Studying ring topology in the NA62 RICH

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Meeting Analisi - Italia

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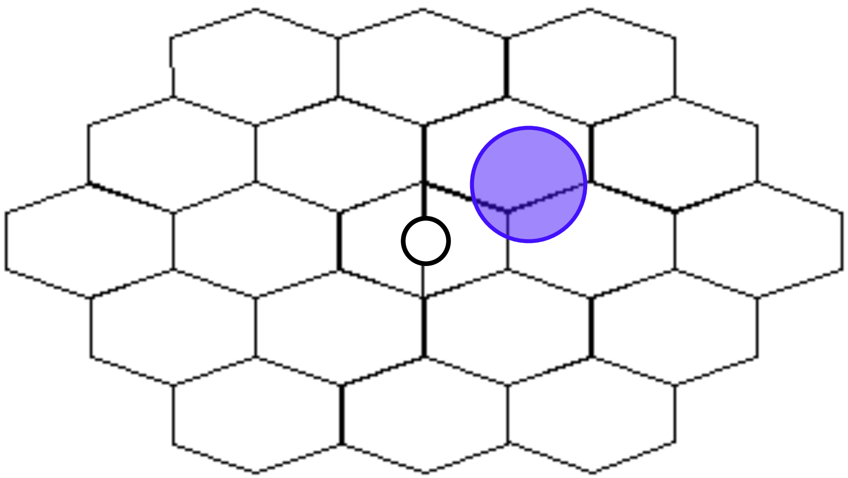
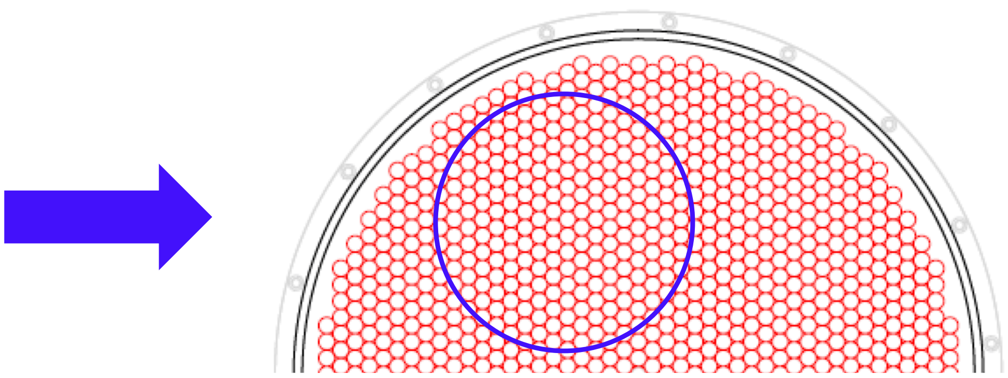
RICH ACCEPTANCE

Remind:

The Cerenkov light emitted by a charged particle hits the RICH mirrors in a circle surface (impact surface) with radius R_{ring}

The RICH geometry remap the reflected photons into a ring with radius R_{ring} in the focal surface (where the PMTs are installed)



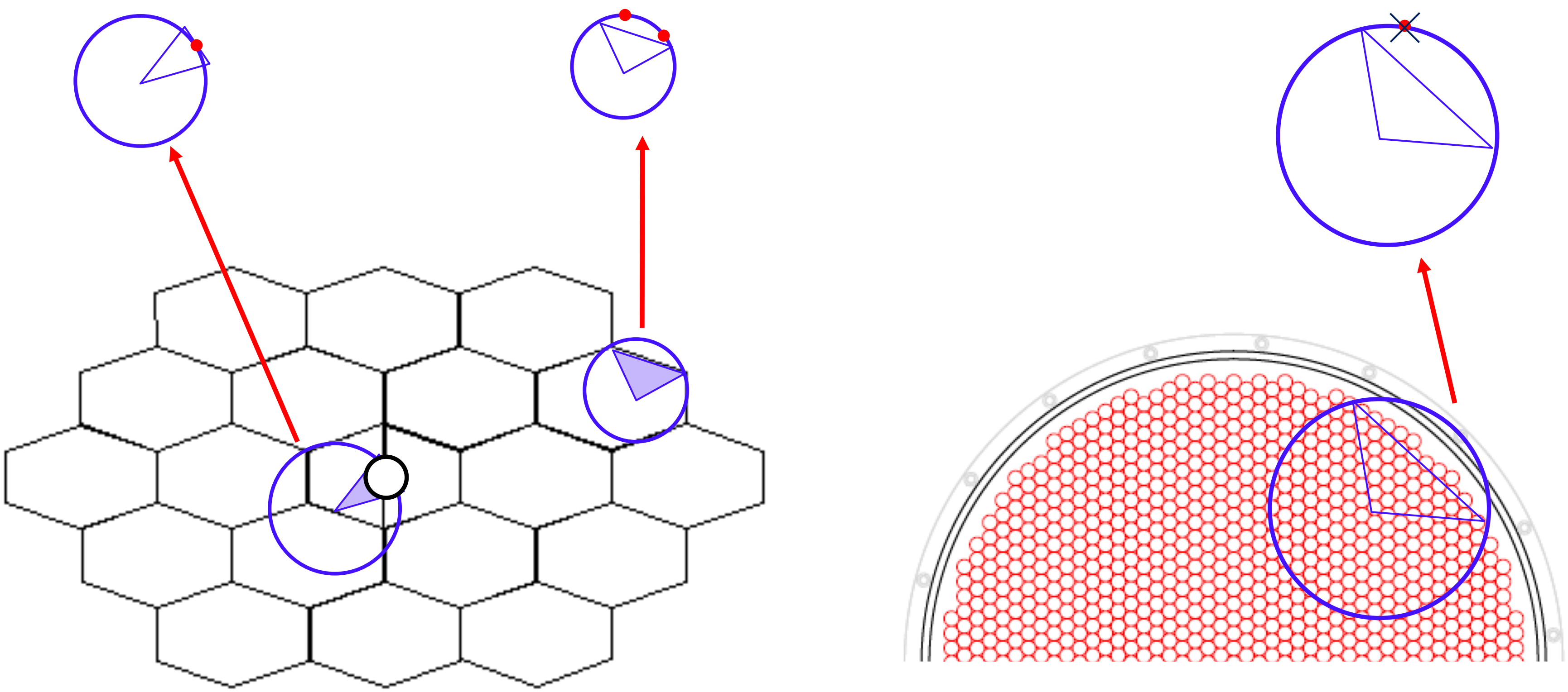


Then RICH geometrical acceptance is mainly defined by 2 constrains:

1) The surface covered by the RICH mirrors
2) The surface covered by RICH PMTs

RICH ACCEPTANCE

Different effects on the possibility to have hits in a certain arc of the ring

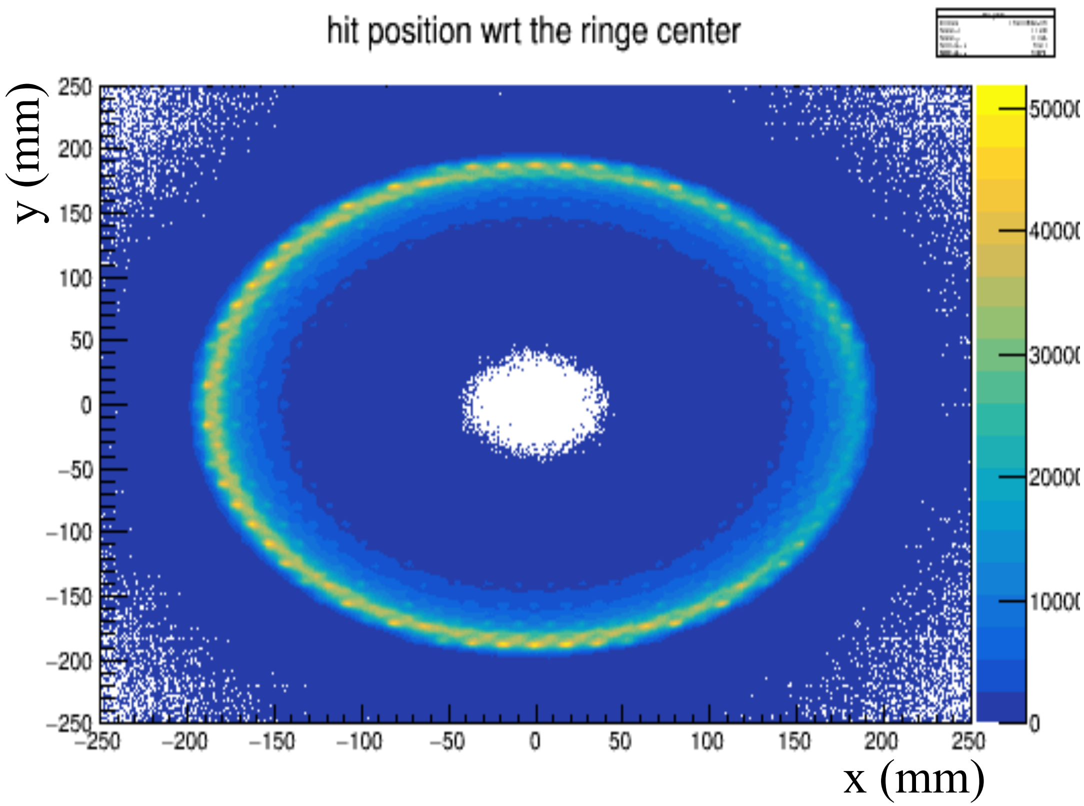


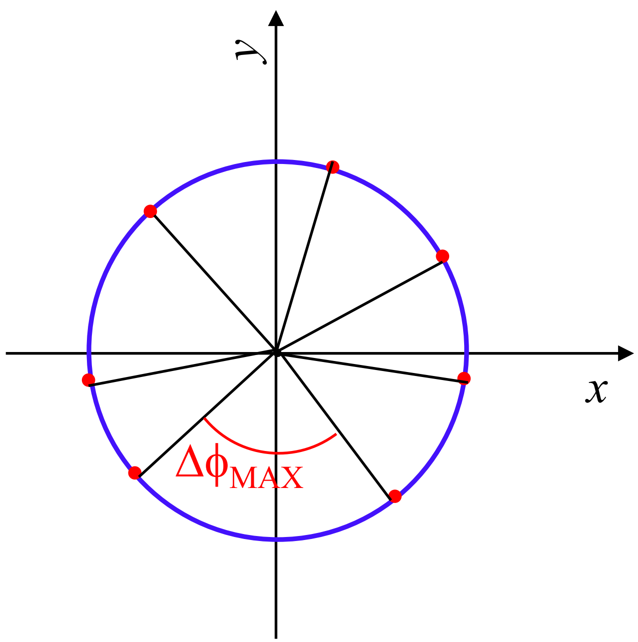
➡ Instead to apply a priori acceptance cuts, let's look to the distributions of the hit in the reconstructed ring

Method

Once a ring is reconstructed:

- For each hit calculate the angle wrt the ring center in the *xy* plane
- Order the angles from the smallest to the largest
- Calculate $\theta_{i+1} - \theta_i$
- Calculate $\Delta\phi_{MAX}$



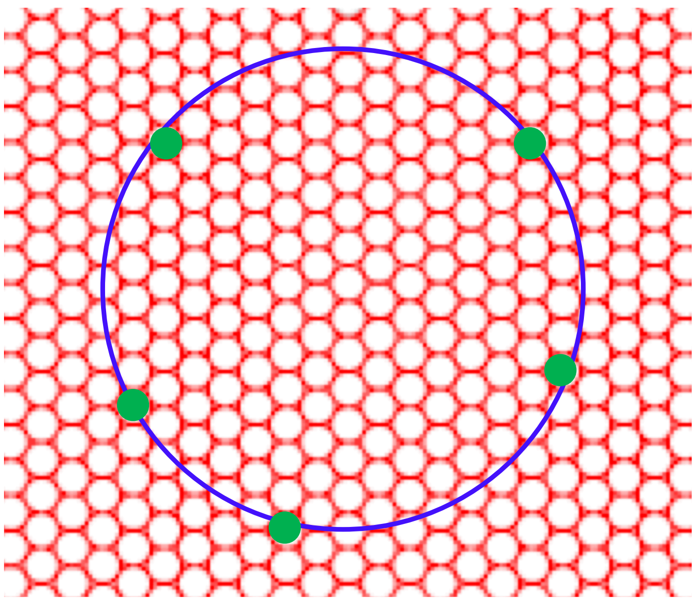


Rest Frame of the ring center

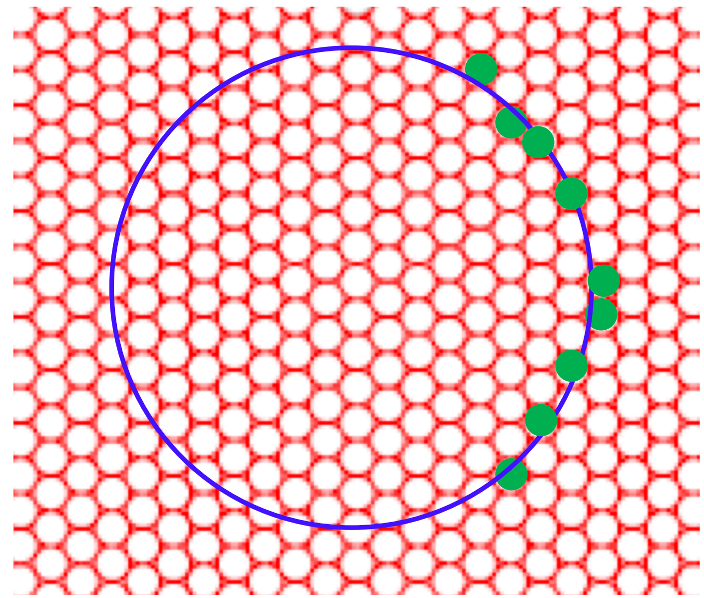
Acceptance and bias to the fit

- Applying a cut on $\Delta\phi_{MAX}$ will also reject rings that are fully contained in the "traditional" geometrical acceptance.
- In any case the fit of rings with large $\Delta\phi_{MAX}$ is expected to be strongly biased

Good situation, even with few hits

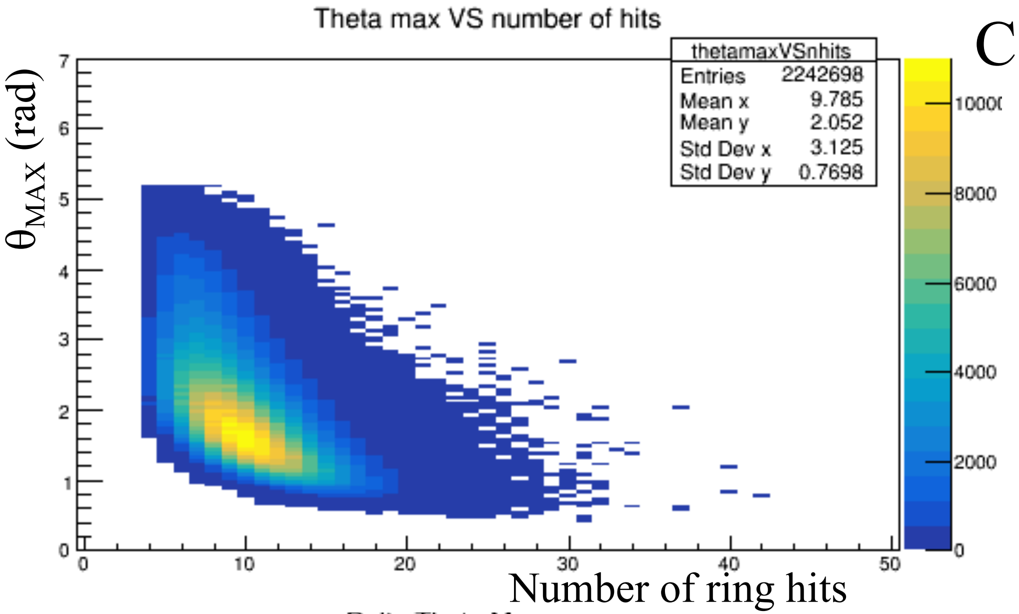


Bad situation, even with many hits

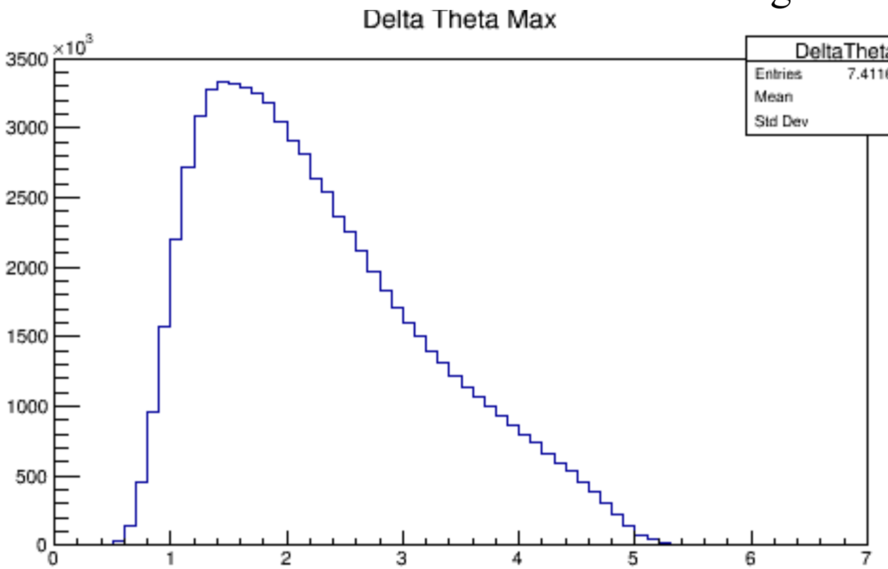


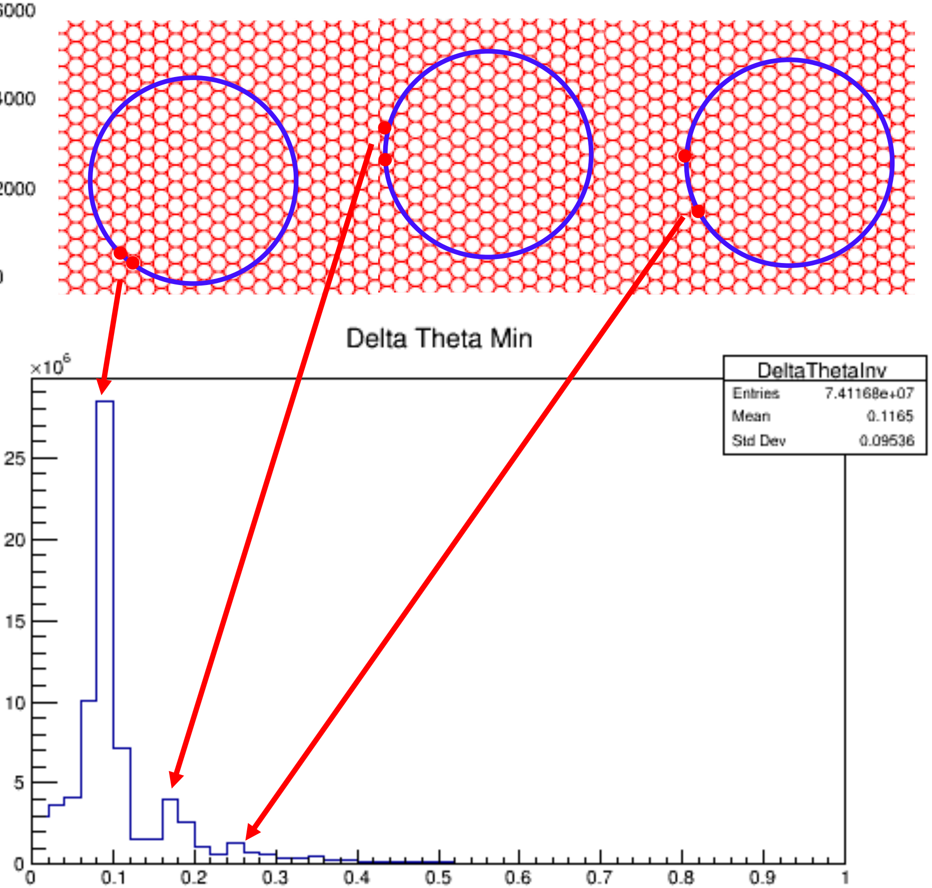
Rings with strong biases to the fit will be removed by a cut on $\Delta\phi_{MAX}$

$\Delta\phi_{MAX}$ and $\Delta\phi_{MIN}$ distributions



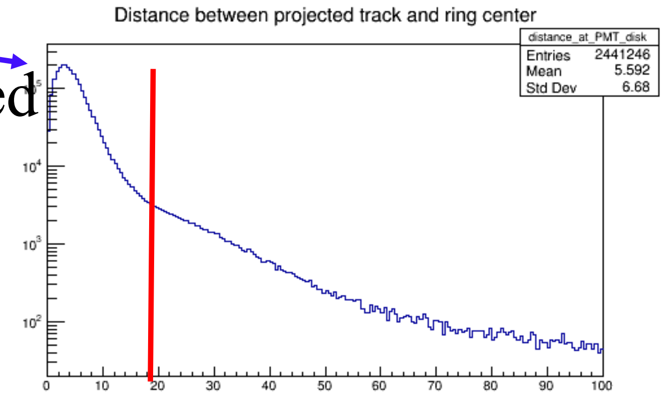
Clear $\Delta\theta_{MAX}$ dependence from n_{Hits}





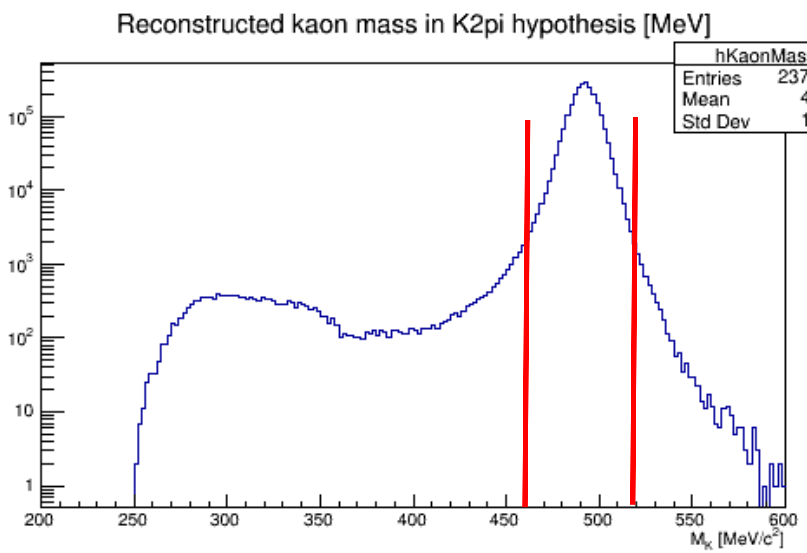
$\pi^+\pi^0$ and kμ2 samples

- Used the standard selections in PhysicsTools with few tighter cuts
- Request to have a space and time coincidence between the track and a RICH ring (4% losses)
- ∼1000 bursts of run 6501 have been analyzed

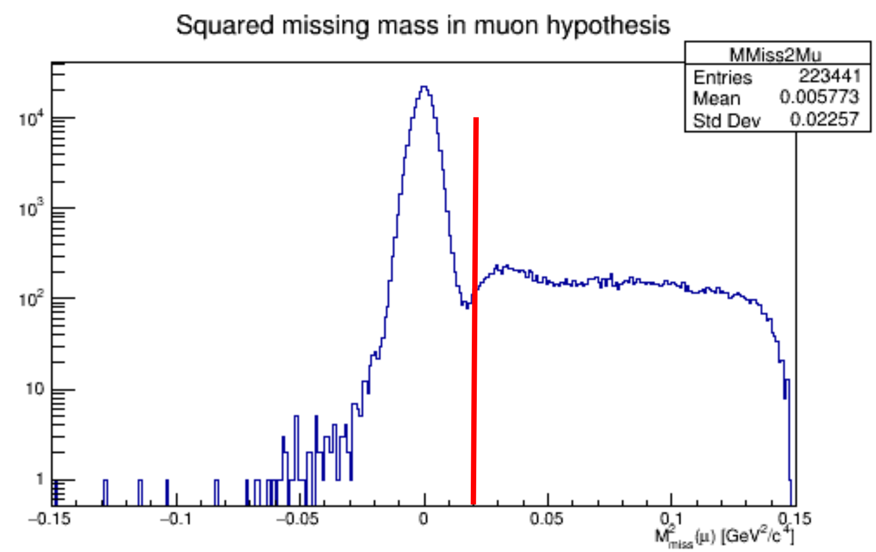


Final samples before the last cuts:

$\pi^+\pi^0$



kμ2

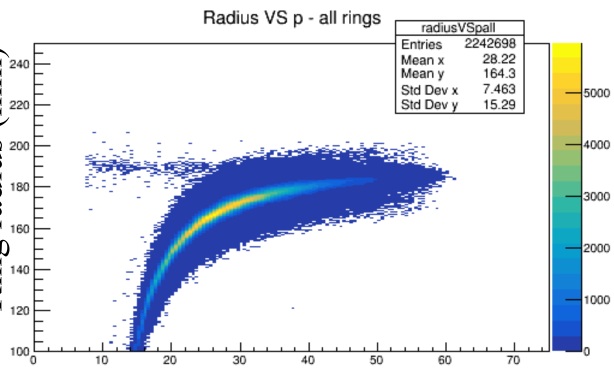


Results

The ring with $\Delta\phi_{MAX}$<2.95 rad (170°) are defined good, bad all the others

$\pi^+\pi^0$

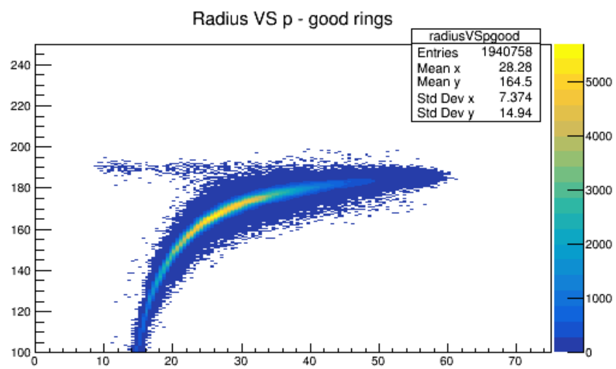
ALL



Ring radius (mm)

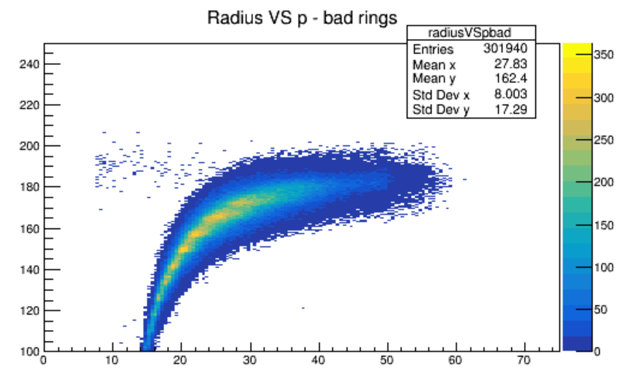
π^+ momentum (GeV/c)

GOOD



π^+ momentum (GeV/c)

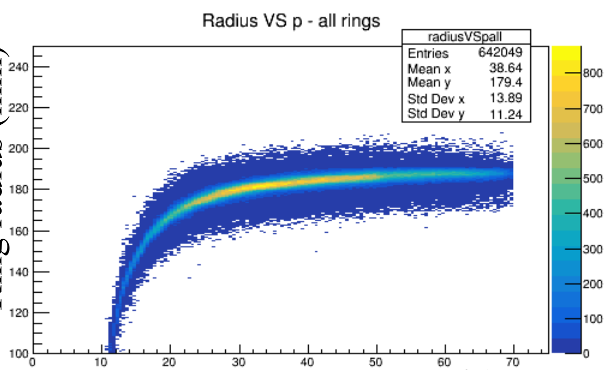
BAD



π^+ momentum (GeV/c)

Kμ2

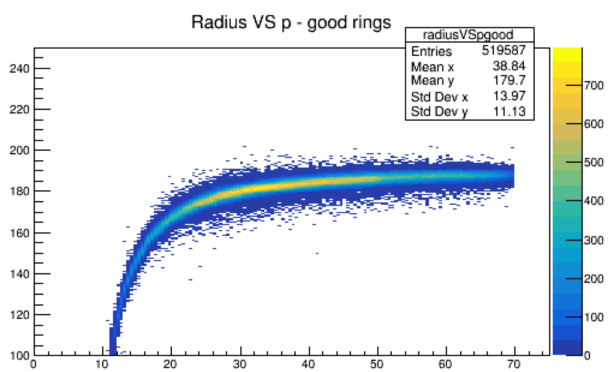
ALL



Ring radius (mm)

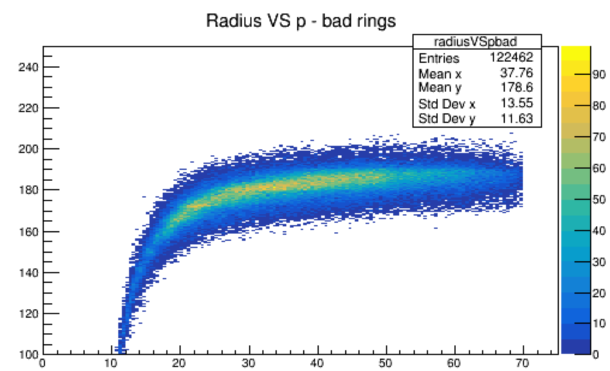
μ^+ momentum (GeV/c)

GOOD



μ^+ momentum (GeV/c)

BAD



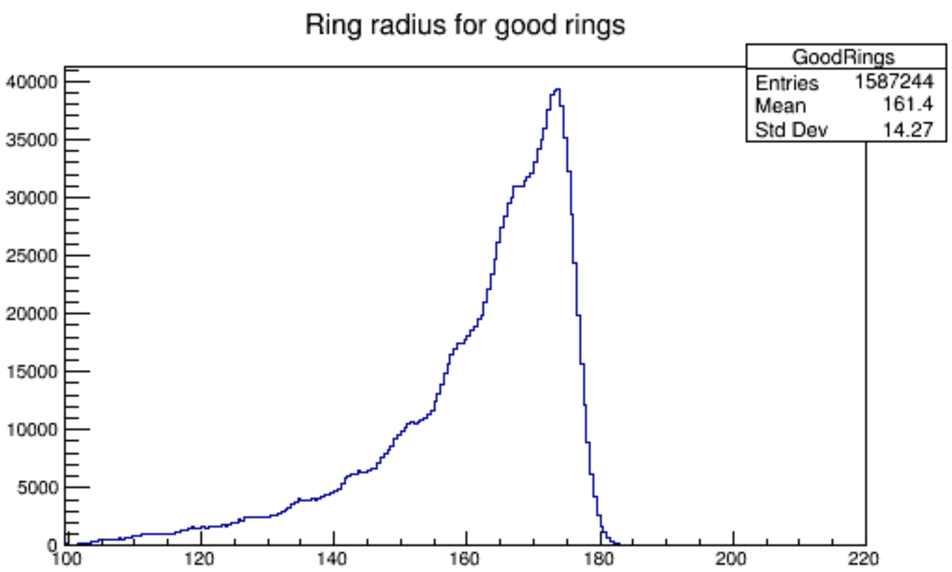
μ^+ momentum (GeV/c)

Radius distribution:good and bad rings

Defined good the ring with $\Delta\phi_{MAX}<2.95$ rad (170°), bad all the others

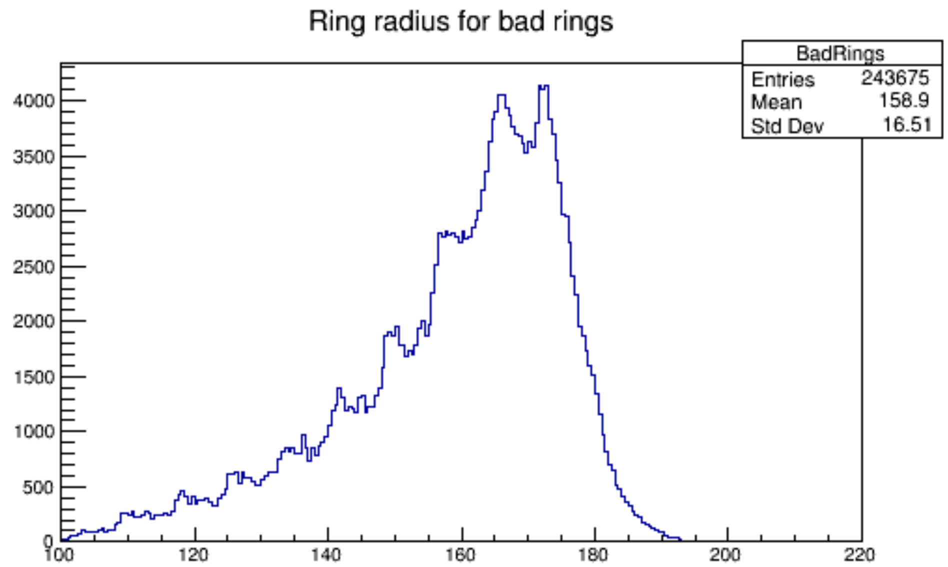
$\pi^+\pi^0$

GOOD



Ring radius (mm)

BAD



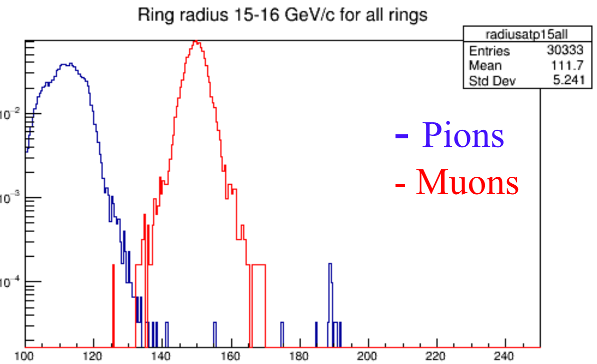
Ring radius (mm)

The result of the fit for bad rings is strongly biased by the pitch of the PMTs in the active flange

π/μ separation

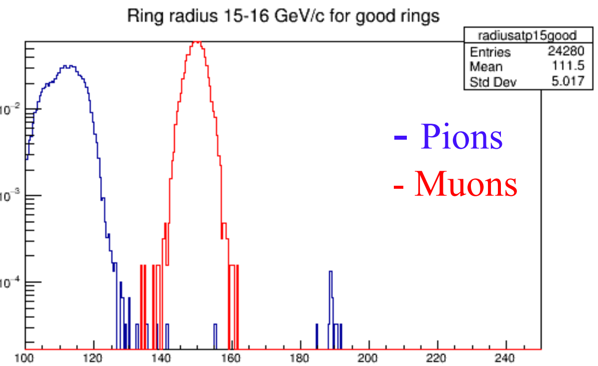
Momentum range: 15-16 GeV/c

ALL



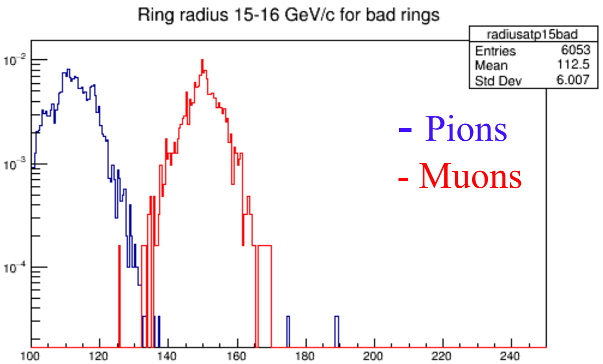
Reconstructed R_{ring} (mm)

GOOD



Reconstructed R_{ring} (mm)

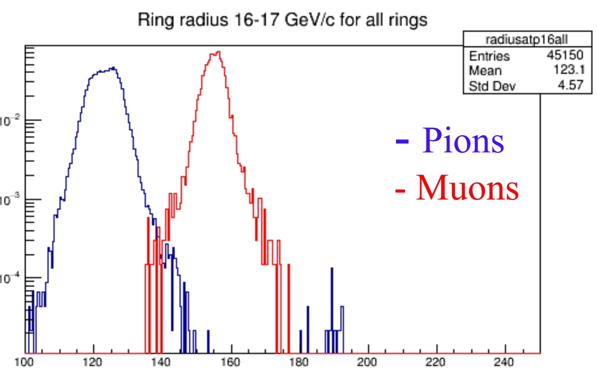
BAD



Reconstructed R_{ring} (mm)

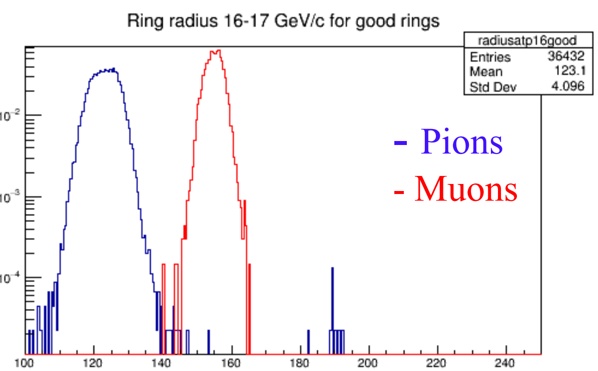
Momentum range: 16-17 GeV/c

ALL



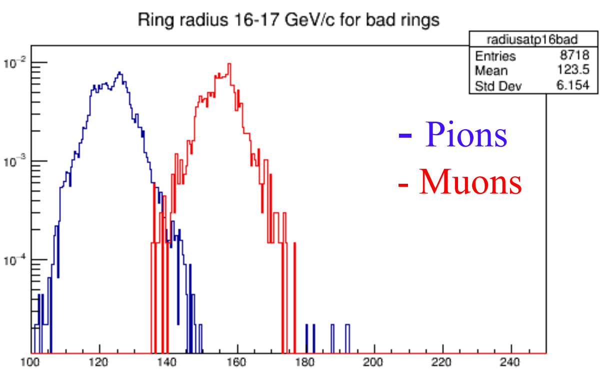
Reconstructed R_{ring} (mm)

GOOD



Reconstructed R_{ring} (mm)

BAD

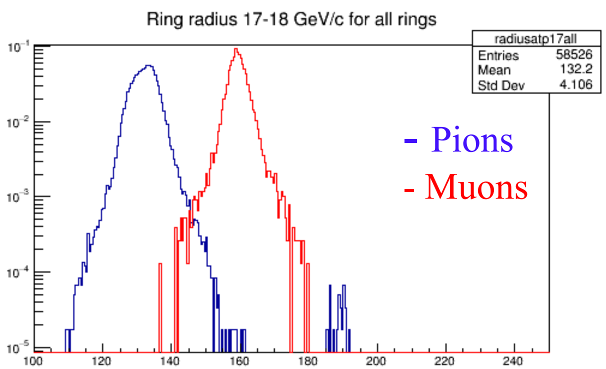


Reconstructed R_{ring} (mm)

π/μ separation

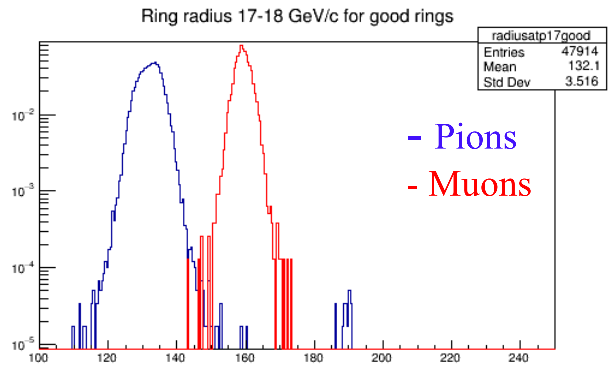
Momentum range: 17-18 GeV/c

ALL



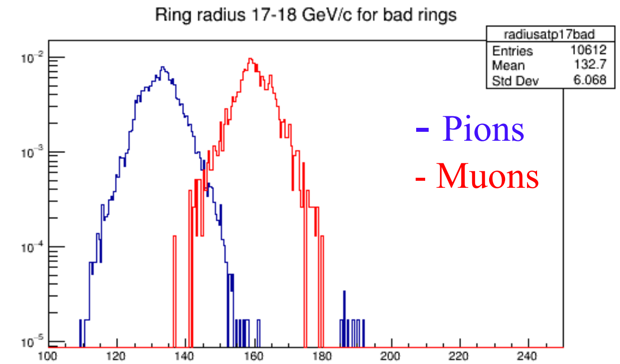
Reconstructed R_{ring} (mm)

GOOD



Reconstructed R_{ring} (mm)

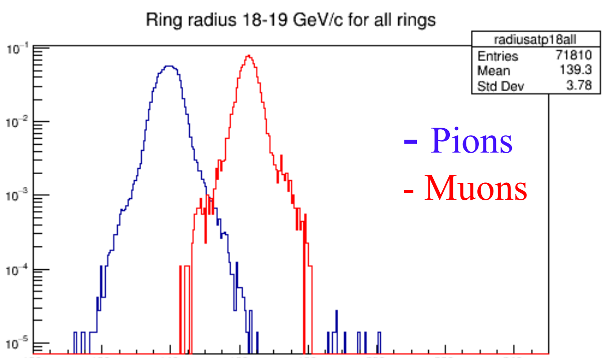
BAD



Reconstructed R_{ring} (mm)

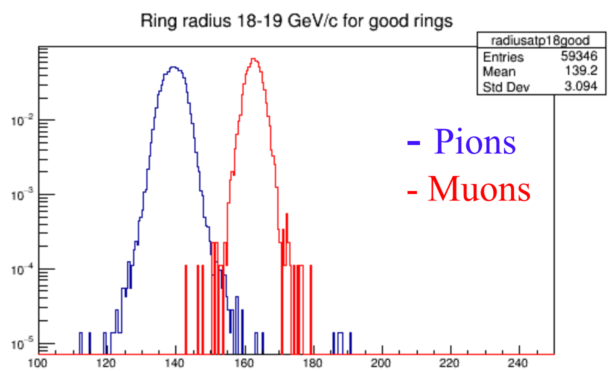
Momentum range: 18-19 GeV/c

ALL



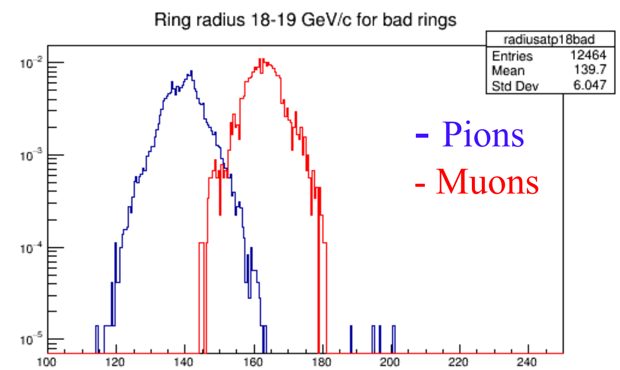
Reconstructed R_{ring} (mm)

GOOD



Reconstructed R_{ring} (mm)

BAD

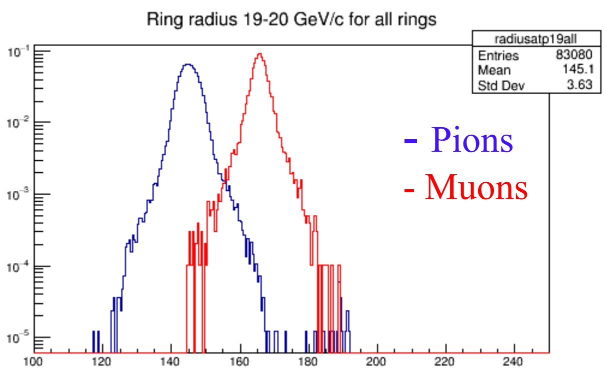


Reconstructed R_{ring} (mm)

π/μ separation

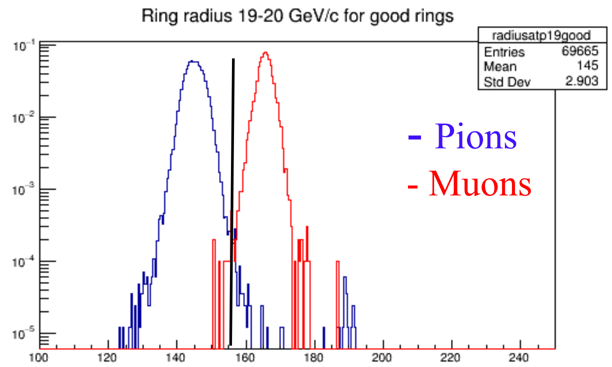
Momentum range: 19-20 GeV/c

ALL



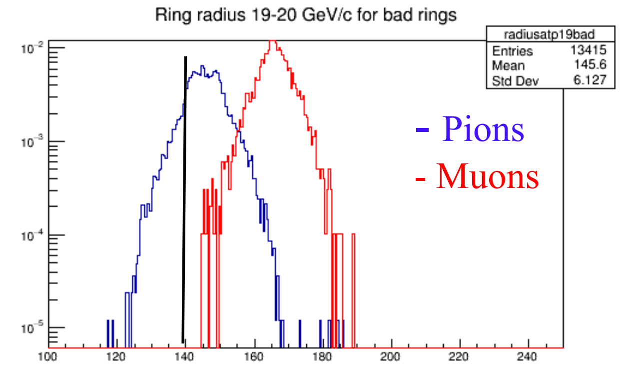
Reconstructed R_{ring} (mm)

GOOD



Reconstructed R_{ring} (mm)

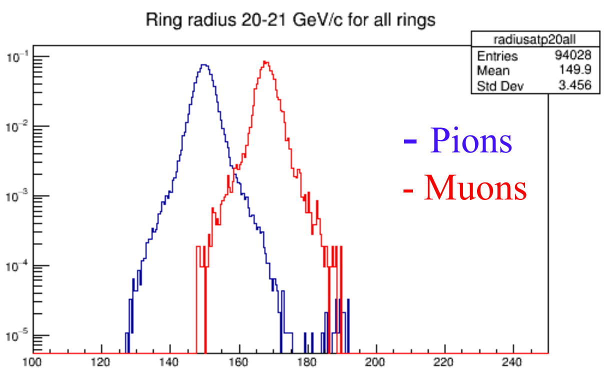
BAD



Reconstructed R_{ring} (mm)

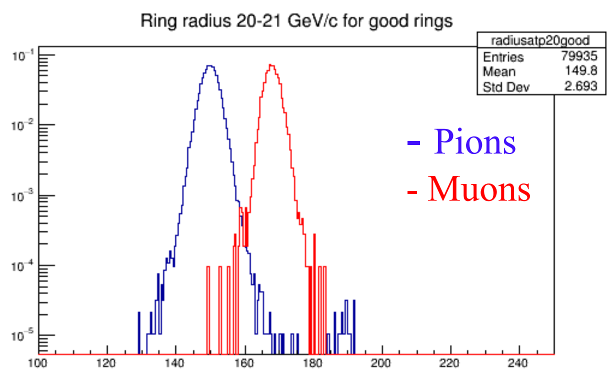
Momentum range: 20-21 GeV/c

ALL



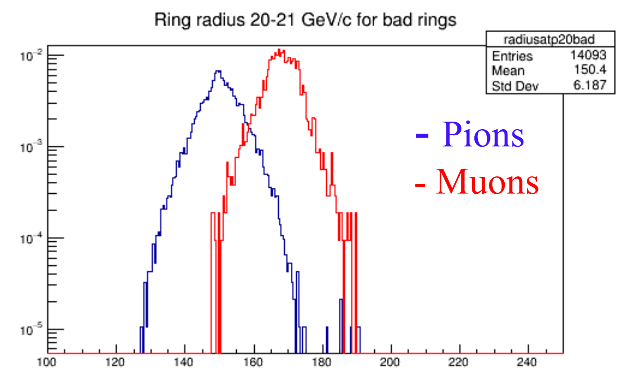
Reconstructed R_{ring} (mm)

GOOD



Reconstructed R_{ring} (mm)

BAD

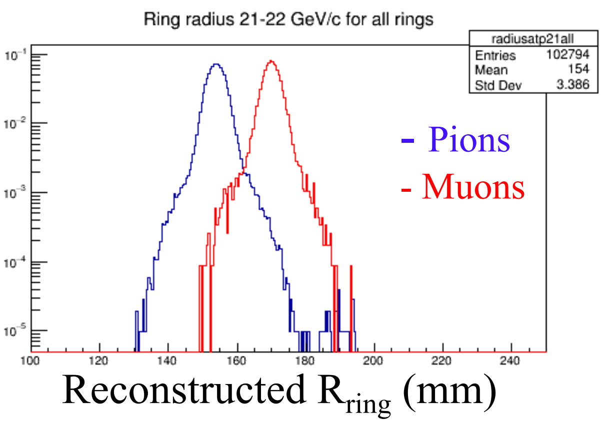


Reconstructed R_{ring} (mm)

π/μ separation

Momentum range: 21-22 GeV/c

ALL



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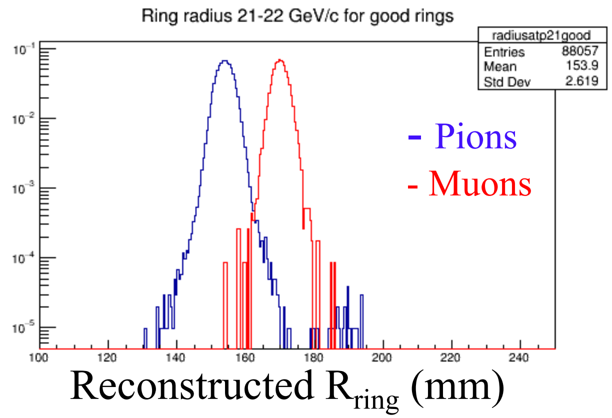

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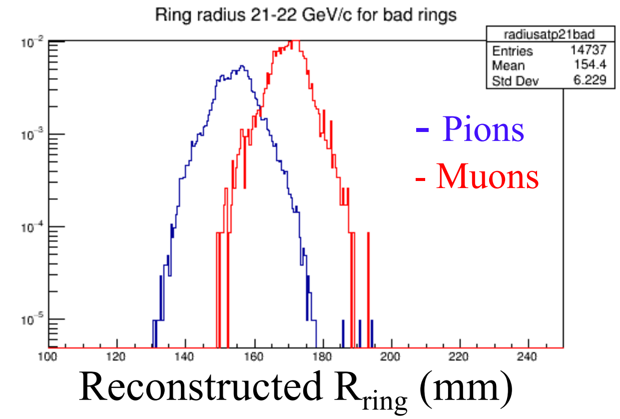
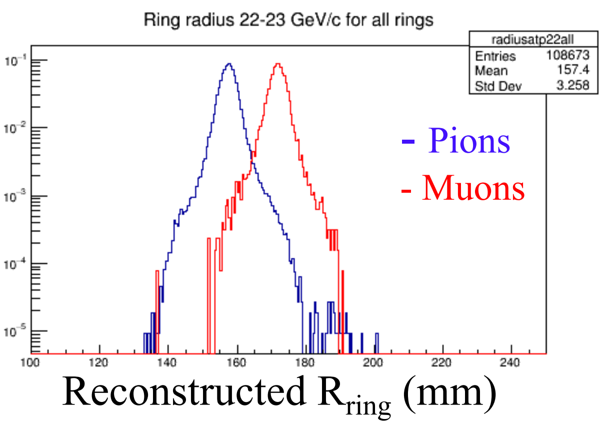


Momentum range: 22-23 GeV/c

ALL



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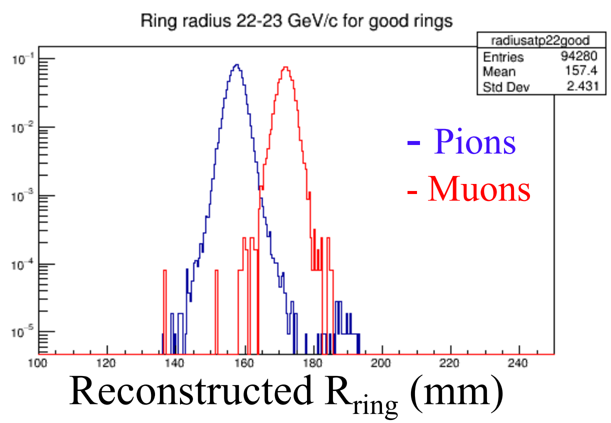

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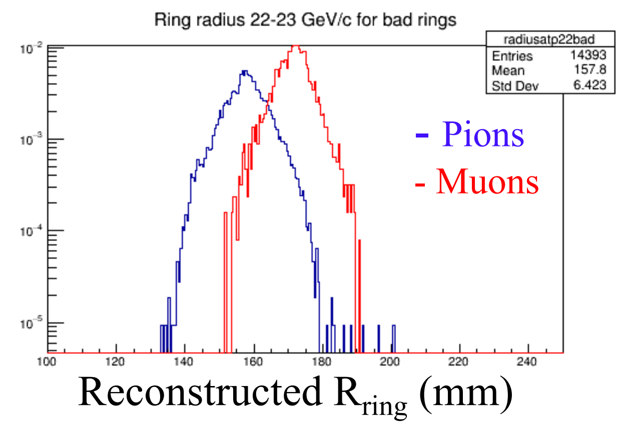
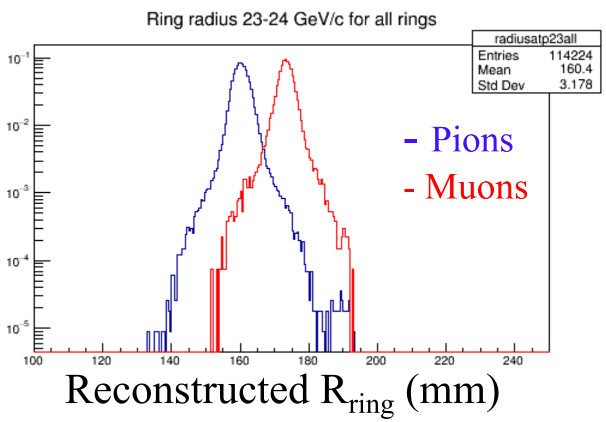


π/μ separation

Momentum range: 23-24 GeV/c

ALL



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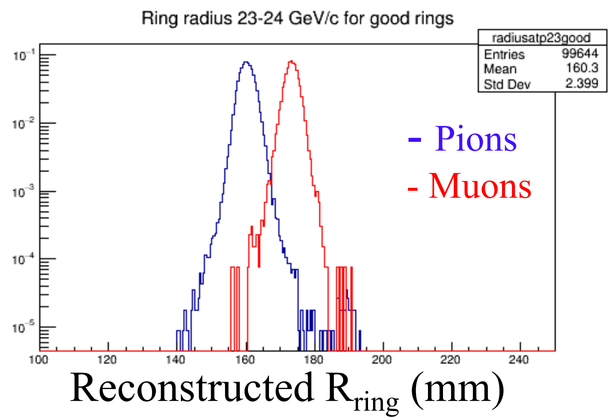

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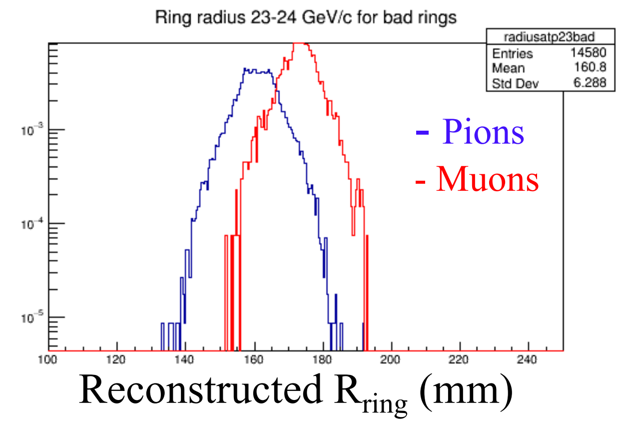
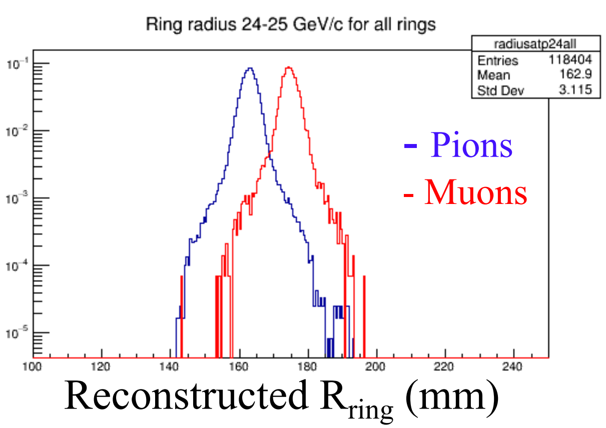


Momentum range: 24-25 GeV/c

ALL



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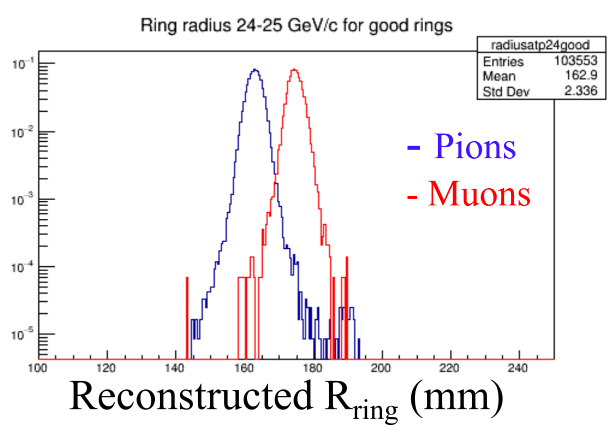

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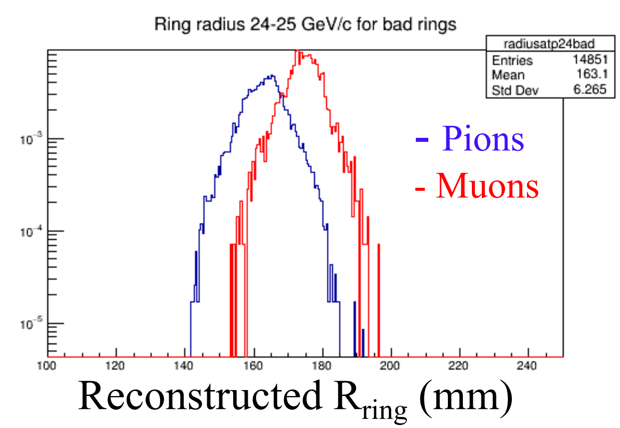
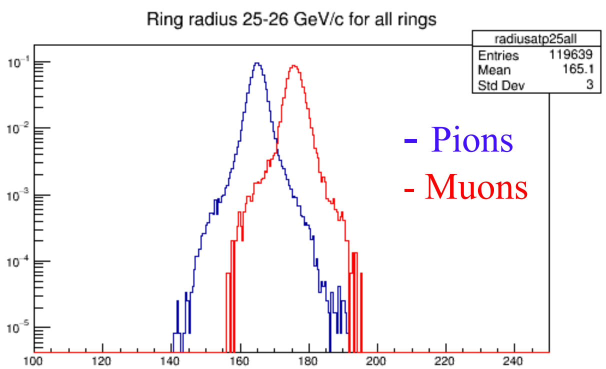


π/μ separation

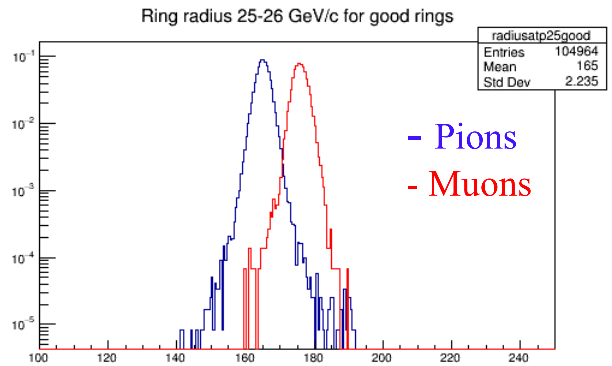
Momentum range: 25-26 GeV/c

ALL



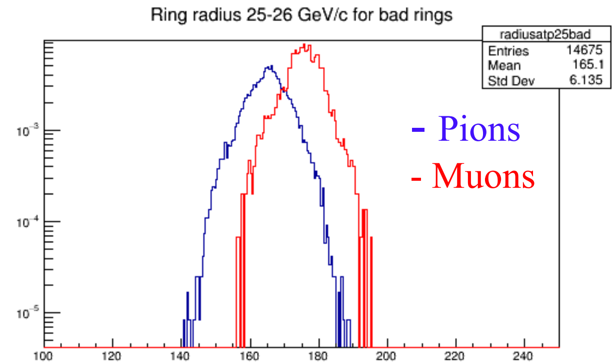
Reconstructed R_{ring} (mm)

GOOD



Reconstructed R_{ring} (mm)

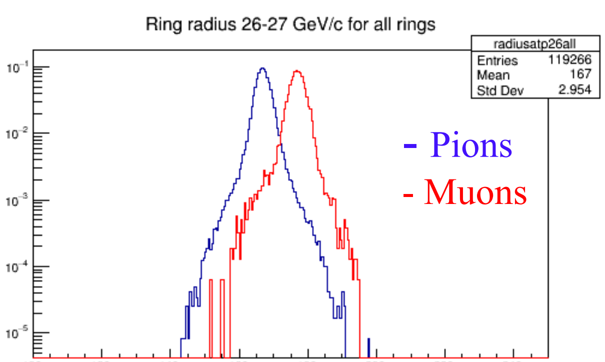
BAD



Reconstructed R_{ring} (mm)

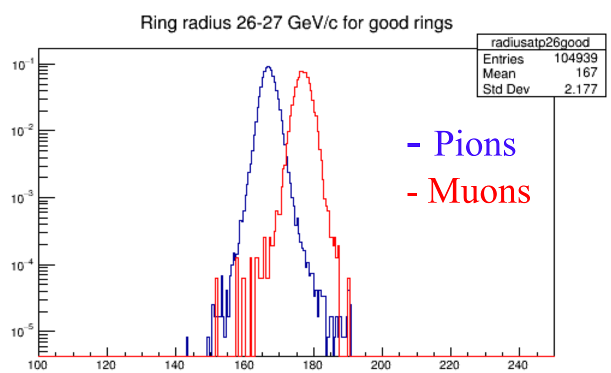
Momentum range: 26-27 GeV/c

ALL



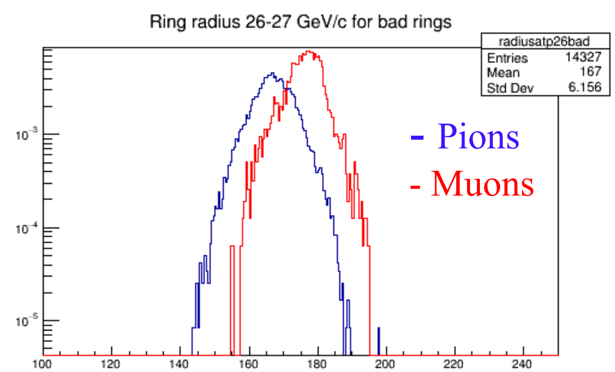
Reconstructed R_{ring} (mm)

GOOD



Reconstructed R_{ring} (mm)

BAD

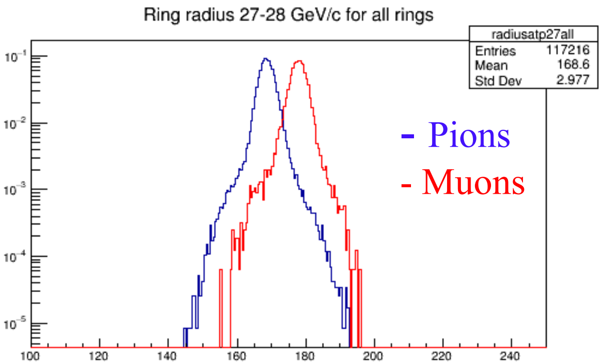


Reconstructed R_{ring} (mm)

π/μ separation

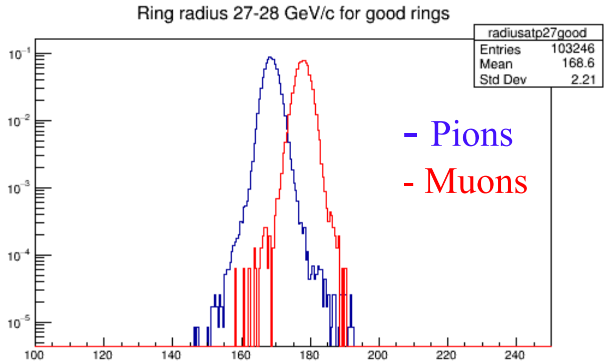
Momentum range: 27-28 GeV/c

ALL



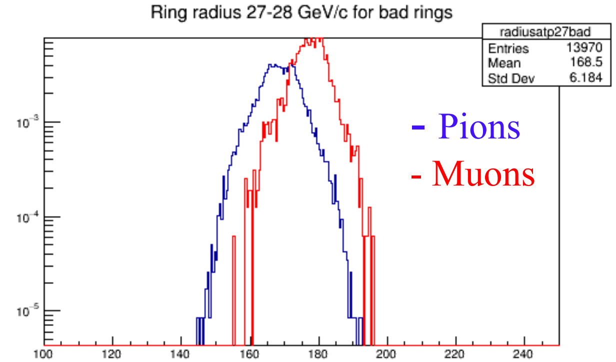
Reconstructed R_{ring} (mm)

GOOD



Reconstructed R_{ring} (mm)

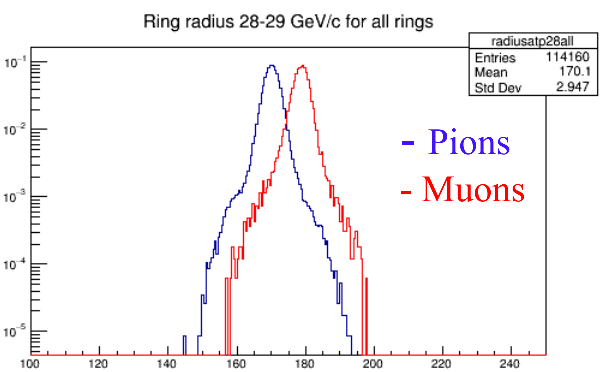
BAD



Reconstructed R_{ring} (mm)

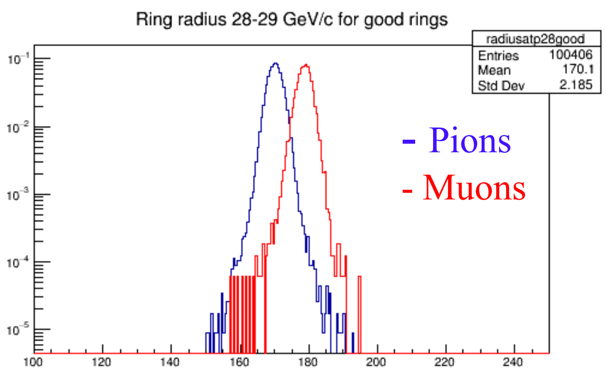
Momentum range: 28-29 GeV/c

ALL



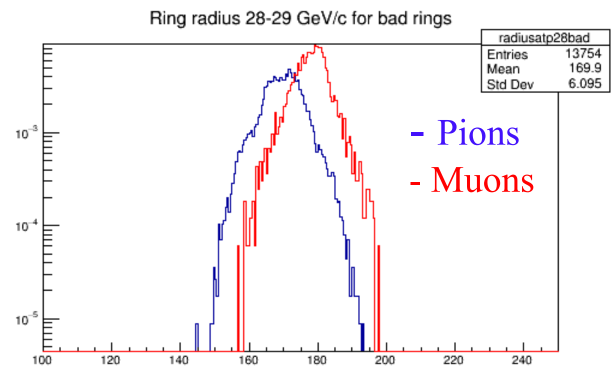
Reconstructed R_{ring} (mm)

GOOD



Reconstructed R_{ring} (mm)

BAD

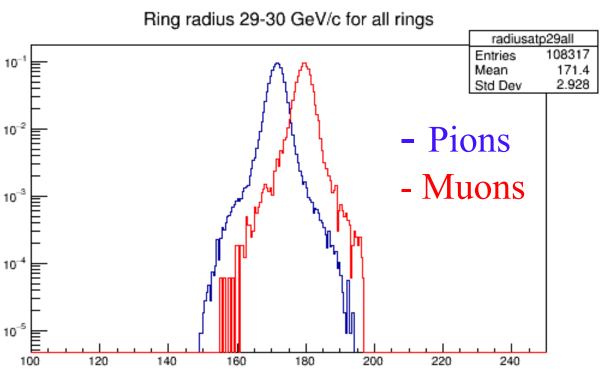


Reconstructed R_{ring} (mm)

π/μ separation

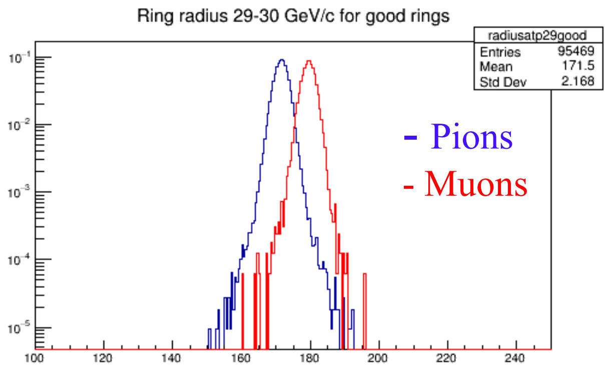
Momentum range: 29-30 GeV/c

ALL



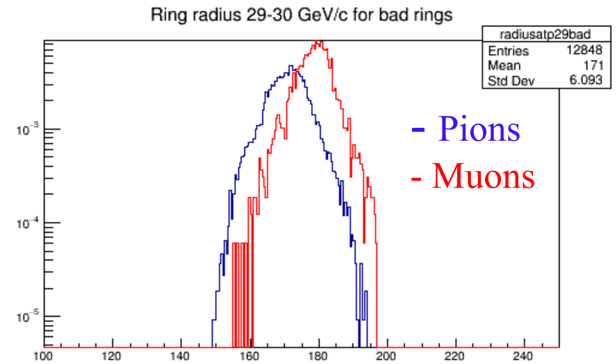
Reconstructed R_{ring} (mm)

GOOD



Reconstructed R_{ring} (mm)

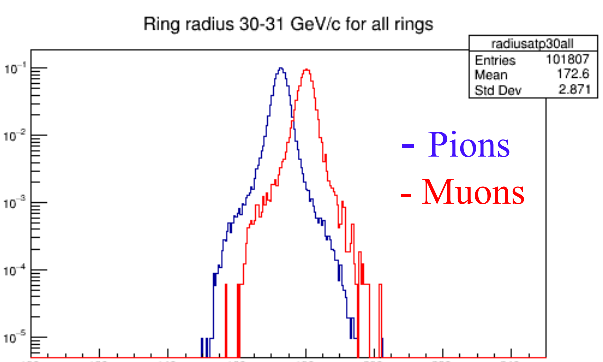
BAD



Reconstructed R_{ring} (mm)

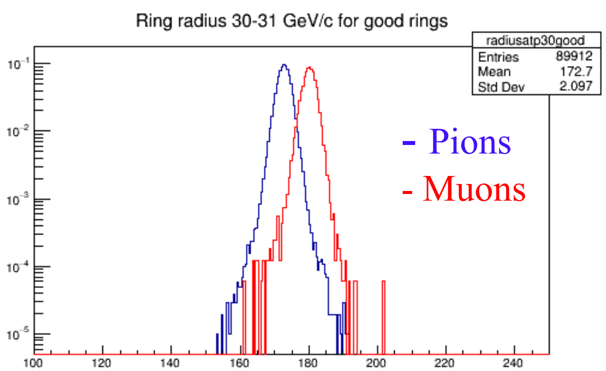
Momentum range: 30-31 GeV/c

ALL



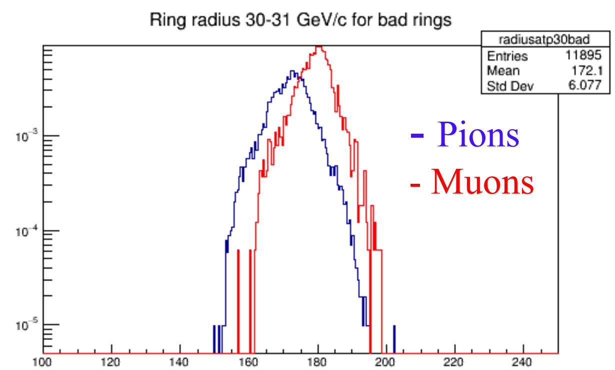
Reconstructed R_{ring} (mm)

GOOD



Reconstructed R_{ring} (mm)

BAD

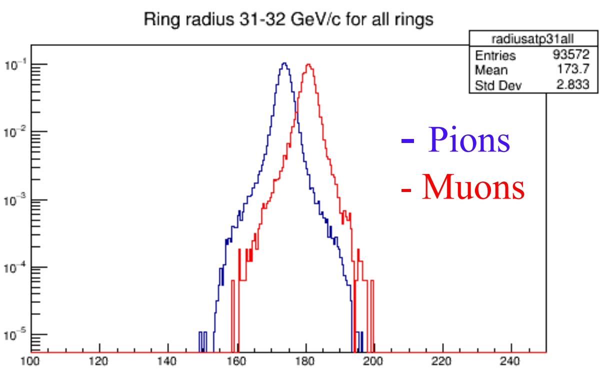


Reconstructed R_{ring} (mm)

π/μ separation

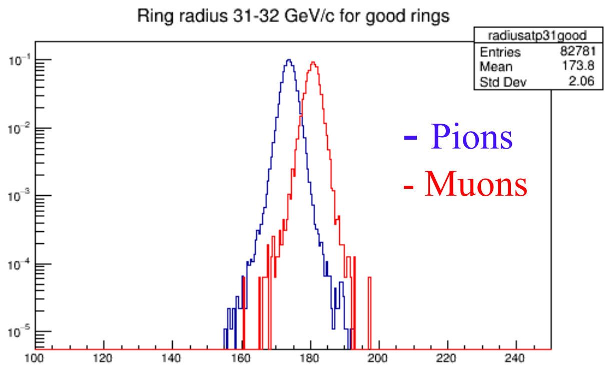
Momentum range: 31-32 GeV/c

ALL



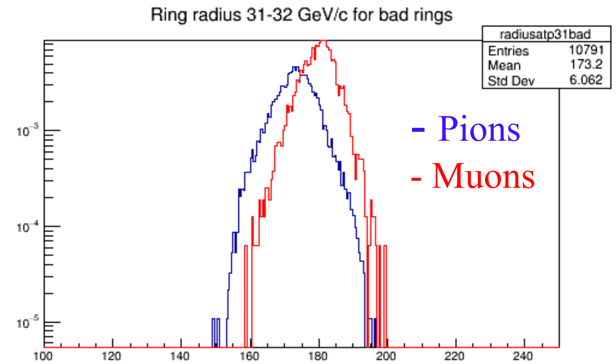
Reconstructed R_{ring} (mm)

GOOD



Reconstructed R_{ring} (mm)

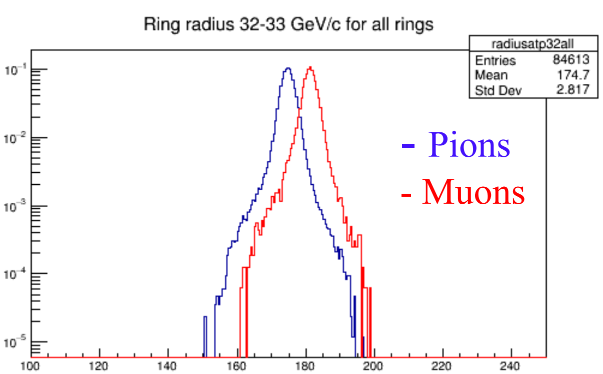
BAD



Reconstructed R_{ring} (mm)

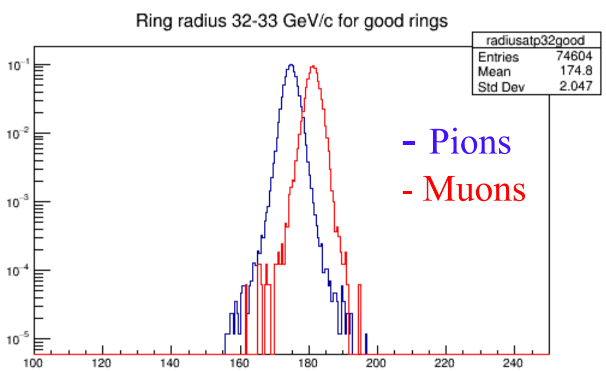
Momentum range: 32-33 GeV/c

ALL



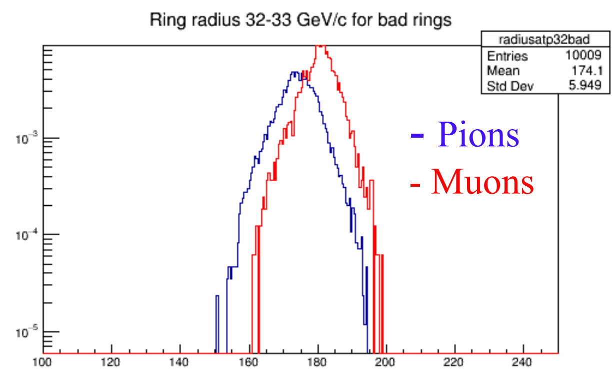
Reconstructed R_{ring} (mm)

GOOD



Reconstructed R_{ring} (mm)

BAD

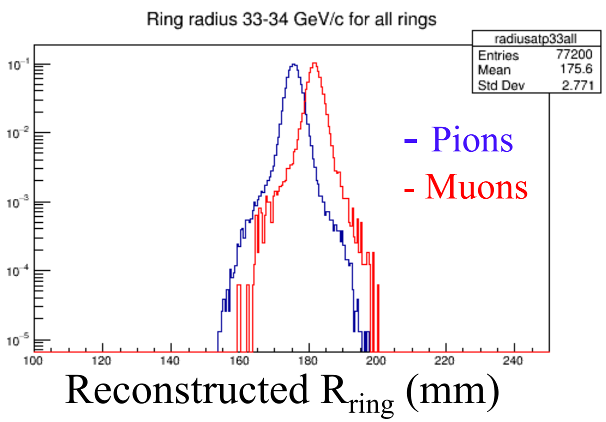


Reconstructed R_{ring} (mm)

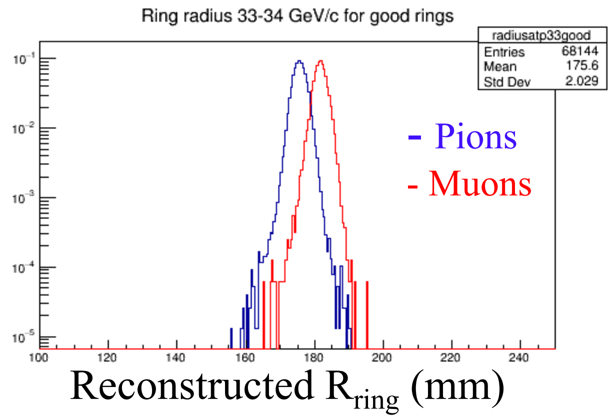
π/μ separation

Momentum range: 33-34 GeV/c

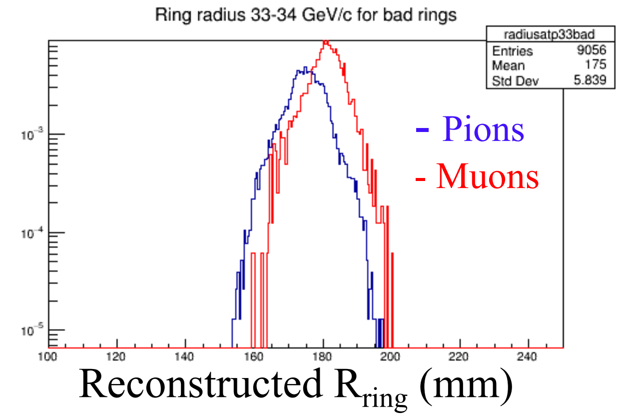
ALL



GOOD

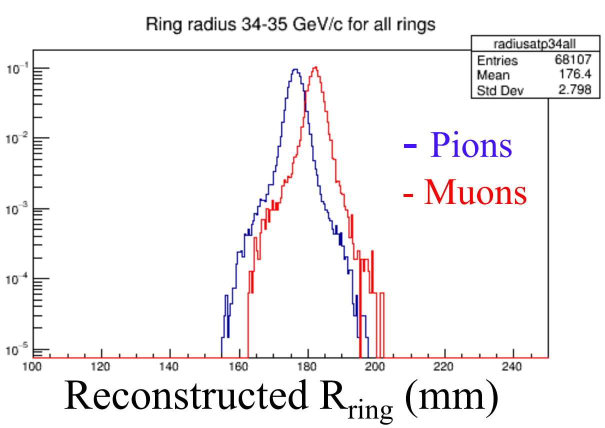


BAD

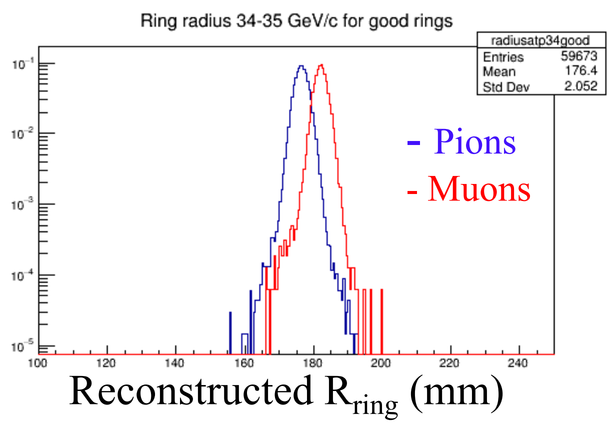


Momentum range: 34-35 GeV/c

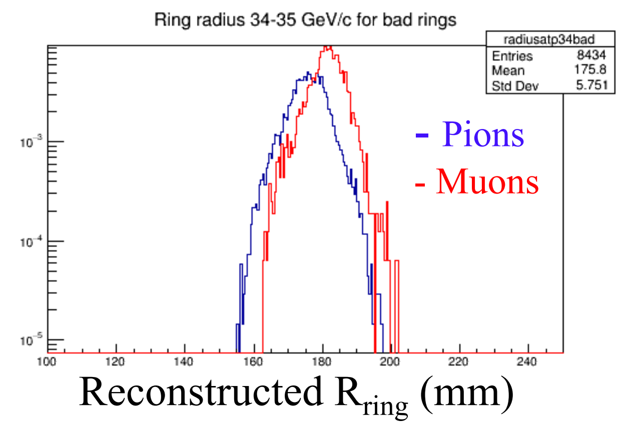
ALL



GOOD

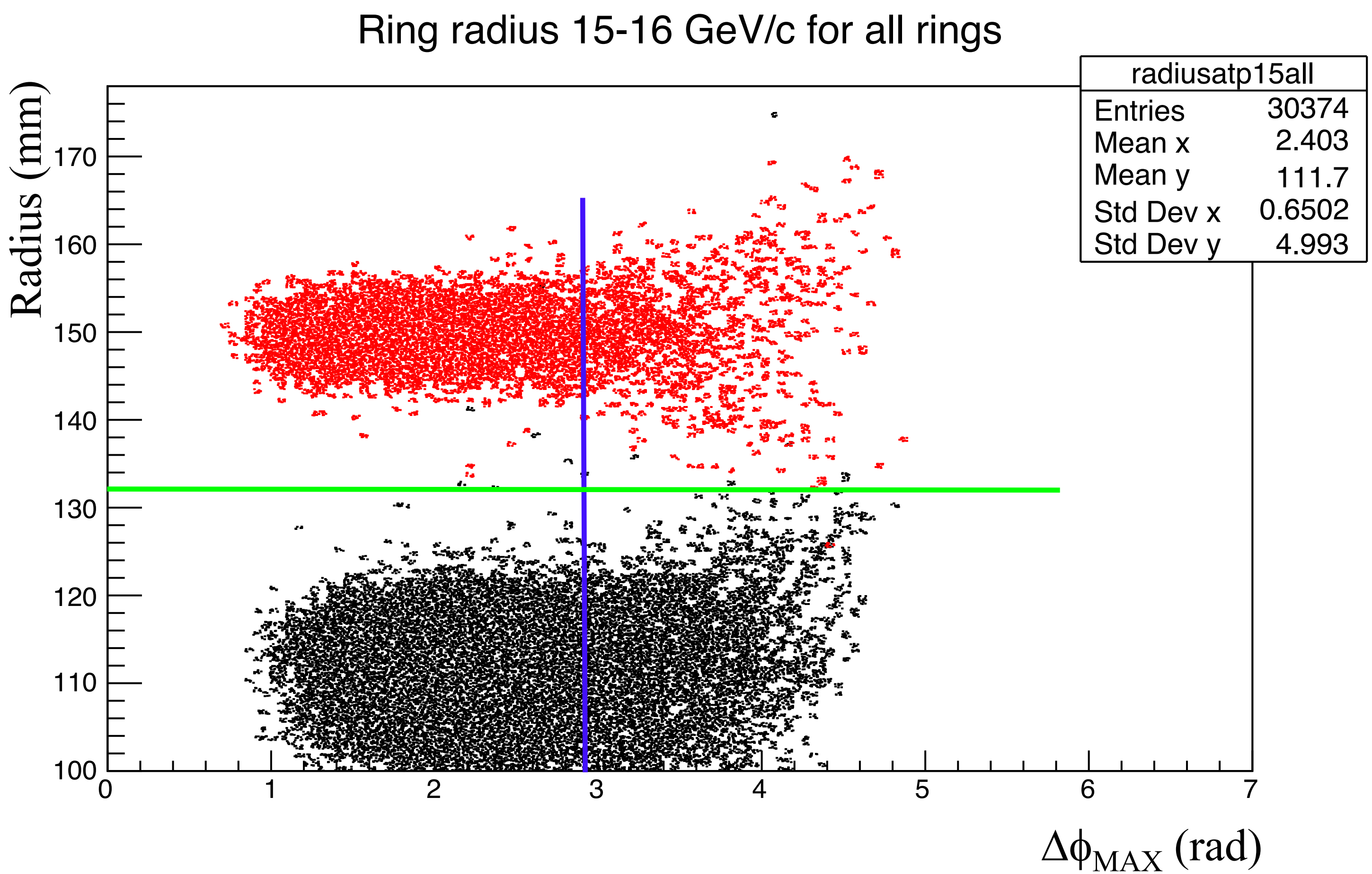


BAD

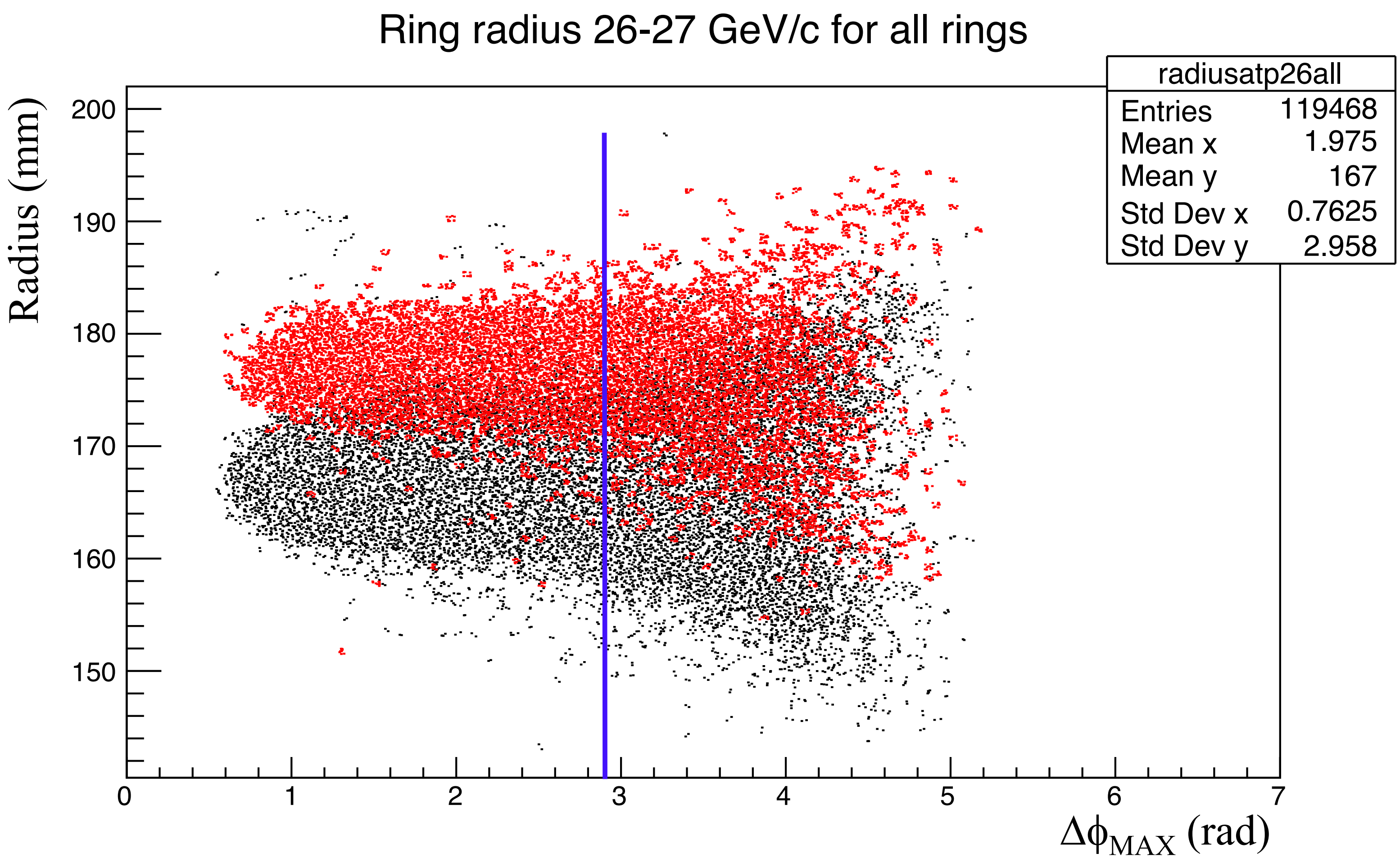


Next step

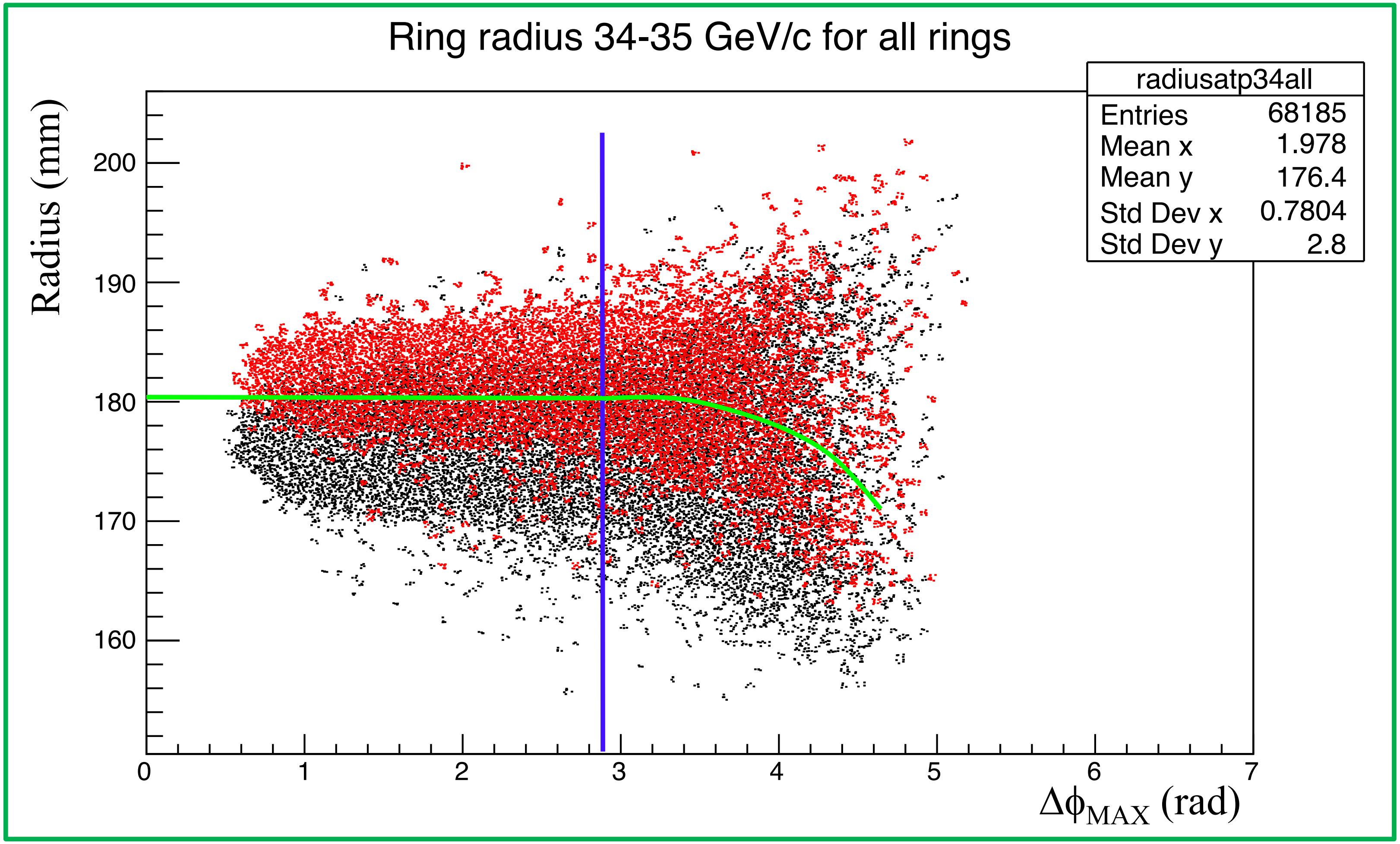
- Suggestion by Ambrosino/Spadaro to build a Likelihood without applying a sharp cut on $\Delta\phi_{MAX}$ (cutting at 170° → 15% of lost pions)



Radius VS $\Delta\phi_{MAX}$



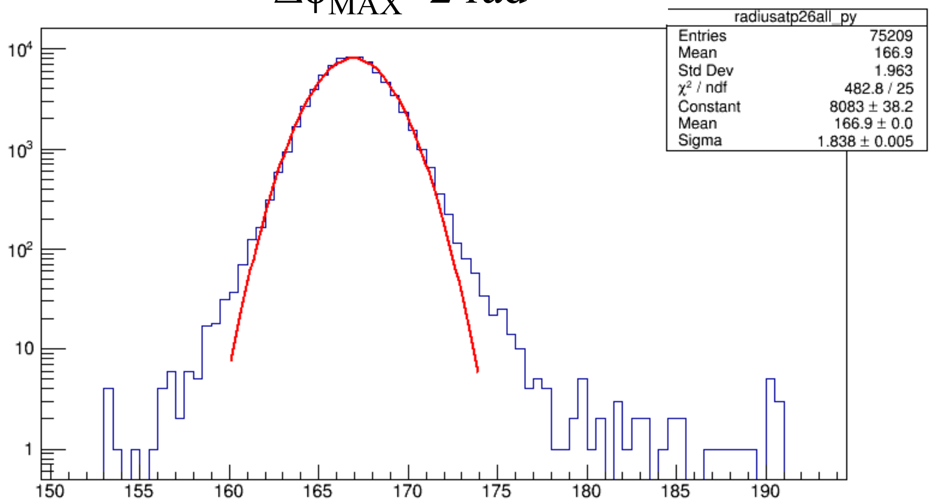
Radius VS $\Delta\phi_{MAX}$



Radius VS $\Delta\phi_{MAX}$

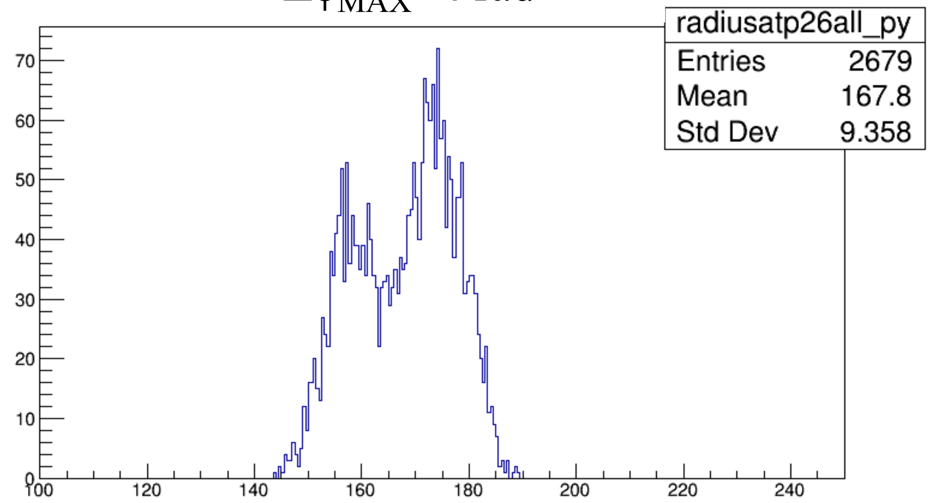
Radius distribution from momentum between 26 and 27 GeV

$\Delta\phi_{MAX}$<2 rad



Radius (mm)

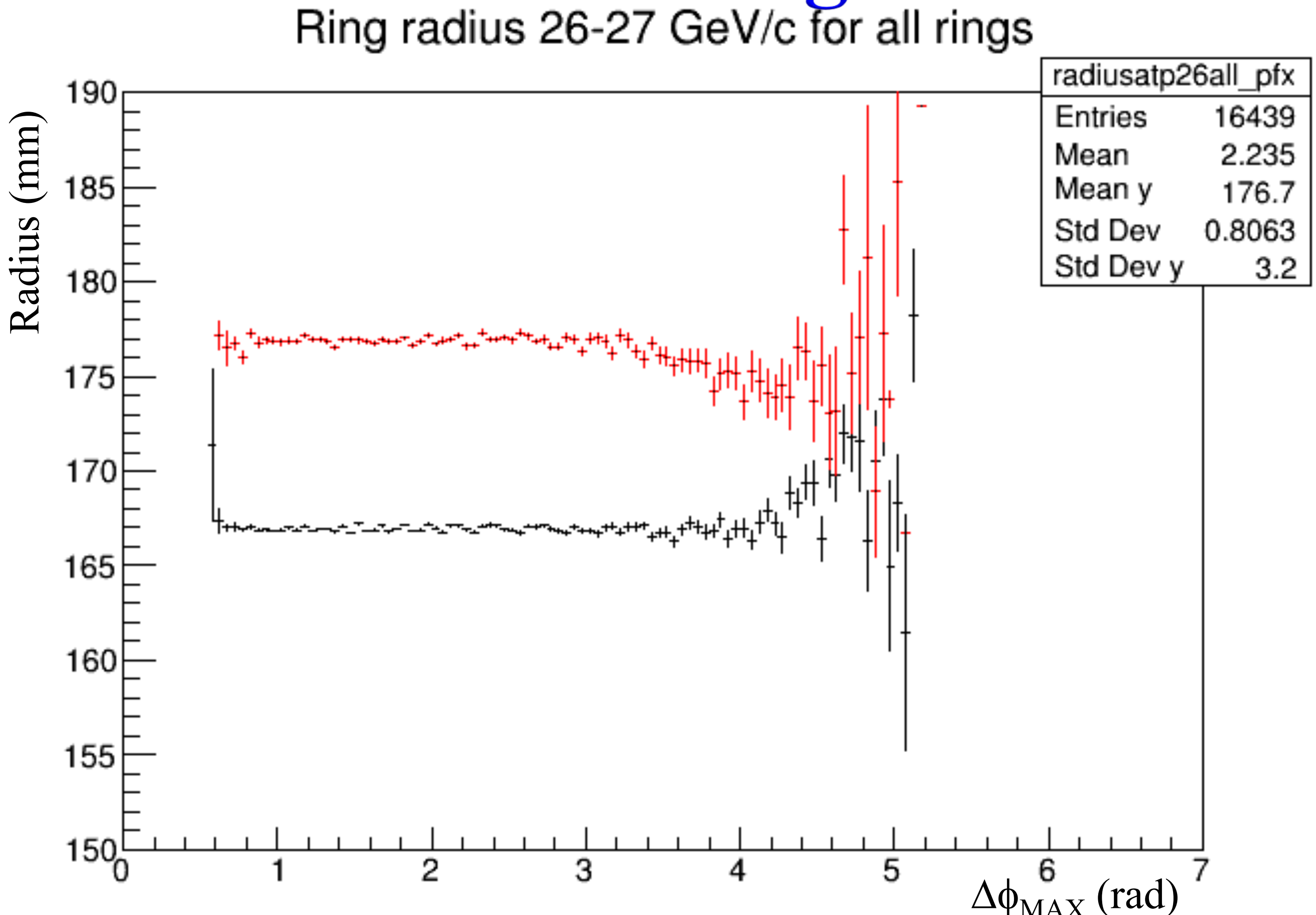
$\Delta\phi_{MAX}$>4 rad



Radius (mm)

No way to parametrize the distribution with Gaussian fits as a function of $\Delta\phi_{MAX}$ → Standard deviation must be used

Profile histogram



Lack of statistics in muon sample

Conclusions

Target: Give a probability for a track to be a pion or a muon as a function of (p, r, $\Delta\phi_{MAX}$).

If we re-weight the pion sample with the $\pi\nu\nu$ distribution extracted from the Monte-Carlo we can even apply a cut on the basis of the accepted inefficiency.

More difficult to apply a cut based on the value of muon contamination:

1) MC driven: consider the distributions of all possible backgrounds
2) Data driven: apply the almost final analysis (no MUV3)

Need to check the correlation between the χ^2 of the fit and $\Delta\phi_{MAX}$