Update on Progressive Tracking and Track Reconstruction

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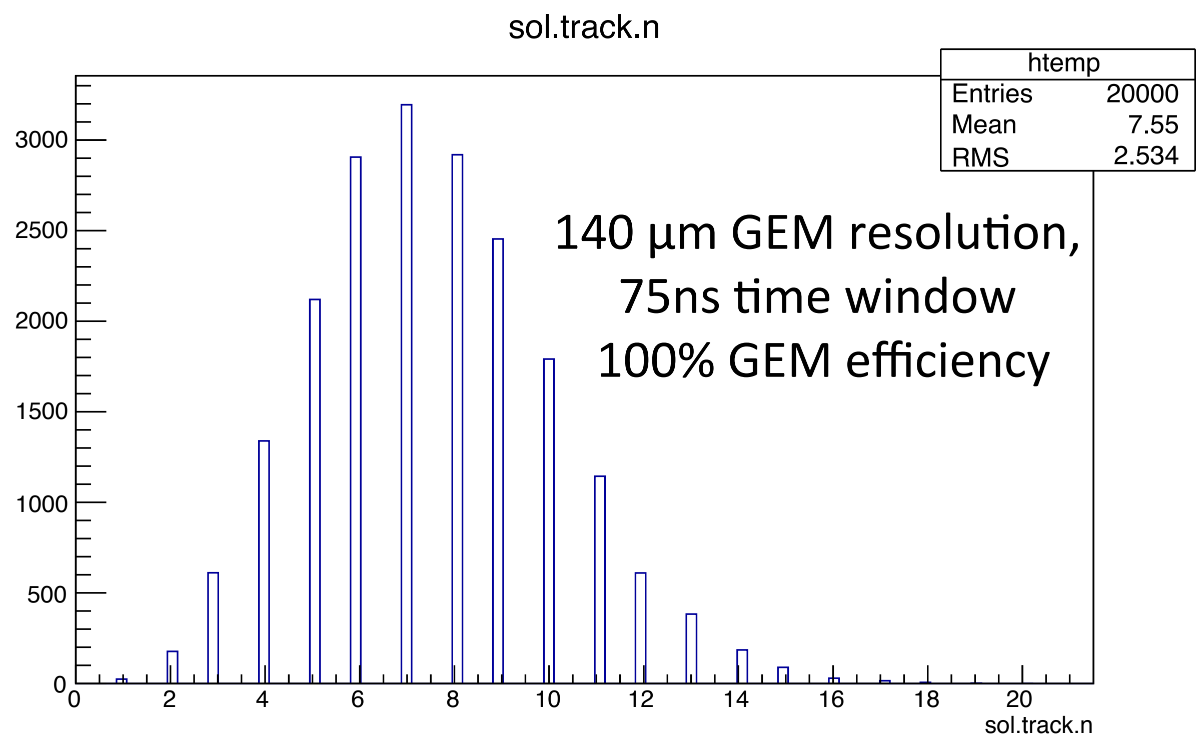
Outline

- Solving the problem with large angle track searching
- Track reconstruction for large angle events and preliminary results
- Summary

Problem With LA Tracks



- Distribution dominated by multi tracks events, due to higher background rate
- Need to add more things to the program to help track searching

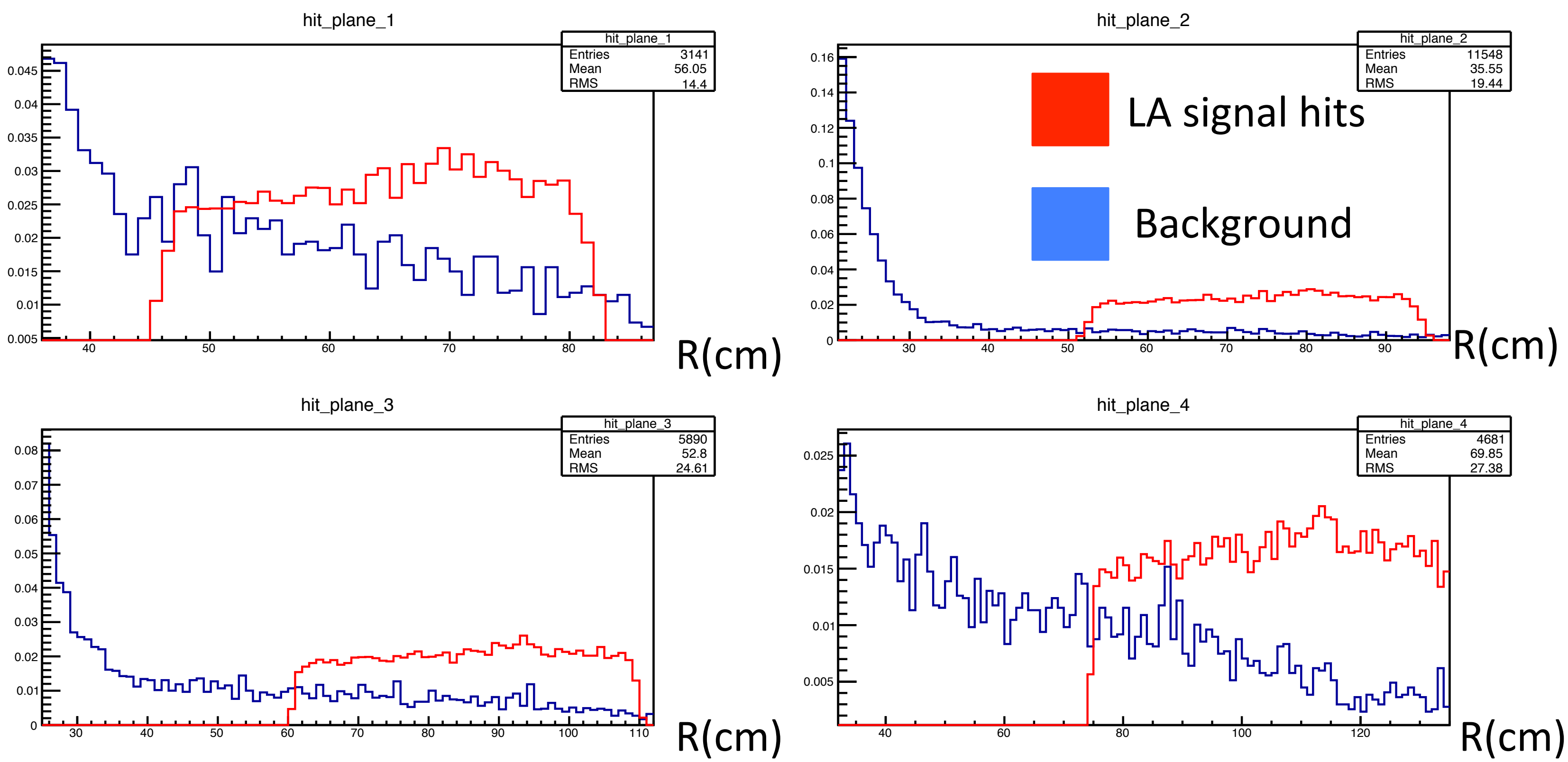
How to deal with this?

- Add a regional cut. GEM 2, 3 and 4 are shared by LA and FA, but LA signal hits do no cover the whole plane.

- Add LAEC to help identify the signal track

- Narrow the momentum range of signal particles(>1GeV)?

Regional Cuts



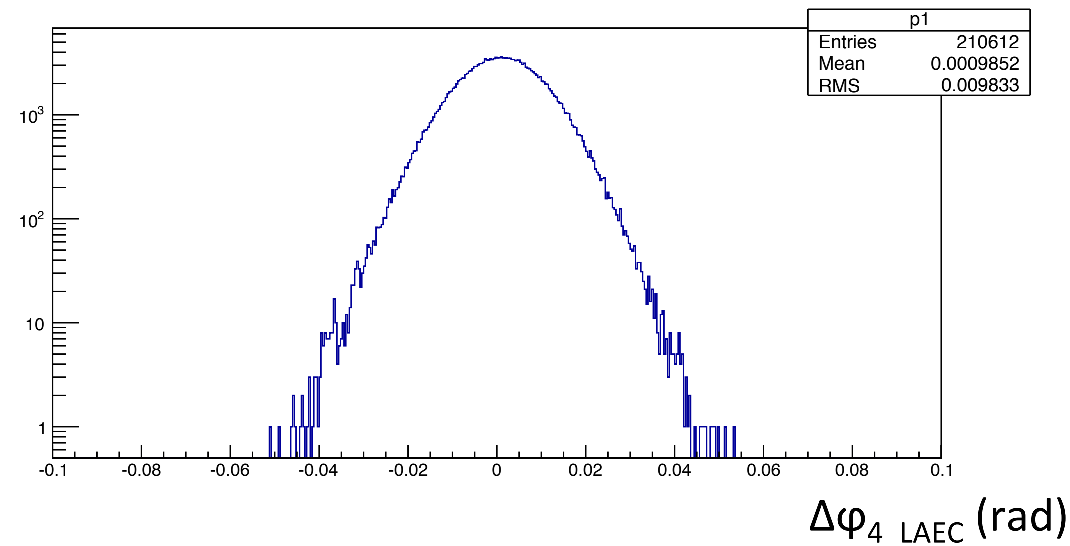
- Do not search for tracks in area where LA hits cannot appear

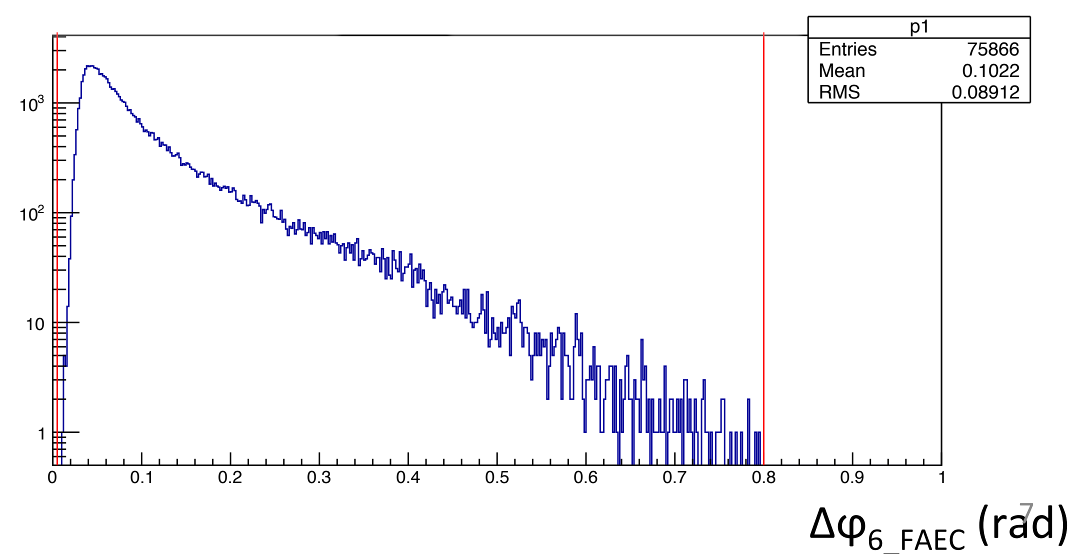
Adding ECs

- Use hit on EC to check whether candidate tracks are good or bad, will use it for backward tracking later.
- EC resolution = 1cm
- Only look at $\Delta\varphi$ between the hit on EC and the last hit of a candidate track. Can exploit it more if needed.

Adding EC

- $\Delta\varphi$ is very small for LA, because the small distance between the LAEC and the GEMs, which helps a lot on improving the efficiency
- Not as useful for FA, but the efficiency was already quite good





Track Finding Efficiency

- Condition: 95% detector efficiency, 95ns TDC time window, 200um detector resolution.

	LA	**FA**
Single Track	98.235%	96.355%
Zero Track	1.46%	2.47%
Multi Tracks	0.305%	1.18%

Track Reconstruction

- Preliminary track reconstruction exists (Xin)

- Start from simple track model (perfect helix inside the detector and straight line outside), get the zeroth order estimates for the vertex variables

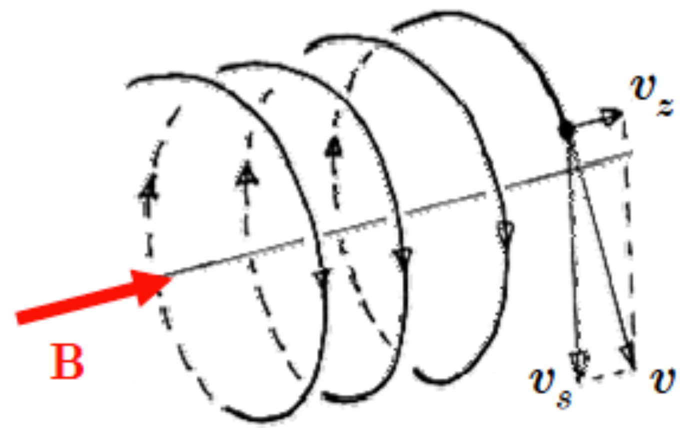
- Use MC vertex variables to get correction functions

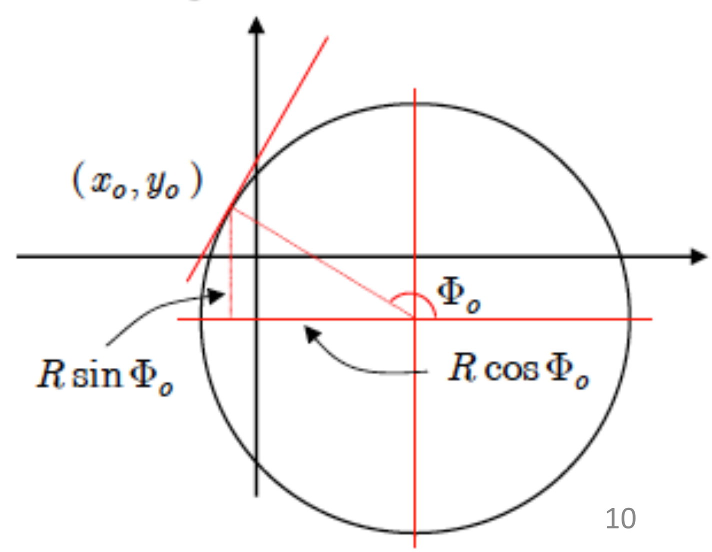
Simple Track Model

$$x(s) = x_o + R\left[\cos\left(\Phi_o + \frac{hs\cos\lambda}{R}\right) - \cos\Phi_o\right]$$

$$y(s) = y_o + R\left[\sin\left(\Phi_o + \frac{hs\cos\lambda}{R}\right) - \sin\Phi_o\right]$$

$$z(s) = z_o + s\sin\lambda$$





- s: arc length of the helix
- λ: dip angle $\tan(\lambda) = P_{||}/P_T$

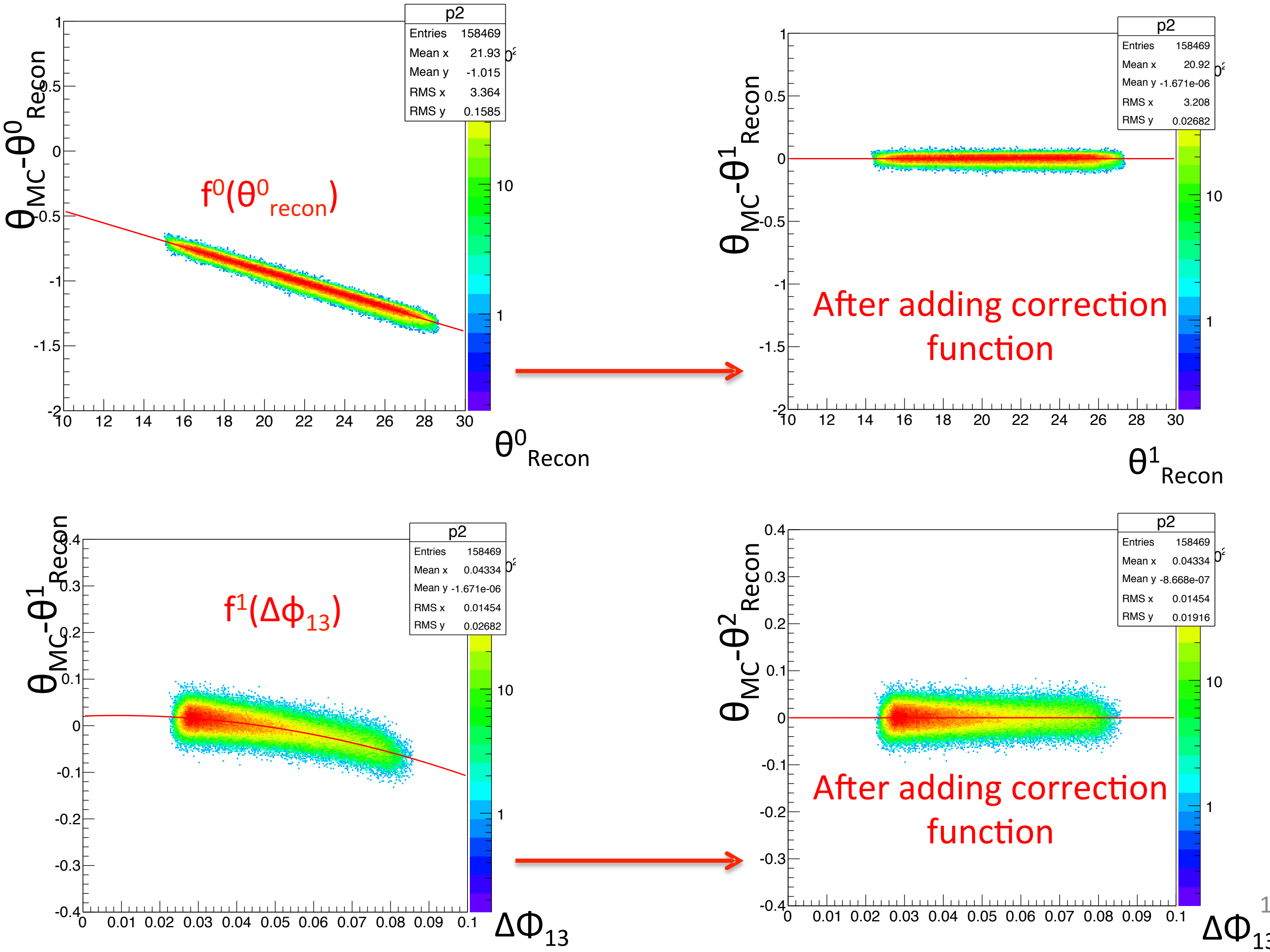
Zeroth order estimates for reconstructed vertex variables

- Calculate R using 3 hits on a track
- Polar angle: $$\tan(\theta) = \cot(\lambda) = \frac{R\Delta\Phi}{\Delta z}$$
- P_T = 0.3BR for electron, P = $P_T/\sin(\theta)$
- Phi: use R and dip angle info, to predict the position and direction of the particle at detector entrance

Higher Order corrections

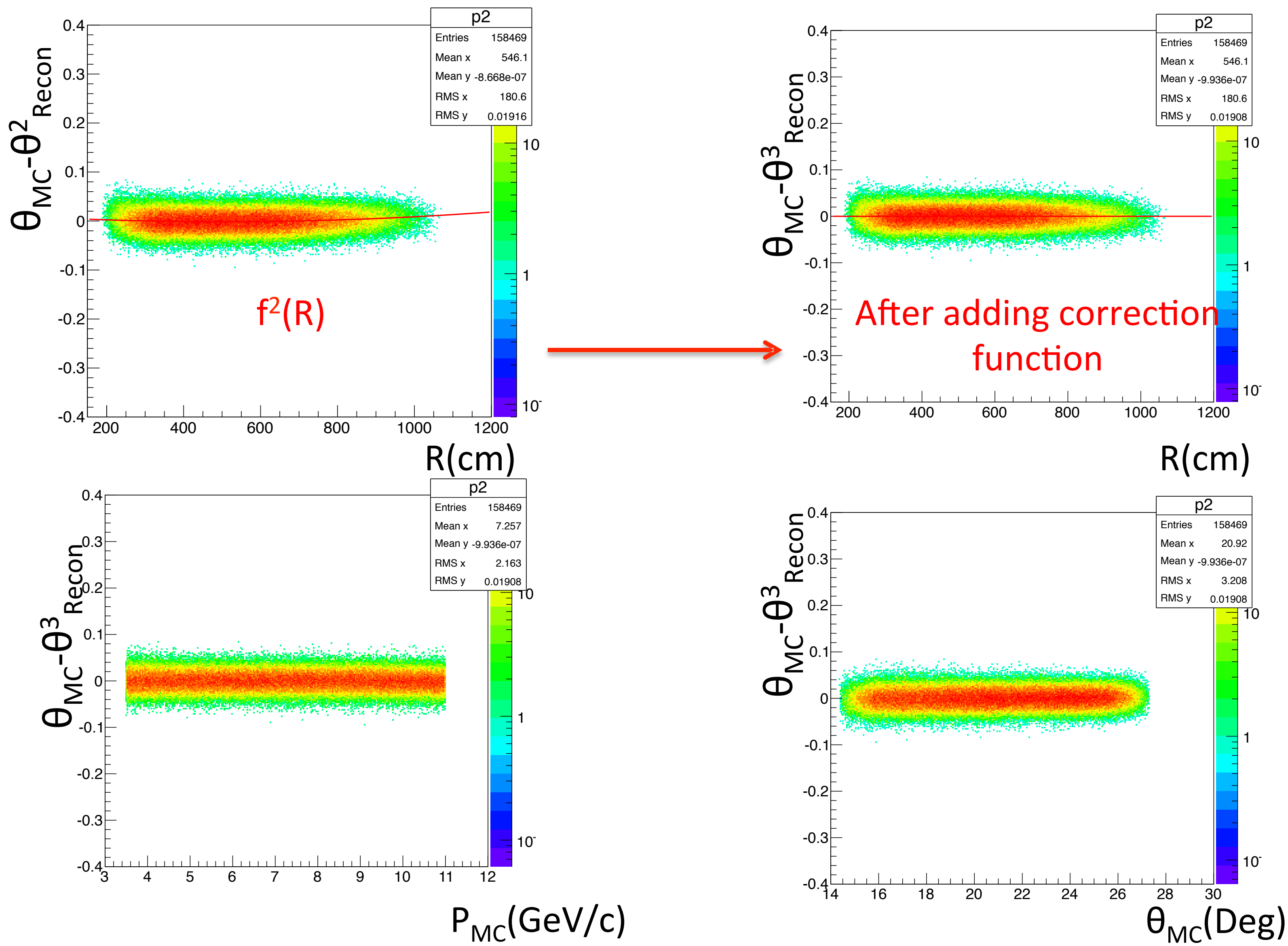
- Assume $Y^{n}_{recon} = Y^{n-1}_{recon} + f^{n-1}(X)$
  - X can be any of the measurement or reconstructed variables: R, angle of rotation between to planes, dip angle…
- How to get the correction function $f^{n-1}(X)$?
  - Use the MC true vertex info Y_{MC}
  - Plot $Y_{MC}-Y^{n-1}_{recon}$ vs X
  - $f^{n-1}(X)$ is then the fitting function of the plot
- These process is iterated until correction function is sufficiently small for all X, and MC true vertex variables agree with reconstructed vertex variables.

Polar Angle



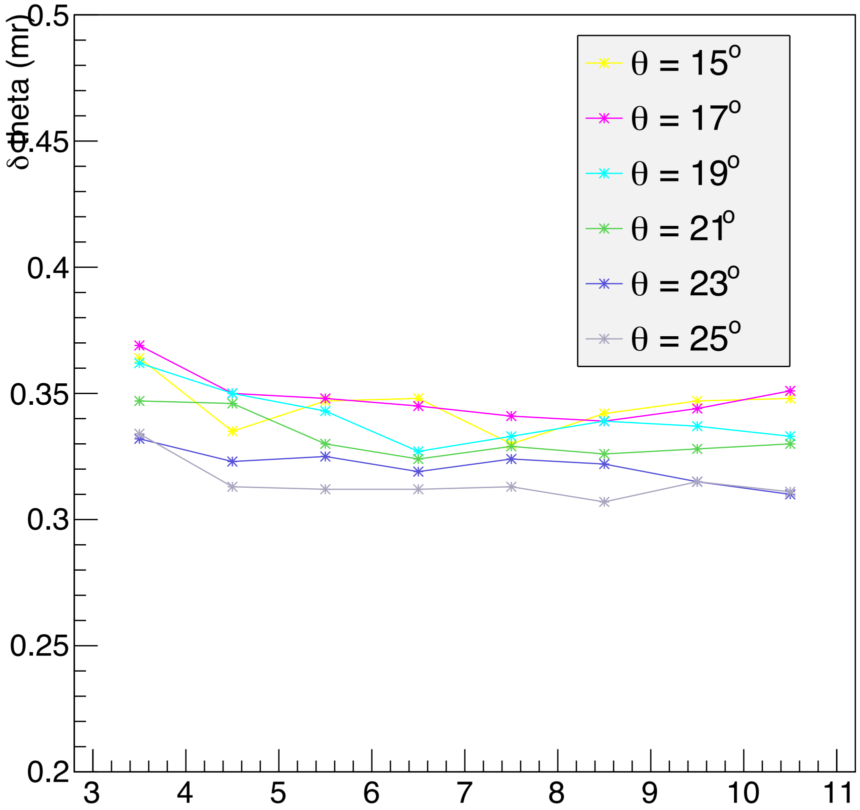
p2
Entries 158469
Mean x 21.93
Mean y -1.015
RMS x 3.364
RMS y 0.1585
$f^0(\theta^0_{recon})$
$\theta_{MC}-\theta^0_{Recon}$
θ^0_{Recon}
p2
Entries 158469
Mean x 20.92
Mean y -1.671e-06
RMS x 3.208
RMS y 0.02682
After adding correction function
$\theta_{MC}-\theta^1_{Recon}$
θ^1_{Recon}
p2
Entries 158469
Mean x 0.04334
Mean y -1.671e-06
RMS x 0.01454
RMS y 0.02682
$f^1(\Delta\phi_{13})$
$\theta_{MC}-\theta^1_{Recon}$
$\Delta\Phi_{13}$
p2
Entries 158469
Mean x 0.04334
Mean y -8.668e-07
RMS x 0.01454
RMS y 0.01916
After adding correction function
$\theta_{MC}-\theta^2_{Recon}$
$\Delta\Phi_{13}$

Polar Angle


p2
Entries 158469
Mean x 546.1
Mean y -8.668e-07
RMS x 180.6
RMS y 0.01916
$\theta_{MC}-\theta^2_{Recon}$
R(cm)
$f^2(R)$
p2
Entries 158469
Mean x 546.1
Mean y -9.936e-07
RMS x 180.6
RMS y 0.01908
$\theta_{MC}-\theta^3_{Recon}$
R(cm)
After adding correction function
p2
Entries 158469
Mean x 7.257
Mean y -9.936e-07
RMS x 2.163
RMS y 0.01908
$\theta_{MC}-\theta^3_{Recon}$
P_{MC}(GeV/c)
p2
Entries 158469
Mean x 20.92
Mean y -9.936e-07
RMS x 3.208
RMS y 0.01908
$\theta_{MC}-\theta^3_{Recon}$
θ_{MC}(Deg)

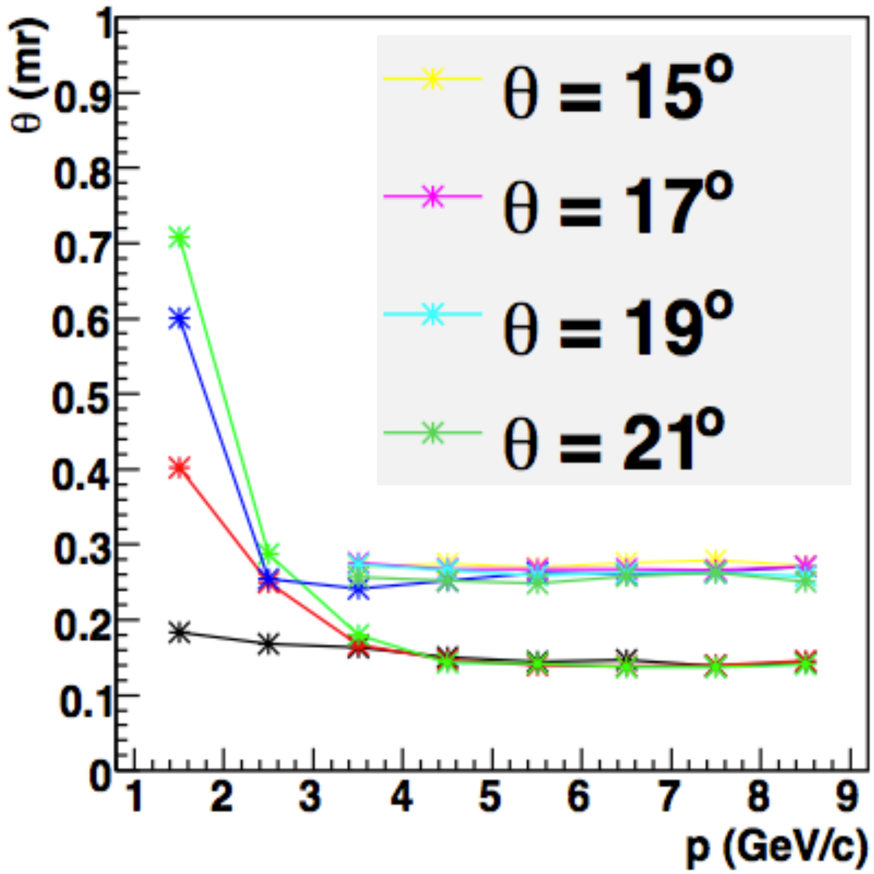
Polar Angle

Polar angle resolution (New)

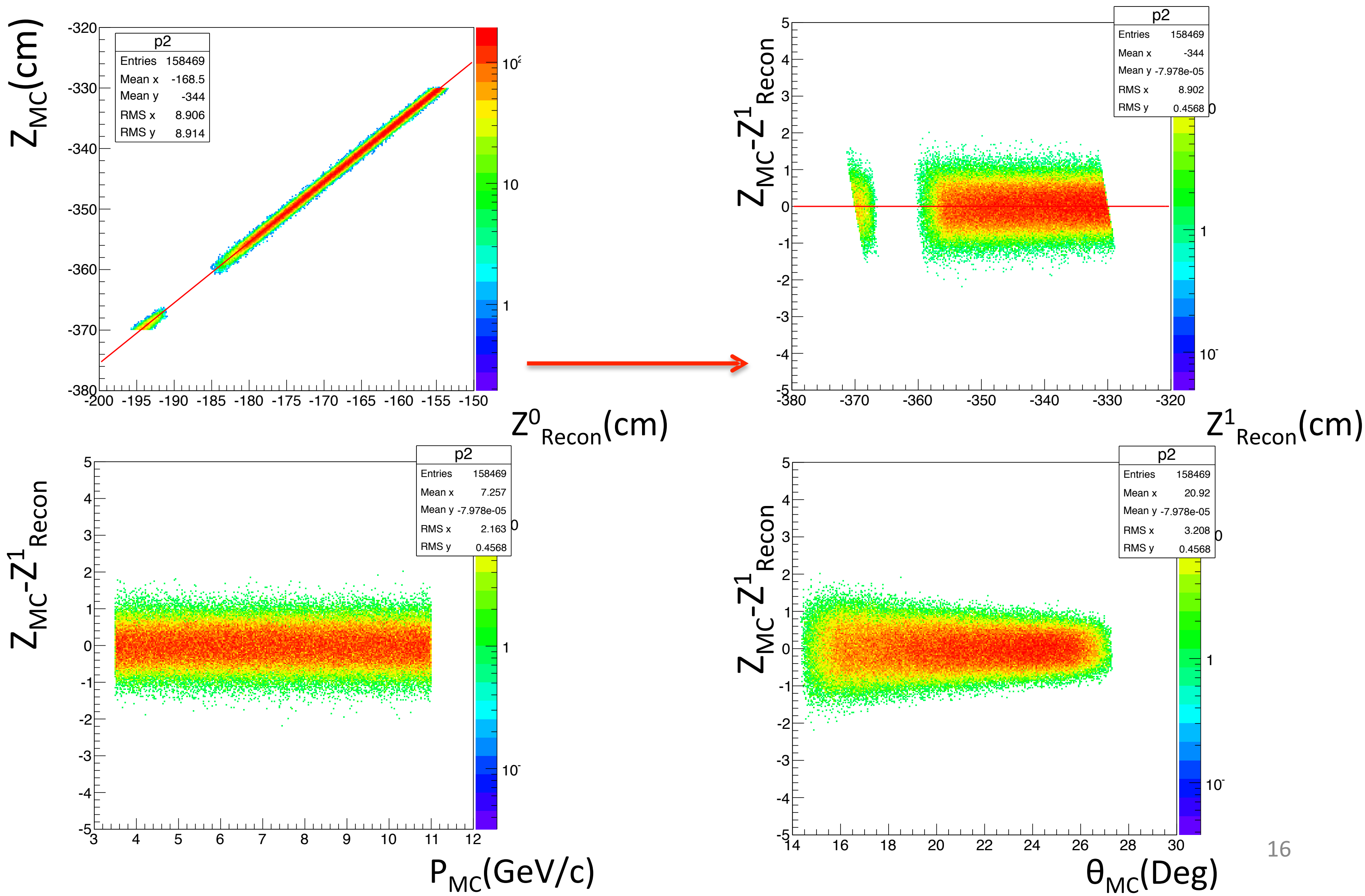


P (GeV/c)

Polar angle resolution (Xin's)



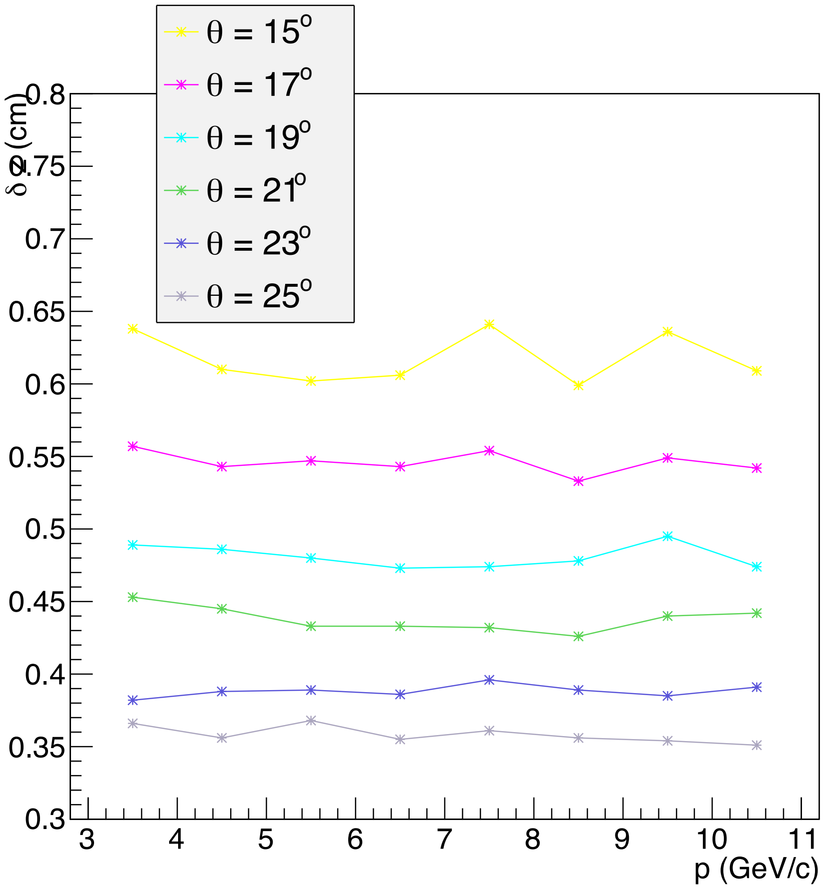
Vertex Z



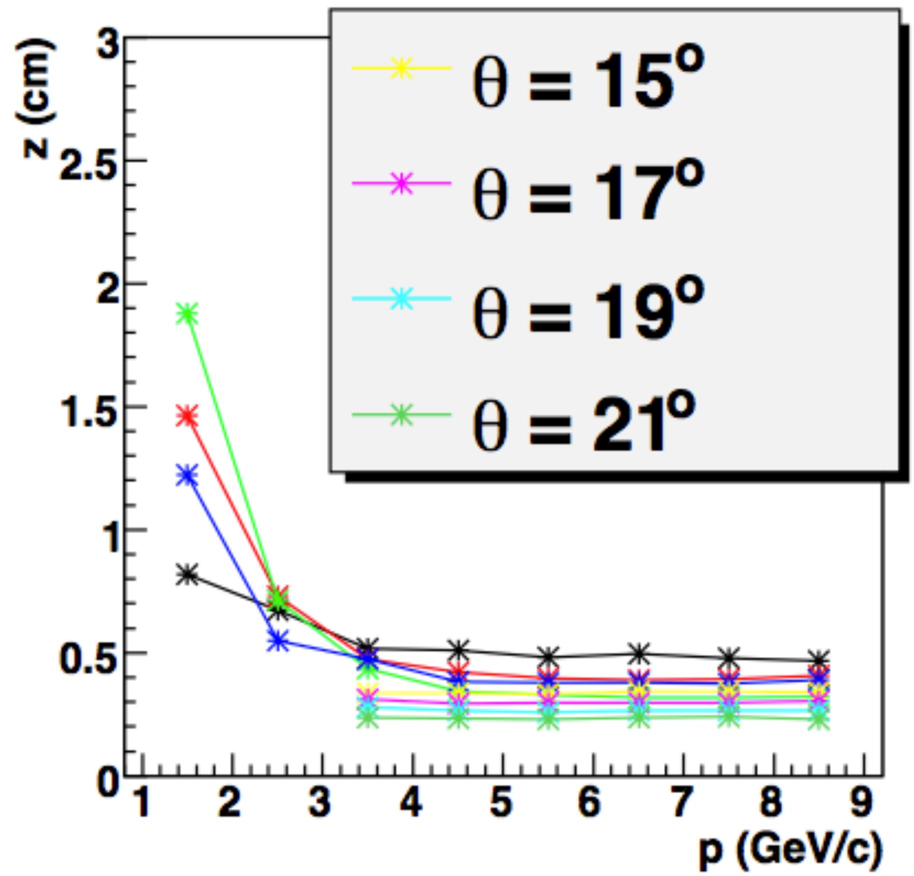
p2
Entries 158469
Mean x -168.5
Mean y -344
RMS x 8.906
RMS y 8.914
Z_{MC}(cm)
Z^0_{Recon}(cm)
p2
Entries 158469
Mean x -344
Mean y -7.978e-05
RMS x 8.902
RMS y 0.4568
$Z_{MC}-Z^1_{Recon}$
Z^1_{Recon}(cm)
p2
Entries 158469
Mean x 7.257
Mean y -7.978e-05
RMS x 2.163
RMS y 0.4568
P_{MC}(GeV/c)
p2
Entries 158469
Mean x 20.92
Mean y -7.978e-05
RMS x 3.208
RMS y 0.4568
θ_{MC}(Deg)

Vertex Z

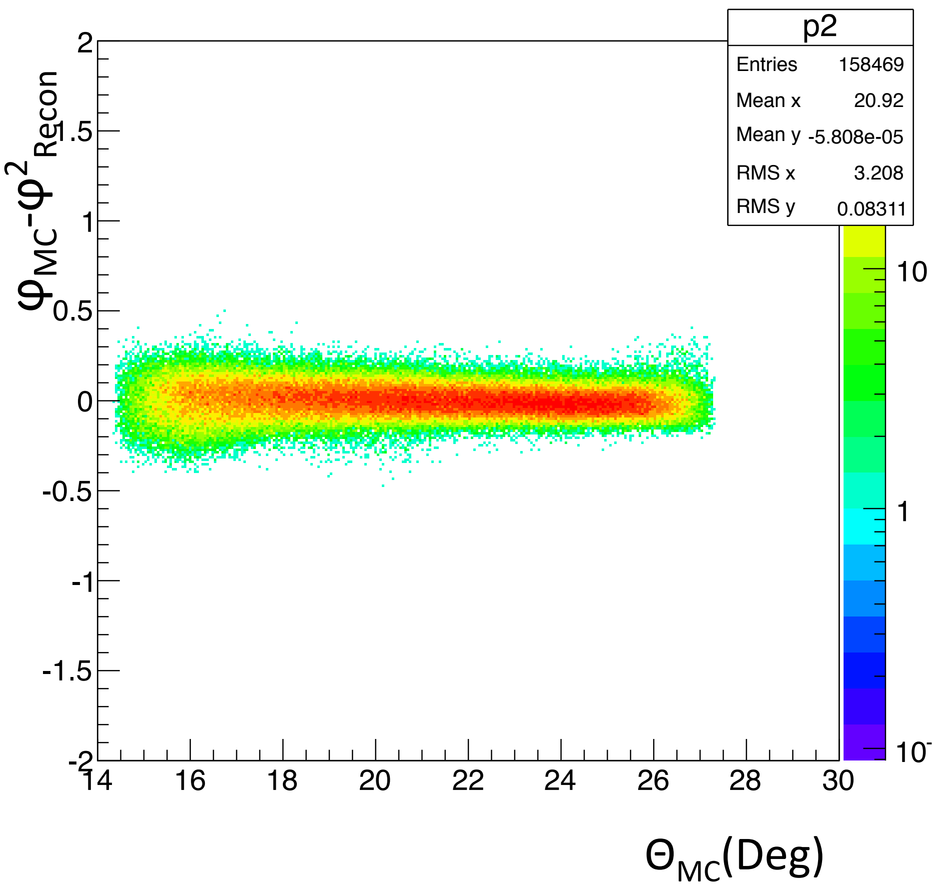
Vertex z resolution (New)

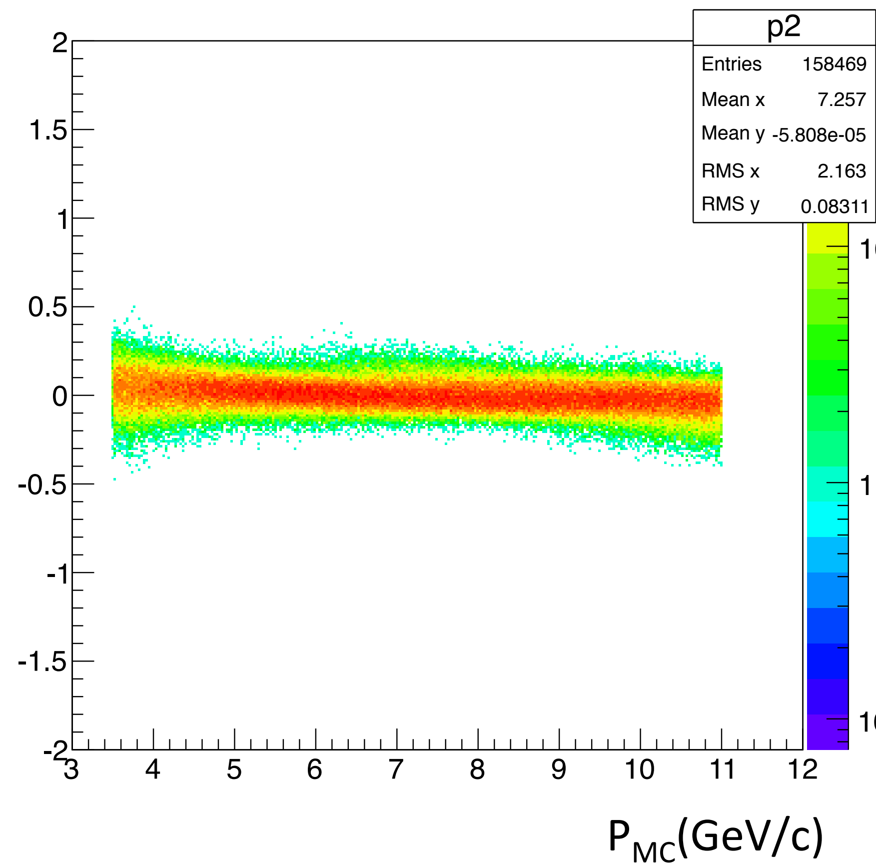


Vertex z resolution (Xin's)



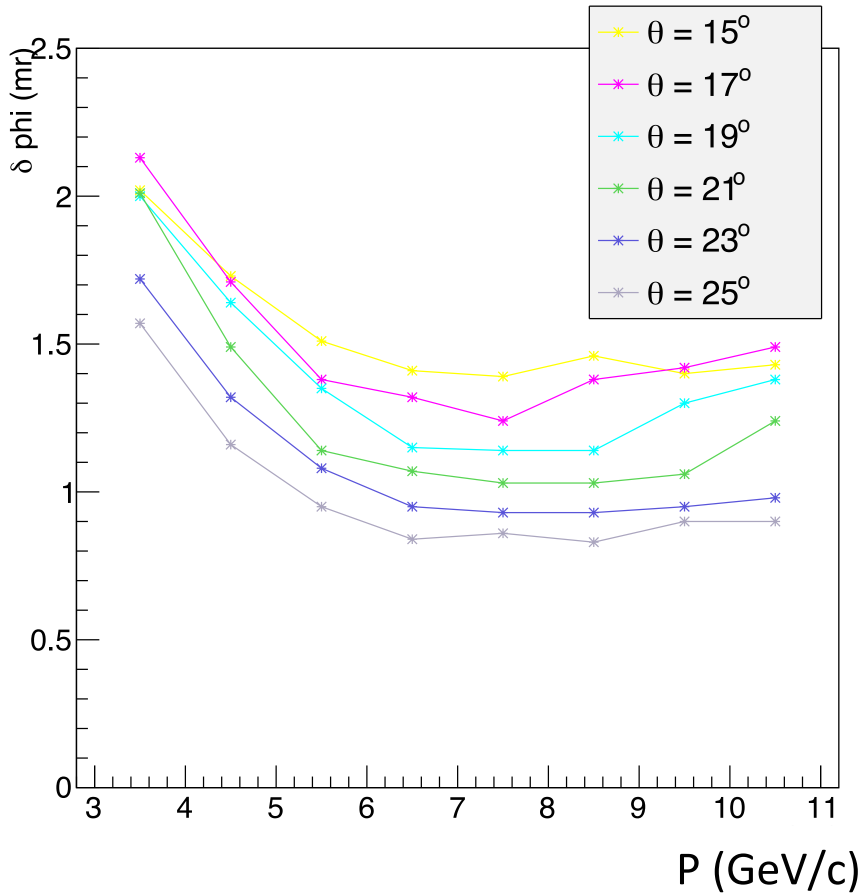
Azimuthal Angle



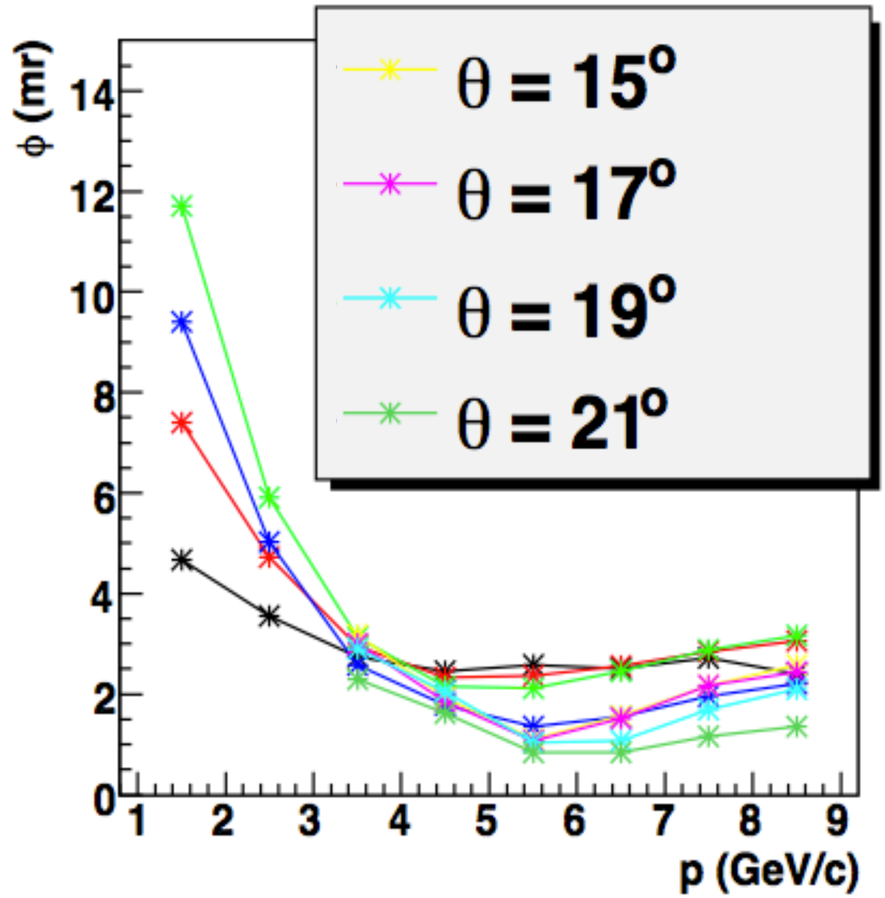


Azimuthal Angle

Azimuthal angle resolution (New)



Azimuthal angle resolution (Xin's)



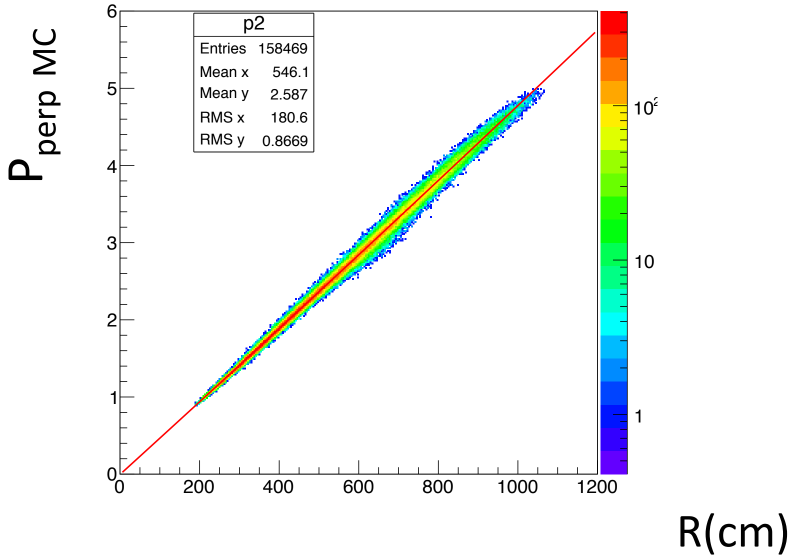
Momentum

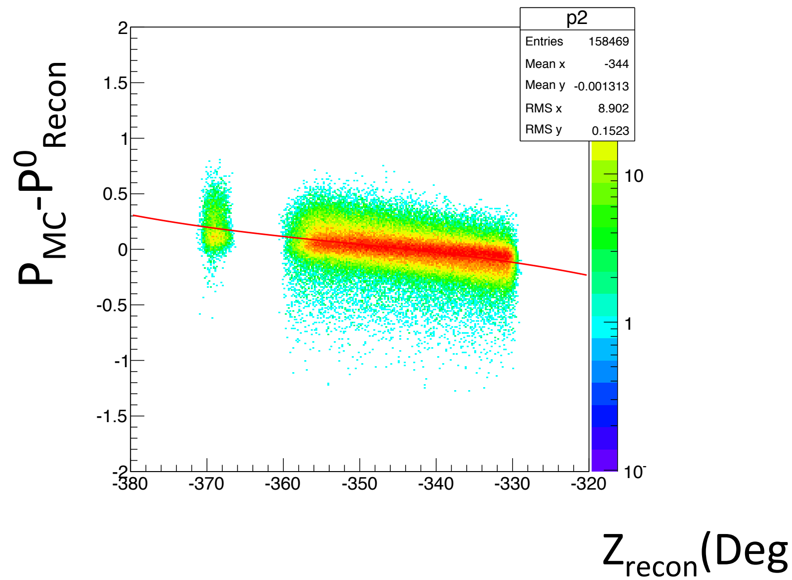
- Difficult to reconstruct, very vulnerable to detector resolution

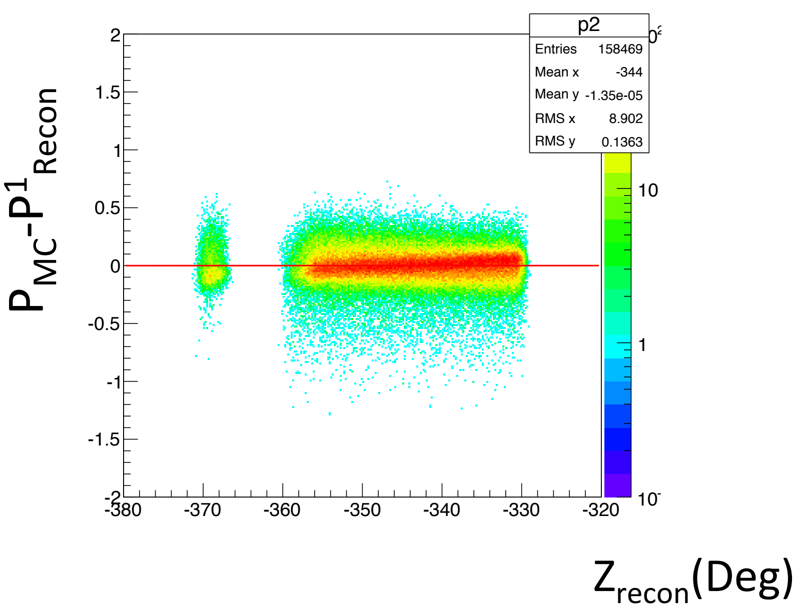
- First construct P_T, which should be linear in R

- $P = P_T/\sin(\theta)$

Momentum

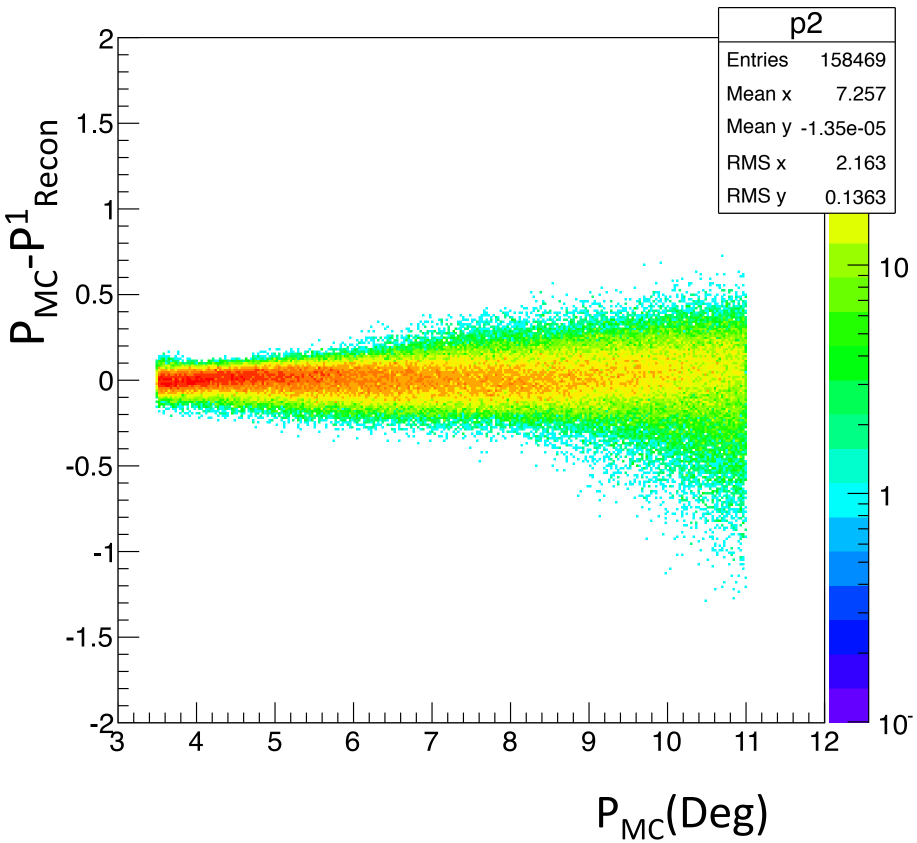




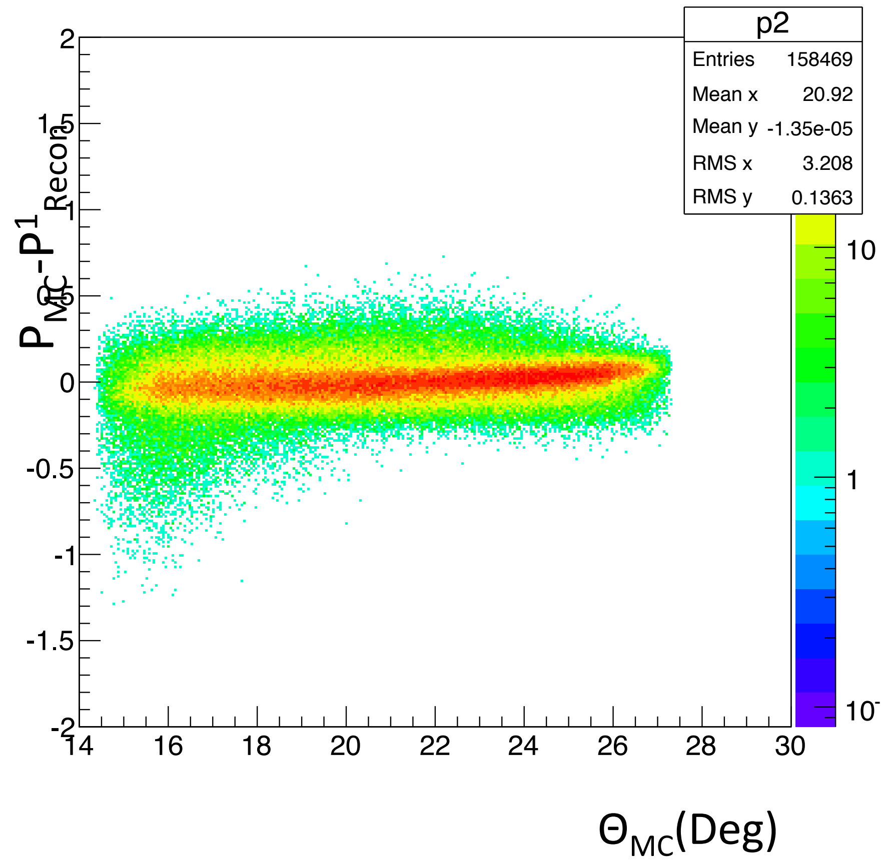


The fit on vertex z is not very good, if apply this correction, the resolution is better, but obvious bias can been seen for large momentum particles

Momentum



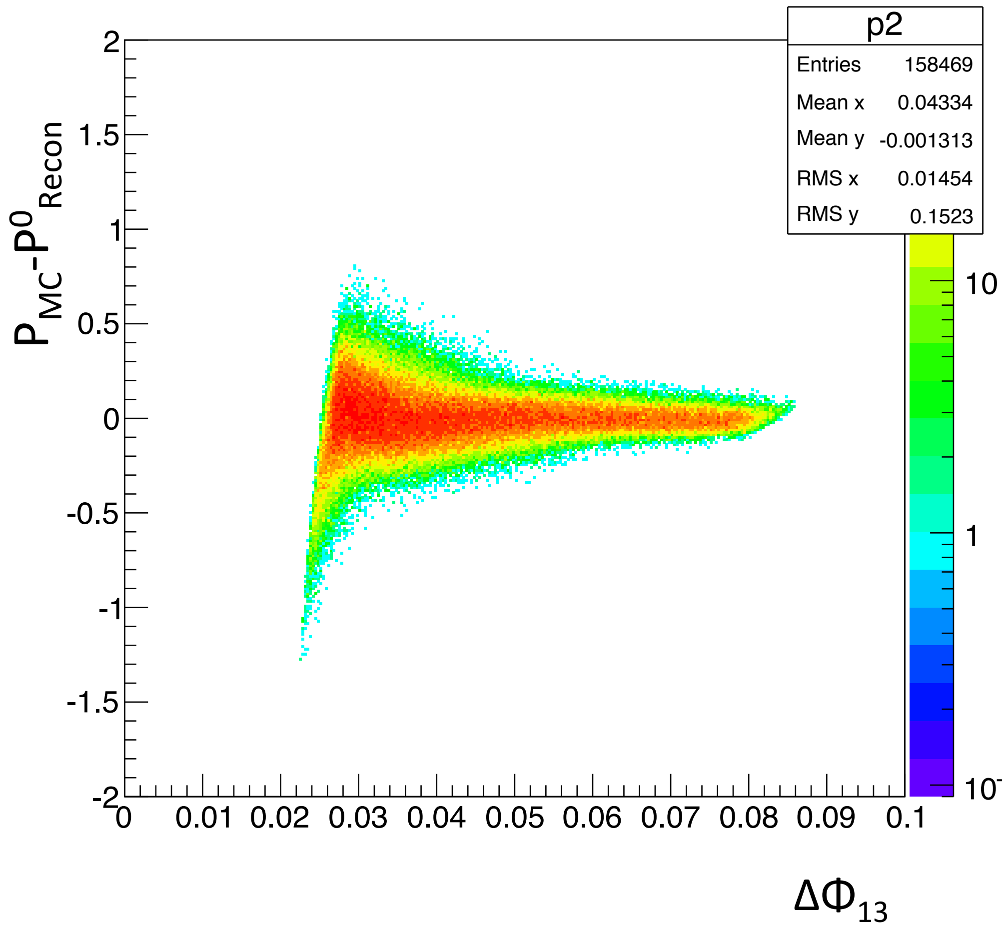
p2
Entries 158469
Mean x 7.257
Mean y -1.35e-05
RMS x 2.163
RMS y 0.1363
$P_{MC}-P^1_{Recon}$
P_{MC}(Deg)



p2
Entries 158469
Mean x 20.92
Mean y -1.35e-05
RMS x 3.208
RMS y 0.1363
$P_{MC}-P^1_{Recon}$
Θ_{MC}(Deg)

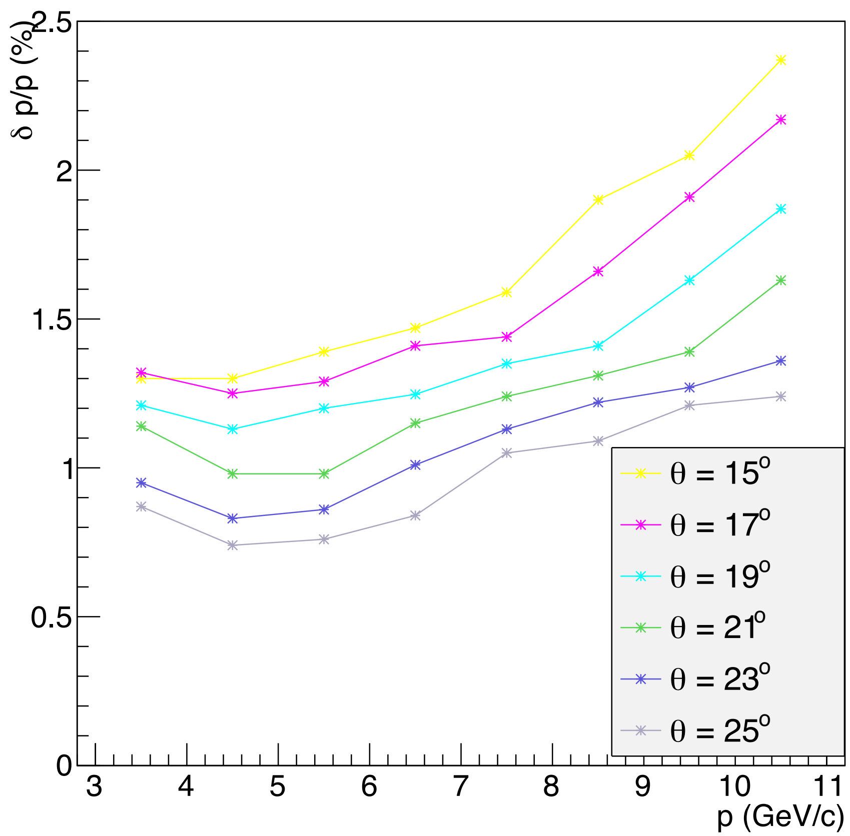
Momentum

- Vertex z is the only variable that has obvious dependence
- For other variable, clearly there is an area where, delta momentum is bad, but difficult to deal with using current method.

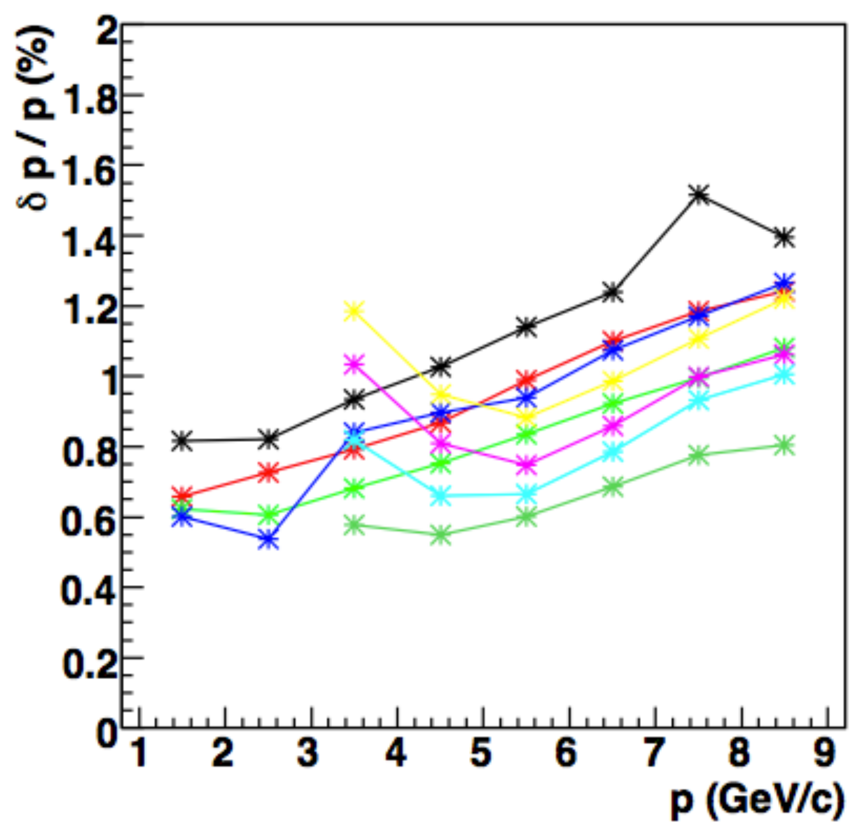


Momentum

Momentum resolution (New)



Momentum resolution (Xin's)



Resolution 100um Vs 200um

	200 um	100um
σ_θ (mr)	0.33	0.17
σ_φ (mr)	1.4	1.14
σ_z (cm)	0.46	0.41
$\Delta p/p$ (%)	p<6: GeV σ = 1.32% 6<p<9 GeV σ = 1.48% p>9 GeV σ = 2.08%	p<6: GeV σ = 1.07% 6<p<9 GeV σ = 1.07% p>9 GeV σ = 1.6%

Summary For Track Reconstruction

- A very empirical method, only gives a rough estimate for the reconstructed variables.

- More precise method can be used for the purpose of reconstruction (Kalman Filter)

- Use only three hits, what should we do with the fourth and fifth hits?