Azimuthal asymmetry of the hadron endcap tracker performance

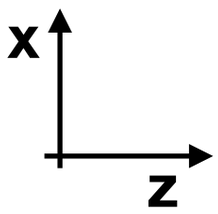
Rey Cruz-Torres

EIC Integration / Complementarity WG meeting

10/21/2020

Momentum Determination (charged particles)

- Momentum is measured by tracking particles traversing a magnetic field



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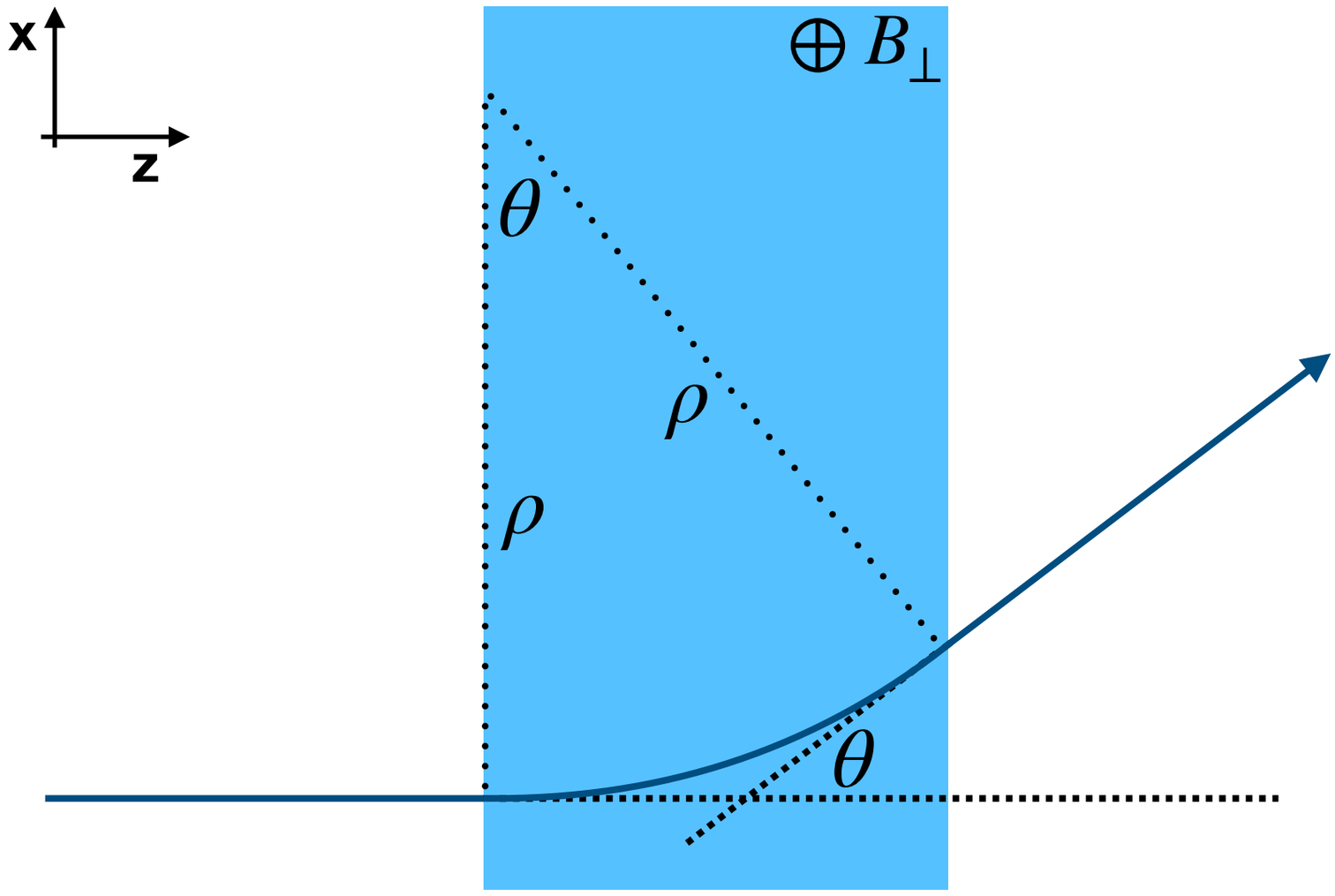

$$m\frac{v^2}{\rho} = evB_\perp$$

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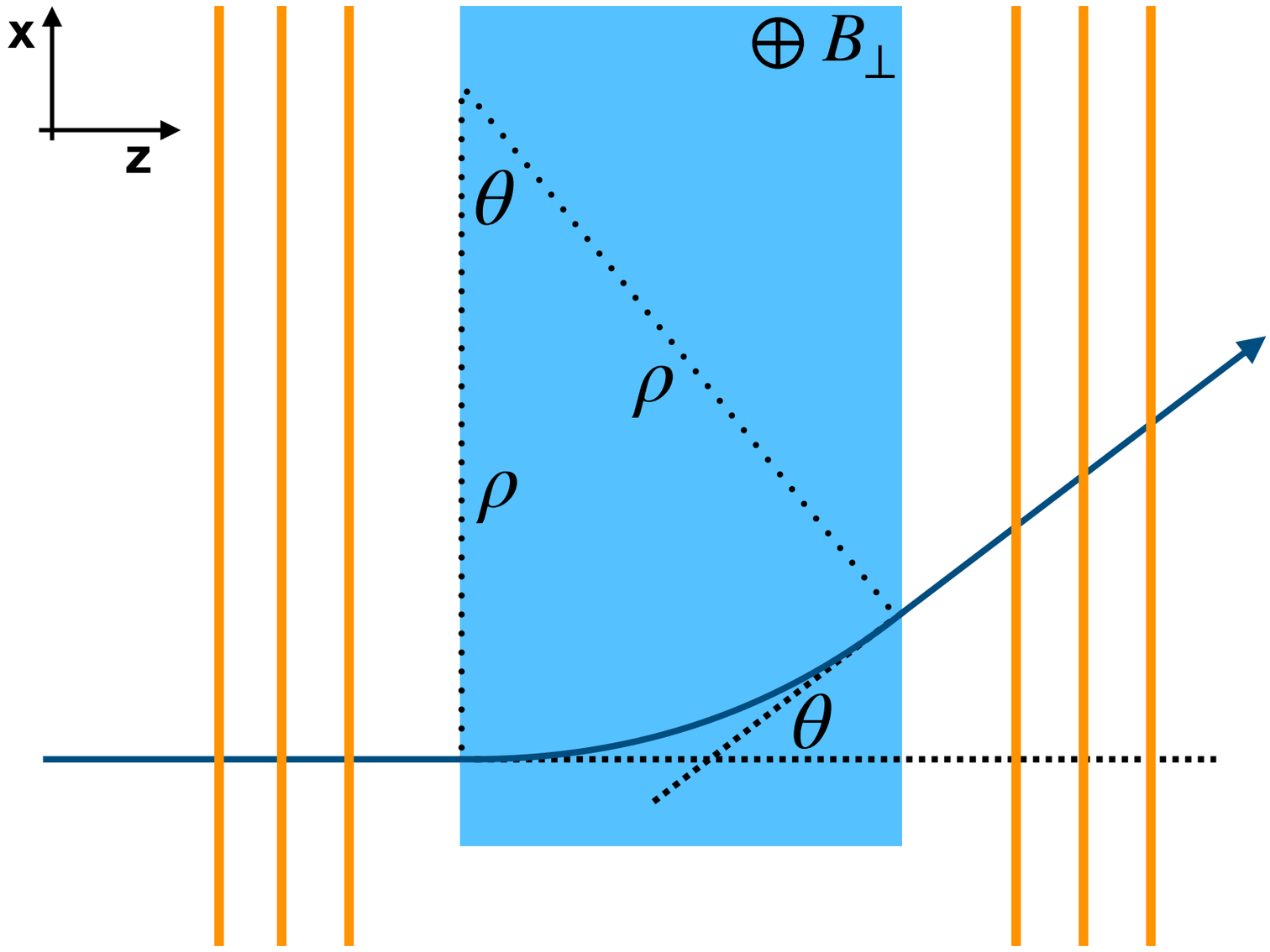

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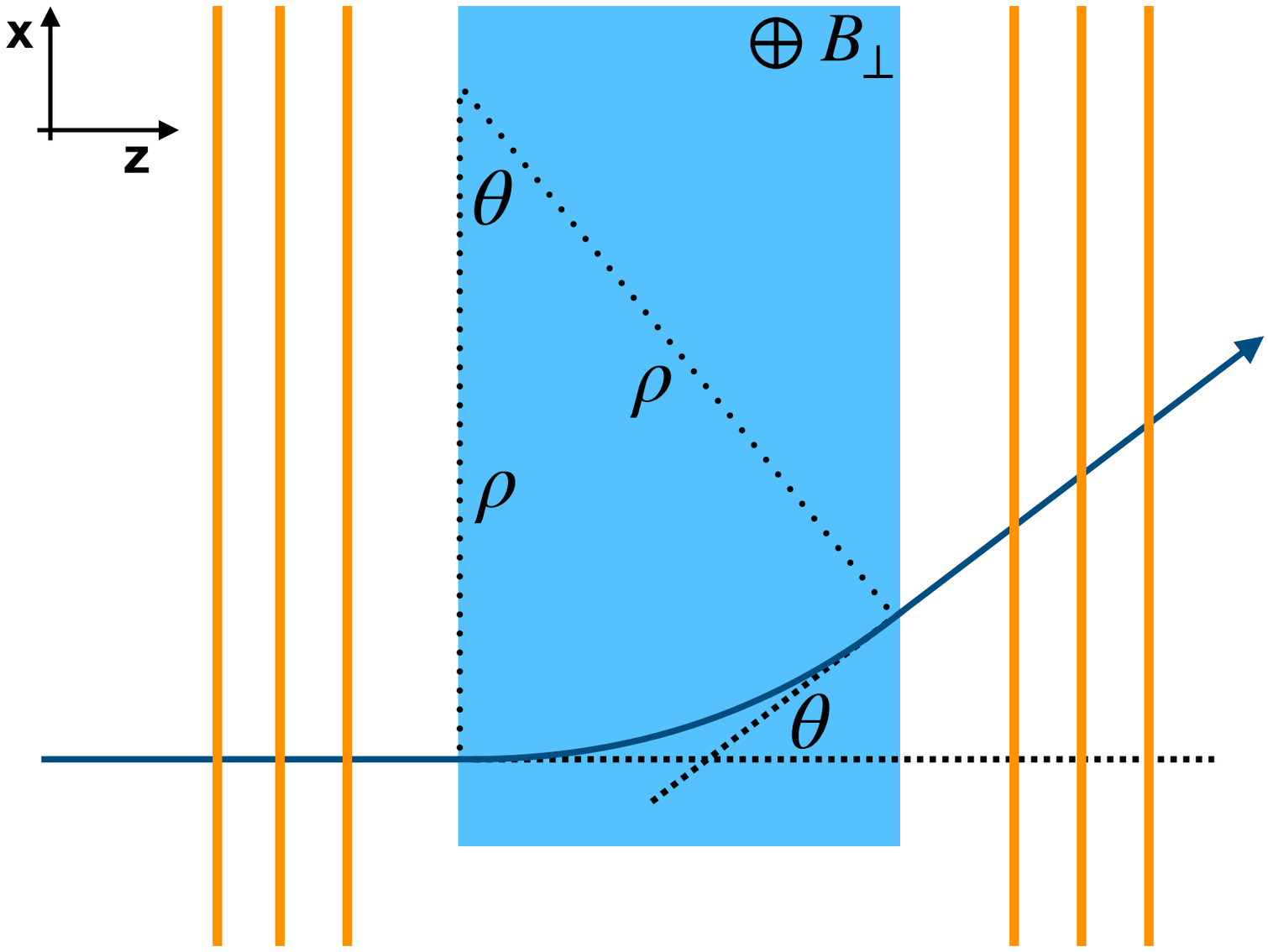


$$m\frac{v^2}{\rho} = evB_\perp$$

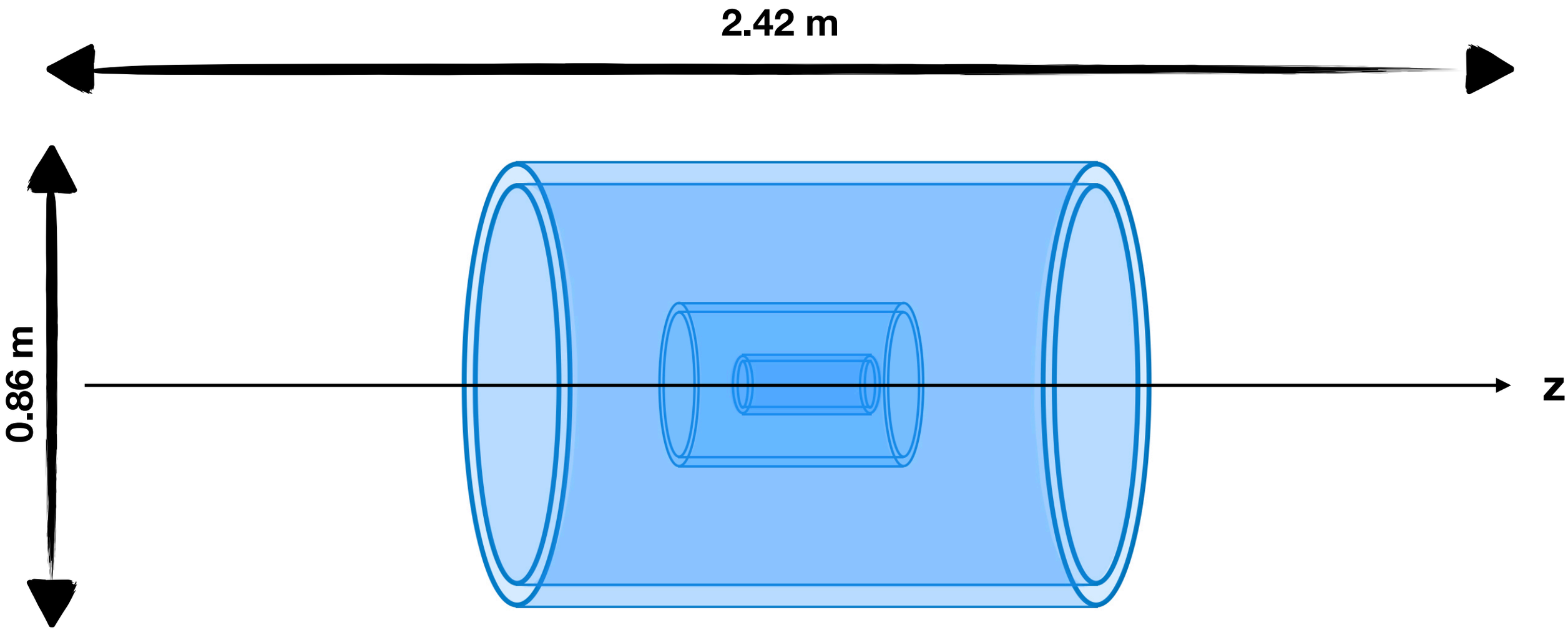
$$p = \rho eB_\perp$$

Bending provided by the B-field component perpendicular to the particle momentum

More bending ($\int B_\perp \cdot dl$) → better momentum resolution

EIC All-Silicon Tracker Prototype

- Momentum is measured by tracking particles traversing a magnetic field



Barrel

EIC All-Silicon Tracker Prototype

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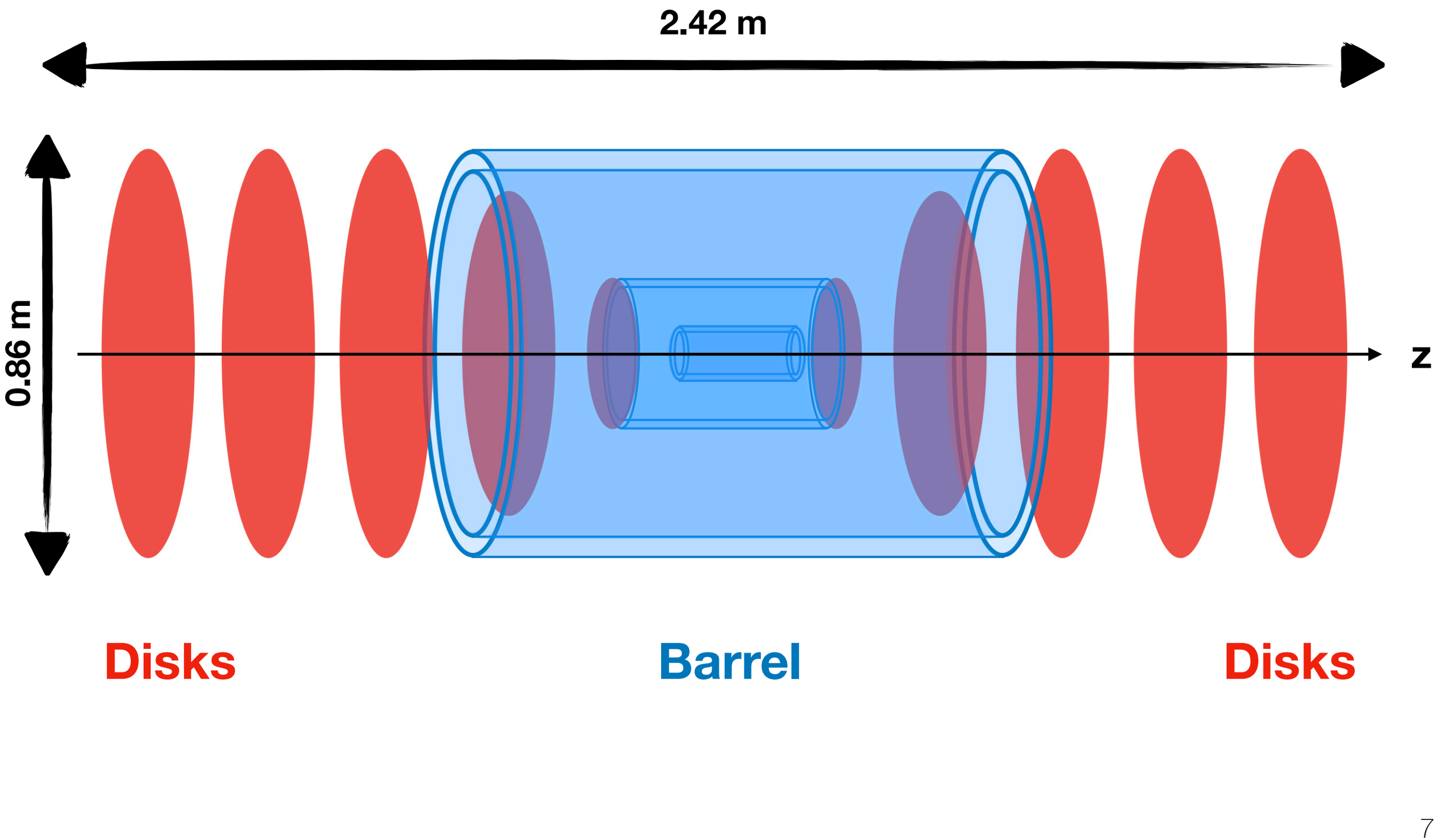

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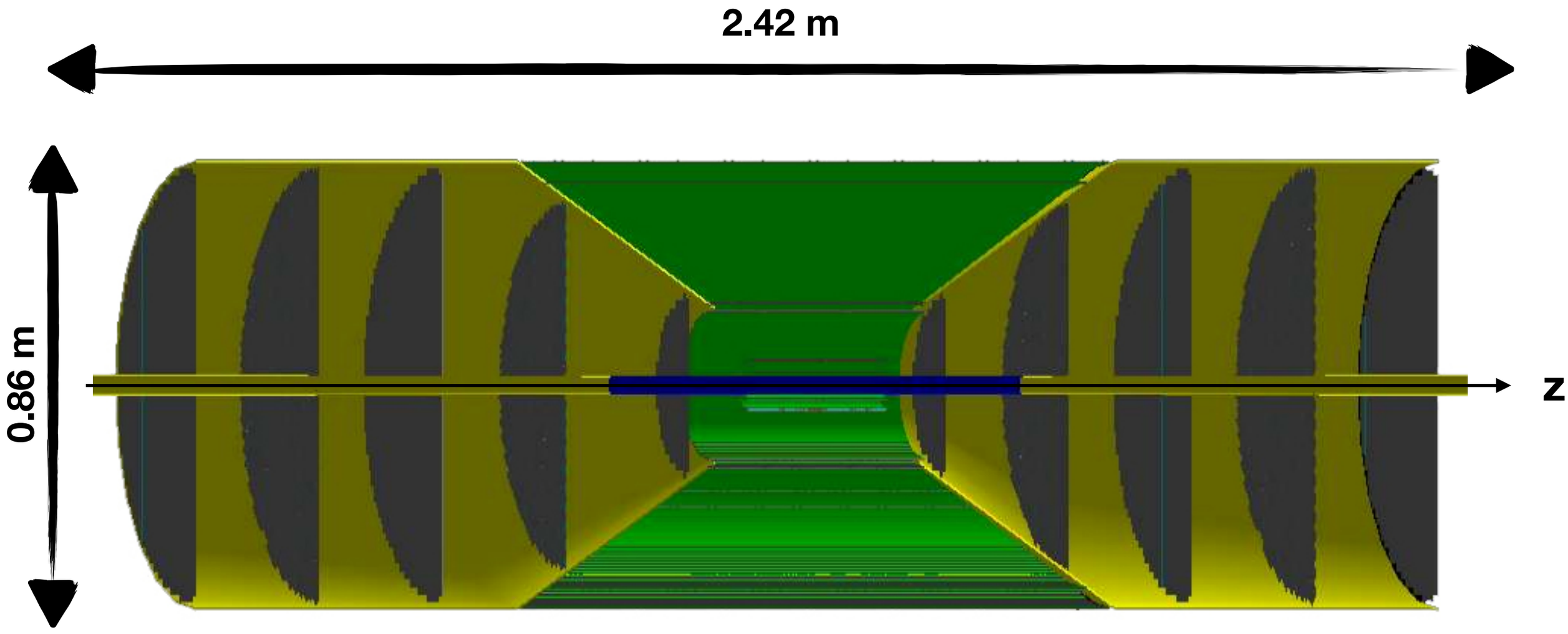


Geant event display

Silicon disks

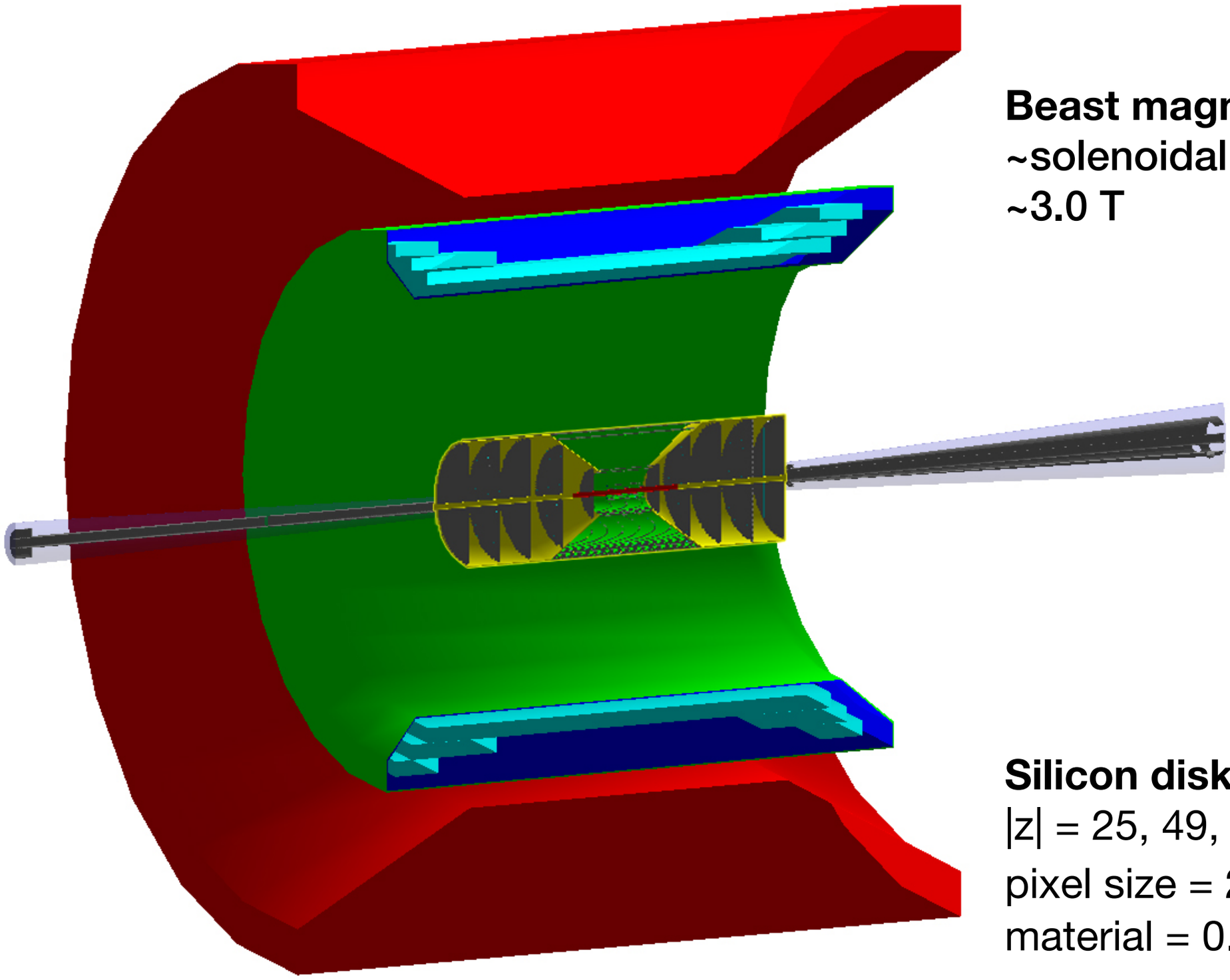
$|z|$ = 25, 49, 73, 97, 121 cm

pixel size = 20 μm

material = 0.3% X/X_0 each

EIC Detector Prototype

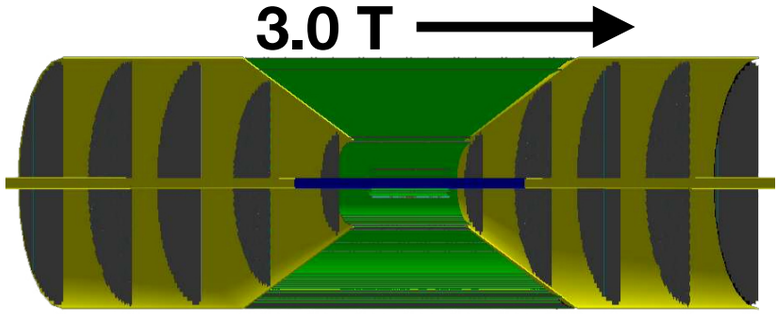
- Momentum is measured by tracking particles traversing a magnetic field

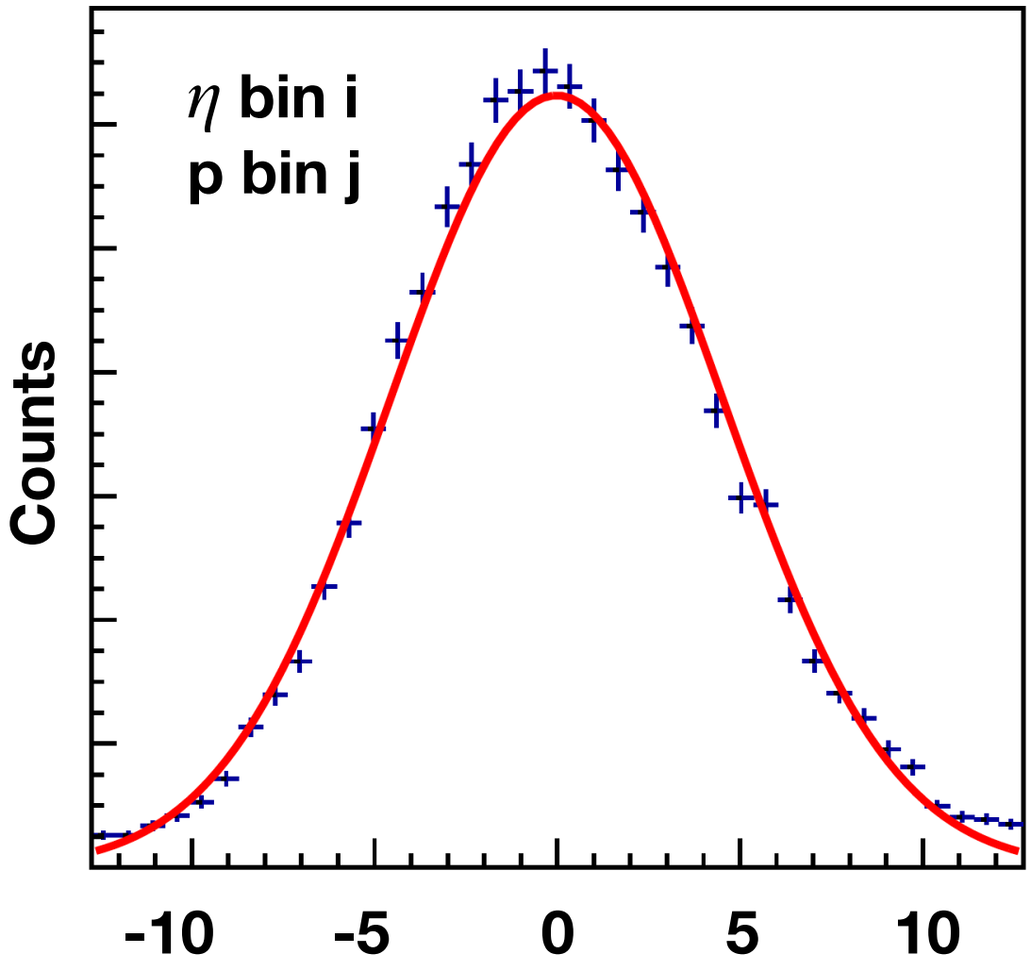


Beast magnet
~solenoidal
~3.0 T

Silicon disks
|z| = 25, 49, 73, 97, 121 cm
pixel size = 20 μm
material = 0.3% X/X_0 each

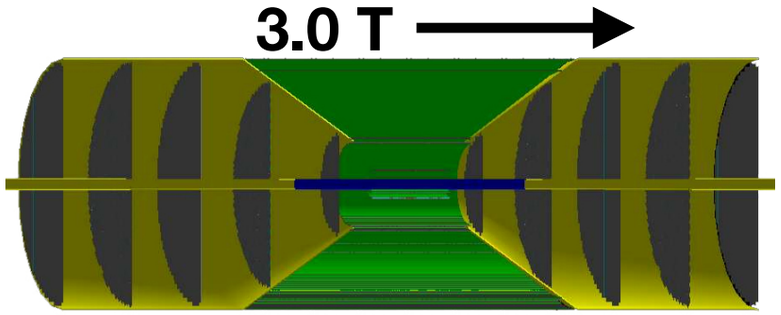
Momentum Resolution Determination

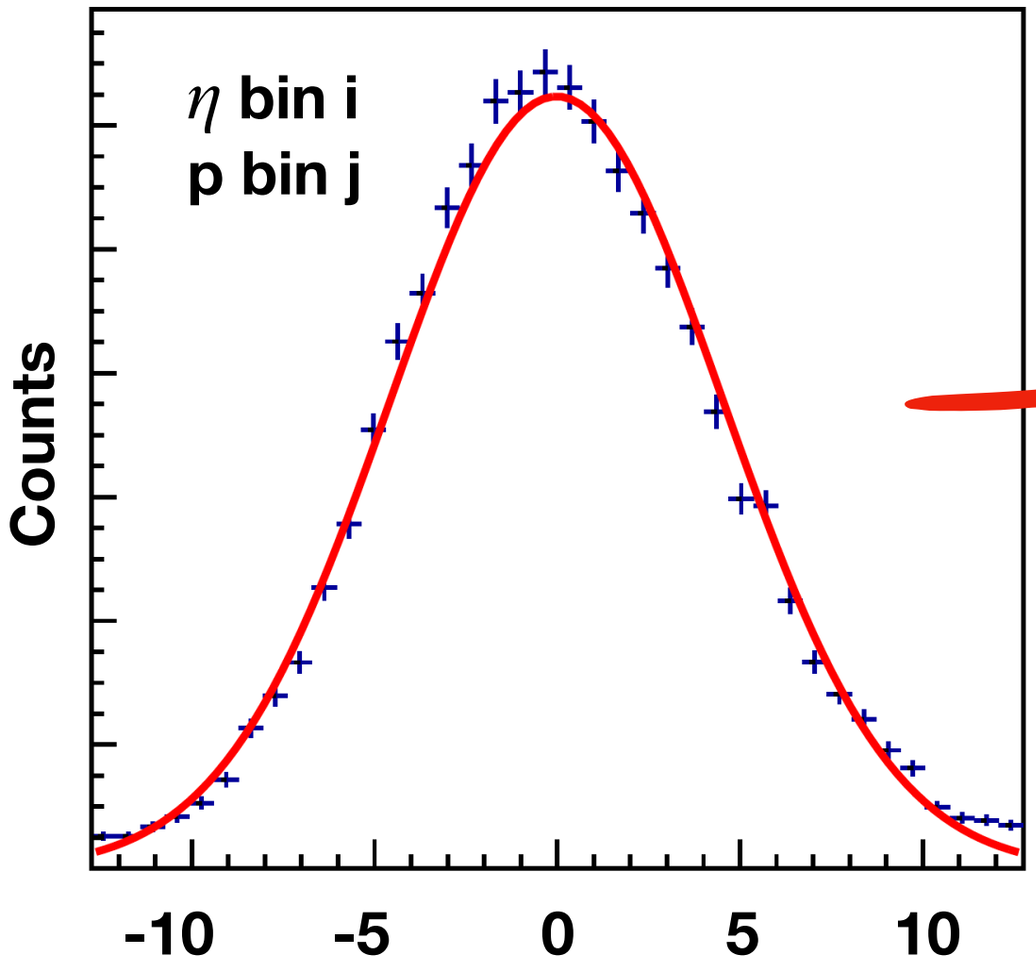




$$\frac{dp}{p} \equiv \frac{p_{reco} - p_{truth}}{p_{truth}} \; [\,\%\,]$$

Momentum Resolution Determination





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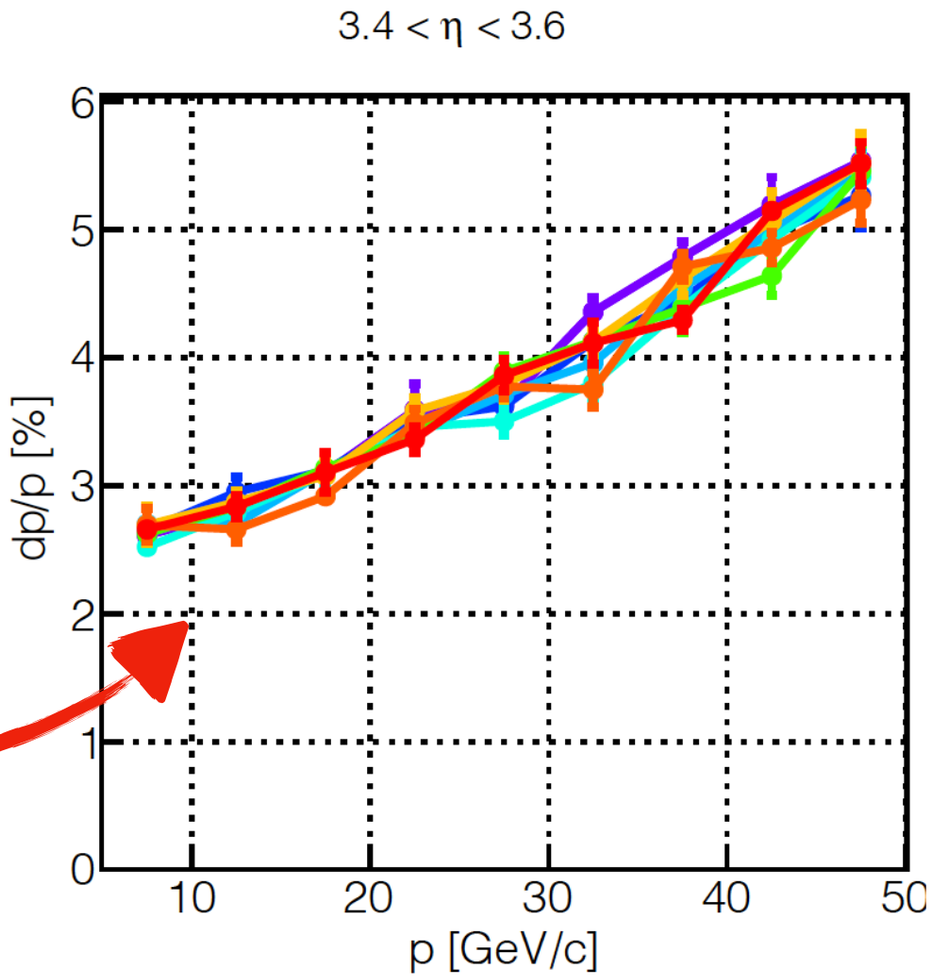
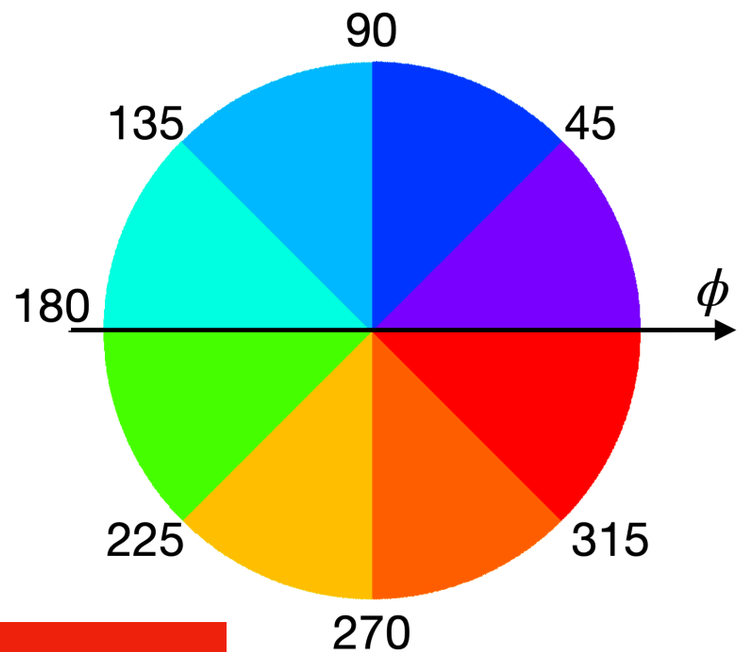
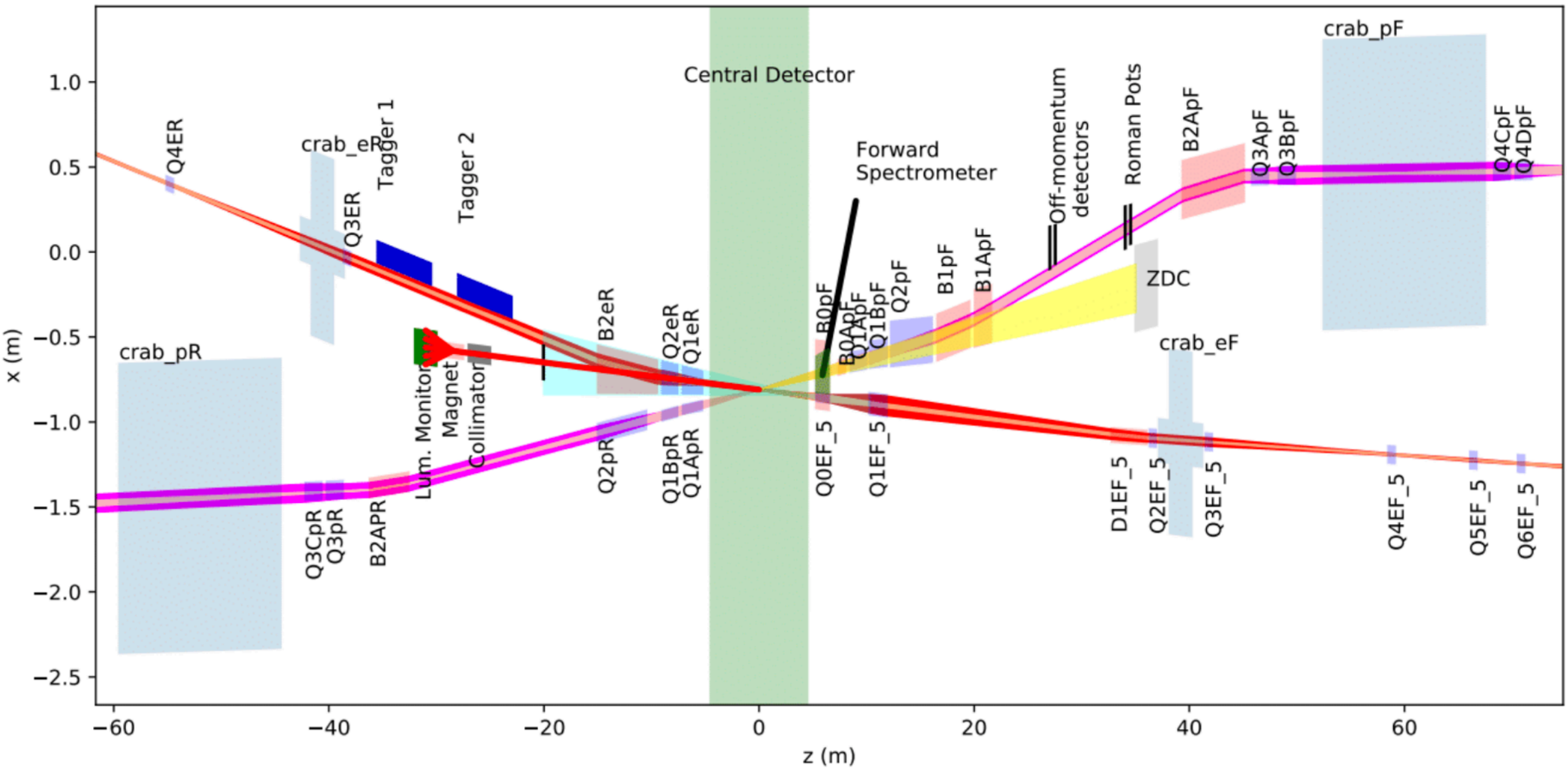


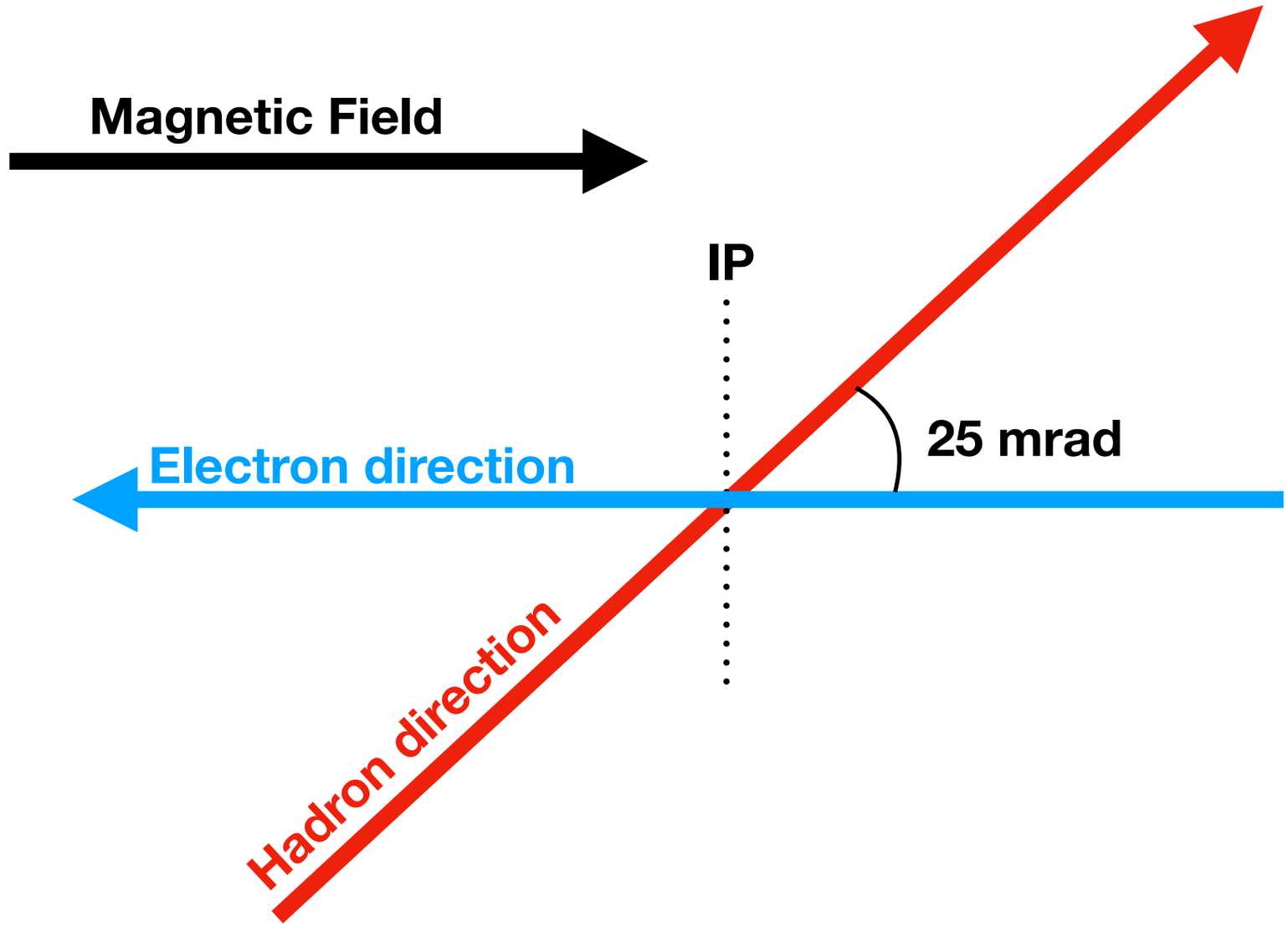


Azimuthally symmetric problem → no phi dependence

Top-down view of the EIC Interaction Region



B field rotated by 25 mrad in hadron-going direction

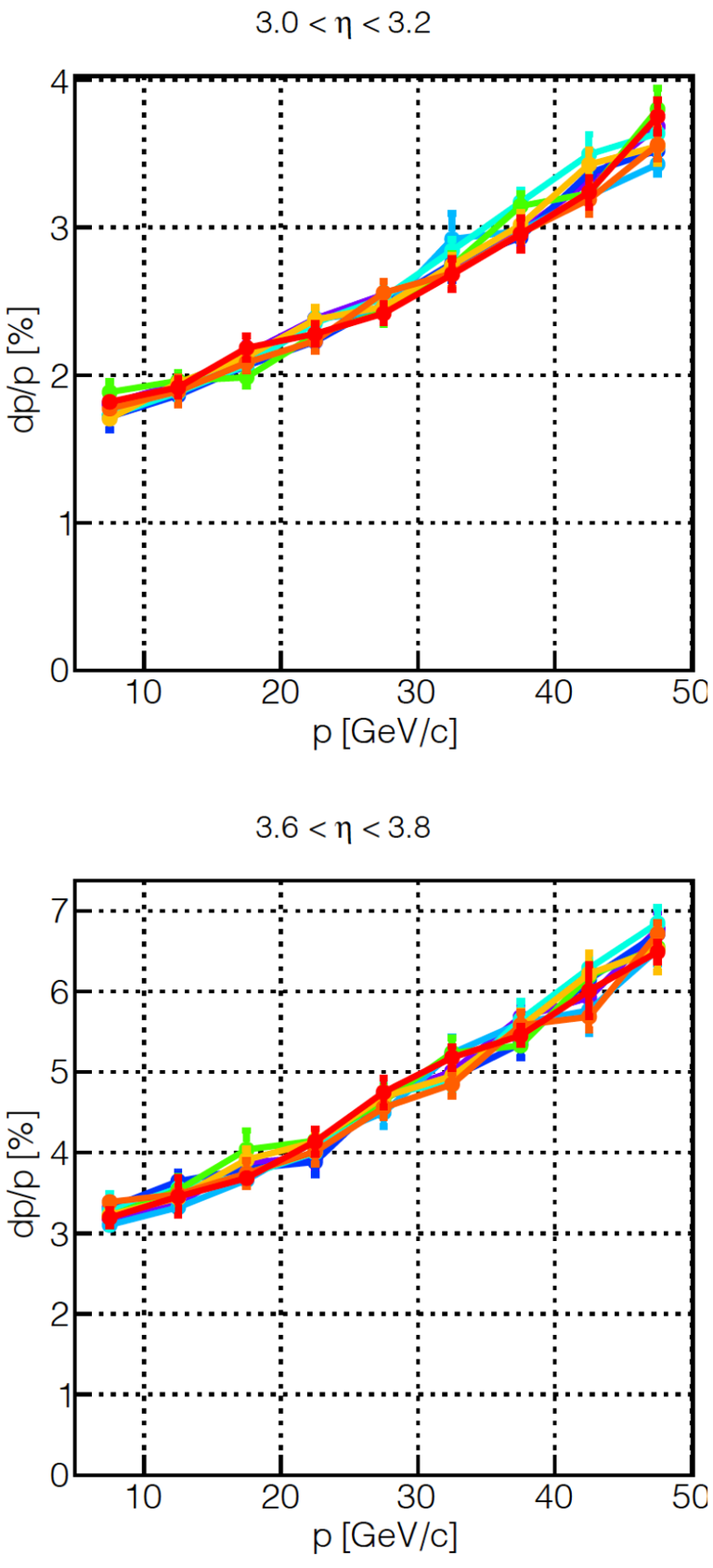


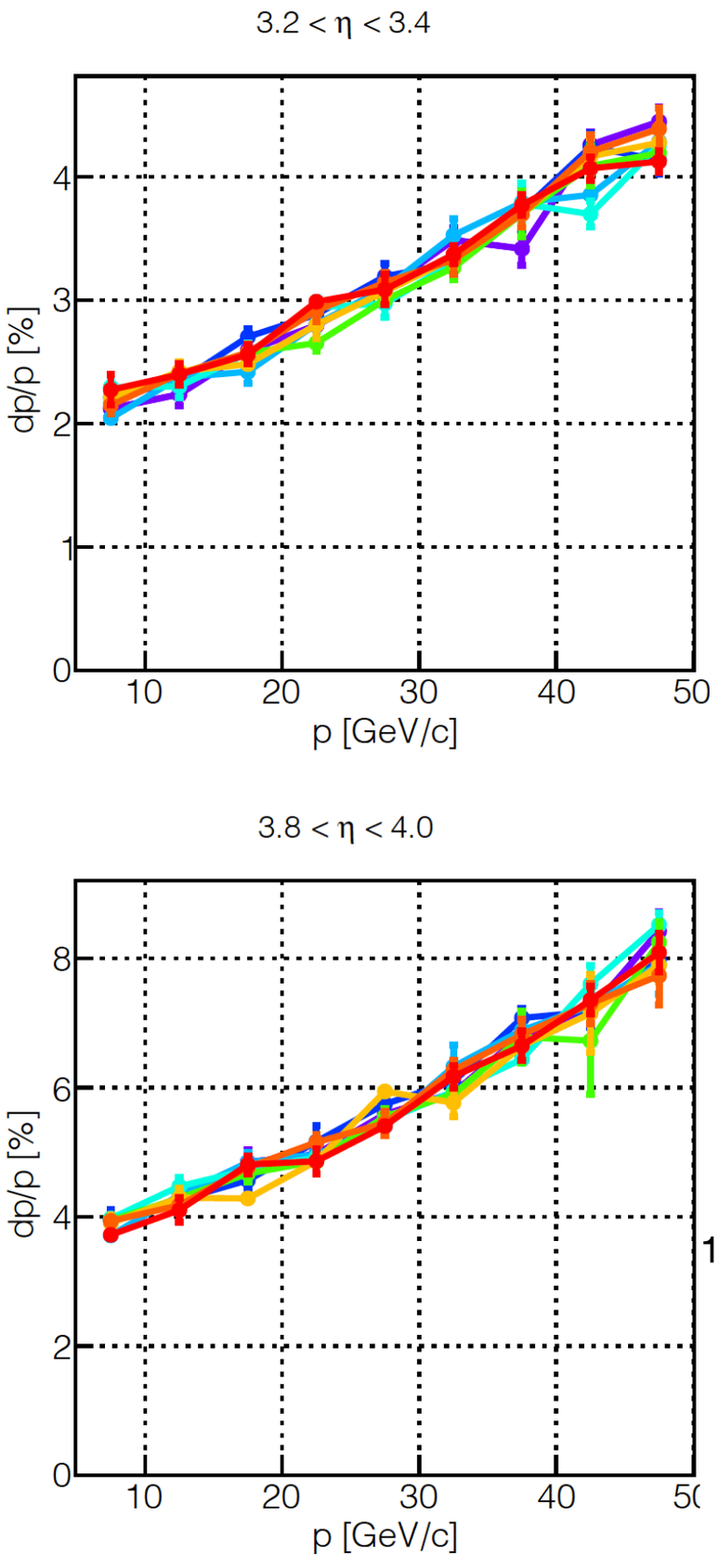
- $\int B \cdot dl$ depends on ϕ

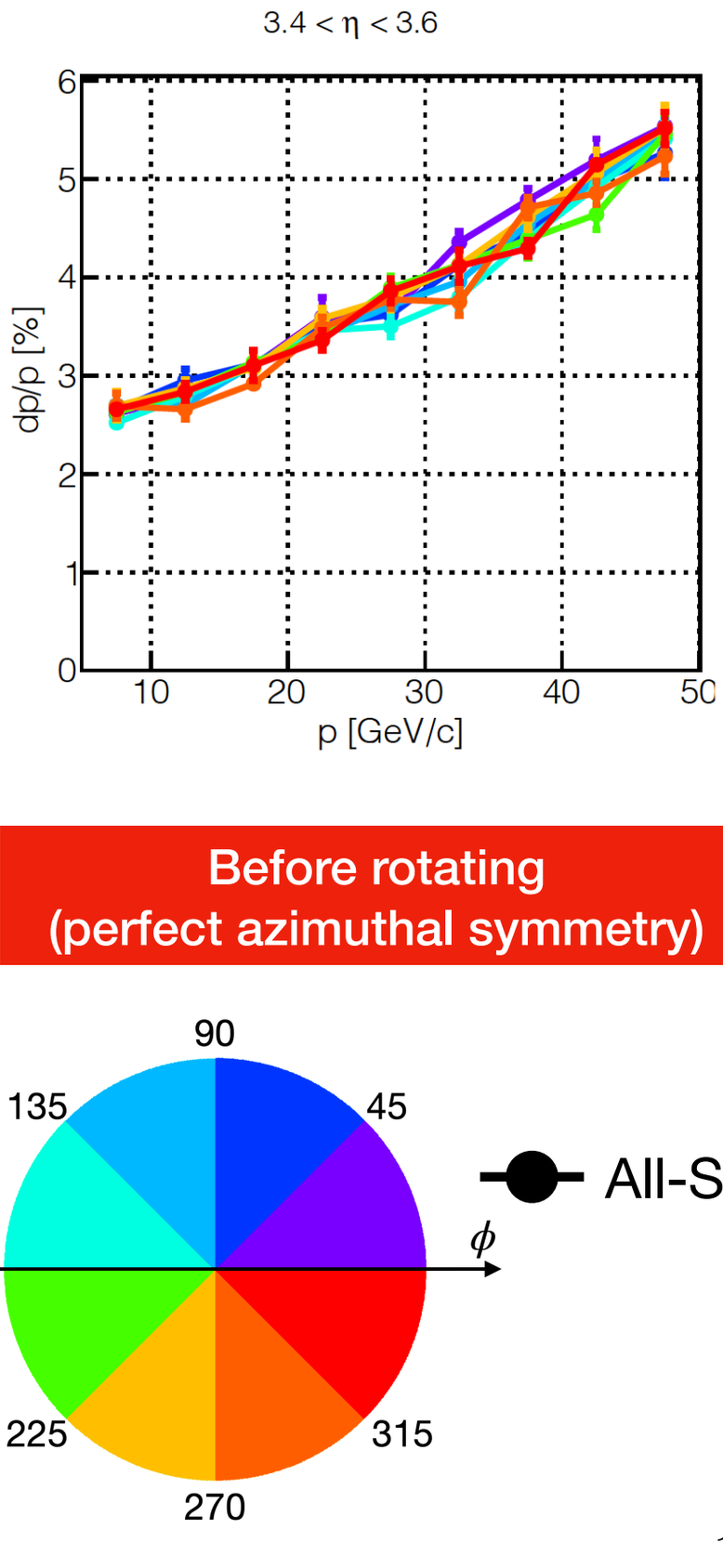
|η|=3.00	|η|=3.50	|η|=4.00	|η|=4.38	|η|=4.50
~99.5 mrad	~60.4 mrad	~36.6 mrad	~25.0 mrad	~22.2 mrad

- Need to assess asymmetry impact on momentum resolution

Momentum resolutions before rotation

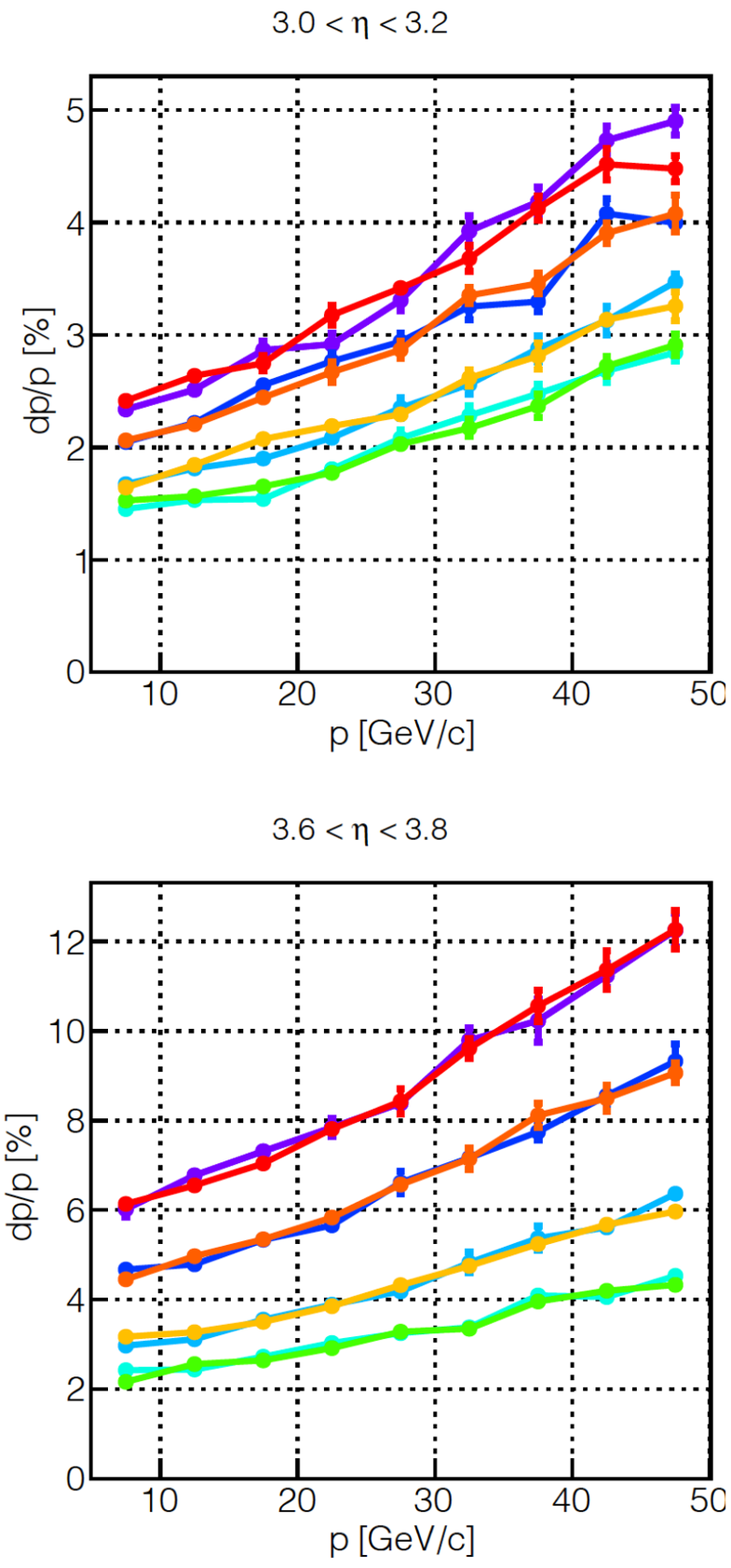


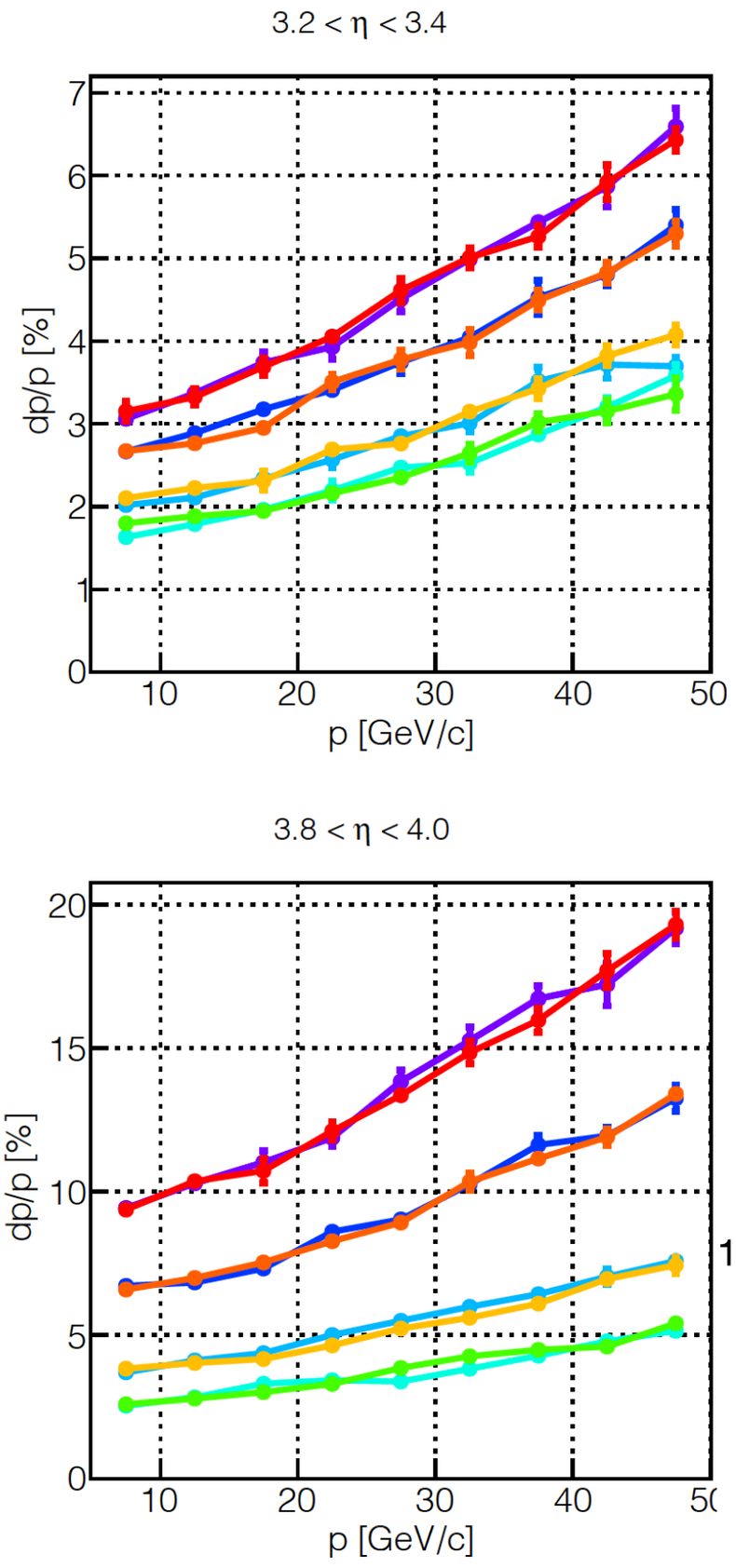


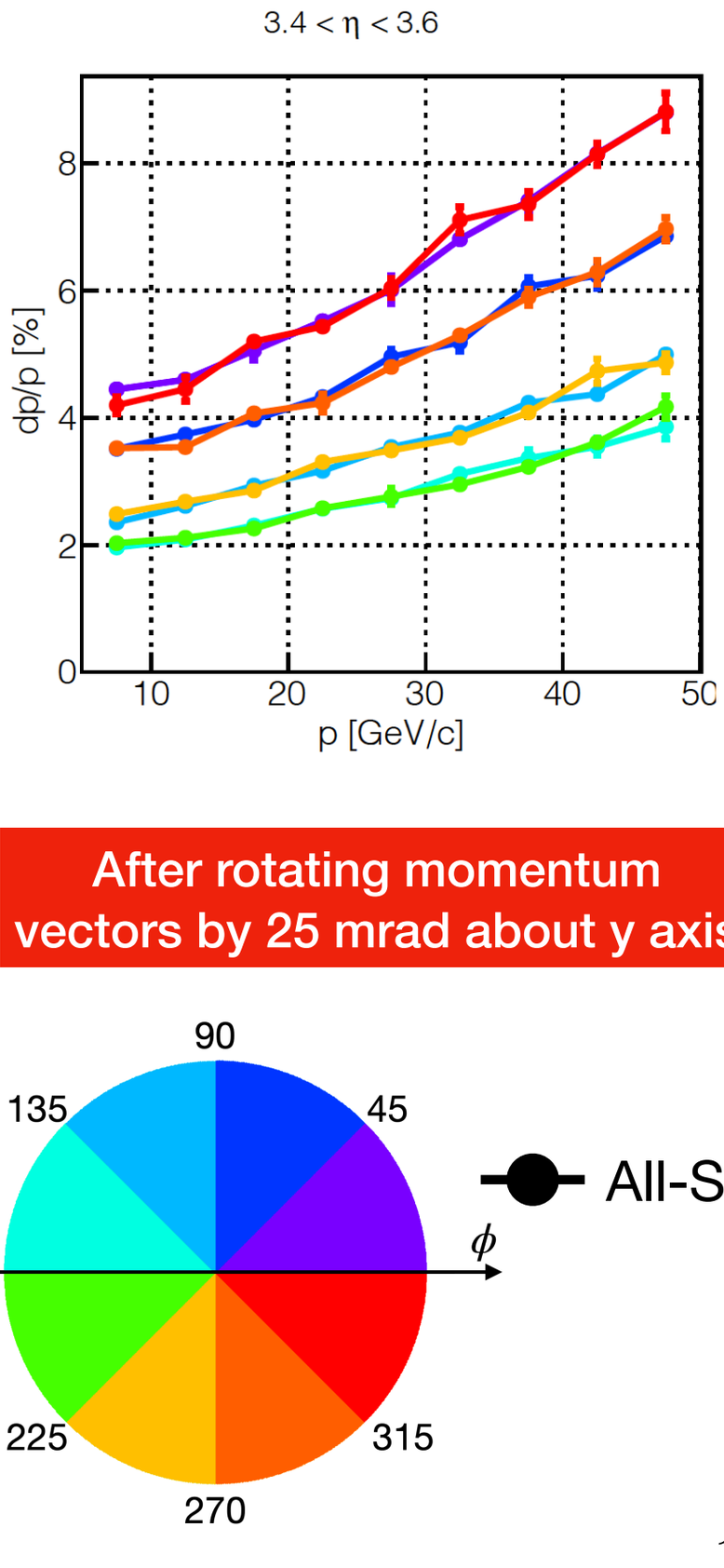


Before rotating (perfect azimuthal symmetry)

Momentum resolutions after rotation

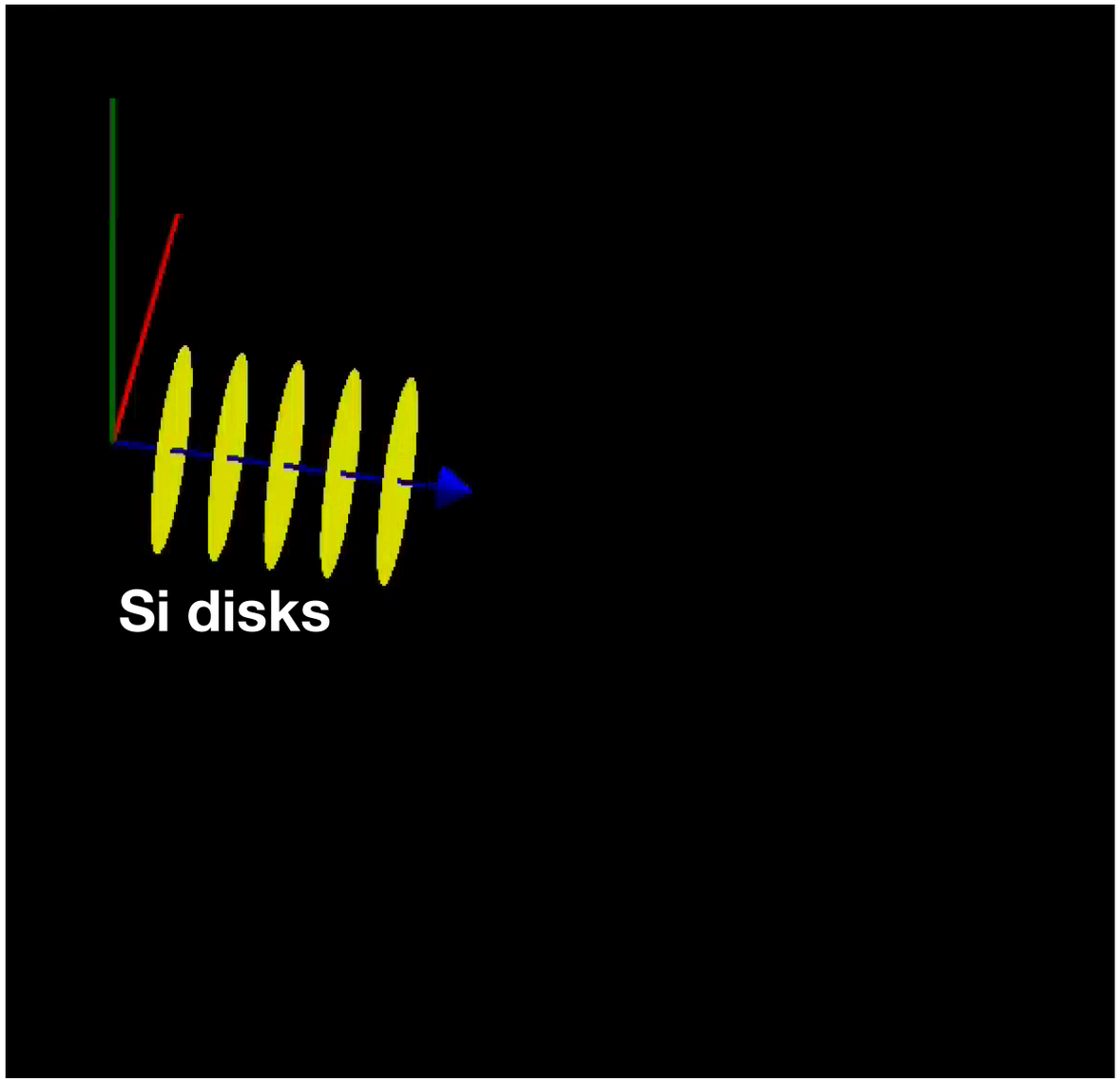






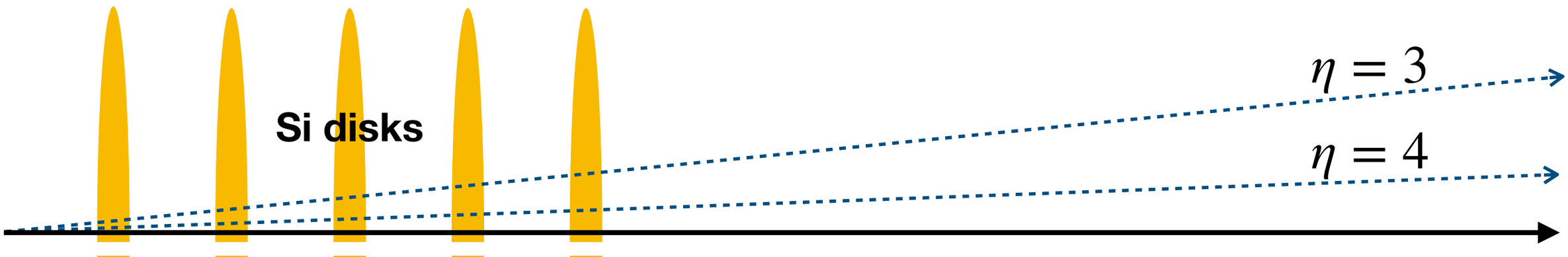
After rotating momentum vectors by 25 mrad about y axis

Detector layout (Si disks)

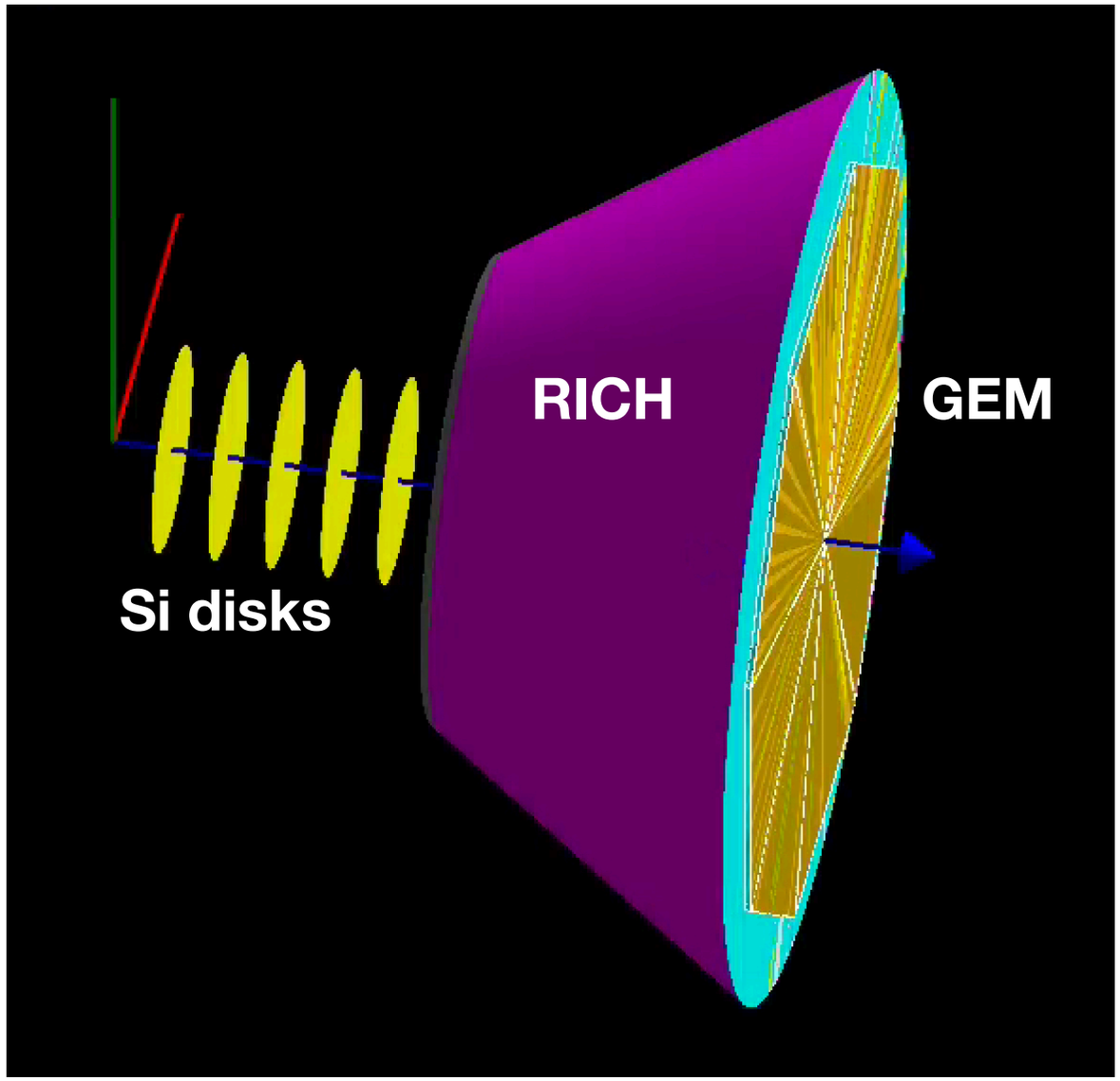


B field: uniform 3.0 T

Silicon disks
z = 25, 49, 73, 97, 121 cm
pixel size = 20 μm
material = 0.3% X/X_0 each



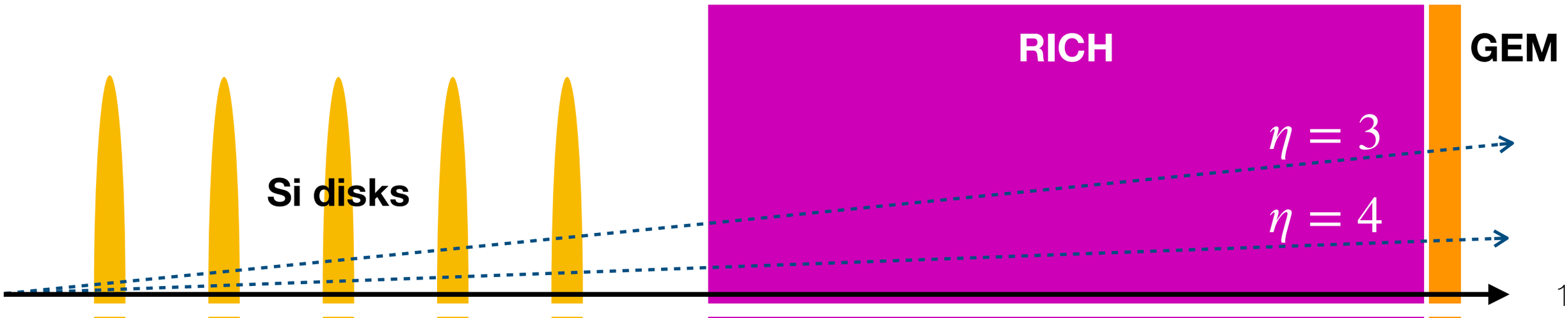
Detector layout (Si disks + GEM)



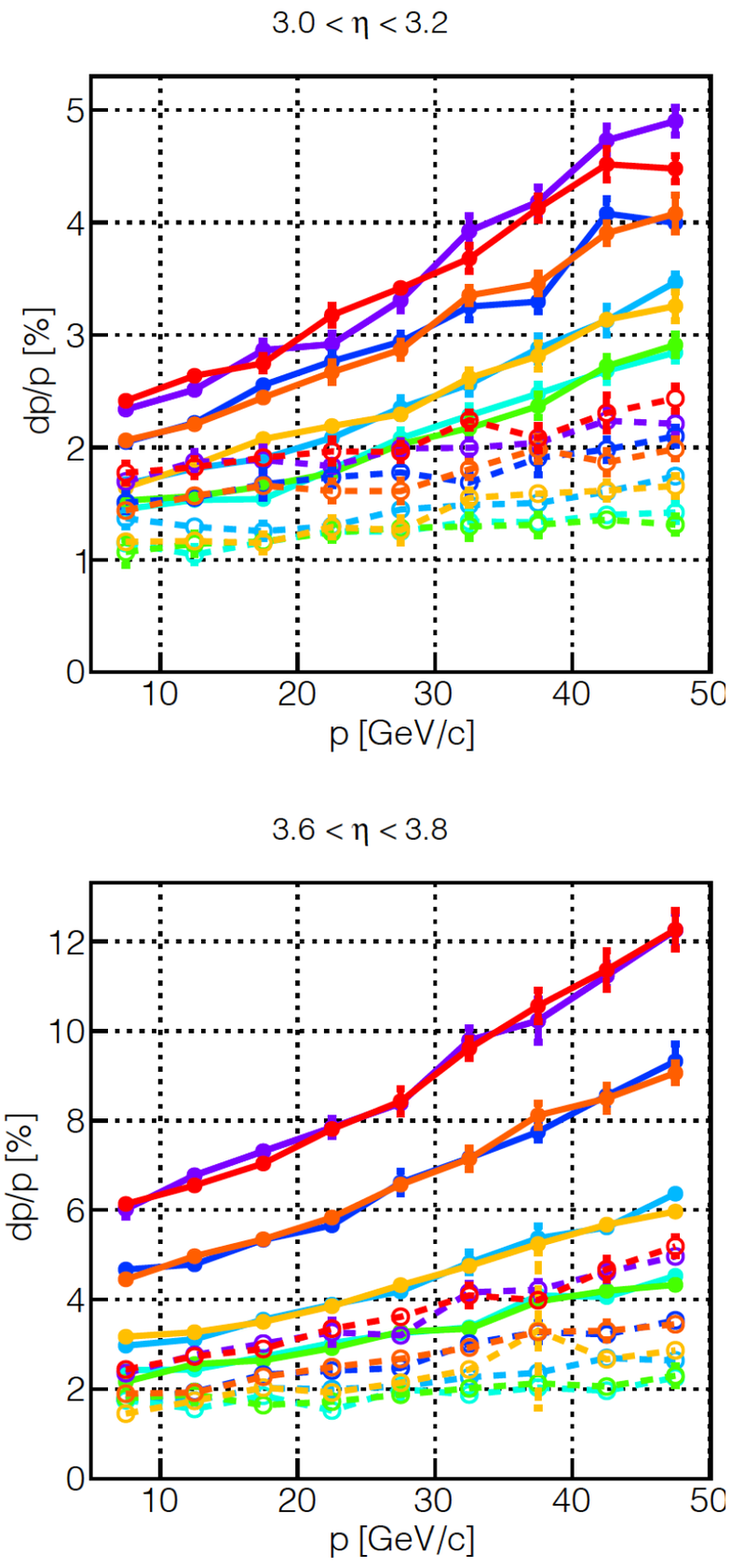
B field: uniform 3.0 T

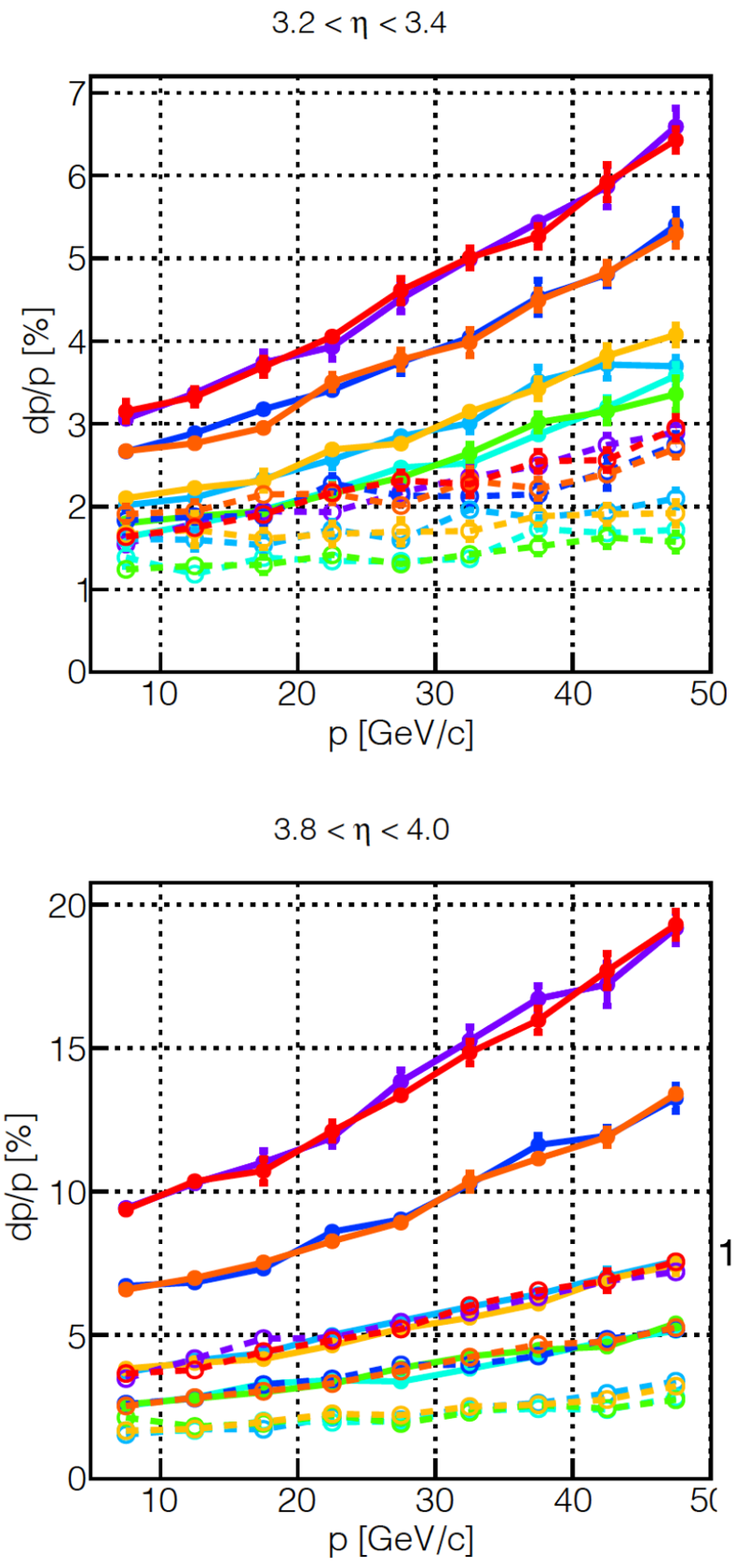
Silicon disks
z = 25, 49, 73, 97, 121 cm
pixel size = 20 μm
material = 0.3% X/X_0 each

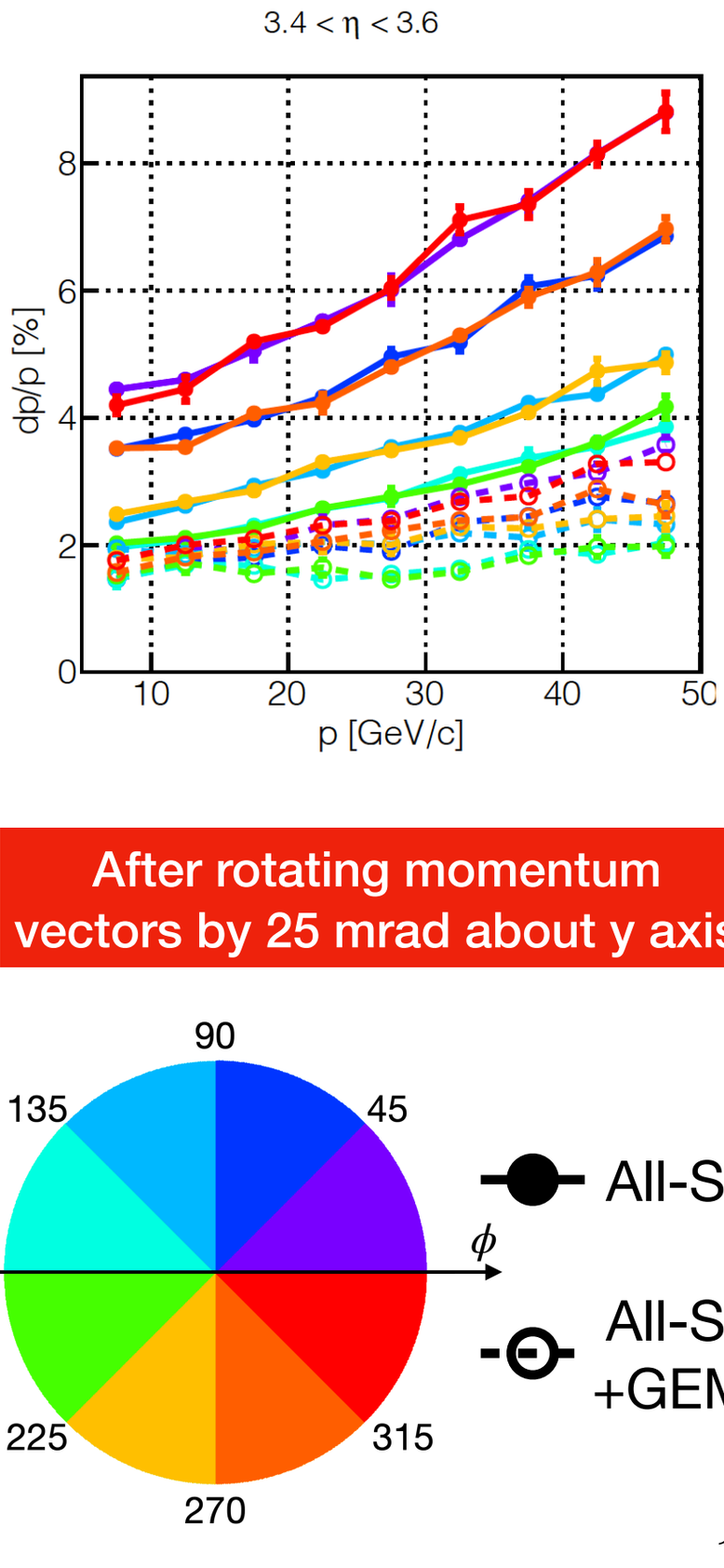
GEM
z position = 300 cm
$\sigma(\hat{r}) = 50\ \mu\text{m}$
$\sigma(\hat{\phi}) = 50\ \mu\text{m}$



Momentum resolutions after rotation







After rotating momentum vectors by 25 mrad about y axis

Summary and Conclusions

- Azimuthal momentum-resolution asymmetry needs to be taken into account in the hadron direction

- Significant momentum-resolution deterioration at higher momenta for $\phi \sim 0$

- Momentum resolution loss may be recoverable with auxiliary tracking*

Backup

Rotation

post-simulation each generated and reconstructed momentum vector is rotated by 25 mrad about the y axis (i.e. on the horizontal plane).