All-Silicon Tracking: Barrel Optimization

Rey Cruz-Torres
UC Consortium for the EIC
10/21/2020

All-Silicon Tracking: Barrel Optimization and Forward Studies

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Outline

- Detector layout and geometry updates

- Detector performance

- Forward studies:
  - Complementing the All-Si tracker with other tracking stations.
  - Azimuthal momentum-resolution asymmetry in forward direction

- Summary and Conclusions

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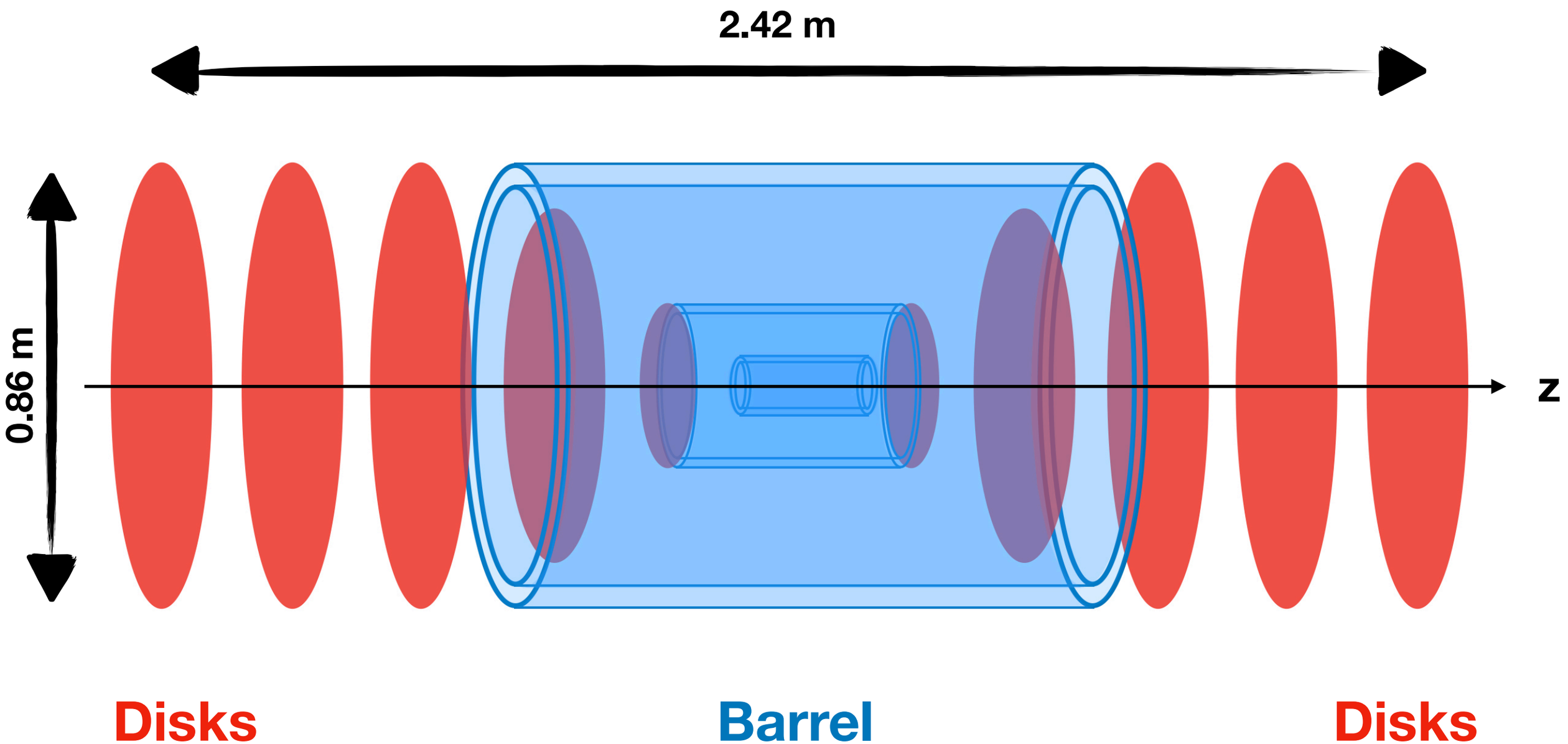
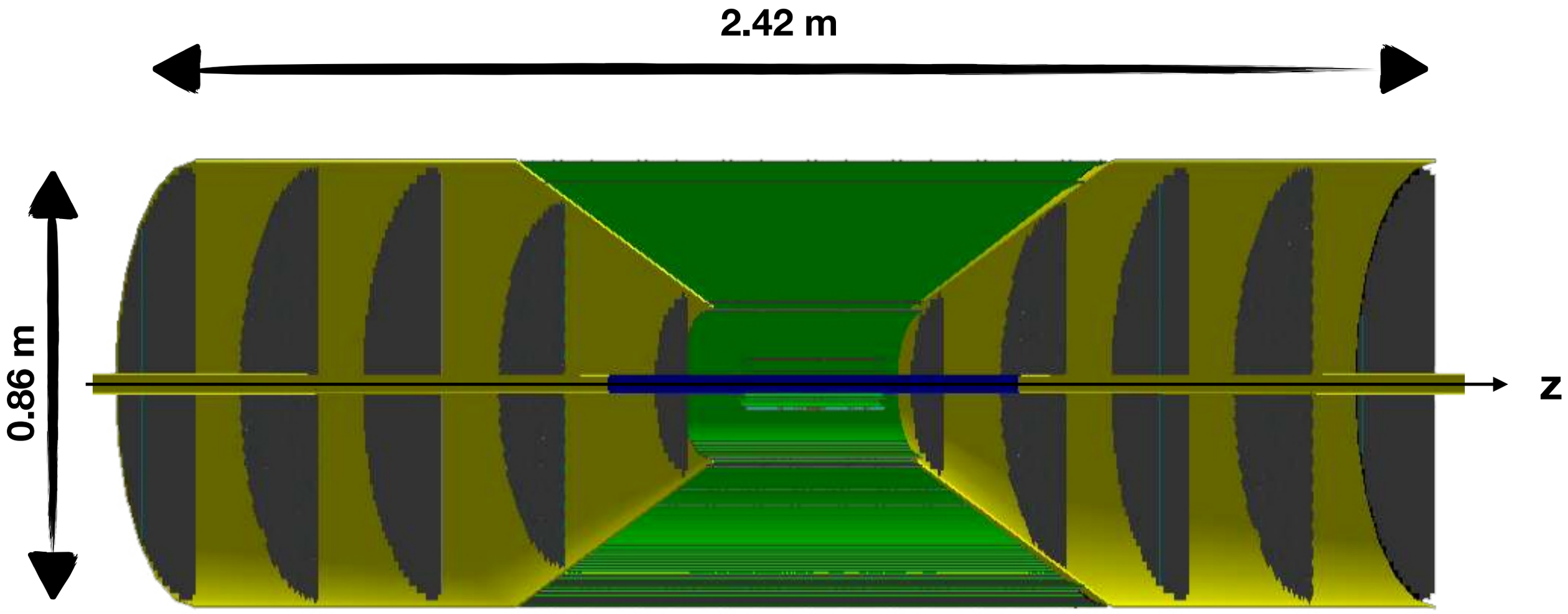
EIC All-Silicon Tracker Prototype



EIC All-Silicon Tracker Prototype

(full) simulations carried out in Fun4All



Support structure **Disks** **Barrel**

*Geometry implemented by Ernst Sichtermann and Yue Shi Lai

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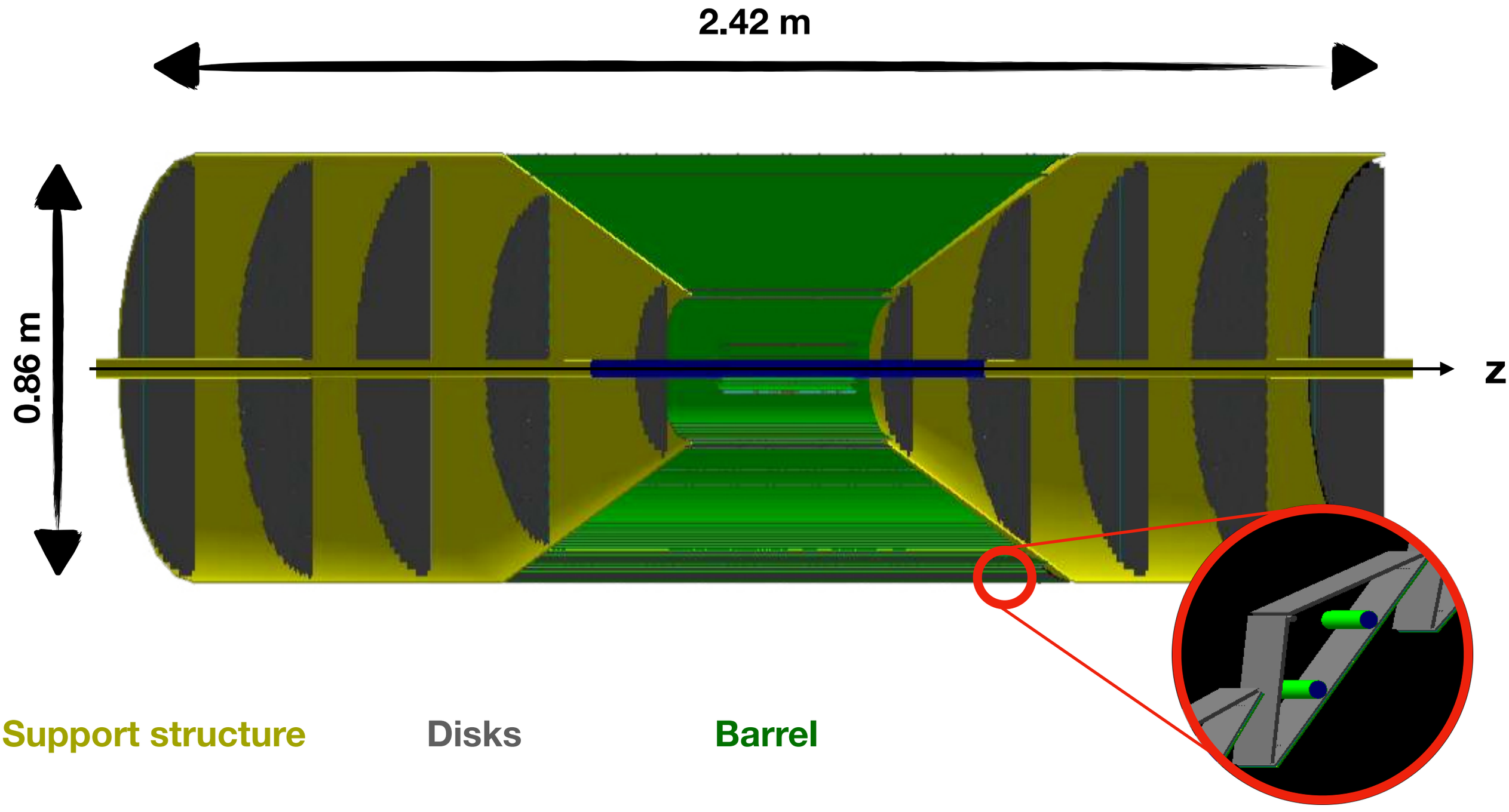
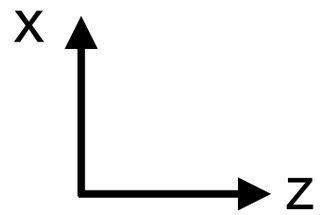


*Geometry implemented by Ernst Sichtermann and Yue Shi Lai

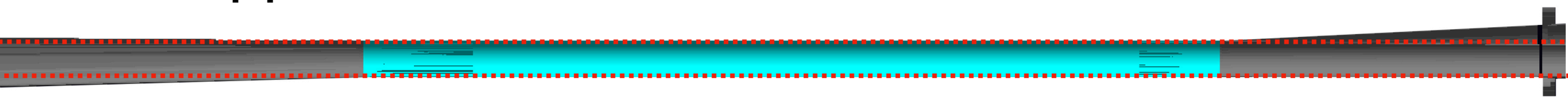
Need for updated detector: larger beampipe

Previous beampipe model

Diameter = 36 mm
Azimuthally symmetric



New beampipe model

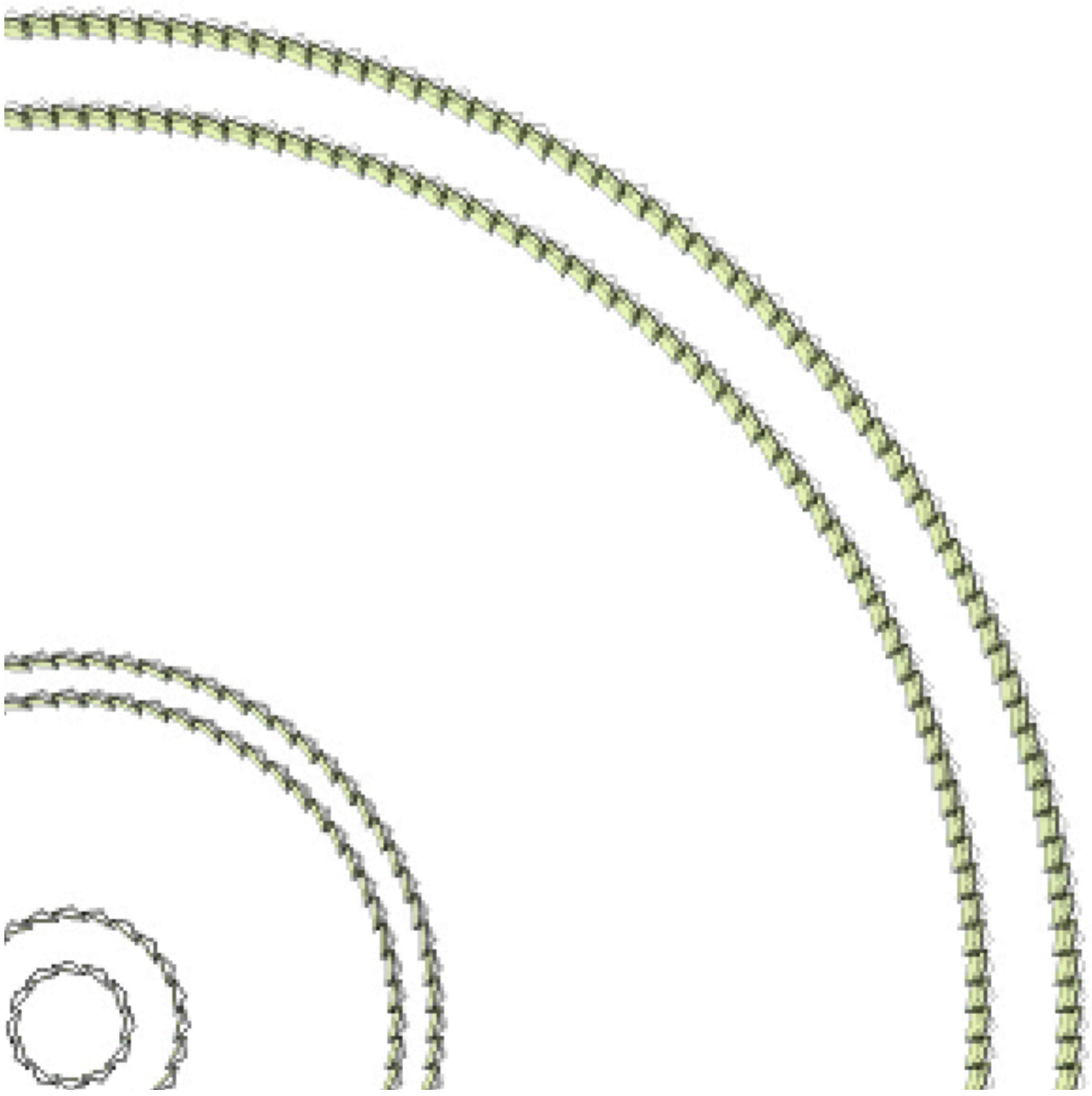


Diameter = 62 mm
Combination of two pipes: electron and hadron (two axes)

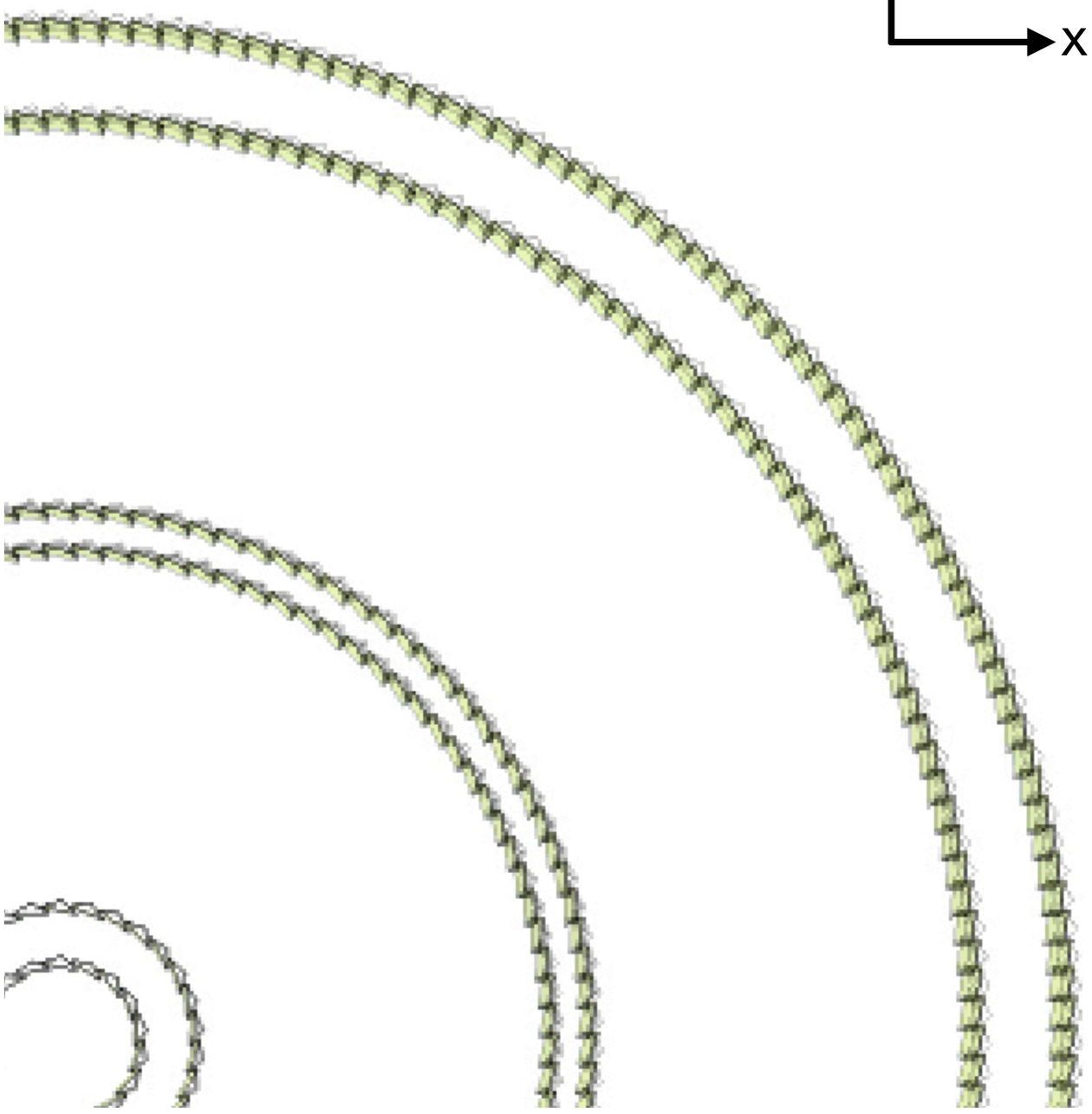
Original detector does not fit around new beampipe

Barrel update and optimization

Original configuration

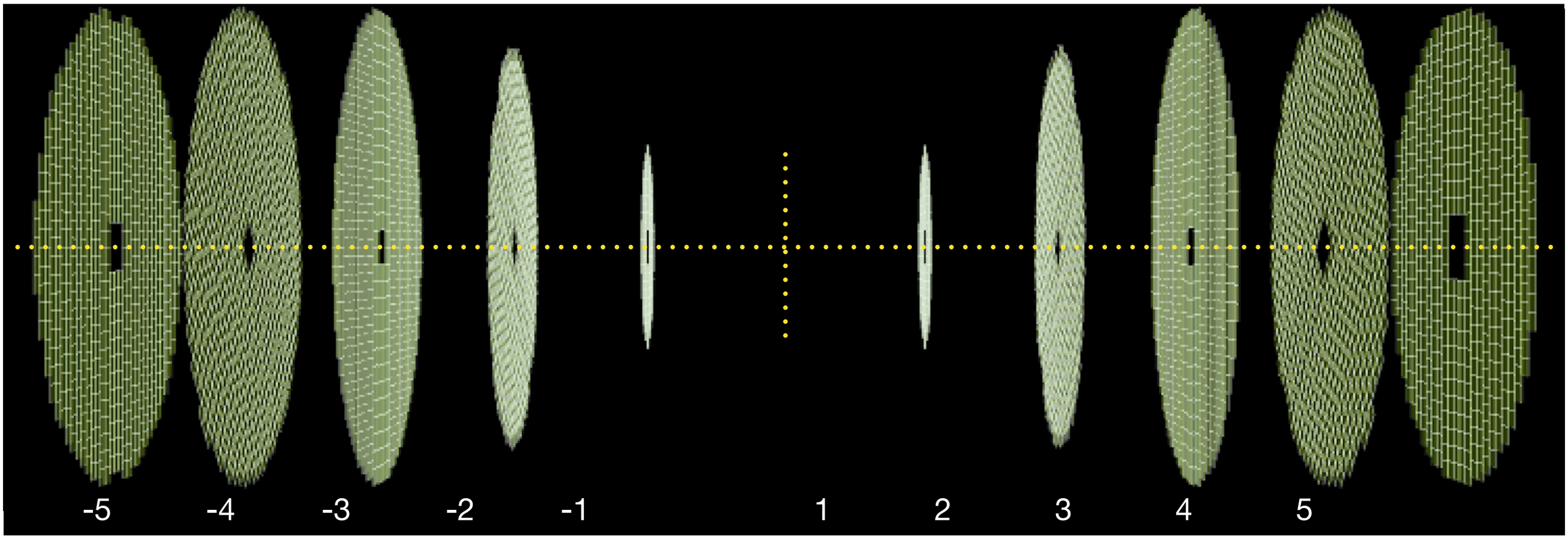


Updated configuration



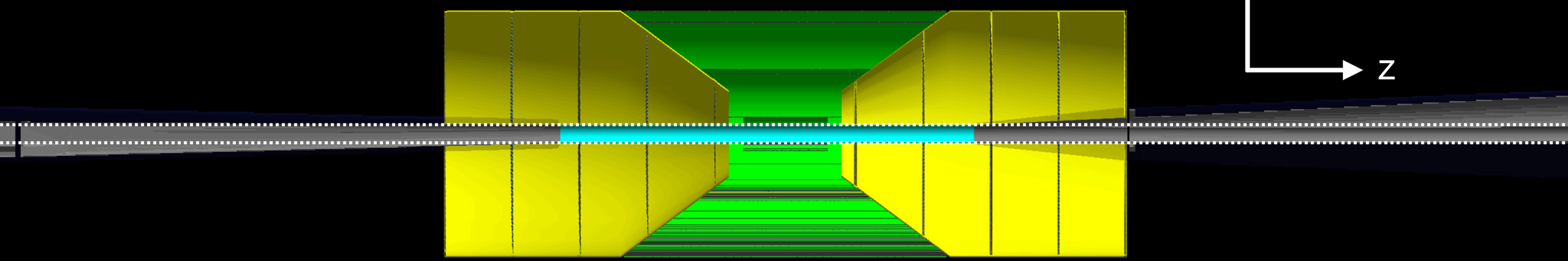
- Innermost 2 layers increased in radii to accommodate new beampipe
- Outermost 2 layers kept exactly the same
- middle 2 layers increased in radii to produce best momentum resolution

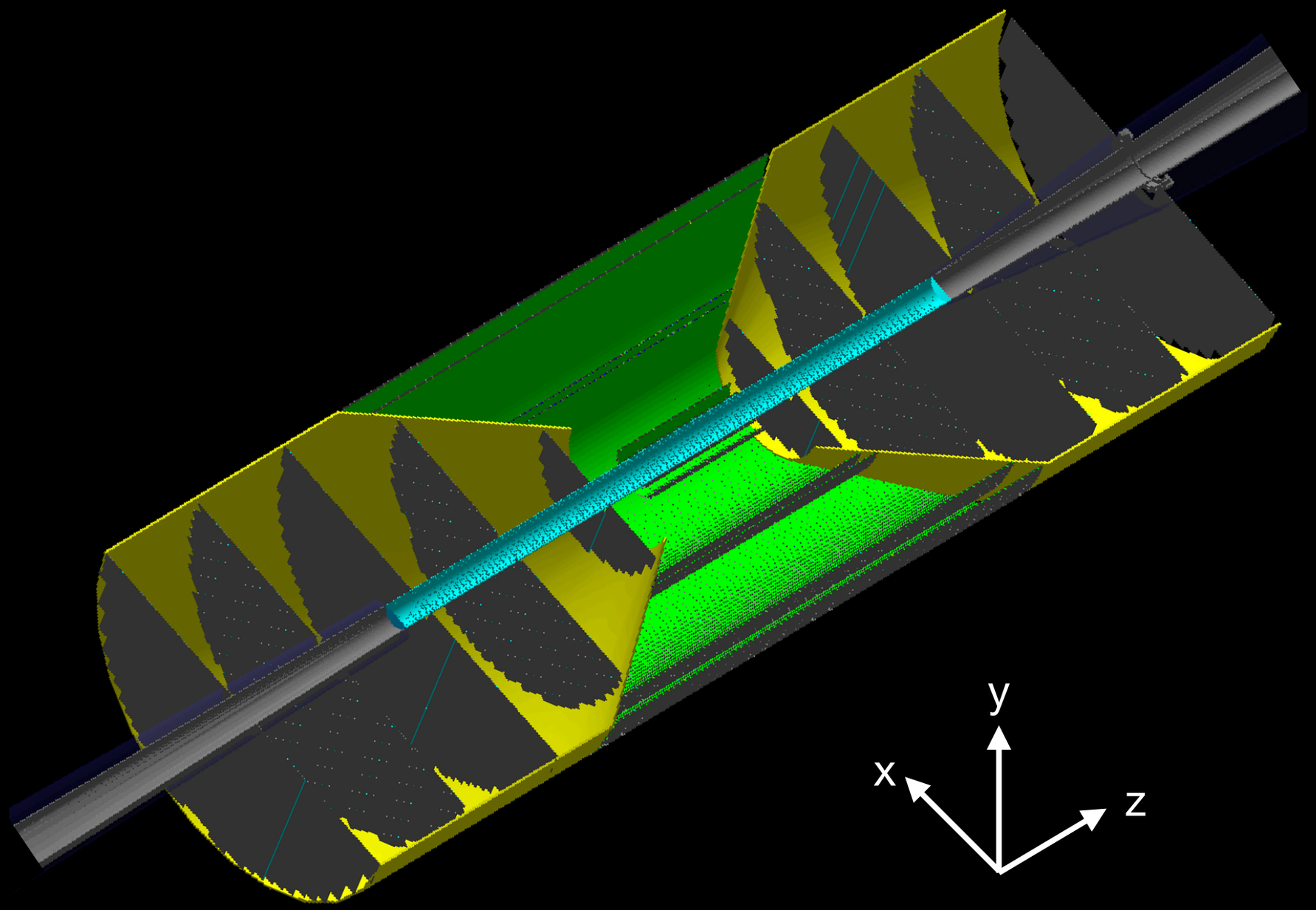
Disk updates



- Increase of inner diameter to accommodate new beampipe
- Forward / backward asymmetry taken into consideration

Top-down view





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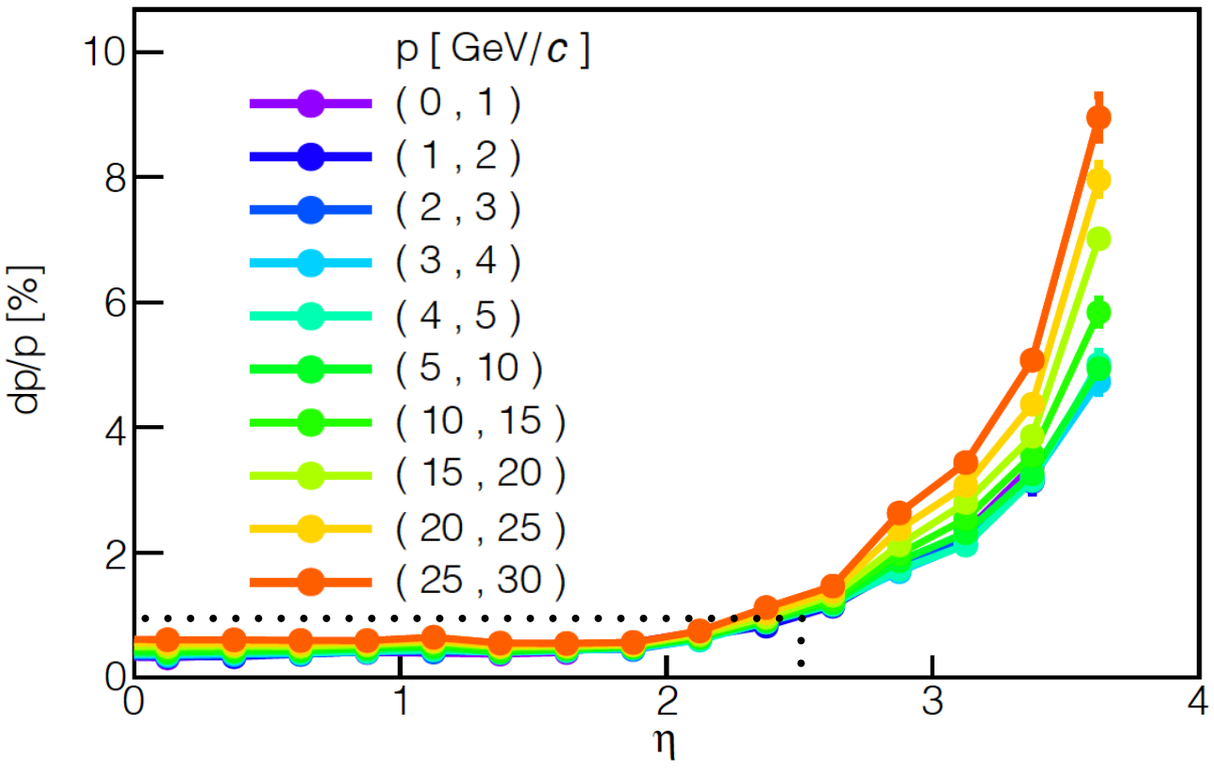
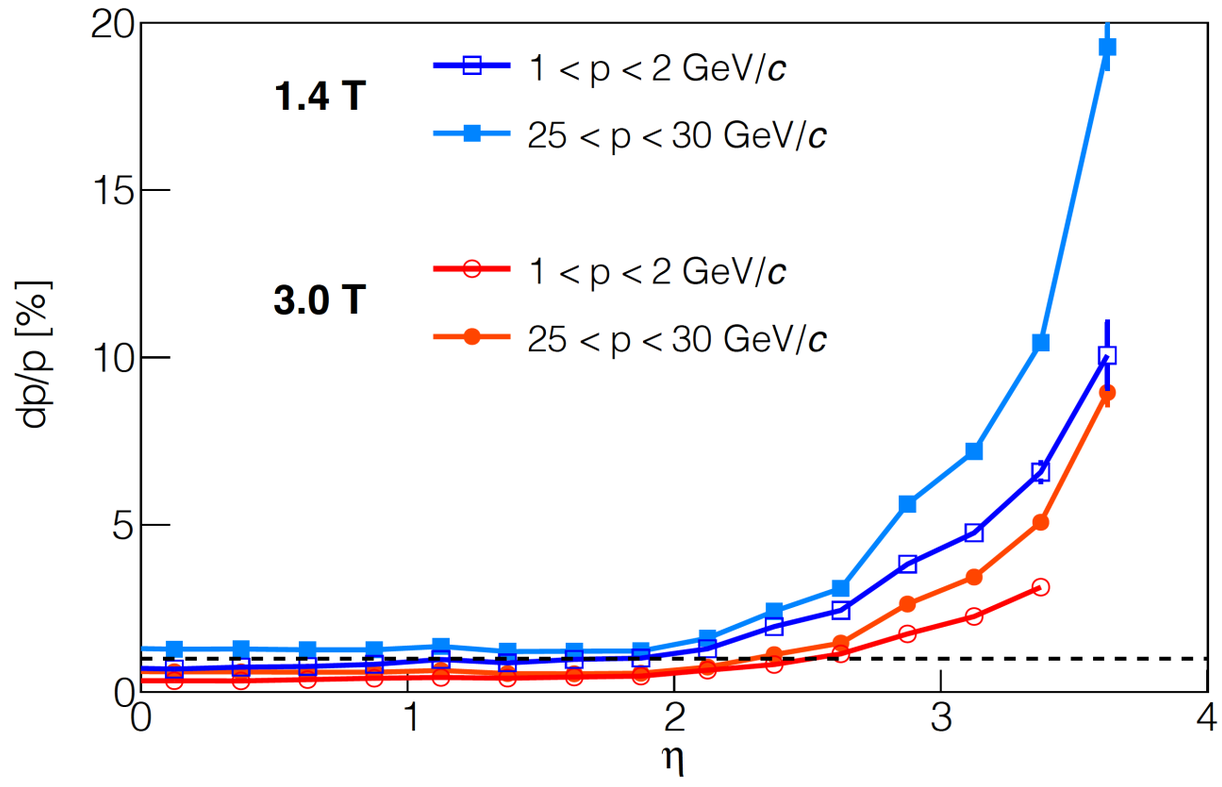
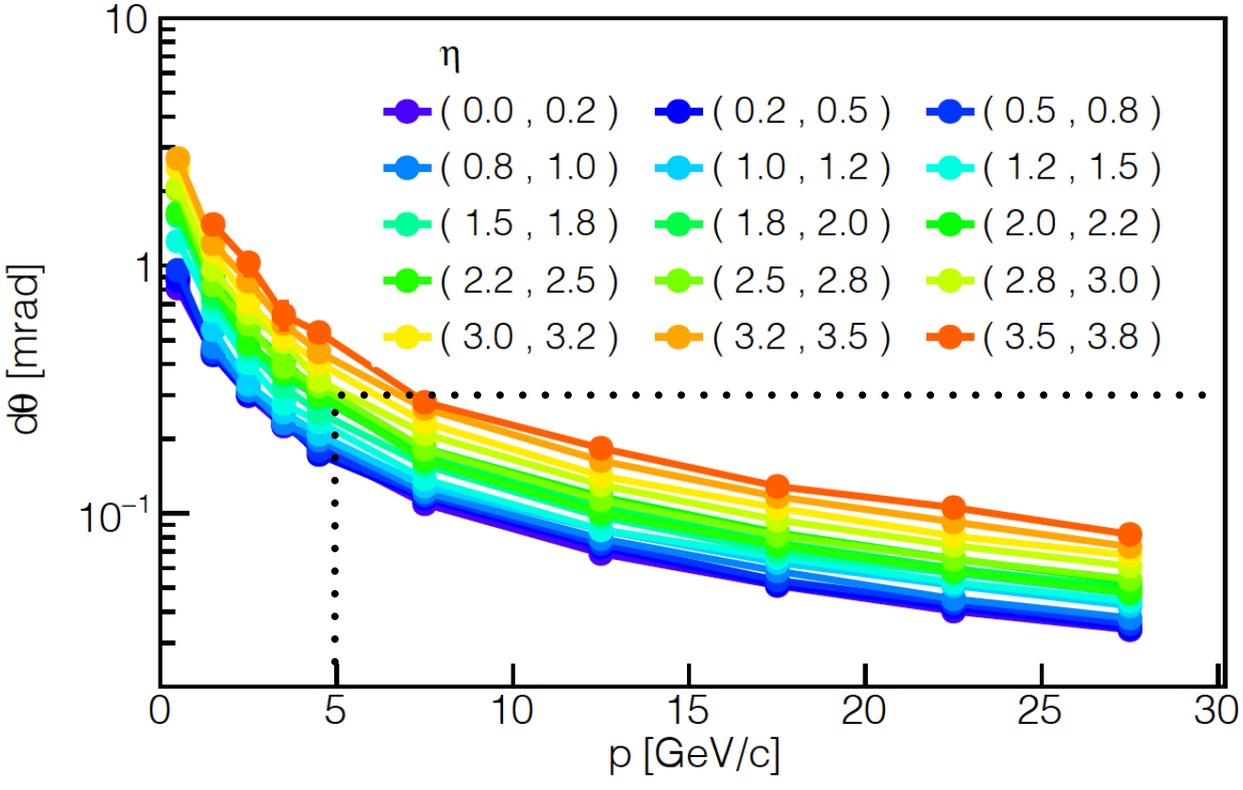
Single-Particle Resolutions

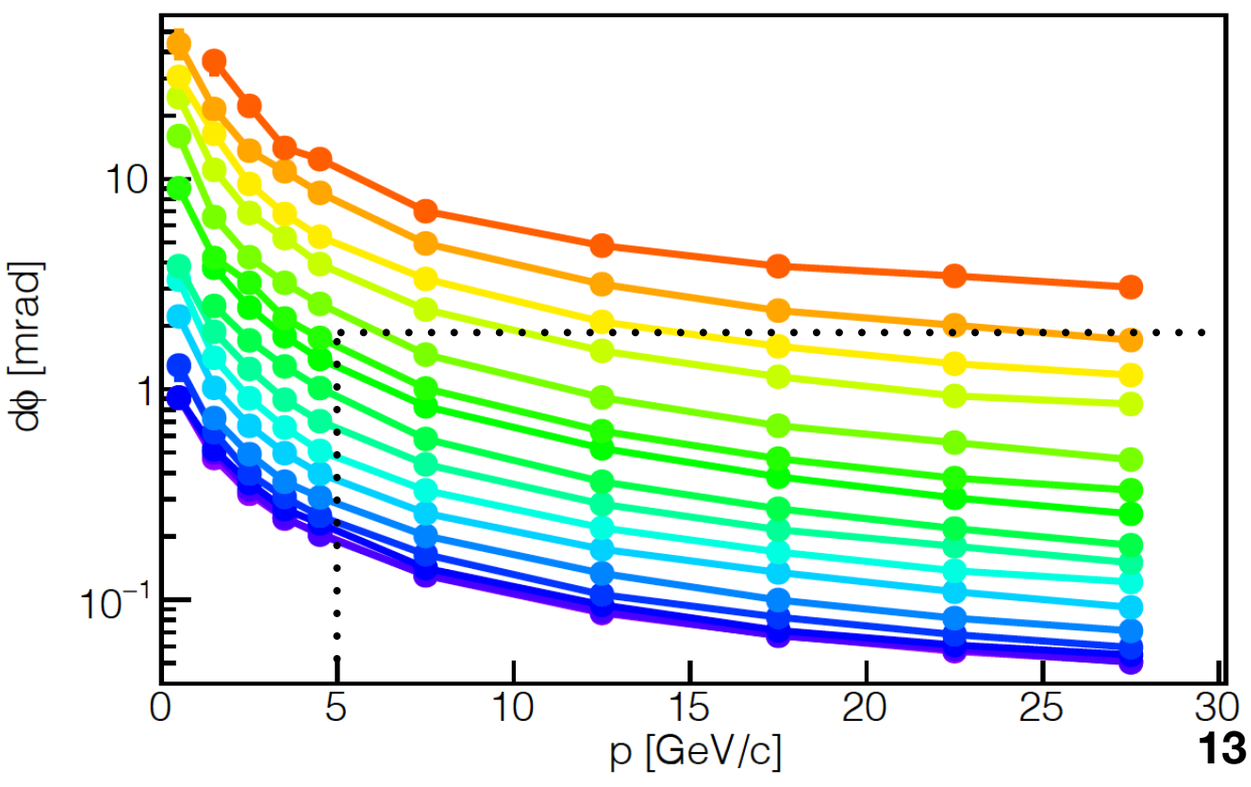
Magnetic field: Beast map (~3.0T)

π^-, 10 μm pixel, $X/X_0 = 0.3\%$

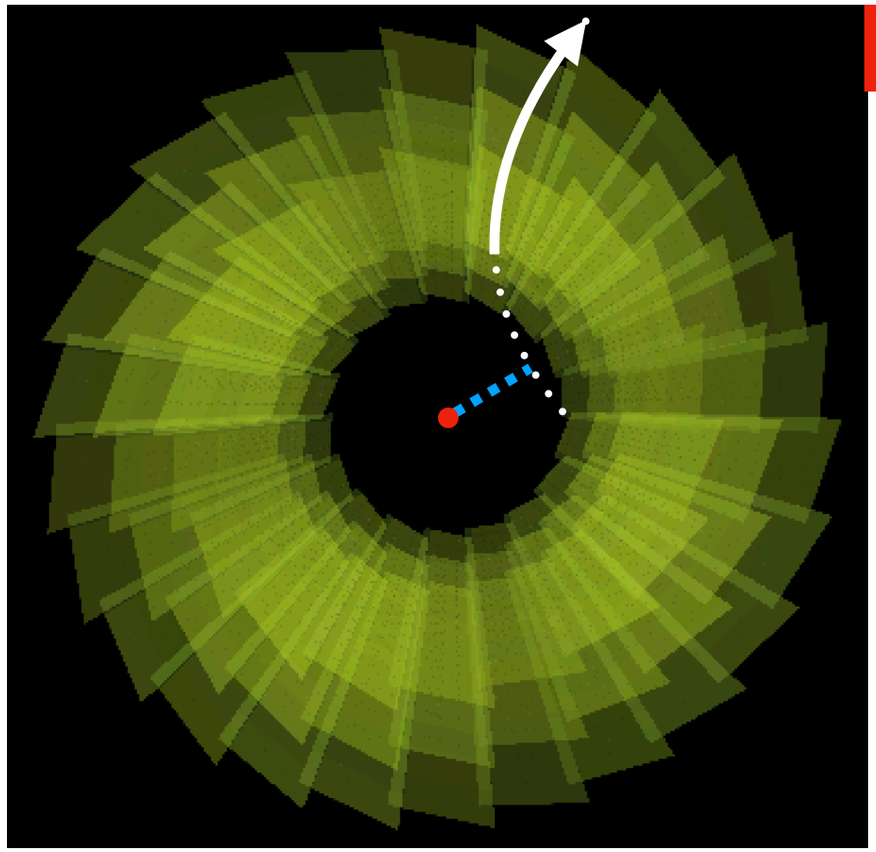




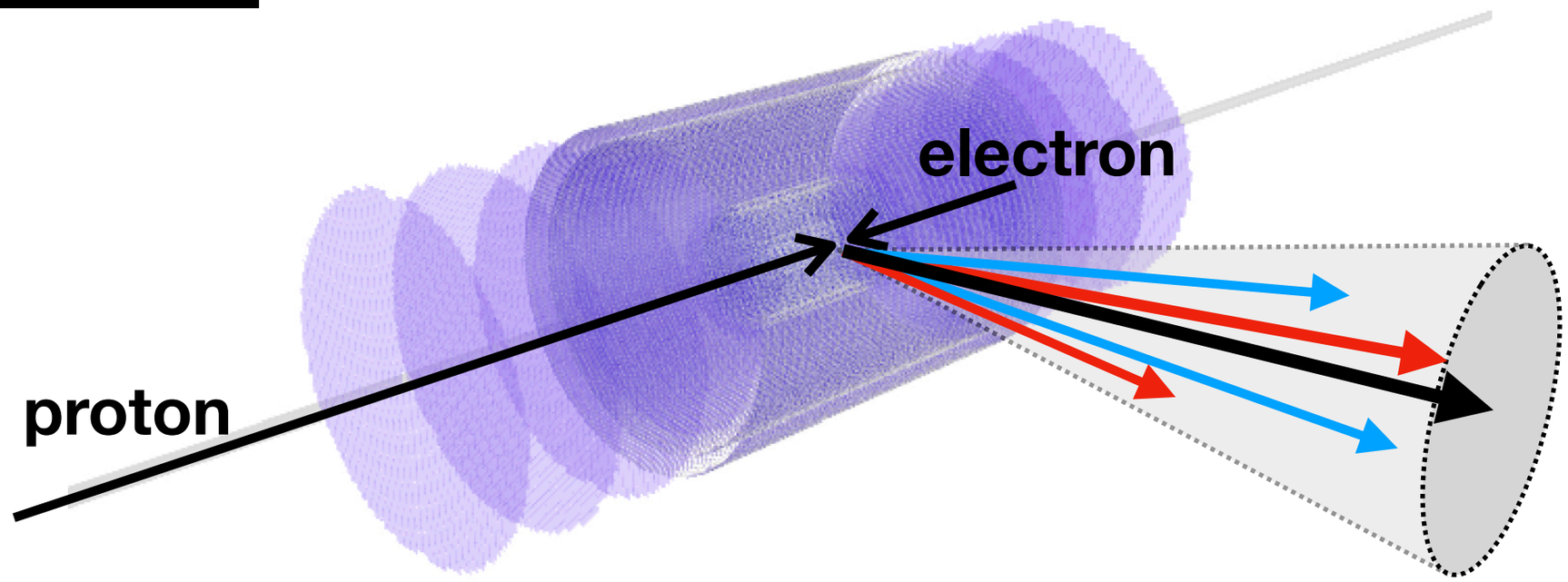




All-Si Tracker Jet resolutions



See talk by Matt Kelsey for details on vertexing studies



See talk by Fernando Torales Acosta for details on jet-resolution studies

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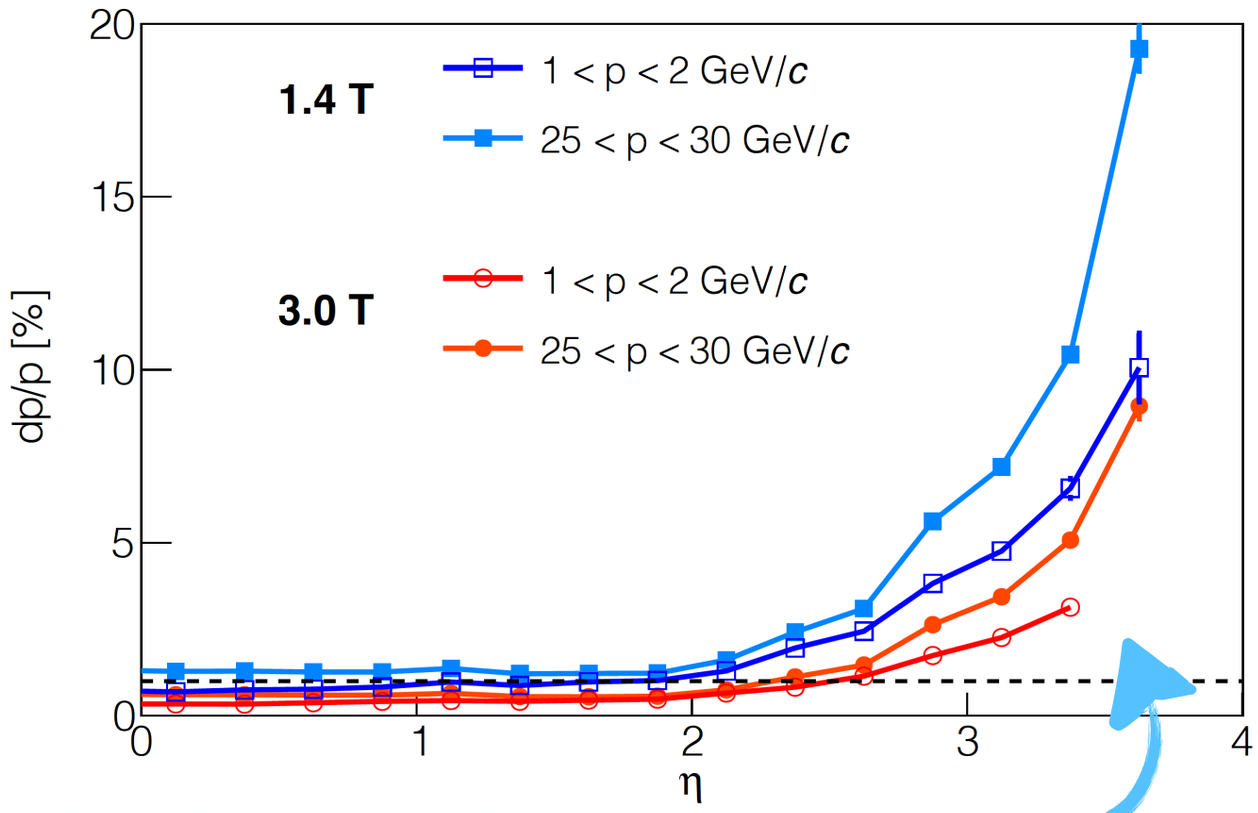
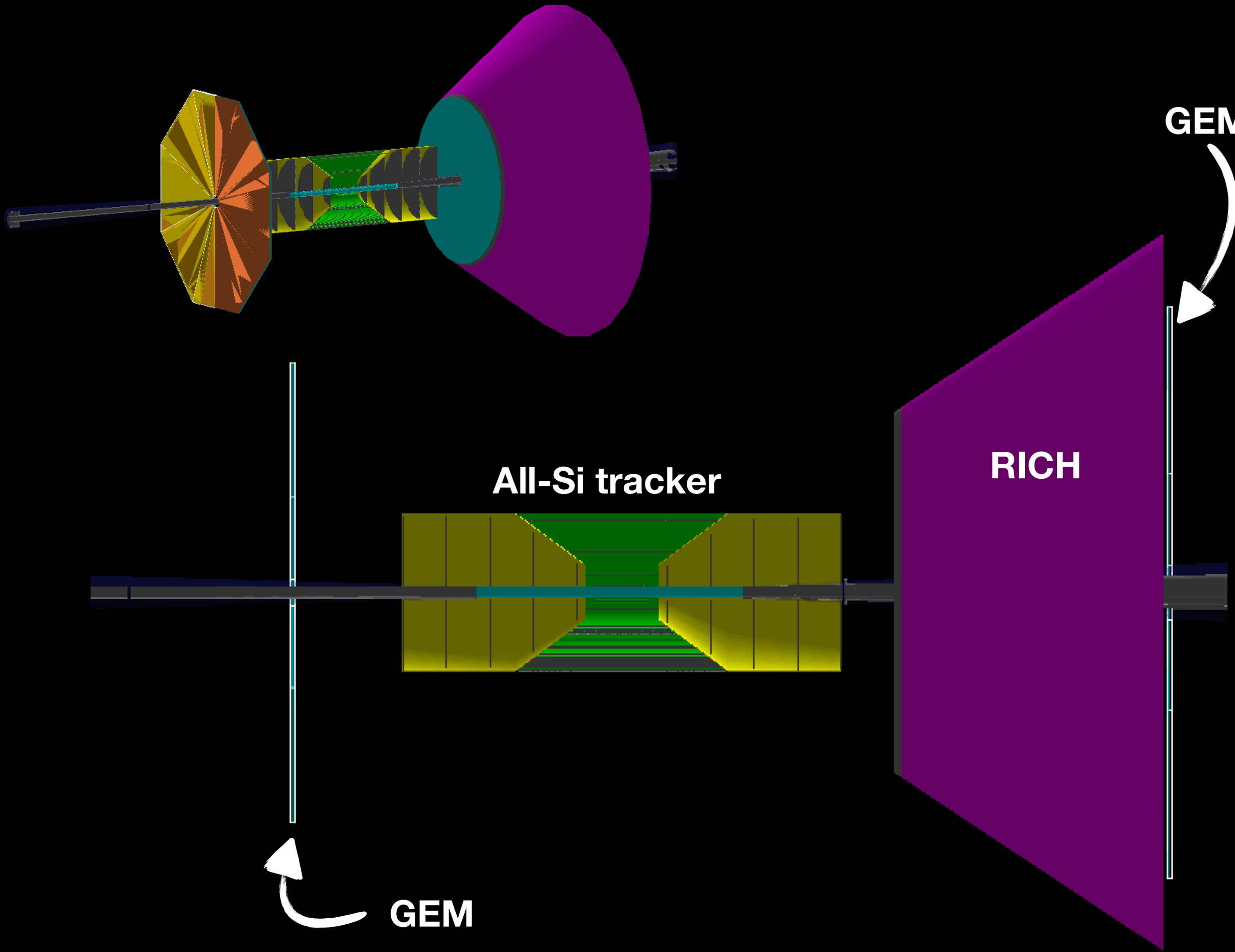
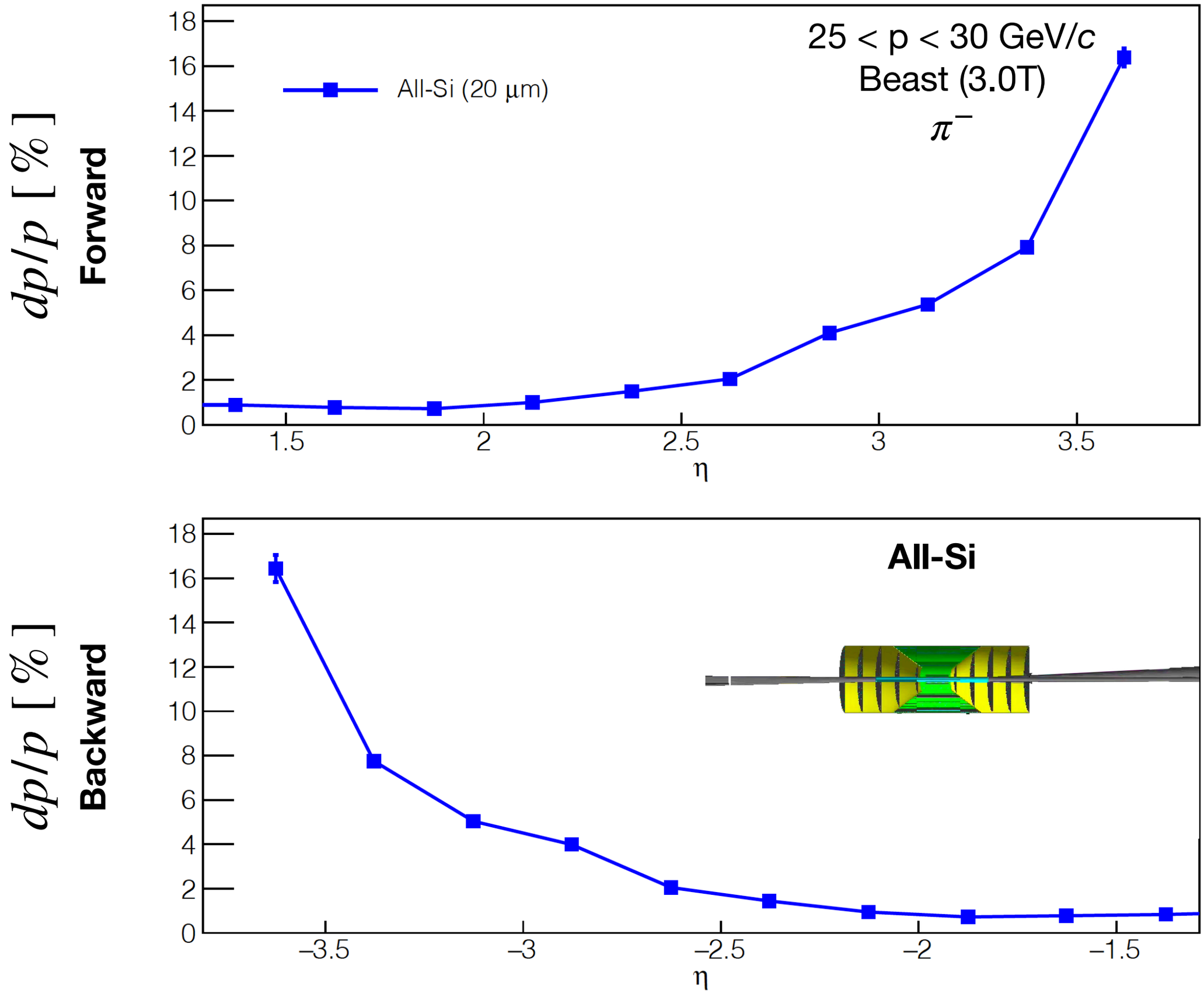



GEM
All-Si tracker
RICH
GEM

Complementing All-Si tracker with other detectors



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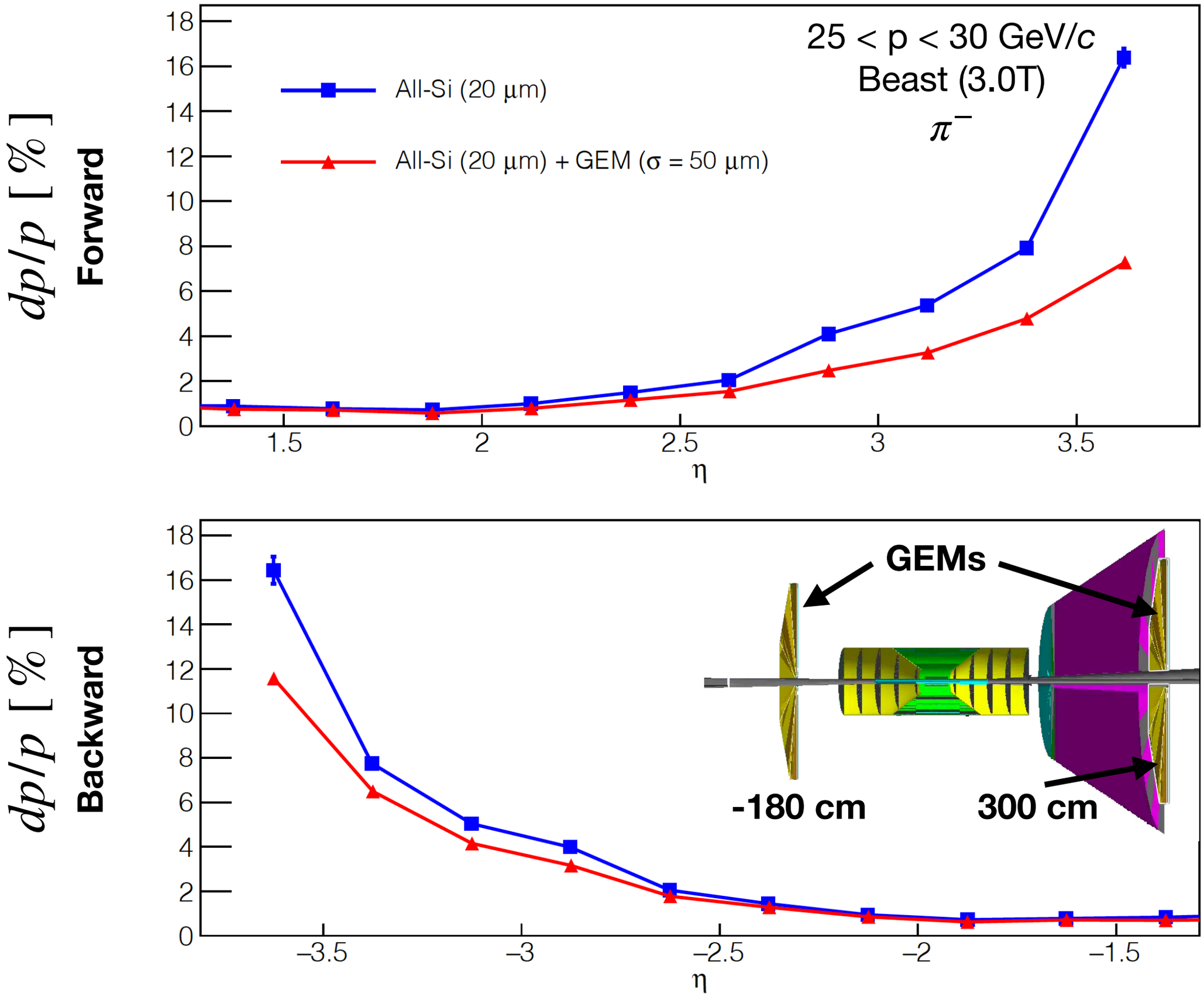

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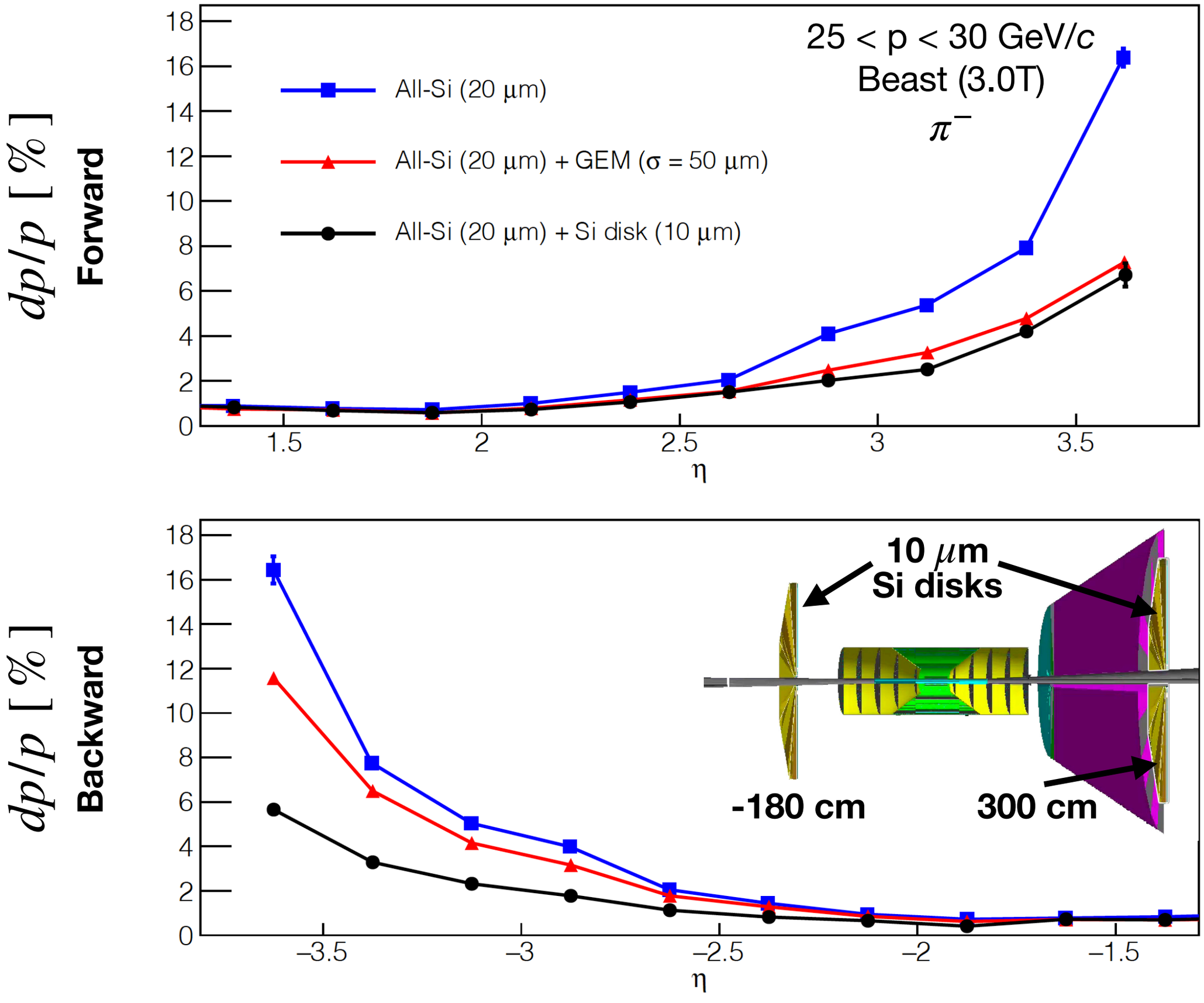
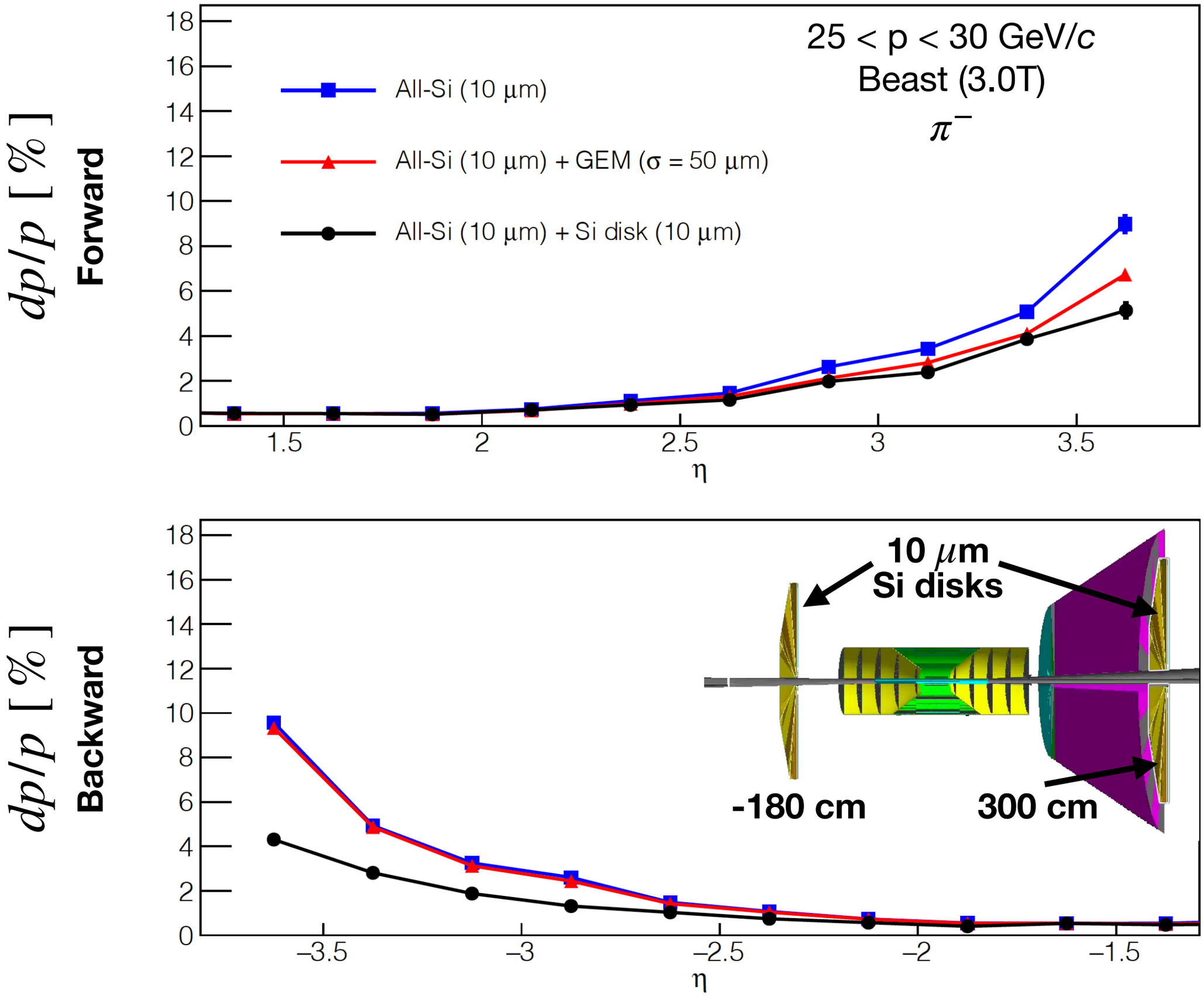


Complementing All-Si tracker with other detectors



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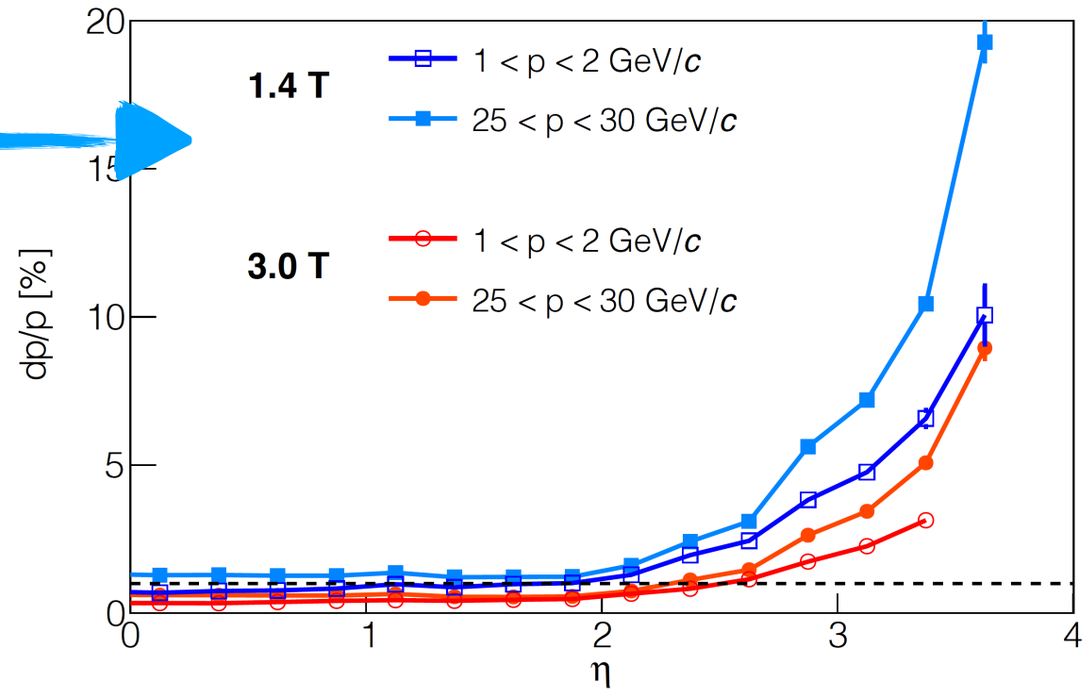
Momentum resolution asymmetry in forward direction

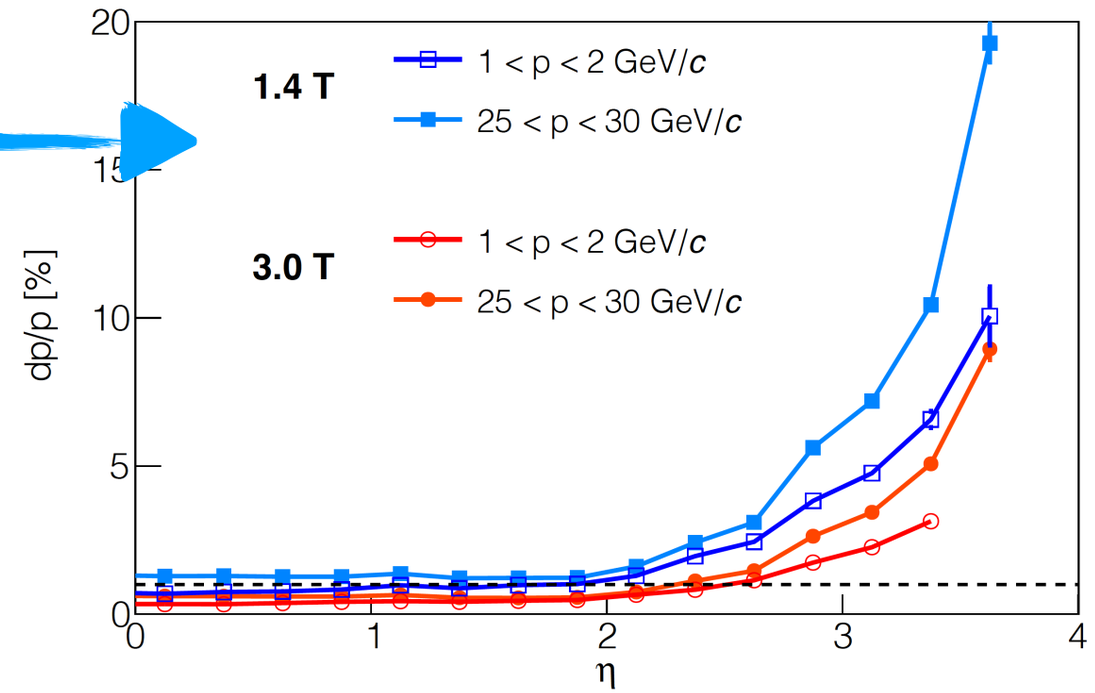
- Results shown so far assuming

  ϕ independence

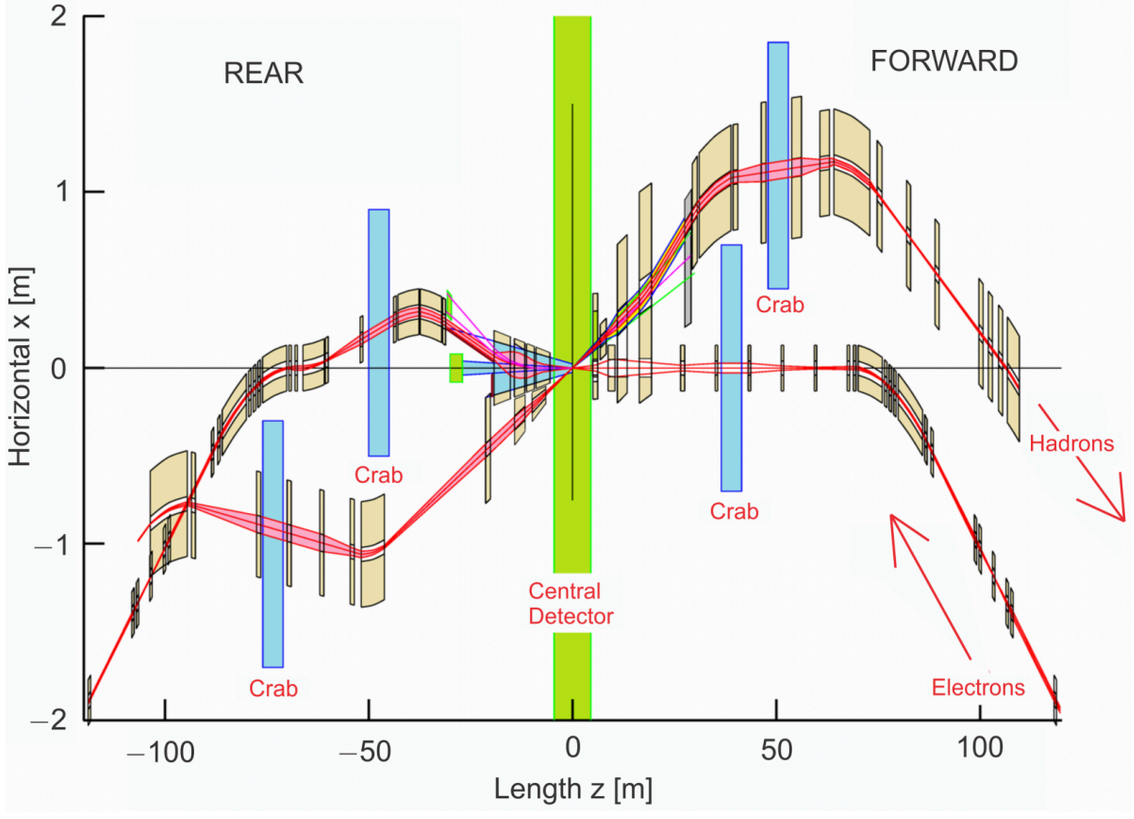


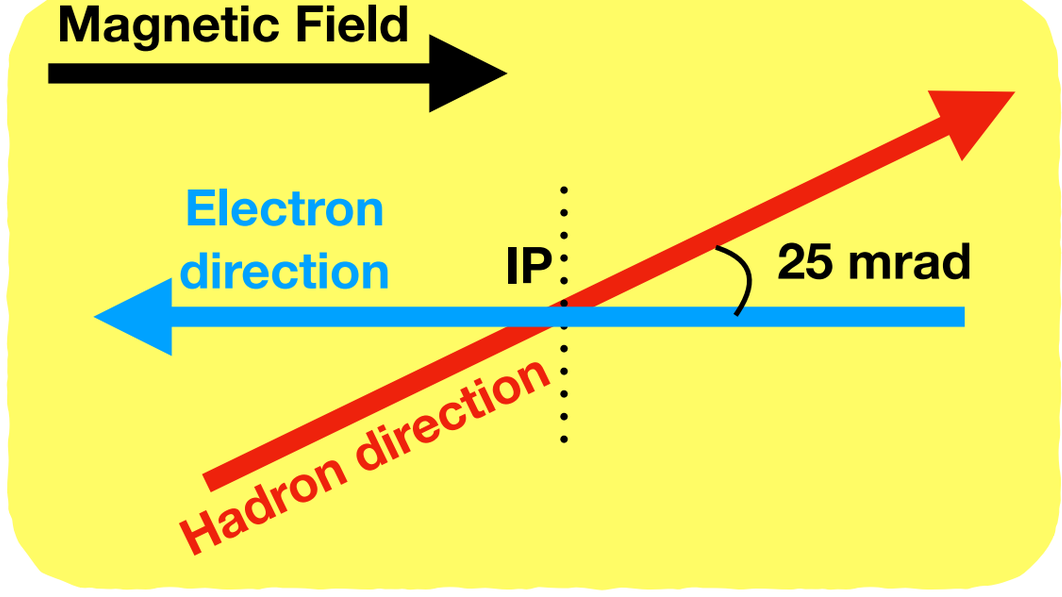
Momentum resolution asymmetry in forward direction

- Results shown so far assuming ϕ independence



- B field rotated by 25 mrad with respect to nominal hadron direction

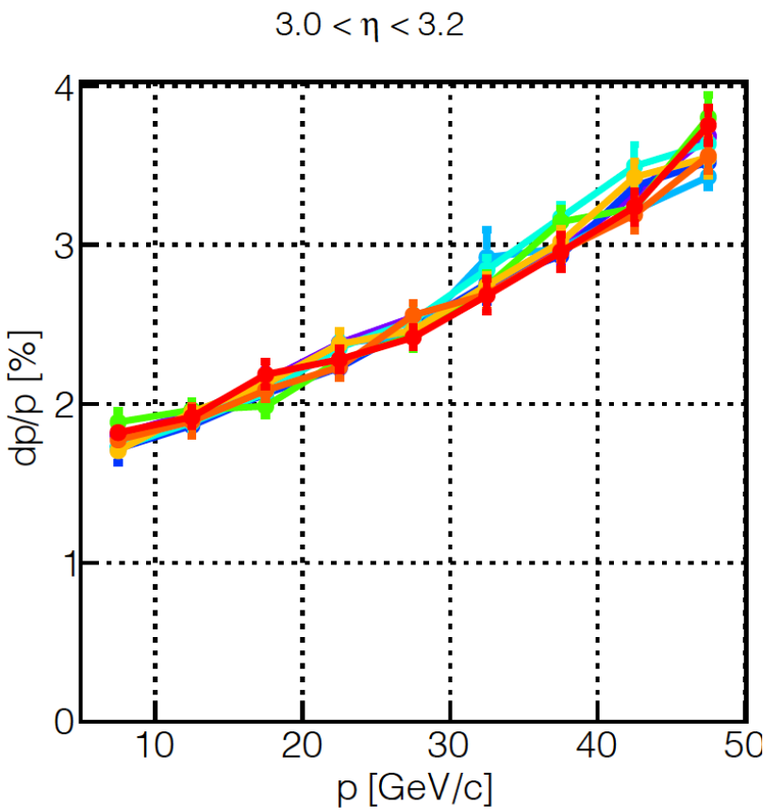


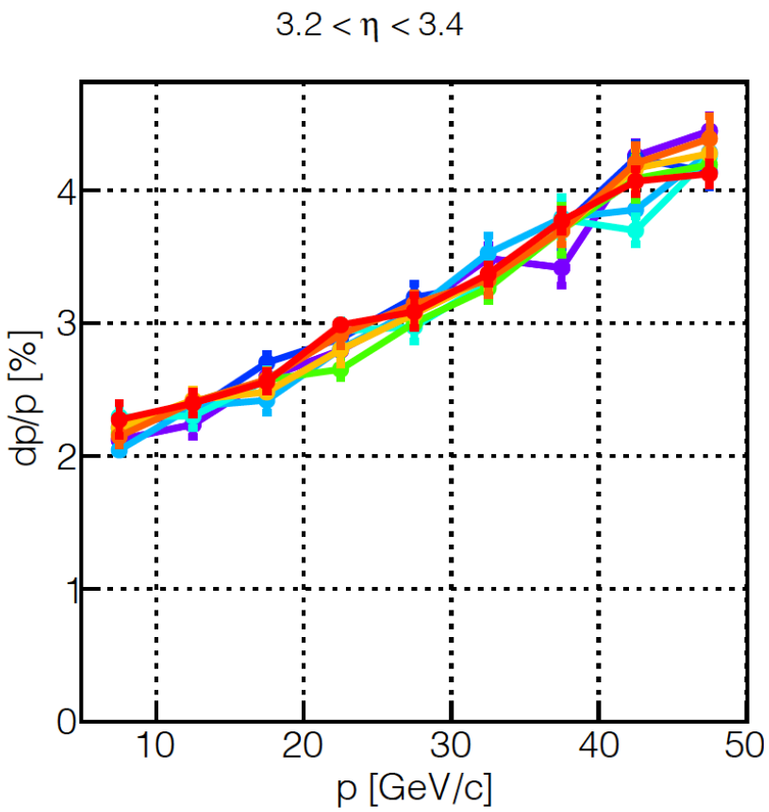


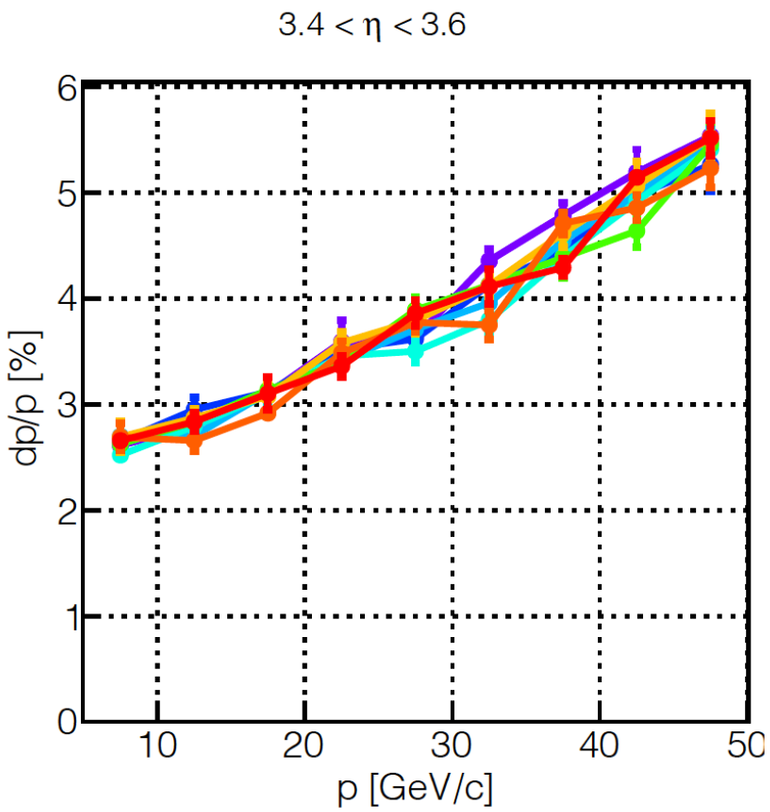
- $\int B \cdot dl$ depends on ϕ

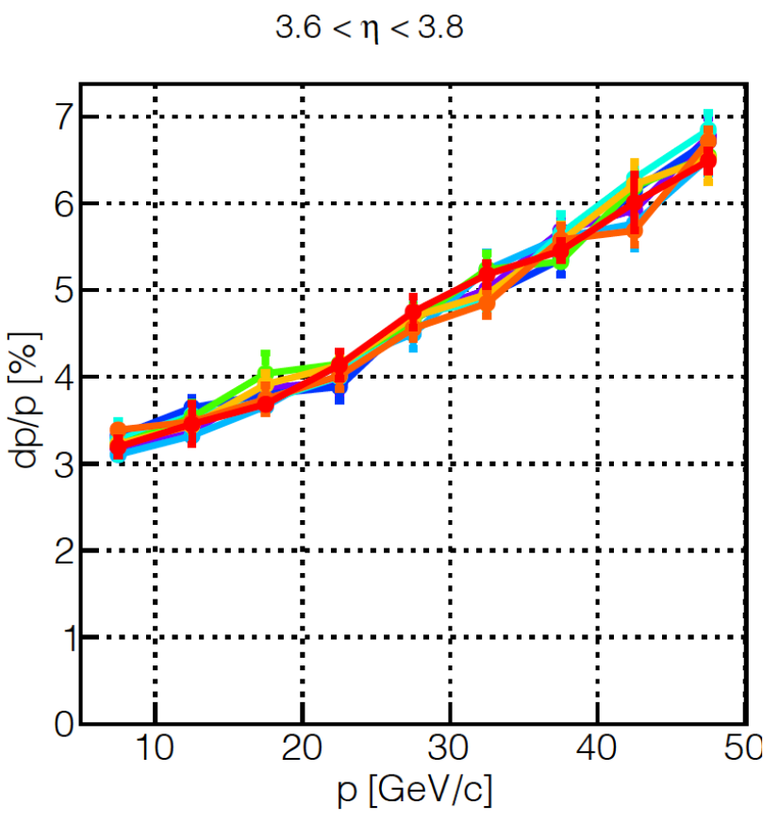
Need to take into account asymmetry impact on momentum resolution

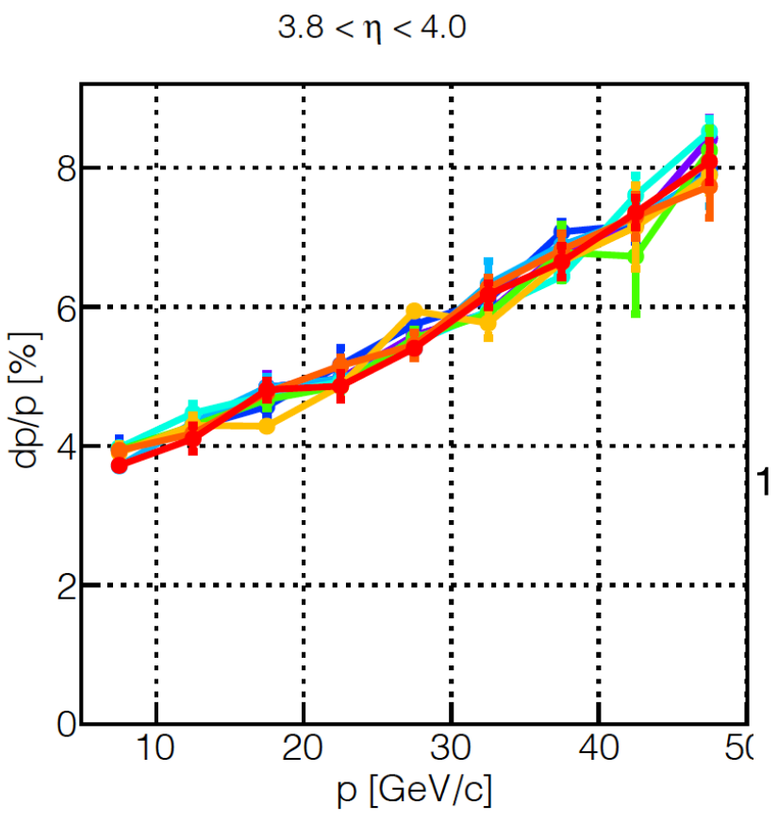
Momentum resolutions before rotation



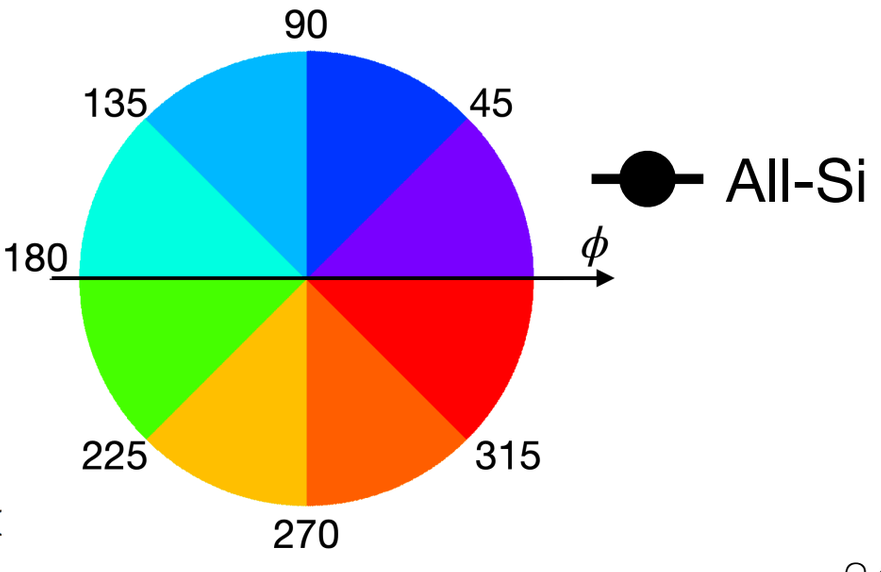




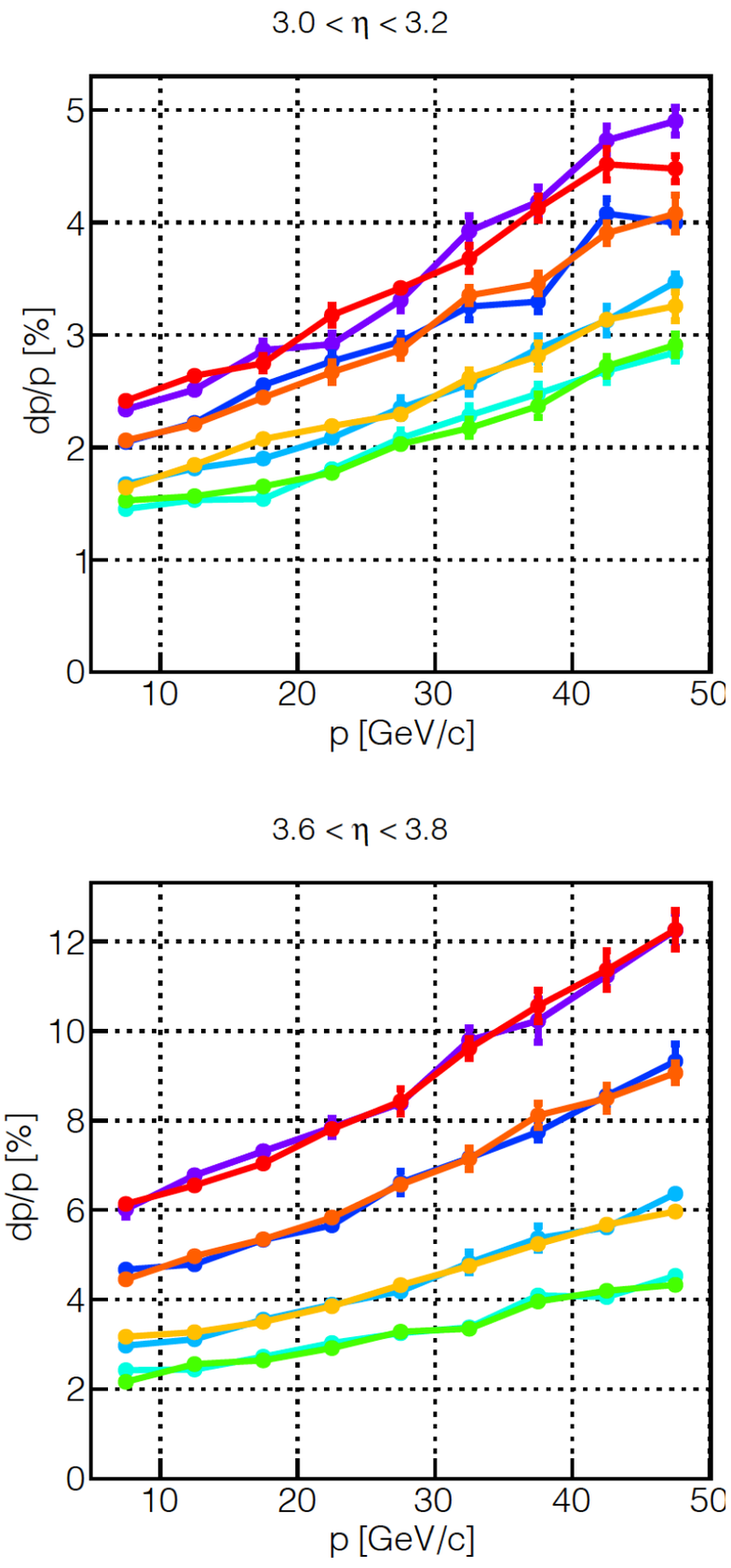


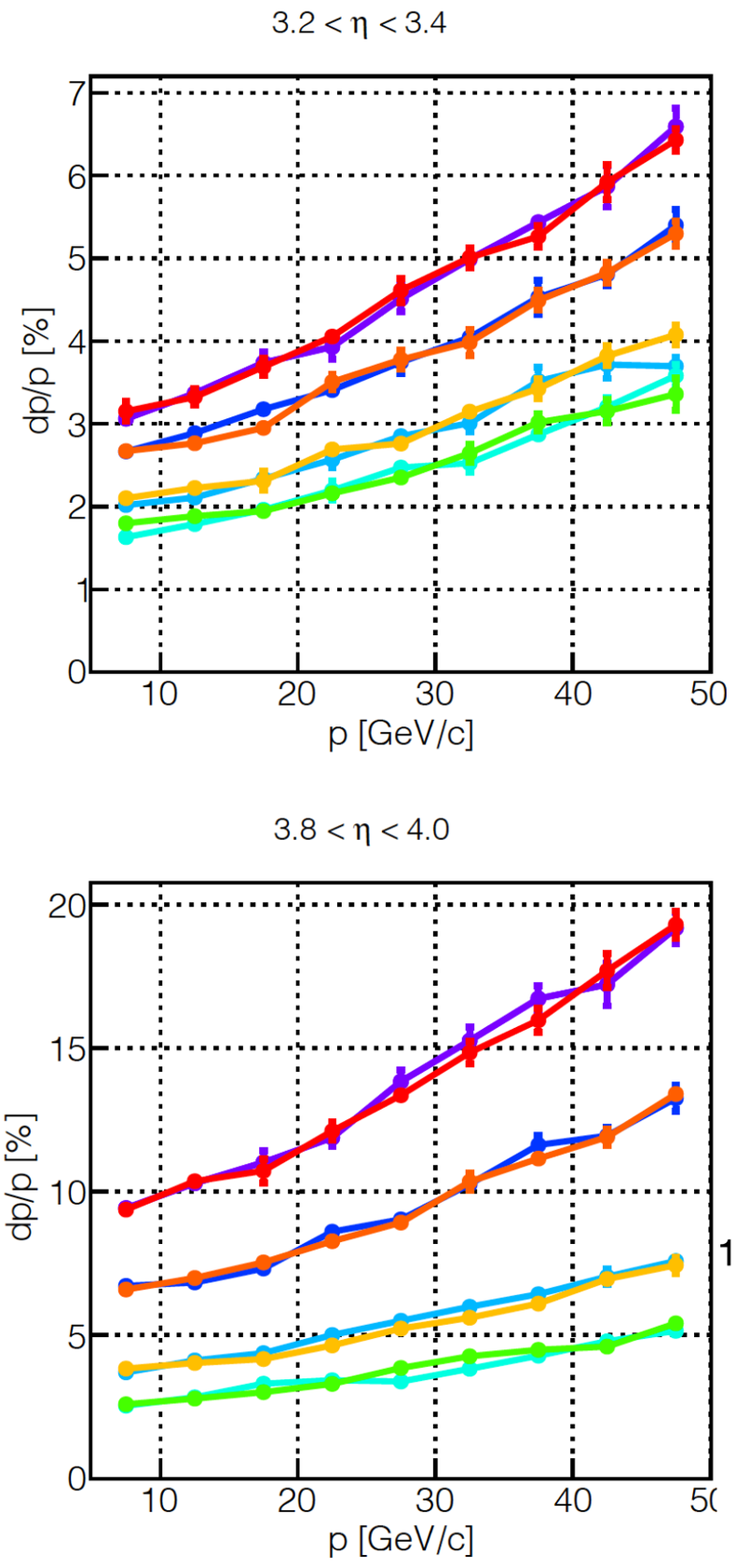


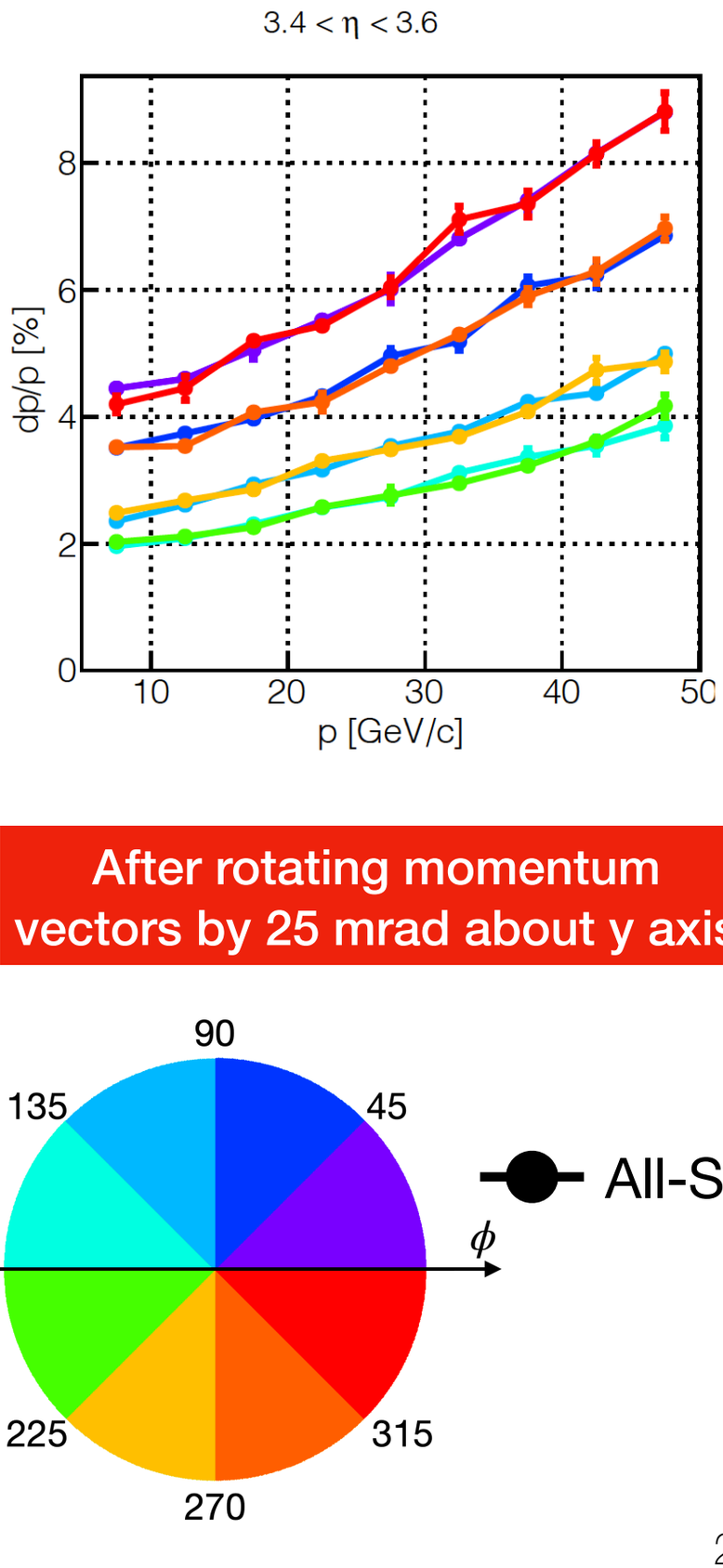
Before rotating (perfect azimuthal symmetry)



Momentum resolutions after rotation

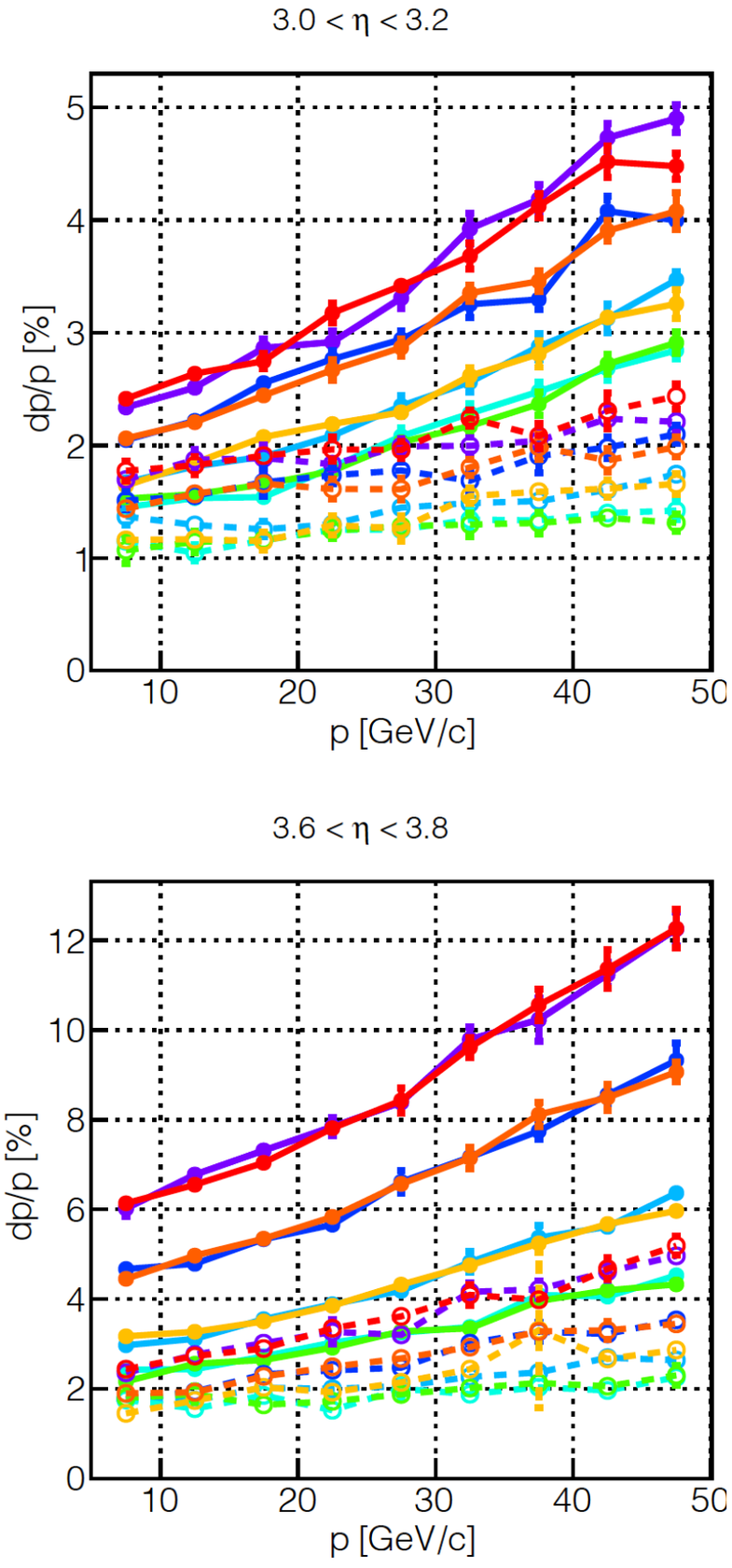


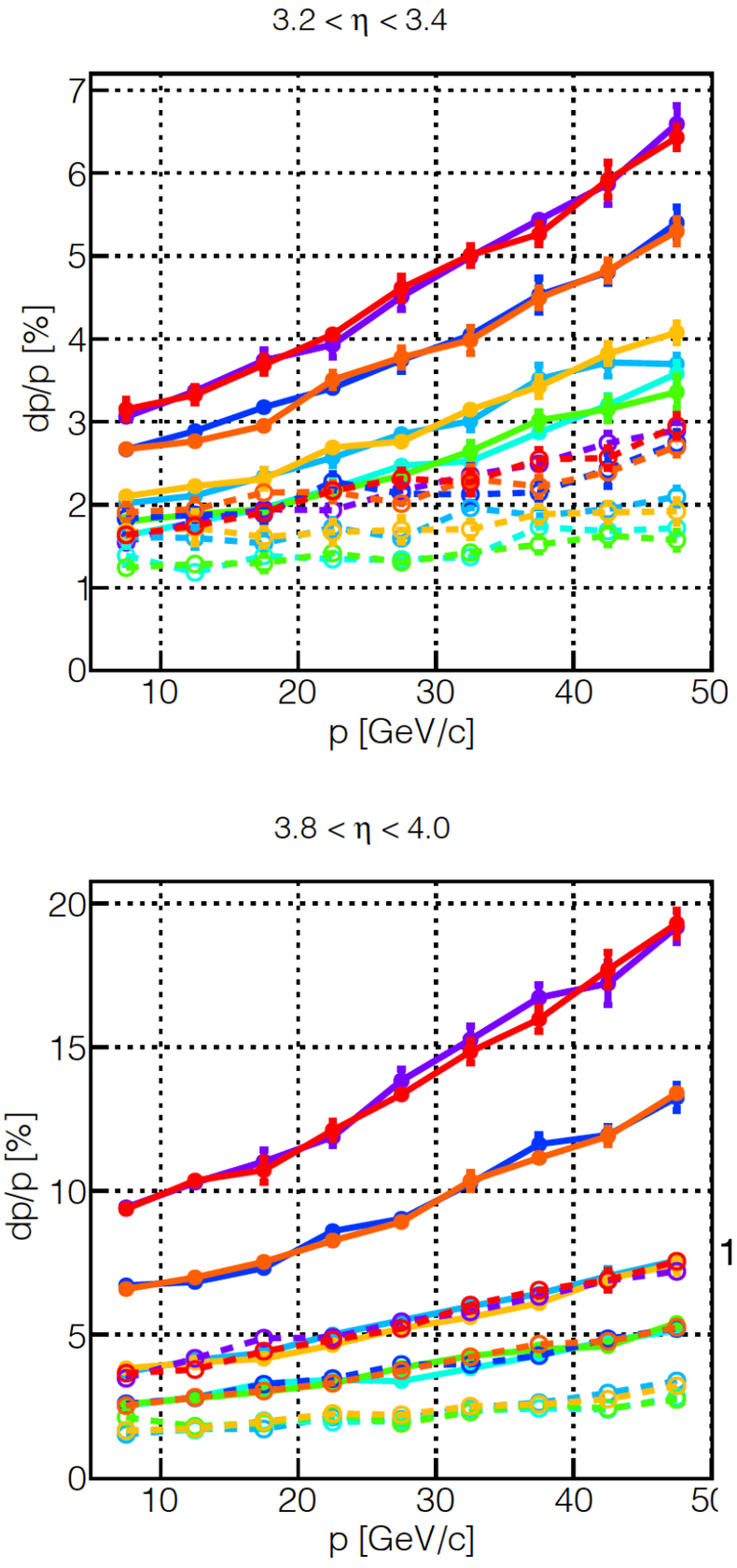


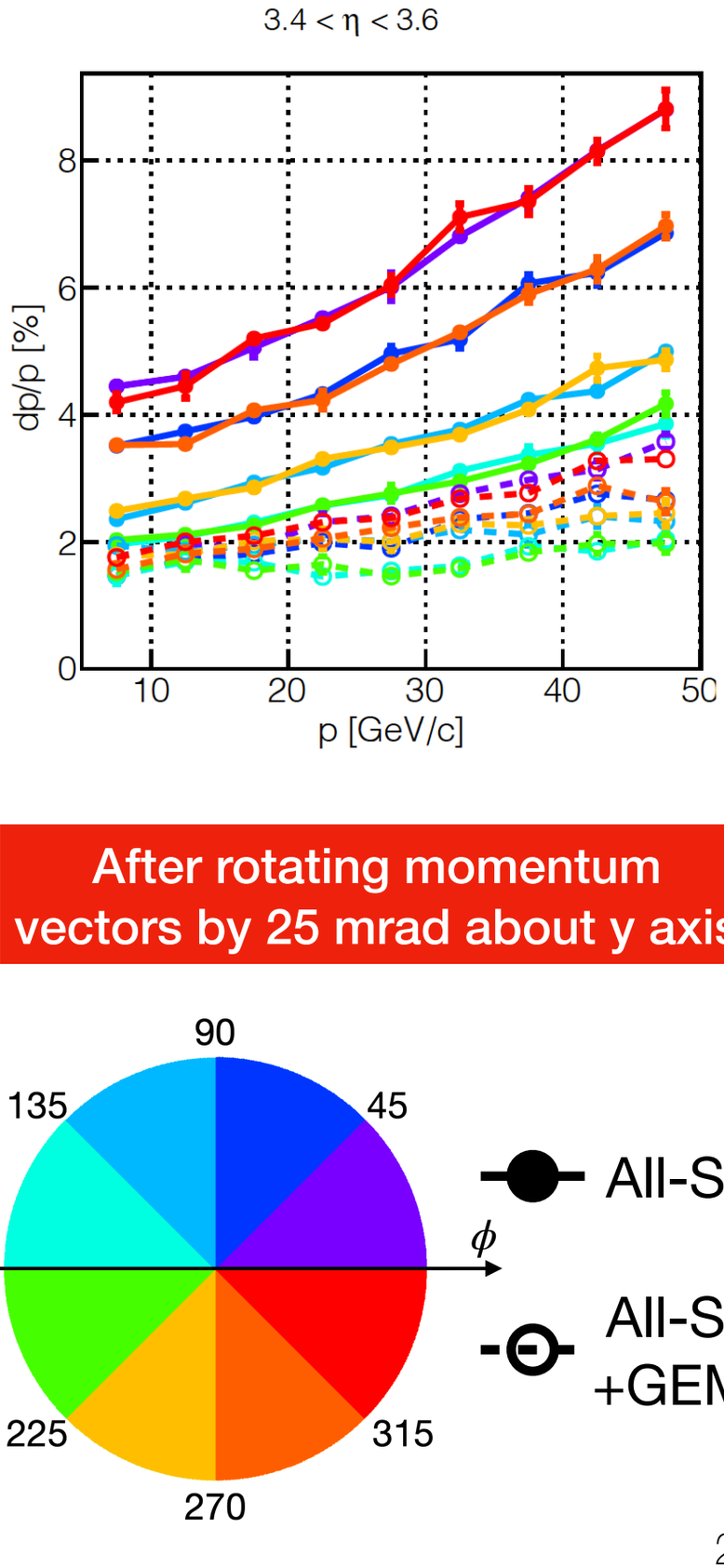


After rotating momentum vectors by 25 mrad about y axis

Momentum resolutions after rotation







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Summary and Conclusions

- Studied All-Silicon tracker prototype for the EIC in Fun4All
- Single particles:
  - **momentum** resolution: **~1%** for $|\eta| \lesssim 2.5$ (B = 3T)
  - $d\theta < 0.3$ **mrad**, $d\phi < 2$ **mrad** for $|\eta| \lesssim 2.5, p > 5$ GeV/*c*
- May get significantly better resolutions by complementing All-Si tracker with other tracking stations in the forward / backward pseudorapidities*.
- Azimuthal momentum-resolution asymmetry:
  - non-negligible
  - maybe recoverable*

* Need realistic B-field maps to really tell

- Tracker satisfies preliminary requirements outlined in EIC detector handbook

Thanks for your attention