

# All-Silicon Tracker + GEMs ("baseline 1") Performance Studies



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ATHENA Tracking Meeting  
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# Outline

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## 1. Nominal configuration

### 2. Variations:

- i. (BARREL) Complementing tracker with MPGDs
- ii. (BARREL) Using ITS-3 technology for Sagitta layers
- iii. (DISKS) longer detector

# Setup

Event generation:

- particle:  $\pi^-$
- p range: [0,30] GeV/c
- $\eta$  range: [-3.7,3.7]
- $\phi$  range: [0,2 $\pi$ ]

GEM  
z = -180 cm  
 $\sigma = 50 \mu\text{m}$

All-silicon  
tracker

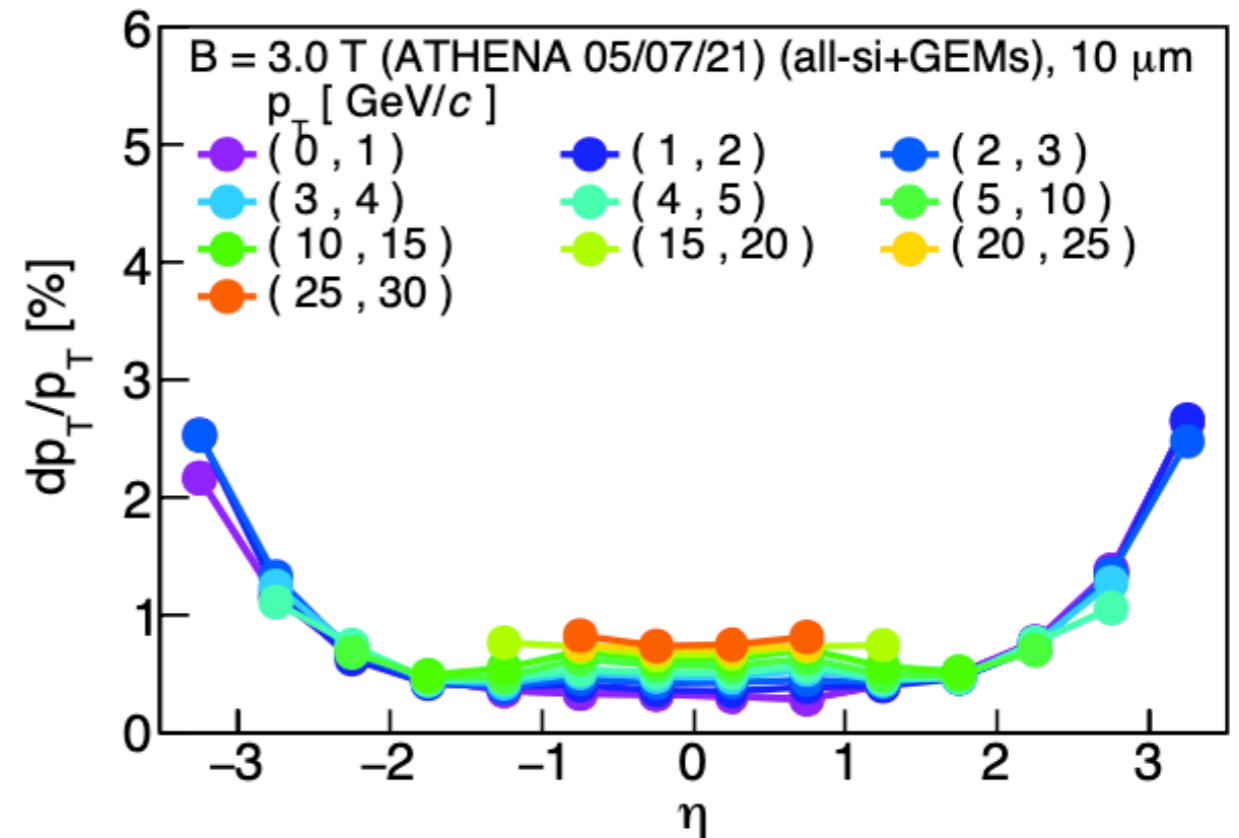
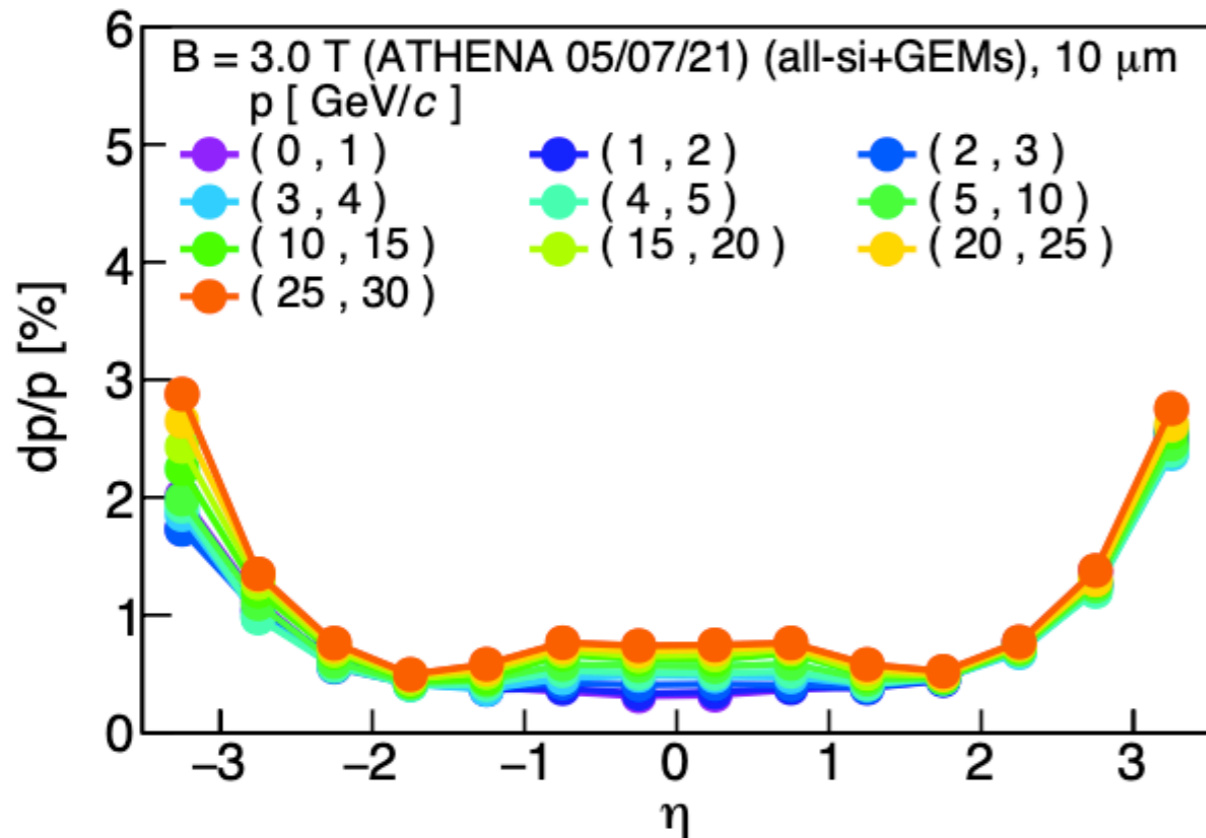
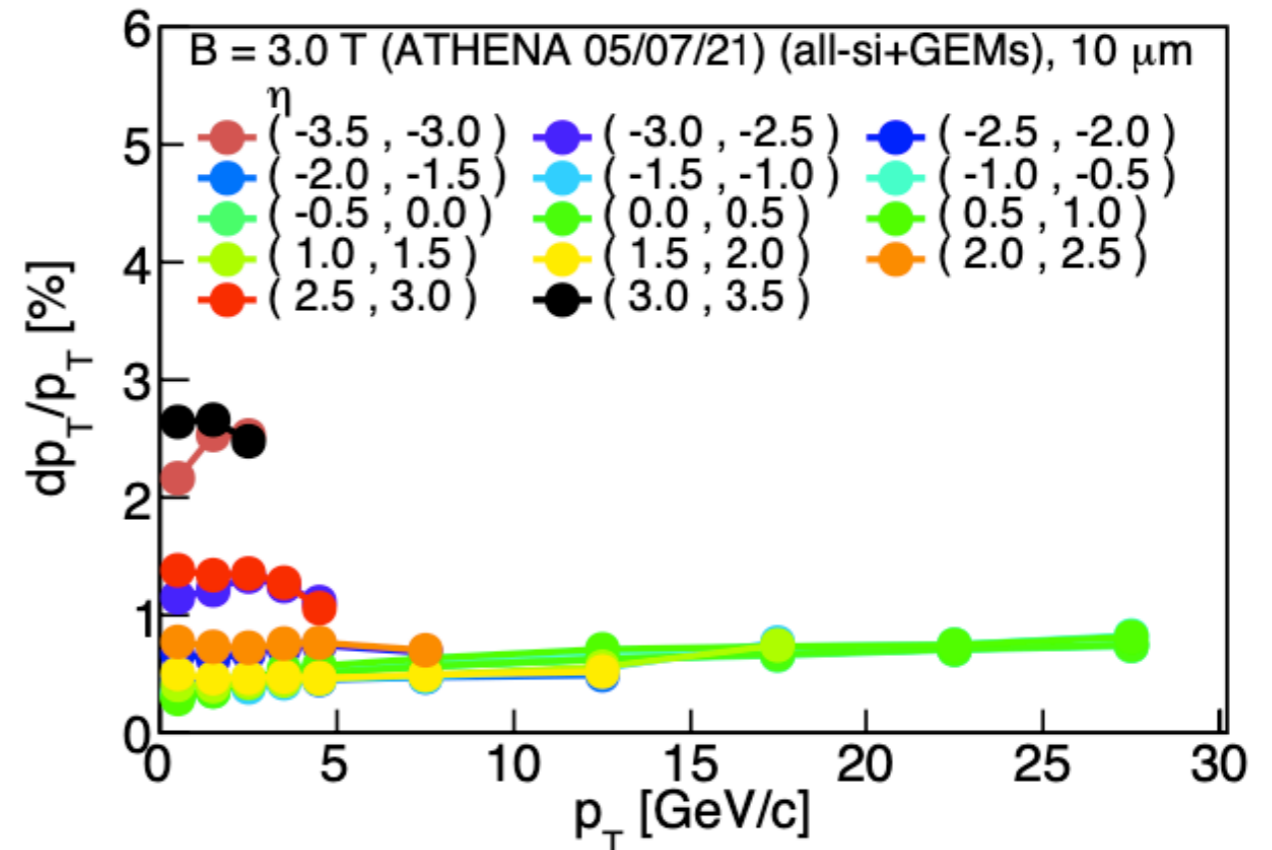
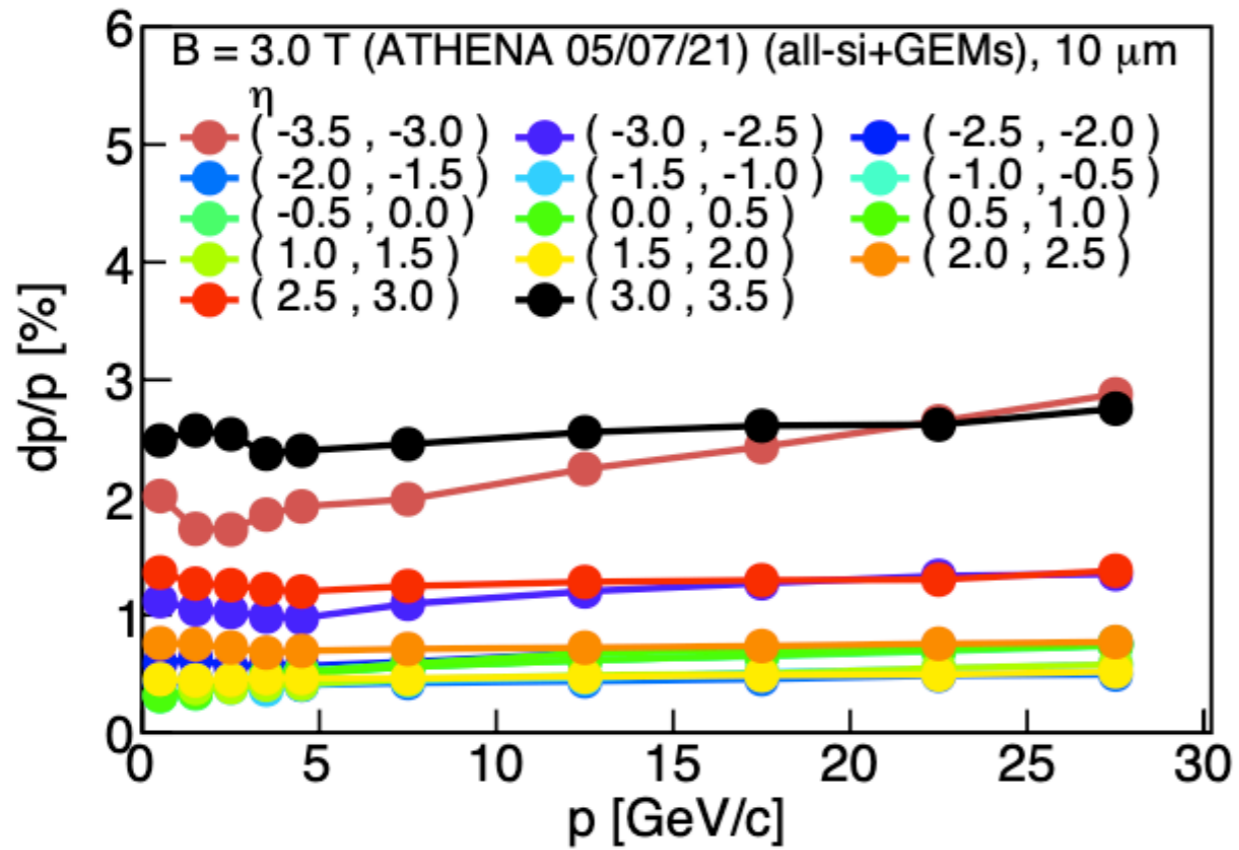
Pixel size:  
10  $\mu\text{m}$

RICH

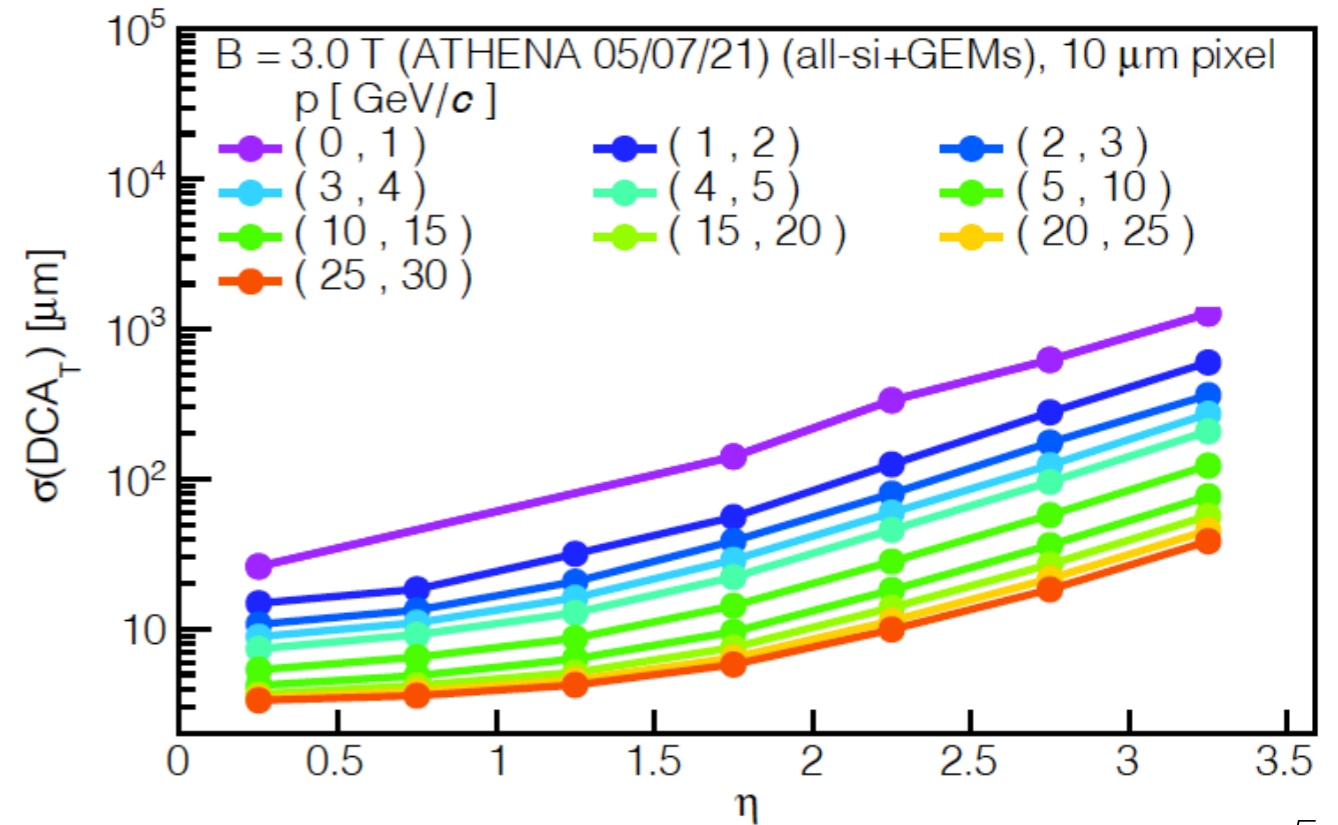
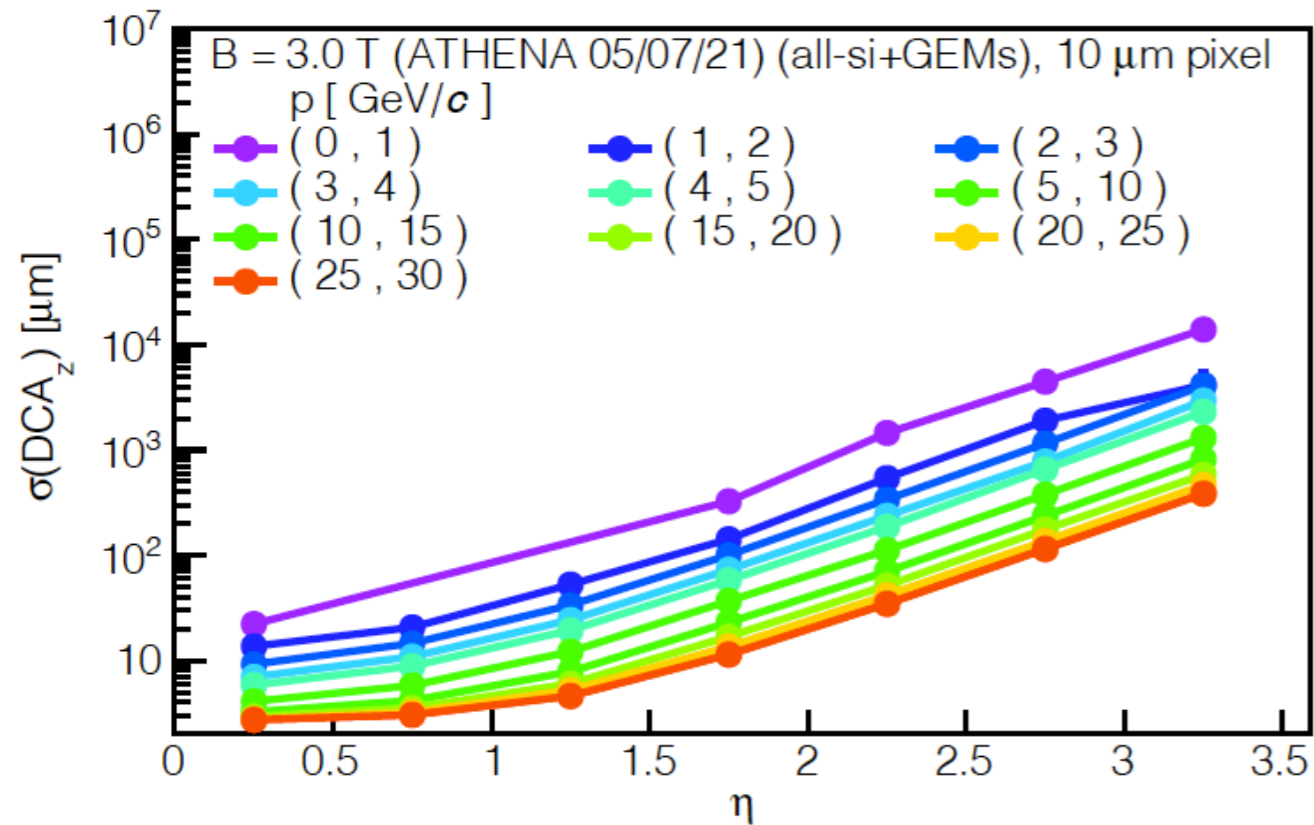
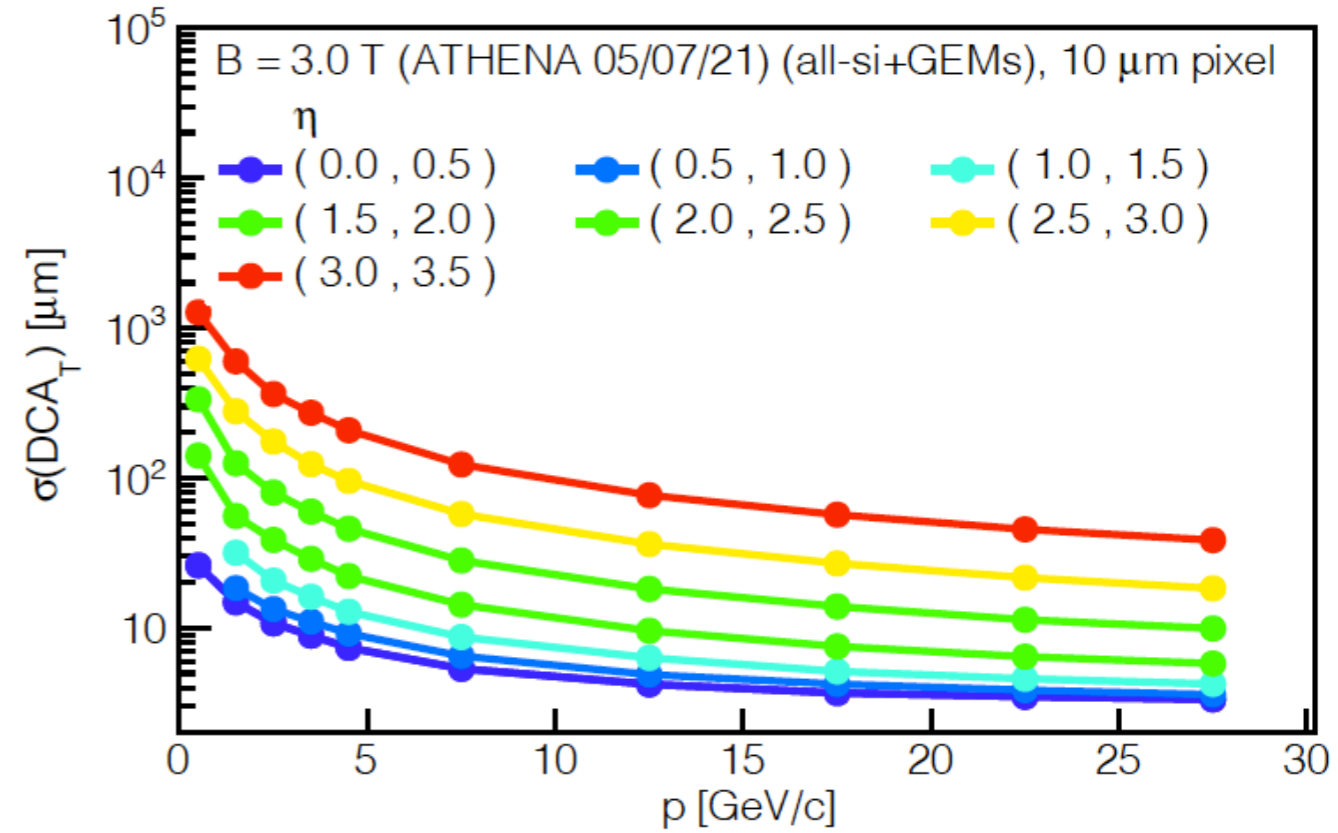
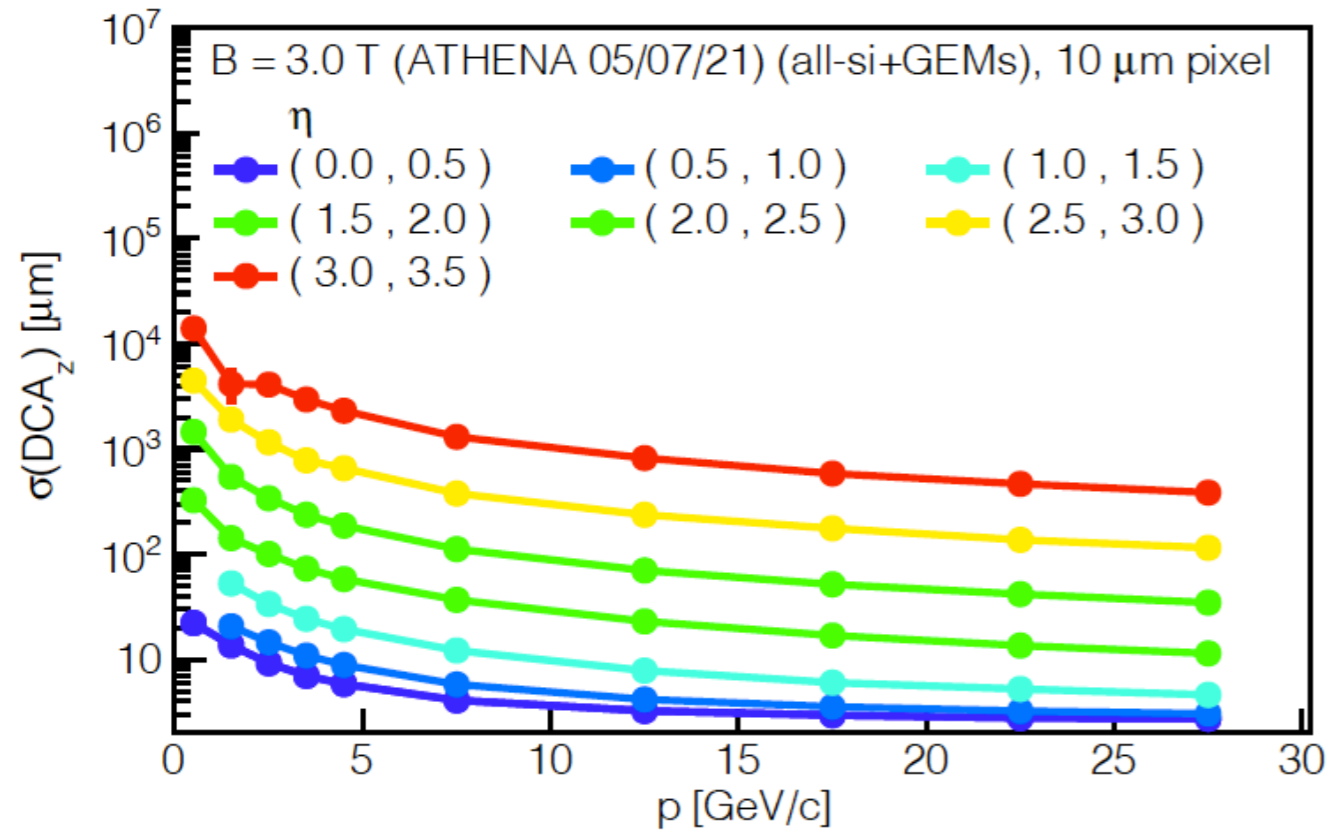
GEM  
z = 300 cm  
 $\sigma = 50 \mu\text{m}$

B field: 3.0 T (ATHENA  
map 05/07/2021)

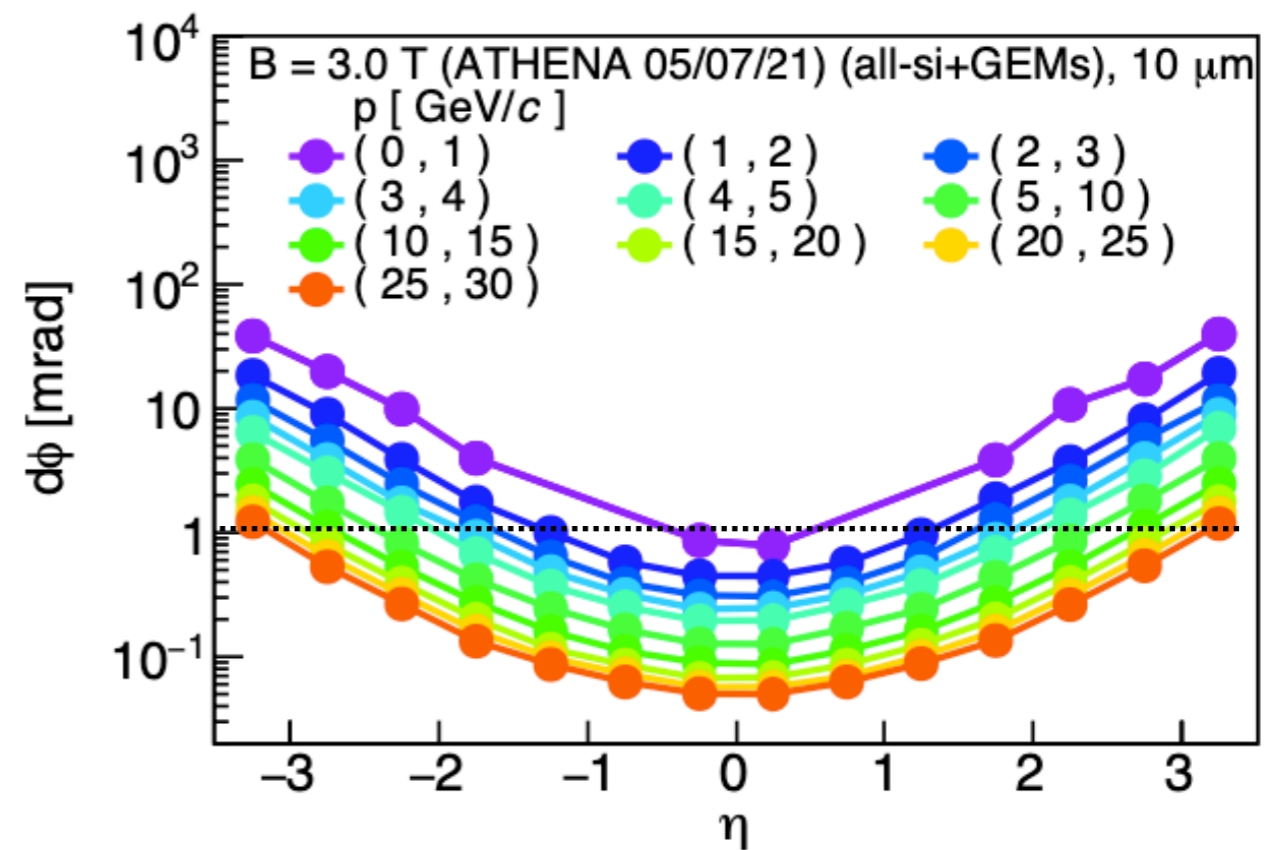
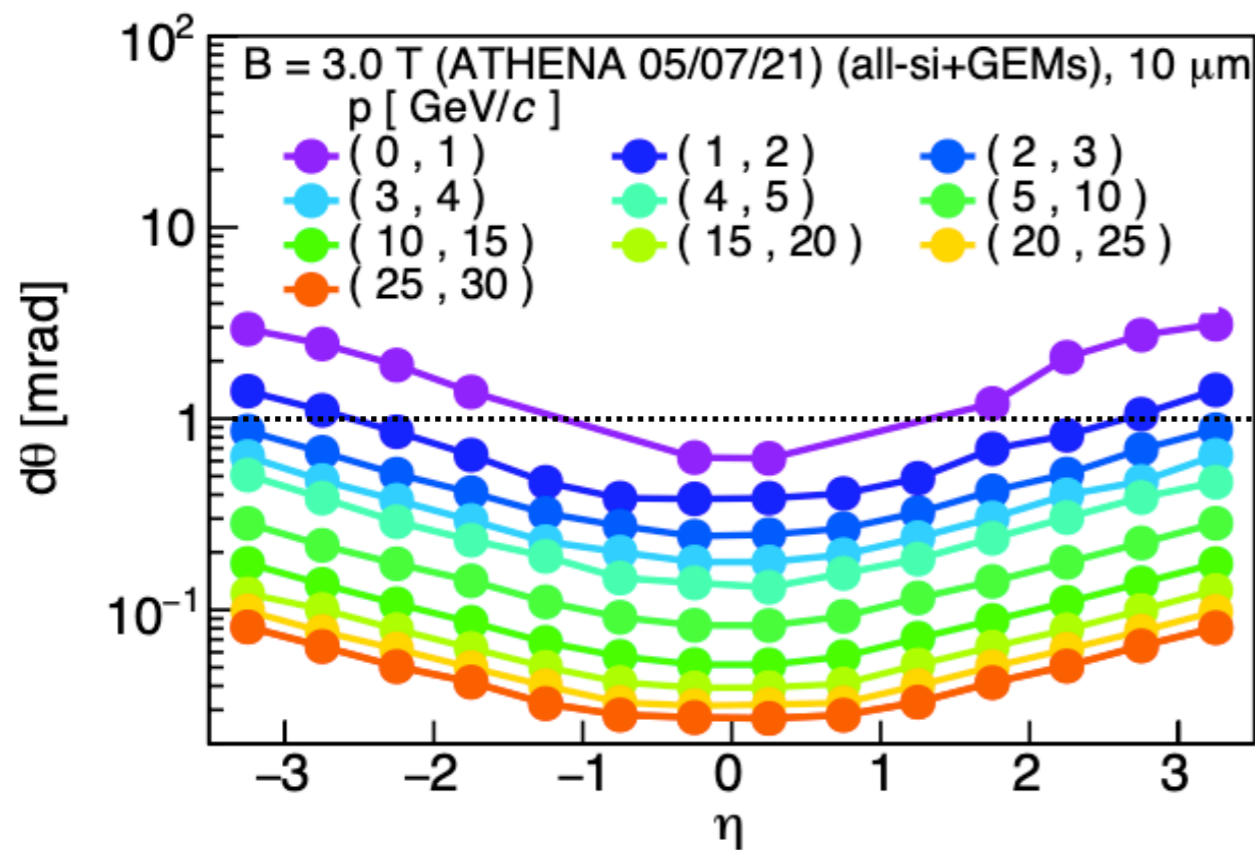
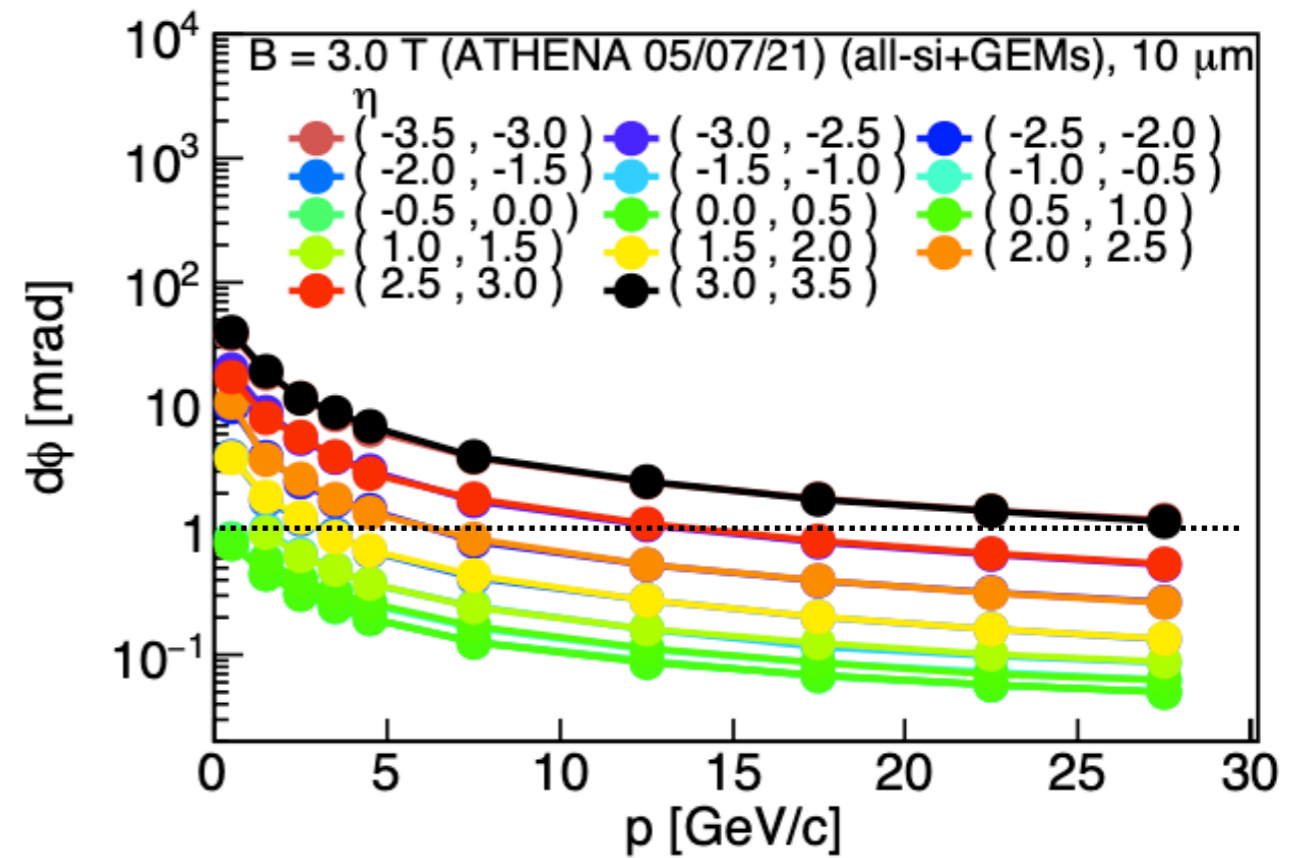
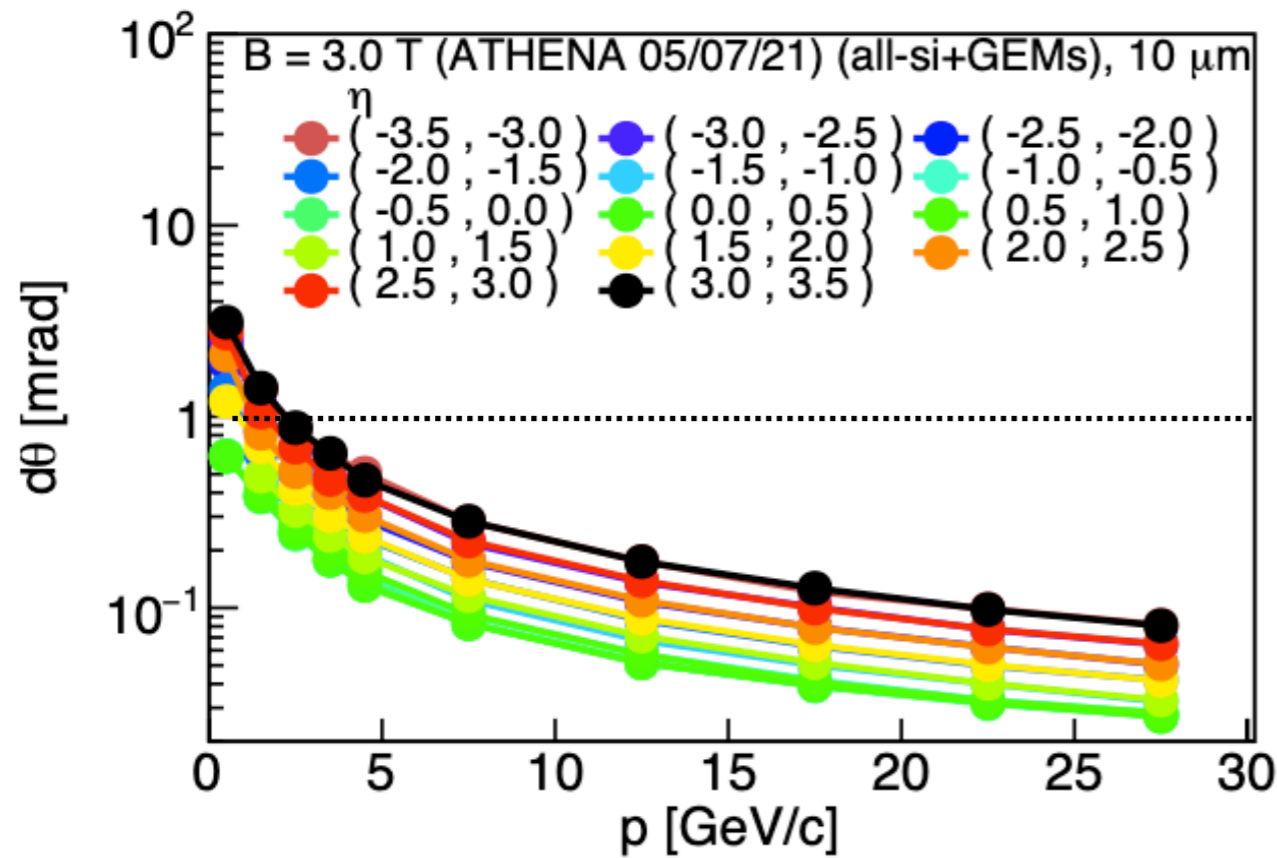
# Momentum resolutions



# DCA resolutions



# Angular Resolutions @vtx



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# Complementing the all-si tracker in the barrel region

Variant #1:

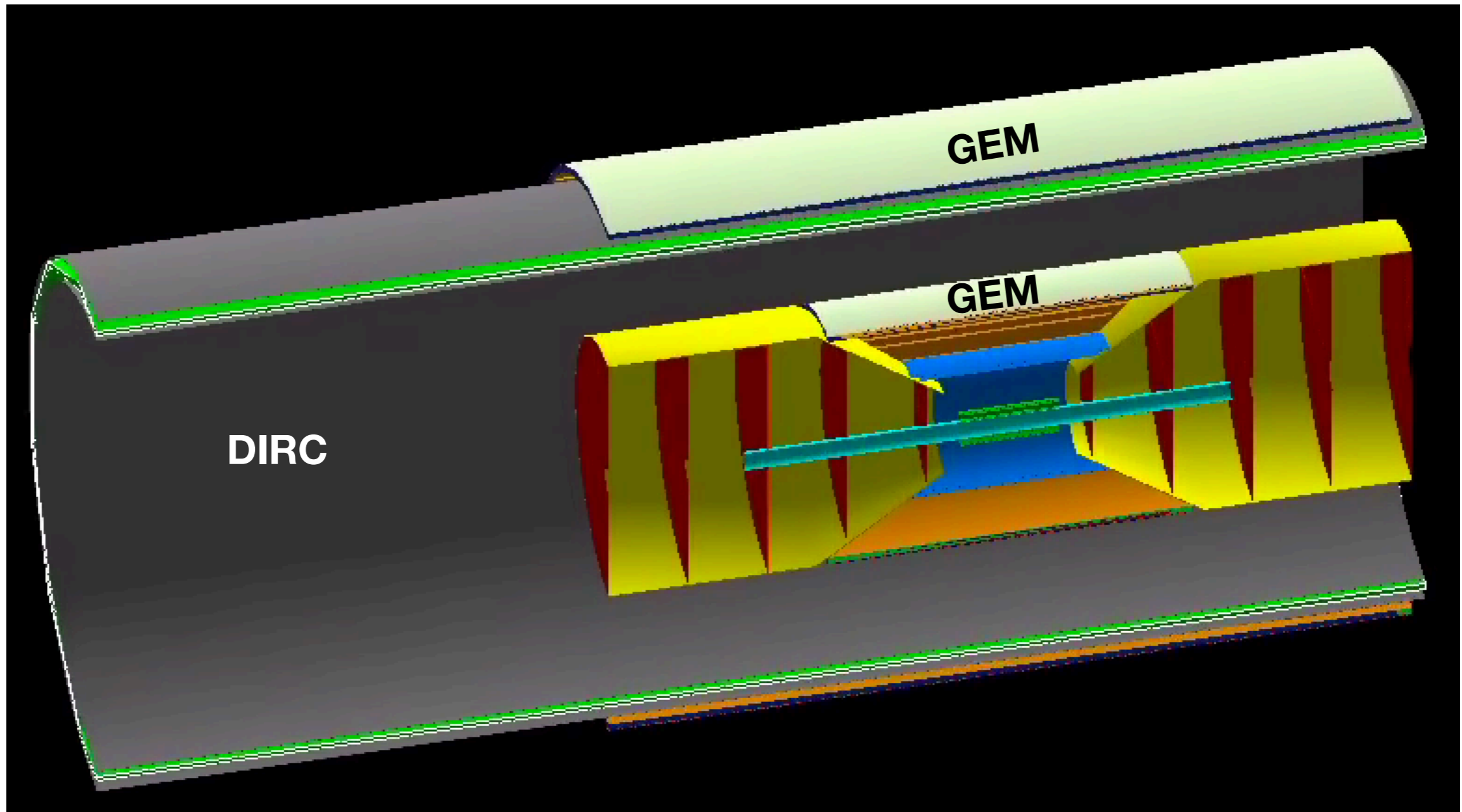
All-silicon tracker + GEM outside the DIRC

Variant #2:

Outermost two barrel layers replaced with a GEM, and a second GEM added outside the DIRC

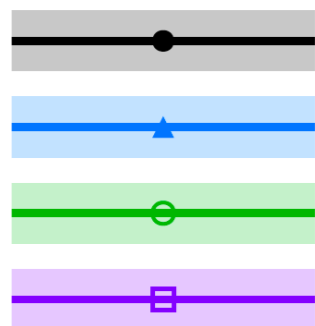
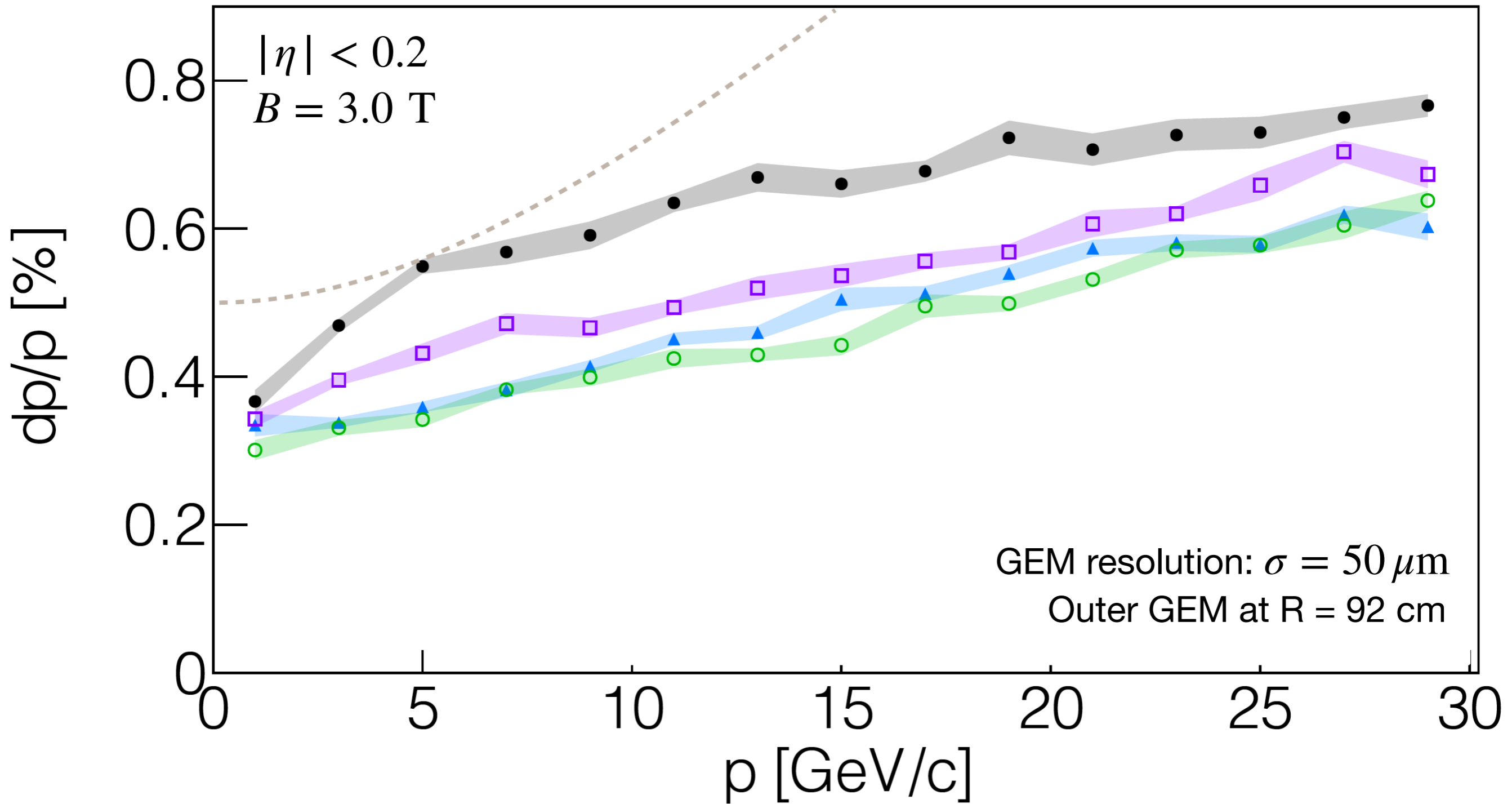
All-si tracker material budget (X/X<sub>0</sub>):

- Vertexing layers: 0.05%
- Barrel Layers: 0.55%
- Disks: 0.24%





# GEM Material Budget Effect



all-si only

all-si + DIRC + GEM (R = 92 cm)

all-si outer two layers replaced with GEM (X/X0=0.7%) + DIRC + GEM (R = 92 cm)

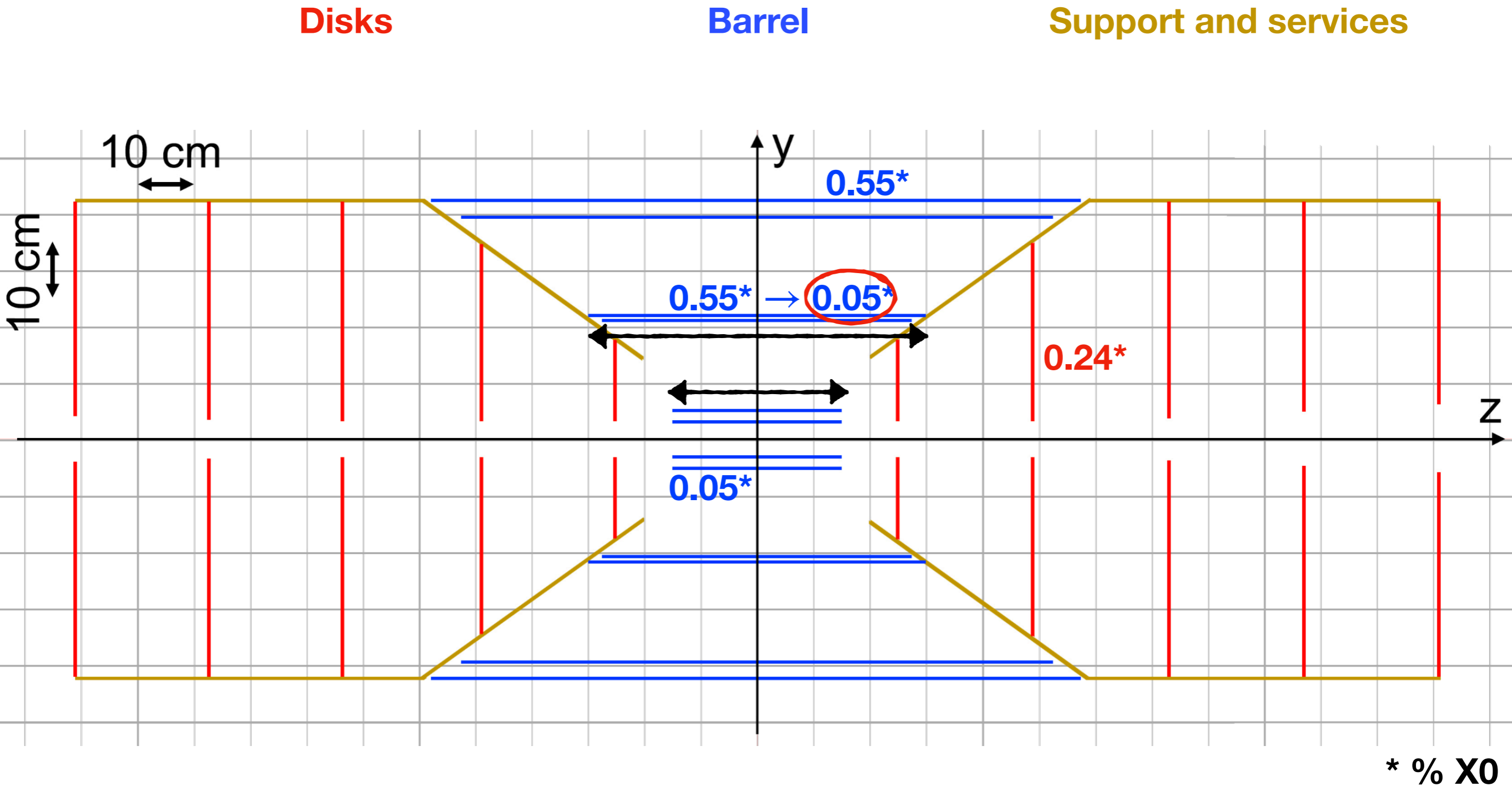
all-si outer two layers replaced with GEM (X/X0=2.4%) + DIRC + GEM (R = 92 cm)

# Outline

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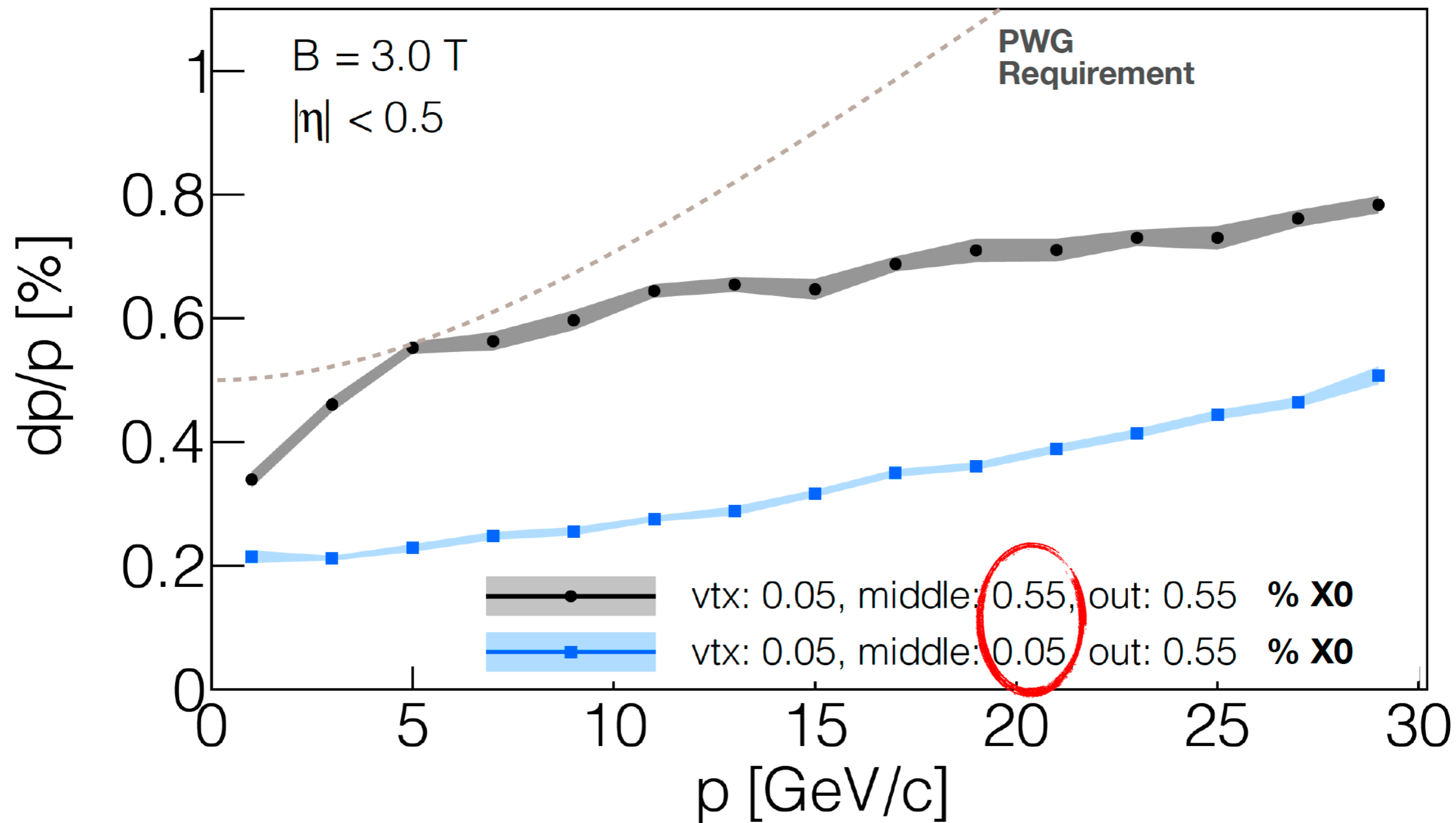
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# Detector diagram

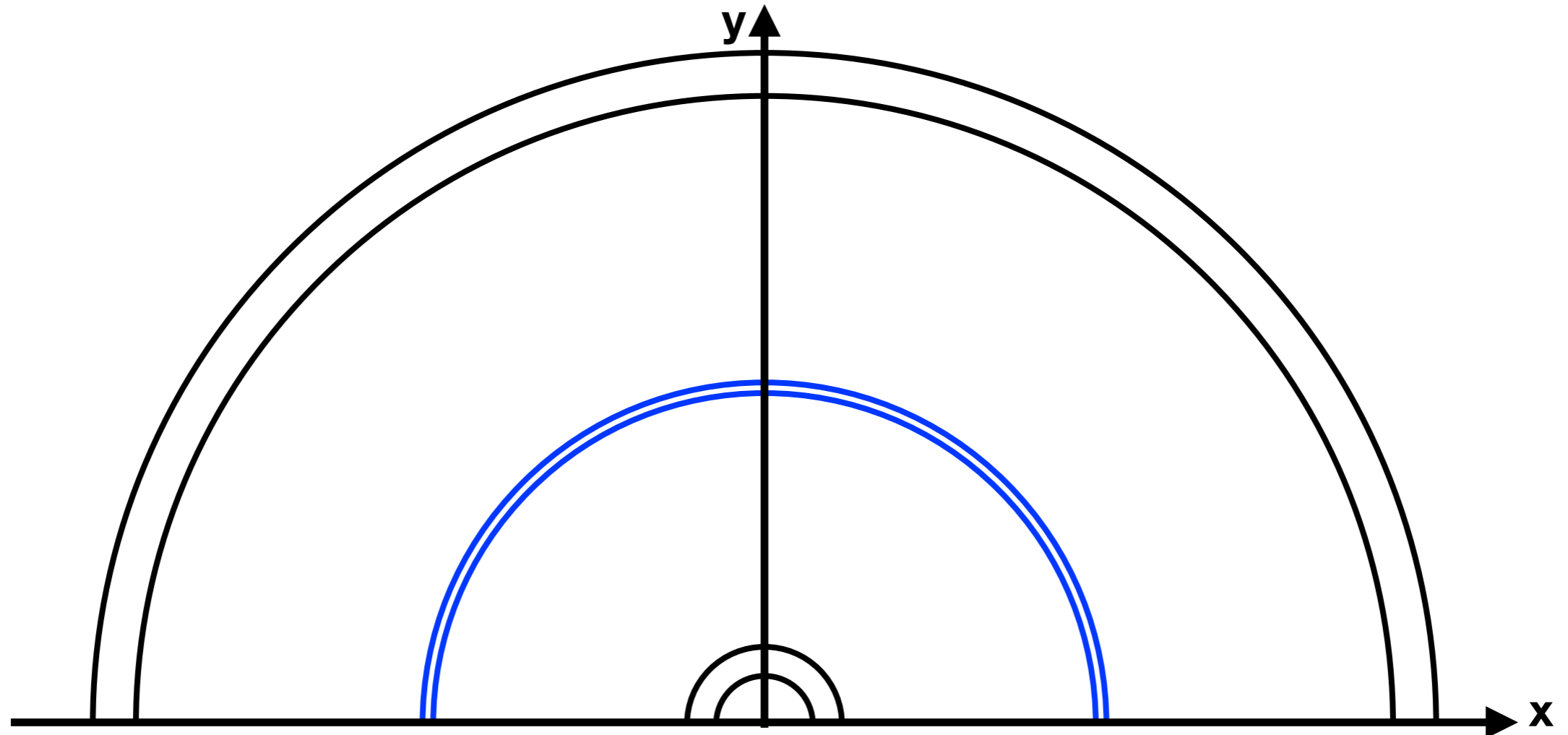
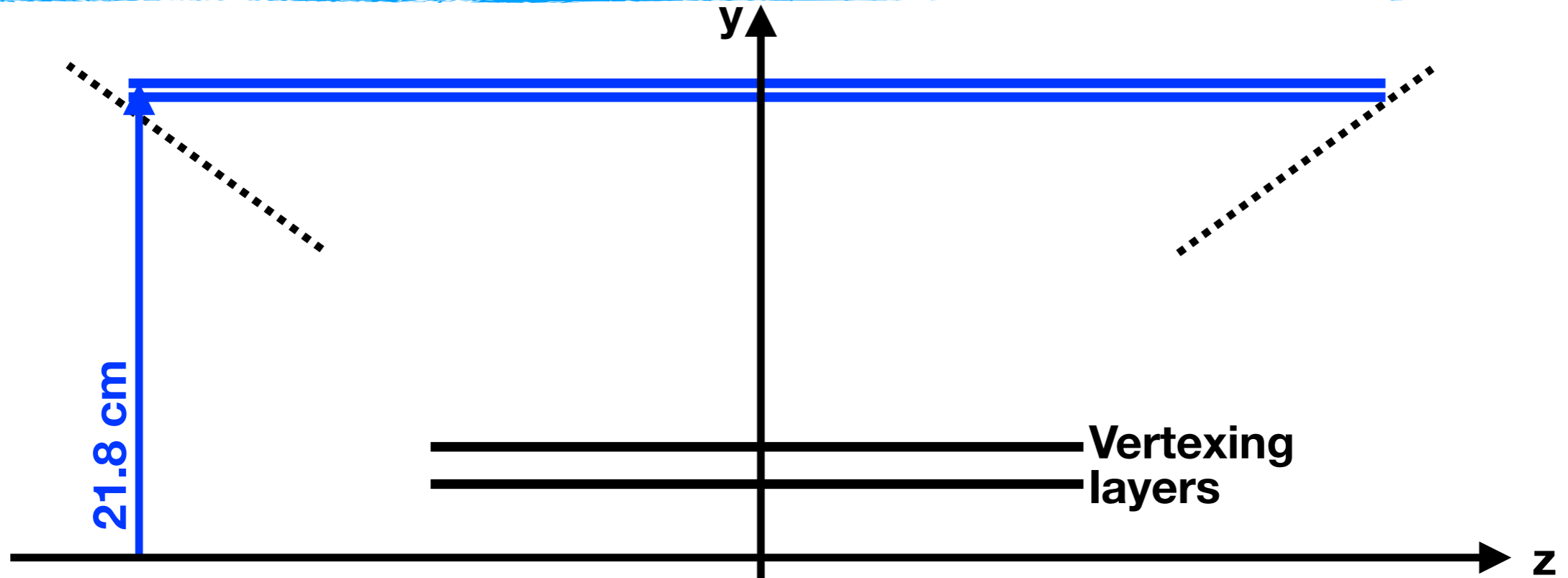


The middle layers are not much longer in  $z$  than the vertexing layers. Can we use the ultra thin ( $0.05\%$   $X_0$ ) bent-silicon technology there? What do we gain?

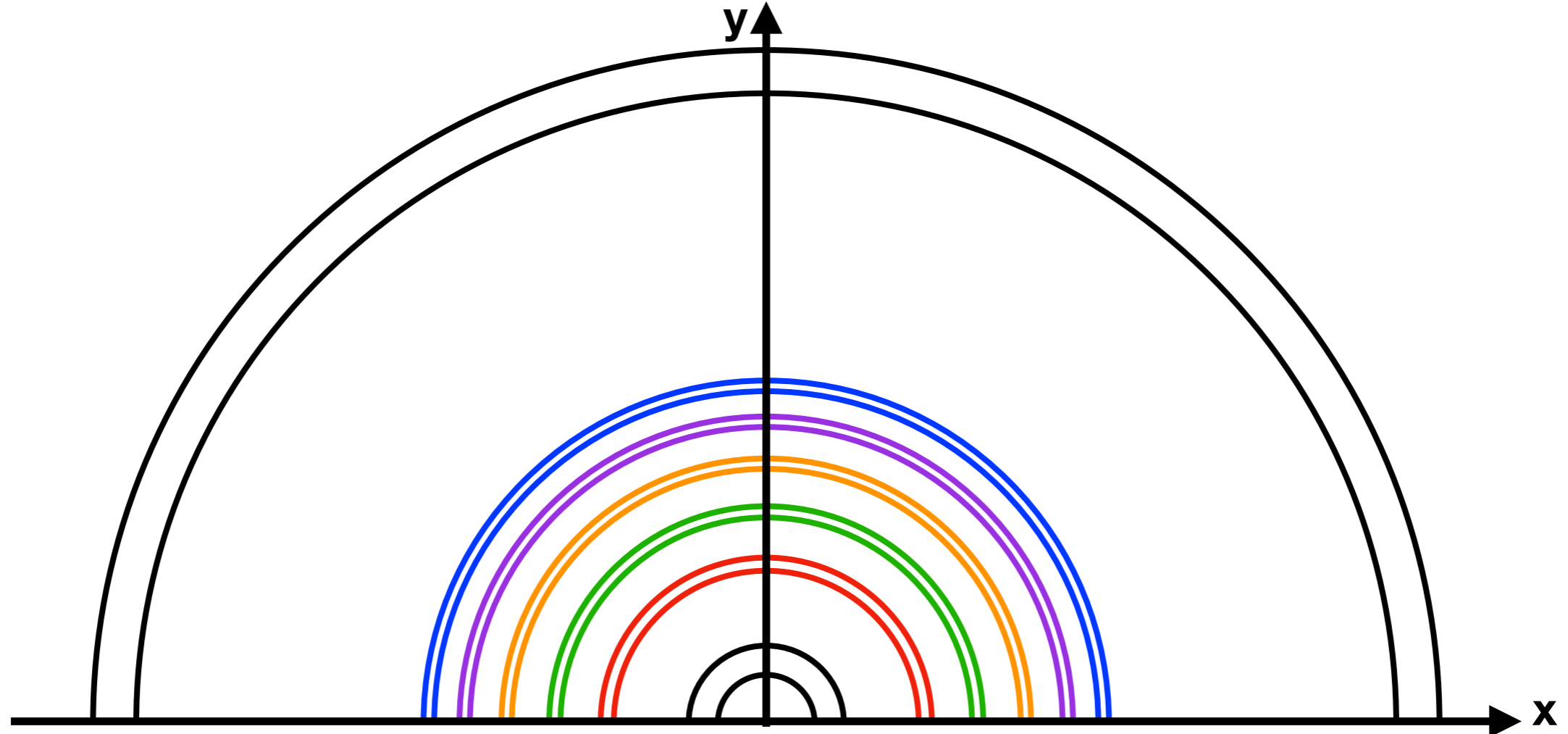
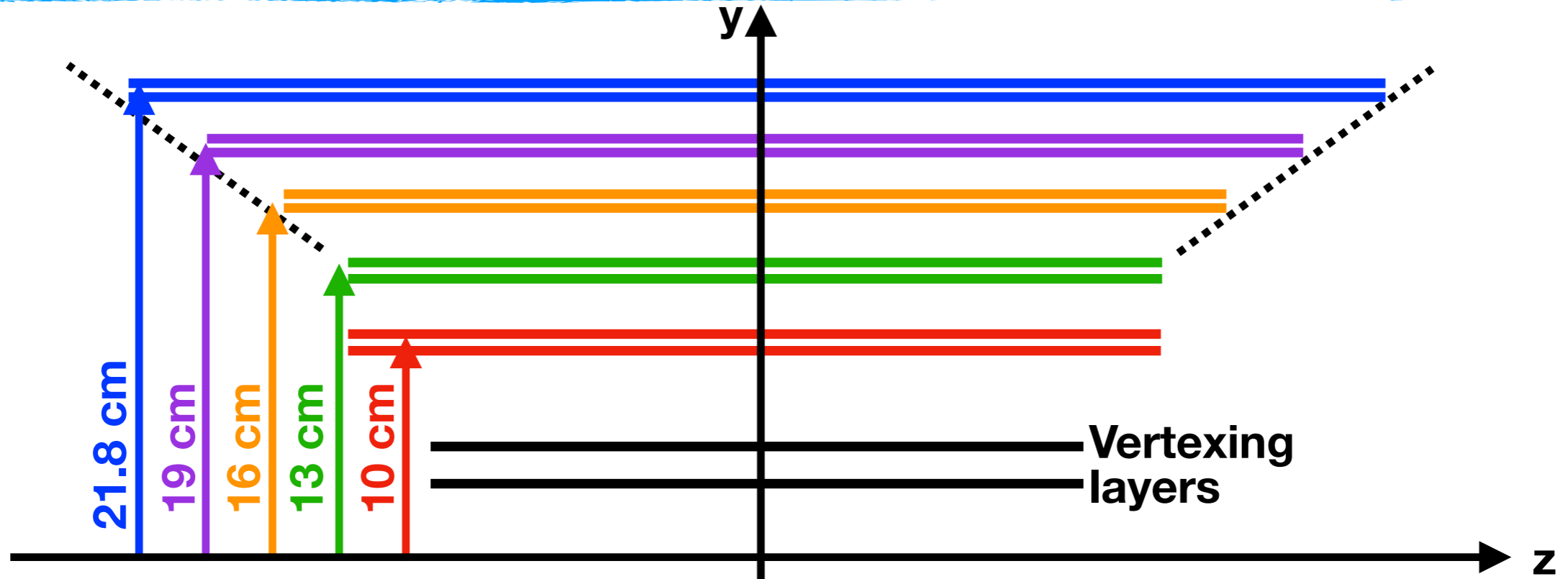
# Momentum resolution impact



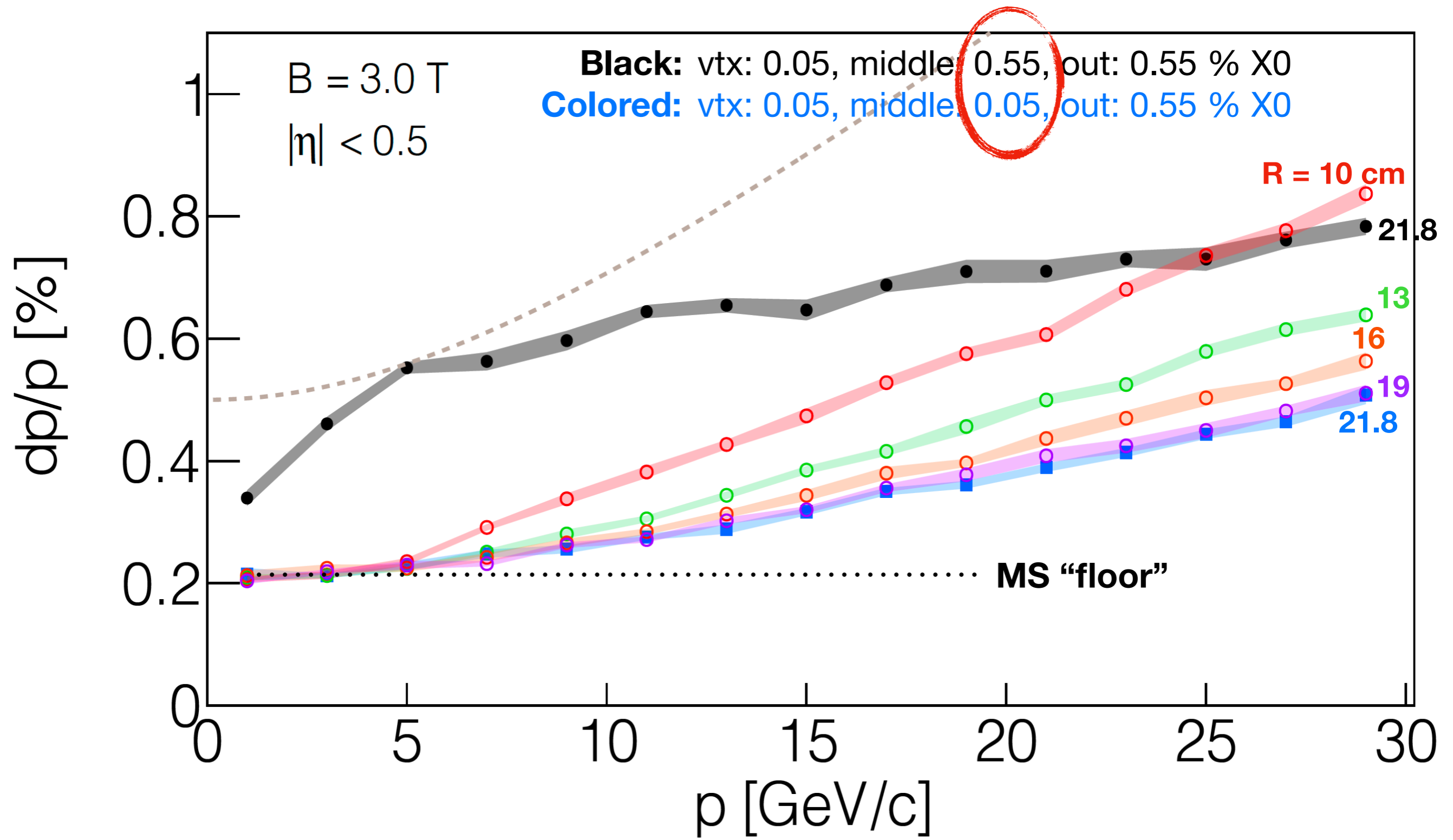
# Placement of barrel middle layers



# Placement of barrel middle layers



# Momentum resolution impact



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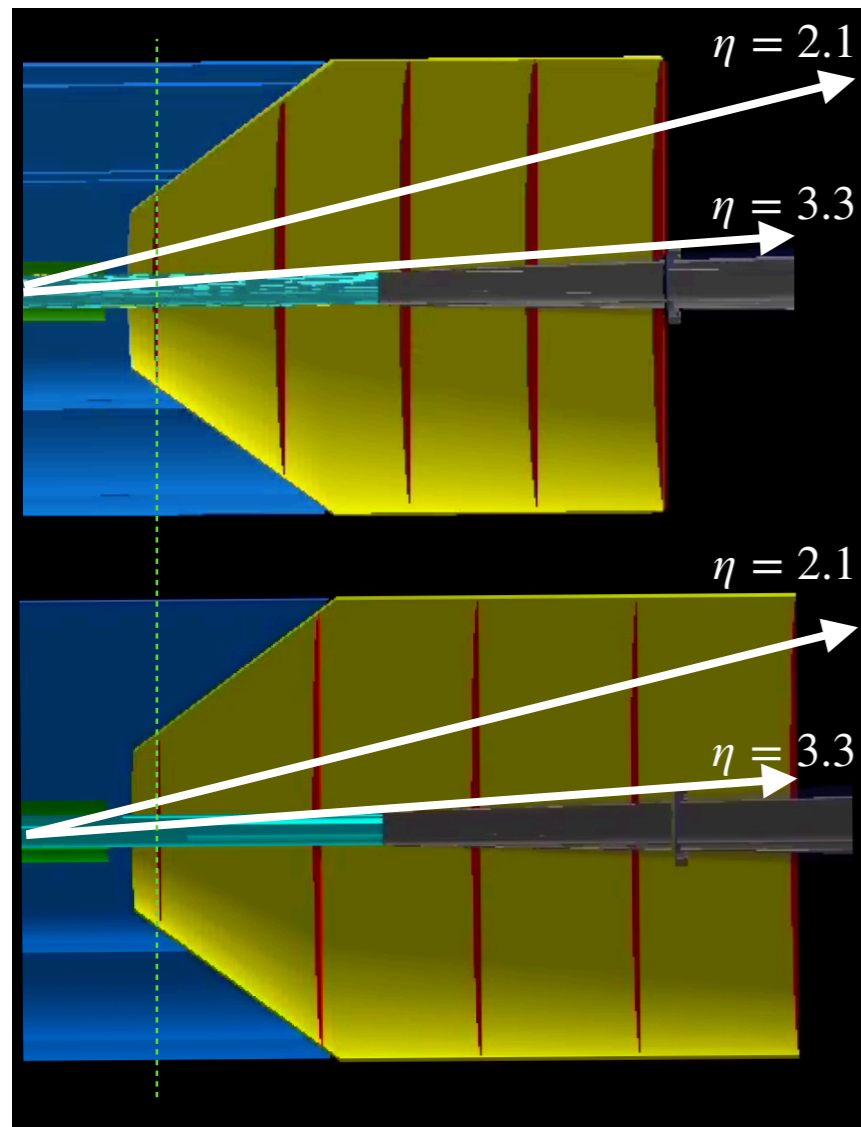
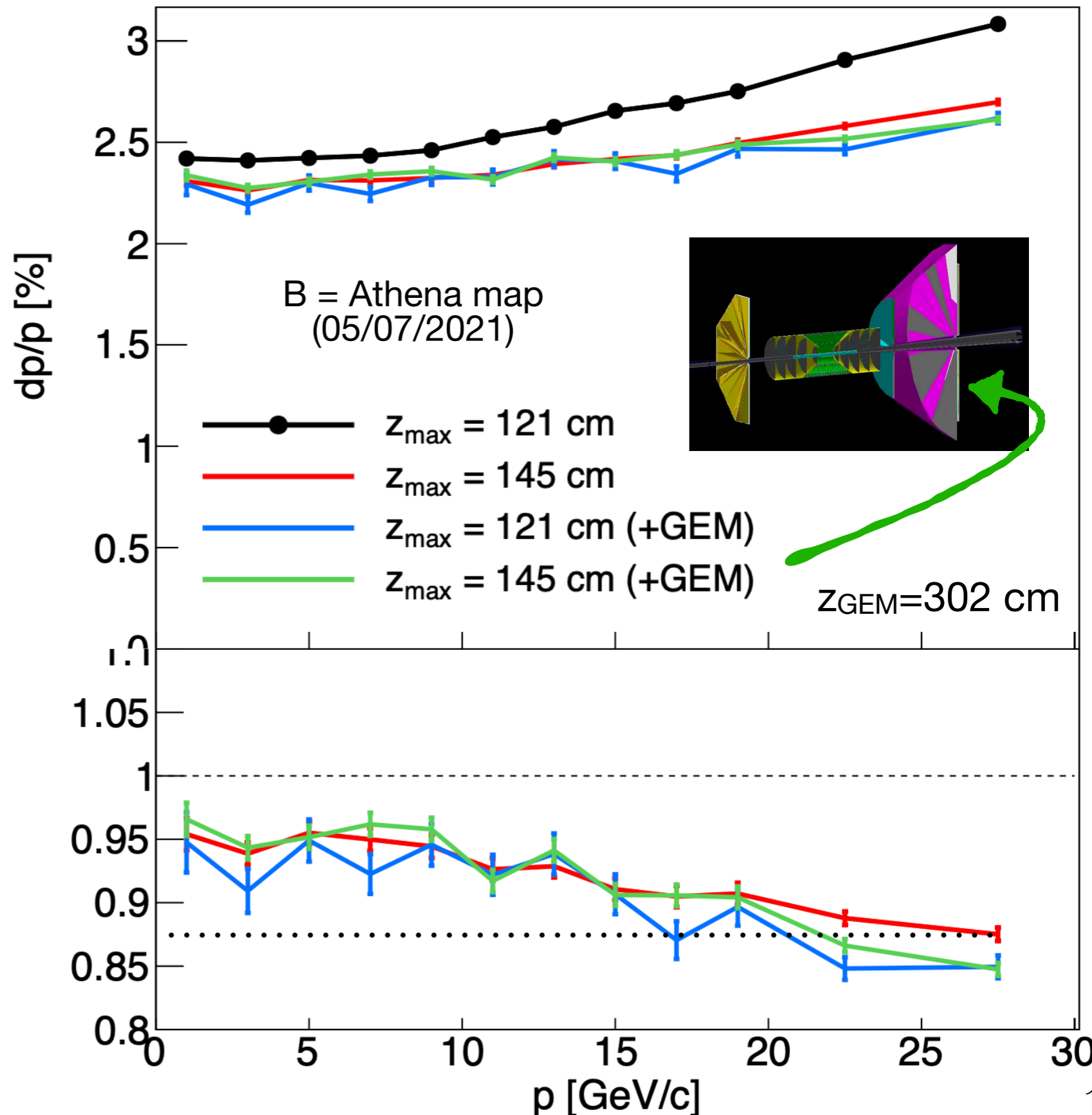
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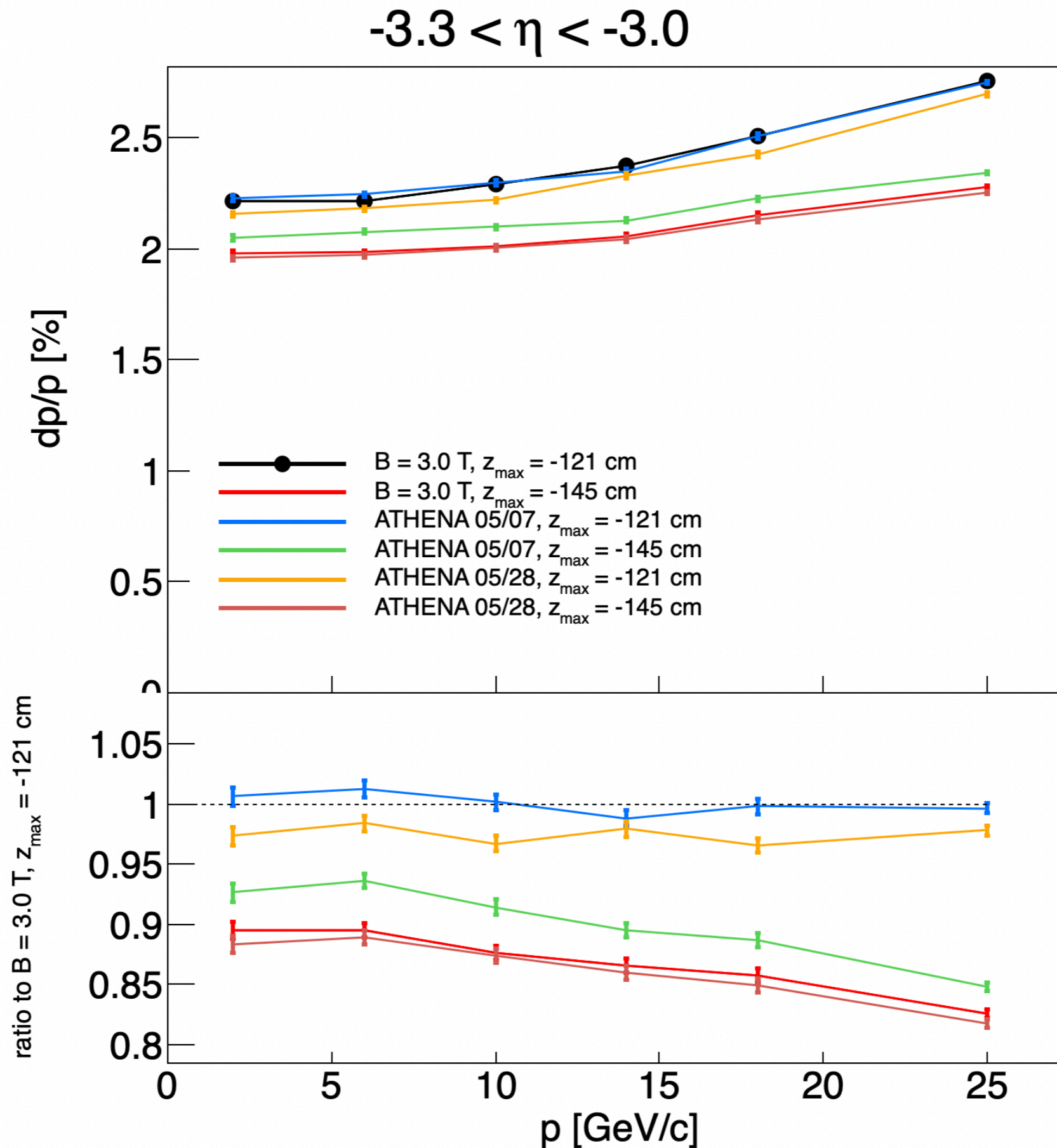
# Extended all-si tracker momentum resolution

$3.0 < \eta < 3.3$

- \* First disk kept at the same position
- \* Last disk moved from 121 to 145 cm
- \* Remaining disks distributed equidistantly in z



# Extended all-si tracker momentum resolution



# Summary

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- ❑ Benchmark figures presented for “baseline 1”
- ❑ Better performance in the barrel region replacing outer two barrel layers with MPGD and using second MPGD behind DIRC
- ❑ Momentum resolution significantly enhanced ( $\sim 50\%$ ) if the ITS3 ultra-thin ( $0.05\%$ ) bent silicon technology is used for the middle (Sagitta) barrel layers.
- ❑ The radius (and thus the length in  $z$ ) can be reduced significantly (from  $r_s \approx 22$  cm down to  $r_s \approx 13$  cm) while still achieving a momentum resolution better than those obtained with the baseline configuration over the entire kinematical range studied.
- ❑ Don't know yet the cost impact from these changes.
- ❑ Extending the all-silicon tracker from  $z = 121$  cm to  $z = 145$  cm improves the high- $\eta$  momentum resolution from  $\sim$  a few % (lower momentum end) to  $\sim 10\%$  (higher momentum end).
- ❑ This improved performance is consistent with the all-silicon tracker + GEM (behind RICH) configuration.
- ❑ Only considered momentum resolution in these studies. Other performance quantities (e.g. efficiencies) need to be checked as well.