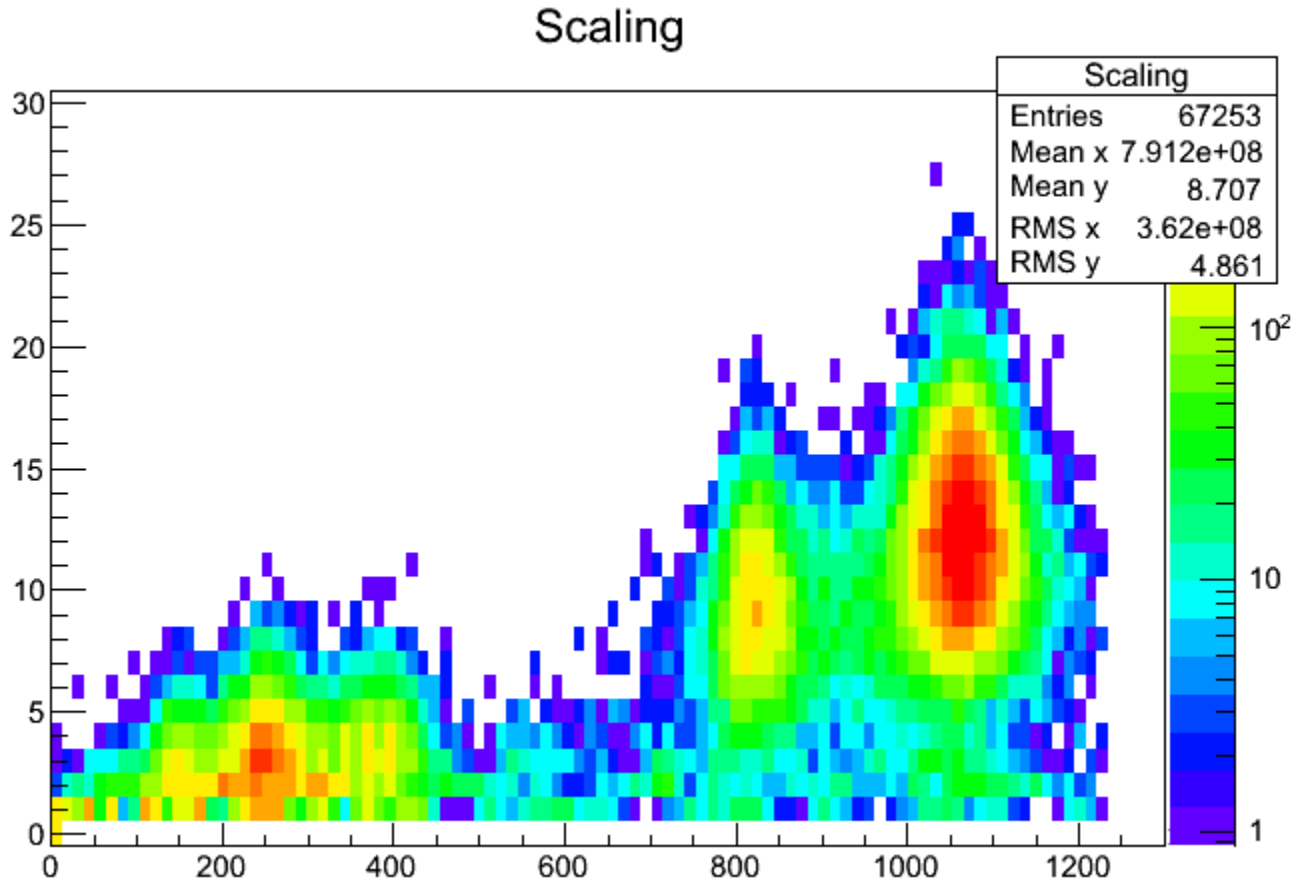






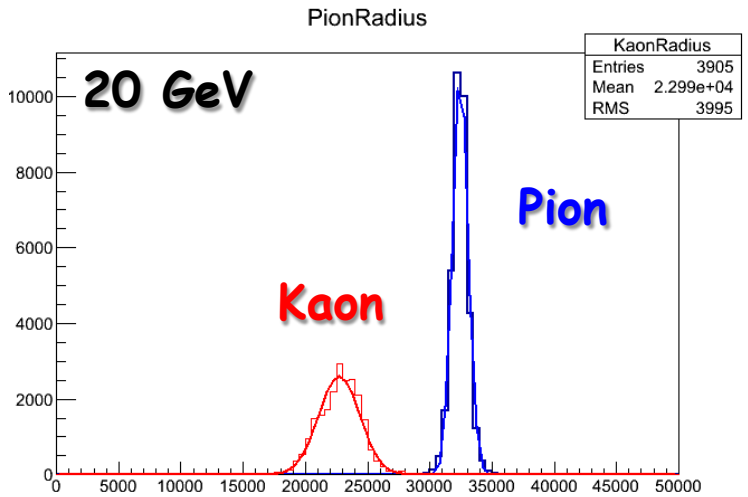
$$dN_\gamma/dL \approx \sin^2\theta_c \approx R^2$$

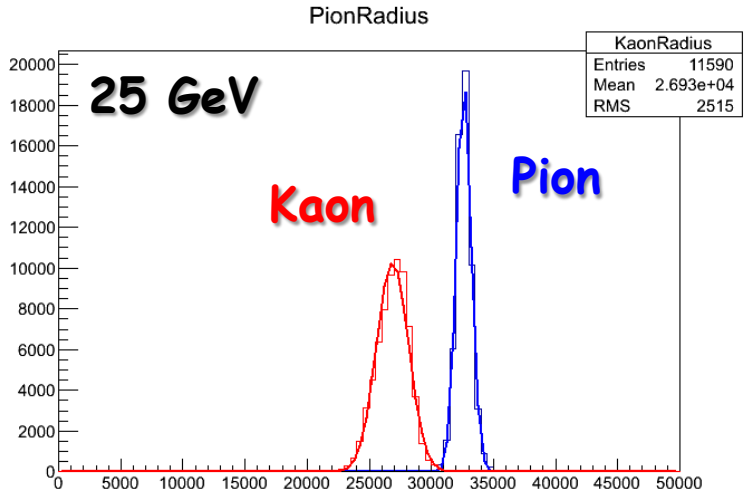
FYI: Cleaner Spectra Possible by Correlation



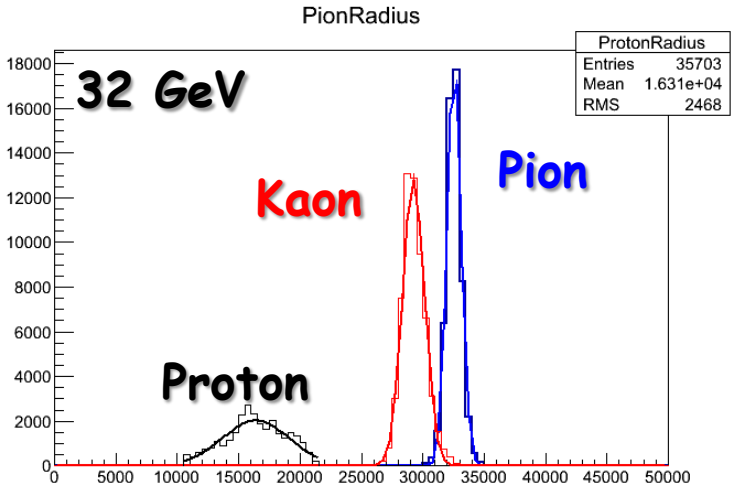
- Fill PID capabilities will also utilize the photon yield to remove background hits.

Radii Results:

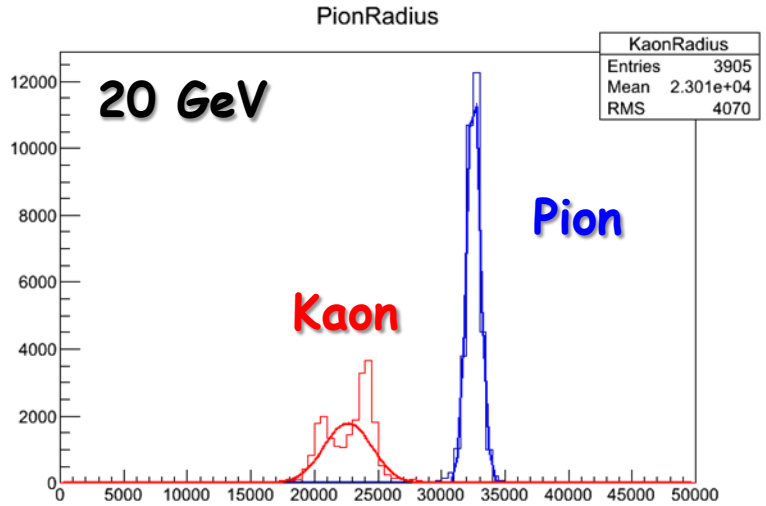




- Reasonable results at all measured energies.
- NOTE: 32 GeV is the highest available energy for Kaons at FTBF.



Note: Take Care with Robust Fitting!!



- Robust Fitting throws out some entries as "outliers".
- The result is that it TRIES to make the results more circular.
- Since the hexagon plane itself contains "pseudo-circular" patterns, tight fitting criteria will introduce features in R.
- Here the Kaon forms a false doublet.

Summary

- So far all results are excellent.
- Some fine tuning of robust fit possible, but care must be taken to avoid false features in spectra.
- Still to do:
  - Analyze MEAN evolution if the radius with momentum.
  - Analyze WIDTH evolution of the fitted radius across all data, driven by convolution of multiple factors:
    - Pad size; Photons/ring; Beam momentum spread, Dispersion, …
    - Can we pin down the size of each factor by p-dependence?
    - Can we use that knowledge to extrapolate performance to 60 GeV?
  - Analyze Forward/Reverse Bias Scans.
  - Analyze Gain Scans.
  - Publish.