

# Crater Lake Material and Coverage

Shyam Kumar, Annalisa Mastroserio, Domenico Elia  
INFN Bari, Italy

Geometry Name: epic\_craterlake\_tracking\_only

epic tag: 23.07.2

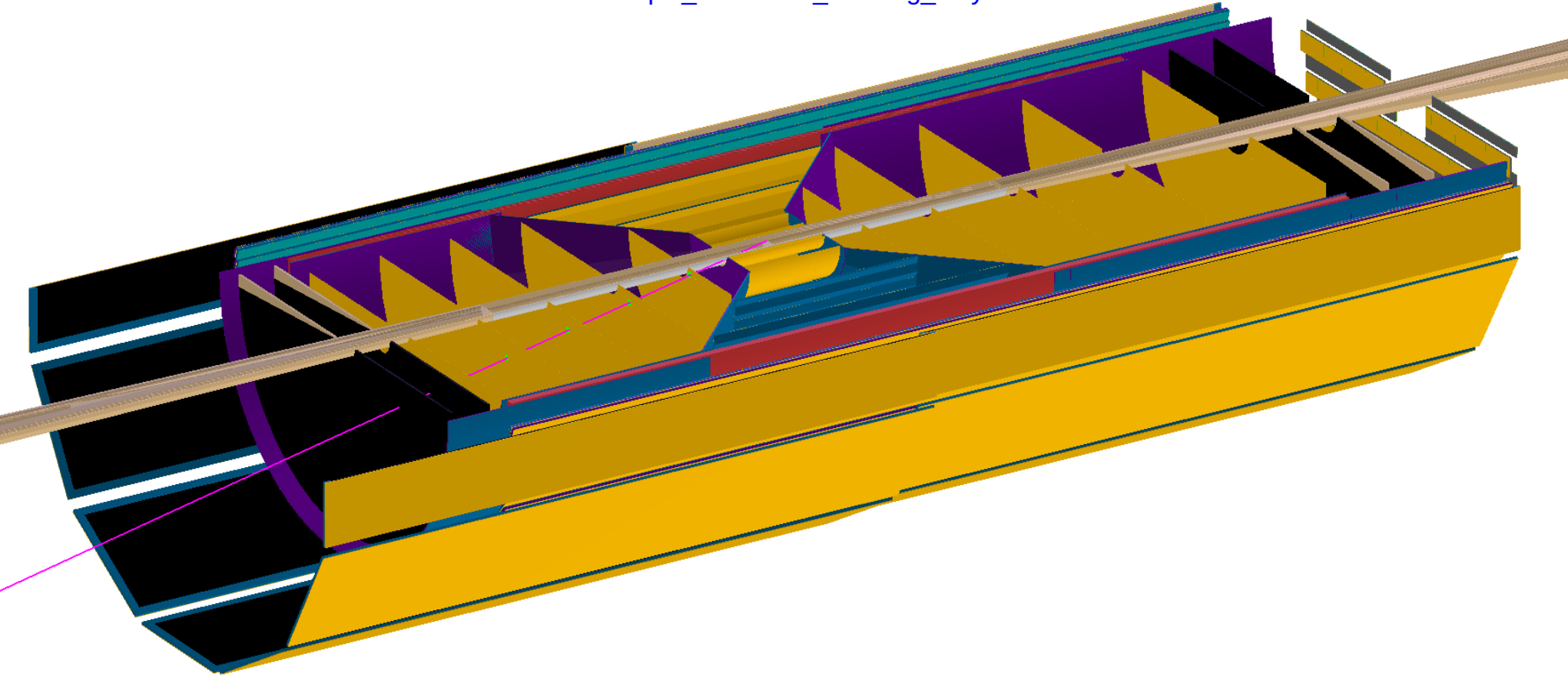
From last week's presentation

[https://indico.bnl.gov/event/20073/contributions/78629/attachments/48575/82607/EPIC\\_Tracking\\_Meeting\\_Shyam13July2023.pdf](https://indico.bnl.gov/event/20073/contributions/78629/attachments/48575/82607/EPIC_Tracking_Meeting_Shyam13July2023.pdf)

# Visualization of Geometry

Event-display

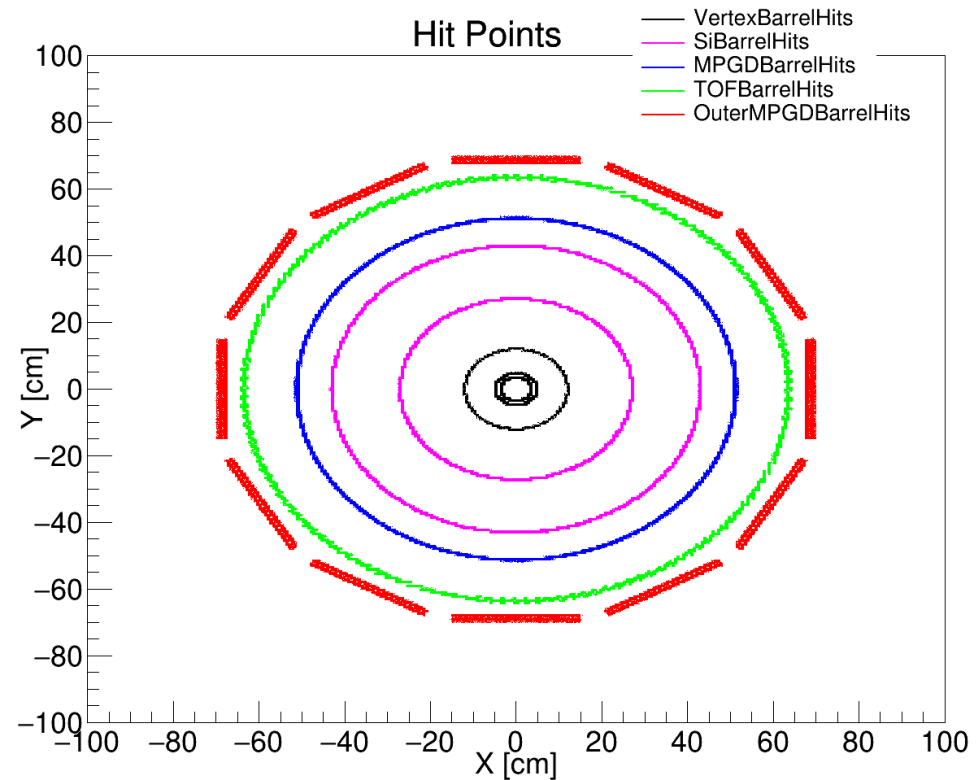
epic\_craterlake\_tracking\_only



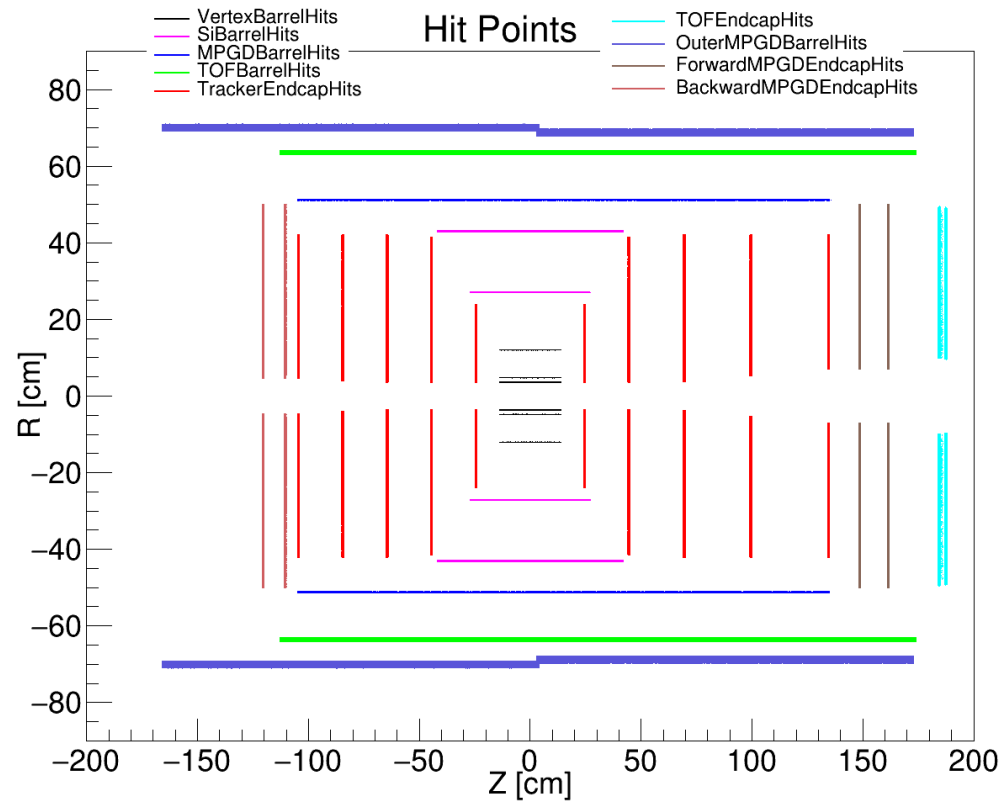
# Simulation Details

Simulation of 3M pi+ in uniform momentum range [0.1, 30.] GeV/c and  $\theta$  [3, 177] deg

## X-Y Points

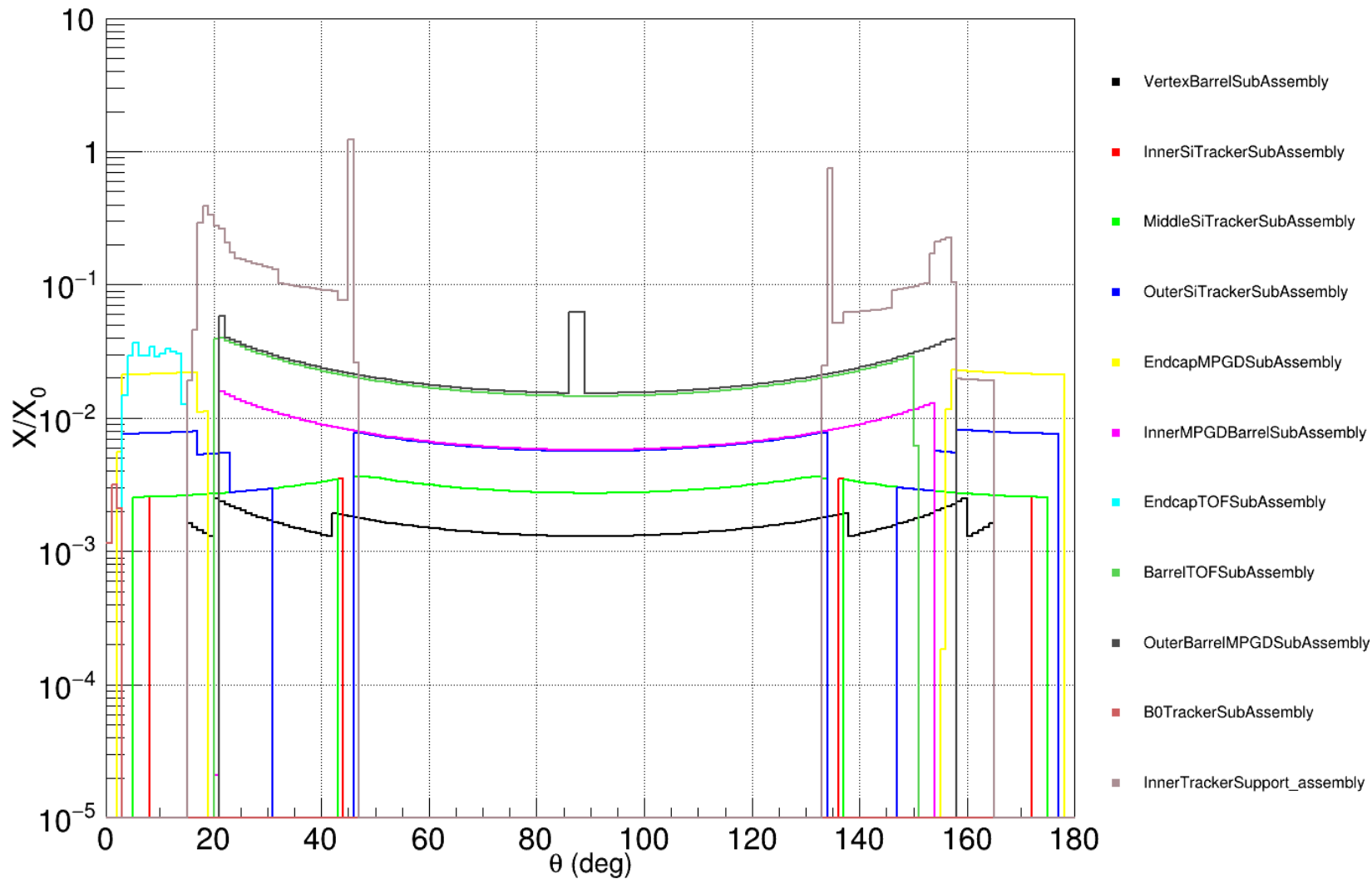


## R-Z Points



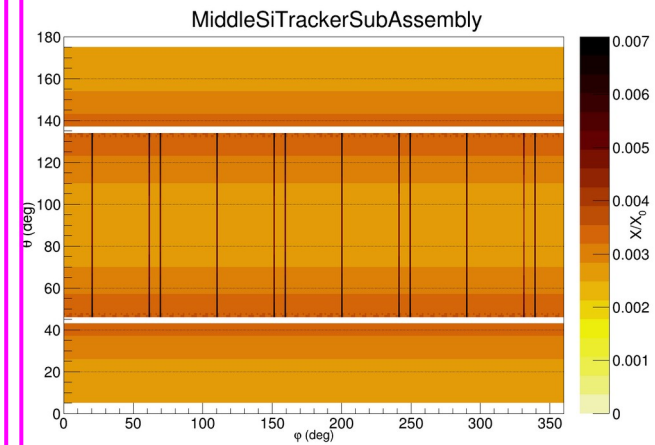
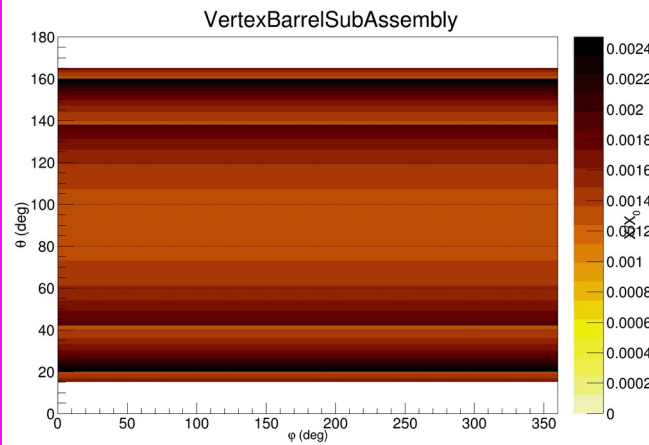
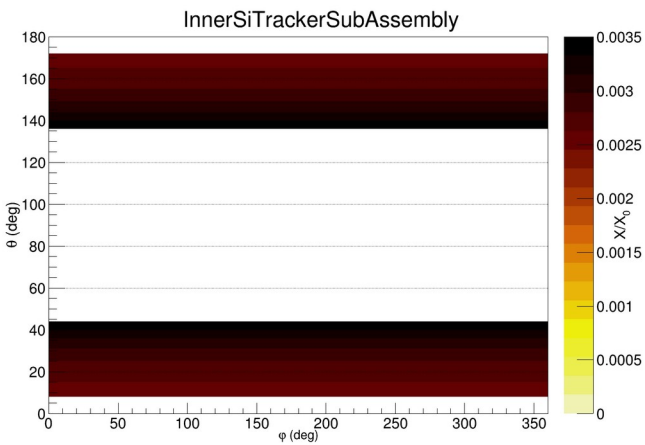
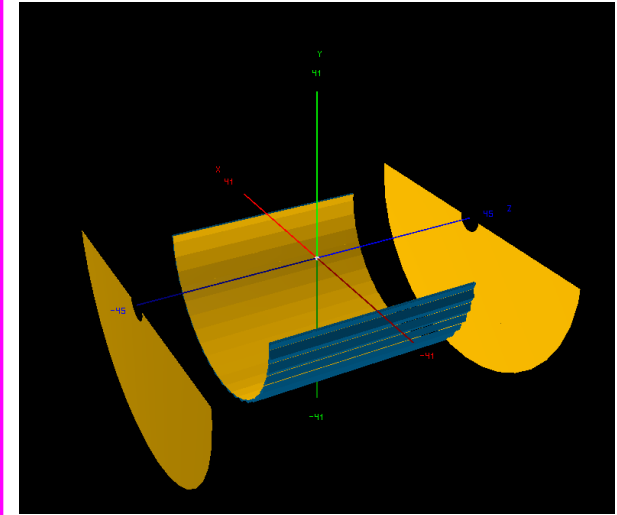
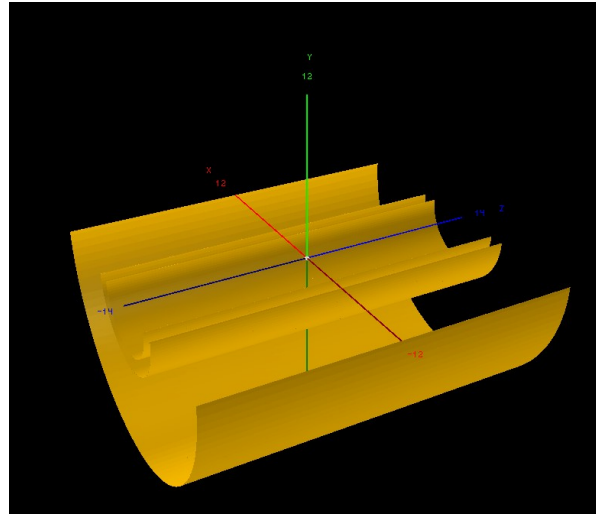
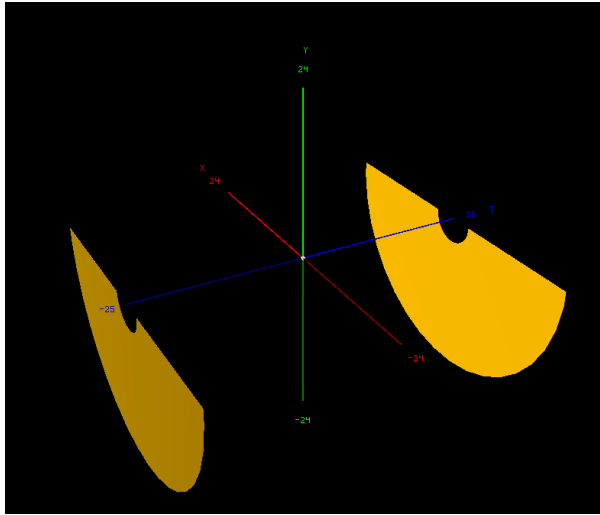
Pixel size for Silicon sensor: 20  $\mu\text{m}$

# Eta Coverage (Acceptance)



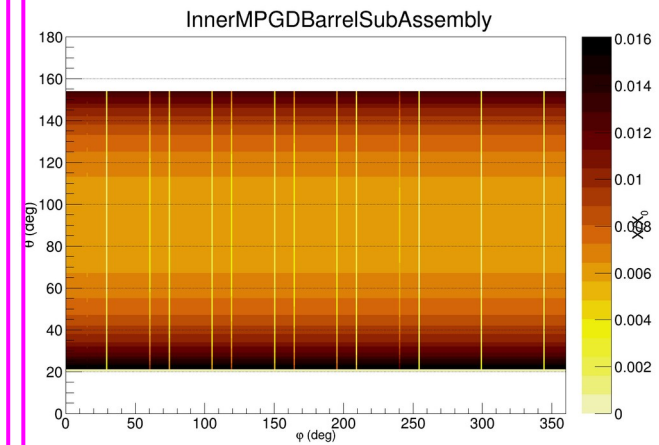
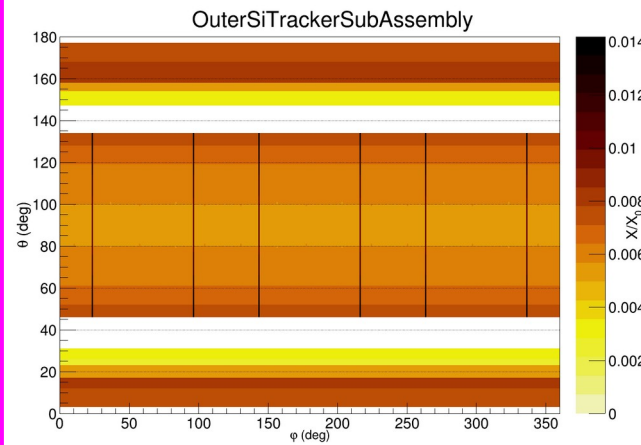
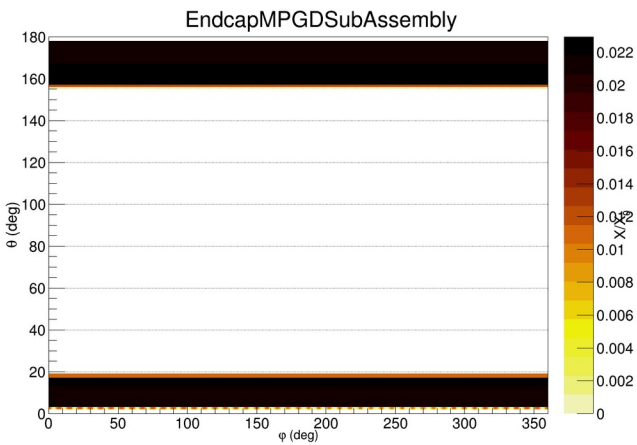
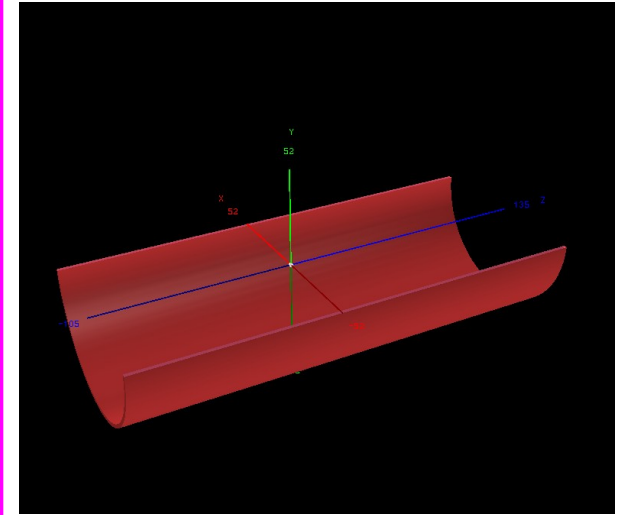
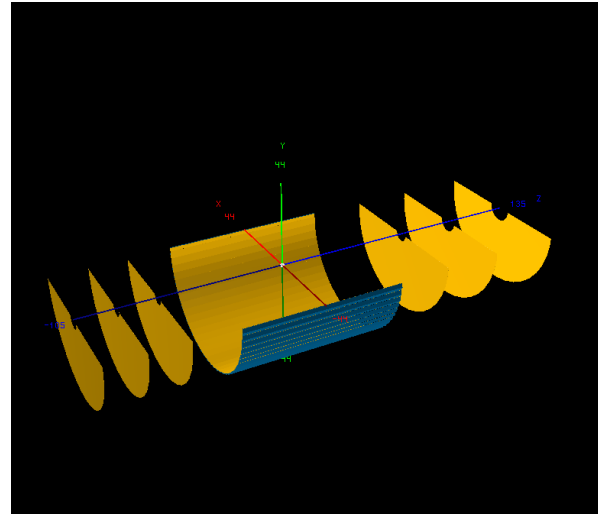
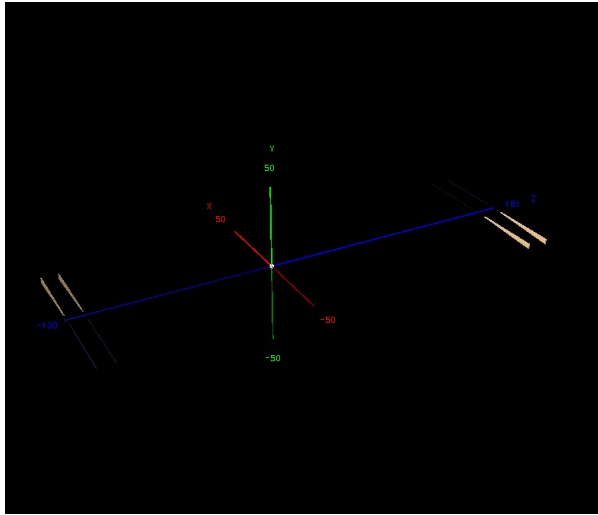
# Material Map

Geometry and corresponding material map in the bottom row



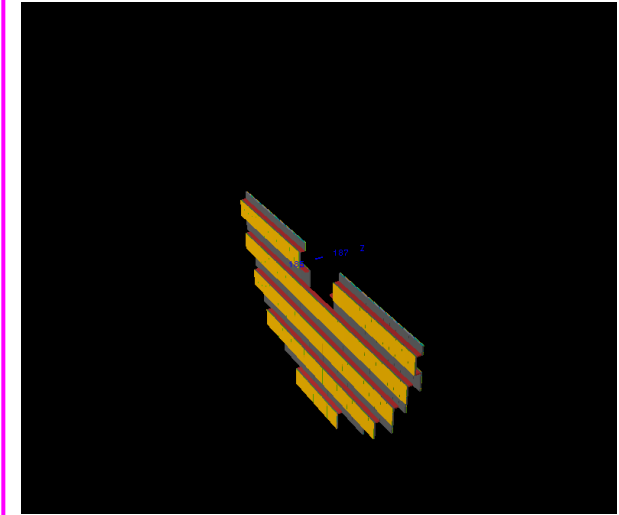
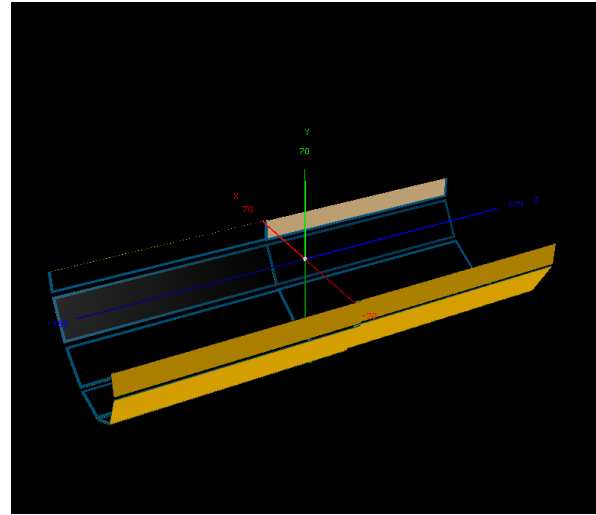
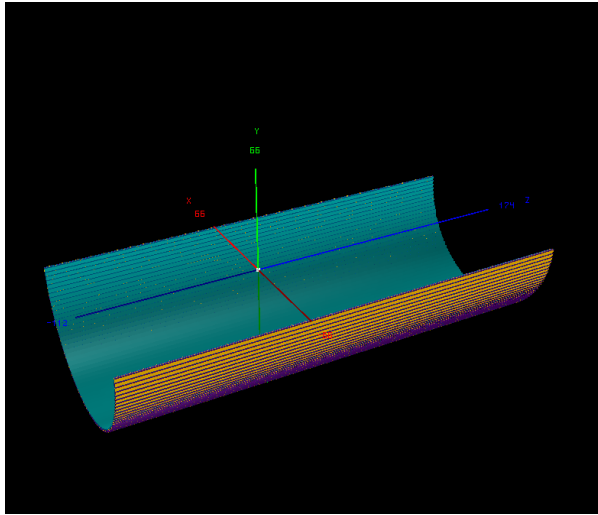
# Material Map

Geometry and corresponding material map in the bottom row

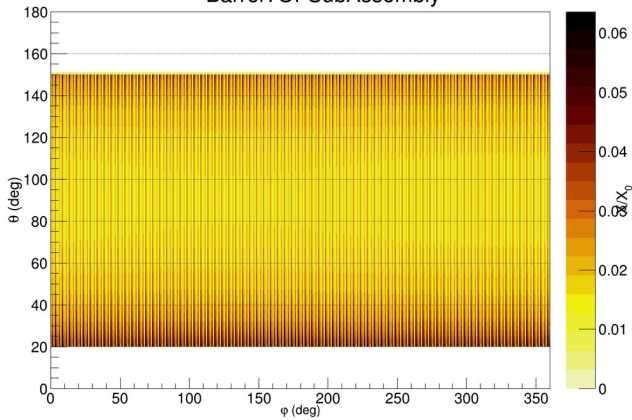


# Material Map

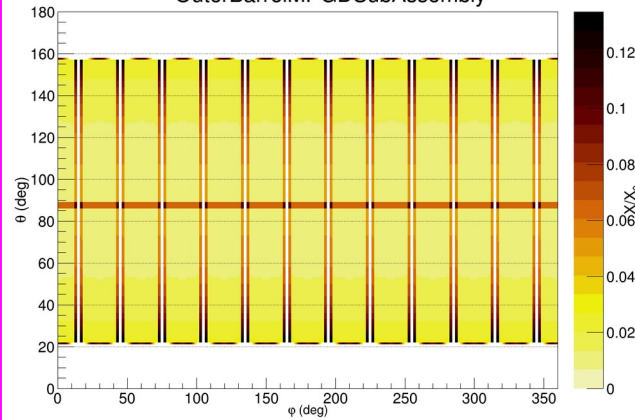
Geometry and corresponding material map in the bottom row



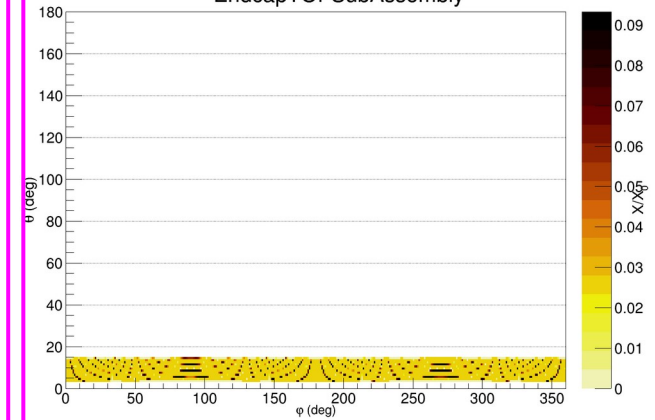
BarrelTOFSubAssembly



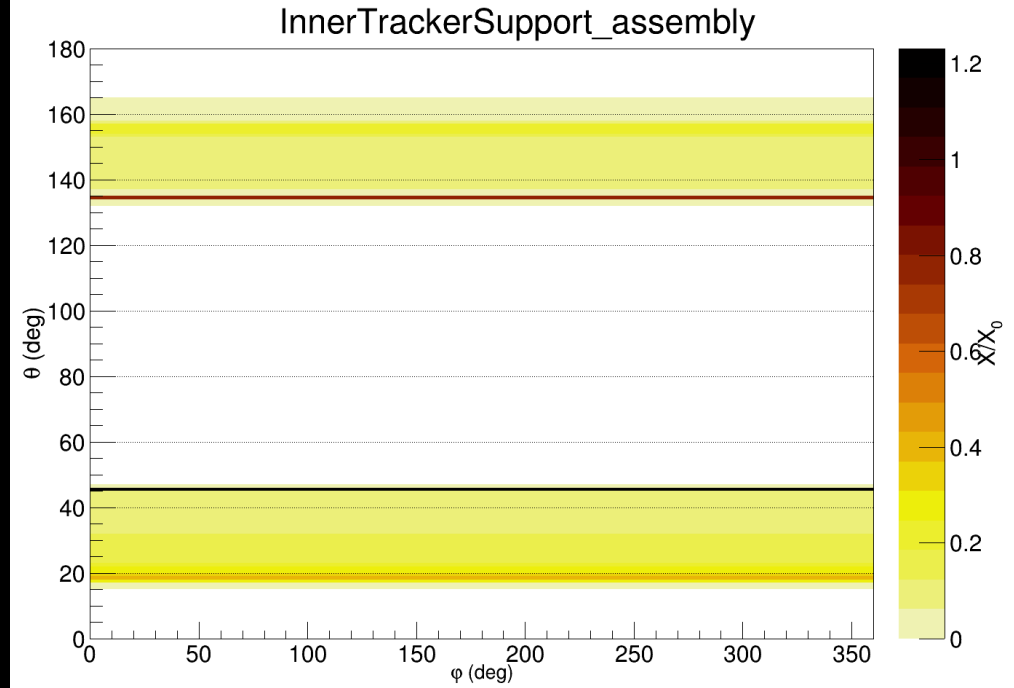
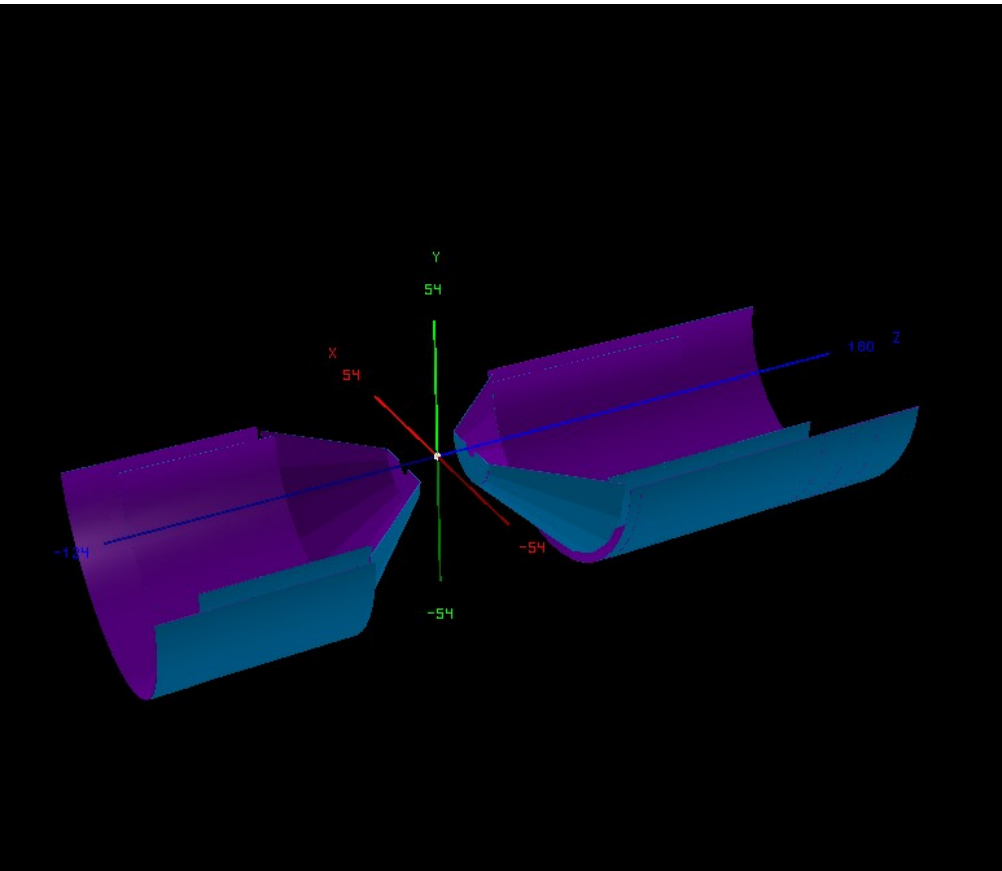
OuterBarrelIMPGDSubAssembly



EndcapTOFSubAssembly

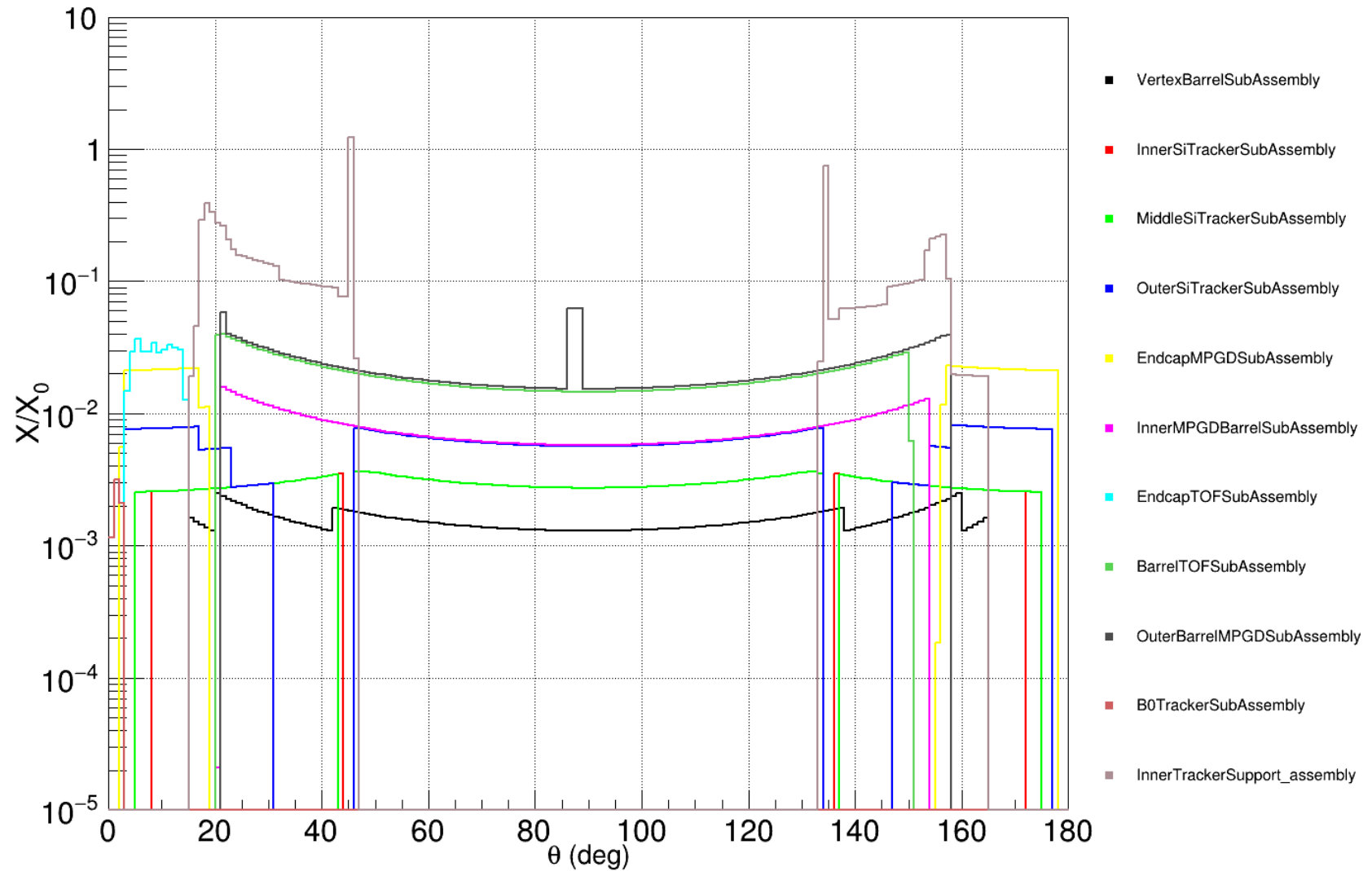


# Inner Tracker Support Assembly





# Material Map (Material Scan)



# Material Scan Numbers

## For track theta = 90 deg (Barrel)

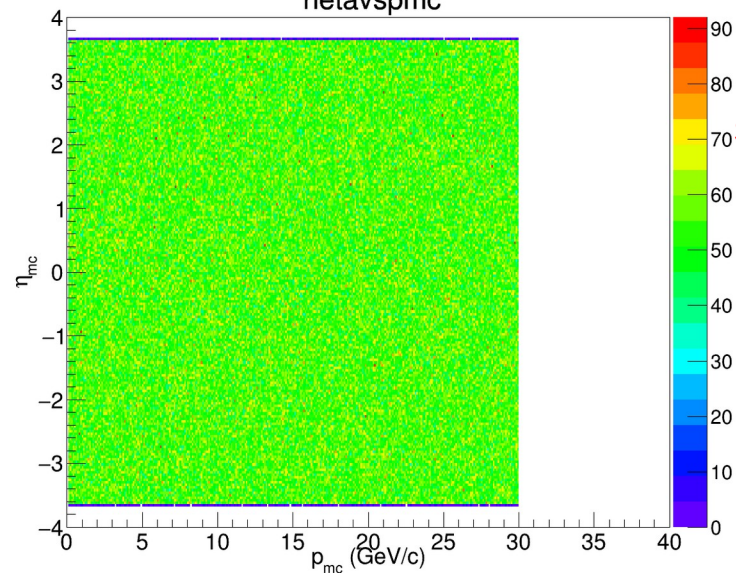
Volume Name:	VertexBarrelSubAssembly	Material Budget: 0.00130081
Volume Name:	MiddleSiTrackerSubAssembly	Material Budget: 0.0027159
Volume Name:	OuterSiTrackerSubAssembly	Material Budget: 0.00572107
Volume Name:	InnerMPGDBarrelSubAssembly	Material Budget: 0.00577311
Volume Name:	BarrelTOFSubAssembly	Material Budget: 0.0146295
Volume Name:	OuterBarrelMPGDSUBAssembly	Material Budget: 0.0153859
Volume Name:	InnerTrackerSupport_assembly	Material Budget: 0
Volume Name:	BeamPipe_assembly	Material Budget: 0.00364154

## For track theta = 5 deg (Forward)

Volume Name:	EndcapMPGDSUBAssembly	Material Budget: 0.0212798
Volume Name:	EndcapTOFSubAssembly	Material Budget: 0.0279914

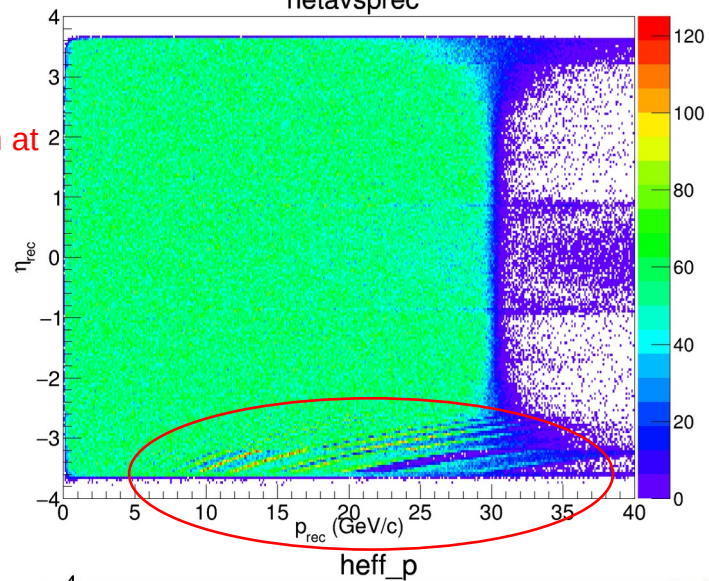
# Eta vs Momentum

Generated level  
hetavspmc



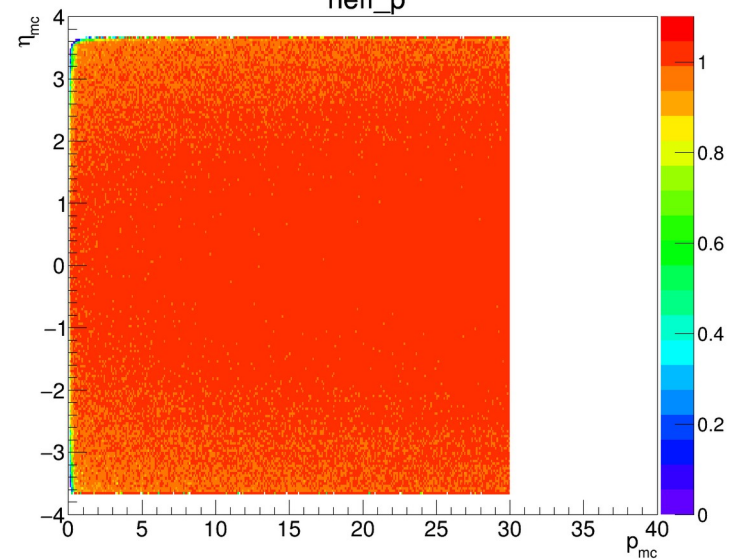
Structure in the backward direction at large  $\eta$  and momentum

Reconstructed level  
hetavsprec



[https://indico.bnl.gov/event/17600/contributions/70847/attachments/44524/75155/EPIC\\_Tracking\\_Meeting\\_Shyam%2017Nov2022.pdf](https://indico.bnl.gov/event/17600/contributions/70847/attachments/44524/75155/EPIC_Tracking_Meeting_Shyam%2017Nov2022.pdf)

Acceptance using truth seeding

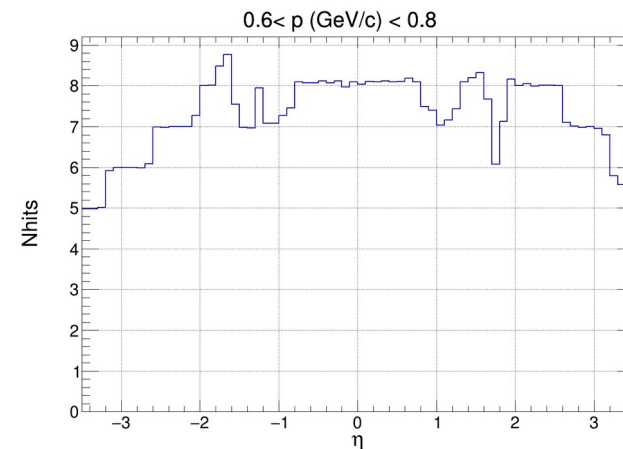
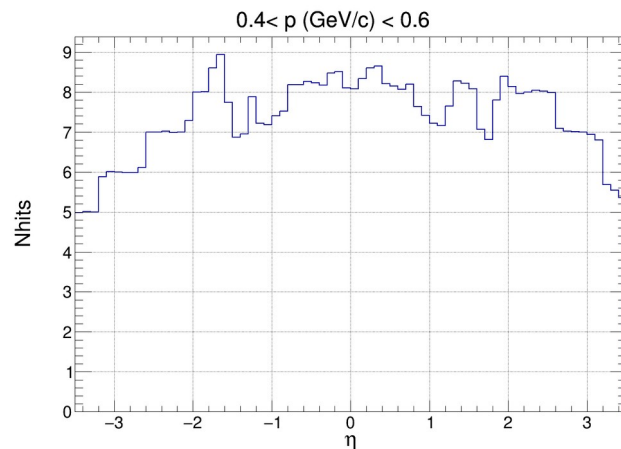
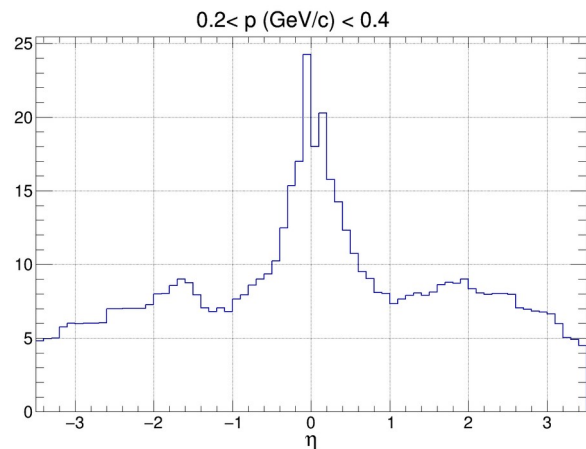


# Nhits vs $\eta$ (Generation Level)

Including calorimeters will improve  
but simulation takes time

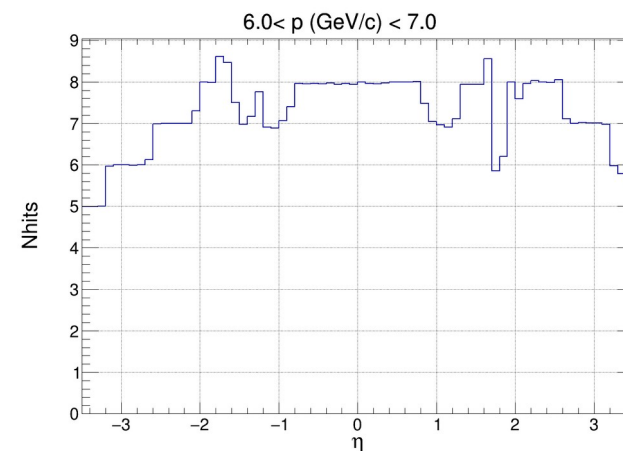
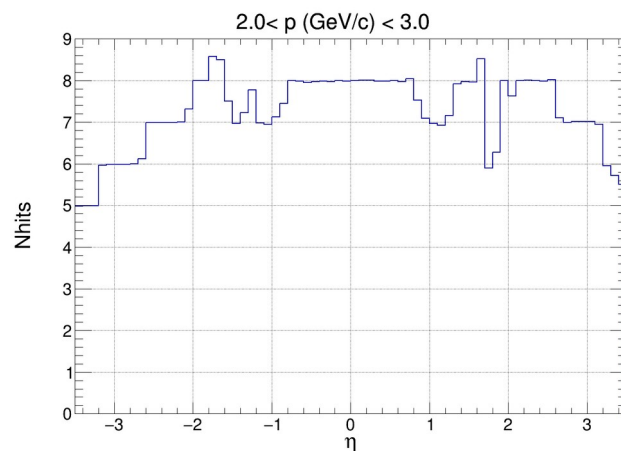
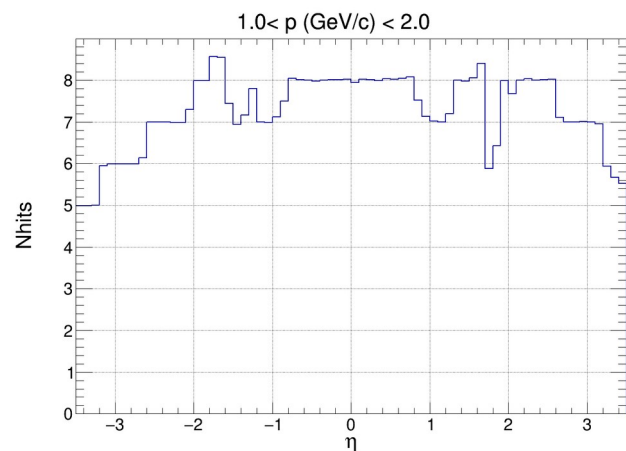
## Without Calorimeters

With primary hits selected  
using quality flag



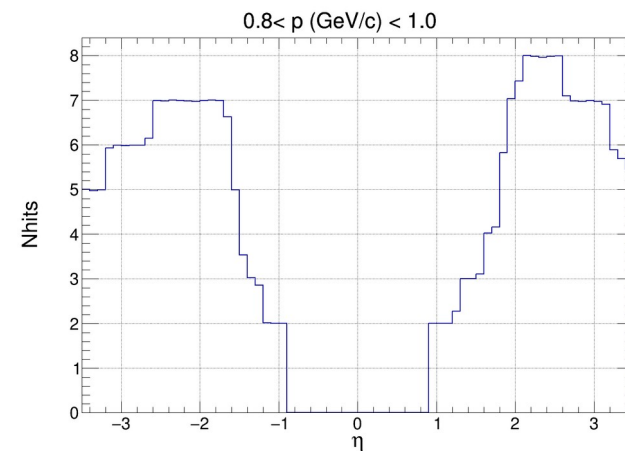
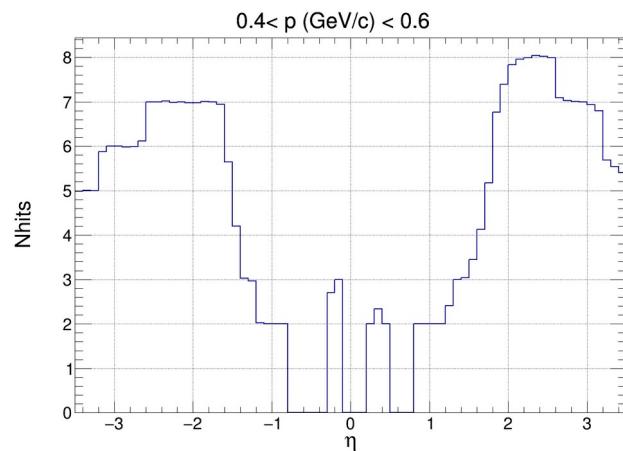
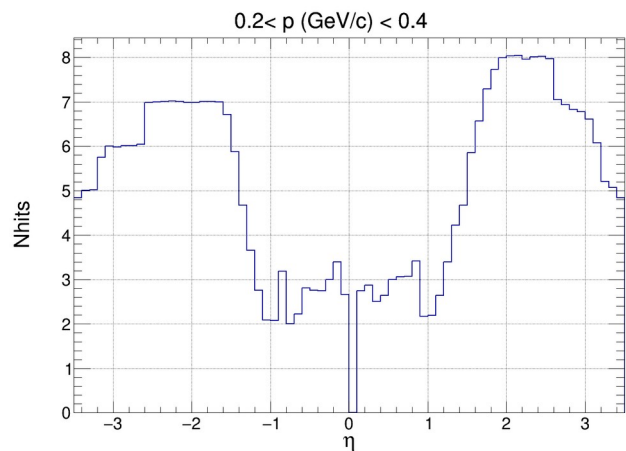
There are atleast 5 hits at extreme  $\eta$  therefore 5 d.o.f. while previously with 3 hits it was 1 d.o.f.

[https://indico.bnl.gov/event/18214/contributions/74857/attachments/46665/79042/EPIC\\_Tracking\\_Meeting\\_Shyam23Mar2023.pdf](https://indico.bnl.gov/event/18214/contributions/74857/attachments/46665/79042/EPIC_Tracking_Meeting_Shyam23Mar2023.pdf)

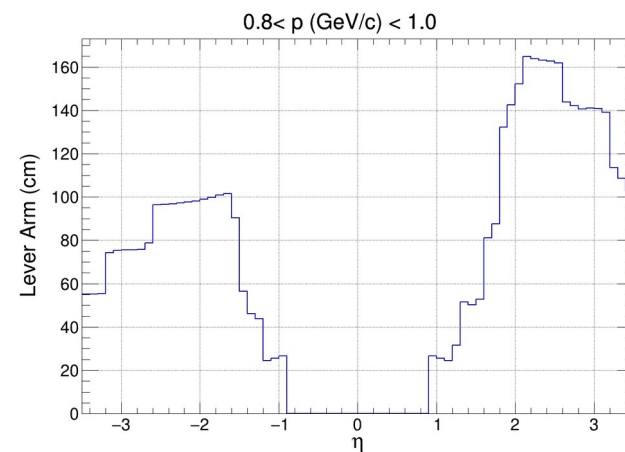
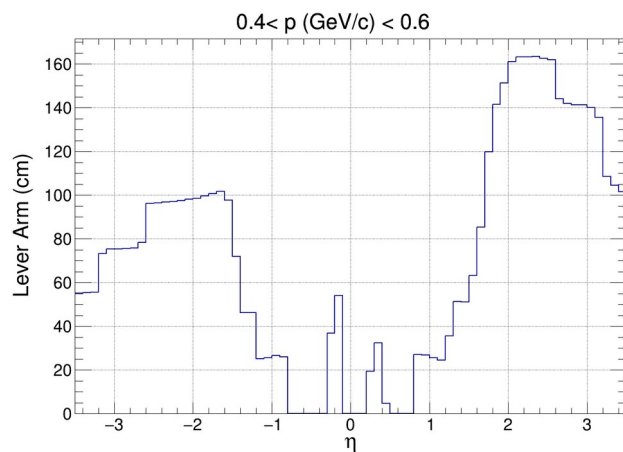
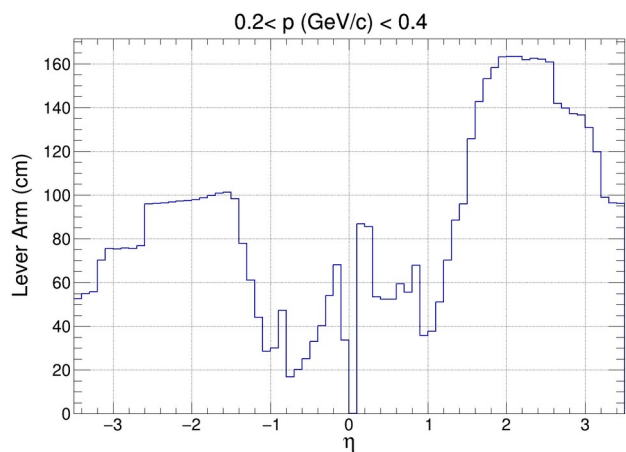


# Nhits vs $\eta$ (EndCap Only)

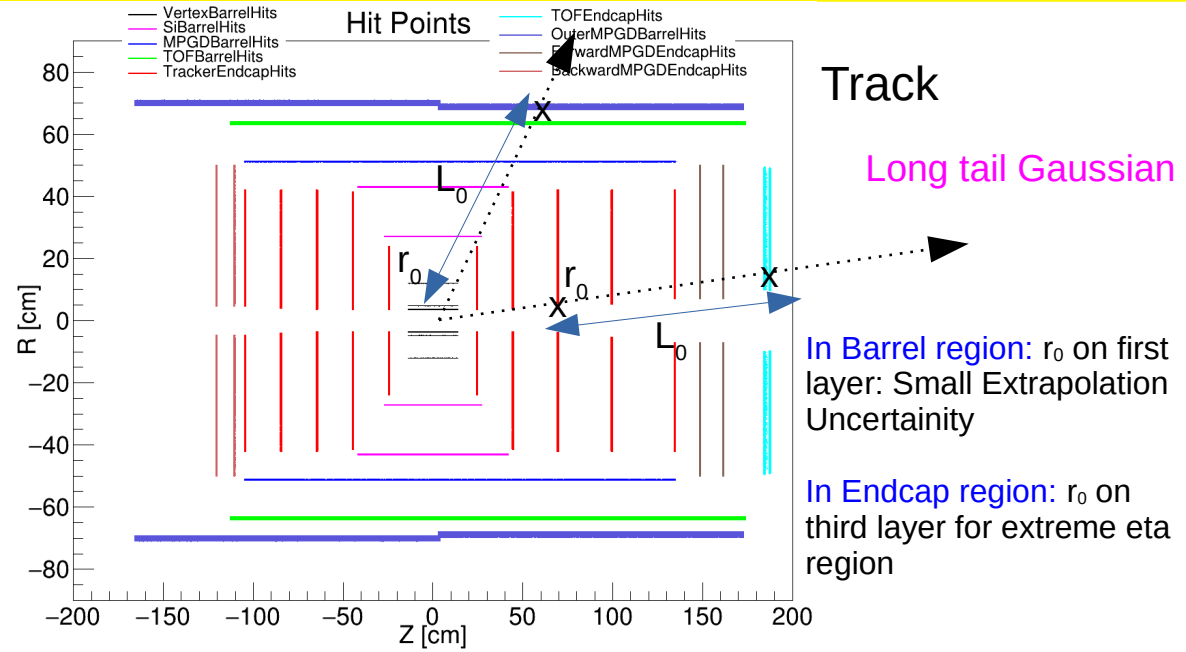
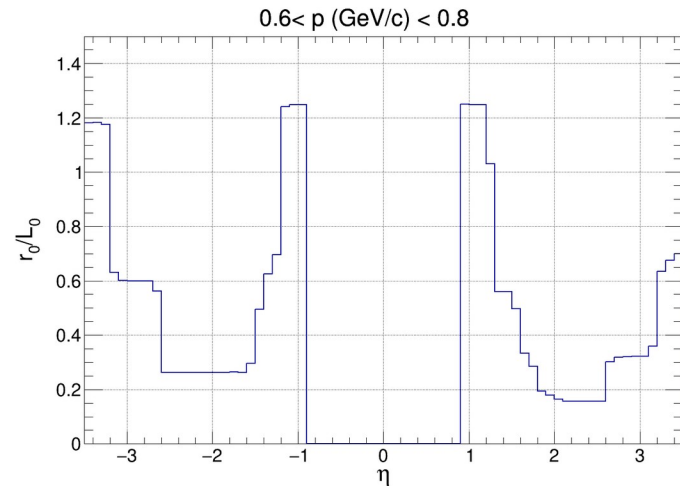
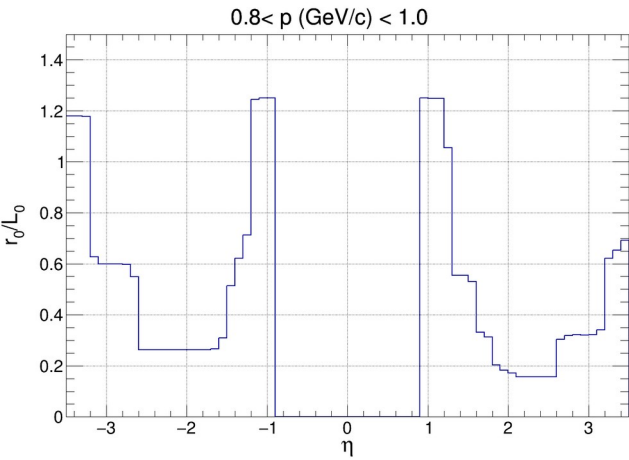
## Nhits [EndCap]



**Lever Arm [distance between first and last hit] affects momentum and DCAxy resolution**



# Barrel vs Forward/Backward Tracking



$p_T$  resolution:

$$\frac{\Delta p_T}{p_T}|_{res.} = \frac{\sigma_{r\phi} p_T}{0.3 B_0 L_0^2} \sqrt{\frac{720 N^3}{(N-1)(N+1)(N+2)(N+3)}} \quad \text{Linear term}$$

$$\approx \frac{12 \sigma_{r\phi} p_T}{0.3 B_0 L_0^2} \sqrt{\frac{5}{N+5}}$$

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

arXiv:1805.12014

DCA<sub>xy</sub> resolution:

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

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

# Summary

- First studies of hit points, material map, acceptance, and number of hits.
- Further need to understand the structure in the negative eta region

**Thank You !!**

# Tracking Performances

A good agreement with the fast simulation

