The PANDA Barrel DIRC Reconstruction methods

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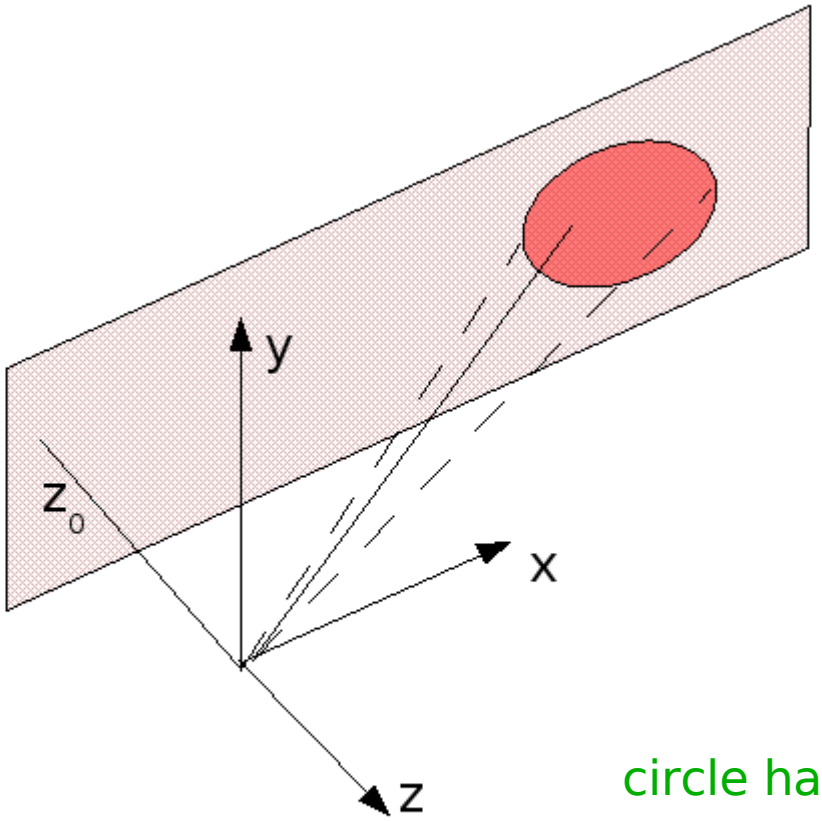
- Motivation
- Principle of Hough Transformation
- Details
  - Position resolution
  - Traps...
- PandaRoot simulations
- Time considerations

Motivation

- Search for a Cherenkov ring reconstruction
  - fast, to allow triggering, “3rd trigger level”
- Fit of ring sections
  - time consuming ~ 1-10s
- Hough transformation
  - simple algorithm, solve a linear eqation system

Ring images



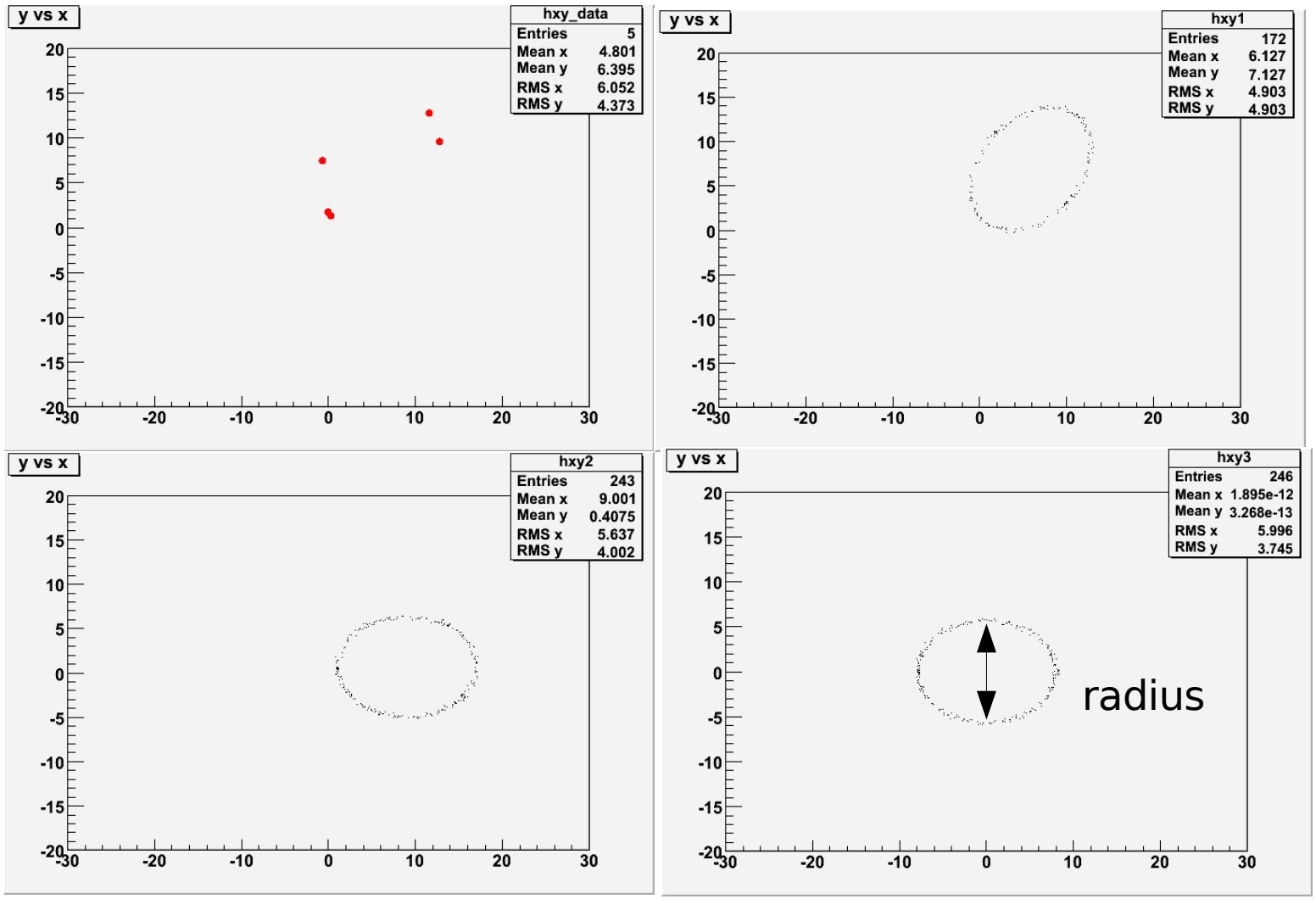
conic section
ellipse
parabola
hyperbola

circle has 3 degrees of freedom
x_m, y_m, radius

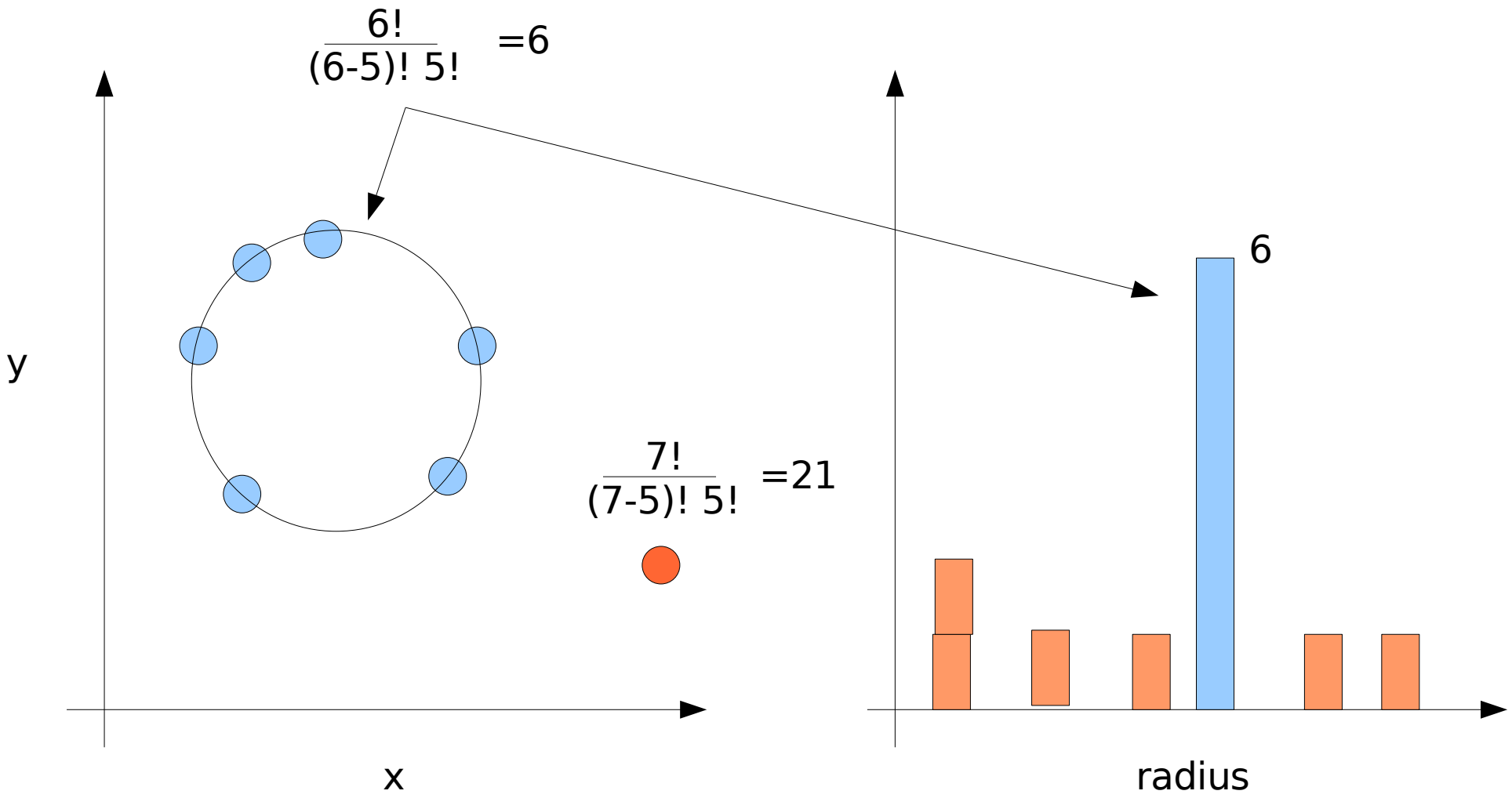
conic section has 5 degrees of freedom
x_m, y_m, radius, theta, phi

Ring images

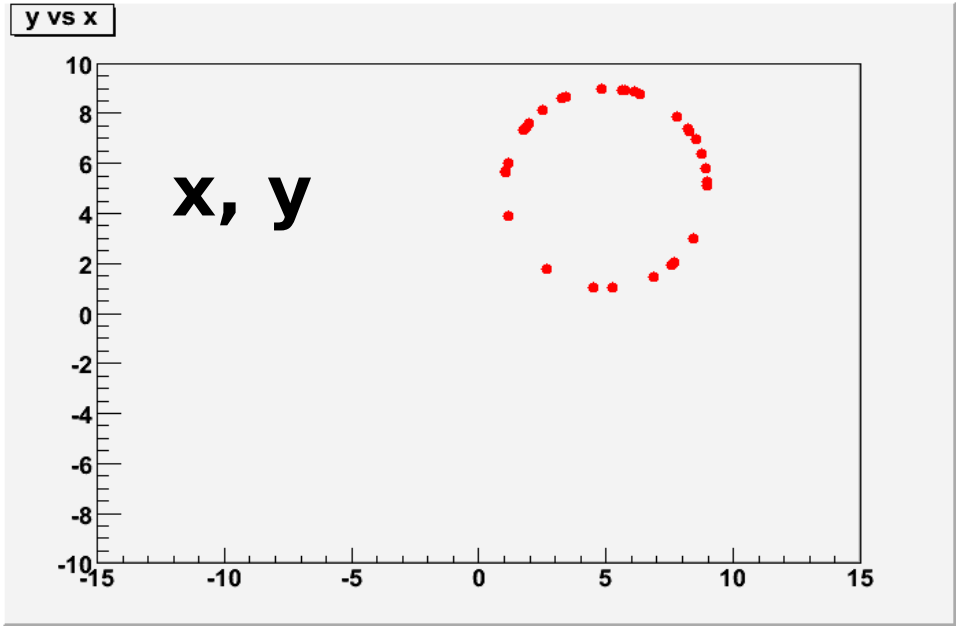
main axis tranformation

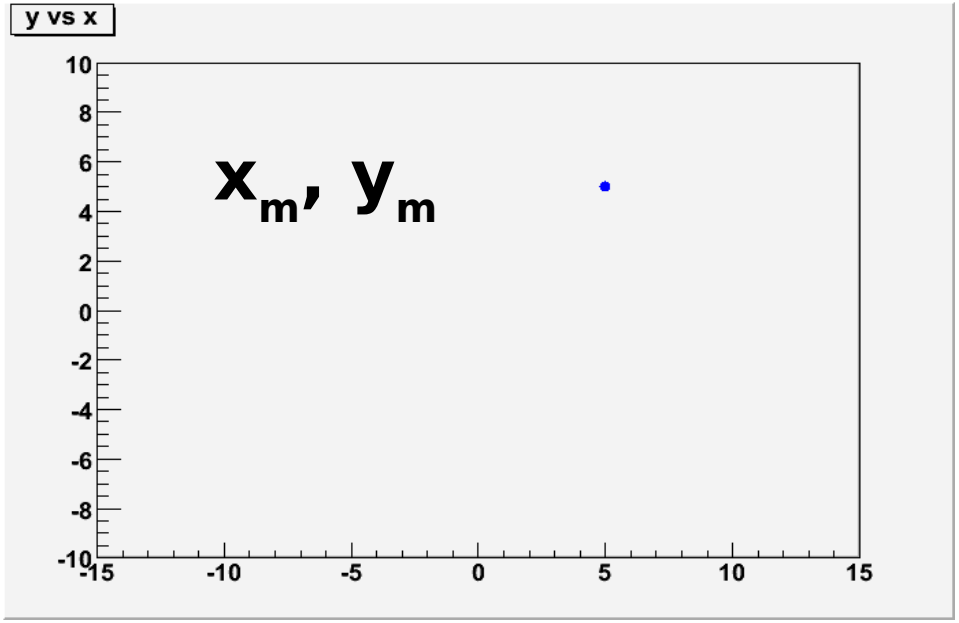


Combinations...



Simple case

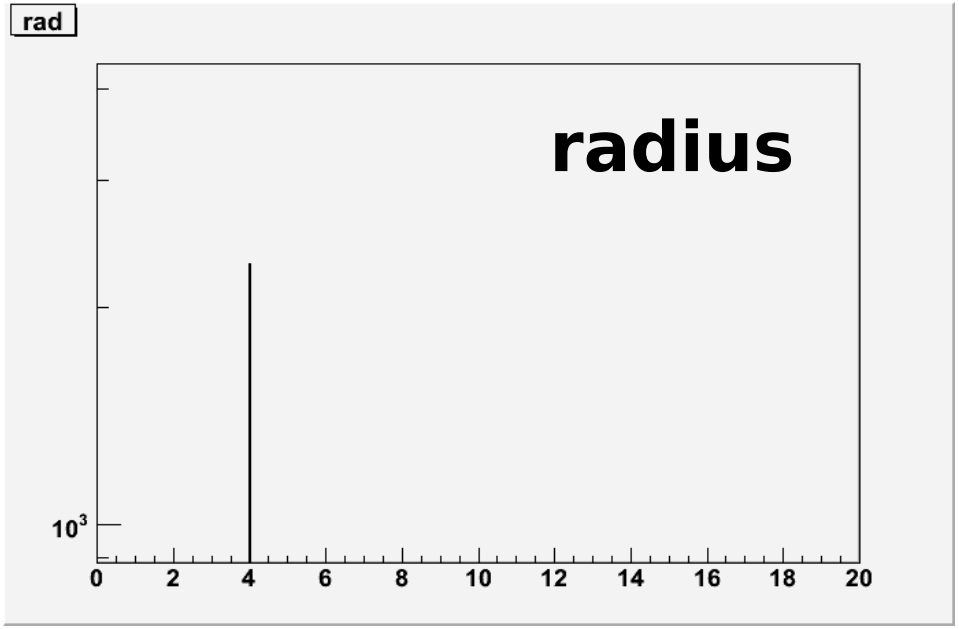




Perfect circle with 30 photons

R = 4
x_m = 5
y_m = 5

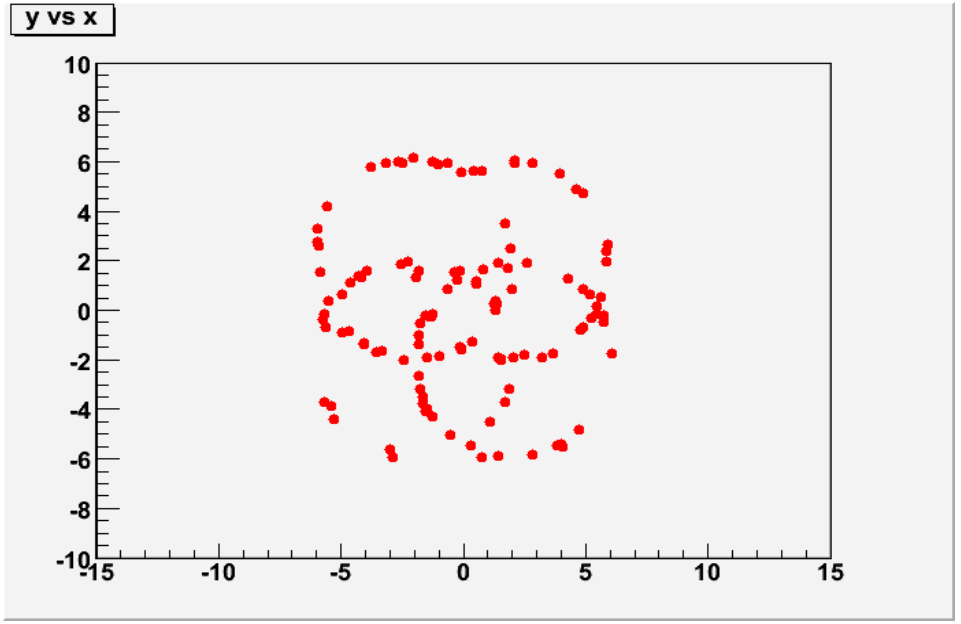
Calculate for all unique combinations of three points the parameters



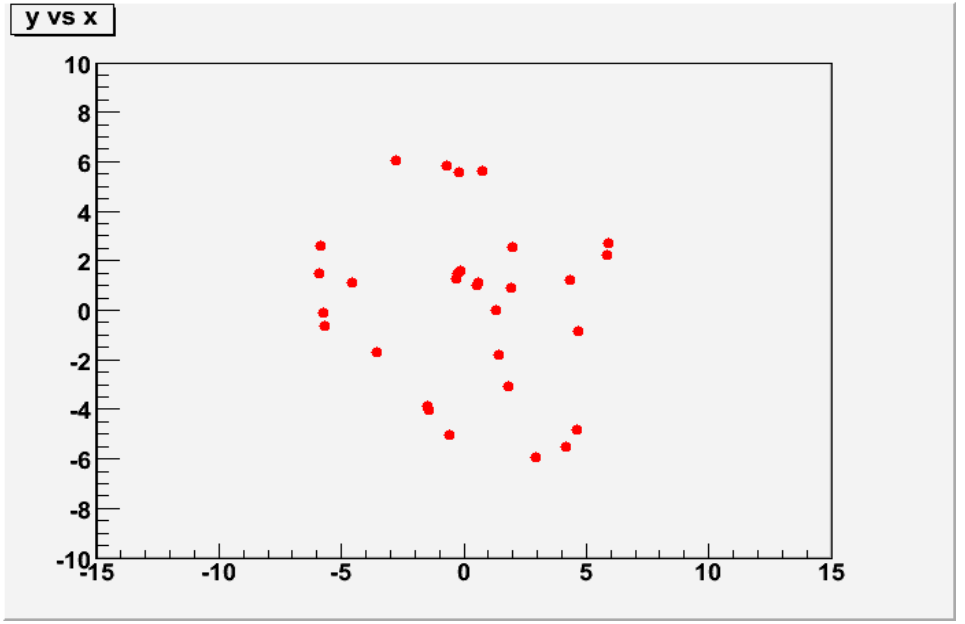
Not so simple case

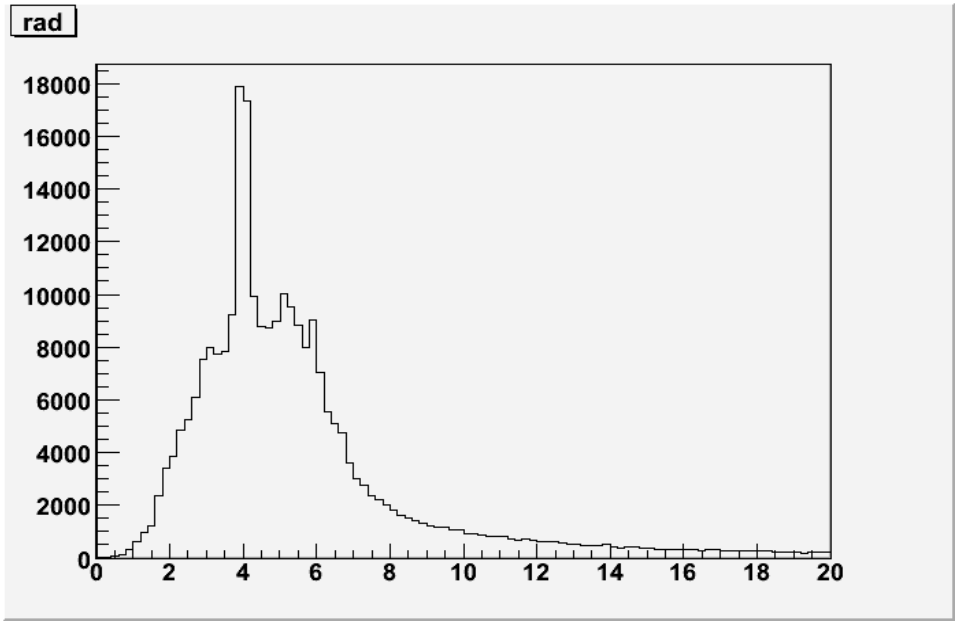
overlapping circle reflections

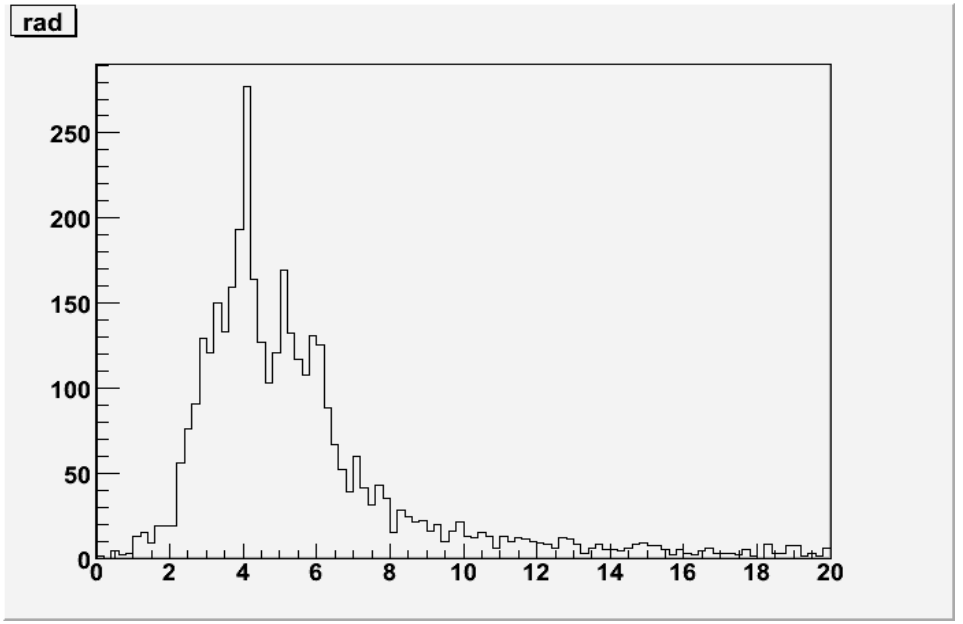
120 photons, smeared



30 photons, smeared

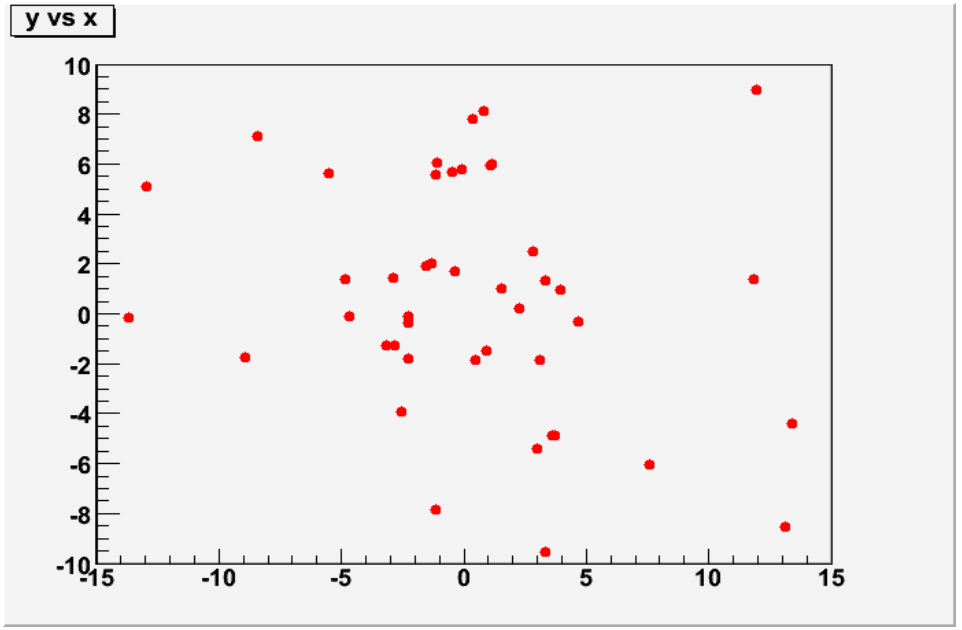


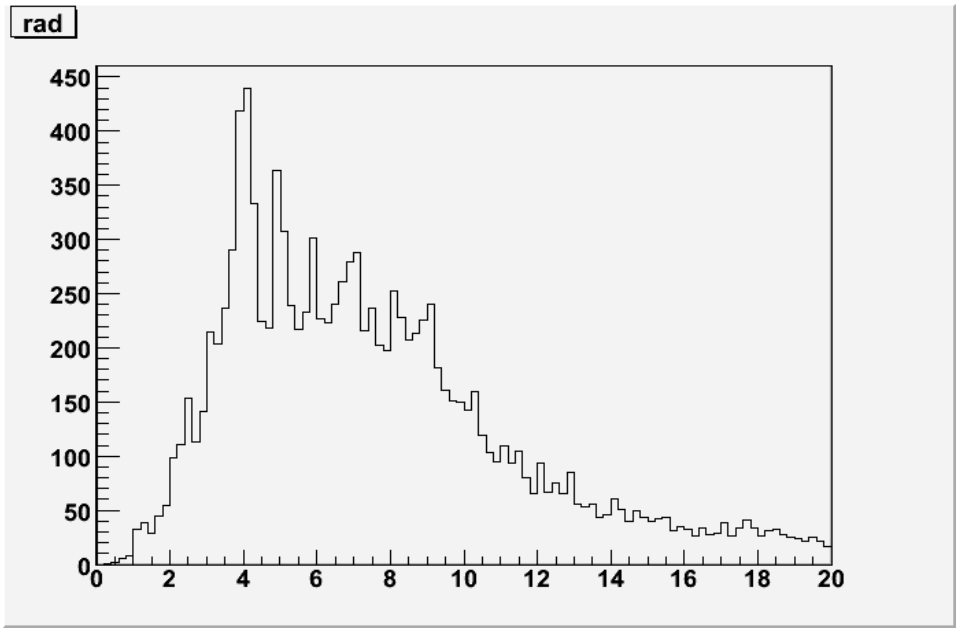




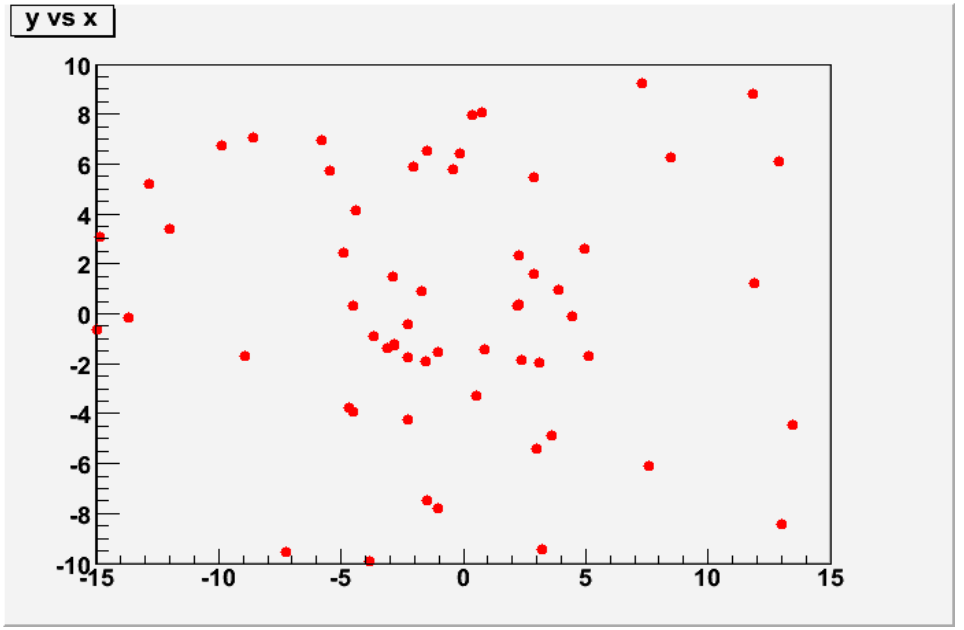
Difficult case

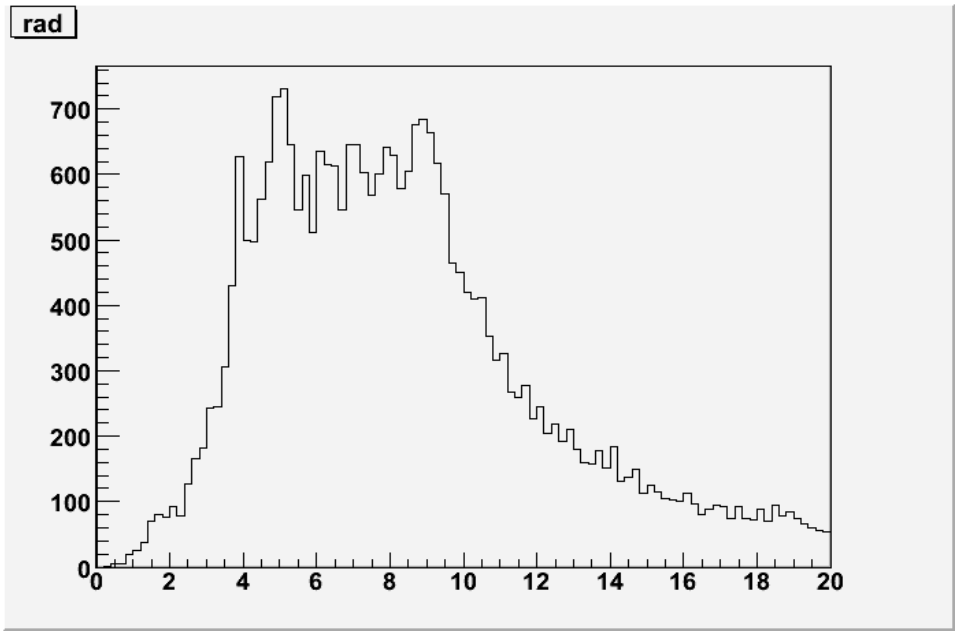
30 photons, smeared
+ 15 photons noise



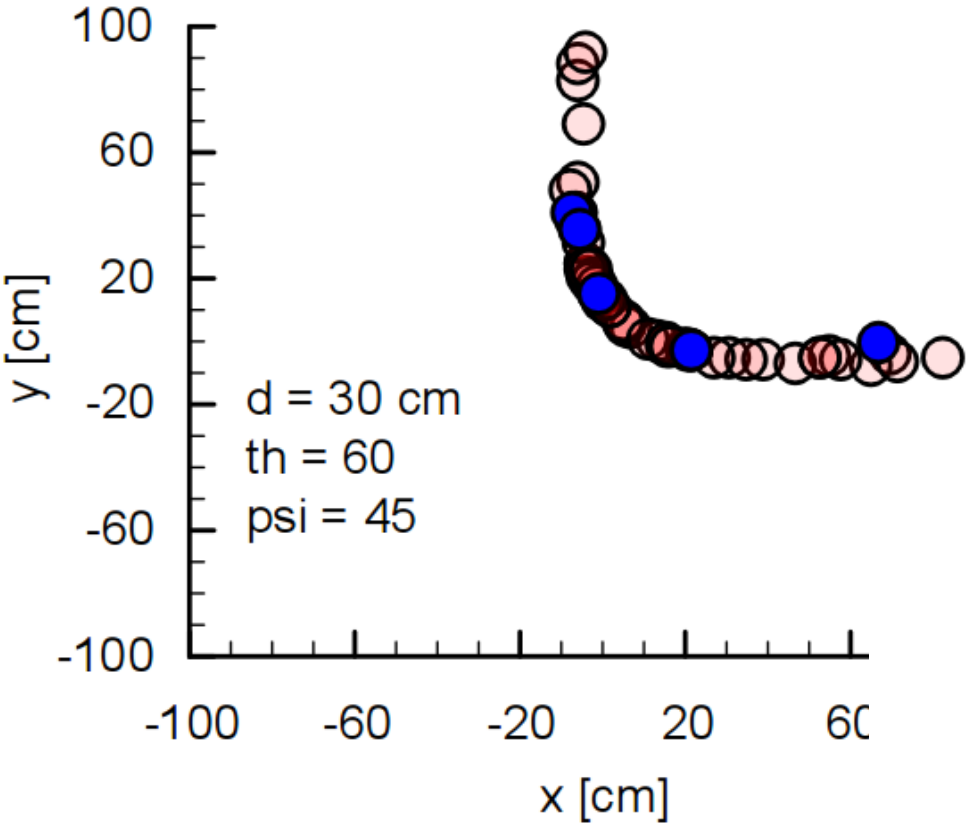


30 photons, smeared
+ 30 photons noise



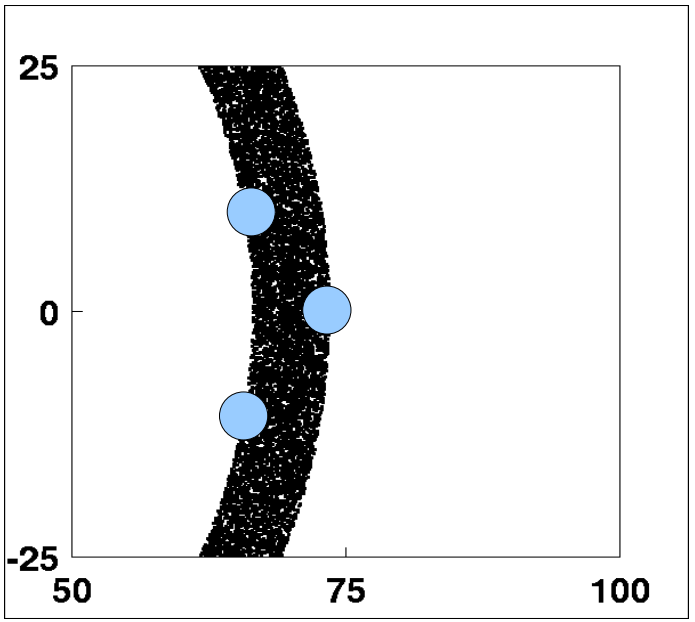


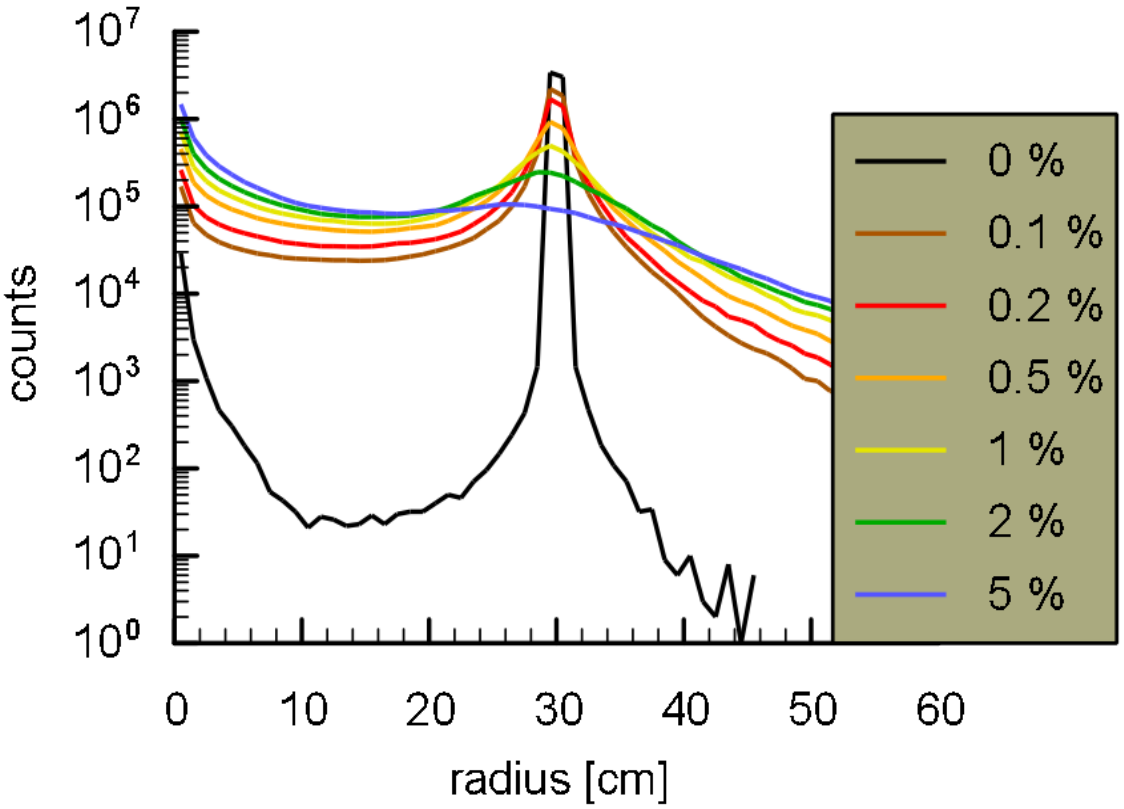
Resolution



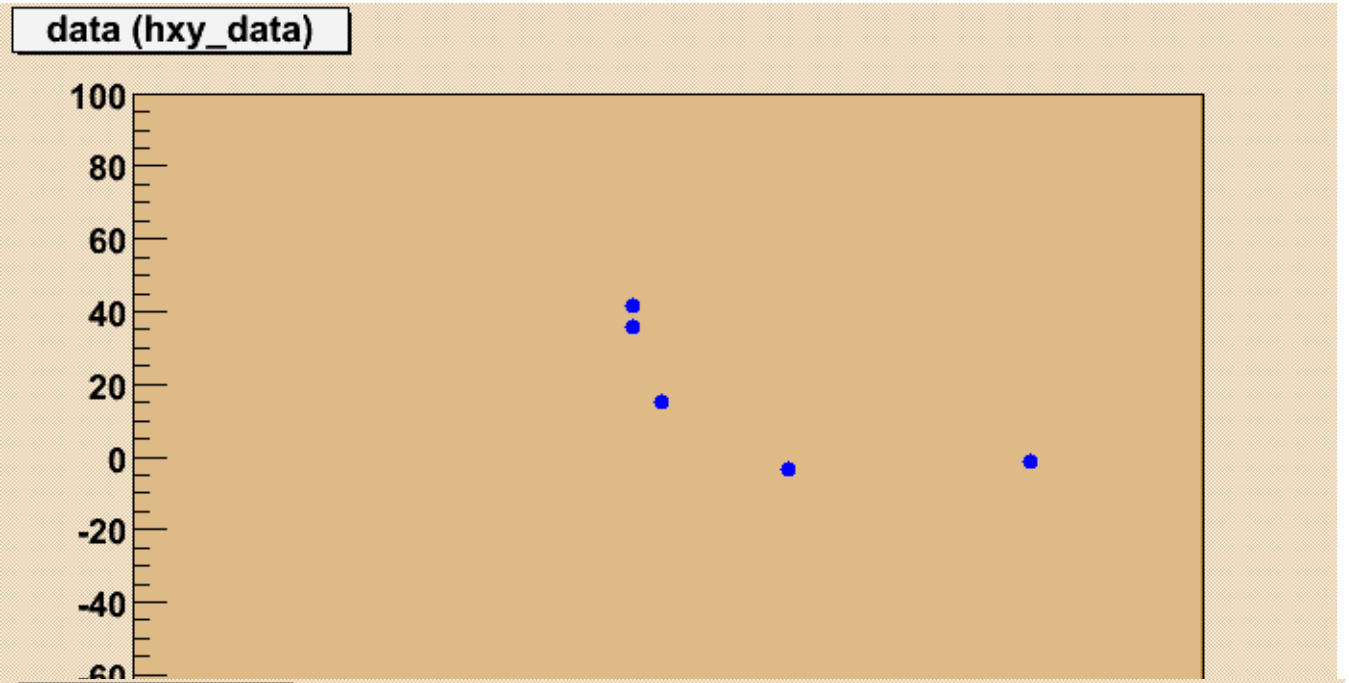
hand-generated data
opening angle smeared

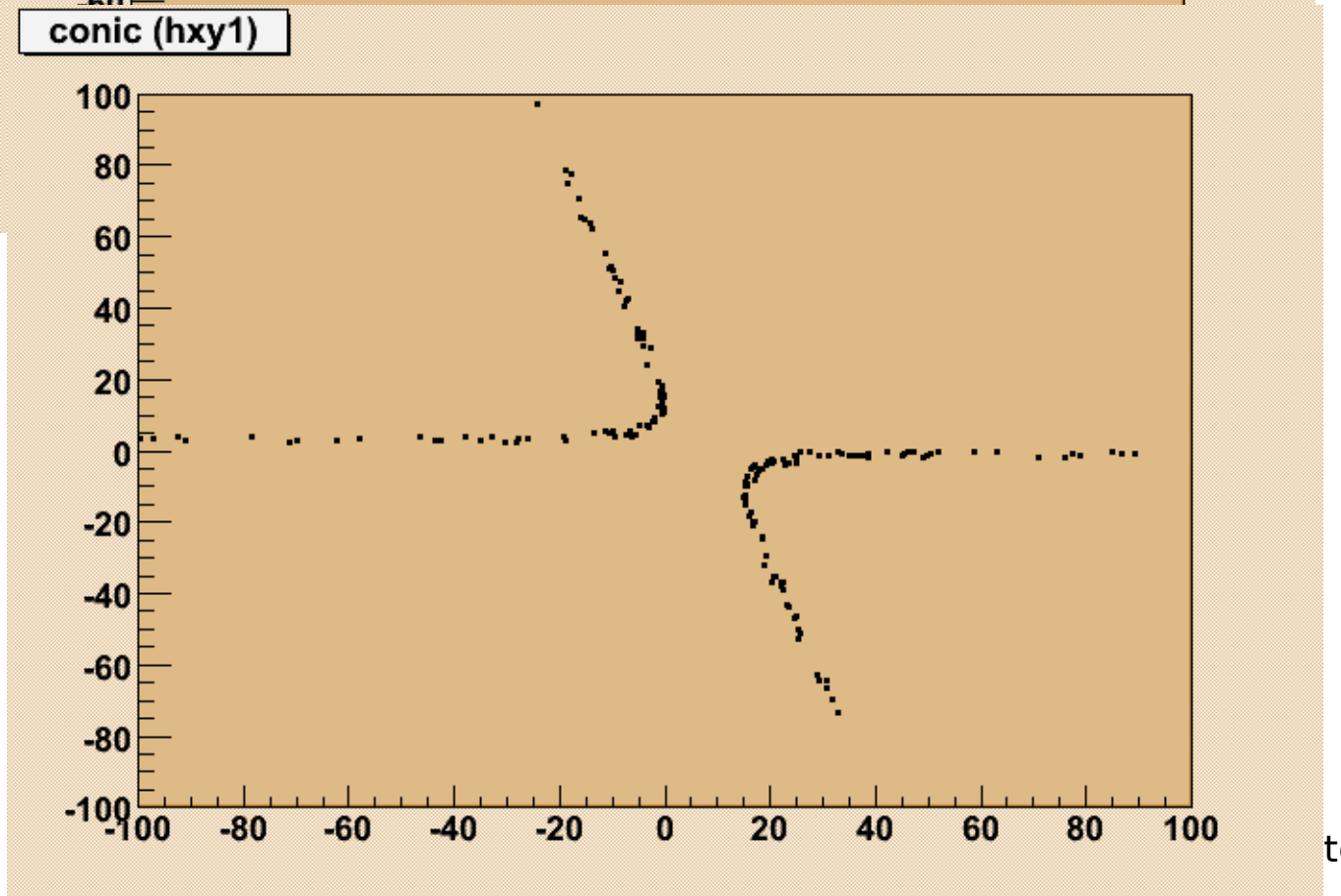
blue = small radii





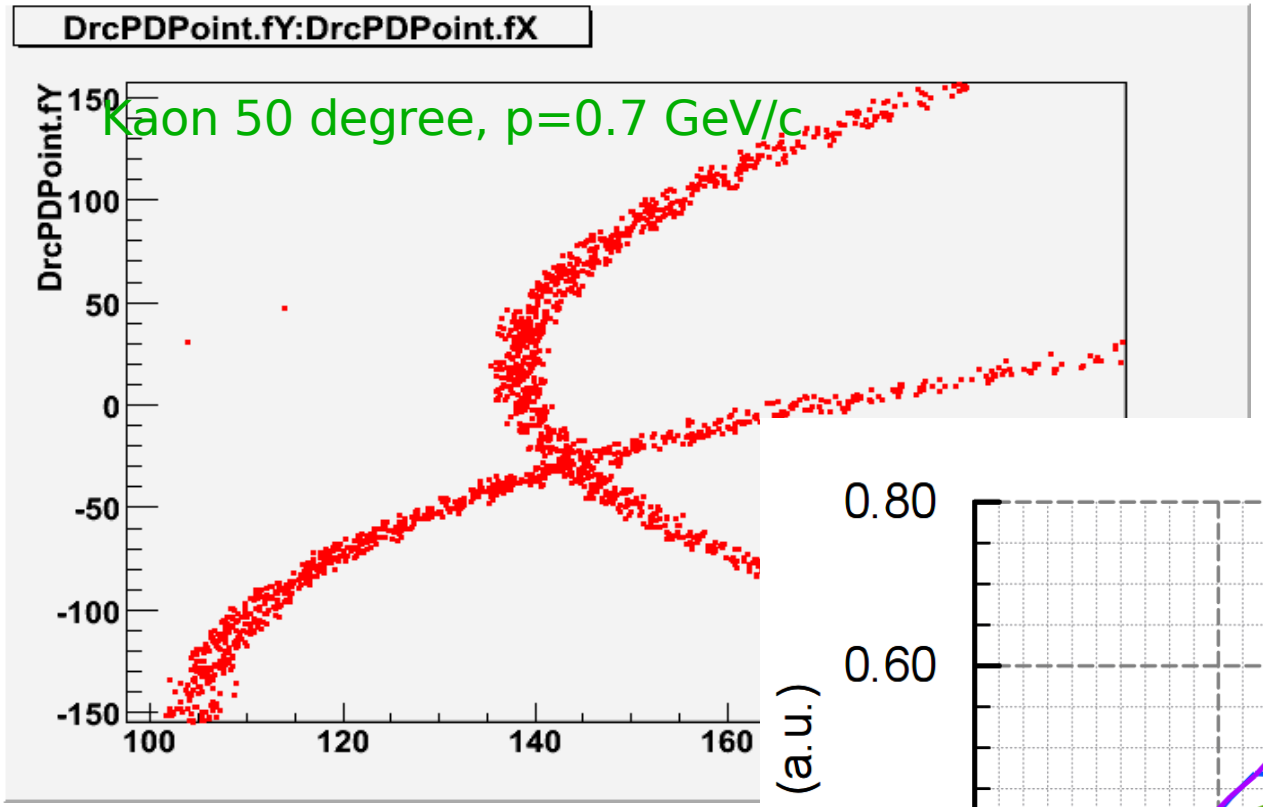
Traps



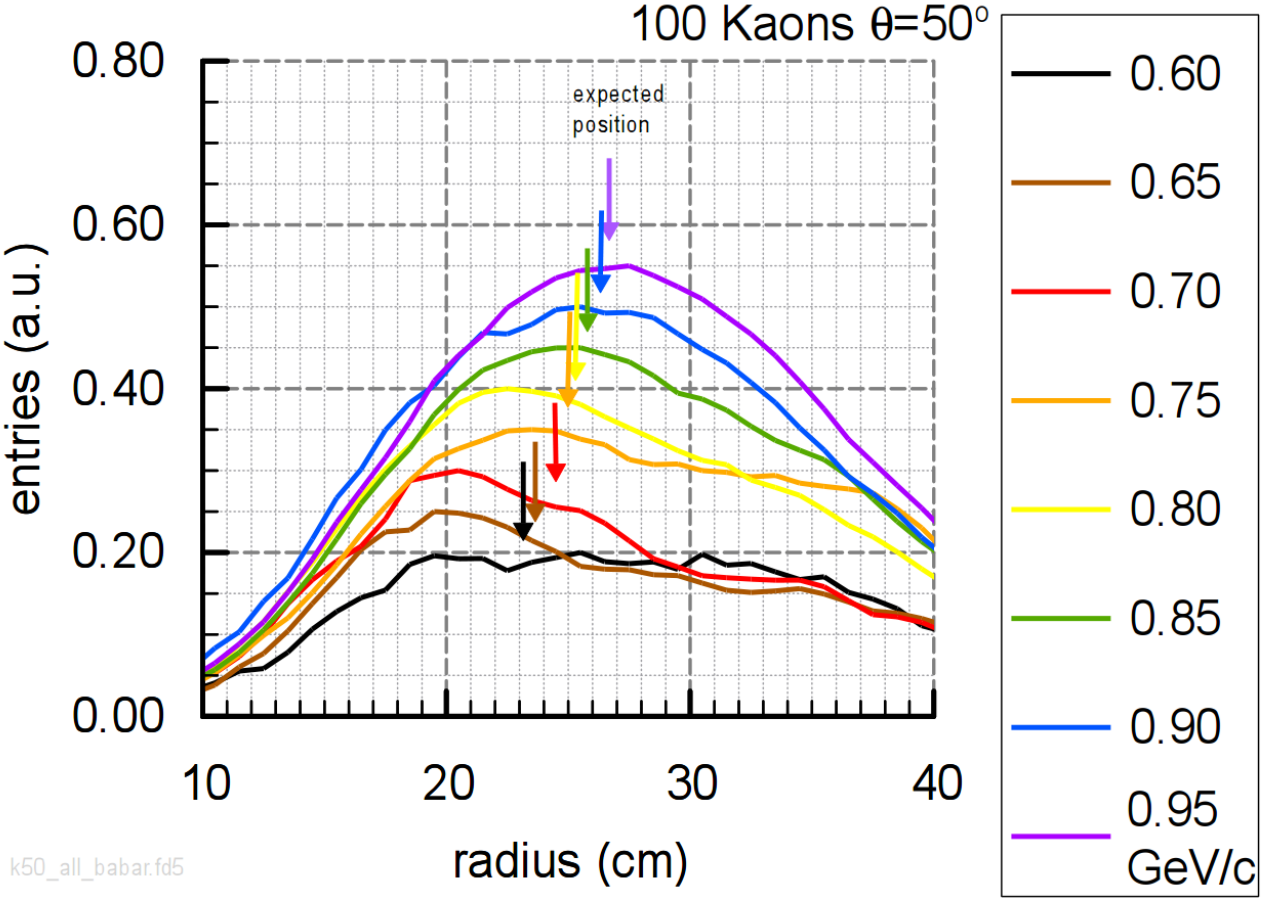


solution on two hyperbola branches!

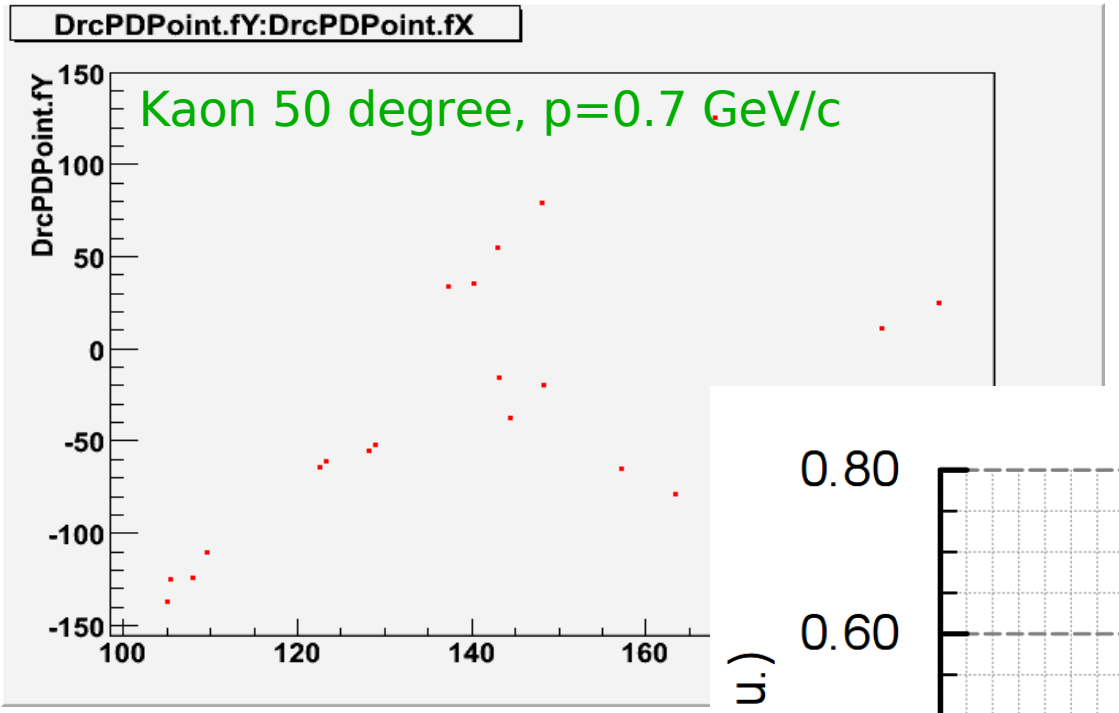
PandaRoot & Hough



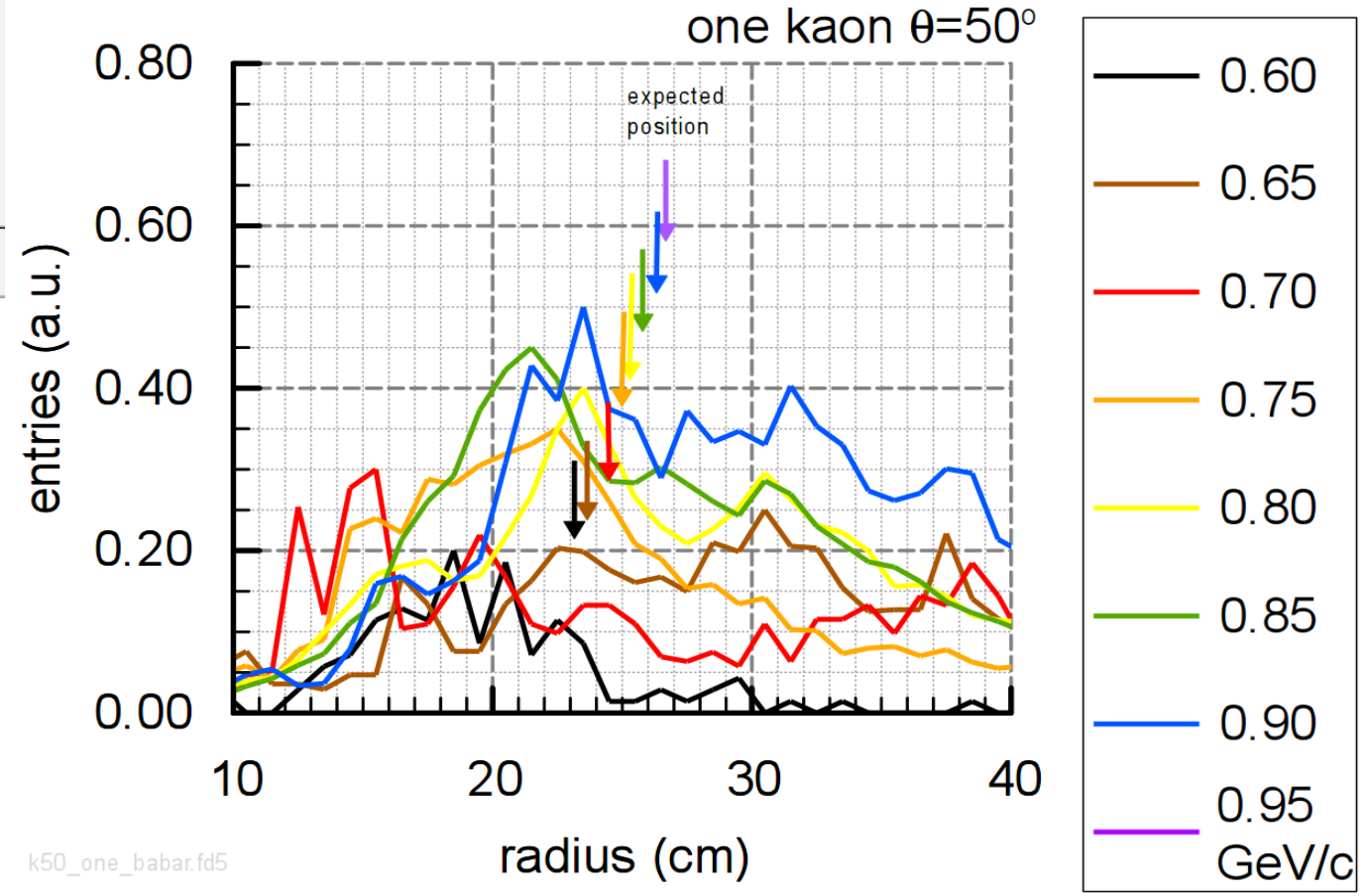
100 events



PandaRoot & Hough



1 events



Time

20 photons $\frac{20!}{(20-5)!\ 5!} = 1.5\ 10^4$ 10 seconds

X 5000

100 photons $\frac{100!}{(100-5)!\ 5!} = 7.5\ 10^7$ 50000 seconds = 14h

One has to work with subsets of combinations

but which data points are signal, which are noise???

Summary

- Very good position resolution is mandatory
  - for single event PID
  - discrimination against noise
- Hough transformation is not fast for $N_{ph}=100$
- Alternatives
  - Fit
  - Pattern lookup in 2D-arrays as function of p_{ch}, radiator# (BaBar focusing DIRC)