

EIC Residuals in Tracking

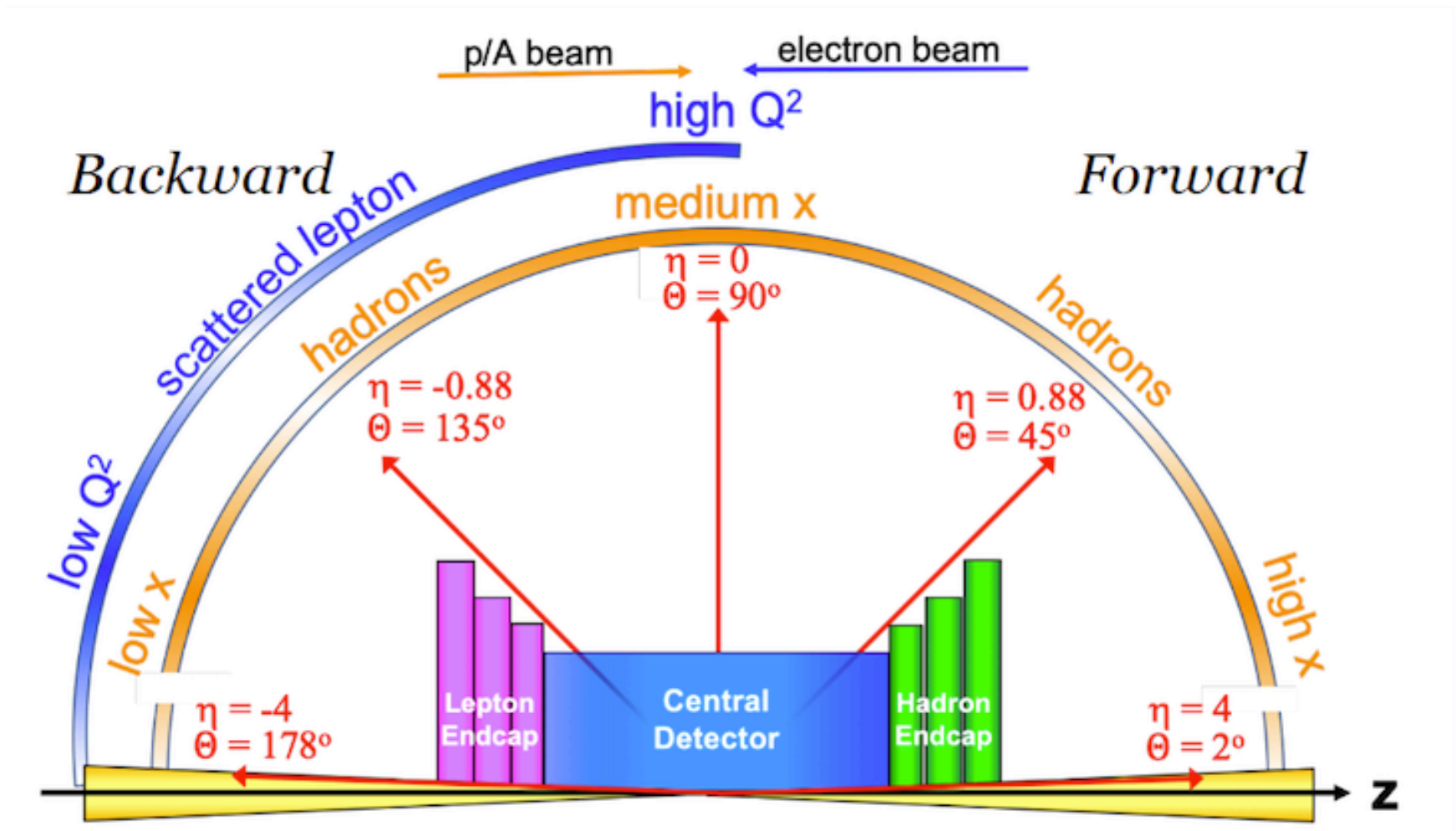
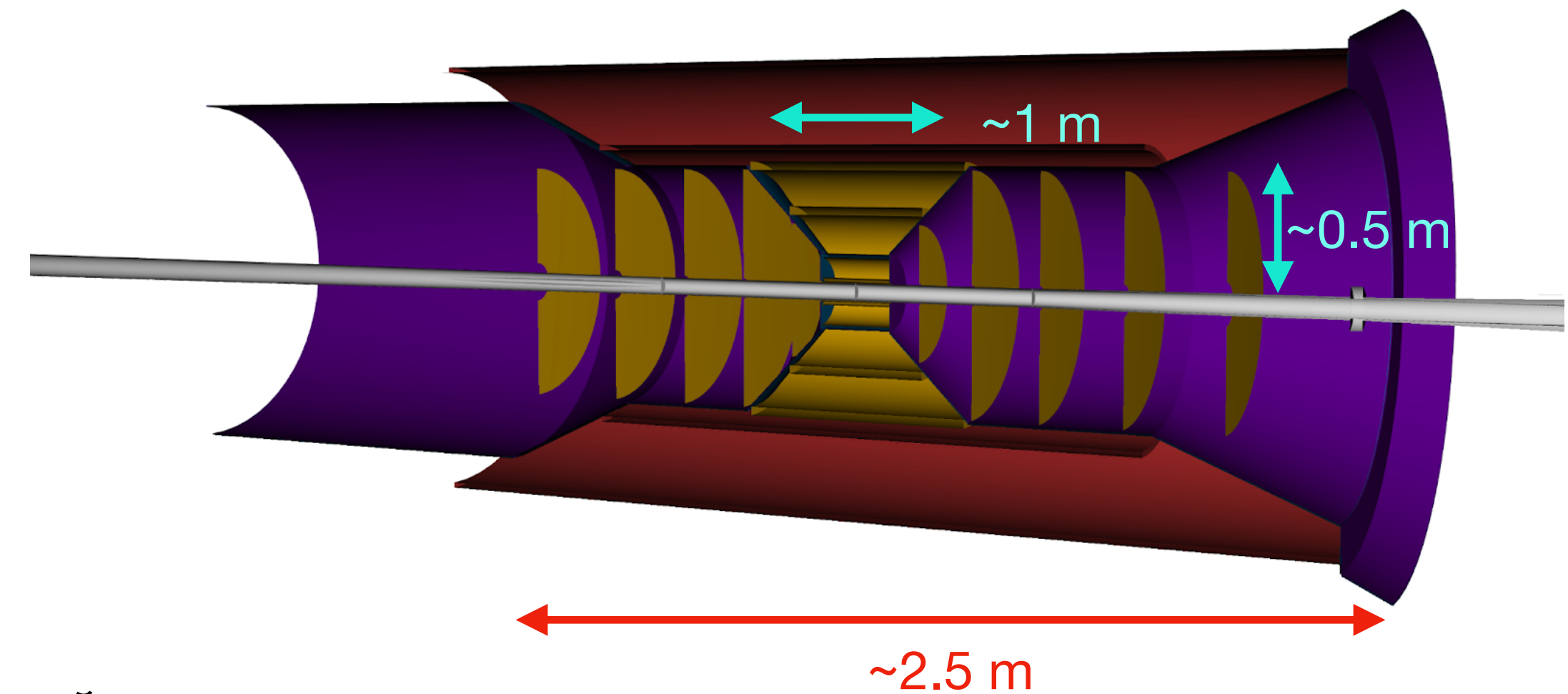
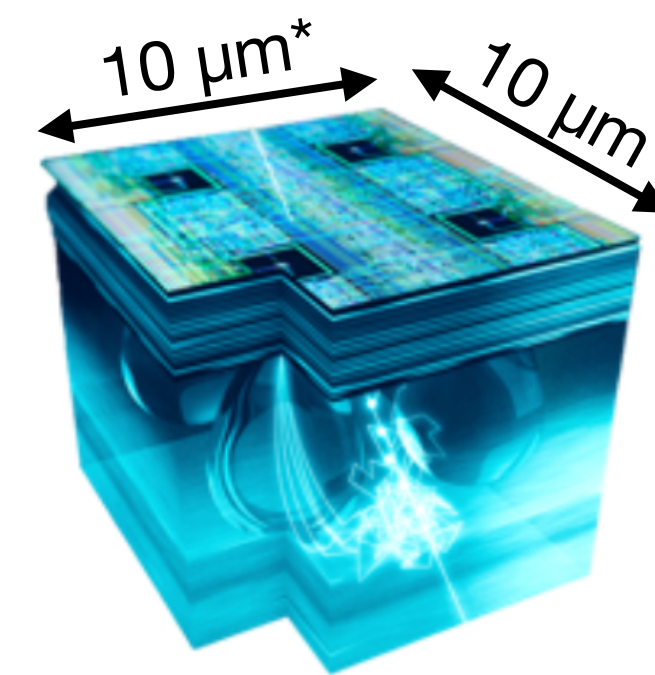
EIC UC Consortium

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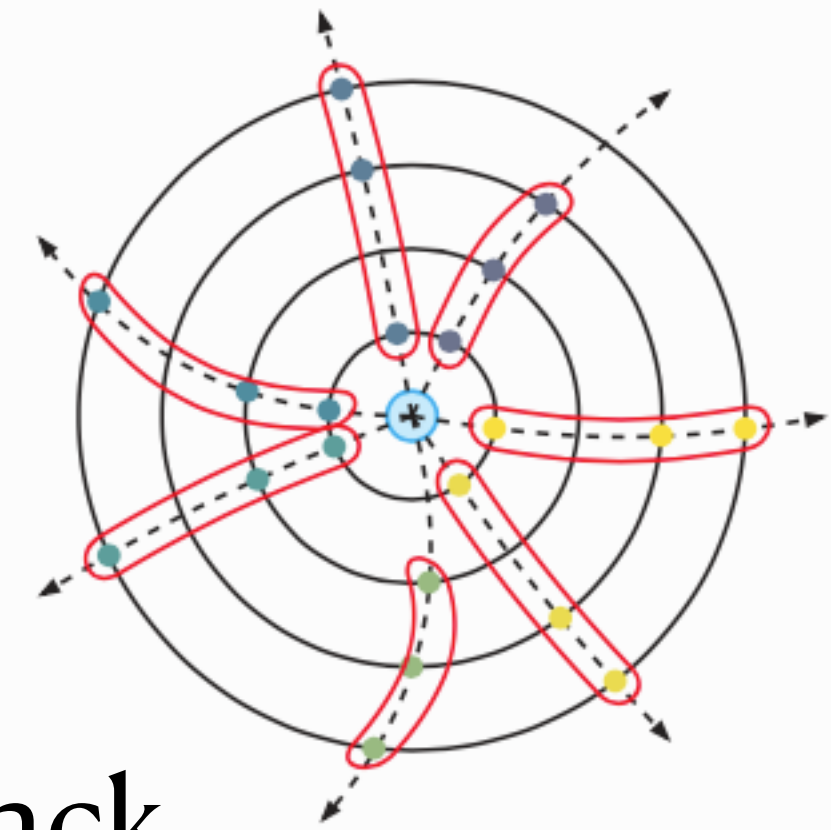
EIC Silicon Tracking Geometry

- Silicon is composed of MAPS chips
 - MAPS = Monolithic Active Pixel Sensors
 - Low material silicon wafers
- Barrel
 - 3 vertexing layers
 - 2 barrel layers
- Disks (forward & backward regions)
 - 5 on each side



* The Si pixel size is currently 20 μm , but is set to 10 μm for this study.

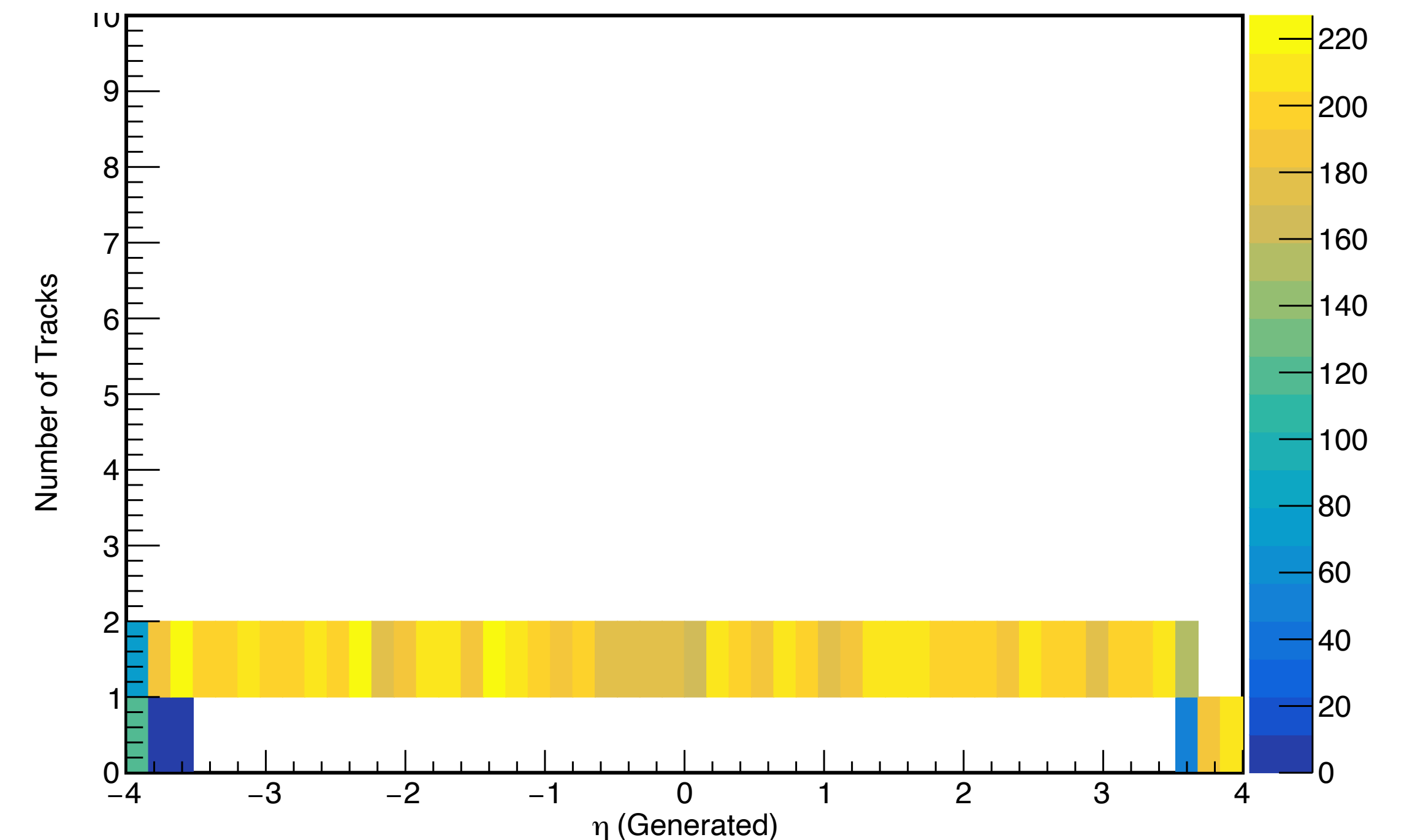
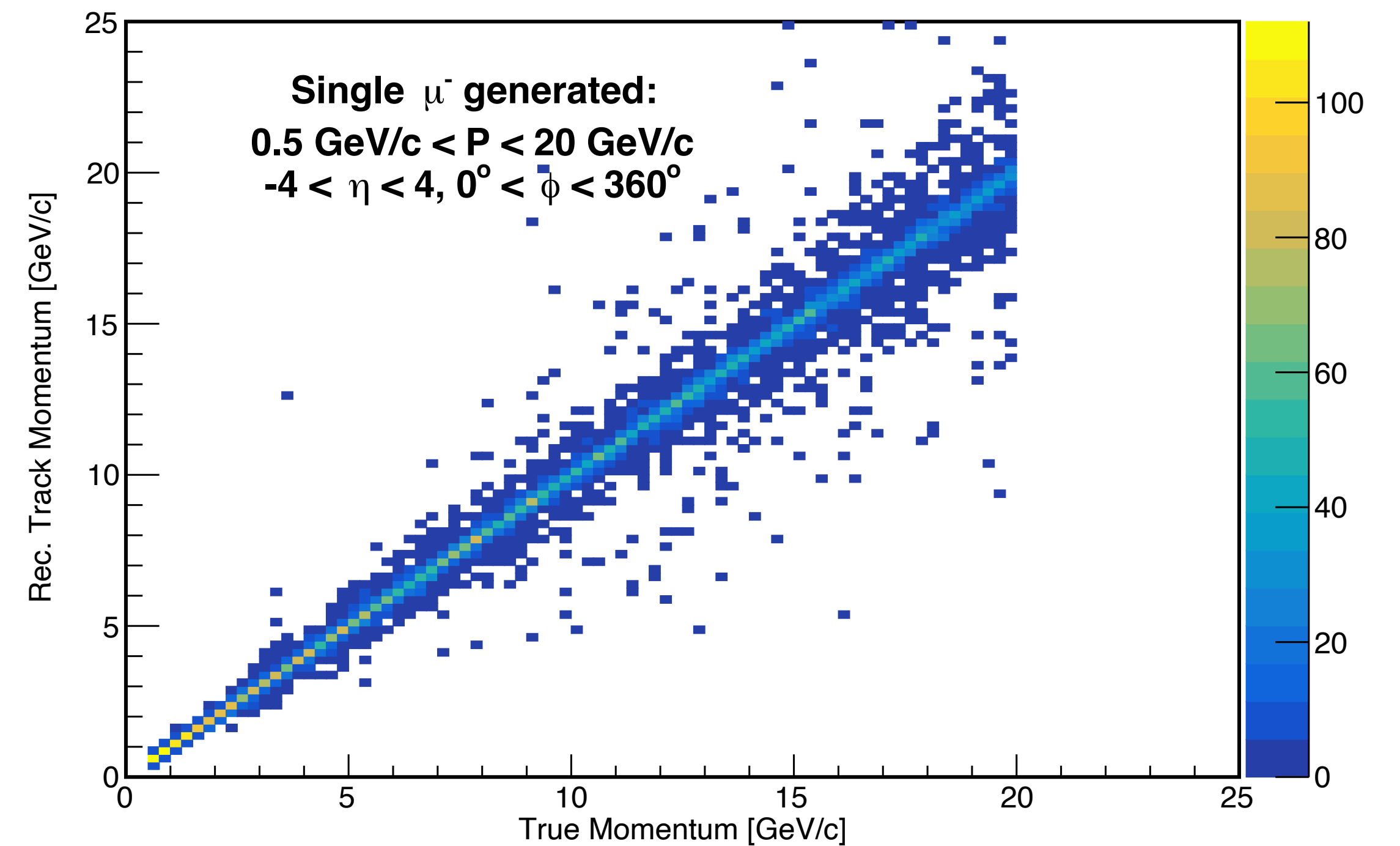
Track Seeding



- A group of three space points that serve as the initial direction for the track reconstruction
 - No seed = no track
- Truth seeding = points taken from the truth information of the generated distribution
- Realistic seeding = seeds are found with no prior knowledge of where a track might be

Events Generated

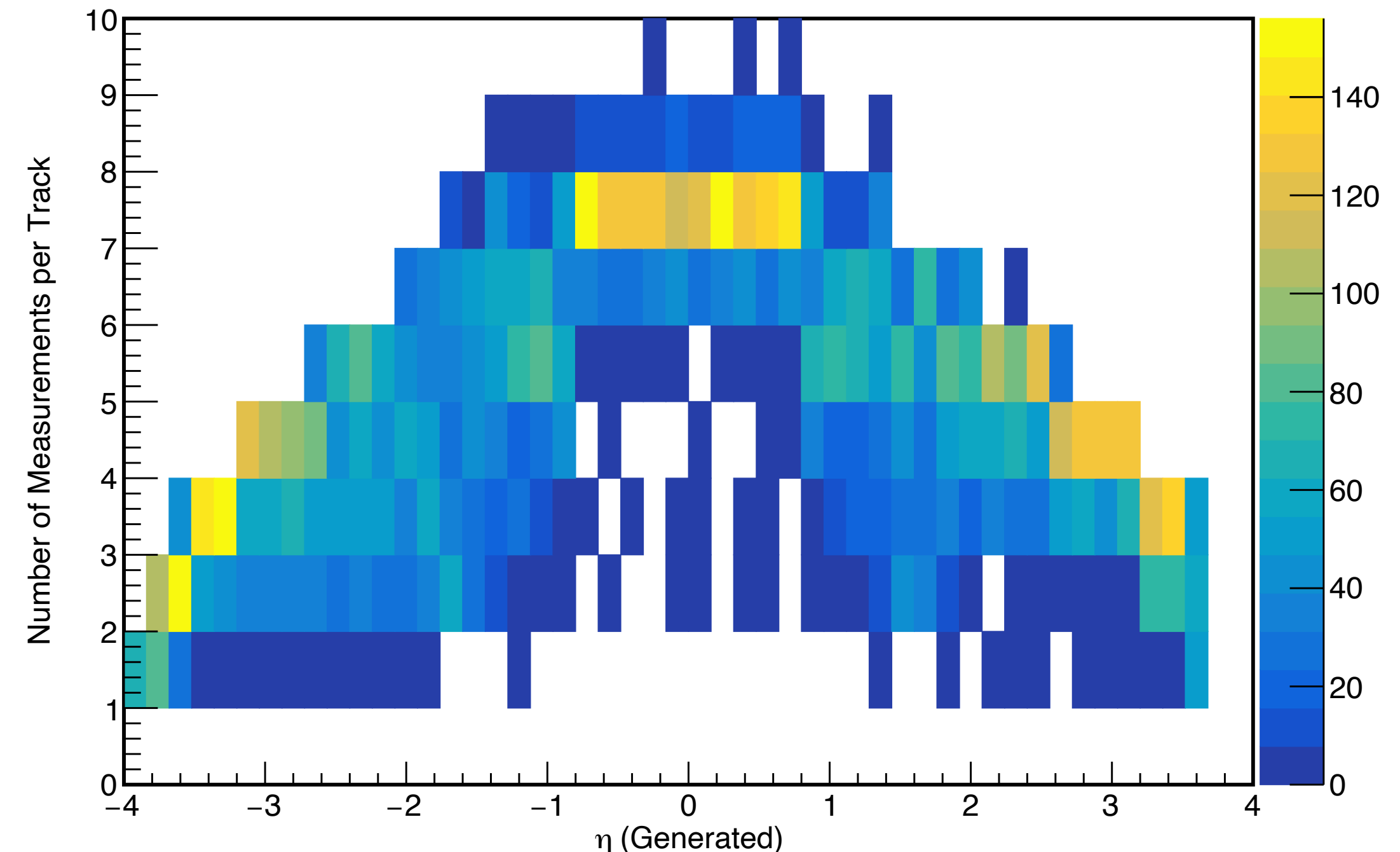
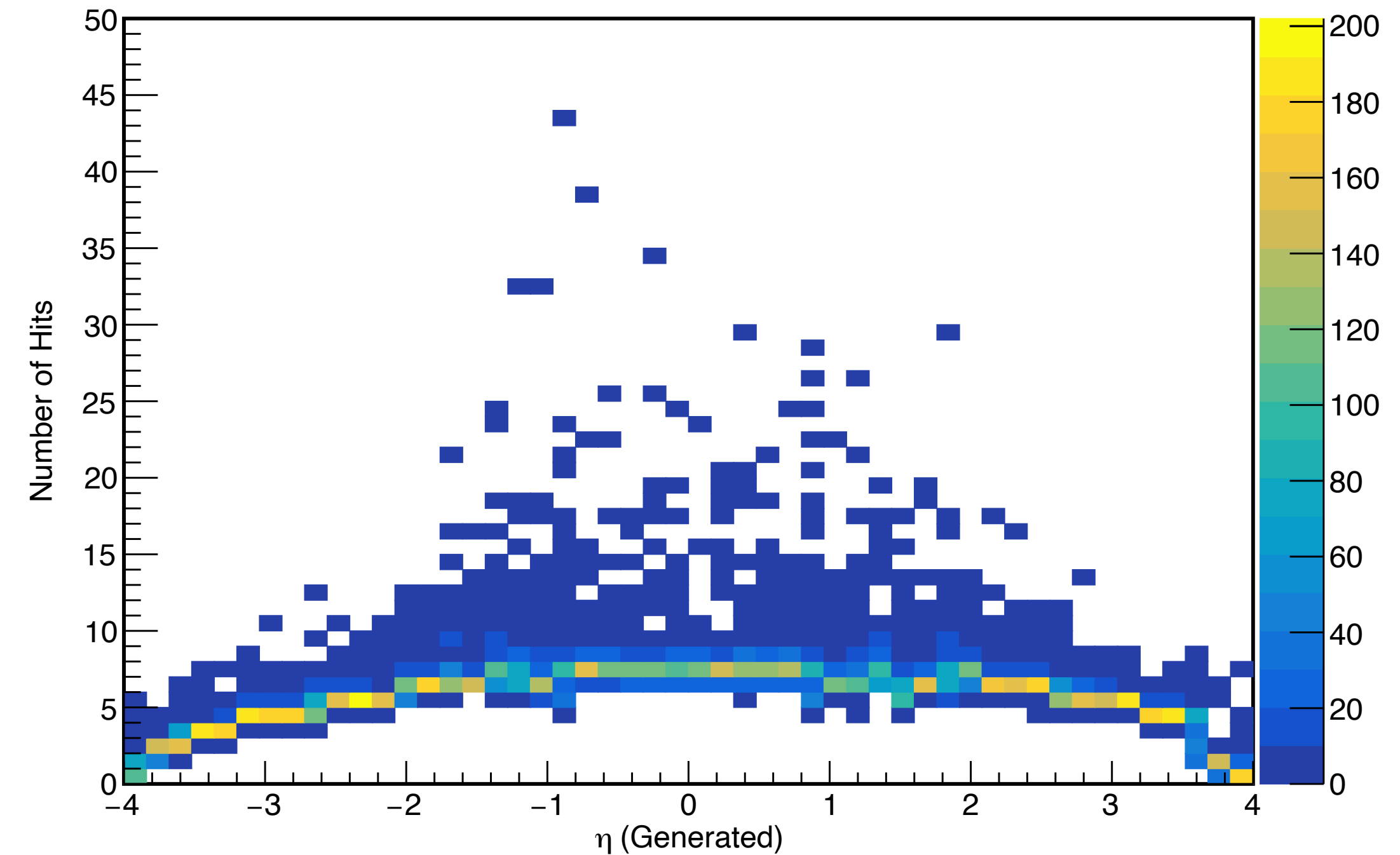
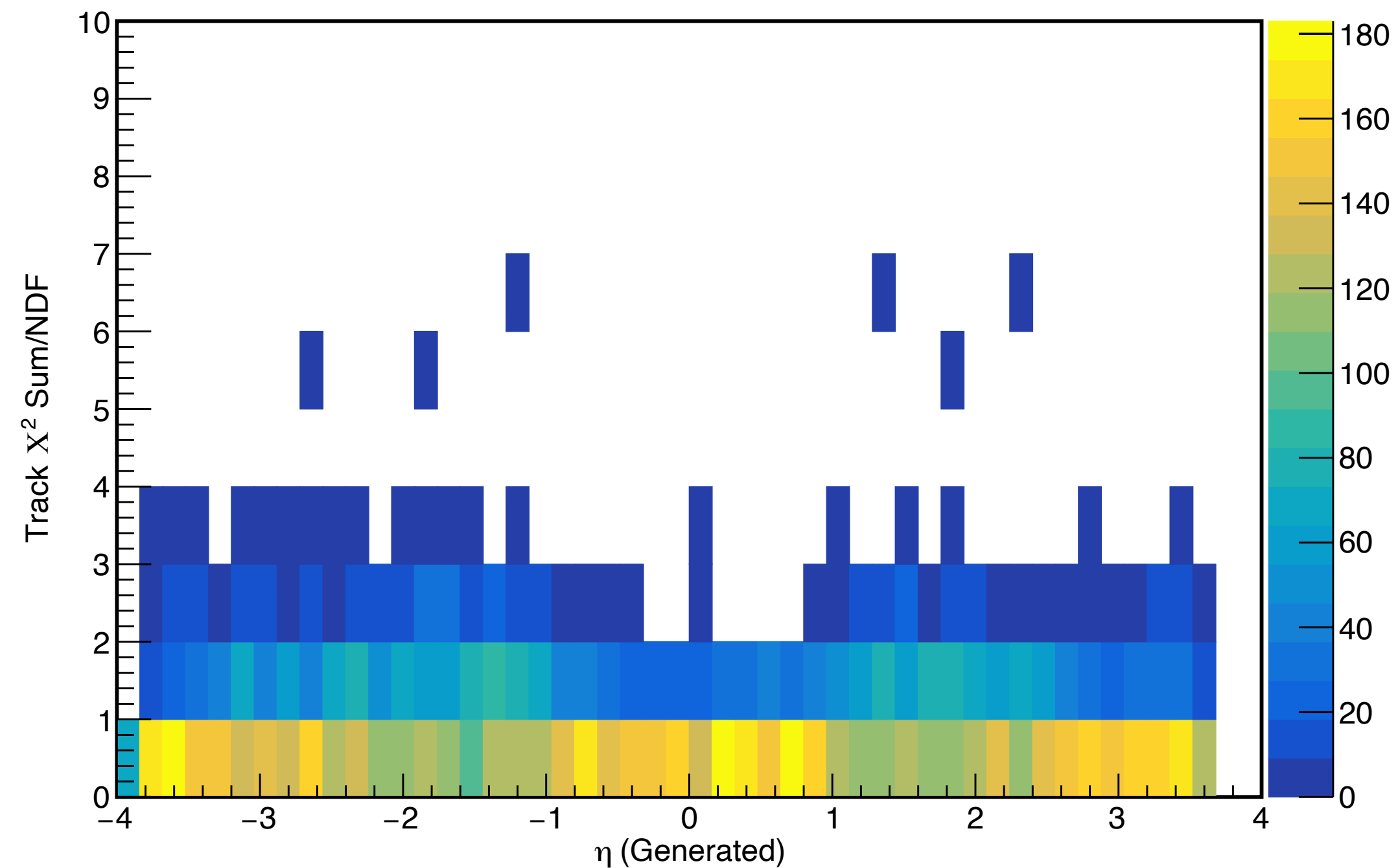
- Particle thrown: muons
- Momentum range: 0.5-20 GeV/c, uniform distribution
- Pseudorapidity: $-4 < \eta < 4$, uniform distribution
- Geometry: bryce_canyon
- Seeding: truth



Track Quality Variables

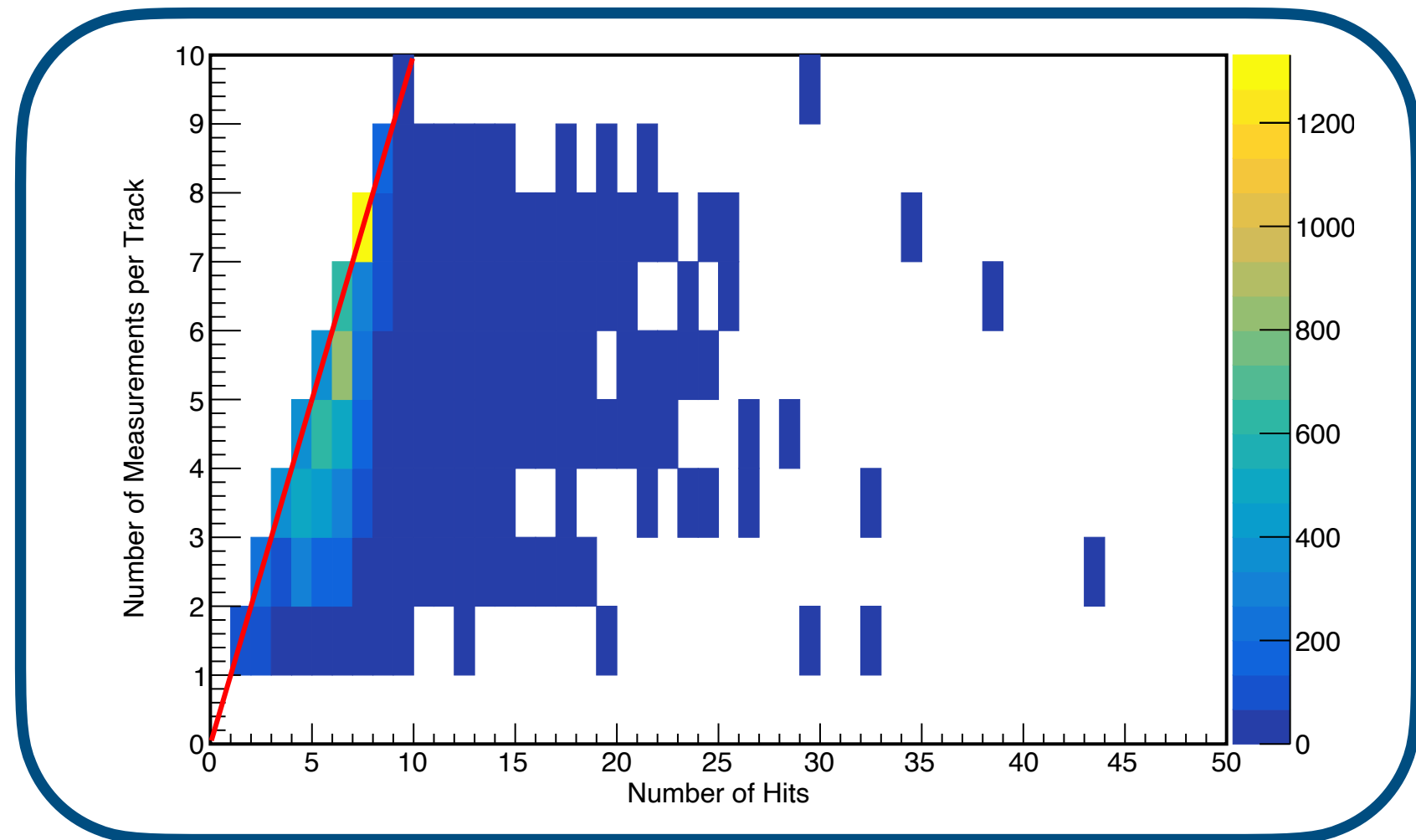
Truth seeding

- The track χ^2 sum tells us how the fit performed
- The number of hits corresponds to how many layers the generated particles travel through
- The # of meas per track corresponds to how many hits are reconstructed in each track

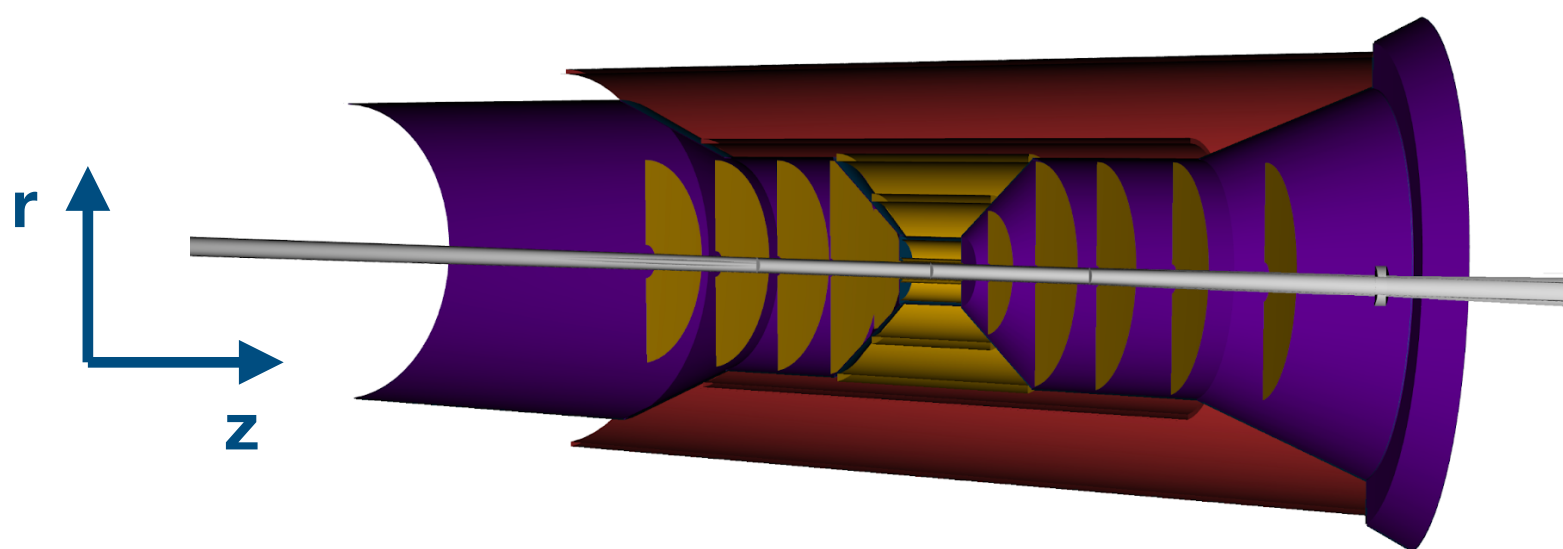


Hits and Reconstructed Track Measurements

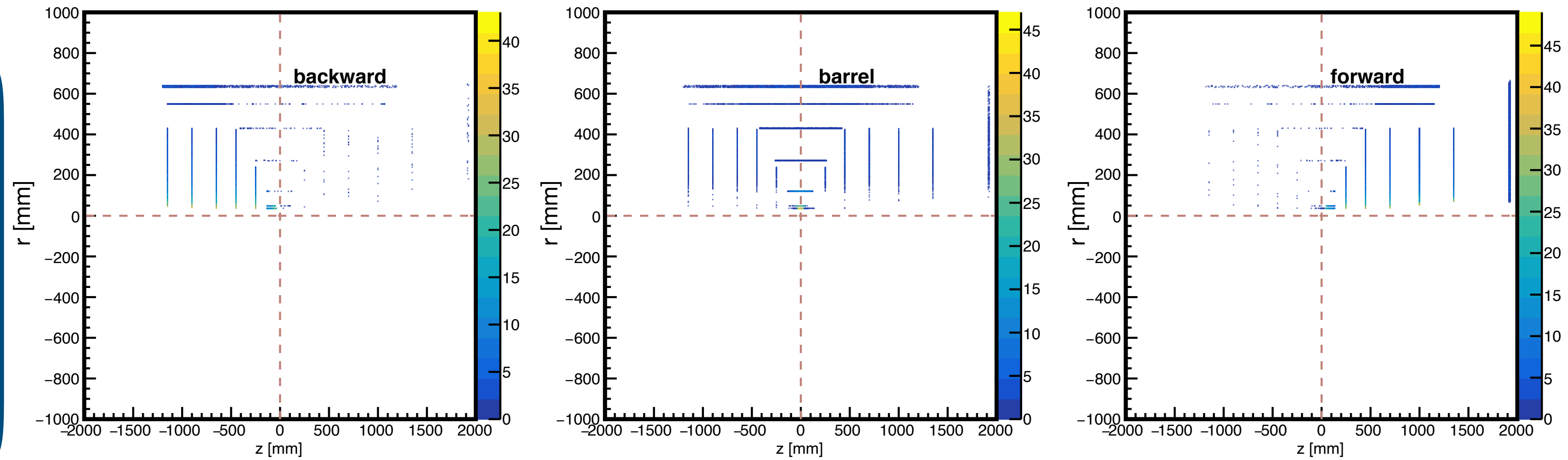
Truth seeding



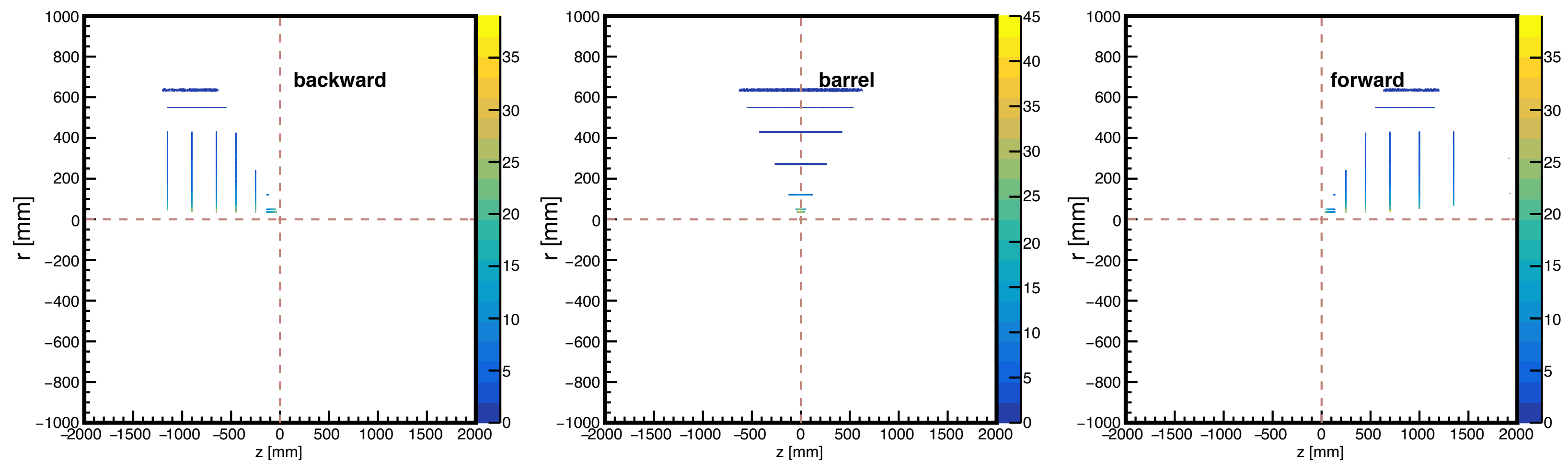
From the hit distributions, we can see where the layers are detecting hits.



Digitized Hits

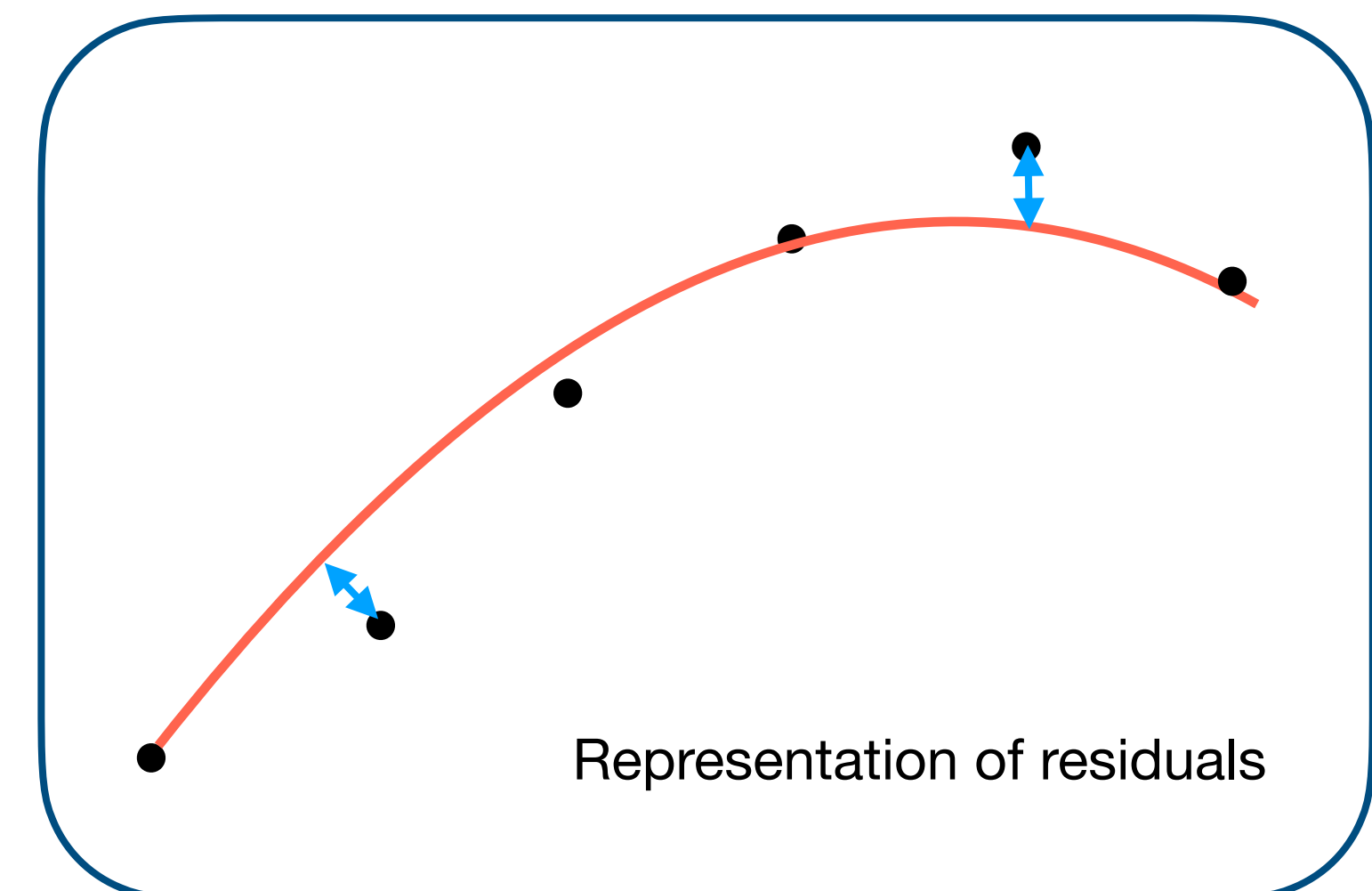


Track State Measurements



What are Residuals?

- Residual = the distance between the hits and reconstructed track
- The points that the track is reconstructed through can be seen in each layer
- Points on the track are matched with hits that were recorded
 - Work by Oscar!
- Subtract the hit from the track to get the residual



Residuals per η region

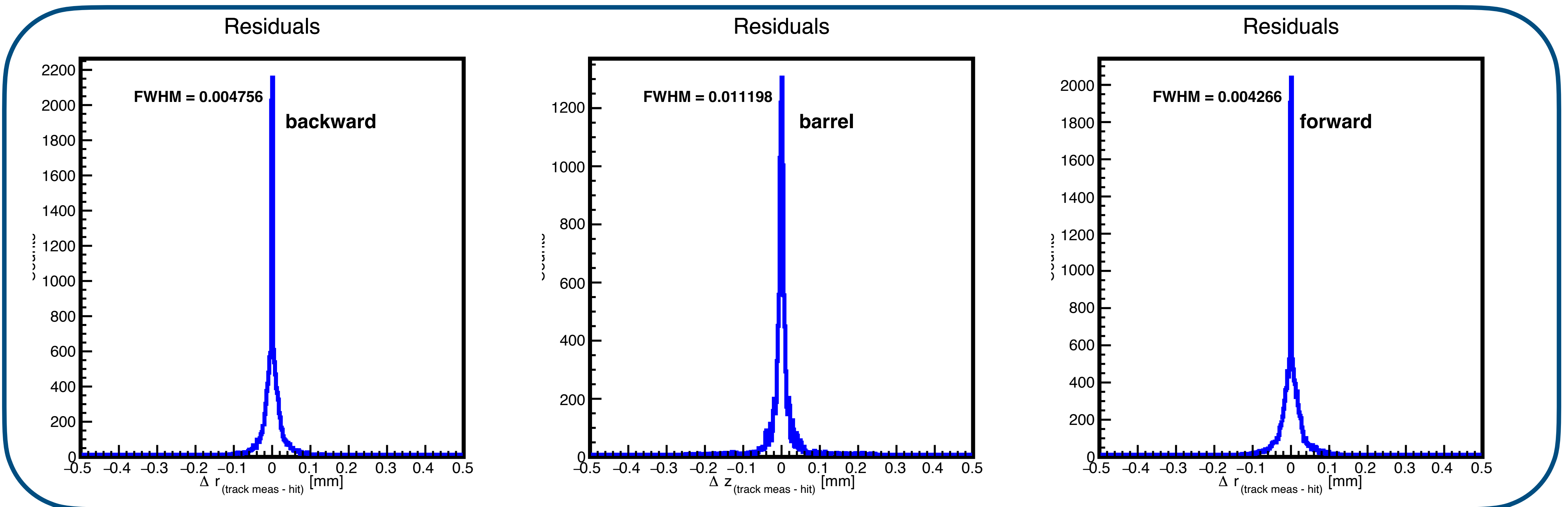
Truth seeding

Backward
 $\eta < -0.88137$

Barrel
 $-0.88 \leq \eta < 0.88$

Forward
 $\eta \geq 0.88137$

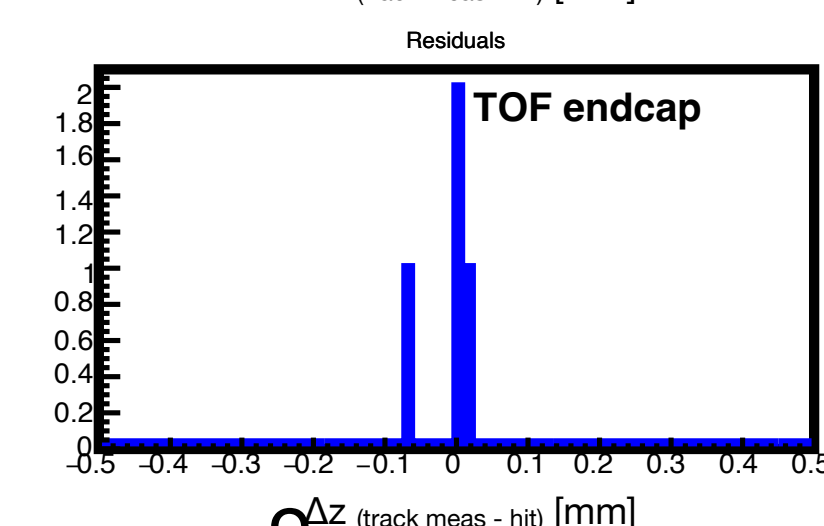
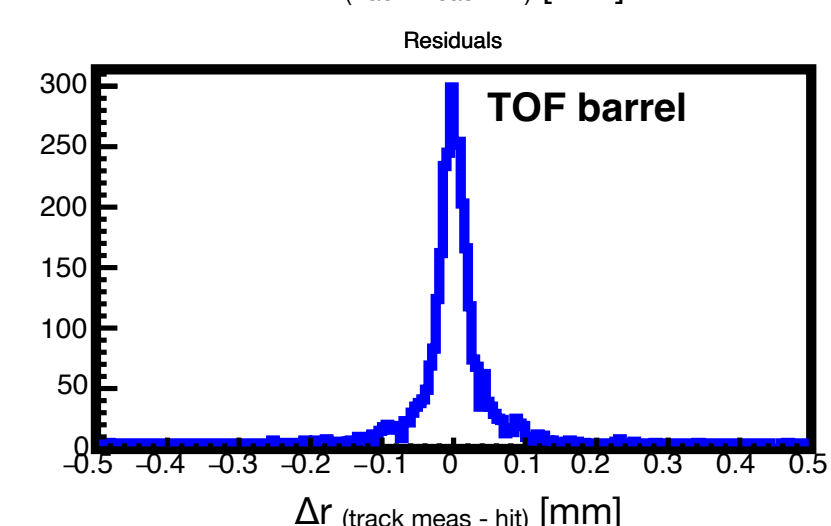
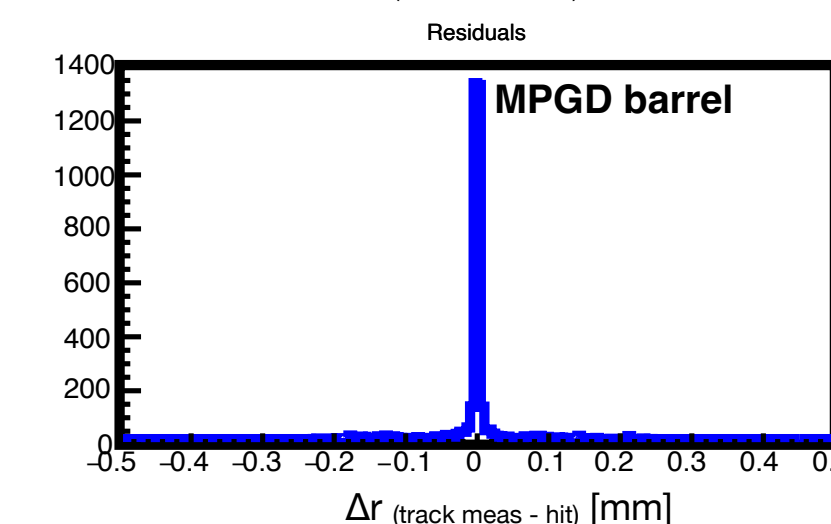
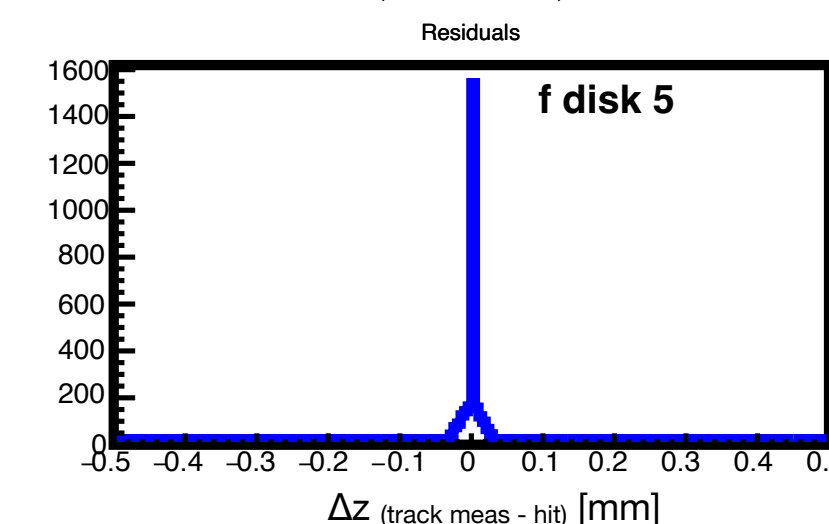
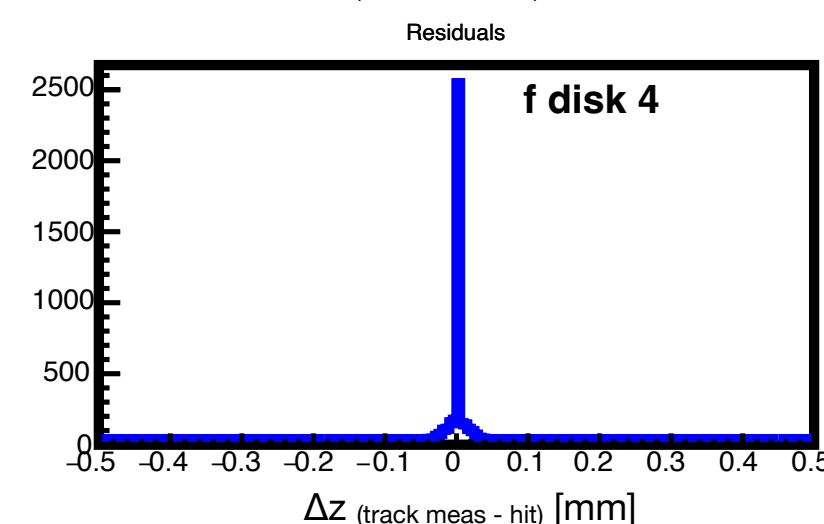
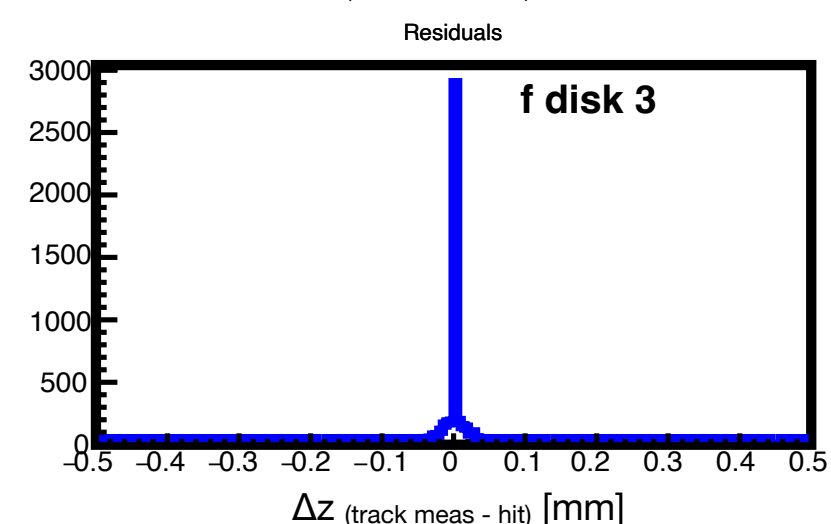
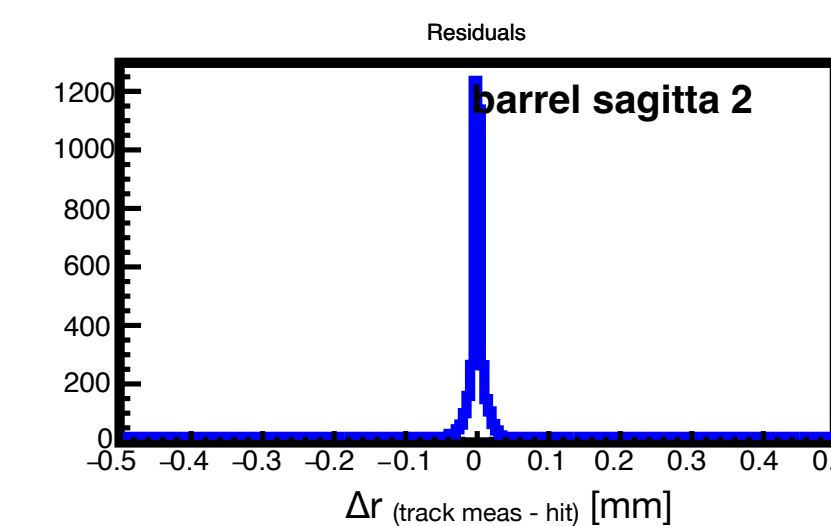
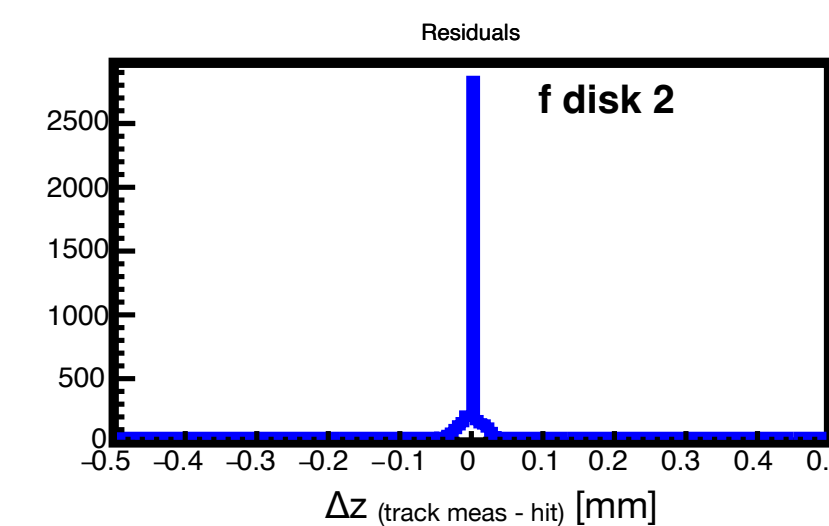
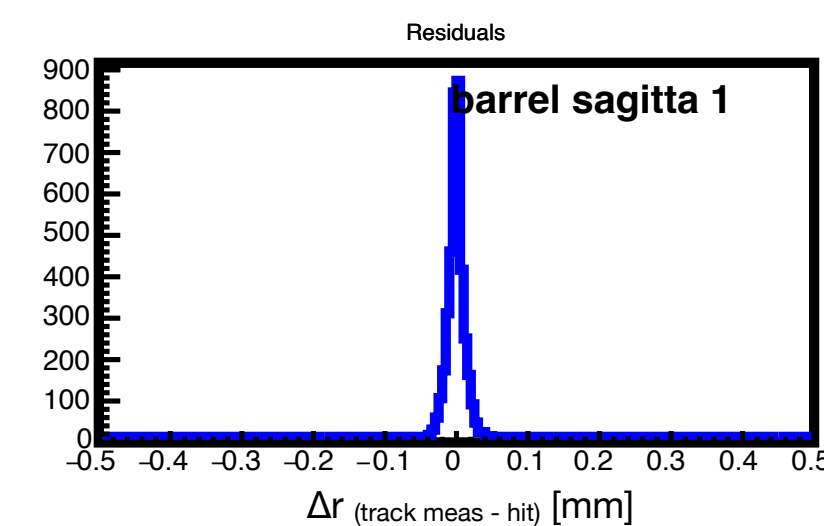
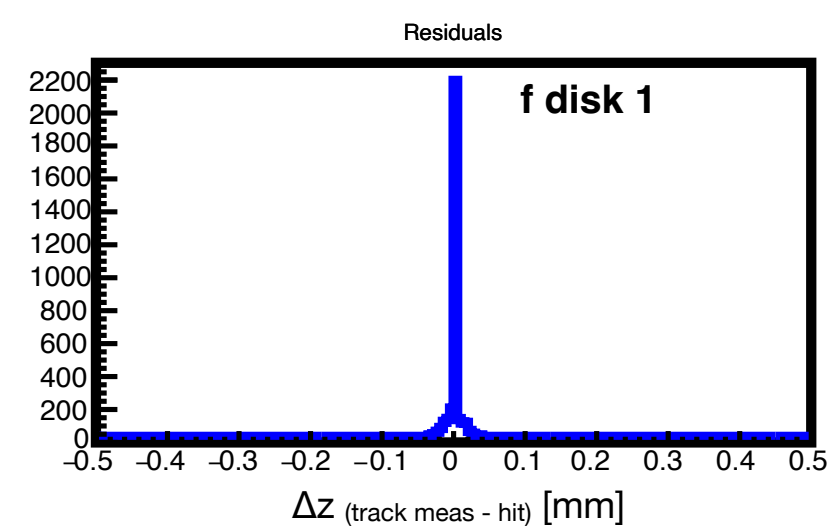
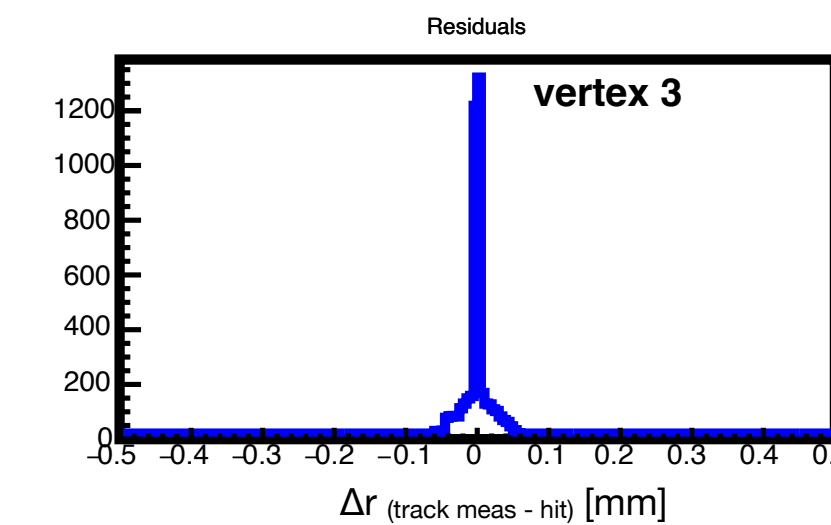
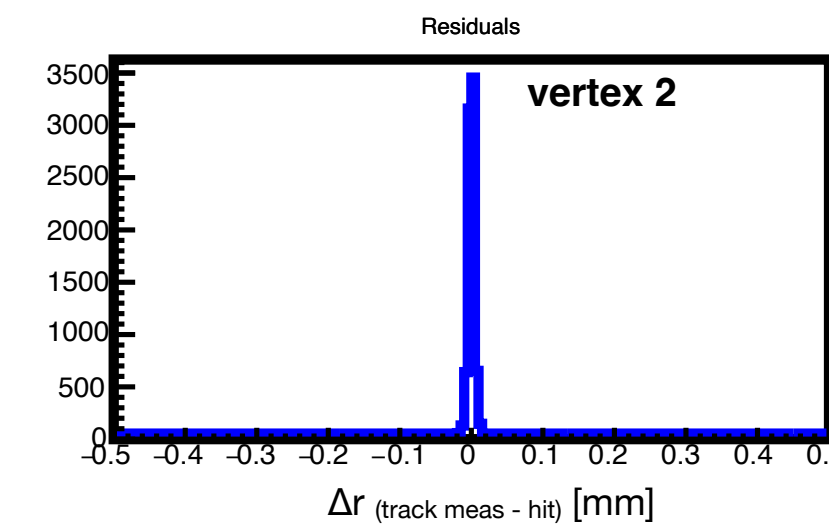
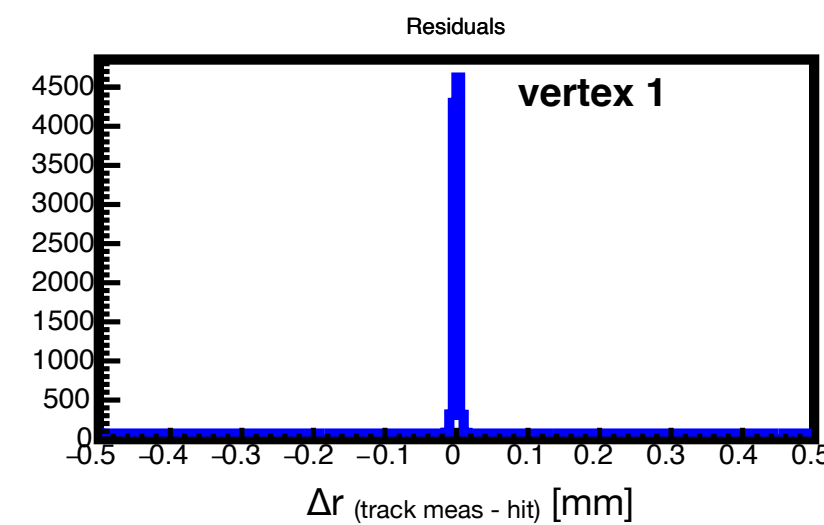
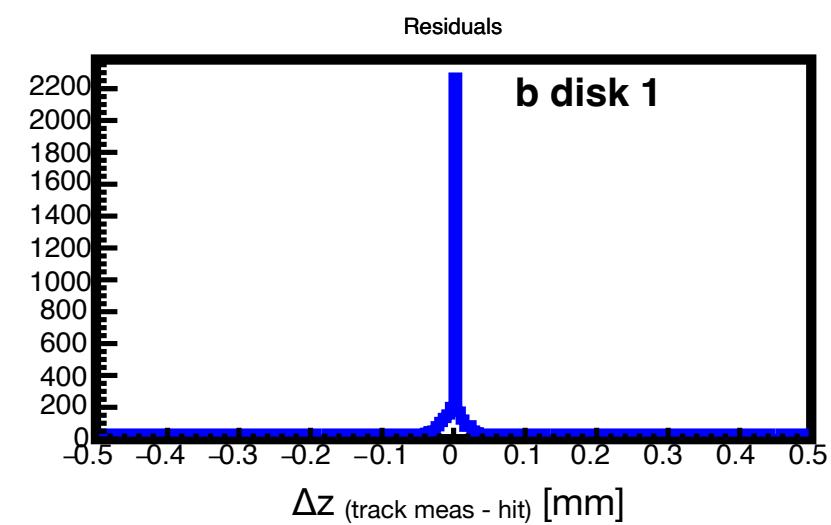
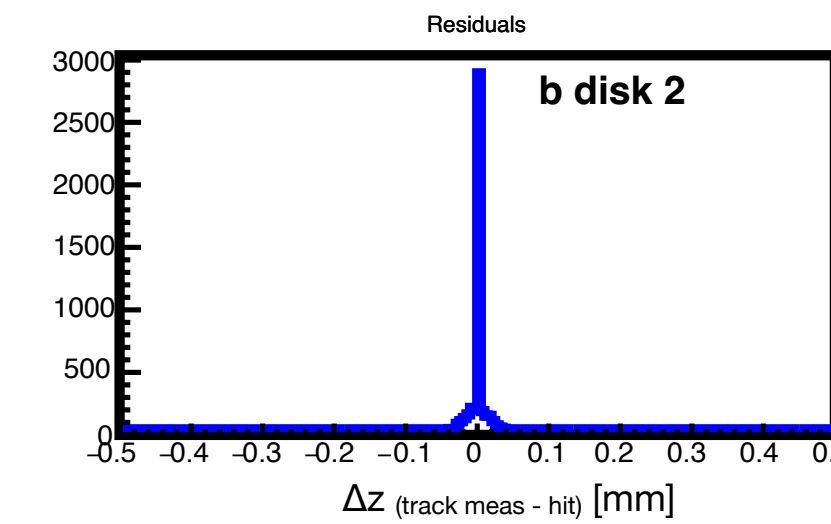
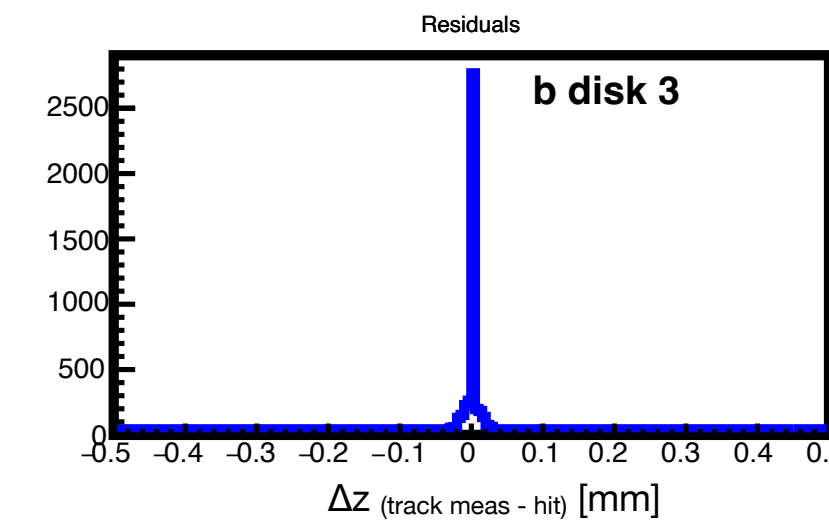
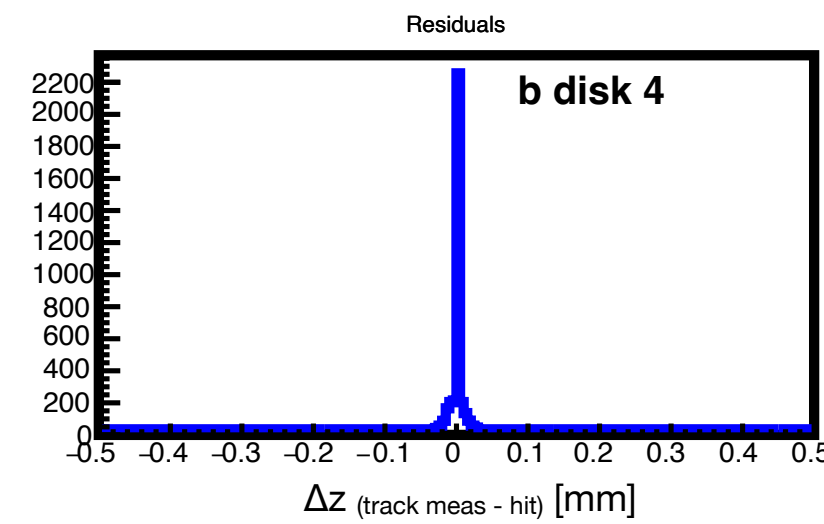
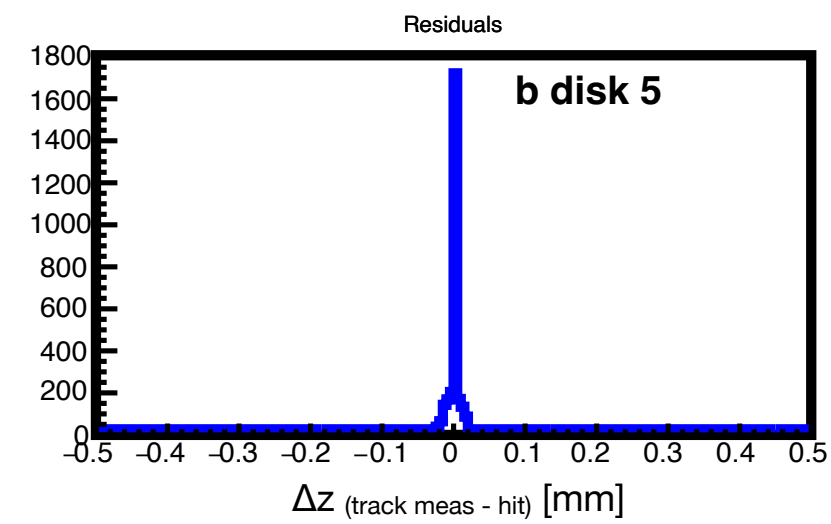
- Peak is at 0, meaning most hits are being reconstructed where they are found. This is good and expected, especially for truth seeding.



Residuals in Each Layer

Truth seeding

- We can also look at the residuals in each layer.
- Most layers get reconstructed between -0.1 - 0.1, with the vertex layers doing best.

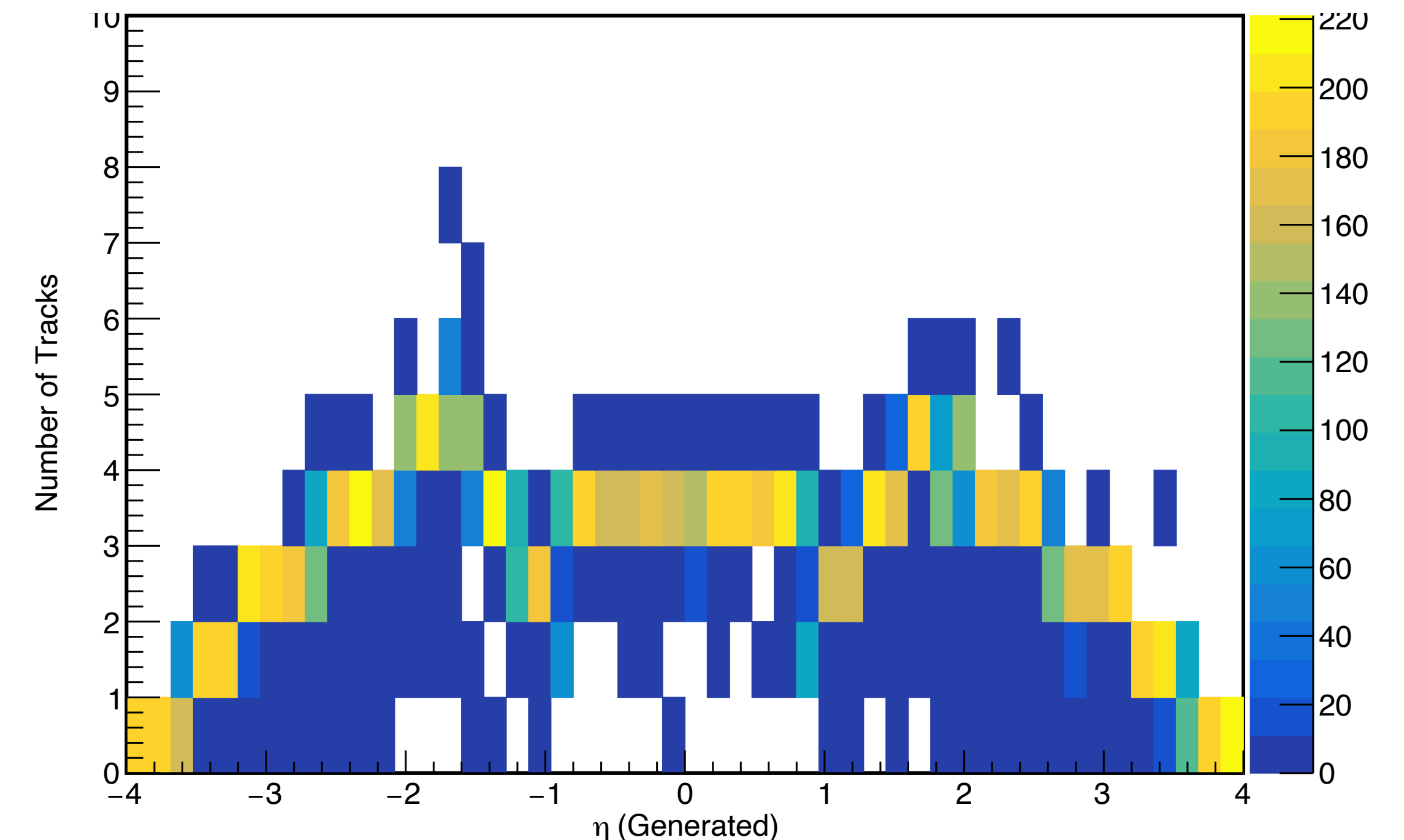
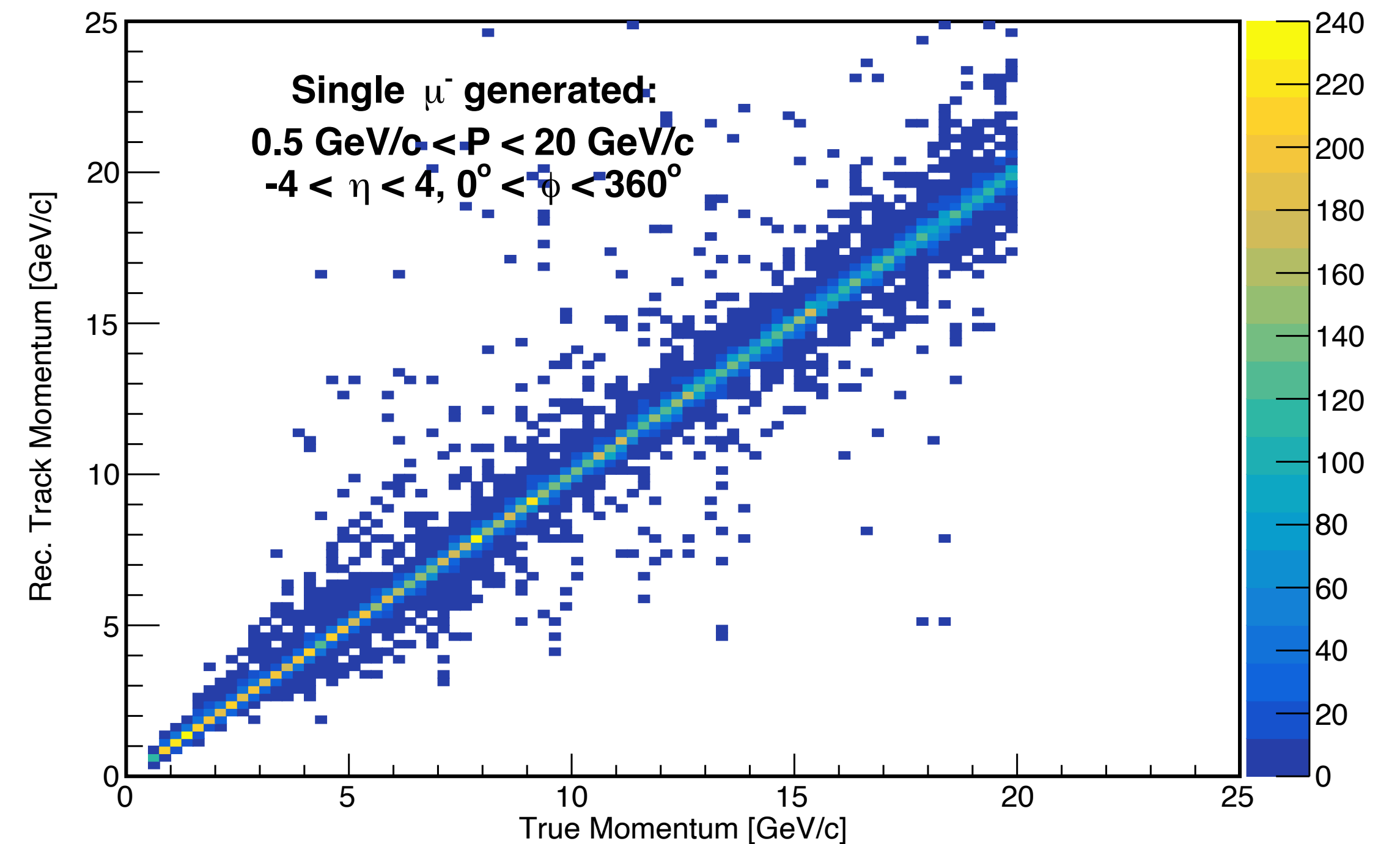


Realistic Seeding

- Work done by Rey Cruz-Torres and Emma Yeats
- Tuned realistic seeding parameters for EIC-specific geometry

Parameter	Description	EICrecon default	Emma's default
bFieldInZ	z component of magnetic field	1.7 T	1.7 T
rMax	Maximum r value to look for seeds	500 mm	440 mm
rMin	Minimum r value to look for seeds	33 mm	33 mm
zMin	Minimum z value to look for seeds	-800 mm	-1500 mm
zMax	Maximum z value to look for seeds	800 mm	1700 mm
beamPosX	Beam offset in x	0	0
beamPosY	Beam offset in y	0	0
deltaRMinTopSP	Min distance in r between middle and top SP in one seed	1 mm	10 mm
deltaRMinBottomSP	Min distance in r between middle and bottom SP in one seed	1 mm	10 mm
deltaRMaxTopSP	Max distance in r between middle and top SP in one seed	400 mm	200 mm
deltaRMaxBottomSP	Max distance in r between middle and top SP in one seed	400 mm	200 mm
collisionRegionMin	Min z for primary vertex	-300 mm	-250 mm
collisionRegionMax	Max z for primary vertex	300 mm	250 mm
cotThetaMax	Cotangent of max theta angle	16	27.29
minPt	Min transverse momentum	100	100 MeV/cotThetaMax
maxSeedsPerSpM	Max number of seeds a single middle space point can belong to - 1	1	0
sigmaScattering	How many standard devs of scattering angles to consider	5	5
radLengthPerSeed	Average radiation lengths of material on the length of a seed	0.1	0.1
impactMax	Max transverse PCA allowed	20 mm	3 mm
rMinMiddle	Min R for middle space point	20 mm	-
rMaxMiddle	Max R for middle space point	400 mm	-
bFieldMin	min B field	-	0.1

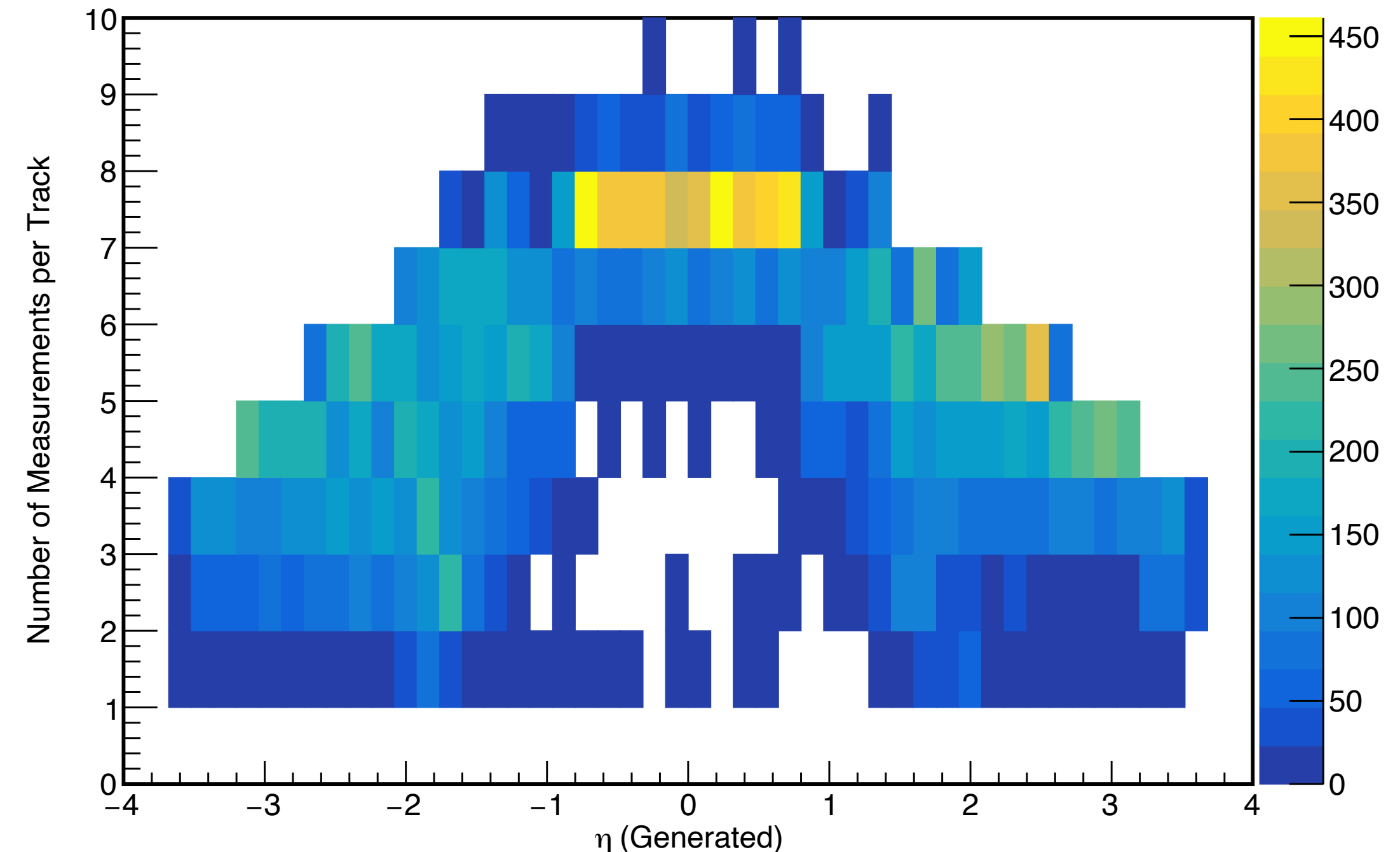
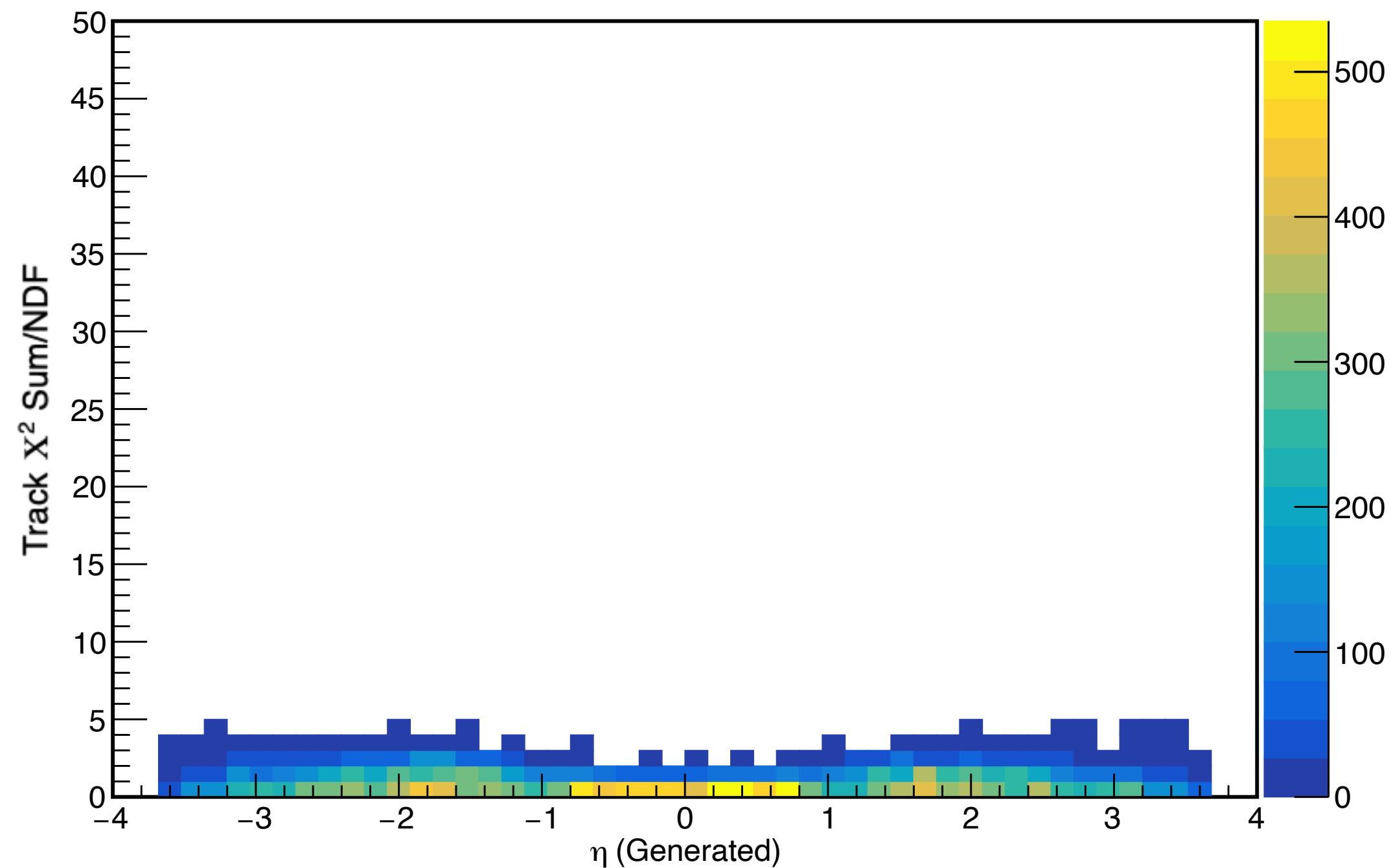
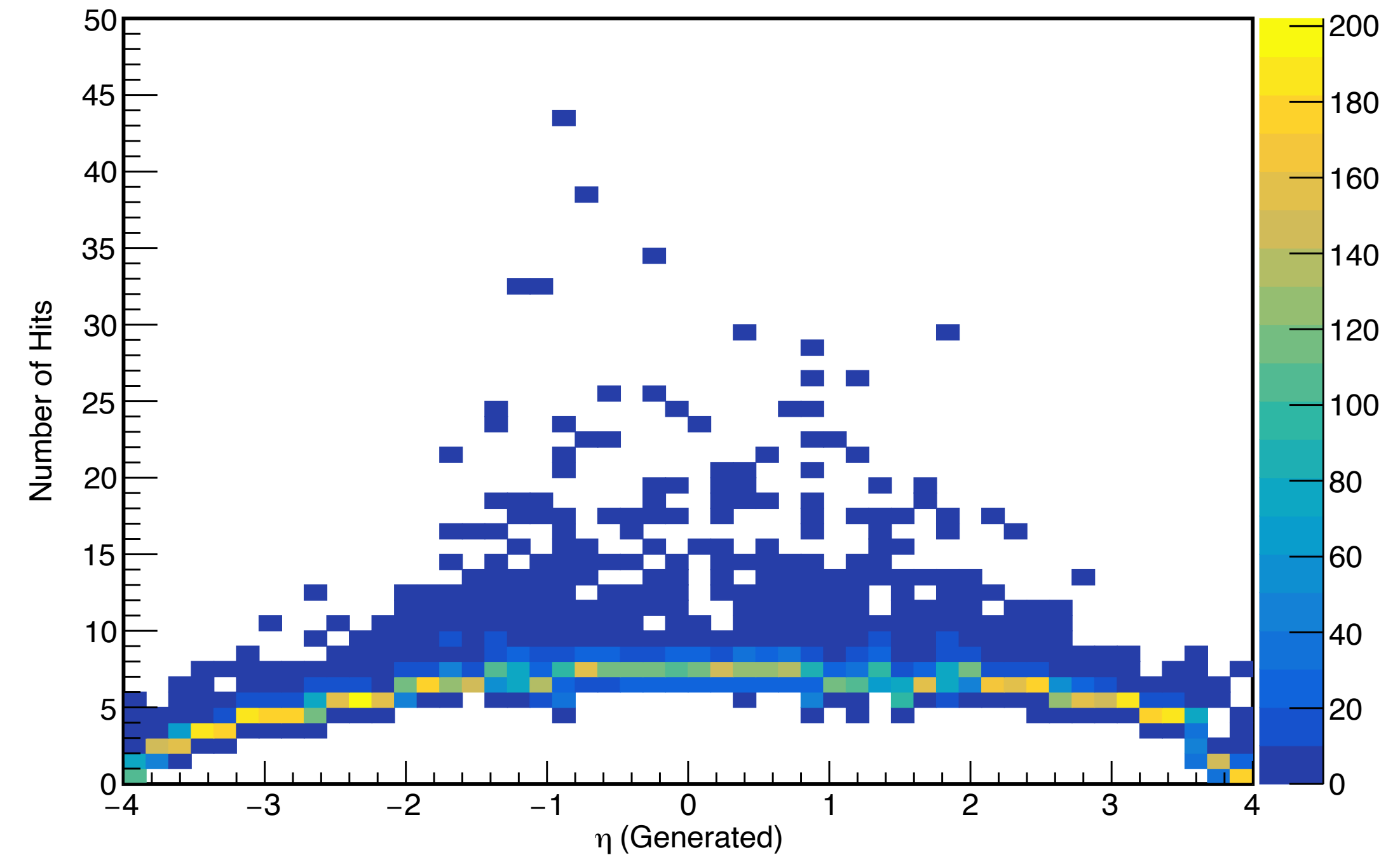
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Track Quality Variables

Realistic seeding

- The track χ^2 sum tells us how the fit performed
- The number of hits corresponds to how many layers the generated particles travel through
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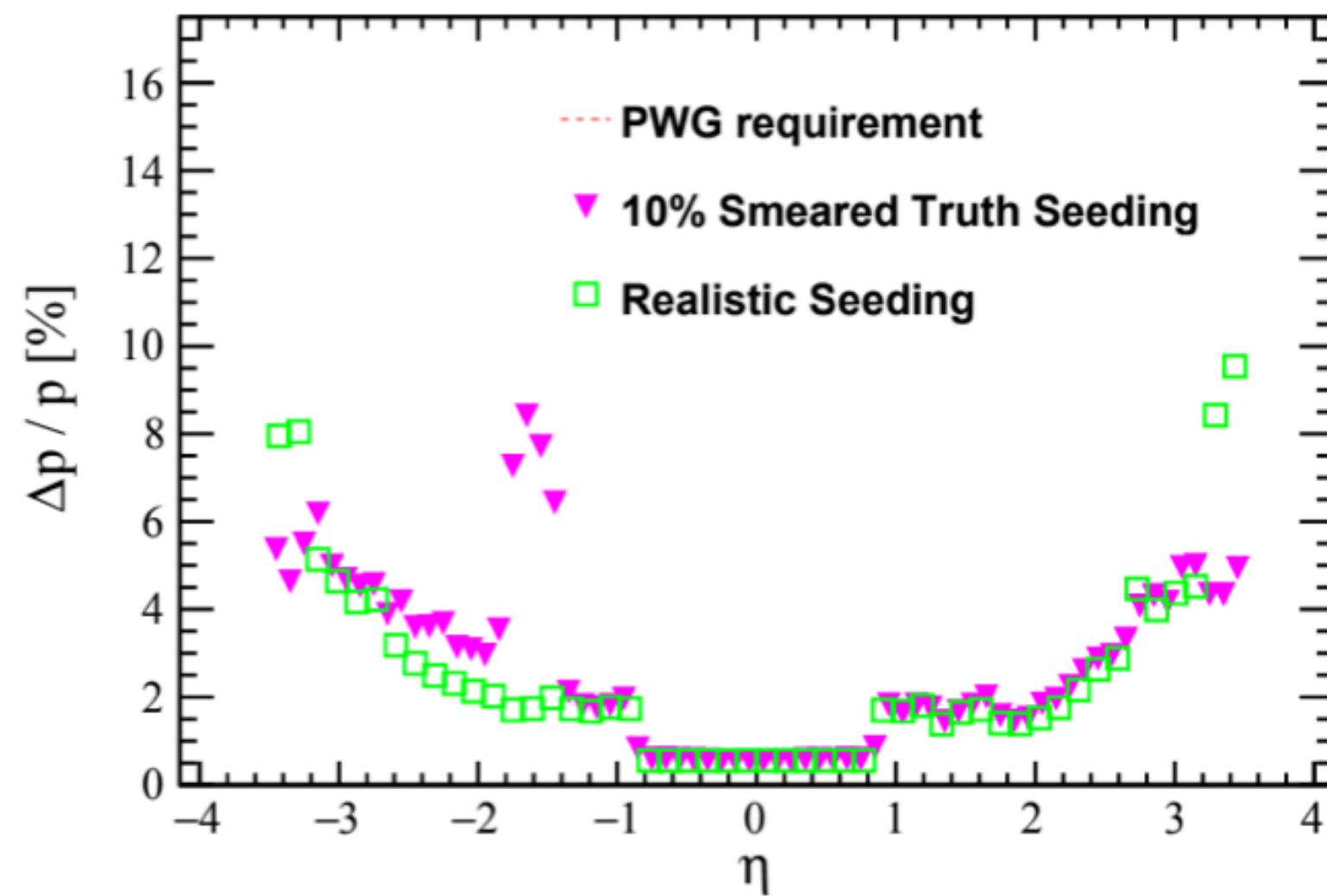


Momentum Resolution

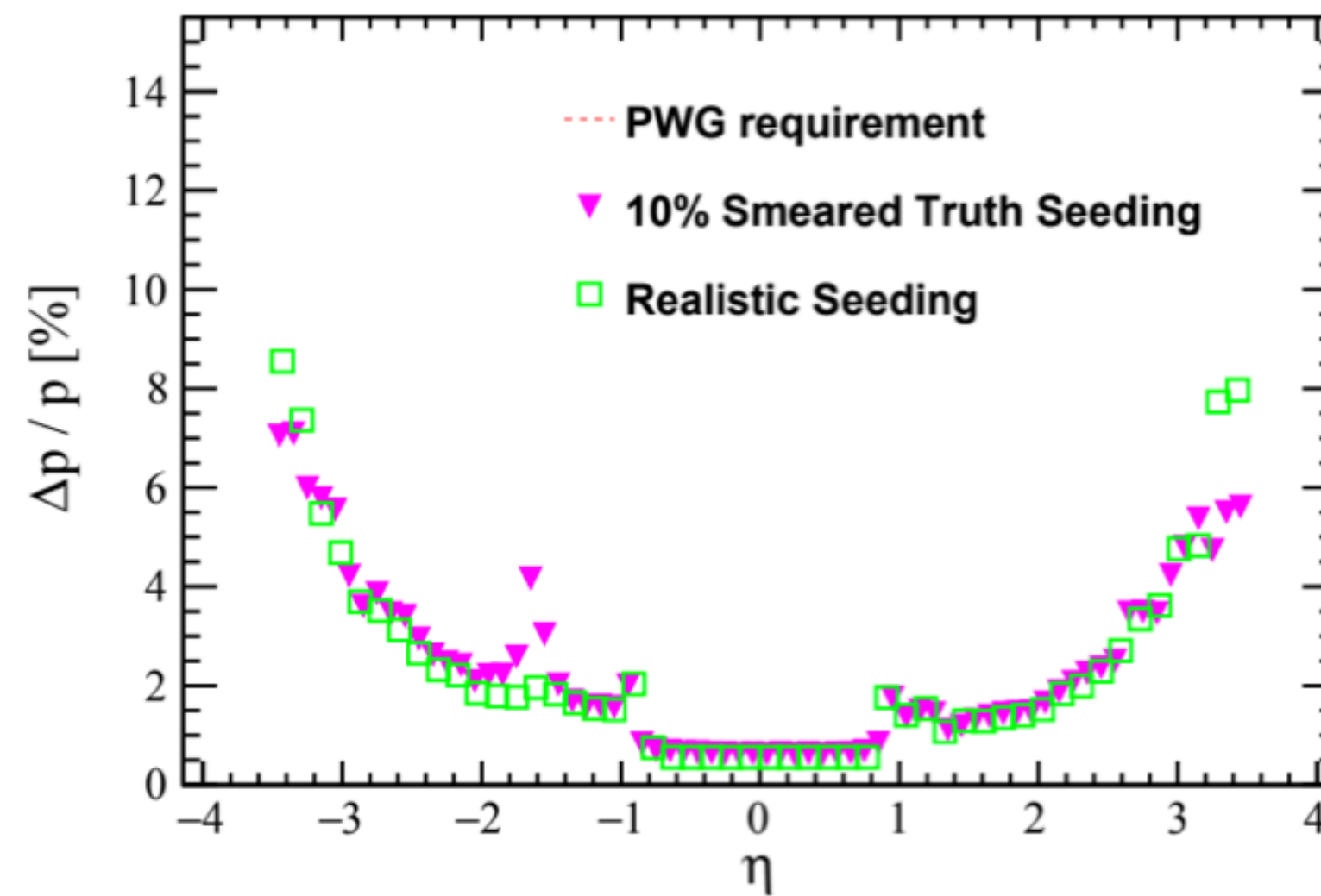
Truth vs Realistic Seeding

- Study done using e-
 - $0 < p_T < 15$ GeV and $-4 < \eta < 4$

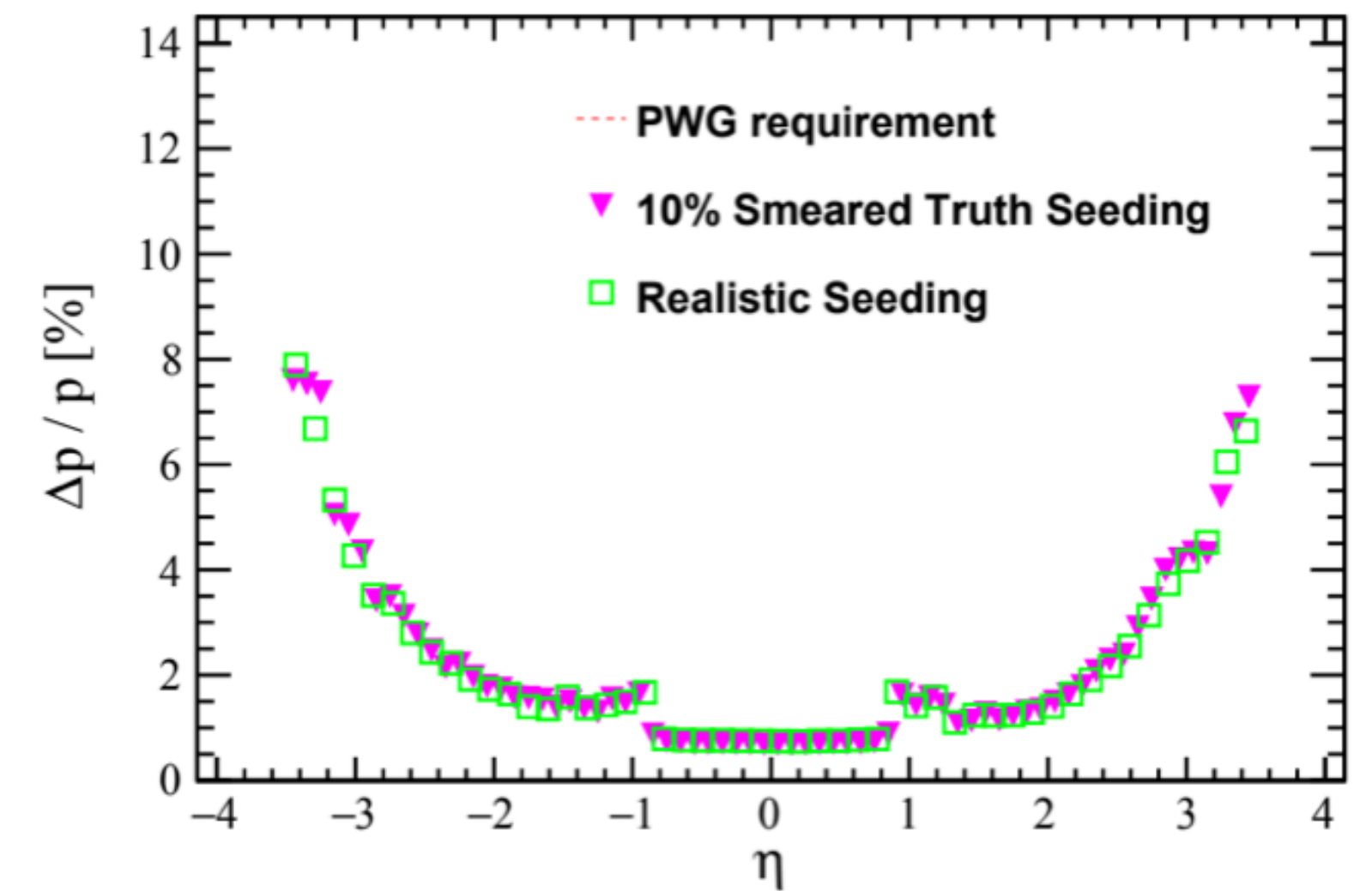
$1 < p < 5$ GeV



$5 < p < 10$ GeV



$10 < p < 15$ GeV



plots from Stephen Maple, [link](#)

Summary

- We are able to look at track quality variables and study how well our track is reconstructed.
- We see that for truth seeding, the track is within ~ 1 pixel of where it should be.
- The realistic seeding reconstruction is currently being worked on and we expect to show results soon.
- Next steps include taking out the hits in a layer and looking at the residuals to see if the track can still be reconstructed consistently.
- Clustering...?

Thank you!

Backup

Track Reconstruction with EICRecon

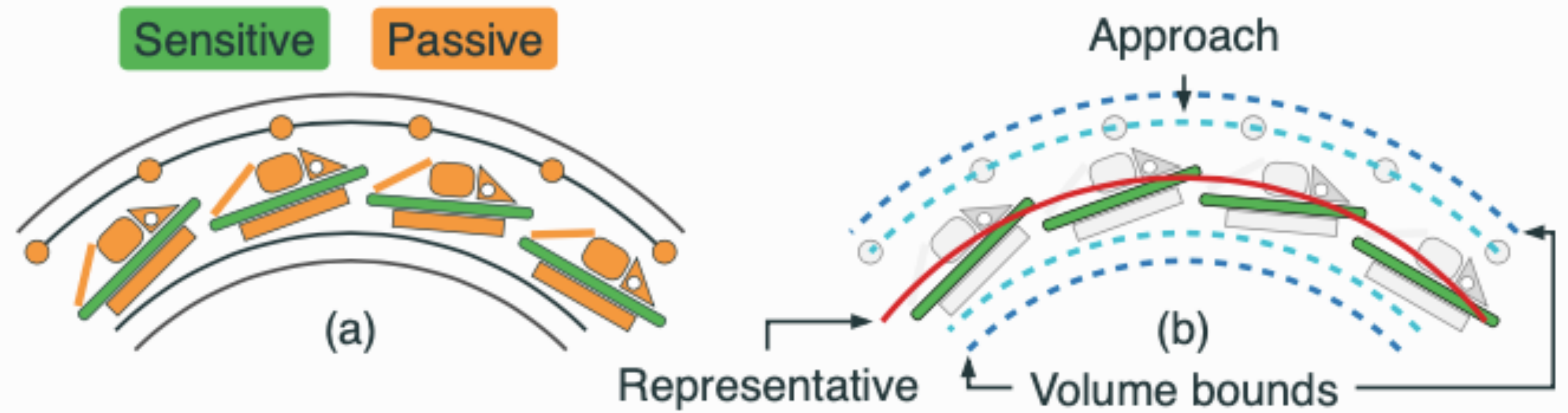
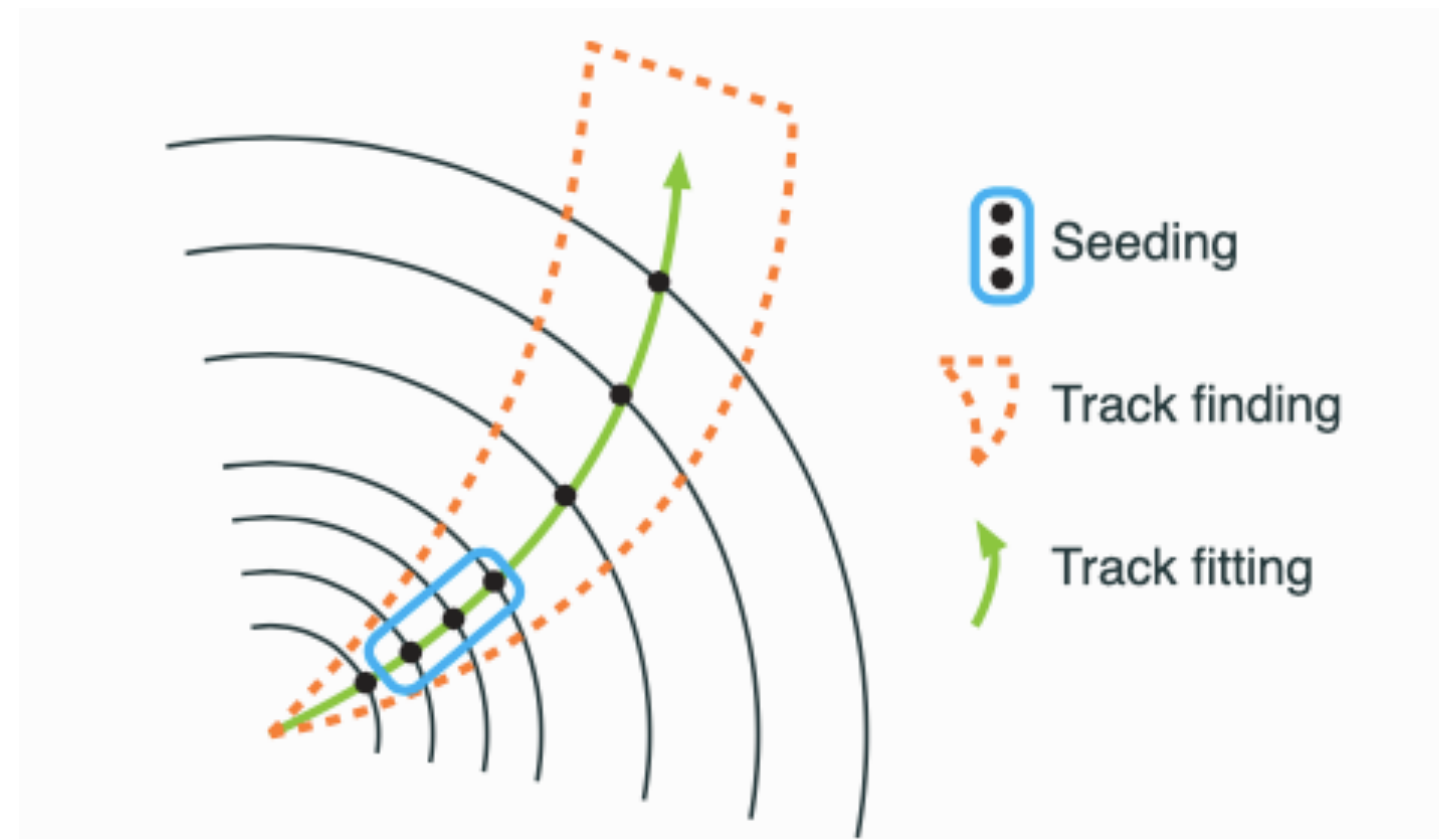


Fig. 7 Sketch of the way a fully detailed simulation geometry (a) models passive elements, in addition to the sensitive elements shown in green. (b) shows a simplified version, where all non-sensitive elements are approximated.

Momentum resolution per η region

