All-Silicon Tracker + GEMs
(“baseline 1”)
Performance Studies

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ATHENA Tracking Meeting
07/13/2021

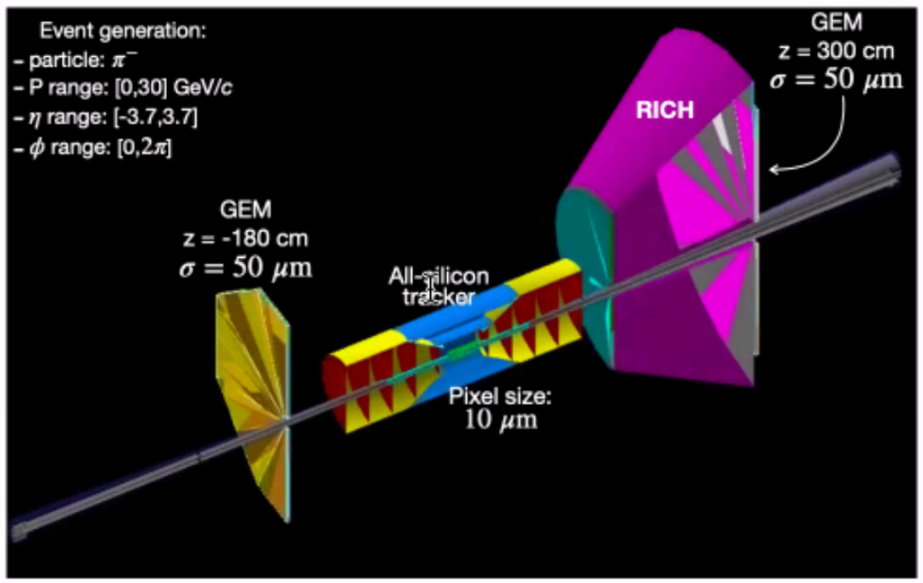
Introduction

L. Gonella's slides from two weeks ago

Benchmark figures

- dp/p vs p
- dp_T/p_T vs p_T
- Pointing resolution transverse and longitudinal
- Angular and position resolution at mid-point of PID
  - Start with z = +220 cm
- Material scan in eta and phi

B-0.0, P-0.0, N-0.0



Silicon

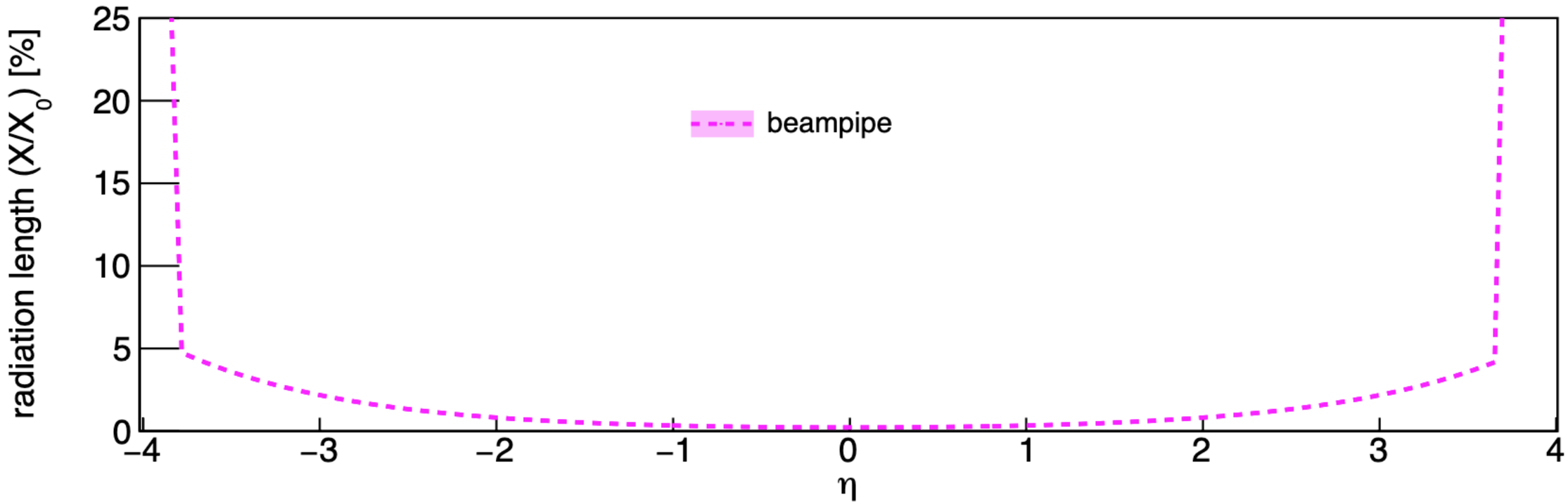
2 vertexing layers, 0.05% X/X0
2 + 2 barrel layers, 0.55% X/X0
5 disks per side, 0.24% X/X0
10 um pixel pitch

GEM (end-caps)

1 on N side, 1 on P side
0.4% X/X0
250 um R
50 un Rphi

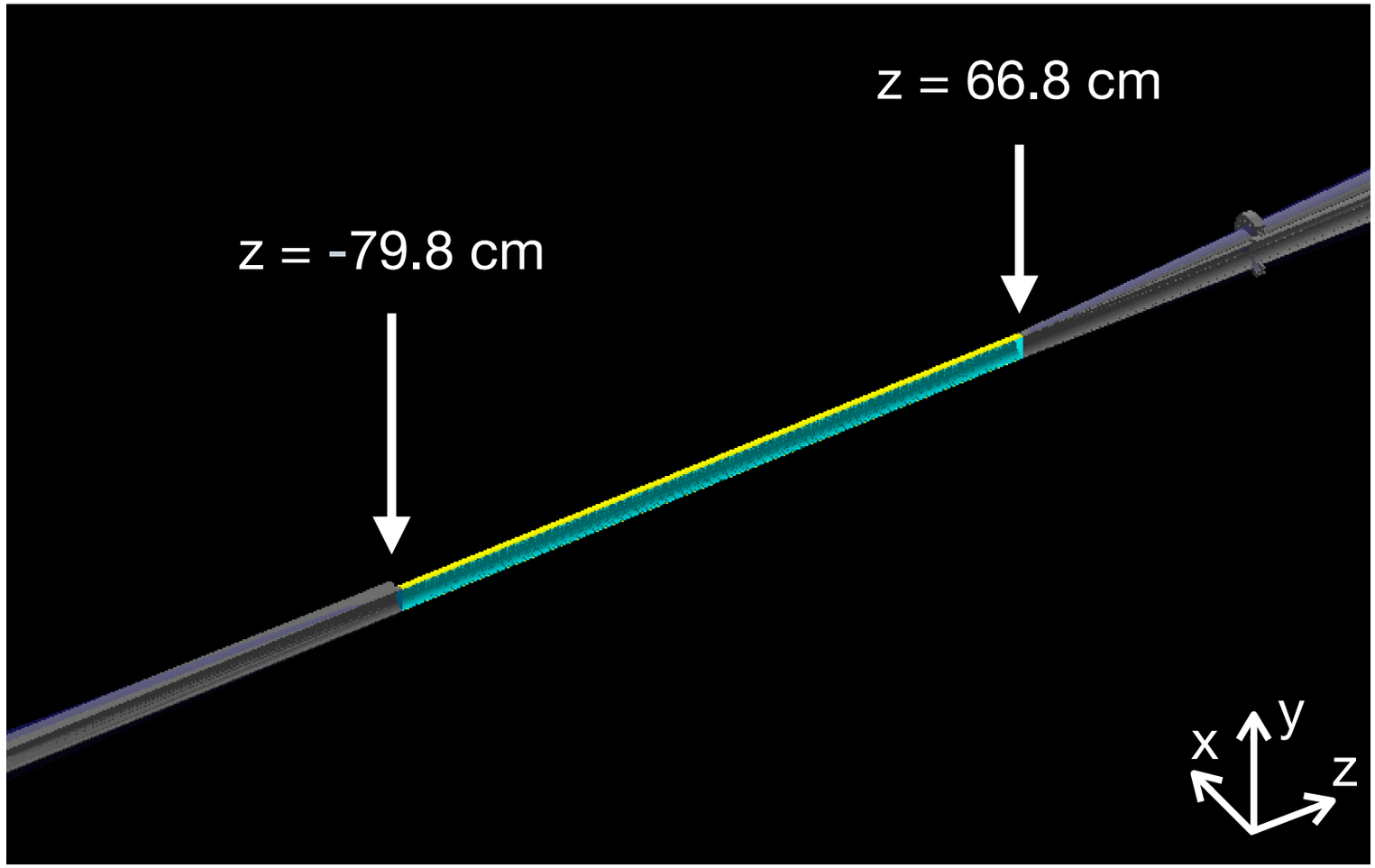
Note:
- Make sure 2 um of gold is added to the beam pipe
- B-field from 7 May 2021 (Magnet: Solenoidal Configuration)
- Please report in two weeks from now

Detector Material Budget

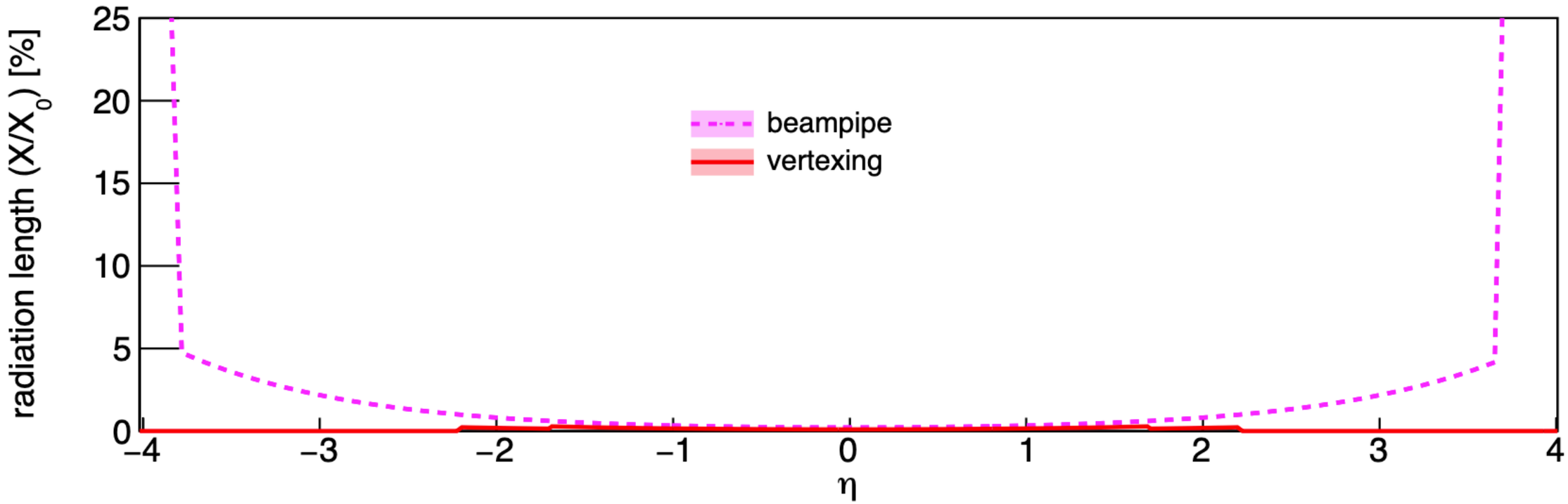


Beampipe (see here):

- Central region:
  - Vacuum inside
  - Beryllium
    - r = 3.1 cm
    - t = $760\,\mu\mathrm{m}$
  - Gold coating ($2\,\mu\mathrm{m}$ thick)
- Forward region:
  - z > 66.8 cm
  - Aluminum
- Backward region:
  - z < -79.8 cm
  - Aluminum

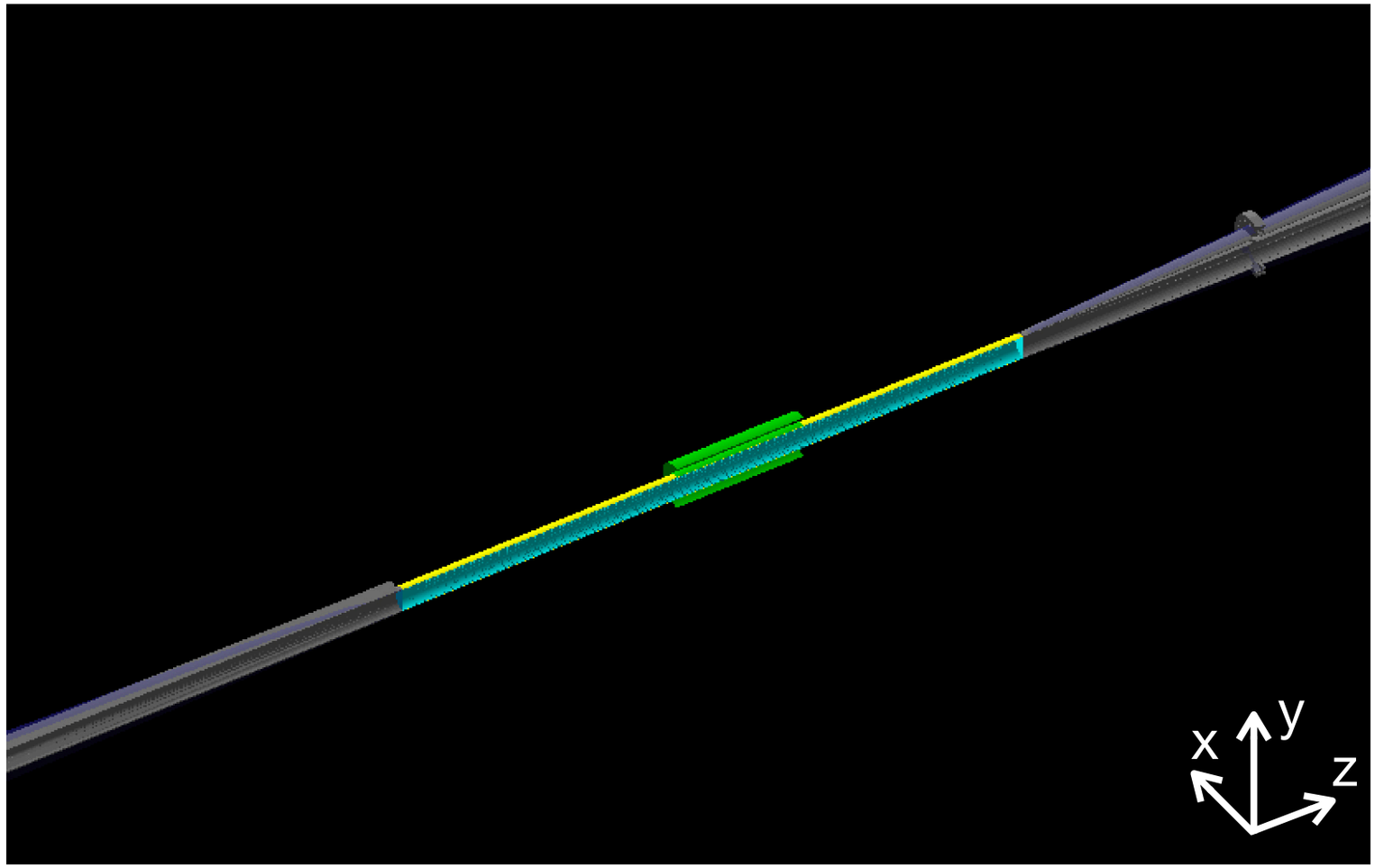


Detector Material Budget

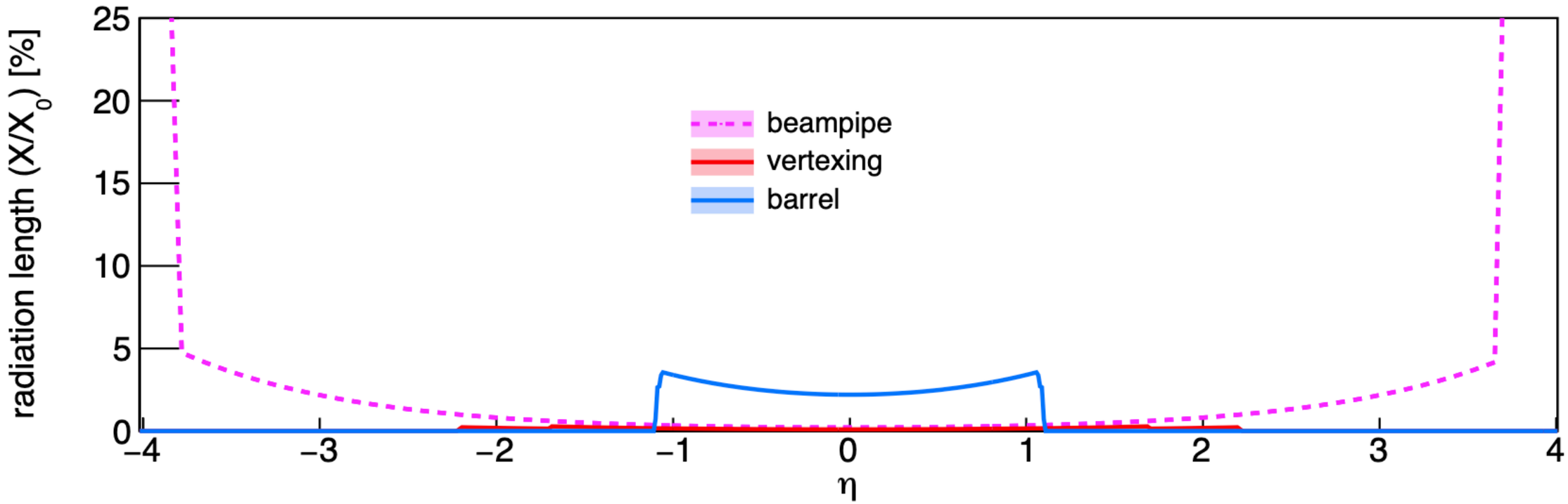


Vertexing layers (see here):

- Transverse material budget:
  - X/X0 = 0.05%
- Layer 1:
  - r = 3.3 cm
  - z length = 30 cm
- Layer 2:
  - r = 5.7 cm
  - z length = 30 cm

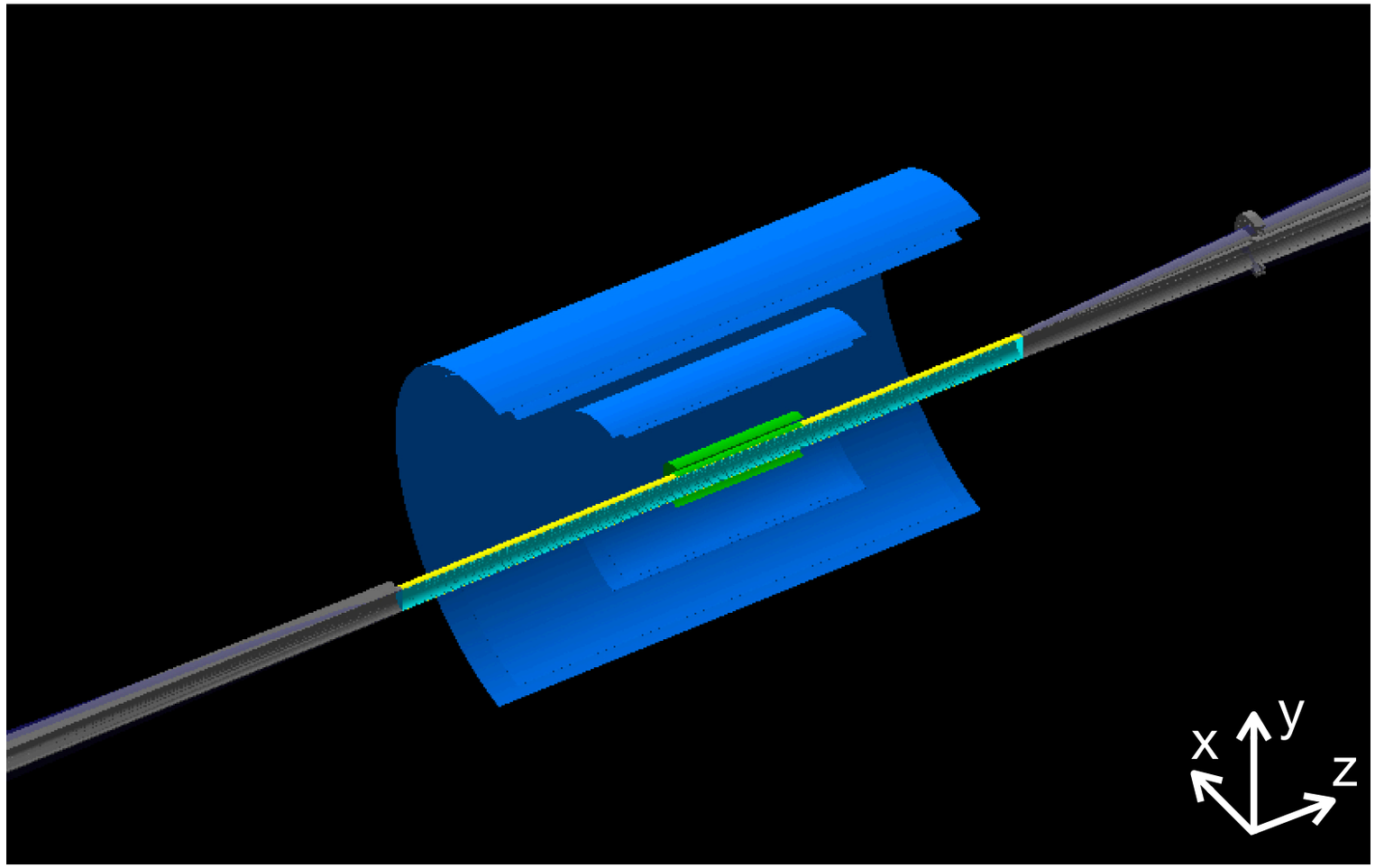


Detector Material Budget

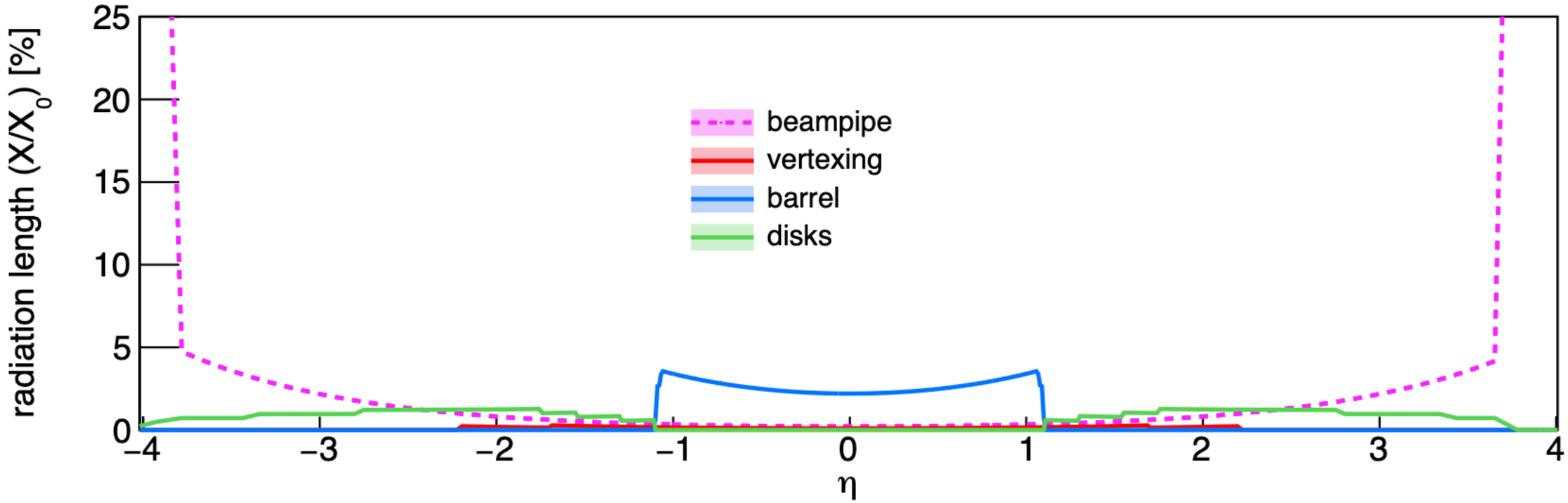


Barrel layers (see here):

- Transverse material budget:
  - X/X0 = 0.55%
- L1: r=21.00, z length=54 cm
- L2: r=22.68, z length=60 cm
- L3: r=39.30, z length=105 cm
- L4: r=43.23, z length=114 cm



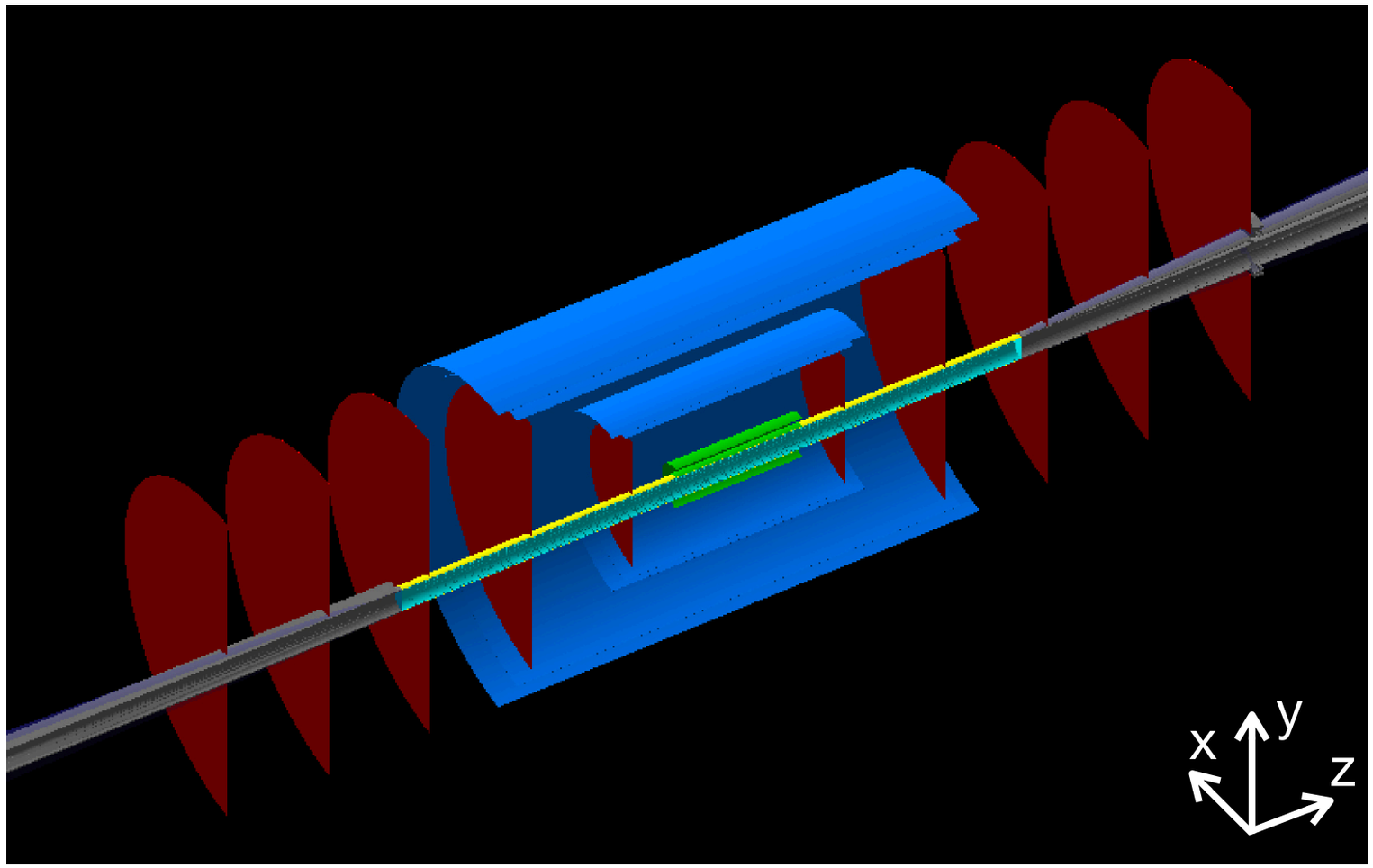
Detector Material Budget



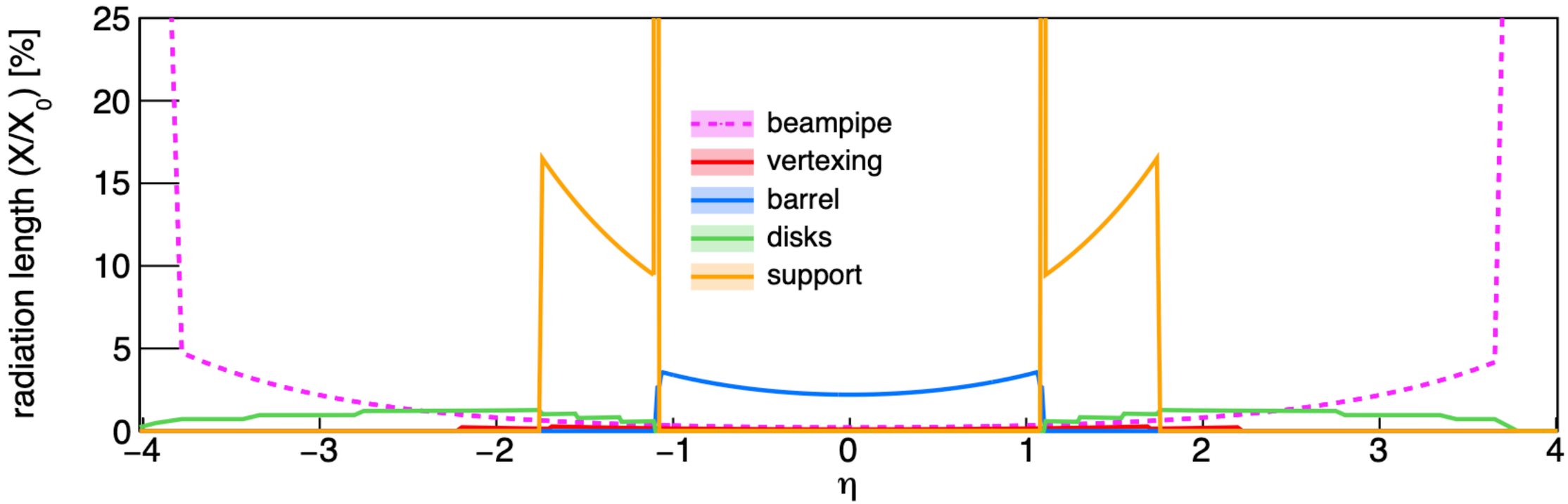
Disk layers (see here):

- Transverse material budget:
  - X/X0 = 0.24%

	z,	rout,	rin [cm]
1:	-121,	43.23,	4.41
2:	-97,	43.23,	3.70
3:	-73,	43.23,	3.18
4:	-49,	36.26,	3.18
5:	-25,	18.50,	3.18
6:	25,	18.50,	3.18
7:	49,	36.26,	3.18
8:	73,	43.23,	3.50
9:	97,	43.23,	4.70
10:	121,	43.23,	5.91

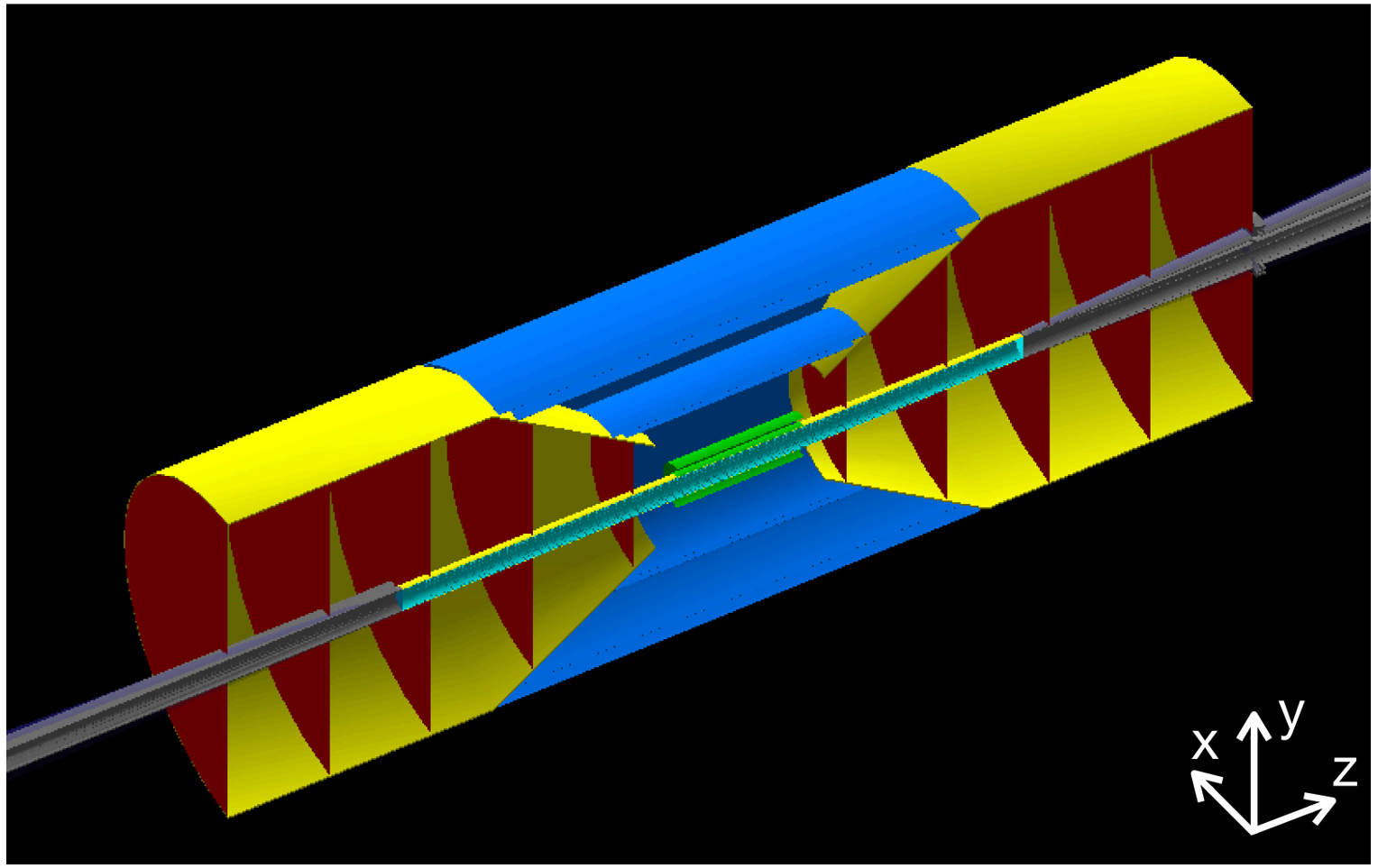


Detector Material Budget

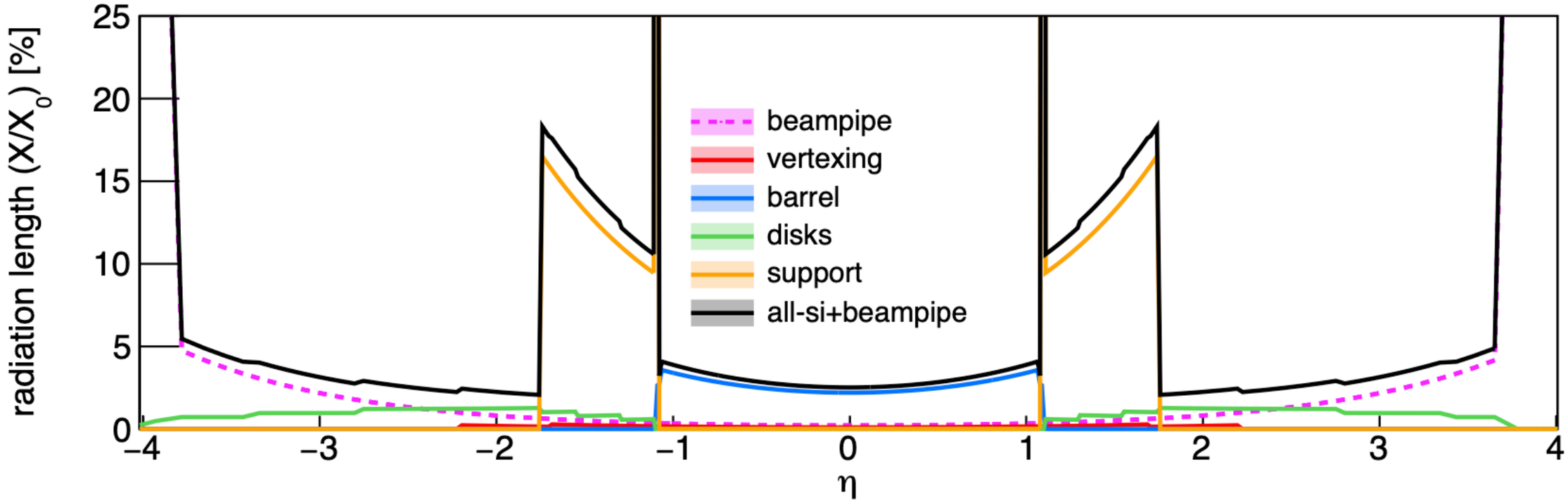


Support and services (see here):

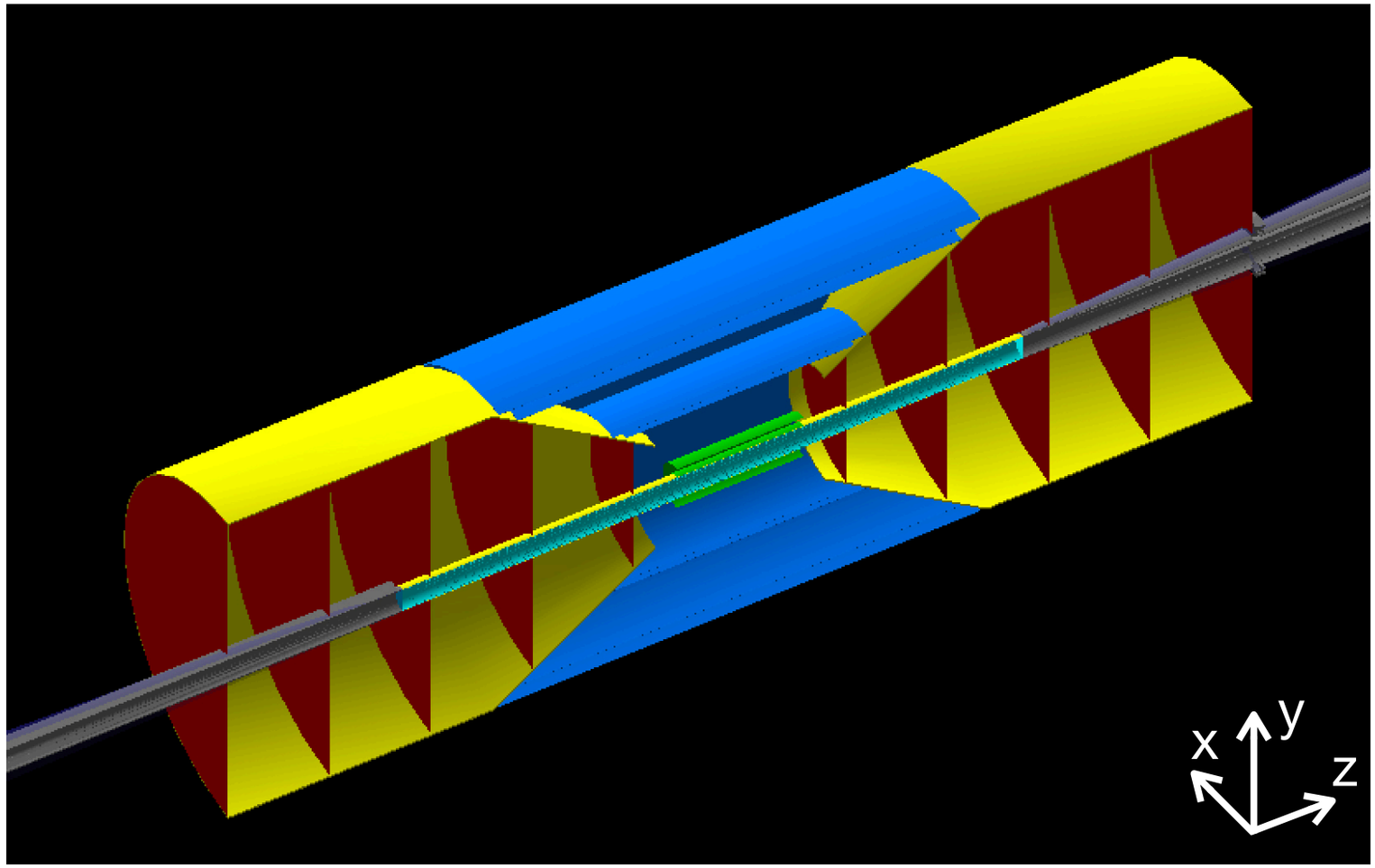
- Thickness: 0.5 cm
- Cone from (z [cm], ρ [cm]) = (20,14.8) to (58.42,43.23)
- Cylinder from (58.42,43.23) to (121,43.23)



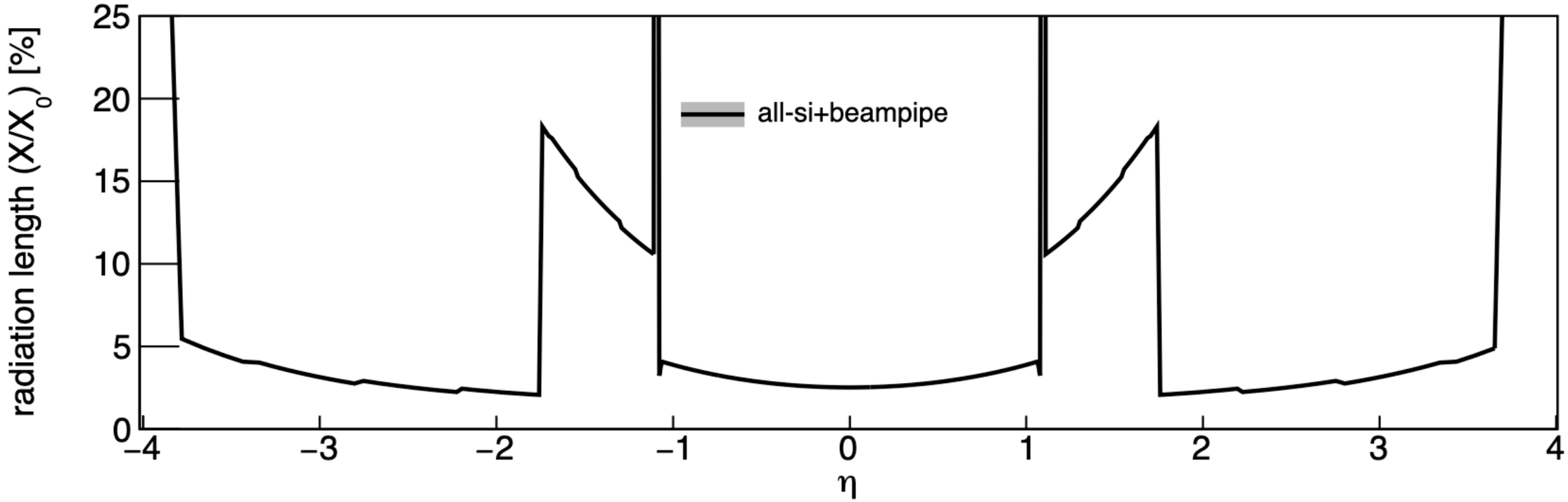
Detector Material Budget



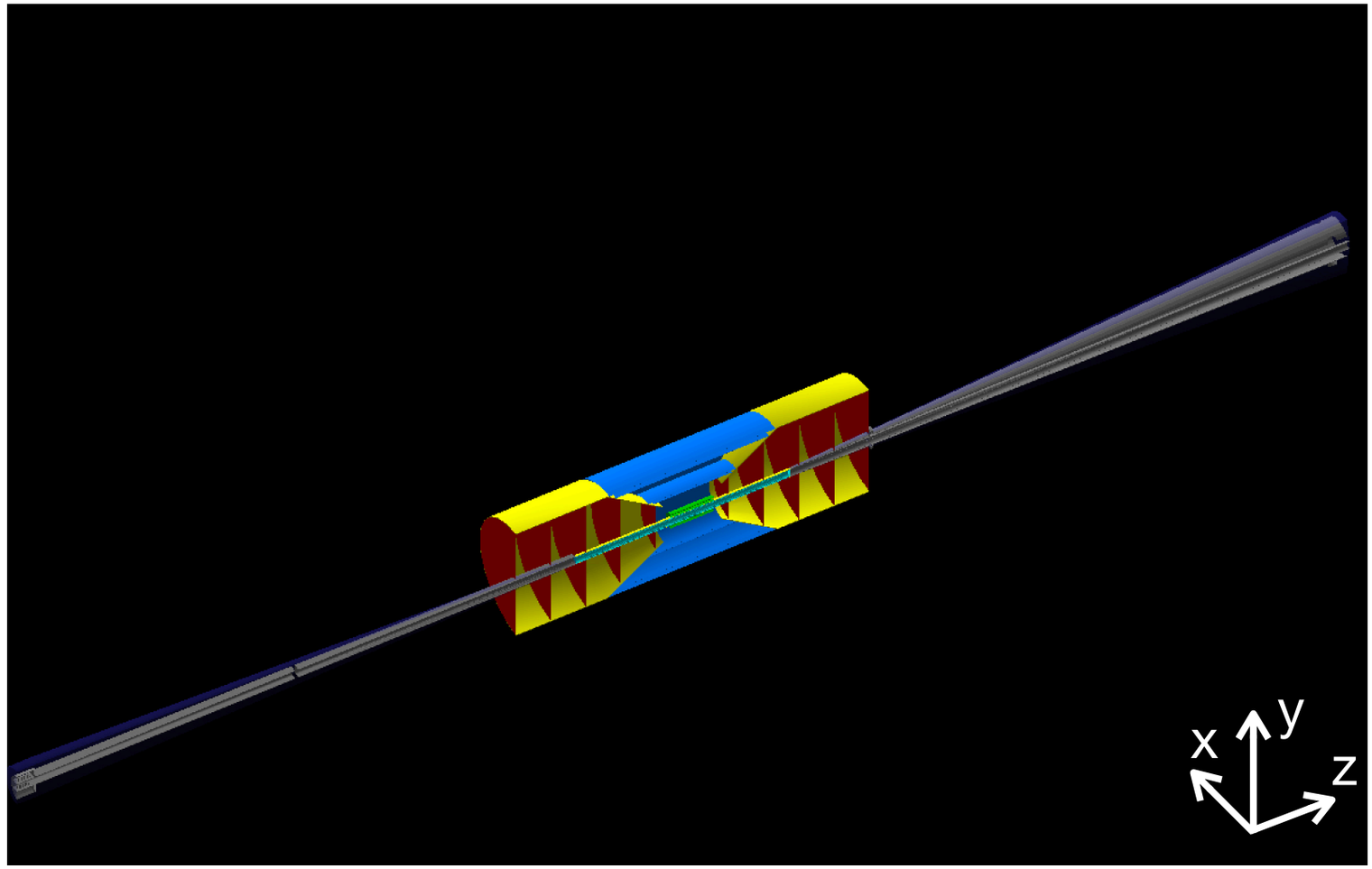
Combined all-silicon tracker material budget



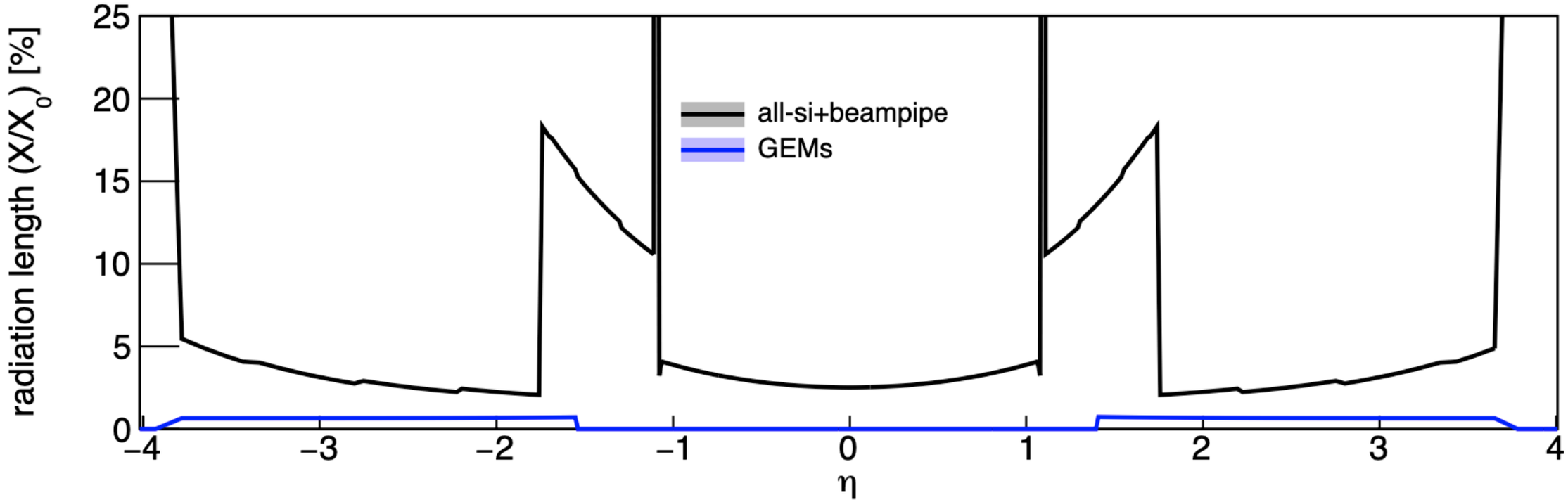
Detector Material Budget



Combined all-silicon tracker material budget

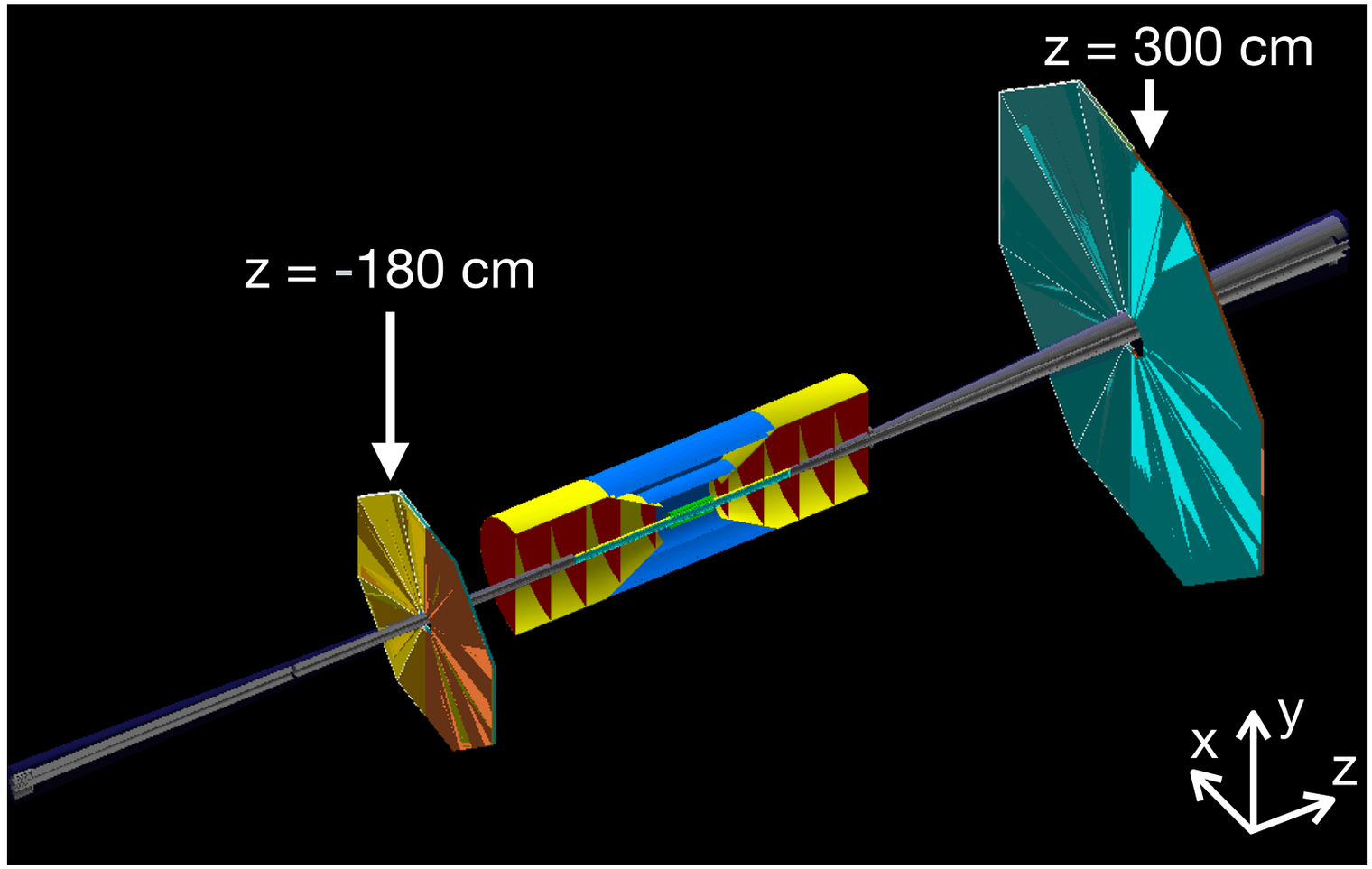


Detector Material Budget

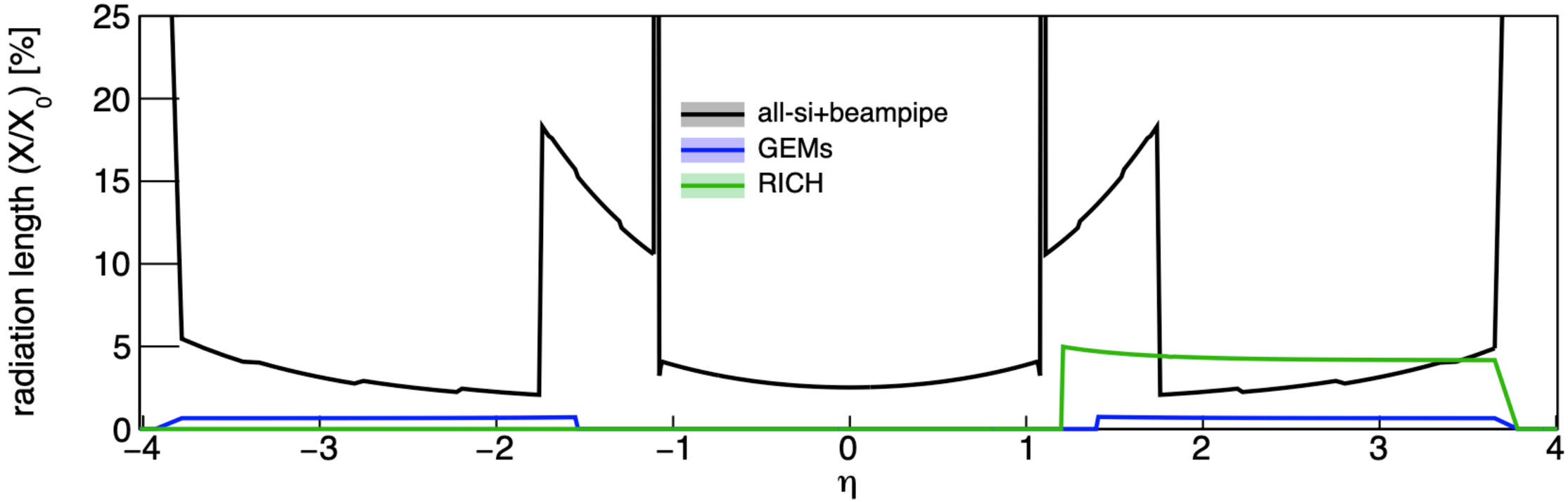


GEMs (see here):

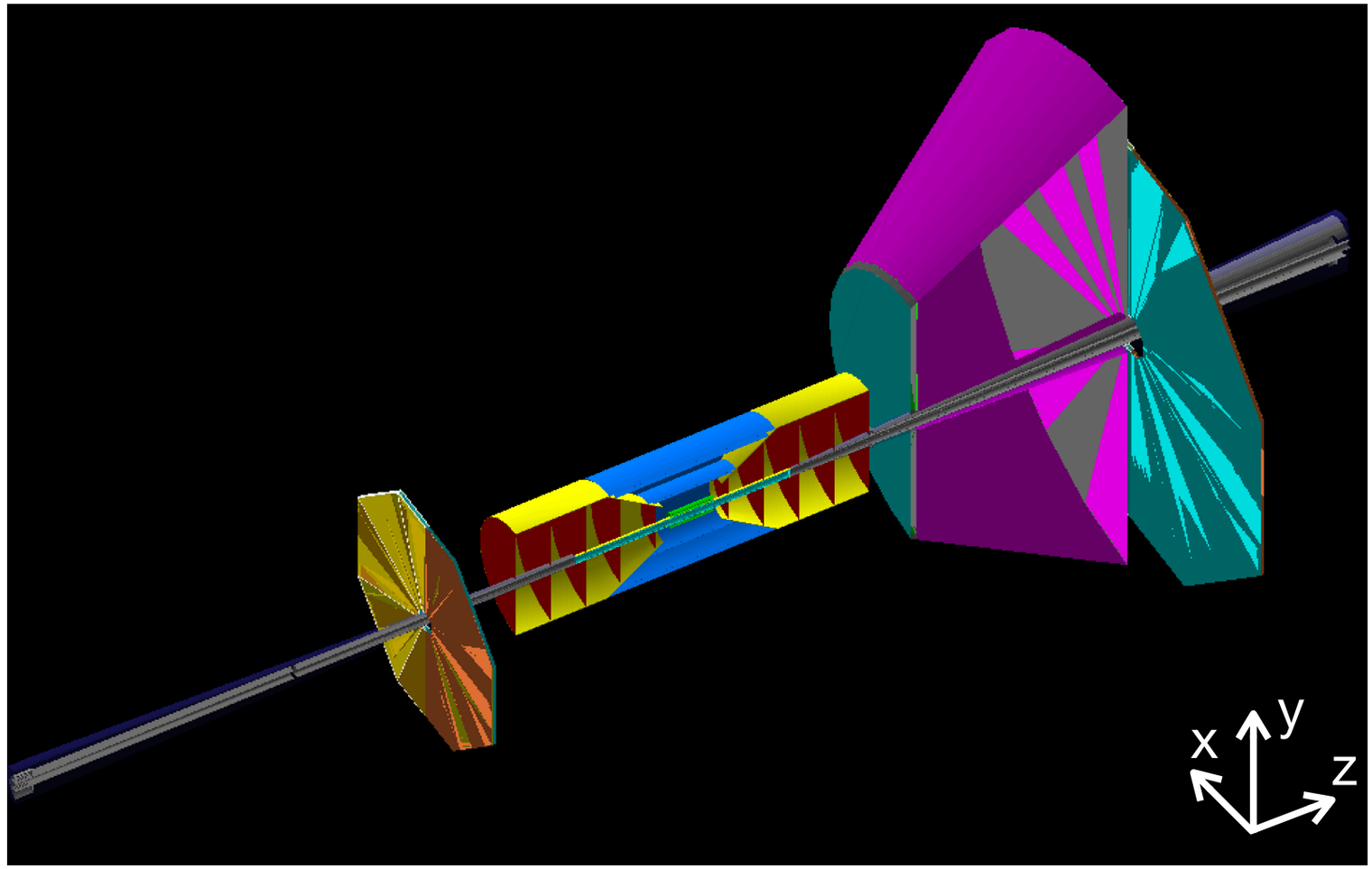
- $\sigma_{r\phi} = 50\ \mu\mathrm{m}$
- z [cm], $\eta_{\min}$, $\eta_{\max}$
- Backward: -180, -1.54, -3.9
- Forward: 300, 1.4, 3.69
- Material budget: X/X0 ~ 0.7%



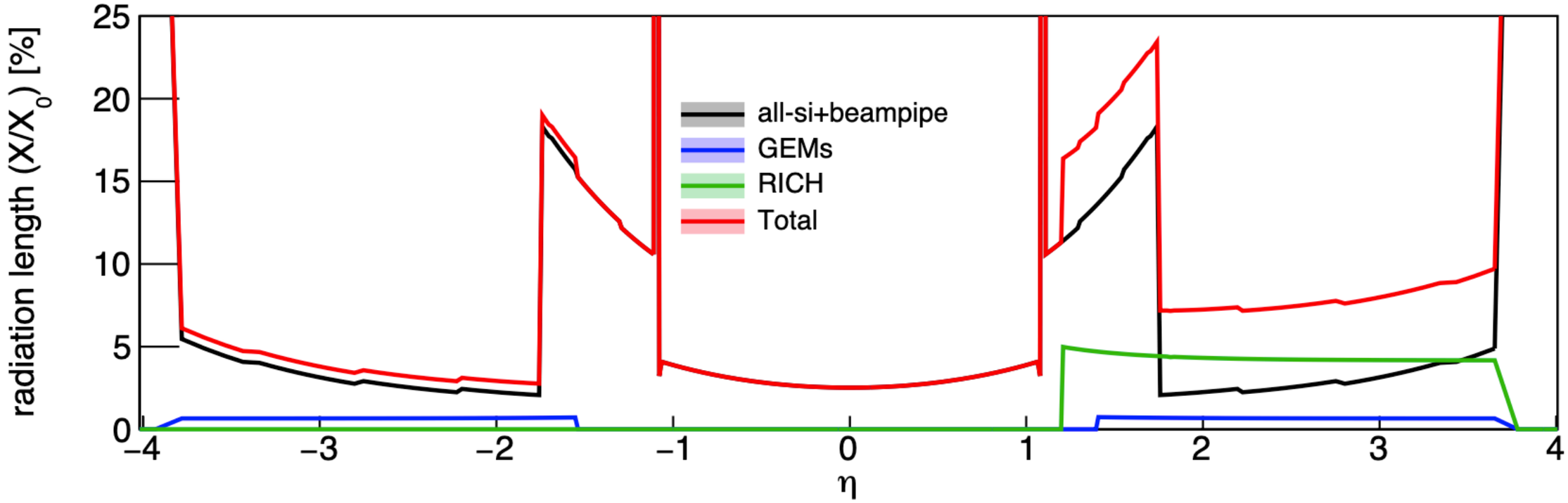
Detector Material Budget



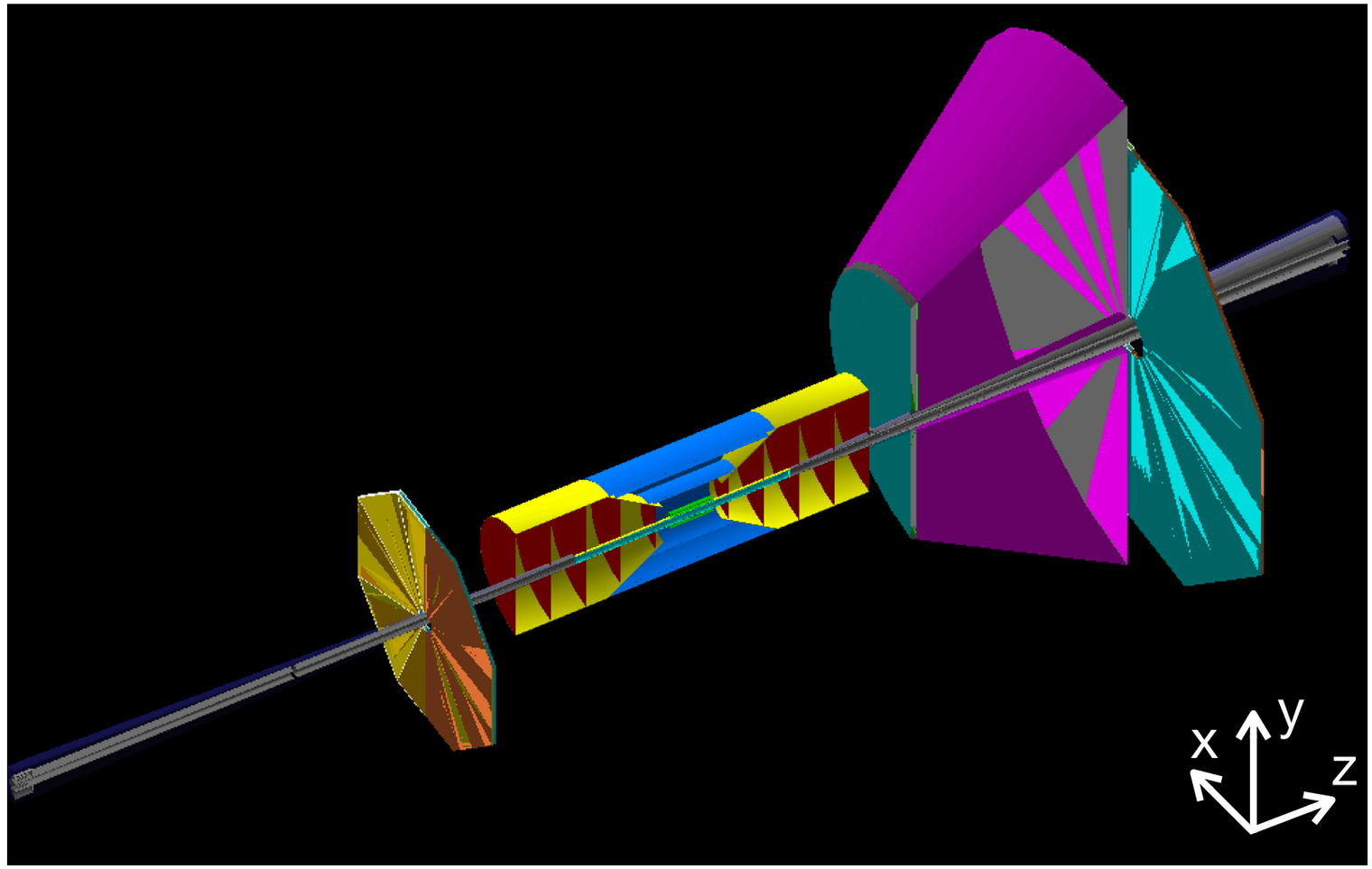
RICH (see here):



Detector Material Budget

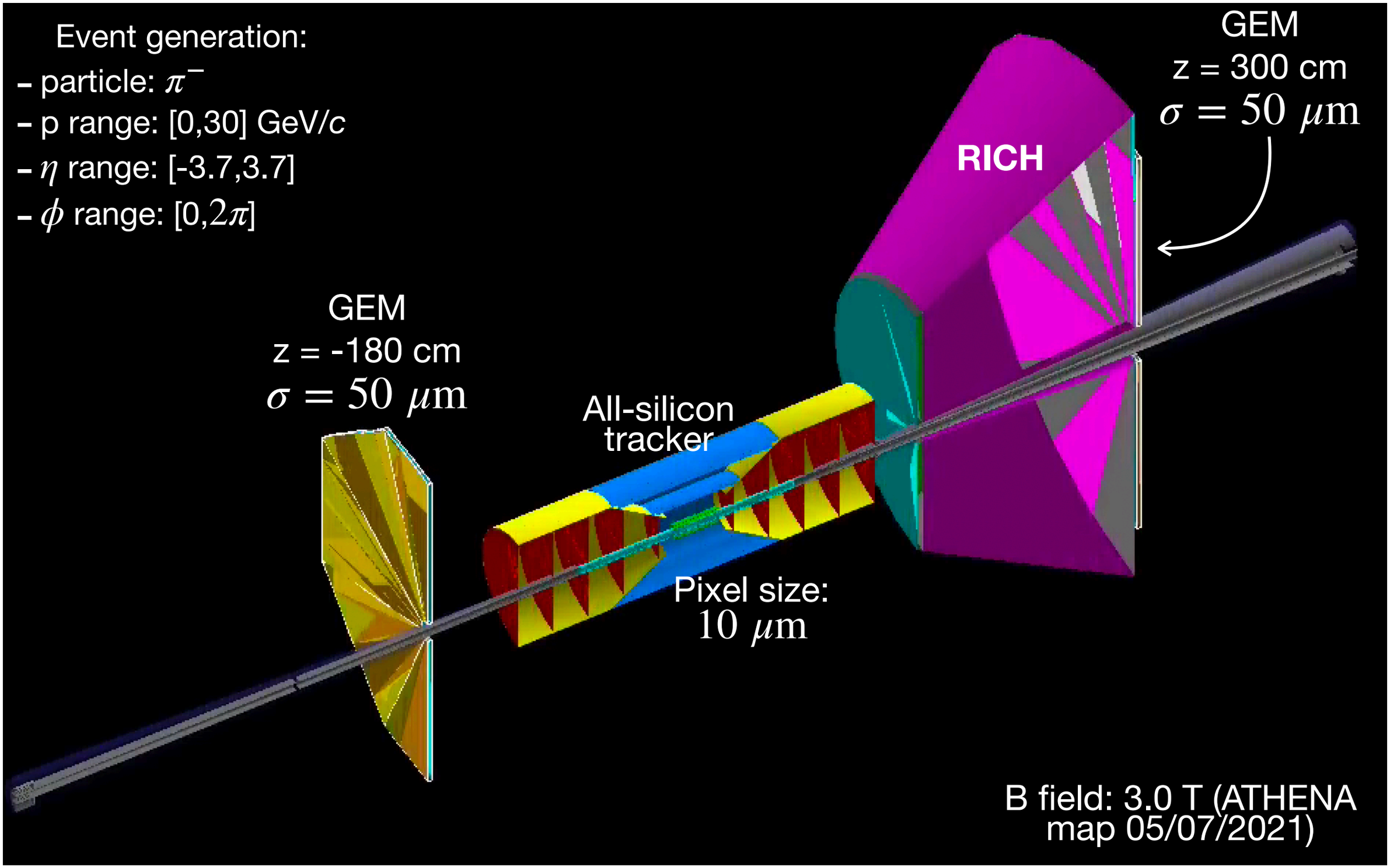


Total Material Budget

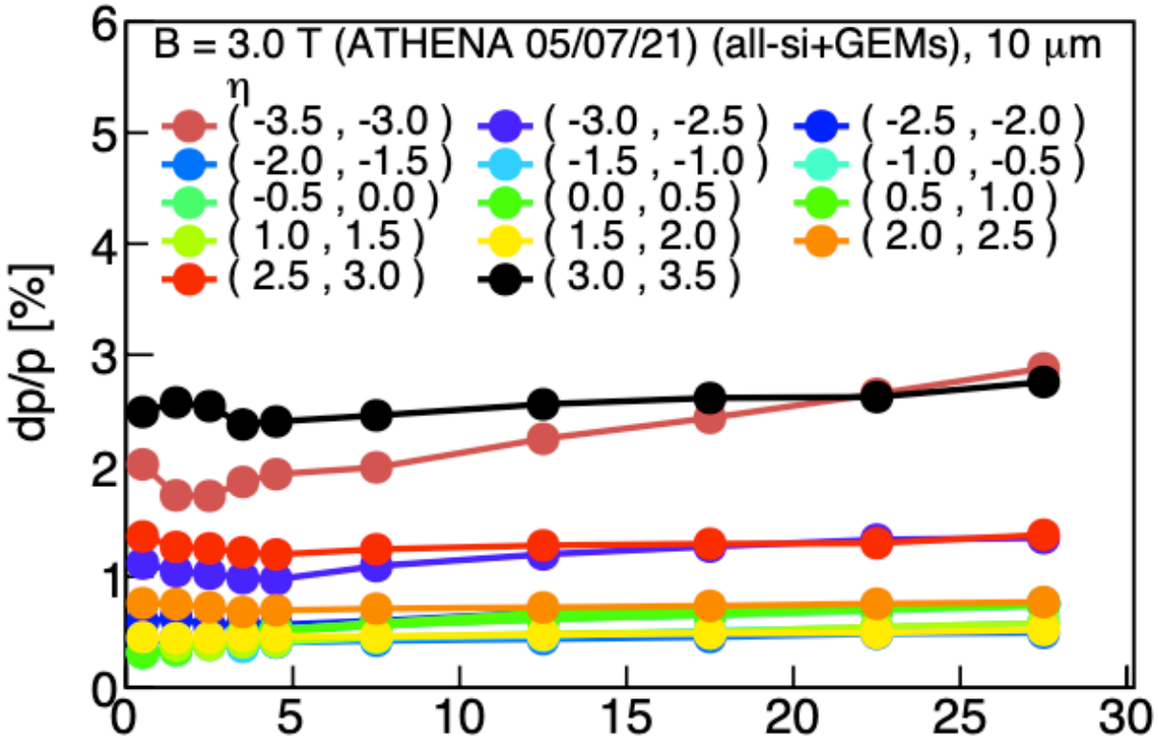


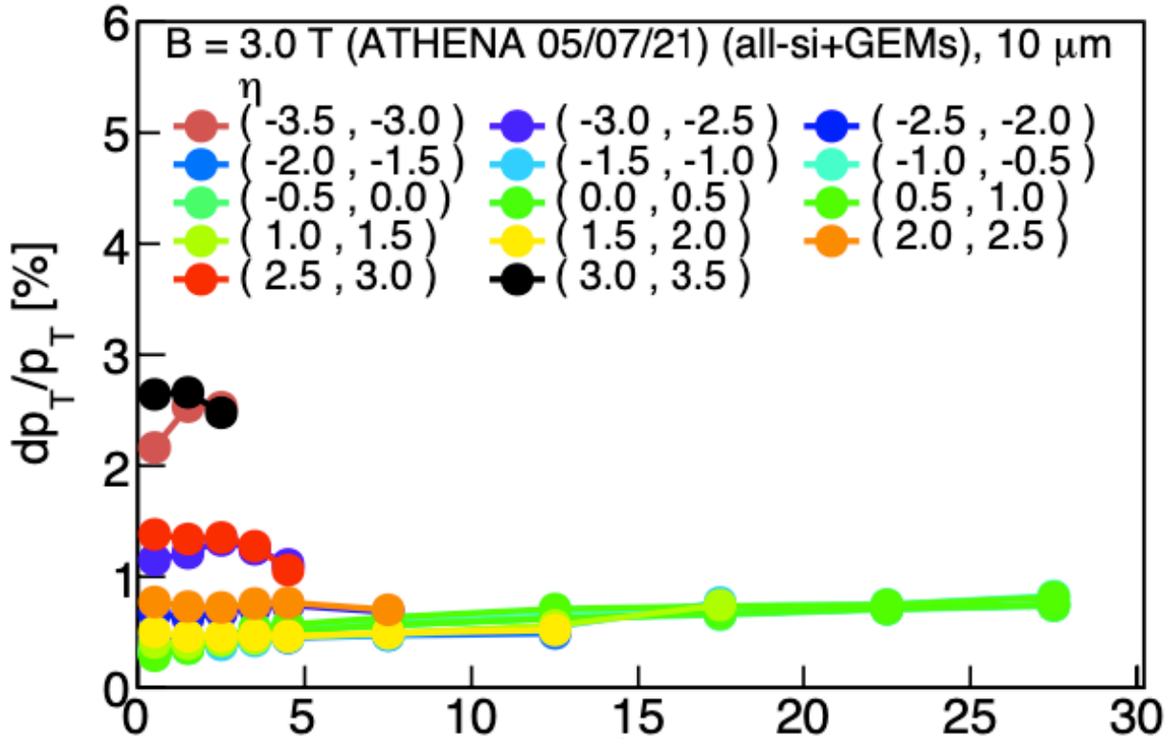
Setup

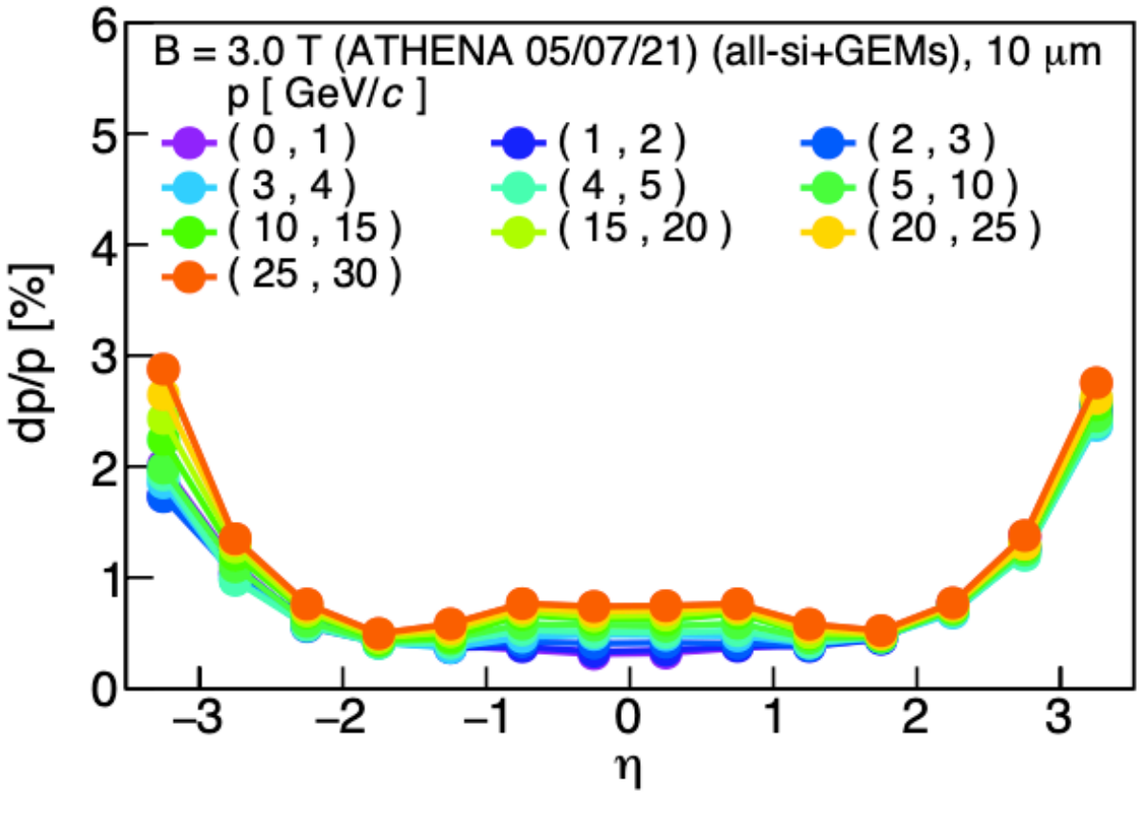
Event generation:
- particle: π^-
- p range: [0,30] GeV/c
- η range: [-3.7,3.7]
- ϕ range: [0,2π]

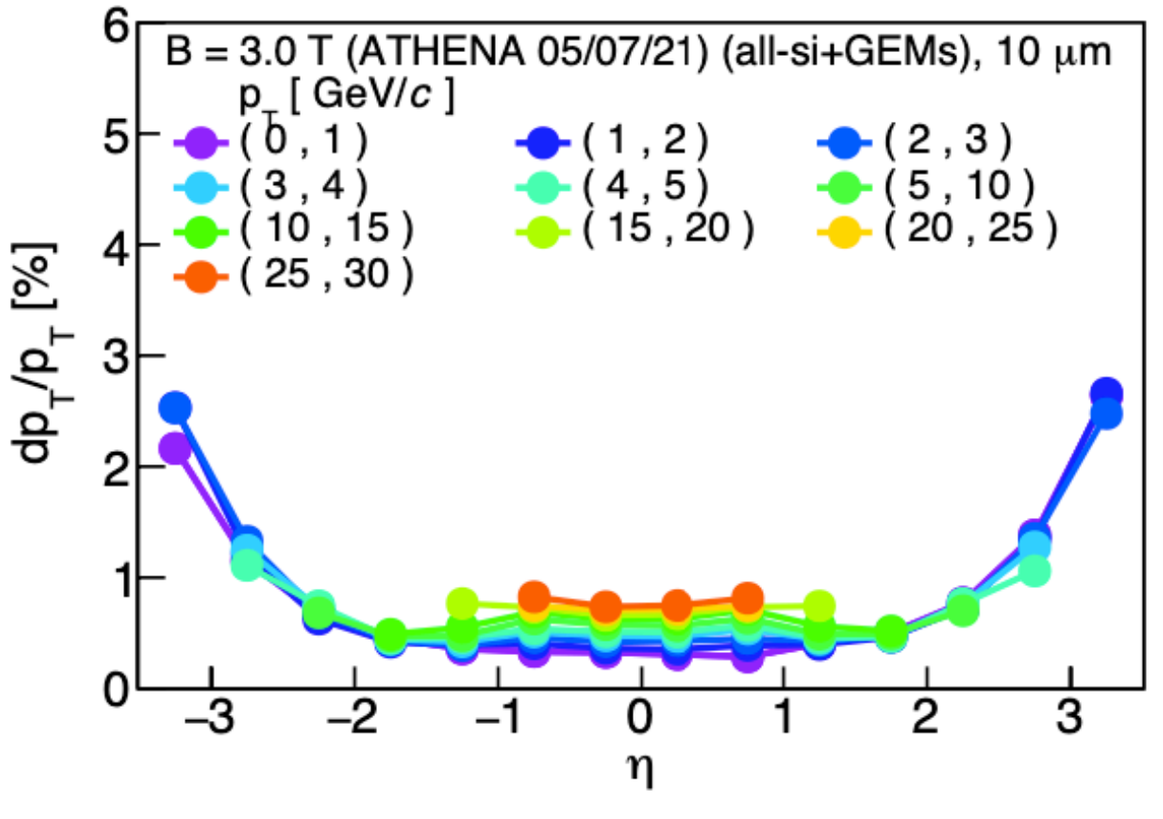


Momentum resolutions

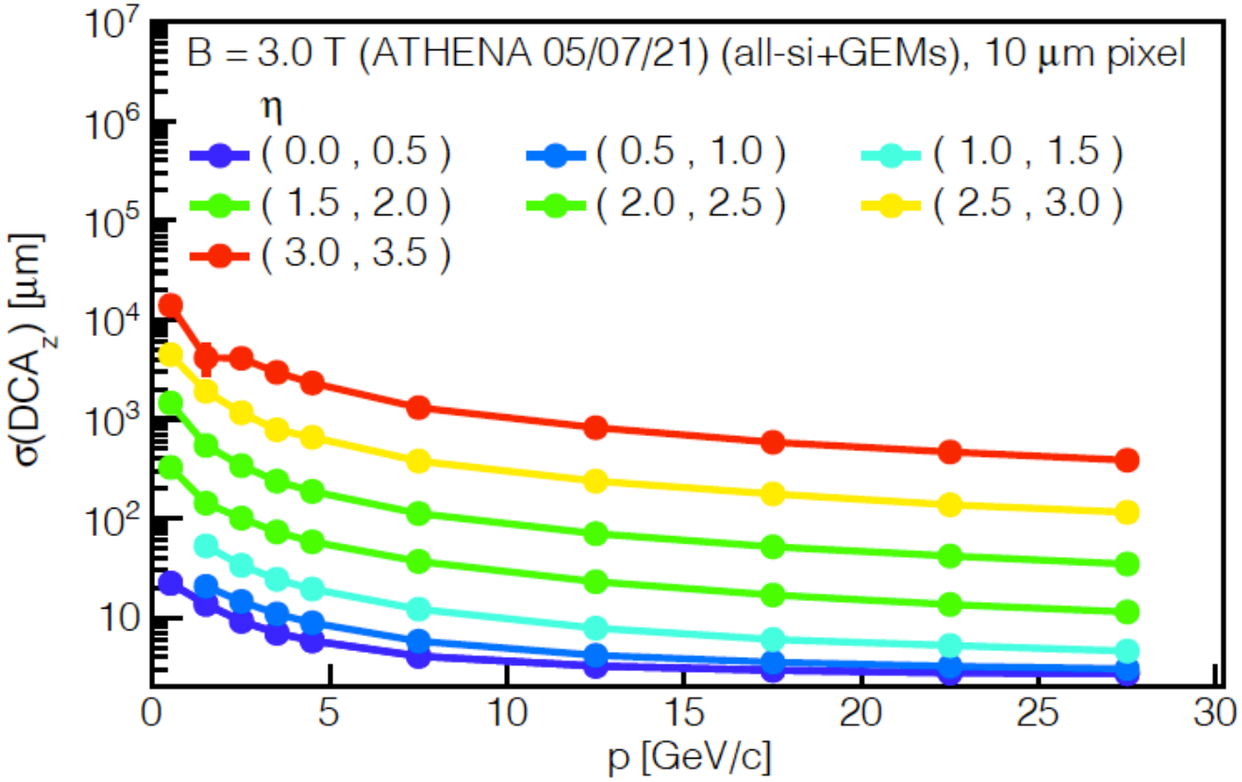


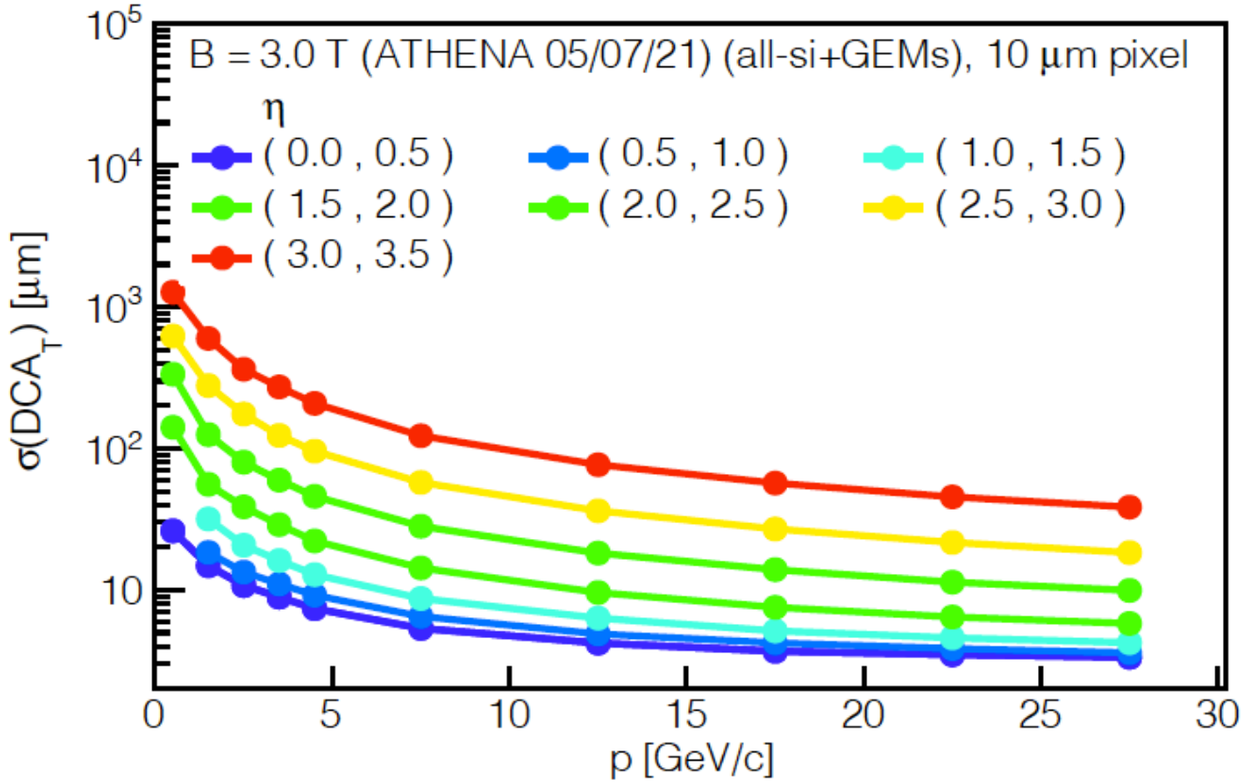


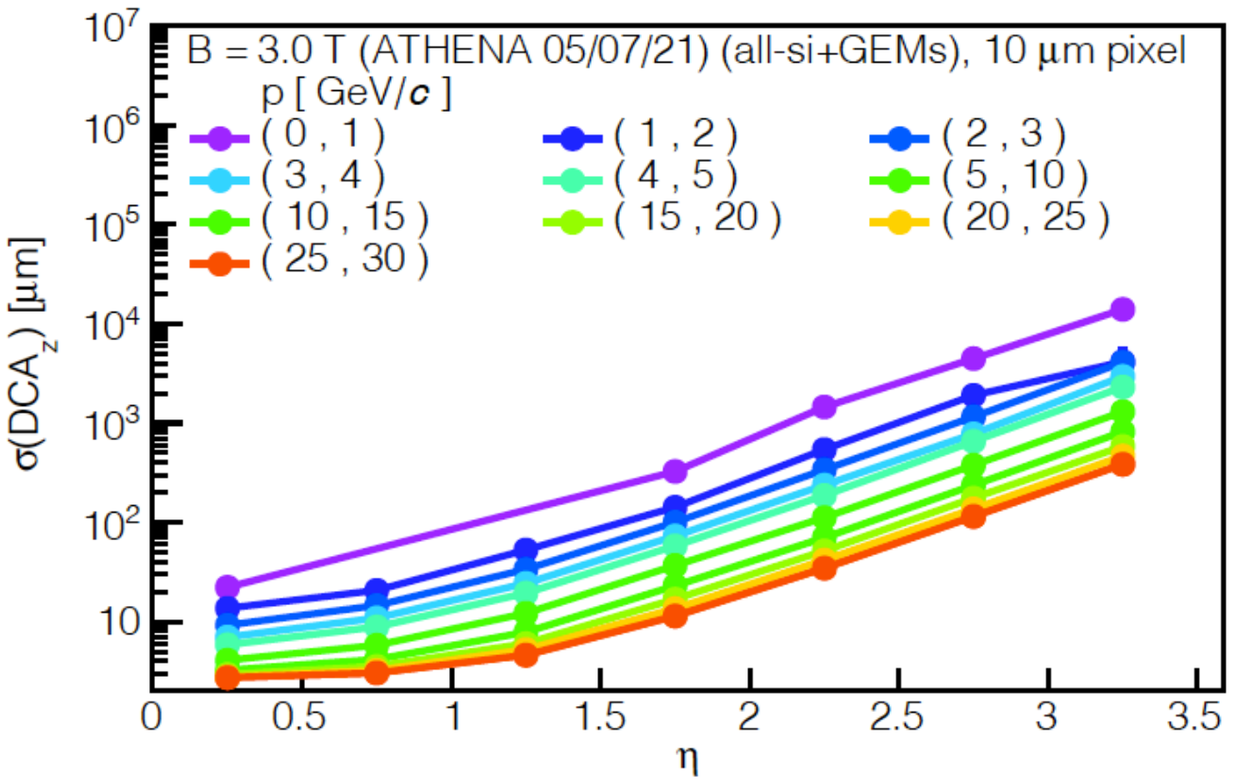


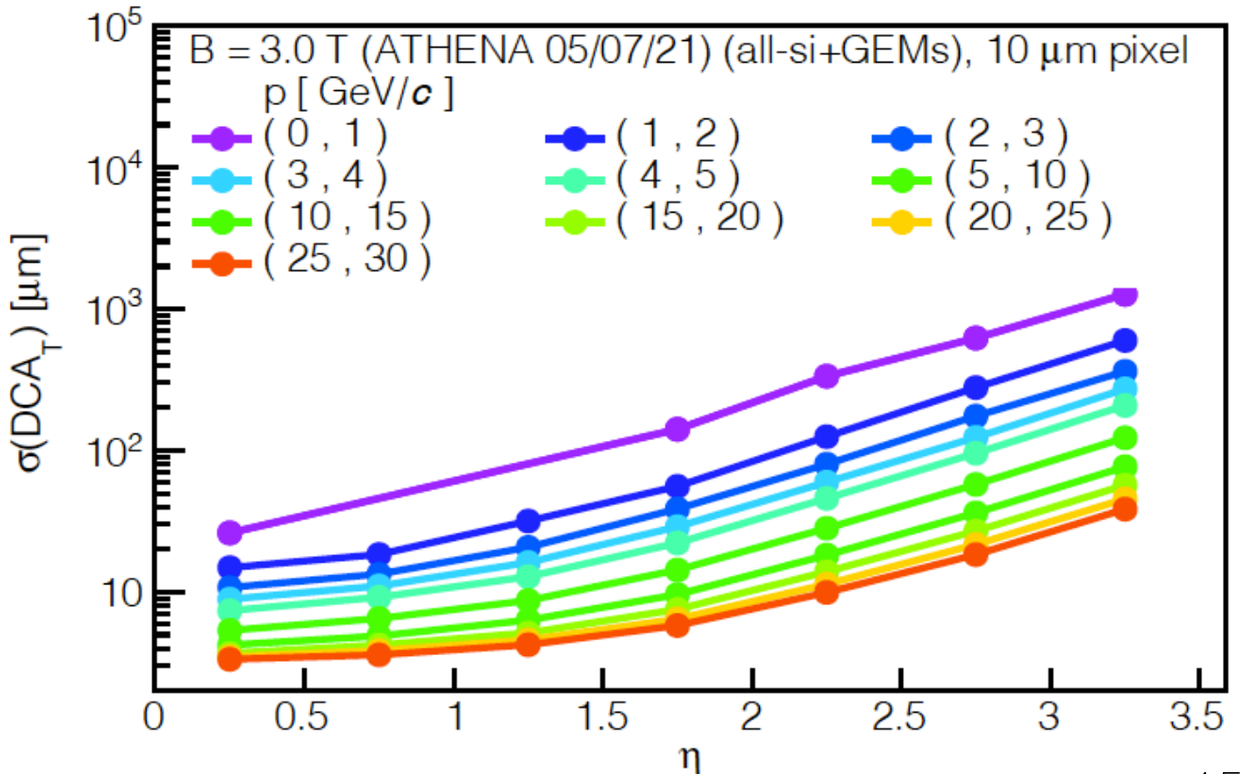


DCA resolutions

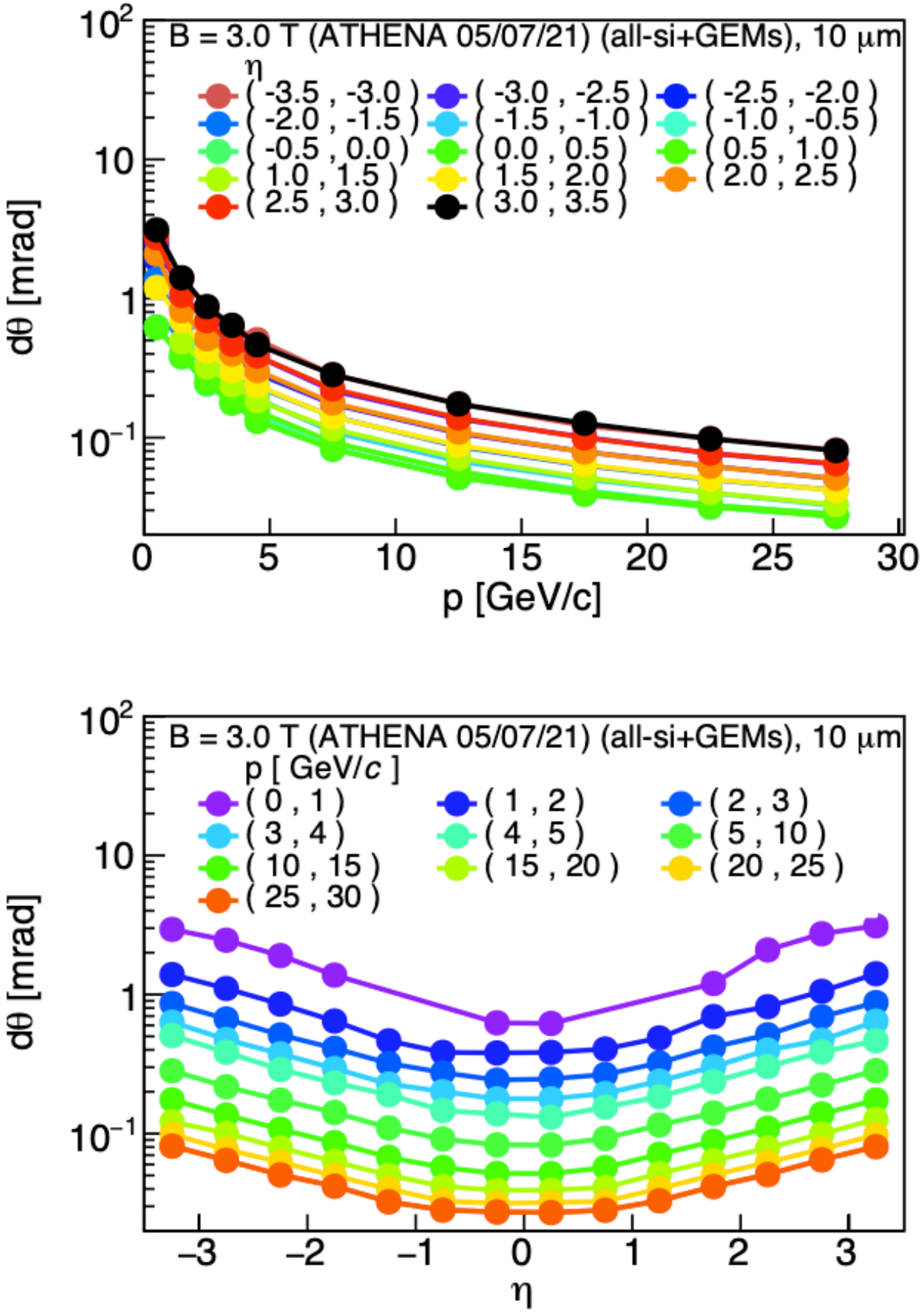


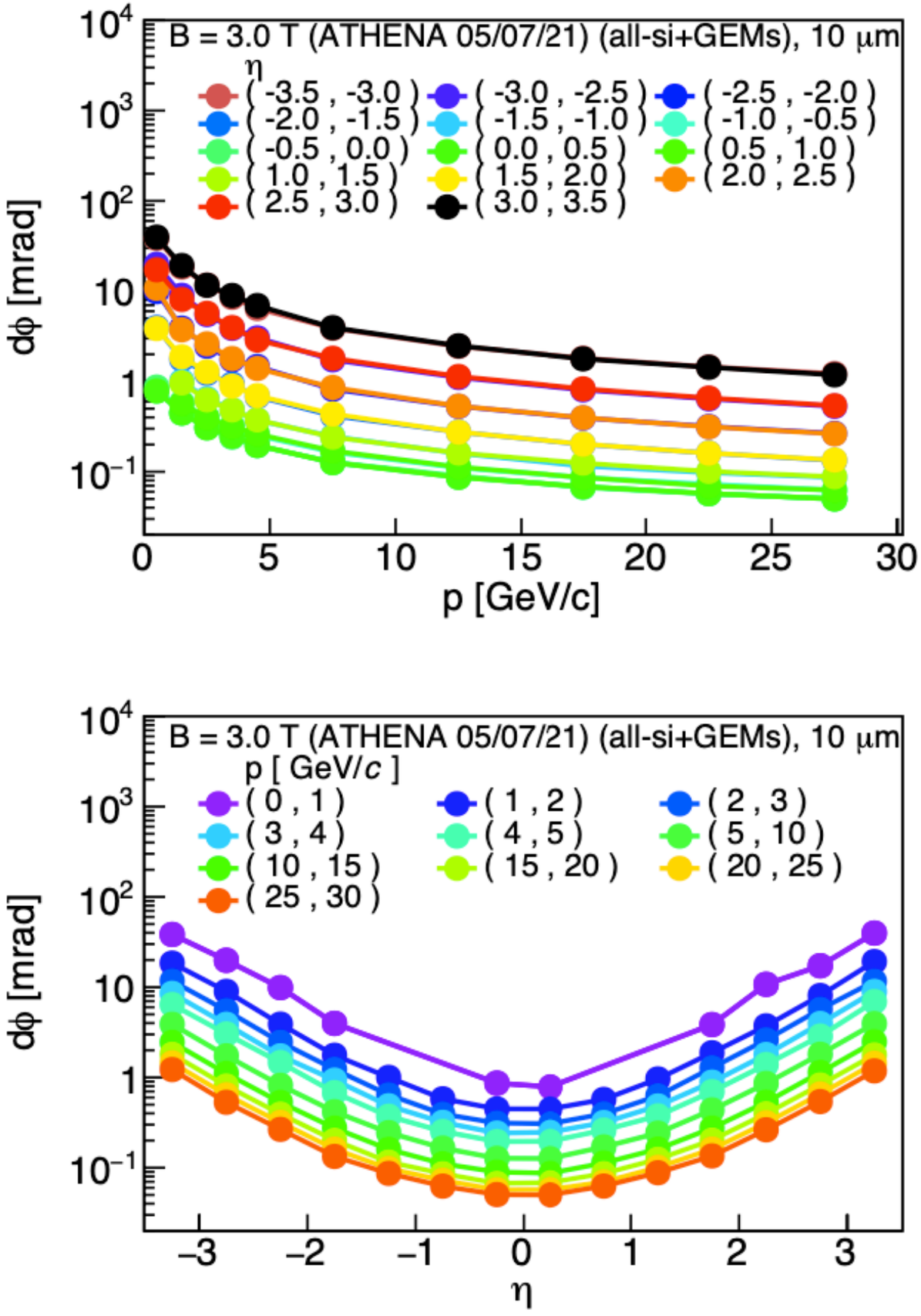




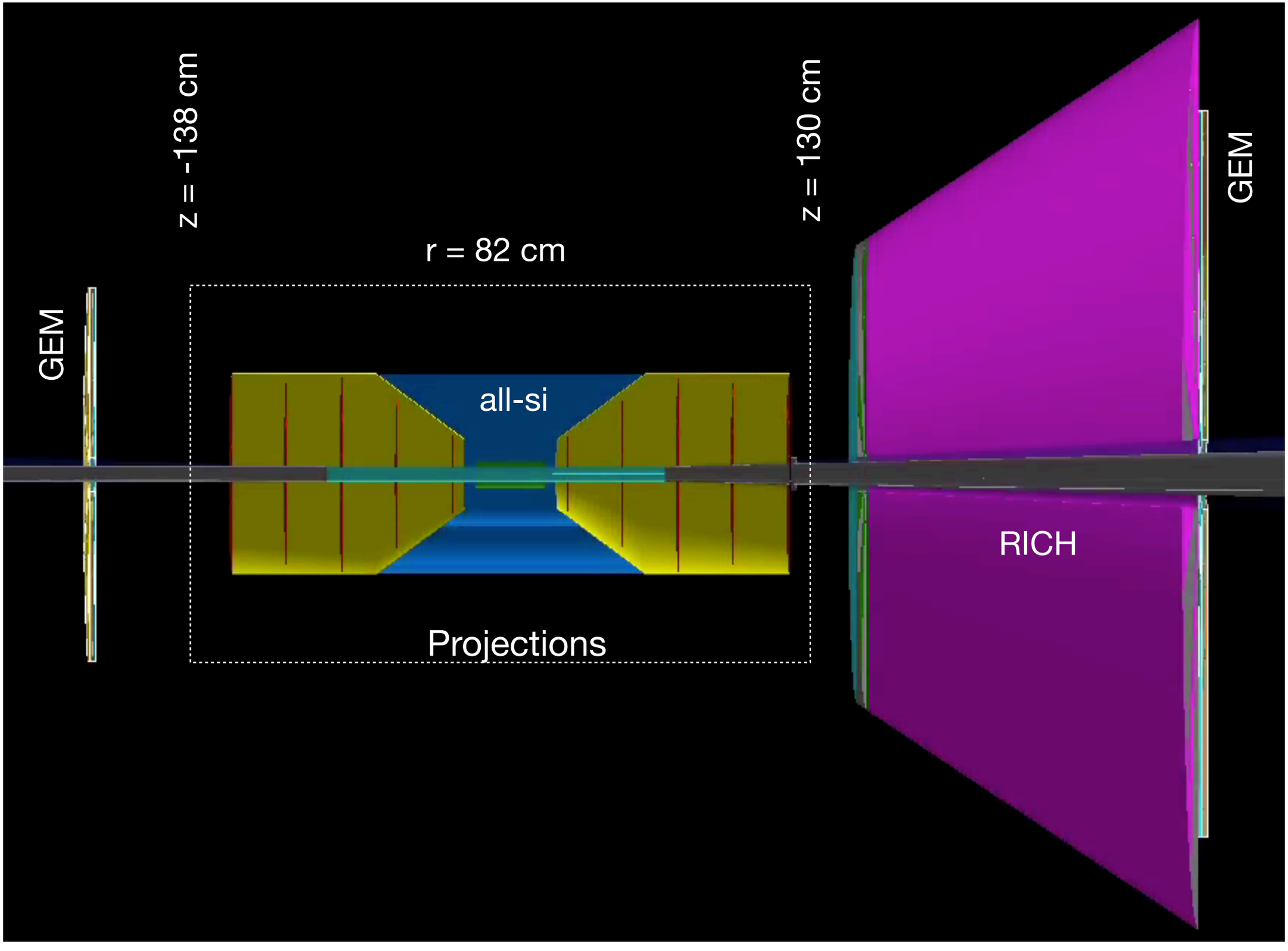


Angular Resolutions @vtx

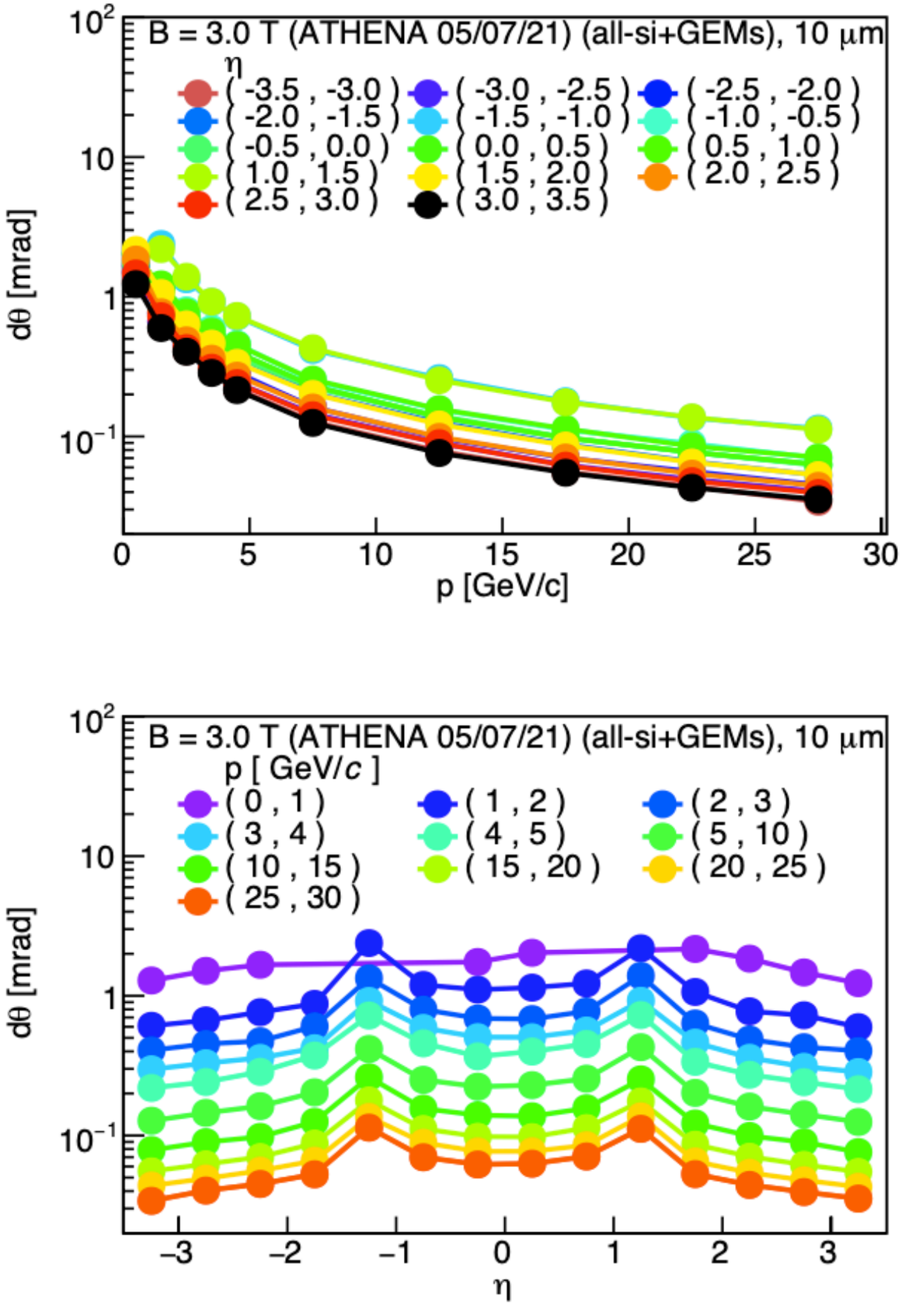


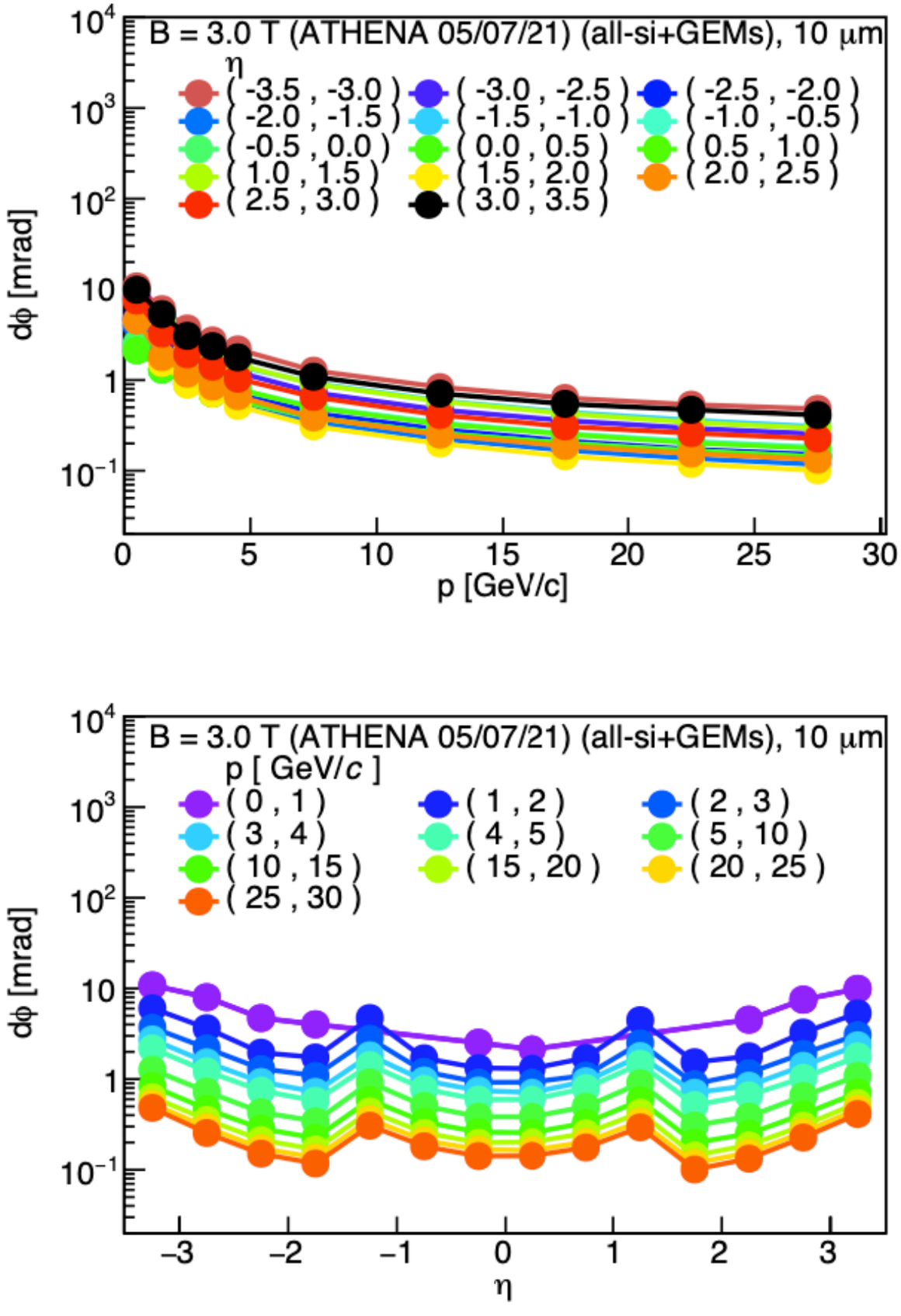


Angular Resolutions @PID

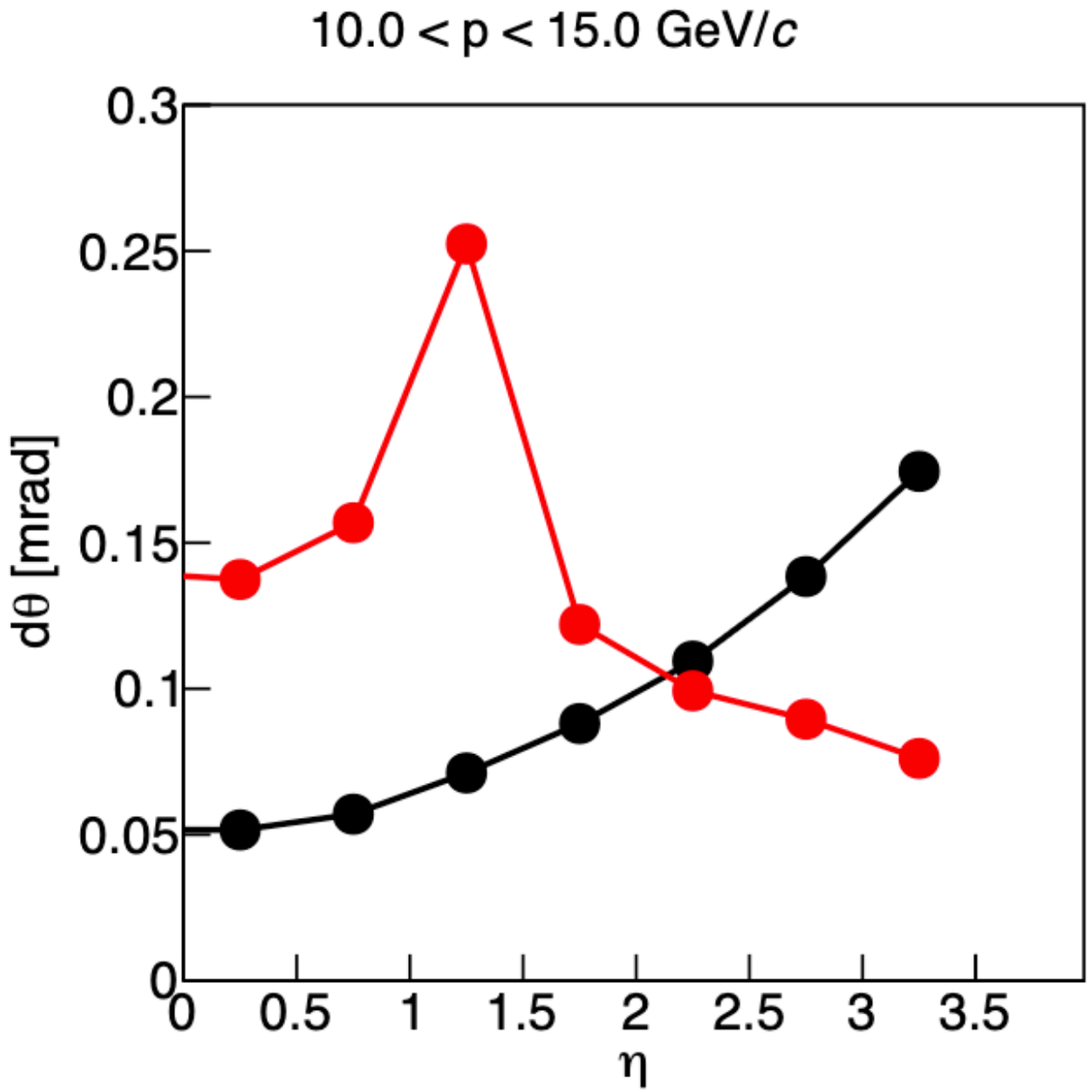


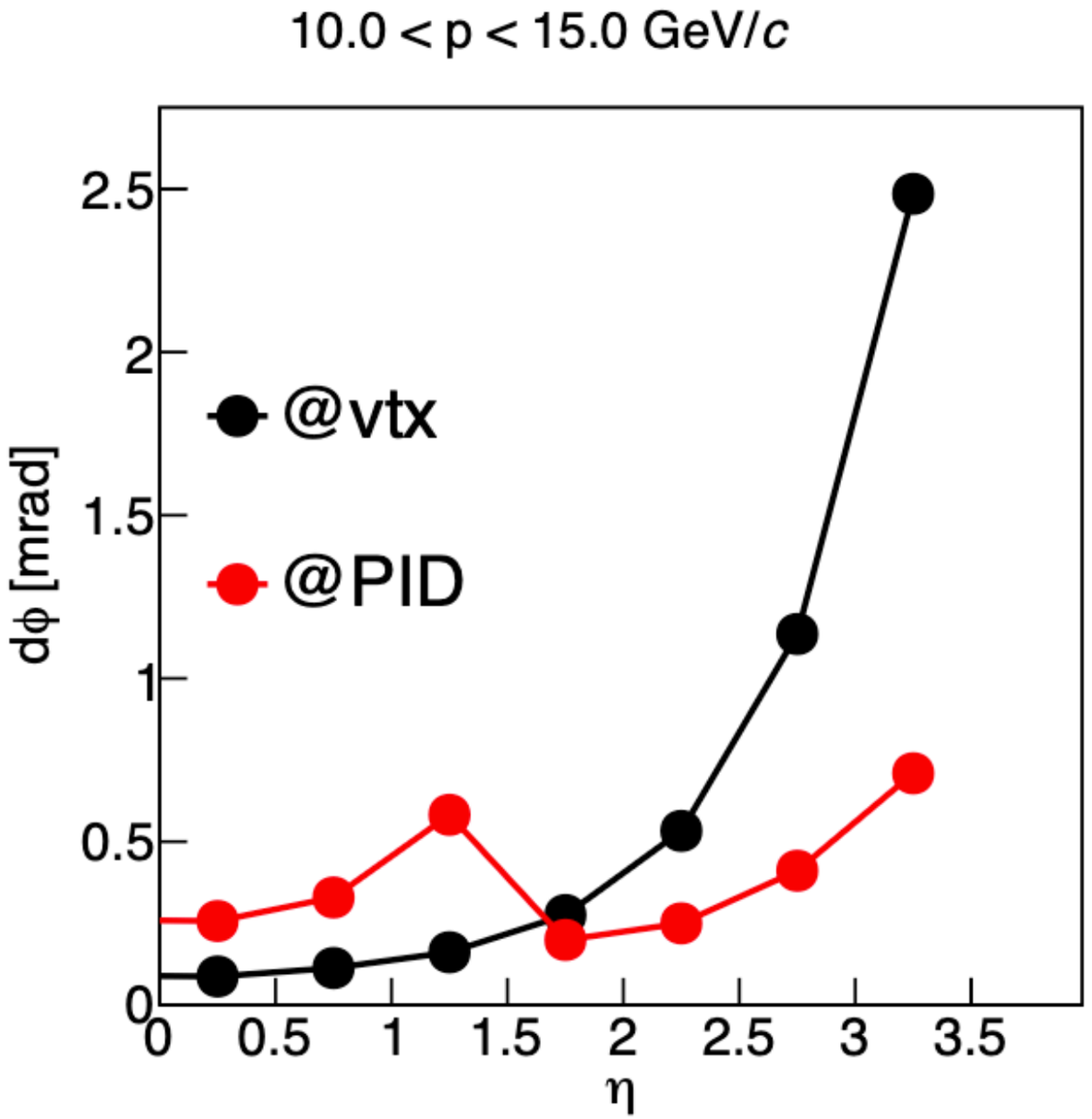
Angular Resolutions @PID





Angular Resolutions





Summary

- Benchmark figures requested were presented for “baseline 1”
  - Material budget
  - Momentum resolutions (both p and p_{T})
  - DCA resolutions (longitudinal and transverse)
  - Angular resolutions (at vertex and at entrance of PID detectors)
- Class that handles projections in Fun4All uses blackholes (cannot register hits behind the “projection surface”). Need to find away around this.
- These plots are still optimistic as there are services and materials missing.