RICH Contribution to Trigger

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Introduction

- Moments calculation
- Resolution on radius and center position of the ring
- Preliminary estimate of rejection efficiency of two tracks events

Moments

Radius and center positions can be computed by using moments:

$$x_{Center} = \frac{\sum_{j=1}^{N} x_j}{N} = \frac{\mu_{1x}}{\mu_0} \qquad y_{Center} = \frac{\sum_{j=1}^{N} y_j}{N} = \frac{\mu_{1y}}{\mu_0}$$

$$r^2_{Ring} = \frac{\sum_{j=1}^{N} r_j^2}{N} = \frac{\sum_{i=1}^{n} r_i^2 n_i}{N} = \frac{\sum_{i=1}^{n} \left[\left(x_i - x_{Center} \right)^2 + \left(y_i - y_{Center} \right)^2 \right] n_i}{N} = \frac{\left(\mu_{2x} + \mu_{2y} \right)}{N} - \frac{\left(\mu_{1x}^2 + \mu_{1y}^2 \right)}{N^2}$$

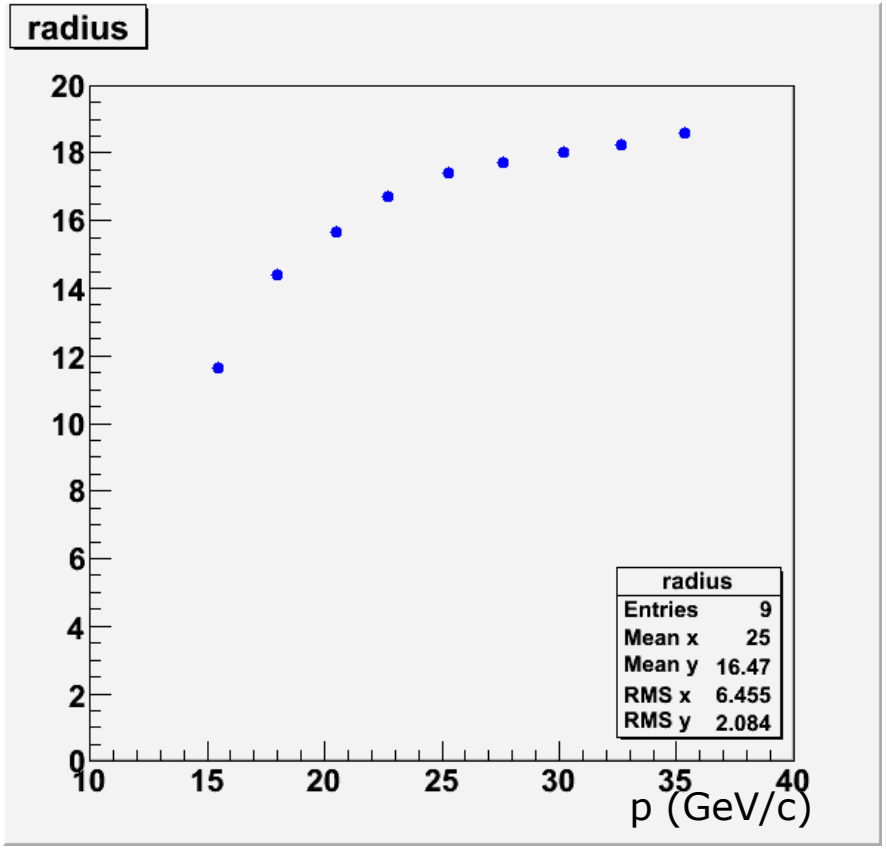
$$\mu_k = \sum_{i=1}^{n} x_i^k n_i$$

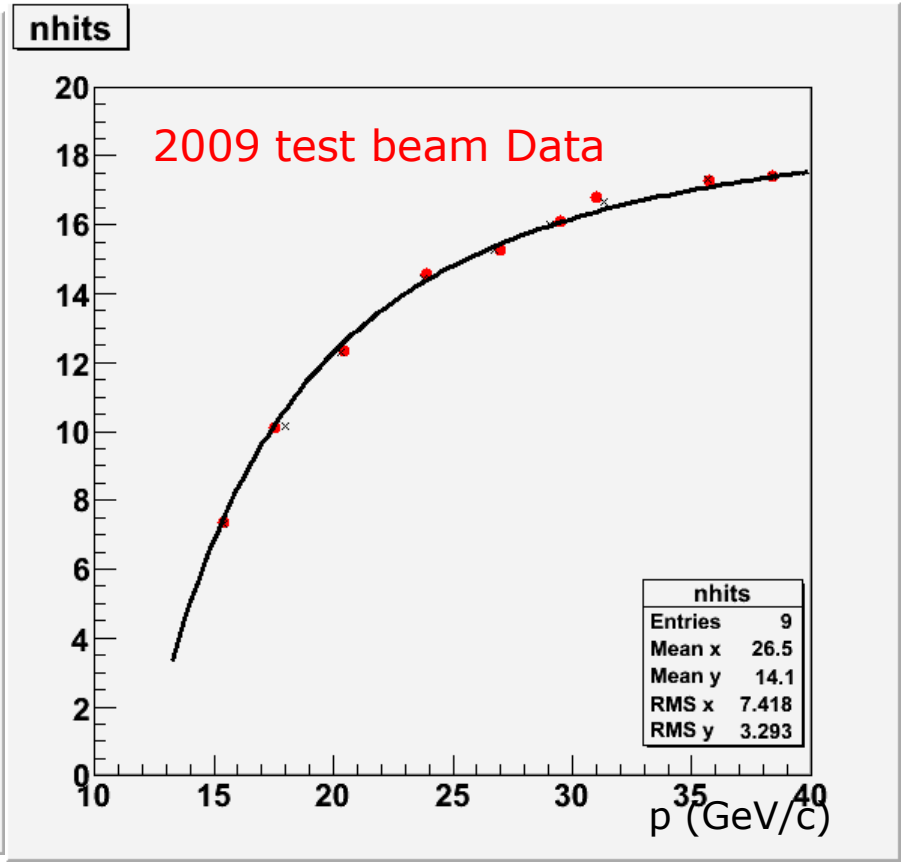
i is the index on all the PMTs

j is the index on the hit PMTs

$$\mu_o = \sum_{i=1}^{n} n_i = N \qquad \mu_{1x} = \sum_{i=1}^{n} x_i n_i = \sum_{j=1}^{N} x_j \qquad \mu_{2x} = \sum_{i=1}^{n} x_i^2 n_i = \sum_{j=1}^{N} x_j^2$$

Radius and Number of Hits vs P

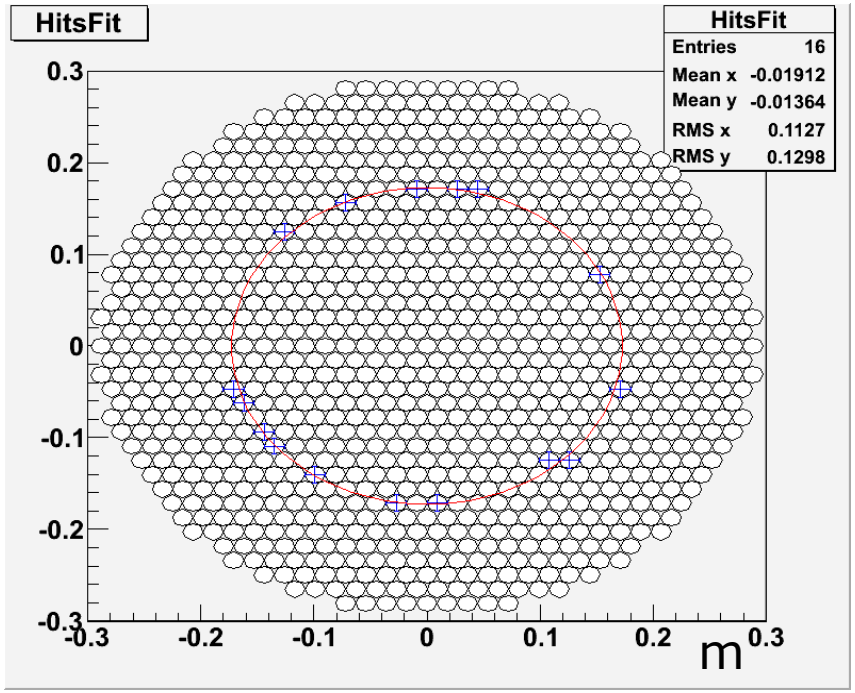




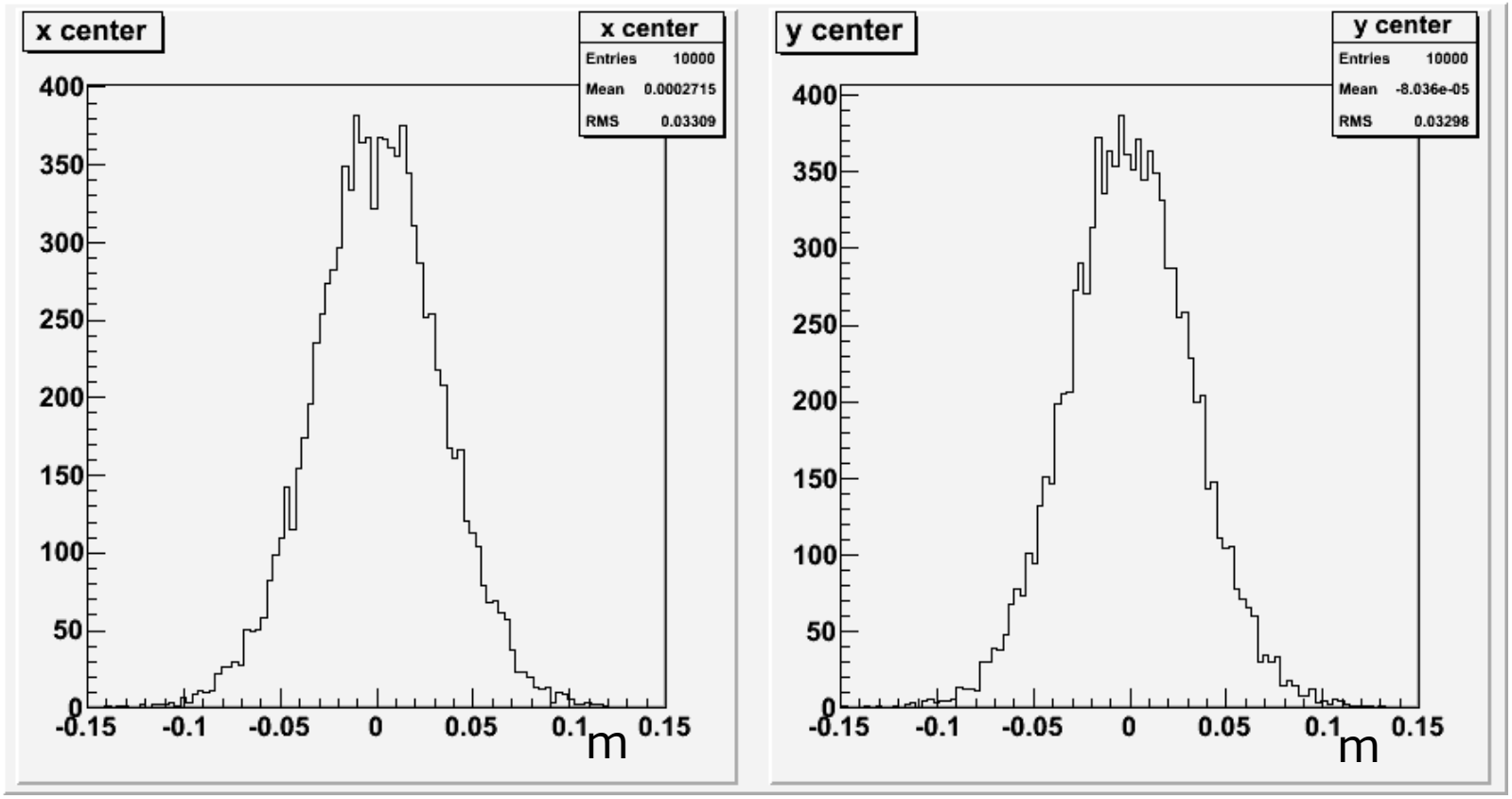
1 Ring Generation

- For each p value, 10000 rings centered in 0 are generated
- with a number of hits following a Poisson distribution
- with μ as obtained from the fit to the data distribution

Example: p=25 GeV/c,
R= 17.26 cm, μ =15

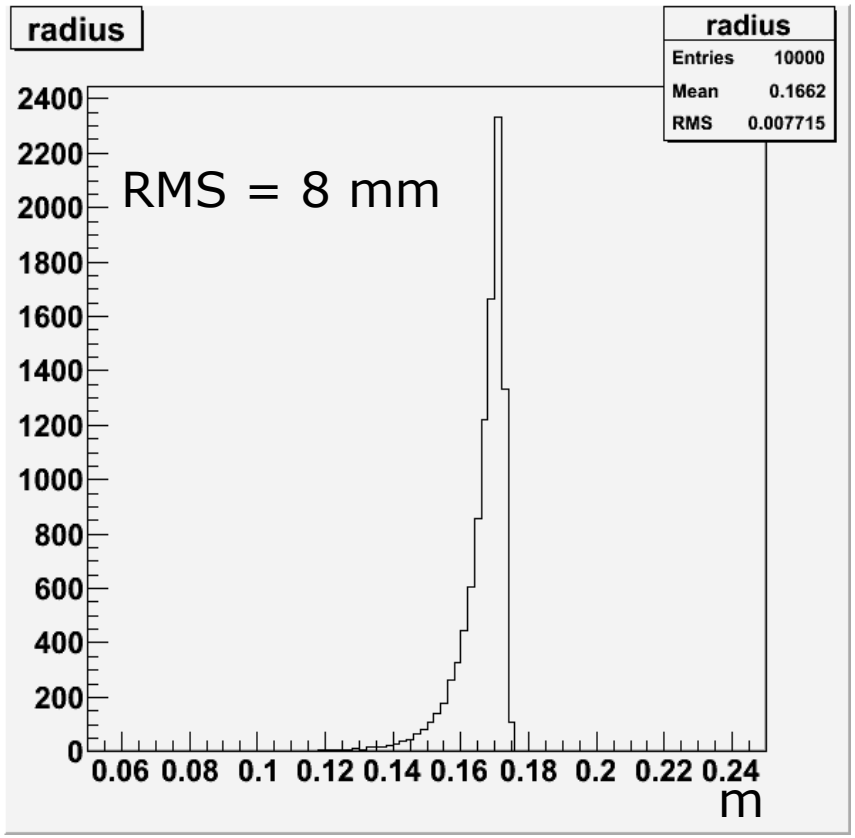


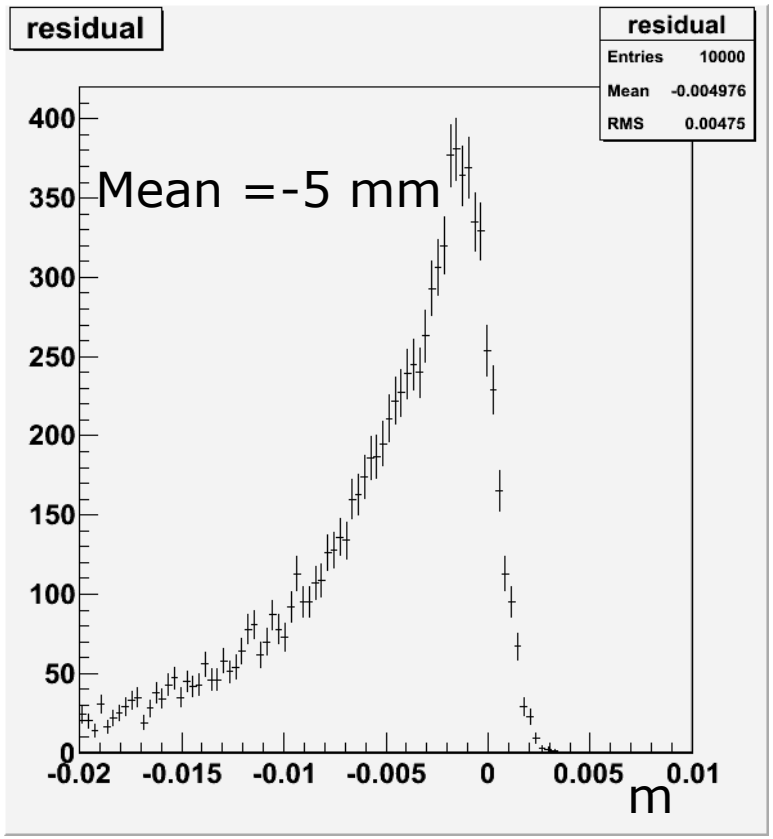
p=25 GeV/c : Center Position



Mean ~ 0 RMS ~ 3 cm

p=25 GeV/c : Radius





Bias does not depend on PMTs granularity

Asymmetry Coefficient

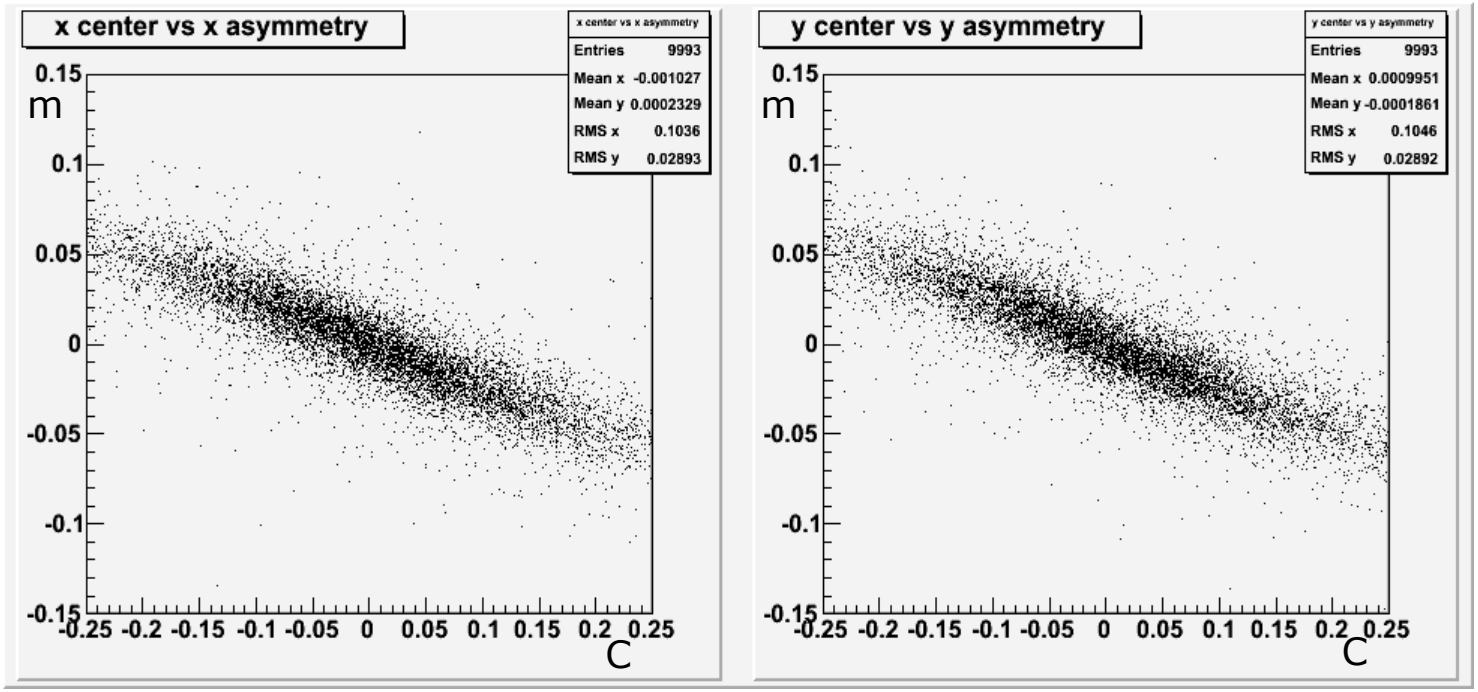
Define an asymmetry coefficient:

$$C_x = \frac{m_{3x}}{\left(m_{2x}\right)^{\frac{3}{2}}} = \frac{\sum_{j=1}^{N}\left(x_j - x_C\right)^3}{\left(\sqrt{\sum_{j=1}^{N}\left(x_j - x_C\right)^2}\right)^3}$$

both for x and y

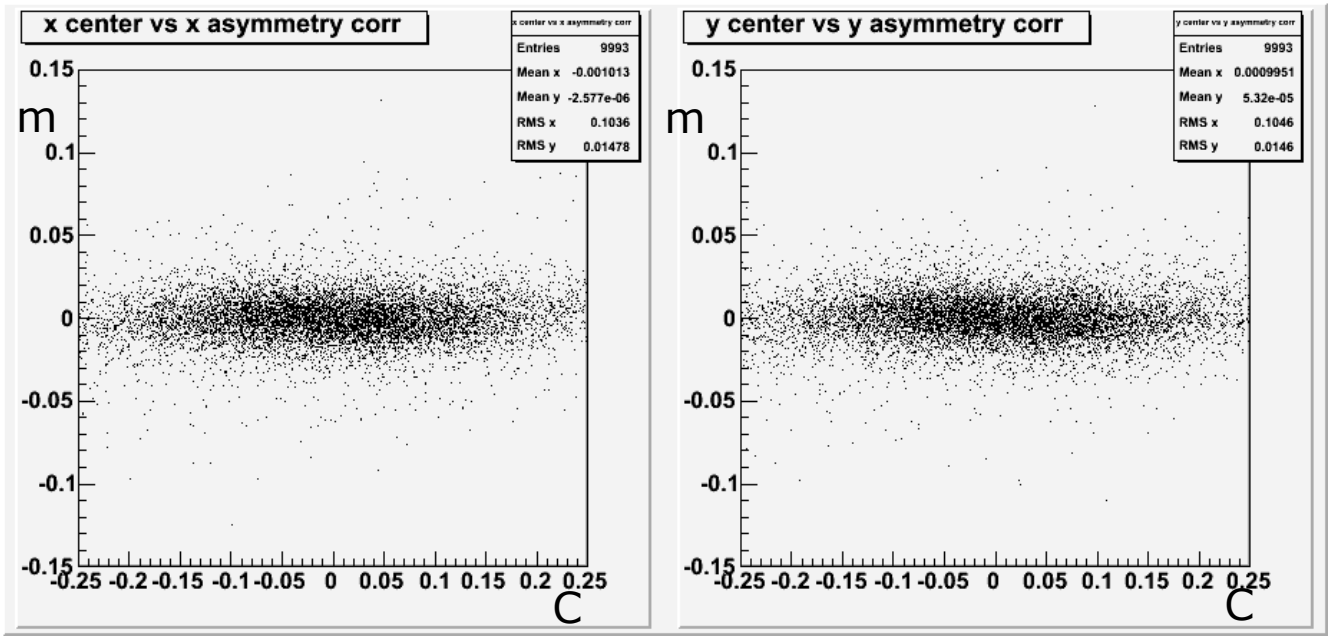
Asymmetry Coefficient

Correlation between center position and asymmetry coefficient

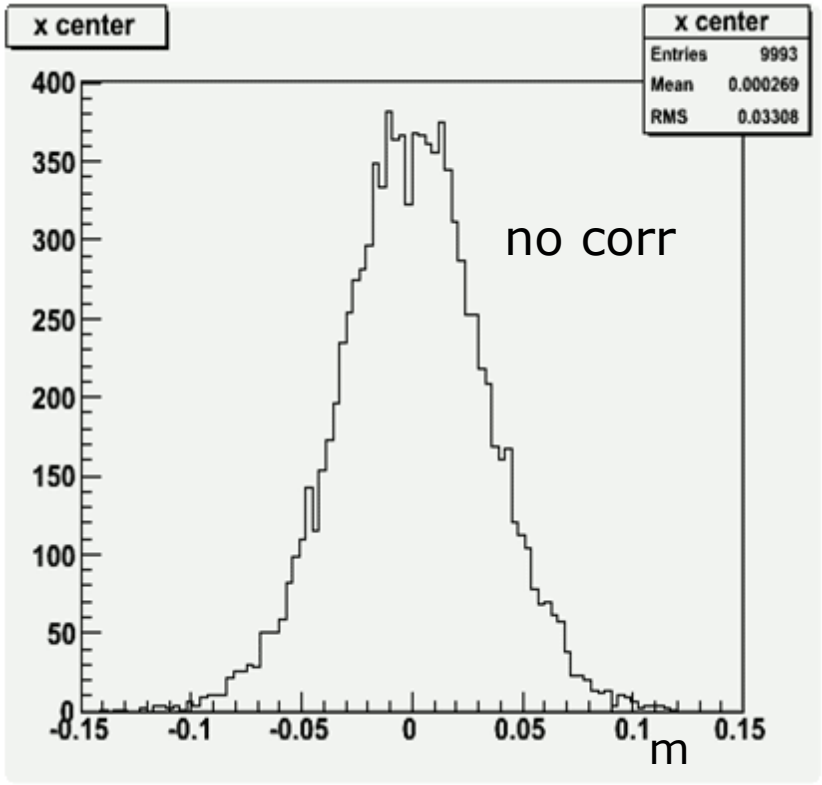


Correction

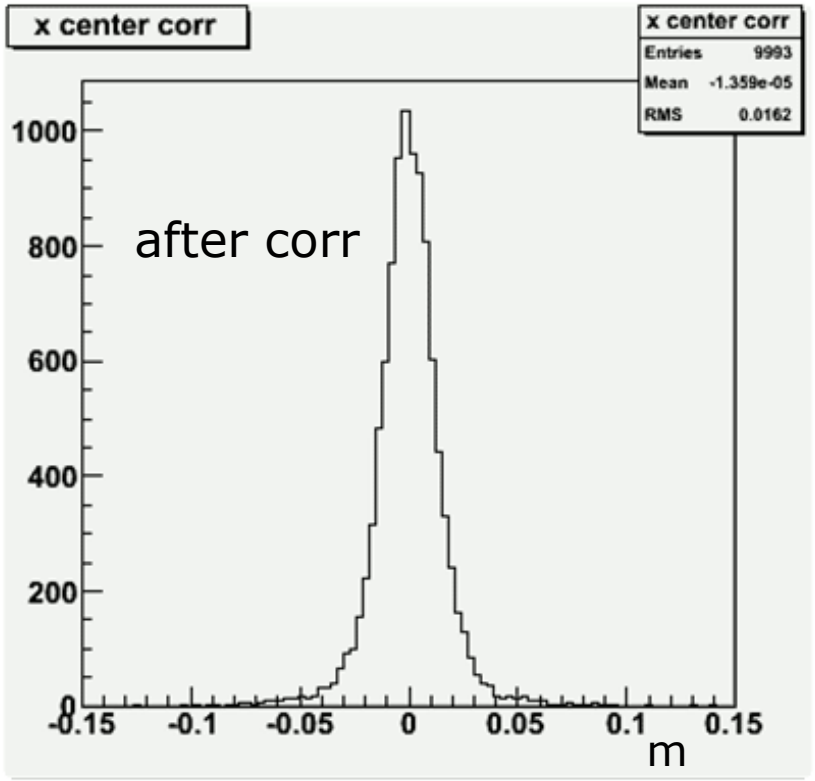
Perform a rotation to reduce the center position resolution



Center Resolution after Correction

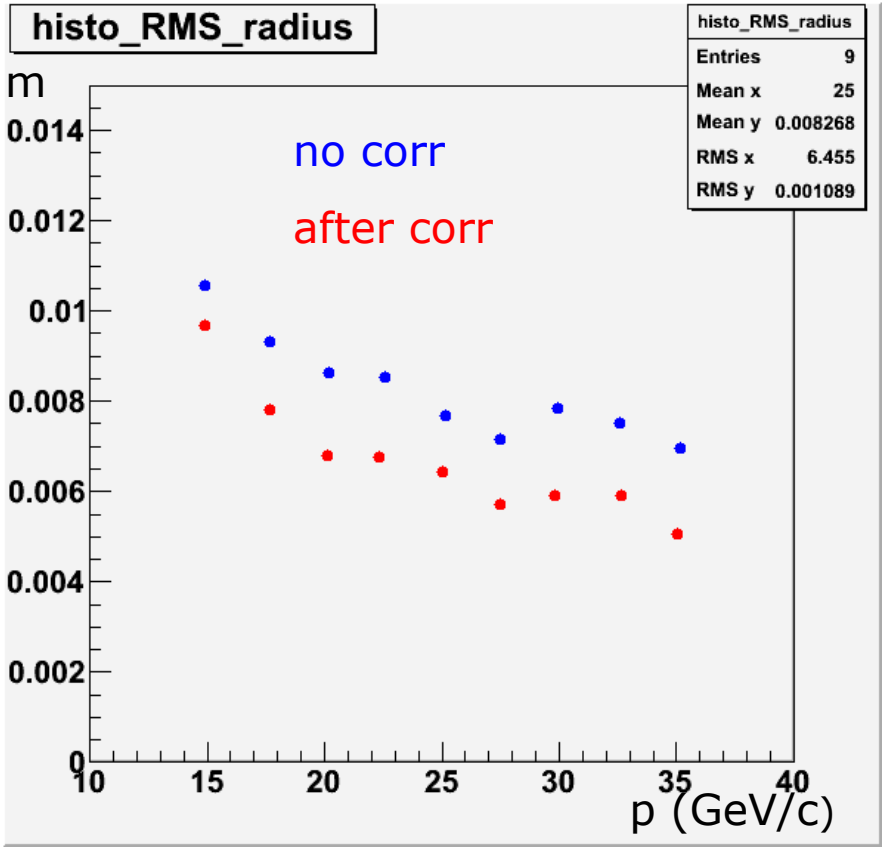


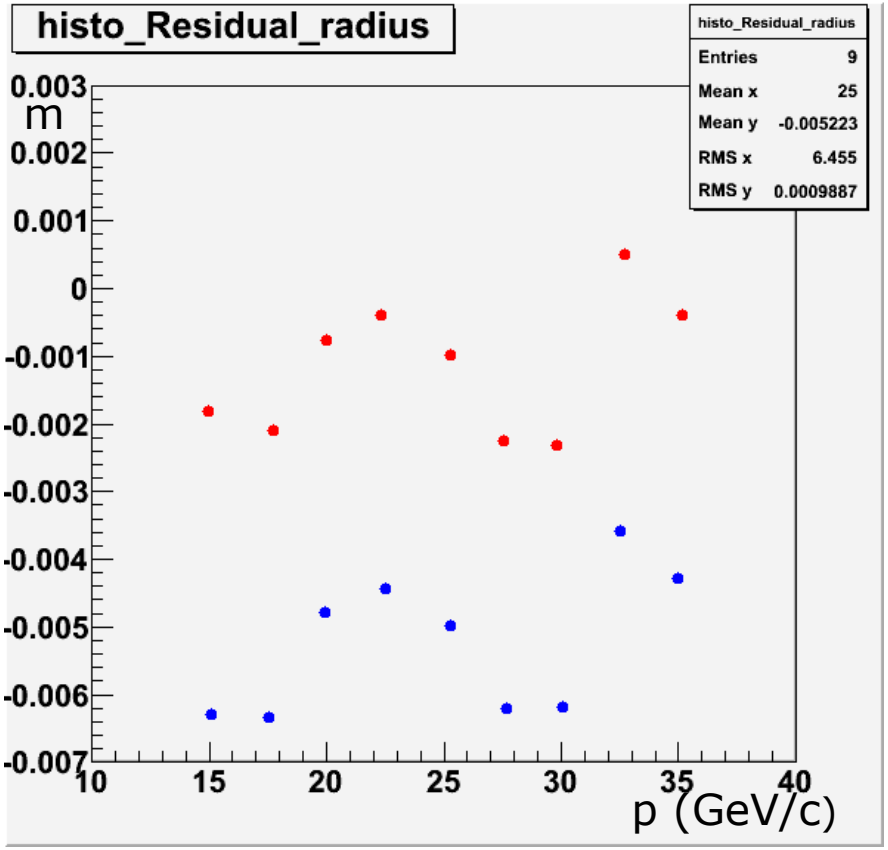
RMS=3.3 cm



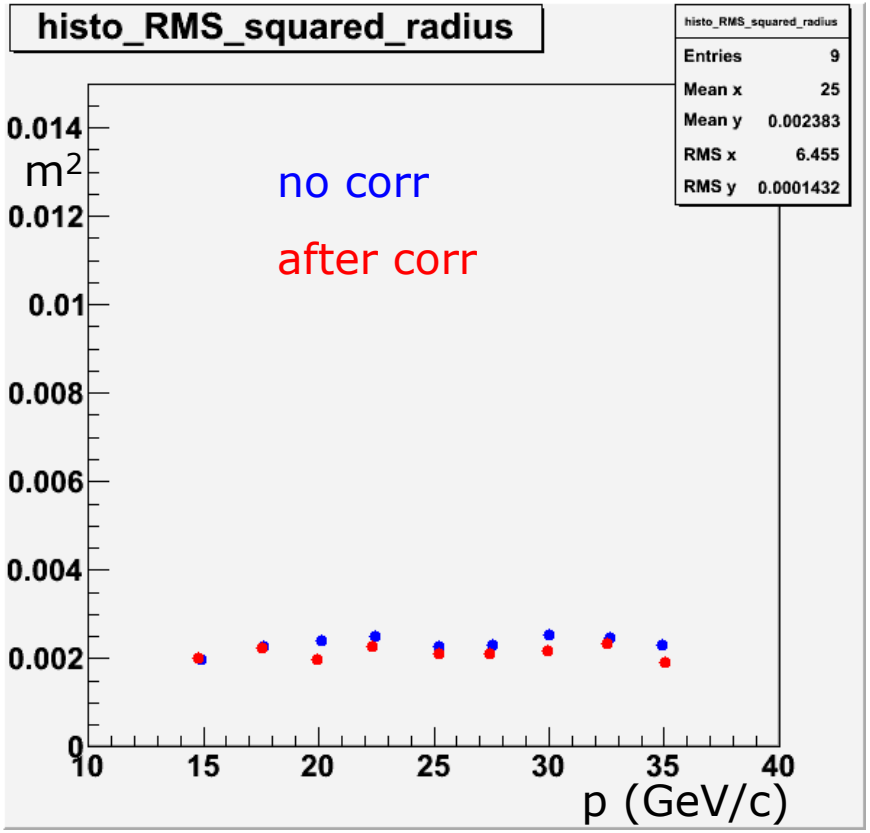
RMS=1.6 cm

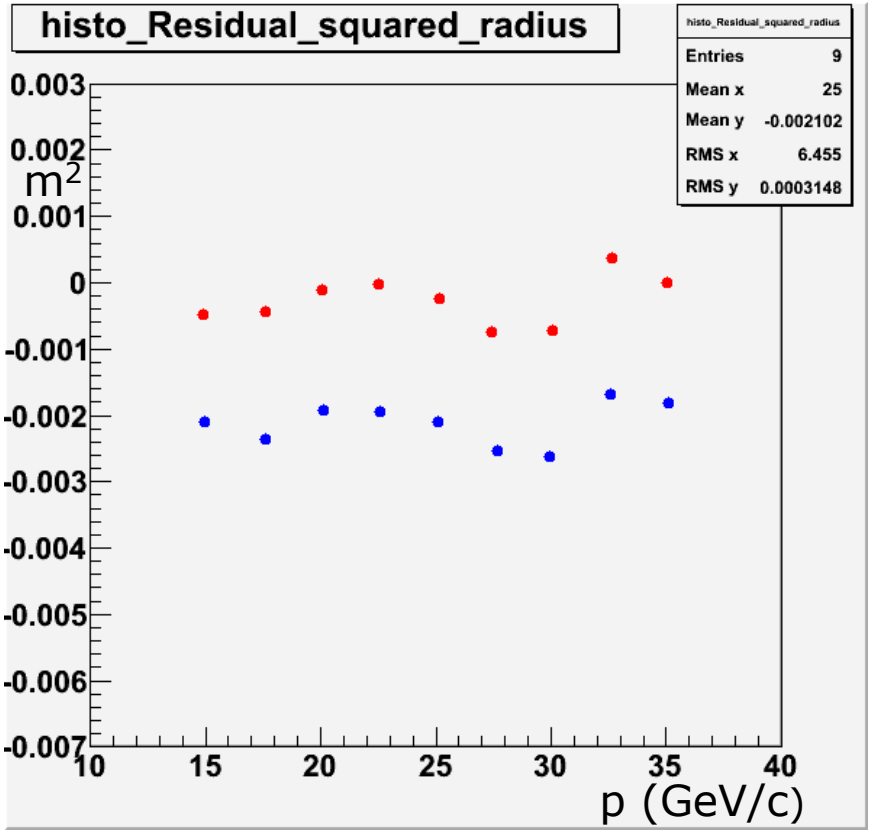
Radius vs Momentum





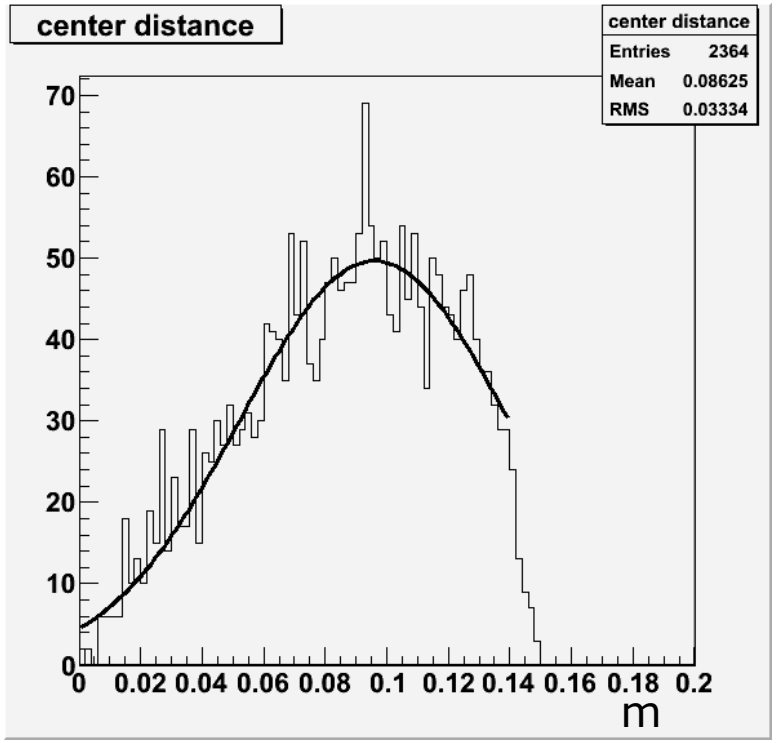
Squared Radius vs Momentum

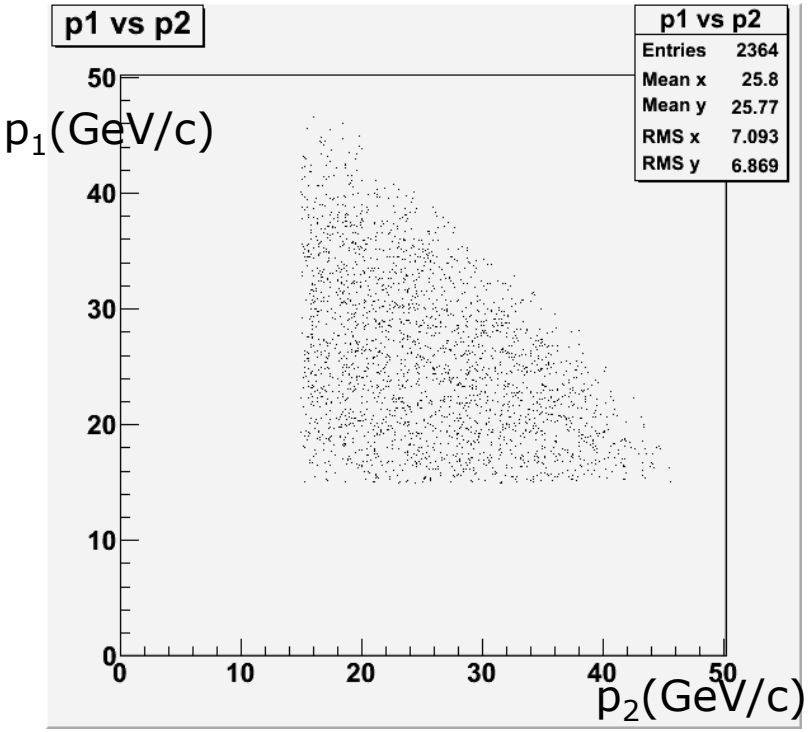




2 Rings Generation

Look at centers distance and momenta distribution in $K^+ \rightarrow \pi^+\pi^+\pi^-$ events

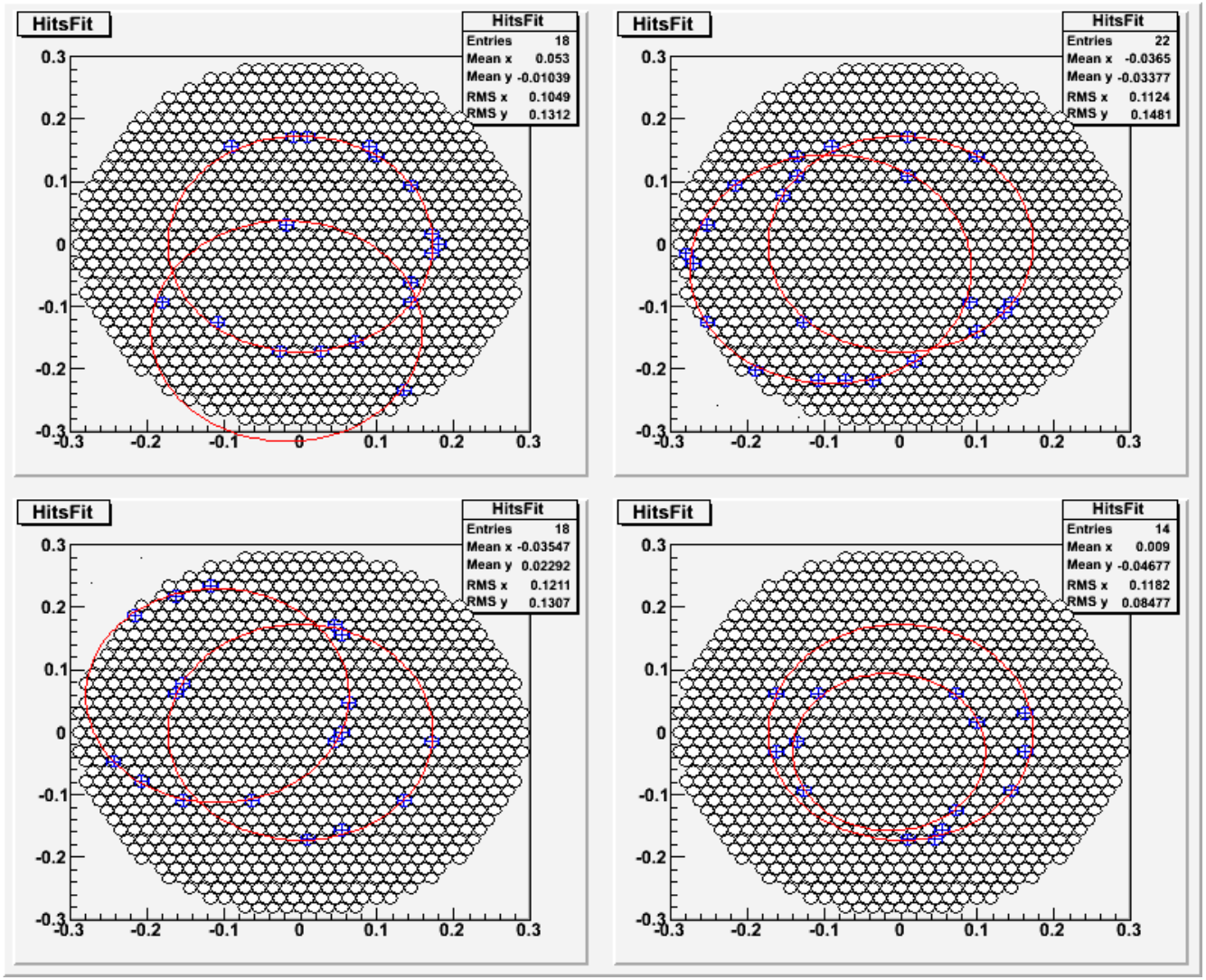




2 Rings Generation

- For each p1 value generate 10000 pairs of rings
- one, centered in 0 with radius and number of hits corresponding to the p1 value
- the other, with radius and number of hits corresponding to the allowed p2 distribution
- and center position following the centers distance distribution

p1=25 GeV/c


HitsFit
HitsFit
Entries 18
Mean x 0.053
Mean y -0.01039
RMS x 0.1049
RMS y 0.1312
HitsFit
HitsFit
Entries 22
Mean x -0.0365
Mean y -0.03377
RMS x 0.1124
RMS y 0.1481
HitsFit
HitsFit
Entries 18
Mean x -0.03547
Mean y 0.02292
RMS x 0.1211
RMS y 0.1307
HitsFit
HitsFit
Entries 14
Mean x 0.009
Mean y -0.04677
RMS x 0.1182
RMS y 0.08477

Kurtosis

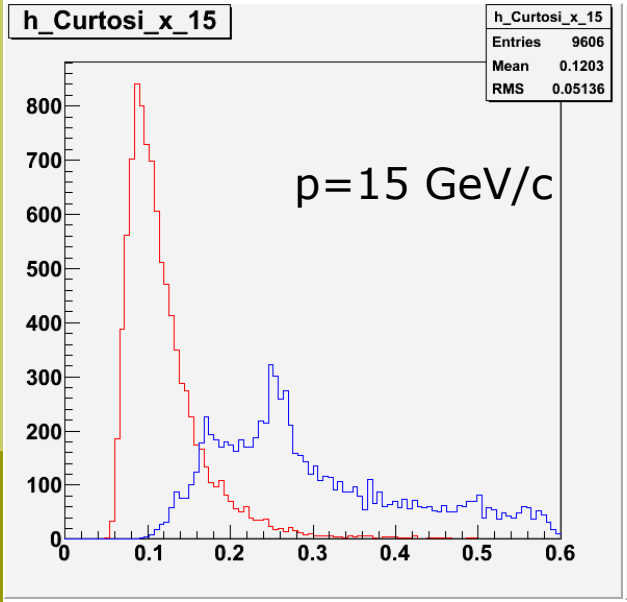
To distinguish between one and two rings events define:

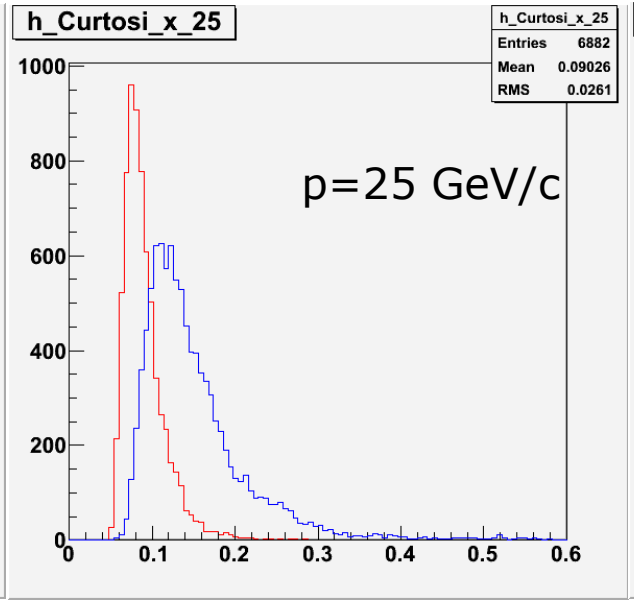
$$\beta_x = \frac{m_{4x}}{m_{2x}} = \frac{\sum_{j=1}^{N} \left(x_j - x_C\right)^4}{\left(\sum_{j=1}^{N} \left(x_j - x_C\right)^2\right)^2}$$

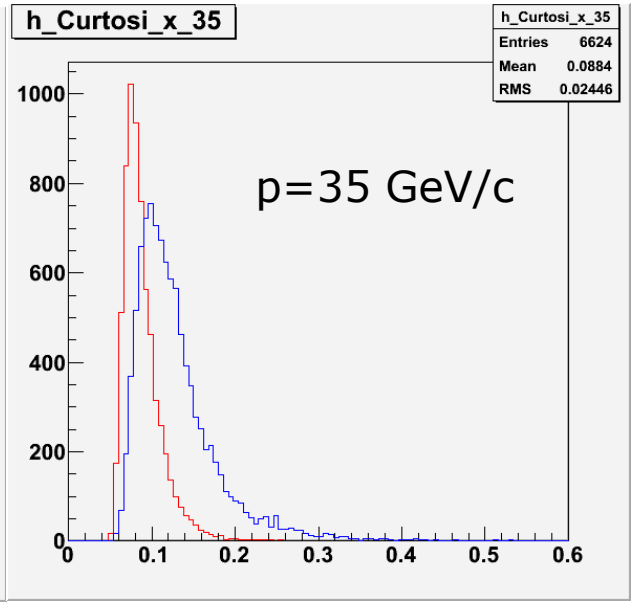
both for x and y

Kurtosis

After requiring 3<nhit ≤ 25







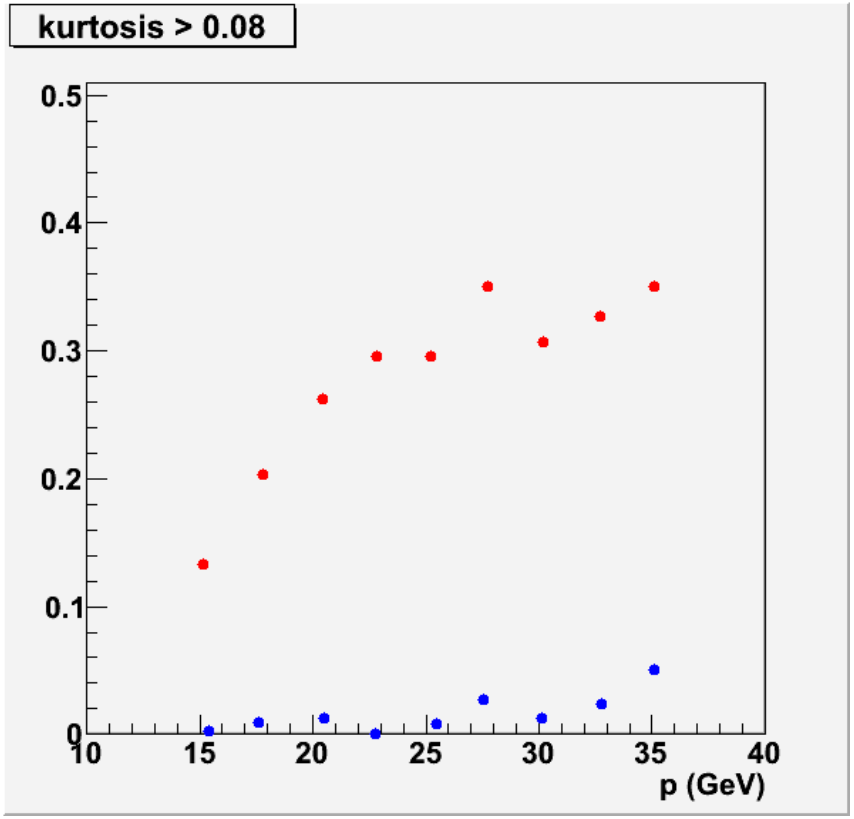
1 ring

2 rings

Two Tracks Events Rejection (Preliminary)

As an example:

- 2 tracks events rejection efficiency
- 1 track events inefficiency



To do list

- Further study on kurtosis rejection power
- Implement moments calculation in NA62 MC to evaluate rejection power and signal inefficiency