Understanding the Momentum Resolution distributions

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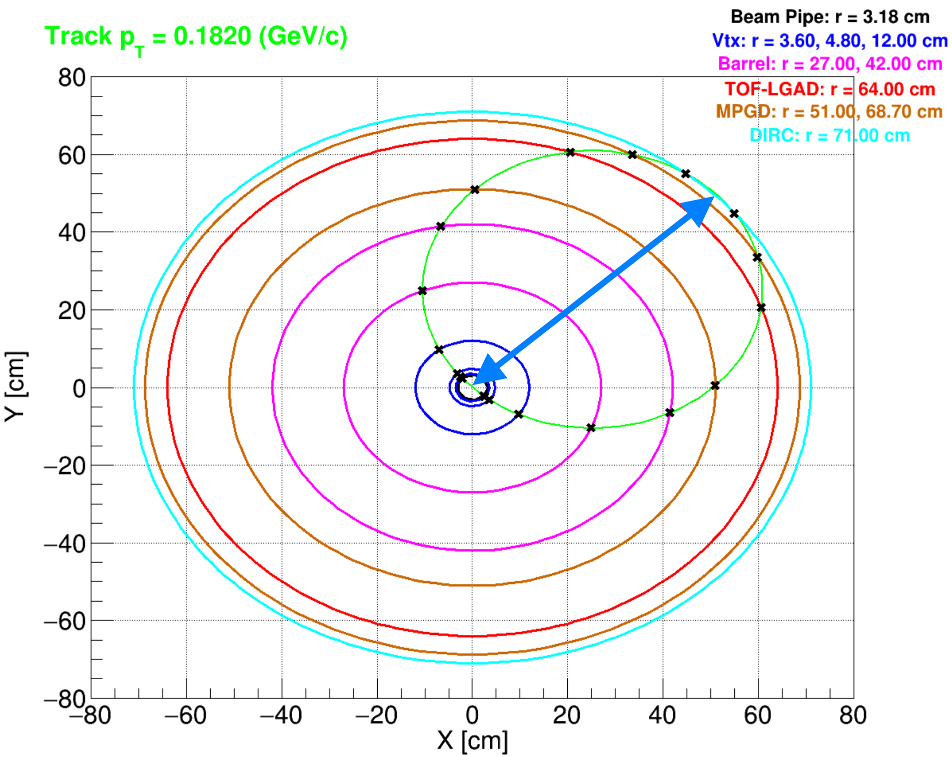
ePIC Barrel Tracker

$$p_T(GeV/c) = 0.3\,B[T]\,R_{track}[m]$$

$$p_{Tmin} = 0.3 \times 1.7 \times 0.3435 = 0.1752\,GeV/c$$

At η = 0 $\quad R_{track} = \frac{R_{OutMPGD}}{2} = 0.3435\,m$



$$\left.\frac{\Delta p_T}{p_T}\right|_{res.} = \frac{\sigma_{r\phi}\,p_T}{0.3\,B_0 L_0^2}\sqrt{\frac{720N^3}{(N-1)(N+1)(N+2)(N+3)}} \approx \frac{12\,\sigma_{r\phi}\,p_T}{0.3\,B_0 L_0^2}\sqrt{\frac{5}{N+5}}$$

$$\left.\frac{\Delta p_T}{p_T}\right|_{m.s.} = \frac{N}{\sqrt{(N+1)(N-1)}}\,\frac{0.0136\,\mathrm{GeV/c}}{0.3\beta\,B_0 L_0}\sqrt{\frac{d_{tot}}{X_0\sin\theta}}\left(1 + 0.038\ln\frac{d}{X_0\sin\theta}\right)$$

Constant term (at β<1 increase)

$$\frac{\sigma_{pT}}{p_T} = \sqrt{\left(\frac{\sigma_{pT_{SR}}}{p_T}\right)^2 + \left(\frac{\sigma_{pT_{MS}}}{p_T}\right)^2} = \sqrt{\left(\frac{A\,p_T}{L_0^2}\right)^2 + \left(\frac{B}{\beta L_0}\right)^2}$$

$$\Delta d_0|_{res.} \approx \frac{3\sigma_{r\phi}}{\sqrt{N+5}}\sqrt{1 + \frac{8r_0}{L_0} + \frac{28r_0^2}{L_0^2} + \frac{40r_0^3}{L_0^3} + \frac{20r_0^4}{L_0^4}}$$

$$\Delta d_0|_{m.s.} \approx \frac{0.0136\,\mathrm{GeV/c}}{\beta p_T}\,r_0\sqrt{\frac{d}{X_0\sin\theta}}\sqrt{1 + \frac{1}{2}\left(\frac{r_0}{L_0}\right) + \frac{N}{4}\left(\frac{r_0}{L_0}\right)^2}$$

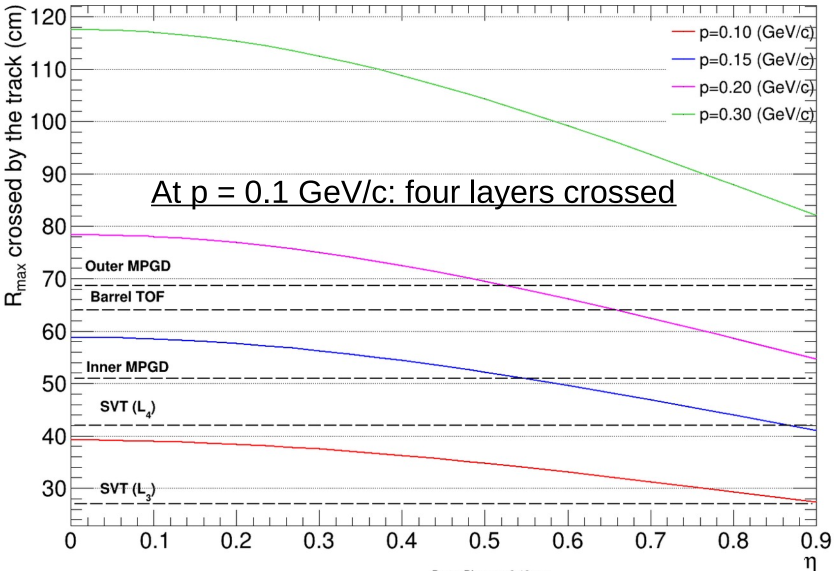
$$\sigma_{d_0} = \sqrt{\sigma_{d0_{SR}}^2 + \sigma_{d0_{MS}}^2}$$

arXiv:1805.12014

Lever arm affects the width of Gaussian (-1.0,1.0), (1.0,2.5), (2.5,3.5)

$$p_T = p\sin(\theta)$$

$$p_T(GeV/c) = 0.3\,B[T]\,R_{track}[m]$$



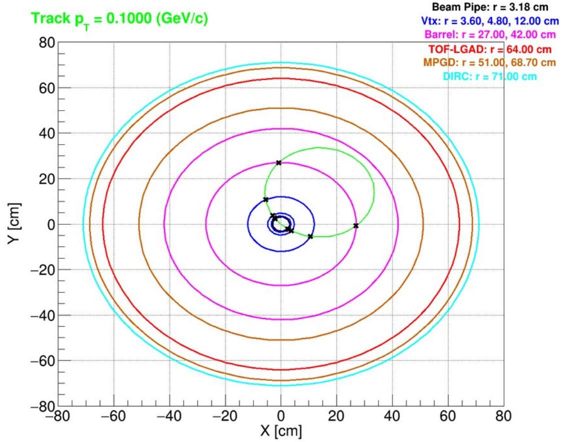
Tracking Performances is affected by

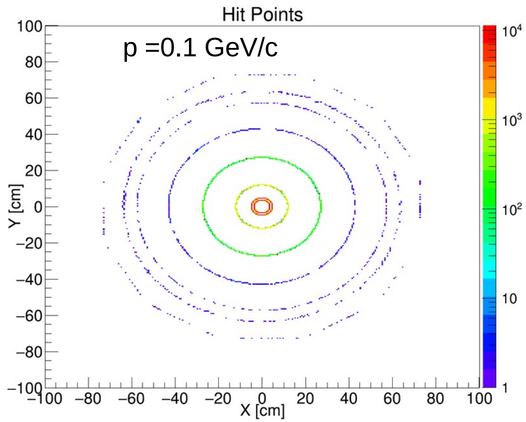
- Different lever arm (convolution of different Guassians)
- Different momentum
- Non Gaussian tails in the multiple scattering at low momentum
- Fitting algorithm: covariances under study

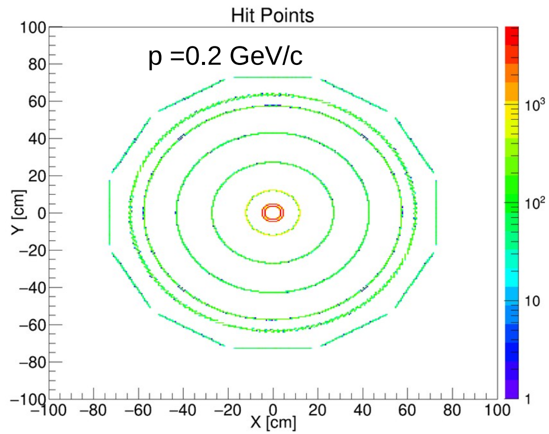
Next strategy: generate particles at a fixed momentum than the uniform distribution of particles in η and momentum

Barrel EMCal
p_{Tmin} = 0.3*1.7*0.78/2 = 0.199 GeV/c

Curling tracks







ePIC Tracking Geometry

epic_craterlake_tracking_only.xml

https://indico.bnl.gov/event/18214/contributions/74857/attachments/46665/79042/EPIC_Tracking_Meeting_Shyam23Mar2023.pdf

```
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24.04.0
shyam@shyam:~/eic/epic$
shyam@shyam:~/eic/EICrecon$ git describe --tags --abbrev=0
v1.12.0
shyam@shyam:~/eic/EICrecon$
```
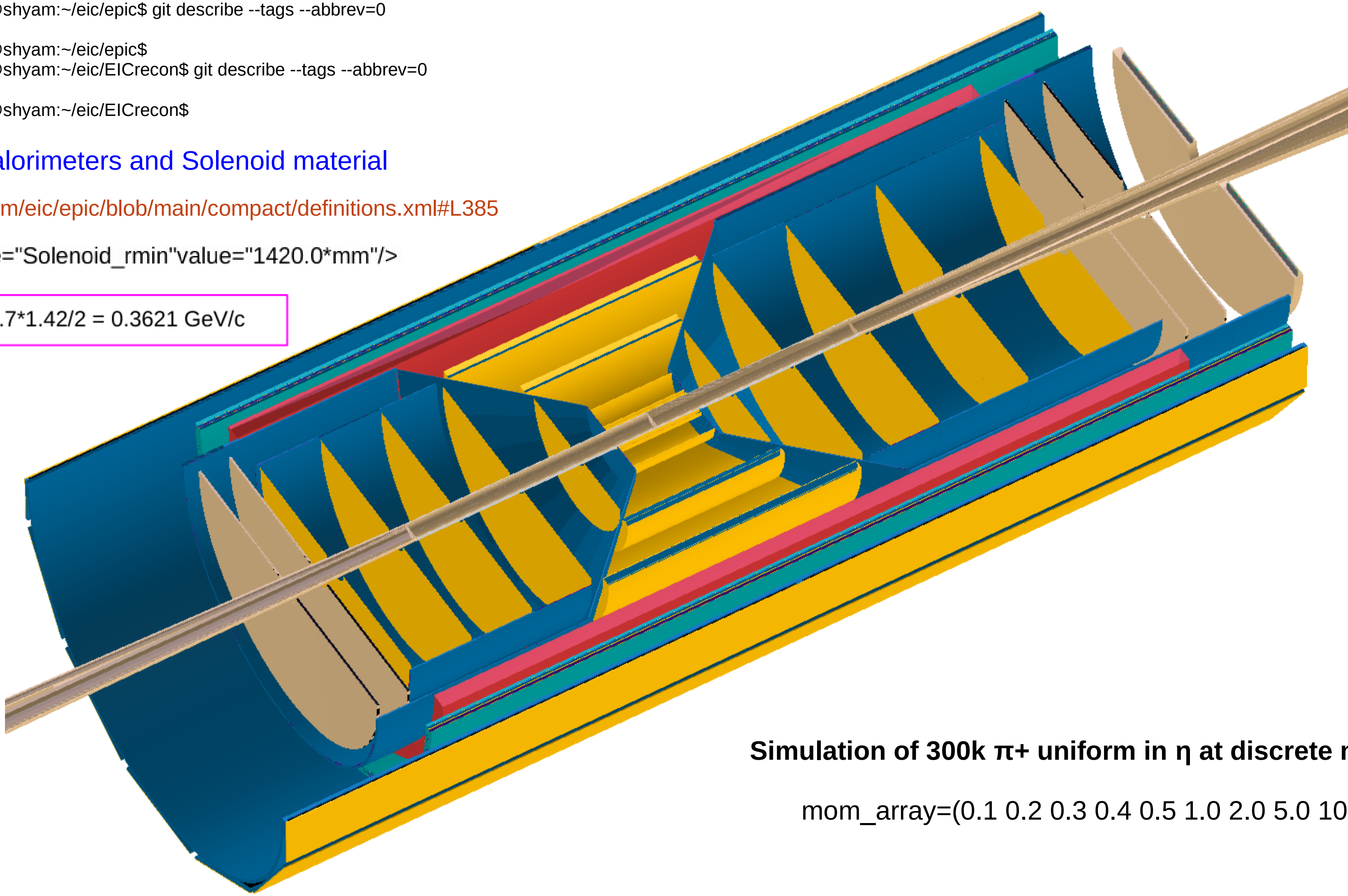

No Barrel calorimeters and Solenoid material

https://github.com/eic/epic/blob/main/compact/definitions.xml#L385

<constant name="Solenoid_rmin"value="1420.0*mm"/>

p_{Tmin} = 0.3*1.7*1.42/2 = 0.3621 GeV/c



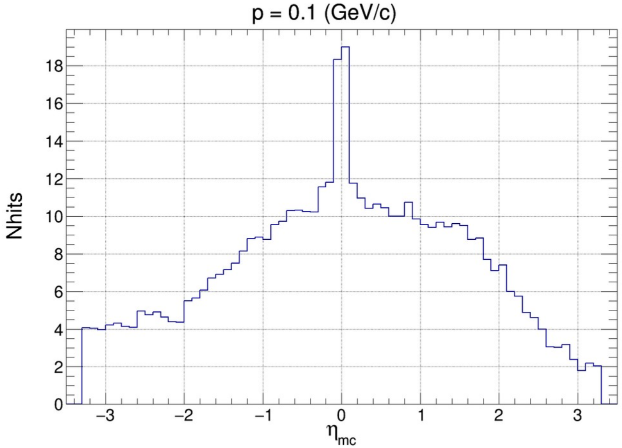
Simulation of 300k π+ uniform in η at discrete momentum

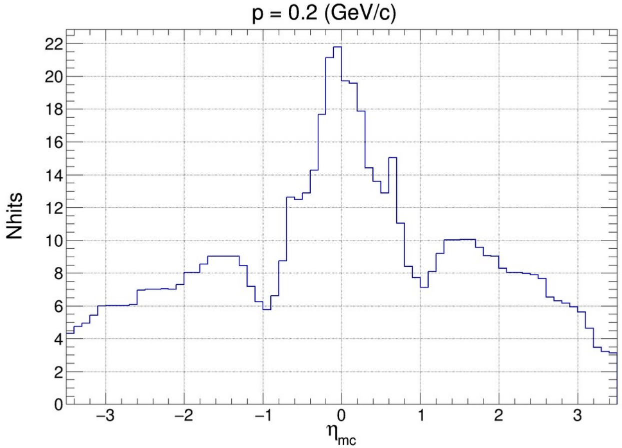
mom_array=(0.1 0.2 0.3 0.4 0.5 1.0 2.0 5.0 10.0 20.0)

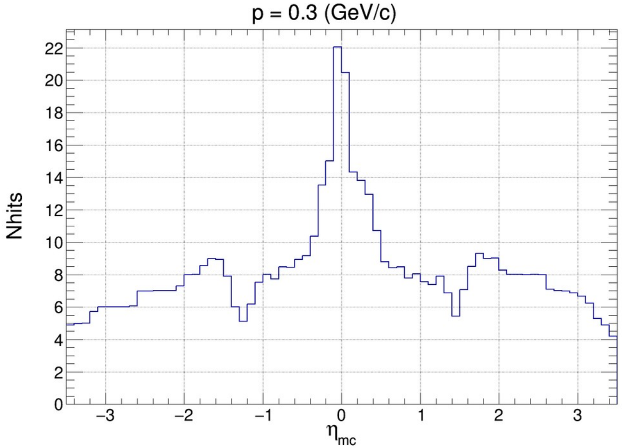
Average Nhits vs η_{mc} (single track)

Curling tracks can produce several hits

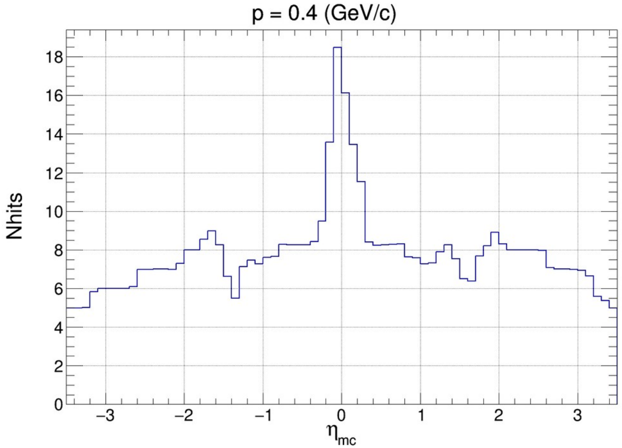
Barrel EMCal p_{Tmin} = 0.3*1.7*0.78/2 = 0.199 GeV/c

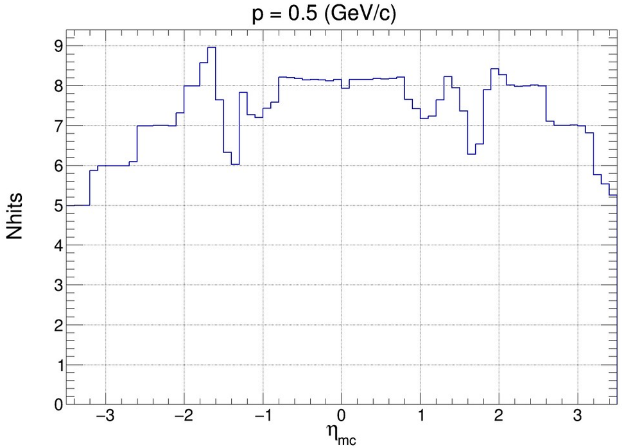


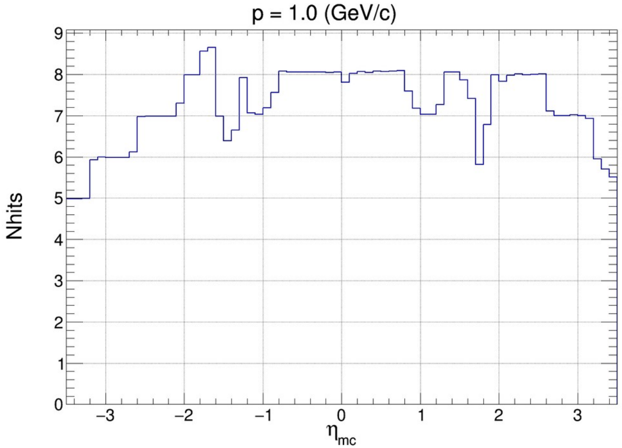




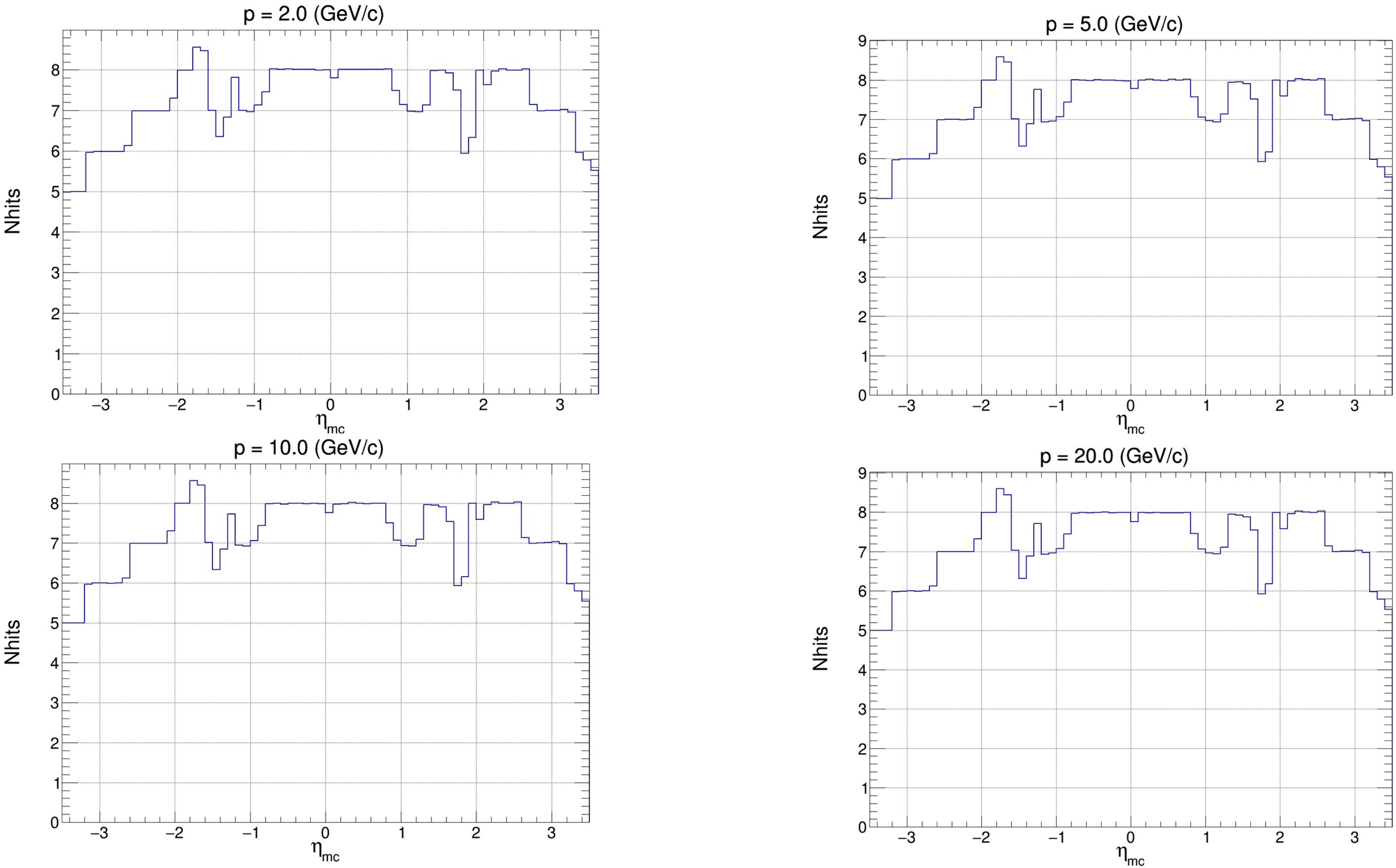
Suggestion to add Barrel EMCal and Solenoid magnet to tracking geometry (epic_craterlake_tracking_only.xml) avoid curling for p > 0.2 GeV/c





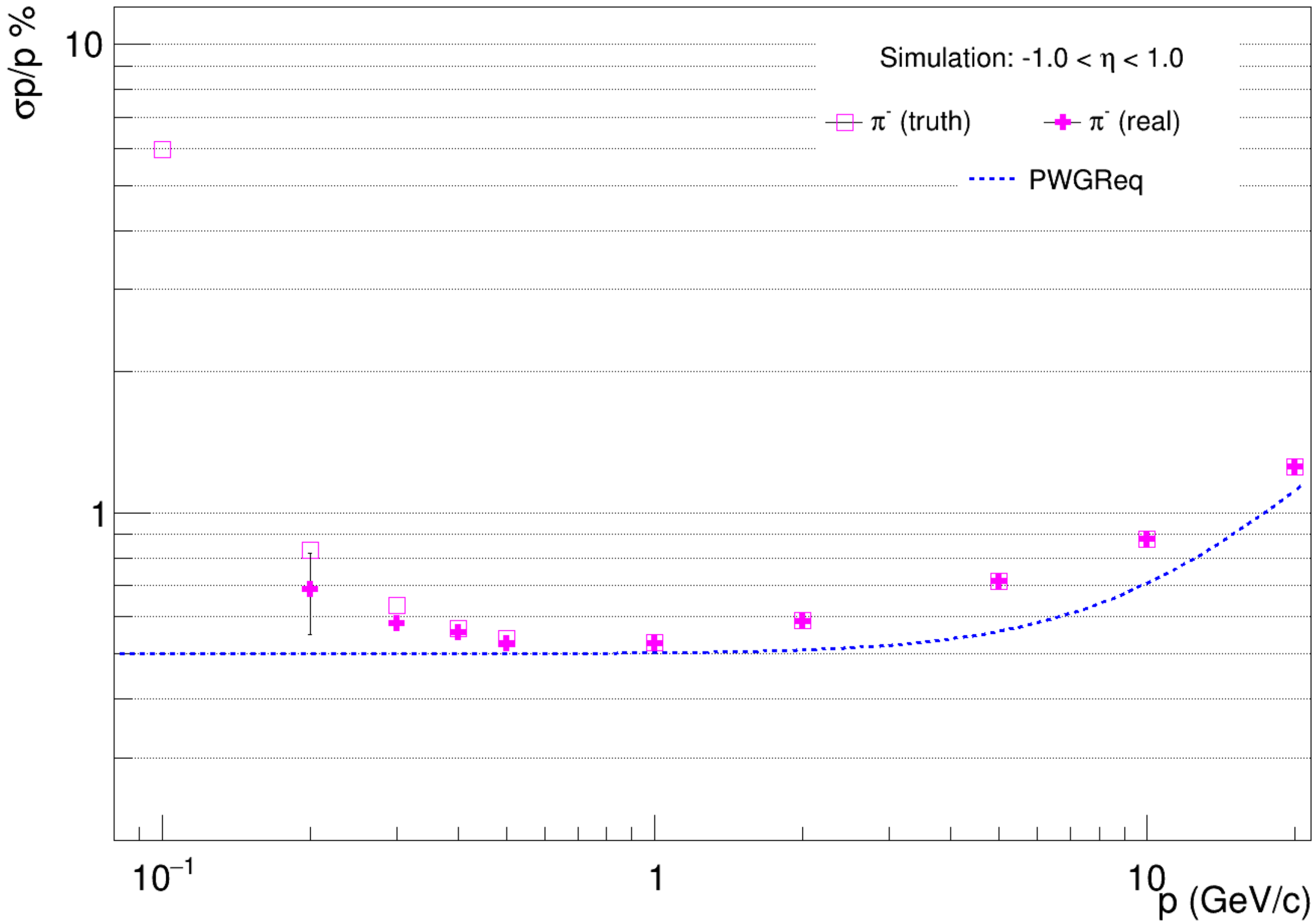


Average Nhits vs η_{mc} (single track)



Simulation of 300k π+ uniform in η at discrete momentum locally

mom_array=(0.1 0.2 0.3 0.4 0.5 1.0 2.0 5.0 10.0 20.0)



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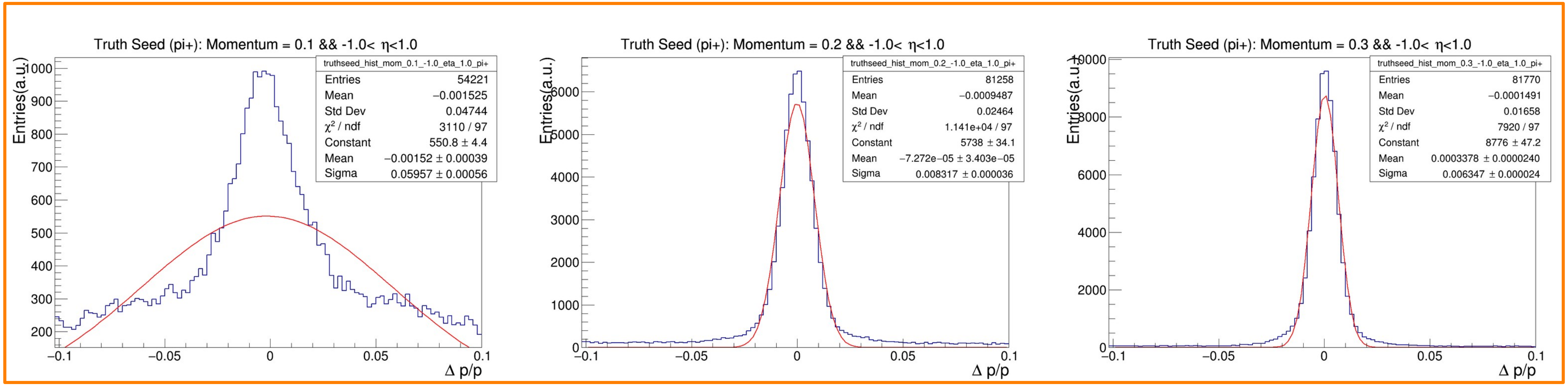
v1.12.0
shyam@shyam:~/eic/EICrecon$

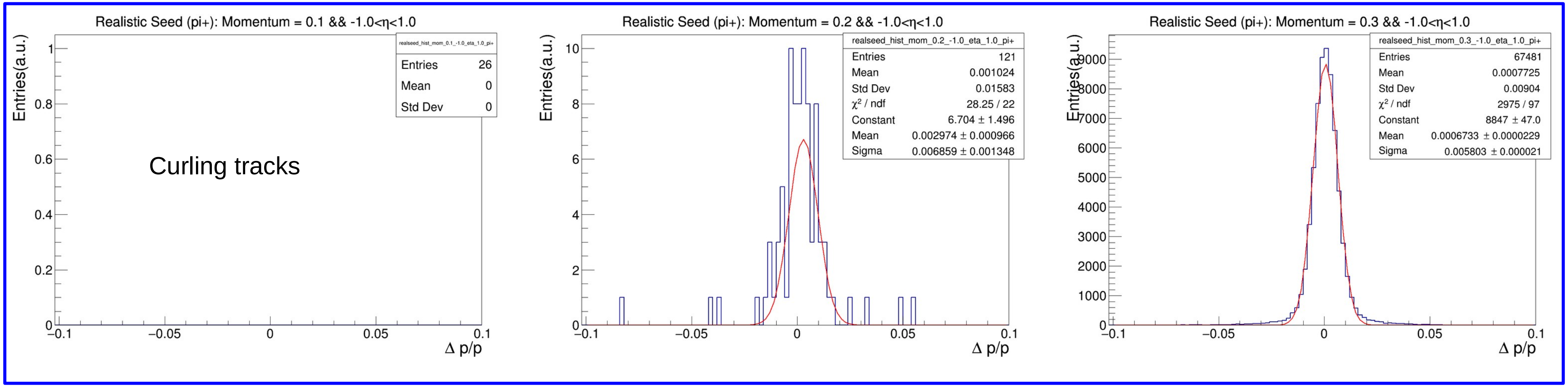
epic_craterlake_tracking_only.xml

Intermediate distributions

Truth Seeding

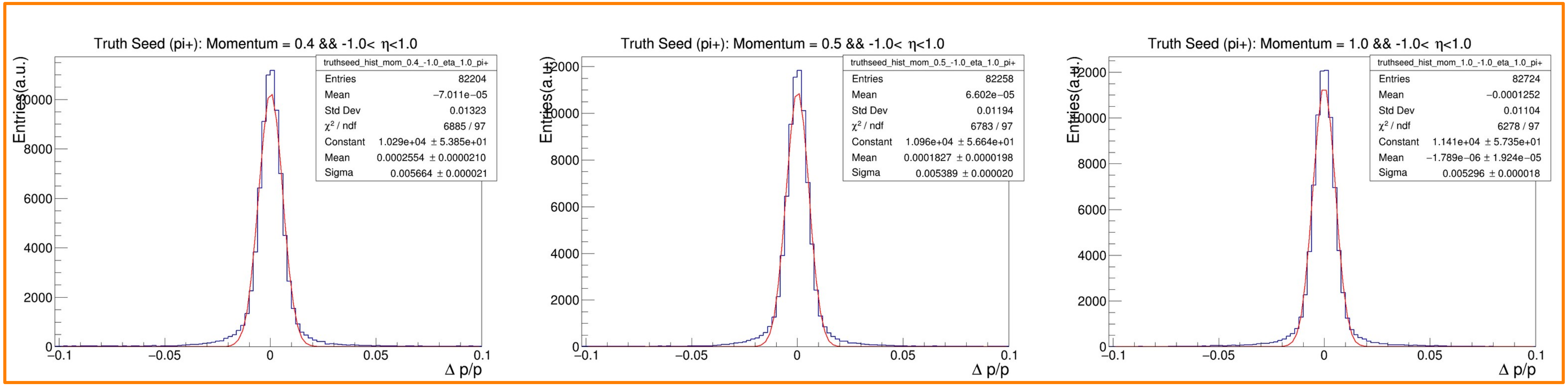


Realistic Seeding

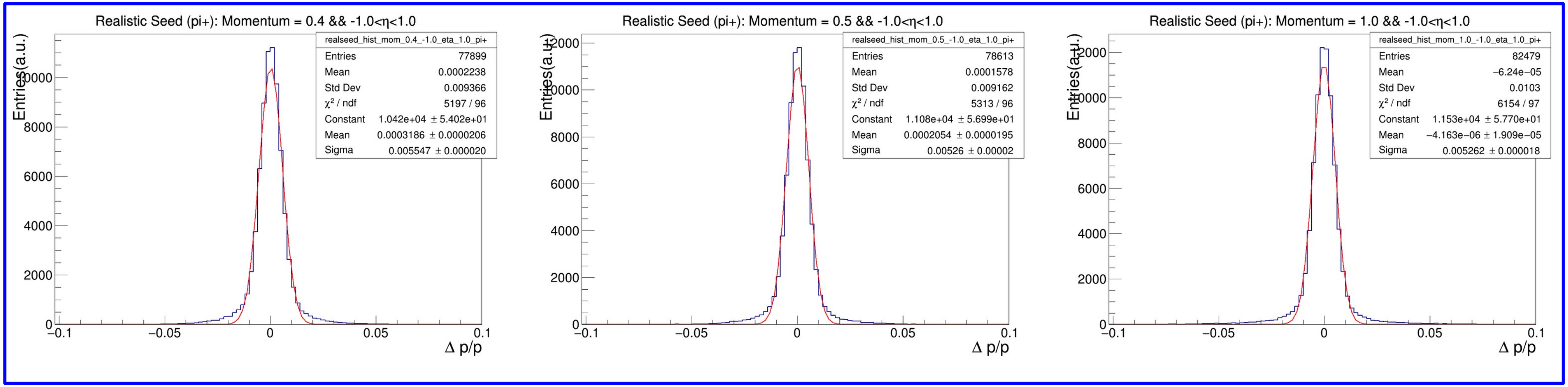


Intermediate distributions

Truth Seeding

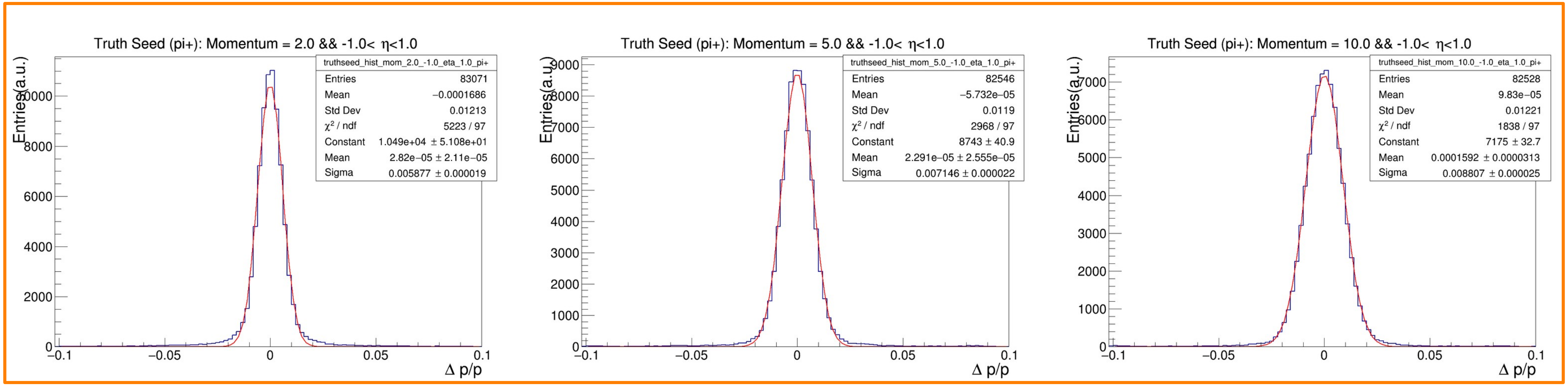


Realistic Seeding

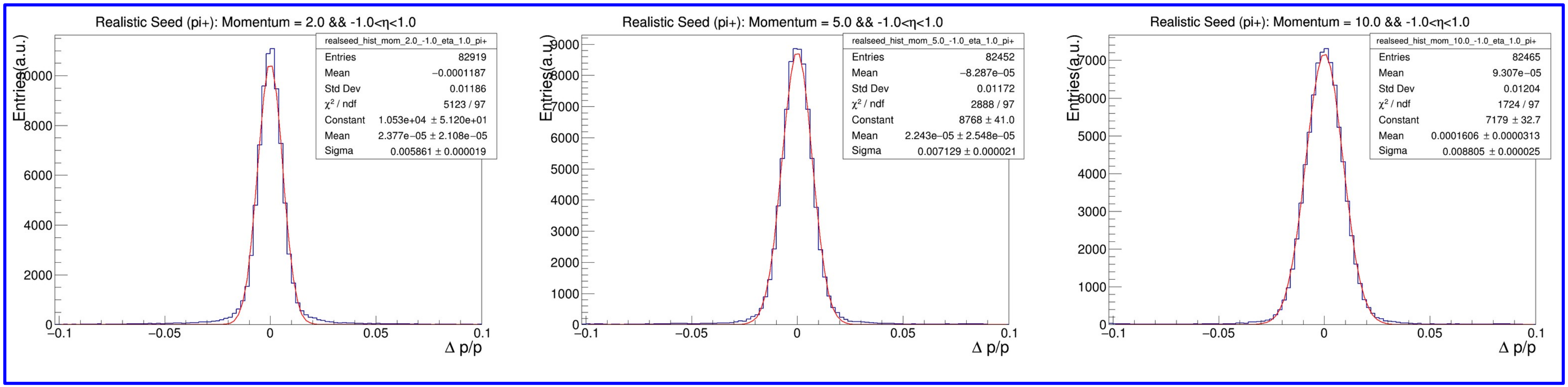


Intermediate distributions

Truth Seeding



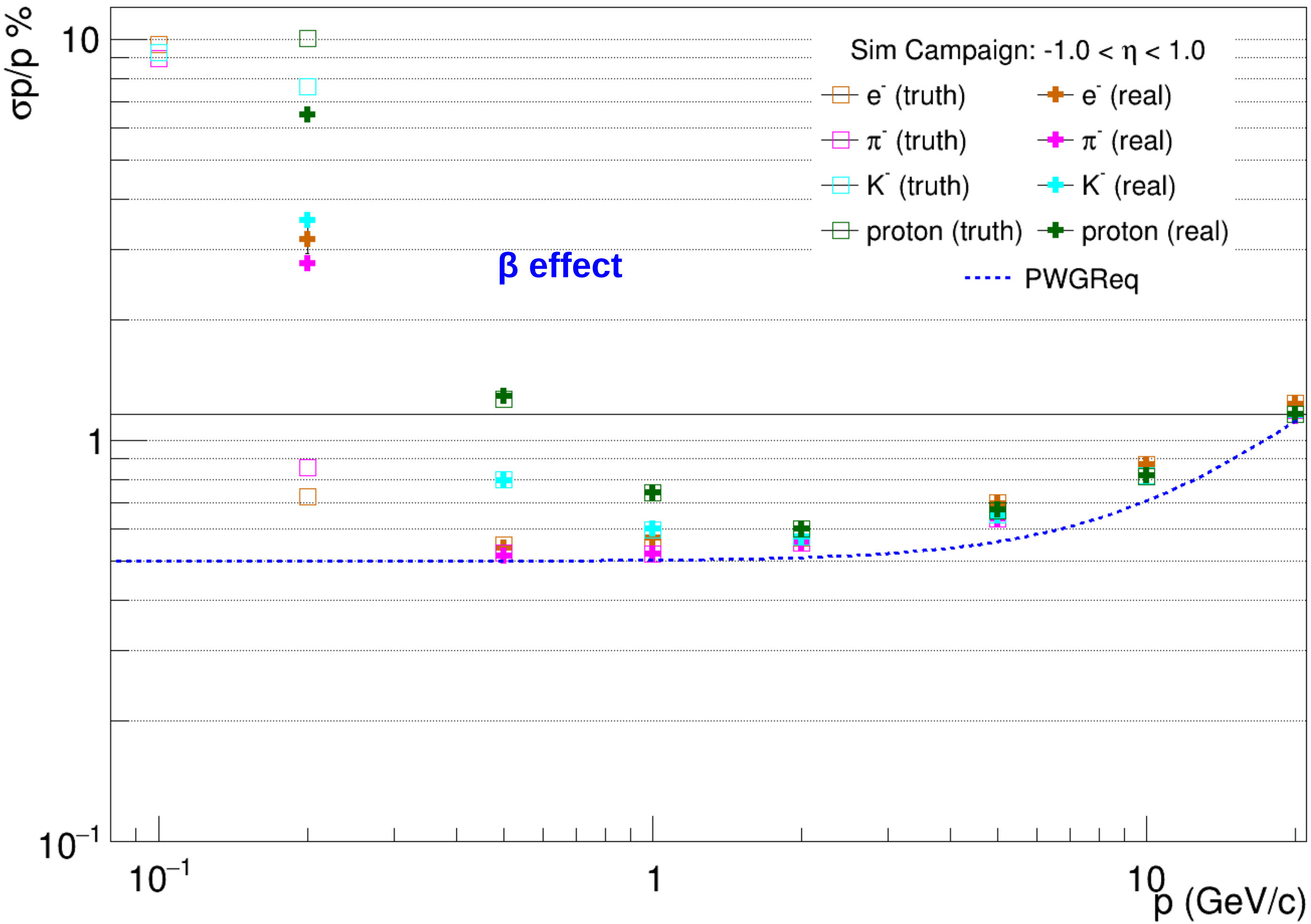
Realistic Seeding



Simulation Campaign (23.12.0)

root://dtn-eic.jlab.org//work/eic2/EPIC/RECO/23.12.0/epic_craterlake

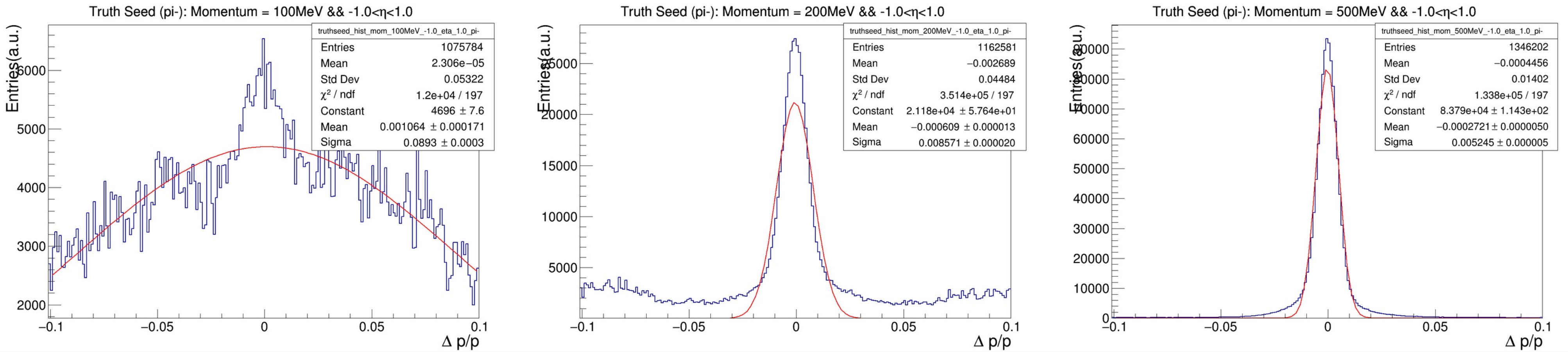
mom_array=(0.1 0.2 0.5 1.0 2.0 5.0 10.0 20.0)



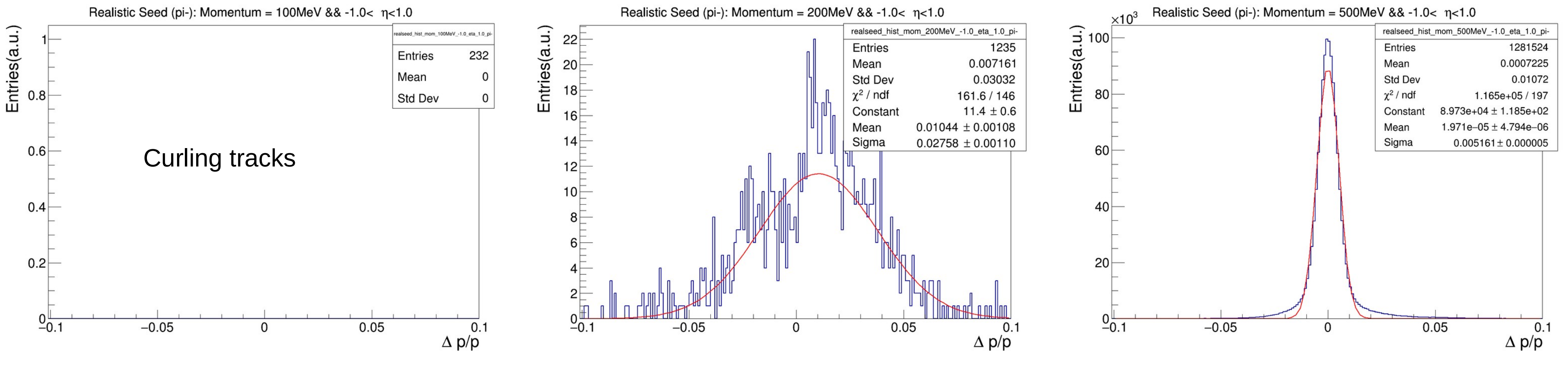
Intermediate distributions (π-) Simulation Campaign

Truth Seeding

root://dtn-eic.jlab.org//work/eic2/EPIC/RECO/23.12.0/epic_craterlake



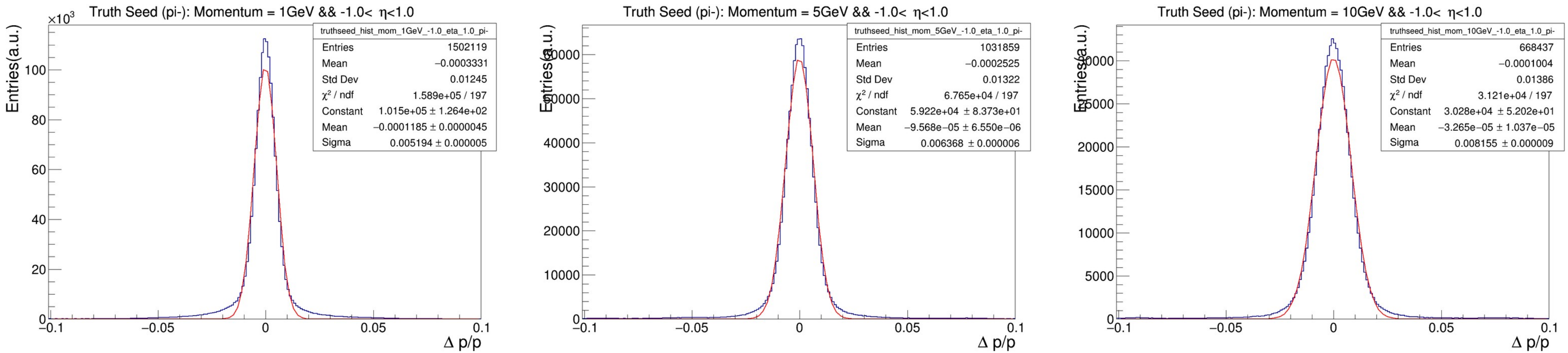
Realistic Seeding



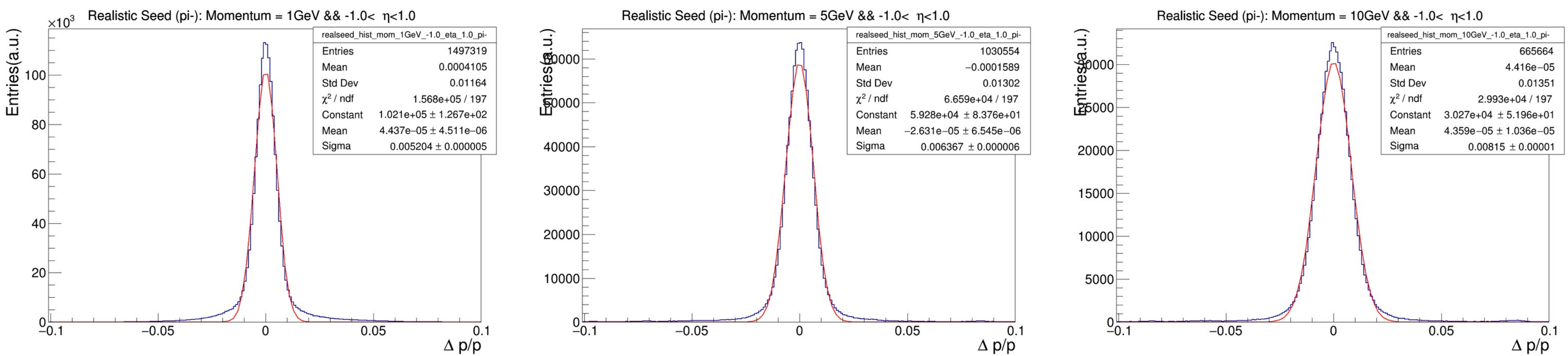
Intermediate distributions (π-) Simulation Campaign

Truth Seeding

root://dtn-eic.jlab.org//work/eic2/EPIC/RECO/23.12.0/epic_craterlake



Realistic Seeding



Summary

- Momentum resolutions distributions are presented with discrete momentum binning ($|\eta|<1$)
- Issues in tracking at very low momenta (curling tracks) need to be further investigated: few suggestions
  - In the simulation campaign change theta from three regions: 3 to 50 deg, 45 to 135 deg, and 130 to 177 deg to 3 deg to 177 deg (easier for me accessing files reduced by a factor of 3).
  - Include also in simulation campaign 0.3, 0.4 GeV ranges just to check things are fine in that region
  - Modify tracking geometry including the material for calorimeters and solenoid magnet which will absorb the curling tracks p_T> 0.2 GeV/c but simulation will be slower
- Further trying to understand other η ranges for momentum and DCA resolutions

Thank You !!