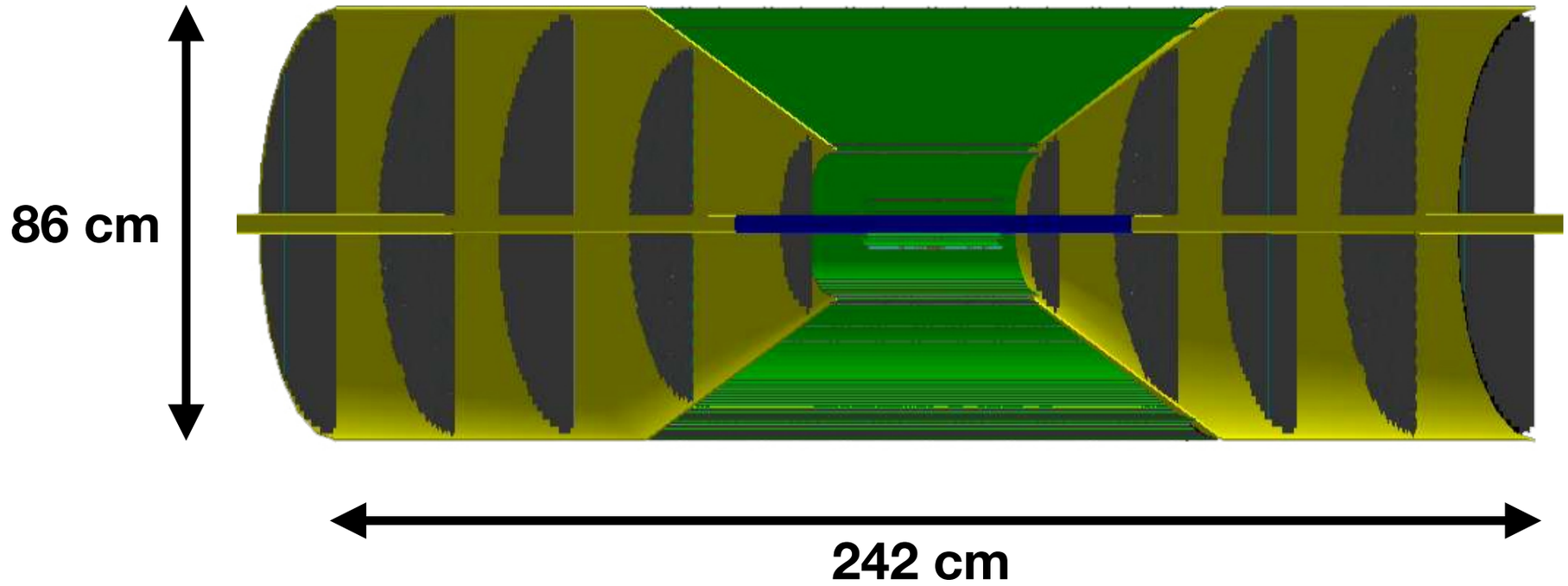
All-Silicon Tracker Geometry Updates

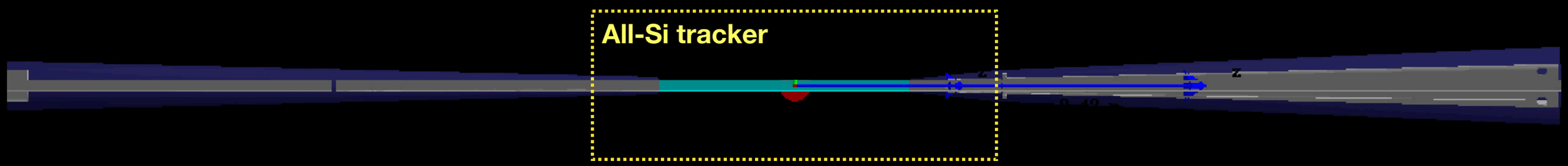


Rey Cruz-Torres
07/30/2020

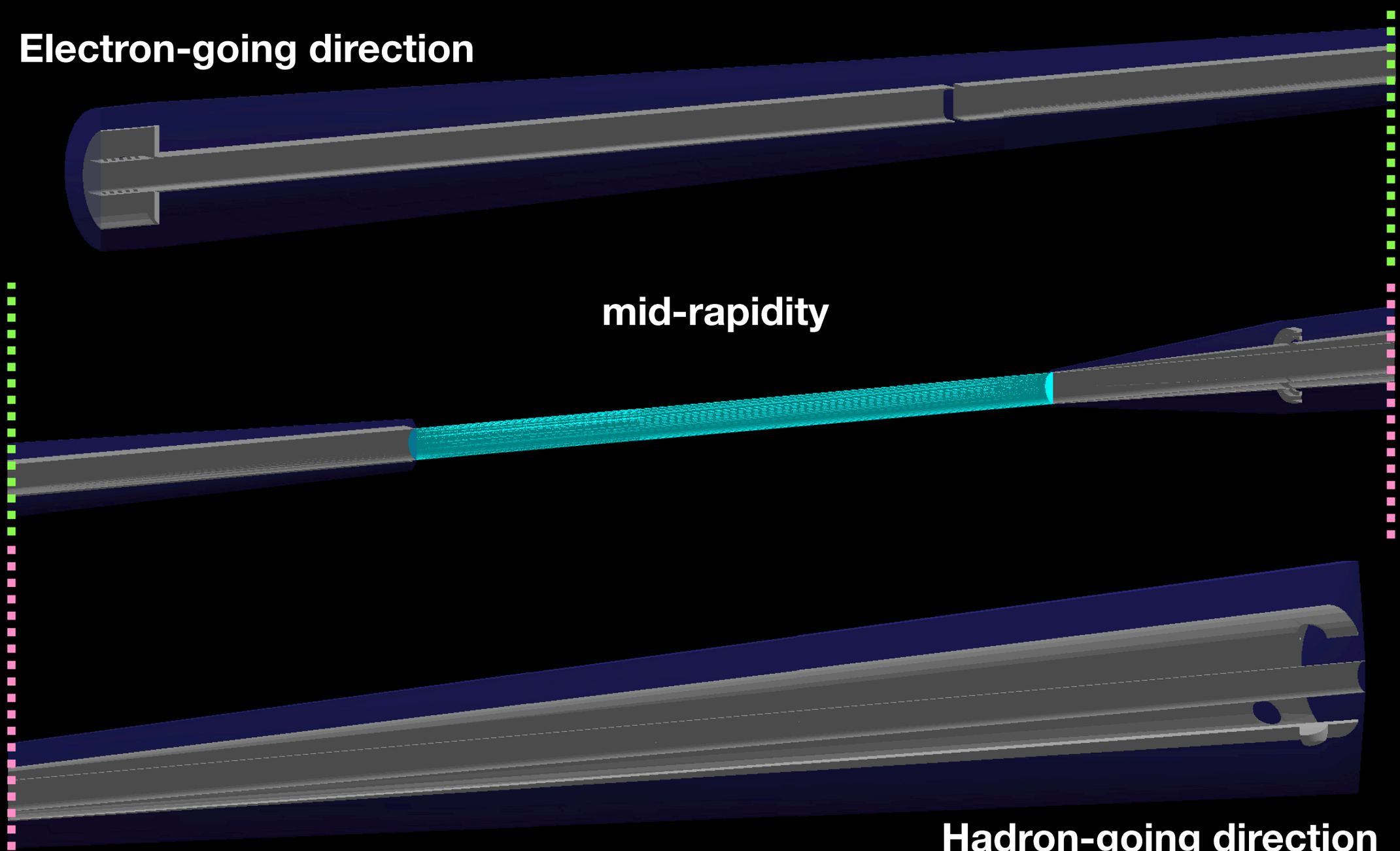
EIC beampipe in Fun4All

Electron-going direction

Hadron-going direction



Electron-going direction



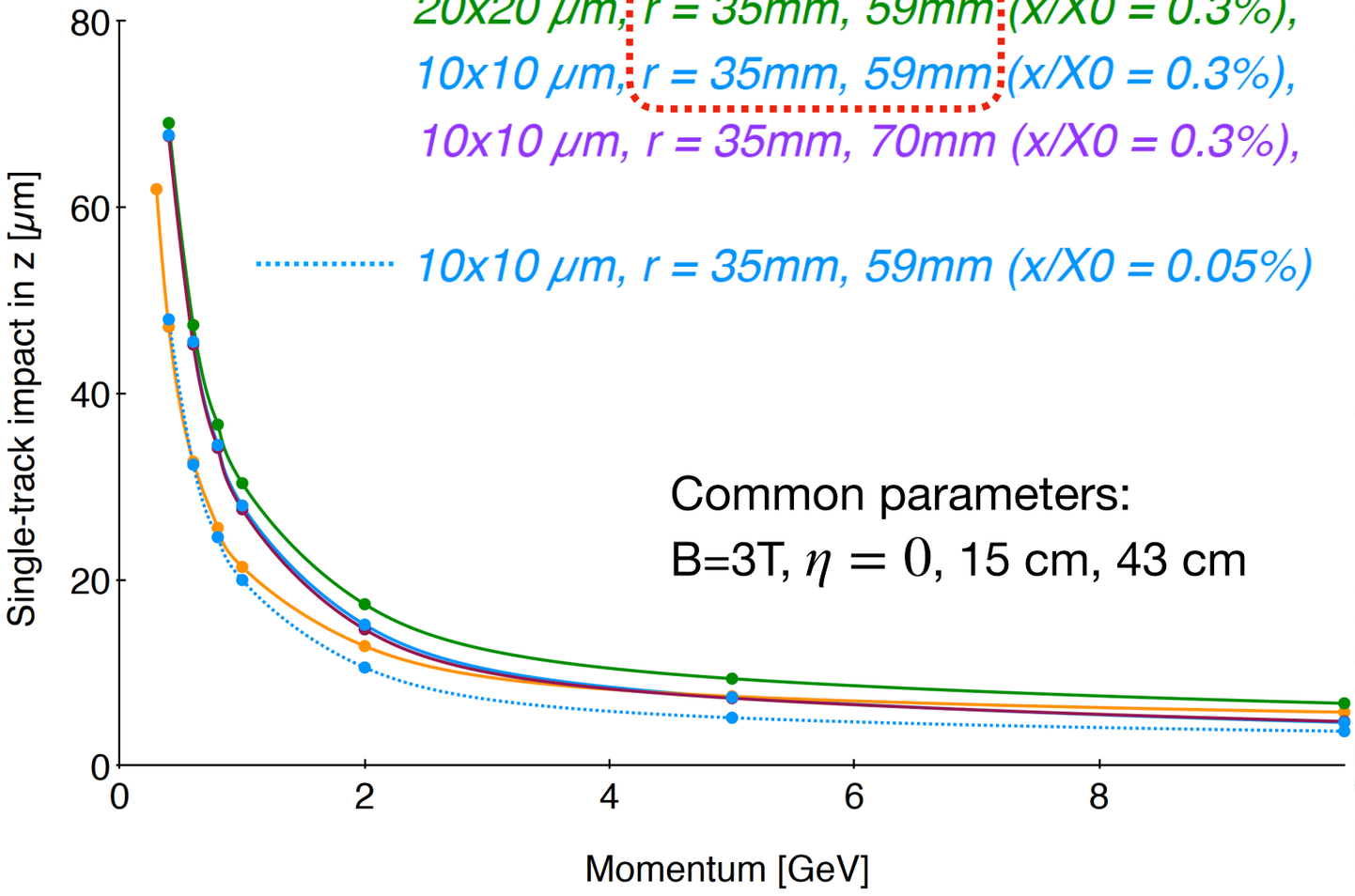
Outline

- EICroot geometry updates
  - Barrel updates
  - Disk updates

- Updated geometry in Fun4All
- New geometry performance

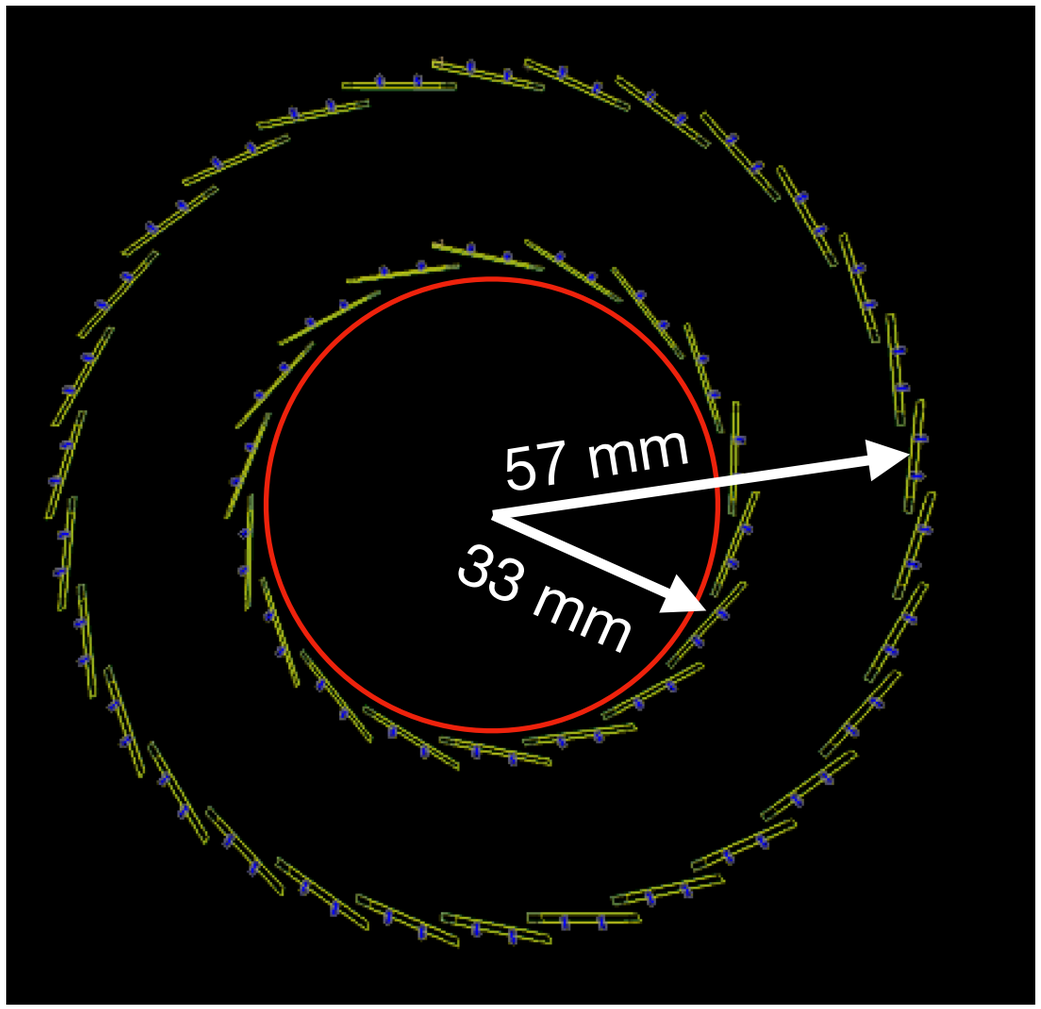
Innermost 2 (Vertexing) Layers

Ernst Sichtermann (fast sim.)



Possible to overcome performance degradation with combination of smaller pixel size and reduced thinness; the displacement between the innermost vertex barrel layers can be kept constant

New Configuration:
(EICroot event display)



Brought inner layer as close as possible to the beampipe, and kept the relative distance to the second layer the same

Middle 2 Layers

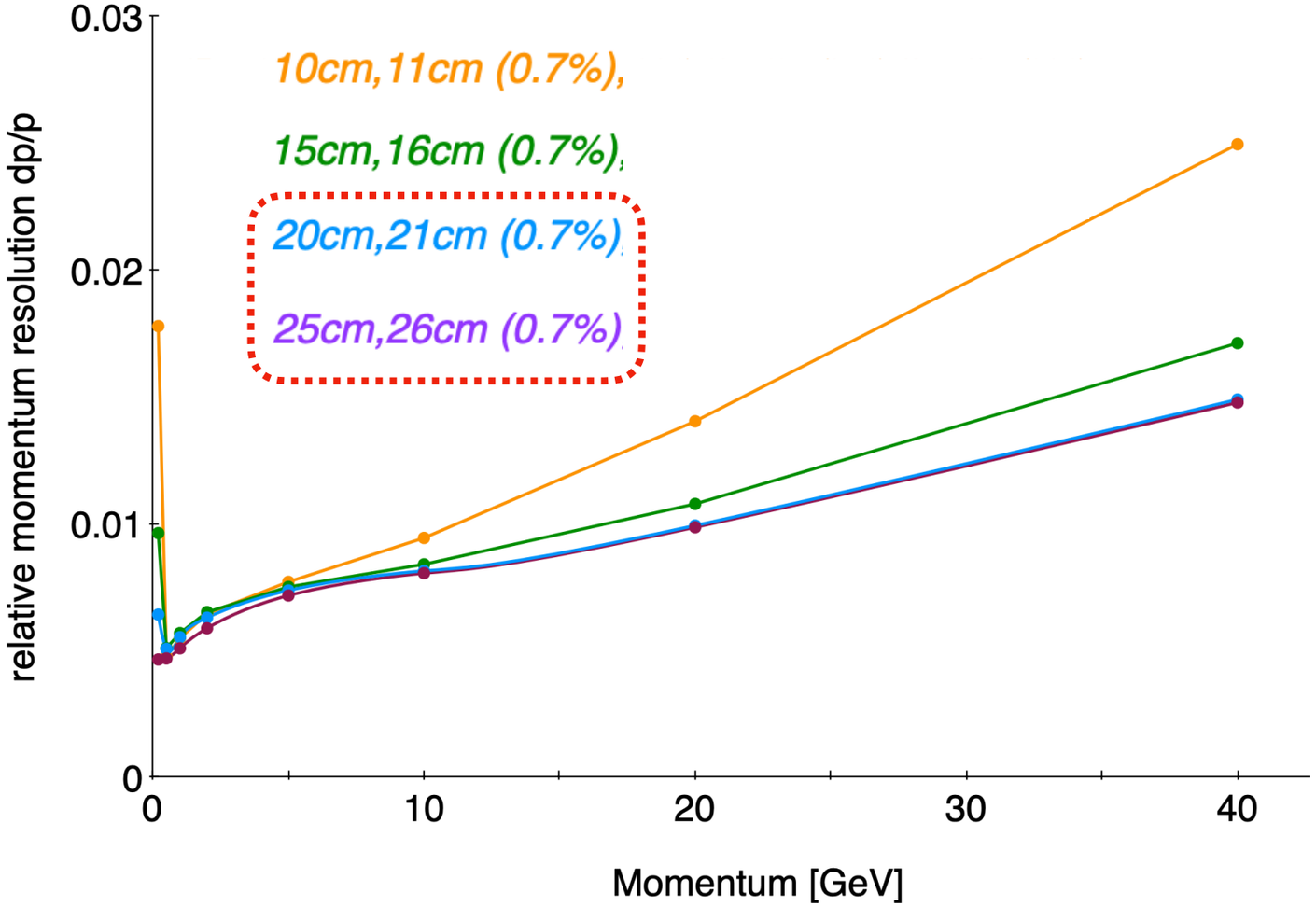
Ernst Sichtermann (fast sim.)

Common parameters:

B=3T, $\eta = 0, 20 \times 20\ \mu\mathrm{m}$

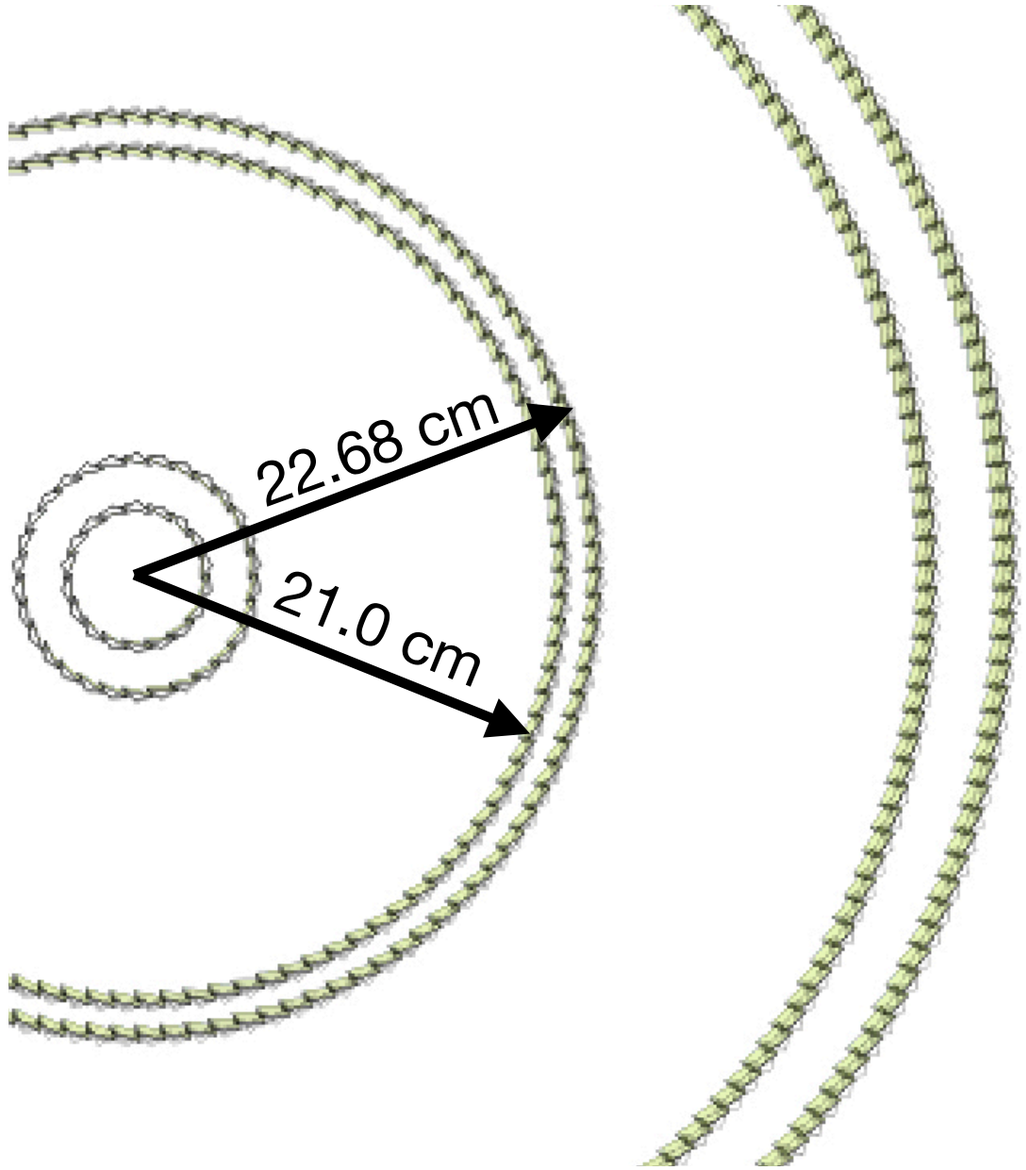
inner layers (r_1 = 35 mm, r_2 = 60 mm, X/X_0 = 0.3%)

outer layers (r_5 = 42 mm, r_6 = 43 mm, X/X_0 = 1.0%)



Radii between 20 - 26 cm for the middle two layers is optimal

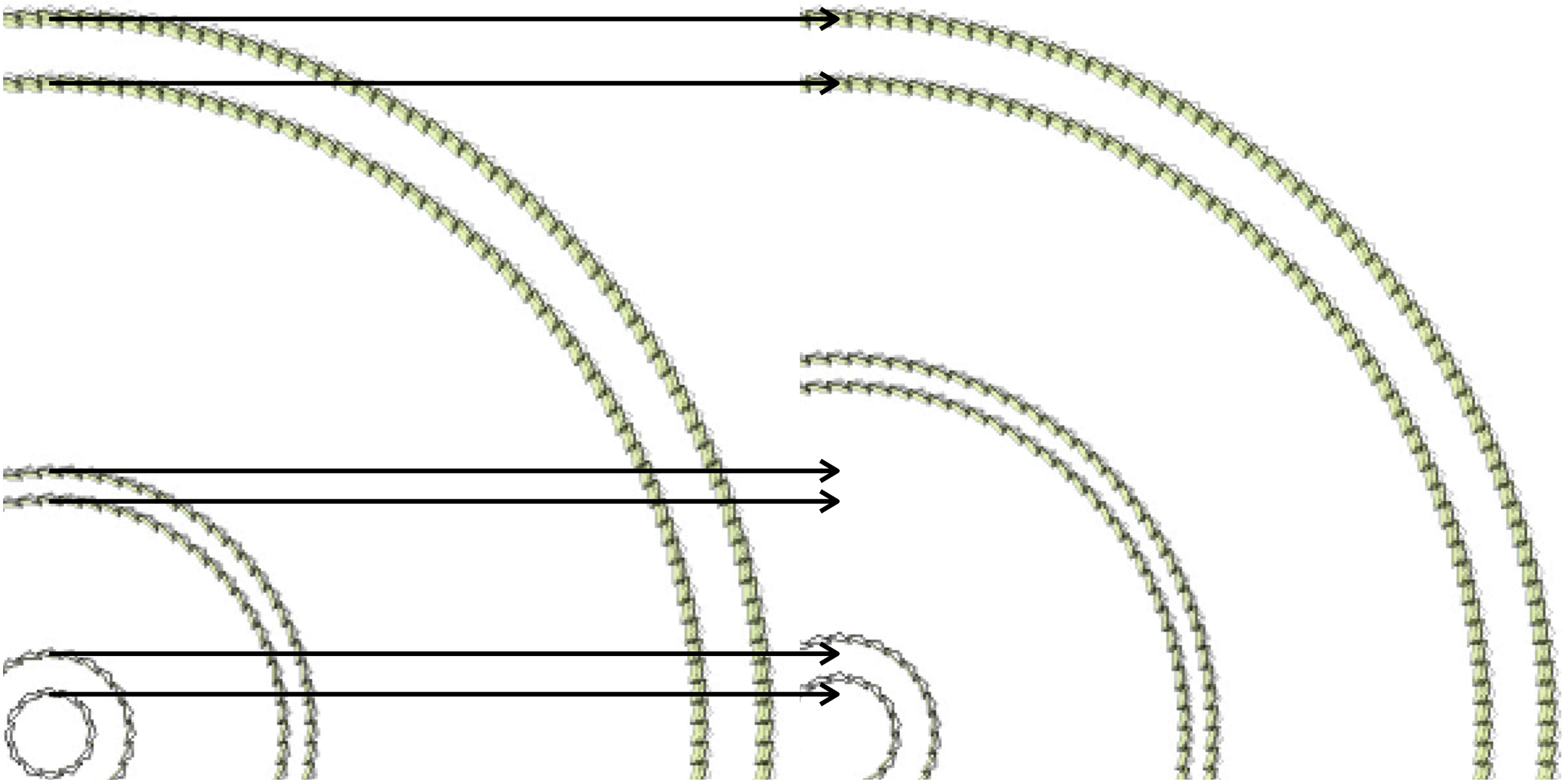
New Configuration: (EICroot event display)



Kept the relative distance between the two layers from original configuration

Barrel updates

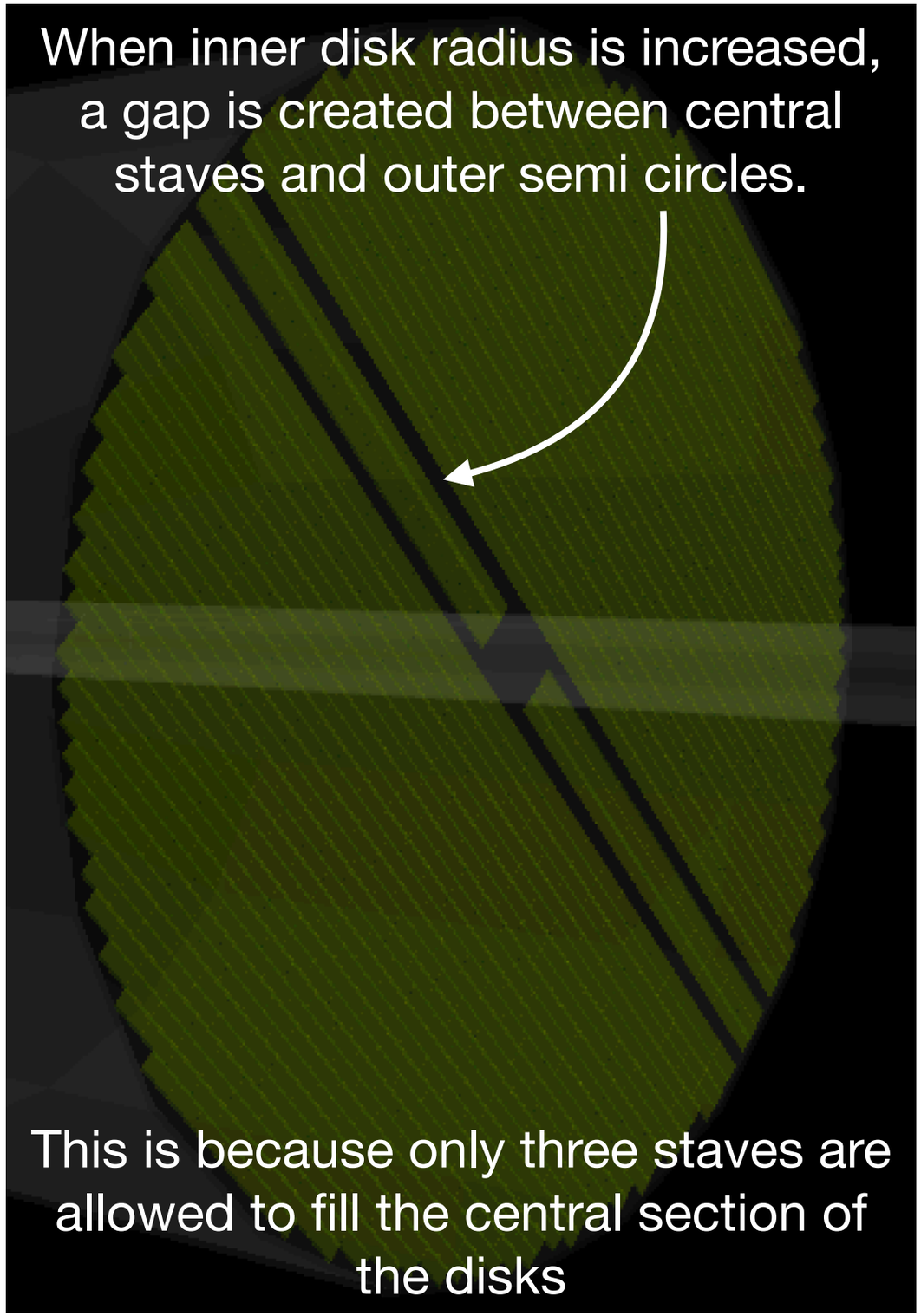
Original configuration **New configuration**



- 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

Ideally this would be as simple as increasing the inner disk radii. However…



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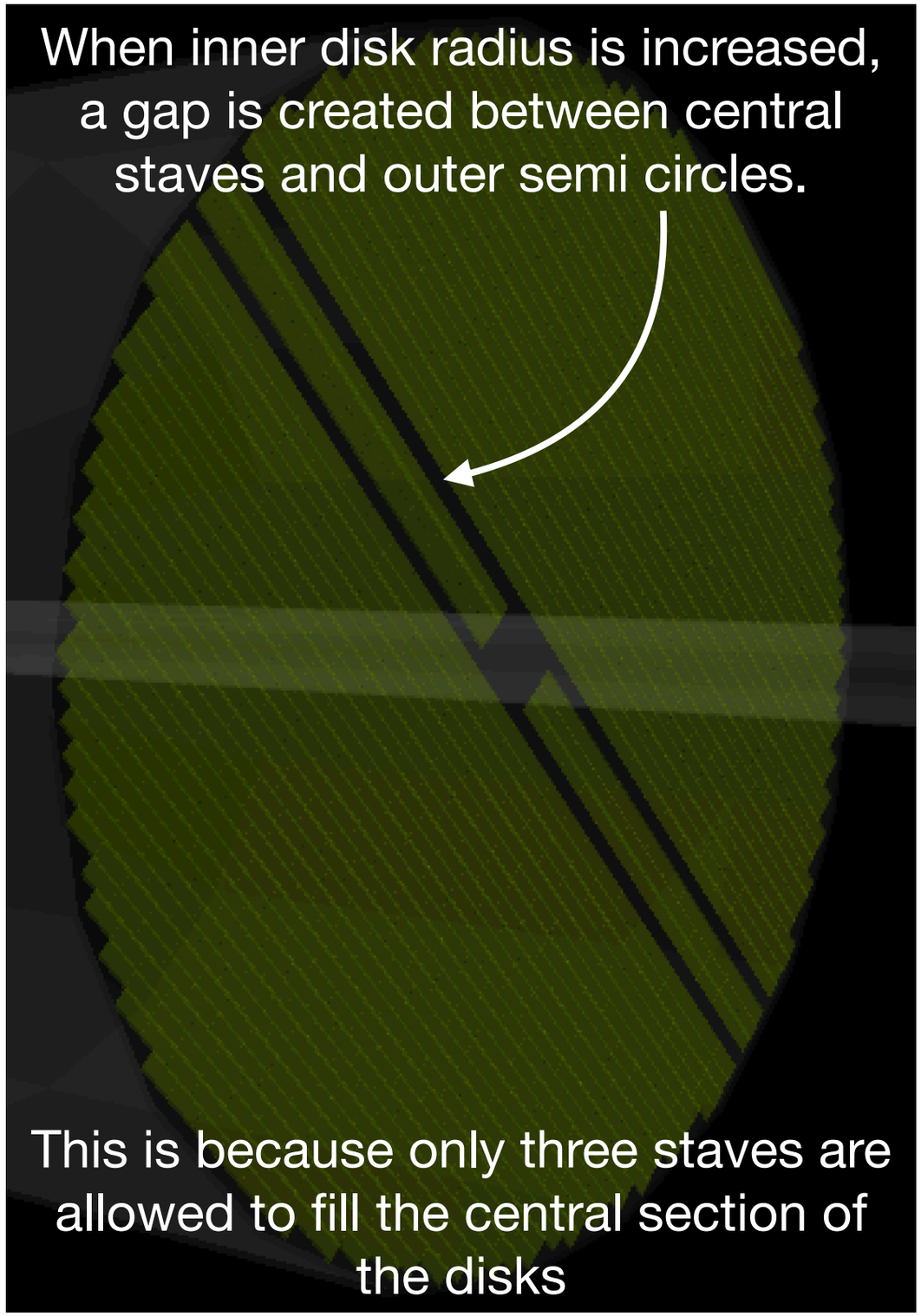
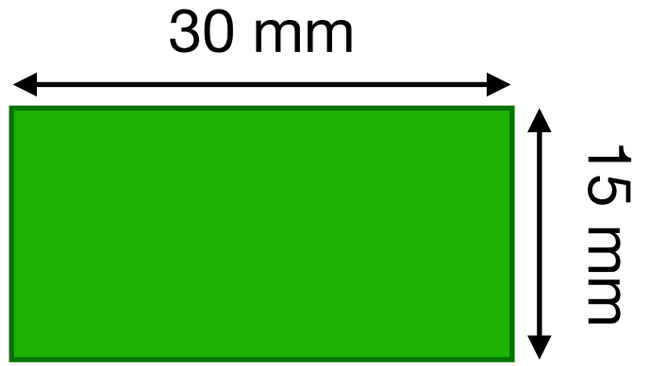
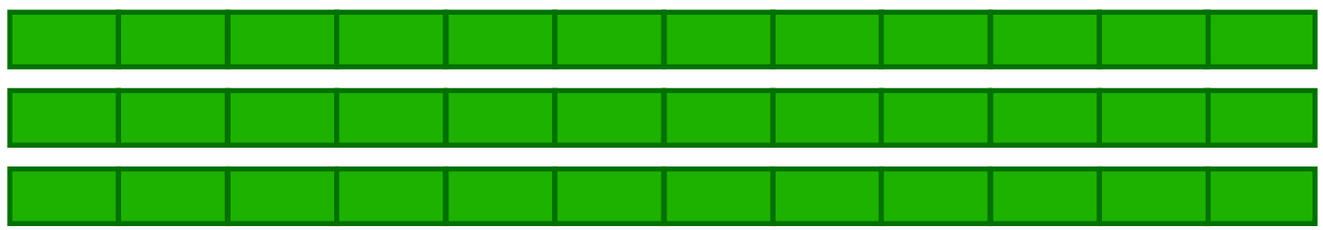


Mimosa Chips: detector lego blocks



Staves:



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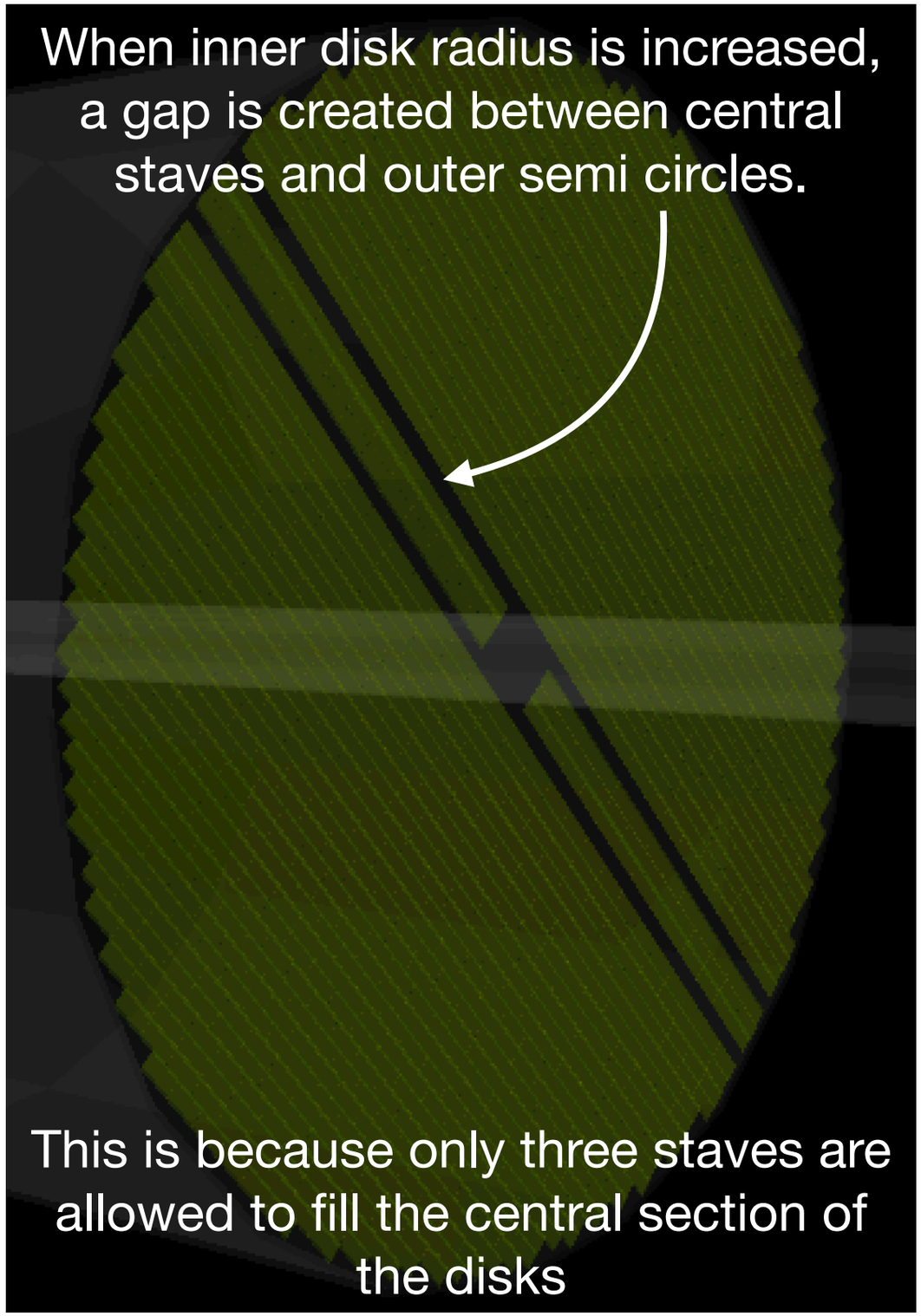
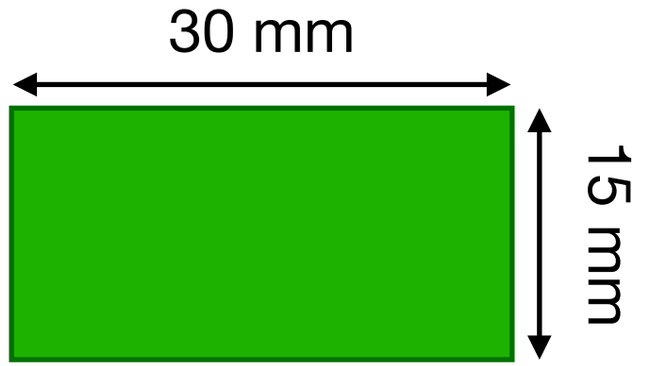
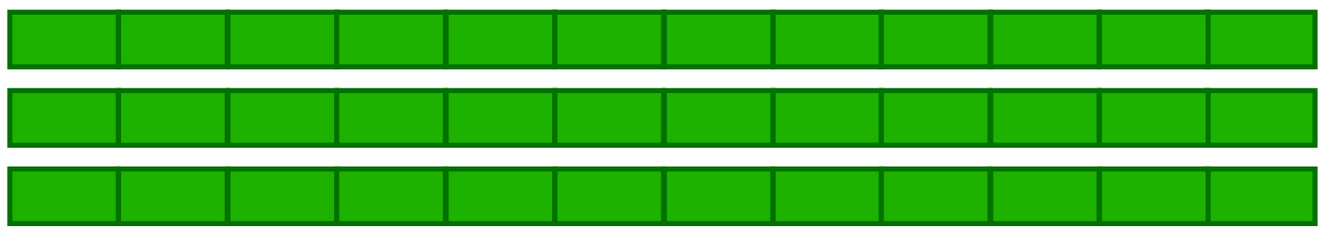


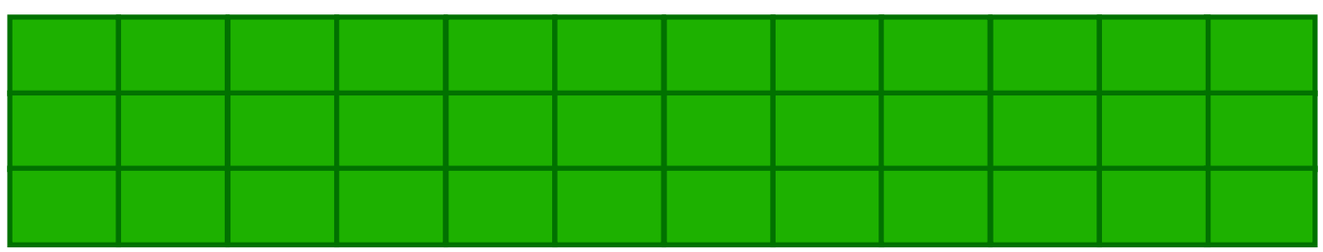
Mimosa Chips: detector lego blocks



Staves:



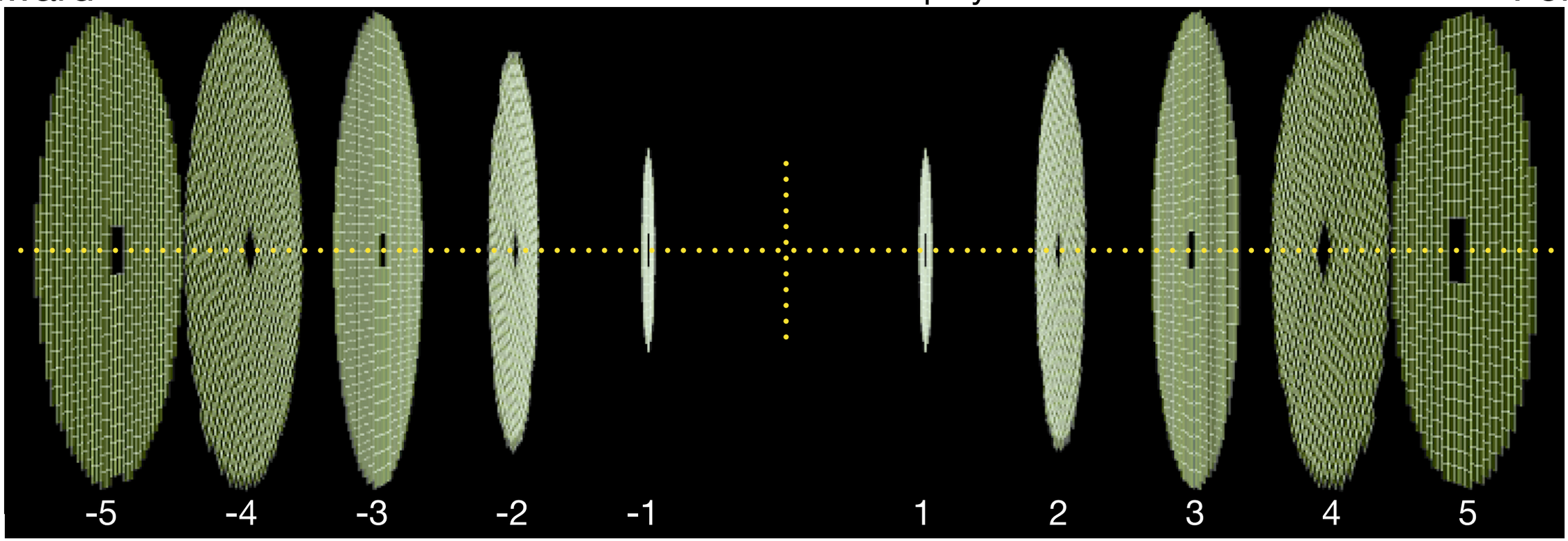
Trick: increase chip width to fill gaps:



Disk updates

	Disk number	z position ("Z") [cm]	axis rotation ("R") [deg]	outer radius [cm]	inner radius [cm]	stave width [cm]	stave separation [cm]
Backward	-5	-121	0	43.23	4.41	3.00	2.60
	-4	-97	45	43.23	3.70	2.60	2.20
	-3	-73	0	43.23	3.18	2.50	1.80
	-2	-49	45	36.26	3.18	2.50	1.80
	-1	-25	0	18.50	3.18	2.50	1.80
Forward	1	25	0	18.50	3.18	2.50	1.80
	2	49	45	36.26	3.18	2.50	1.90
	3	73	0	43.23	3.50	2.60	2.00
	4	97	45	43.23	4.70	3.20	2.60
	5	121	0	43.23	5.91	3.80	3.30

Backward — ElCroot event display — Forward



Outline

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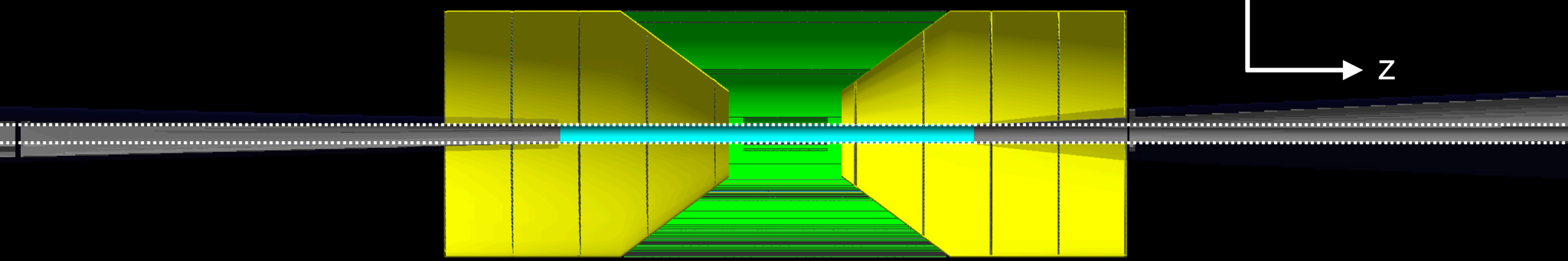
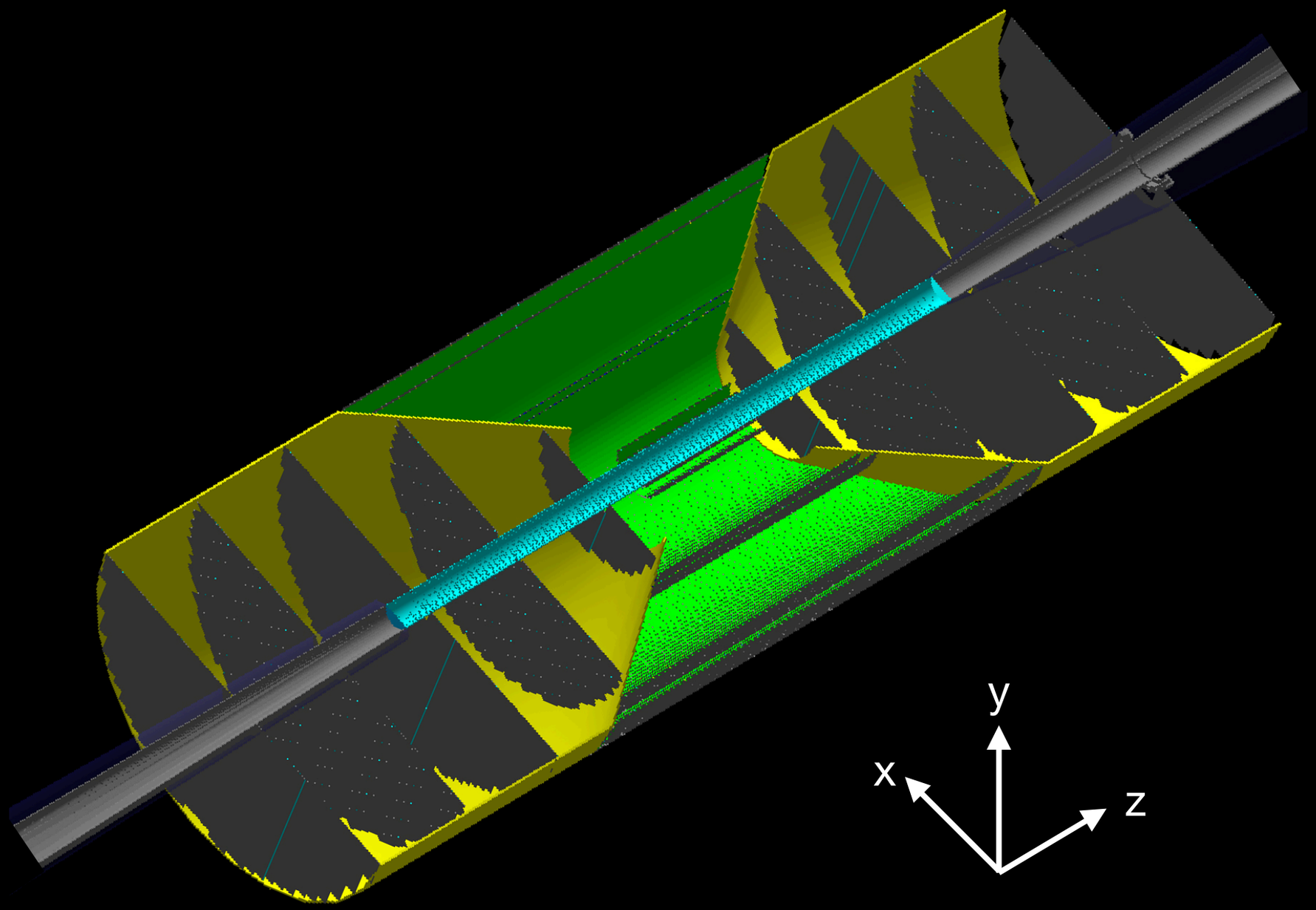
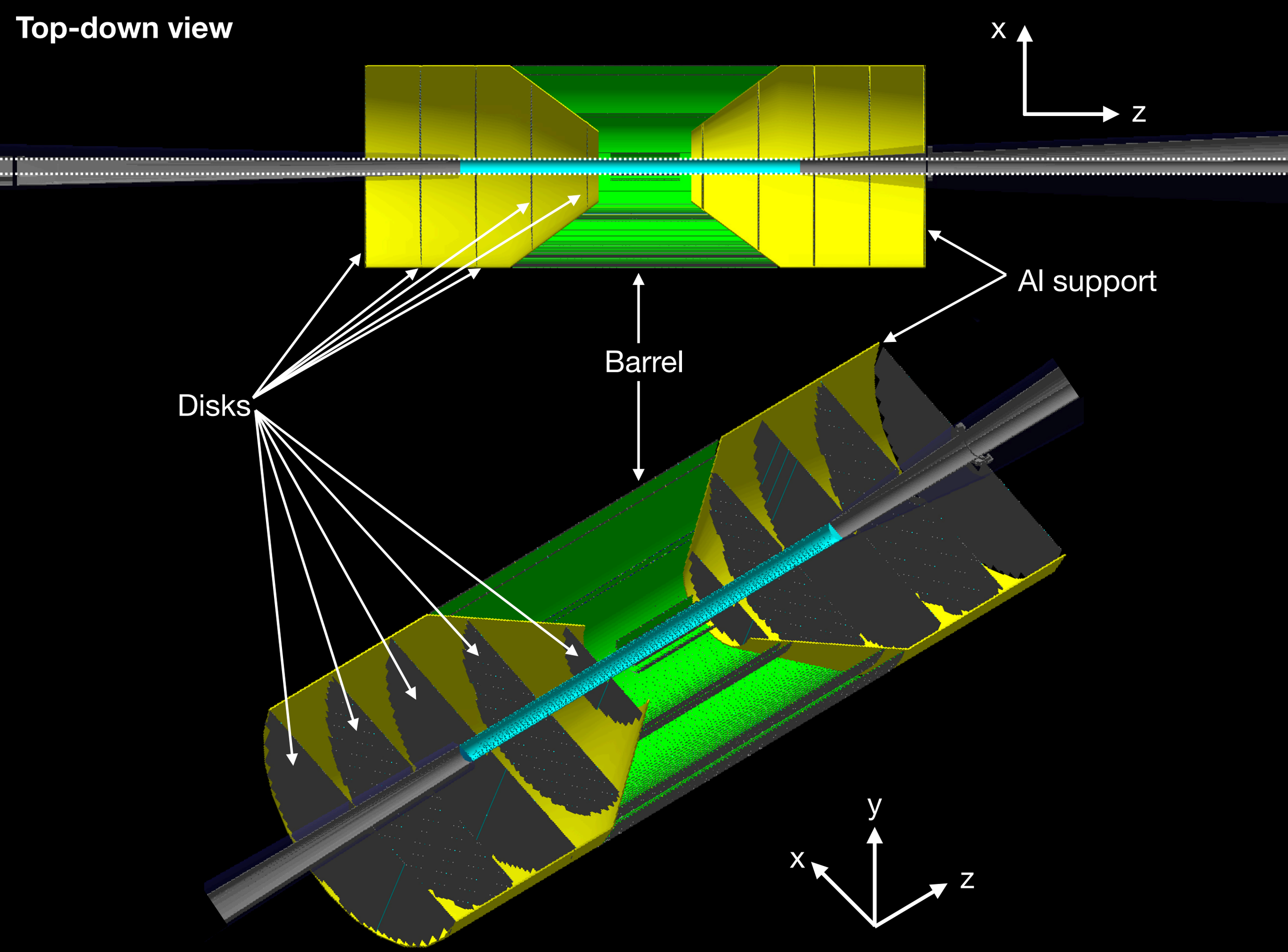
  - Barrel updates
  - Disk updates
- Updated geometry in Fun4All
- New geometry performance

Top-down view





Top-down view



Outline

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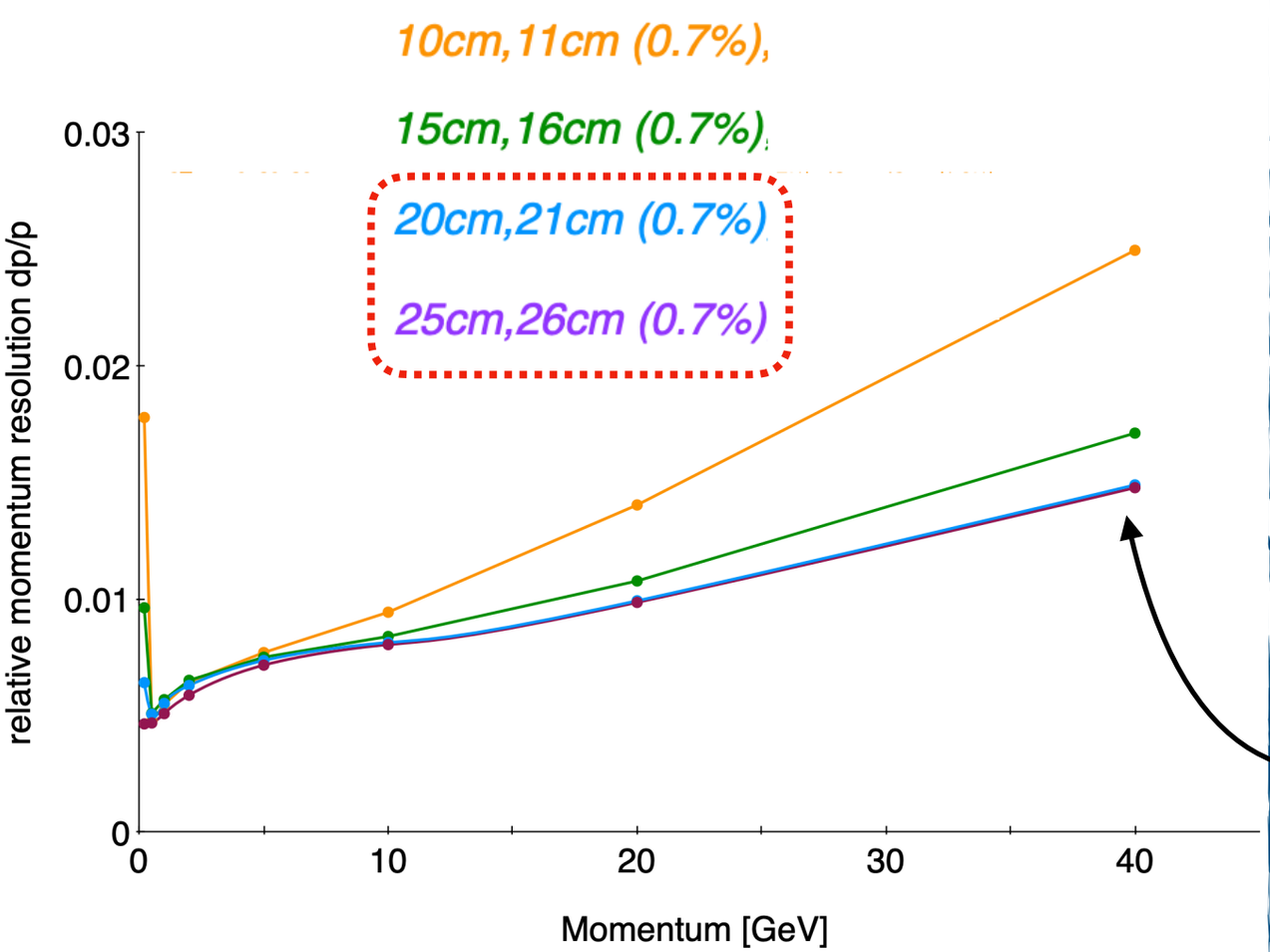
Momentum resolution comparison to fast sim.

Ernst Sichtermann
(fast sim.)



Common parameters:
B=3T, $\eta = 0$, $20 \times 20\ \mu\mathrm{m}$
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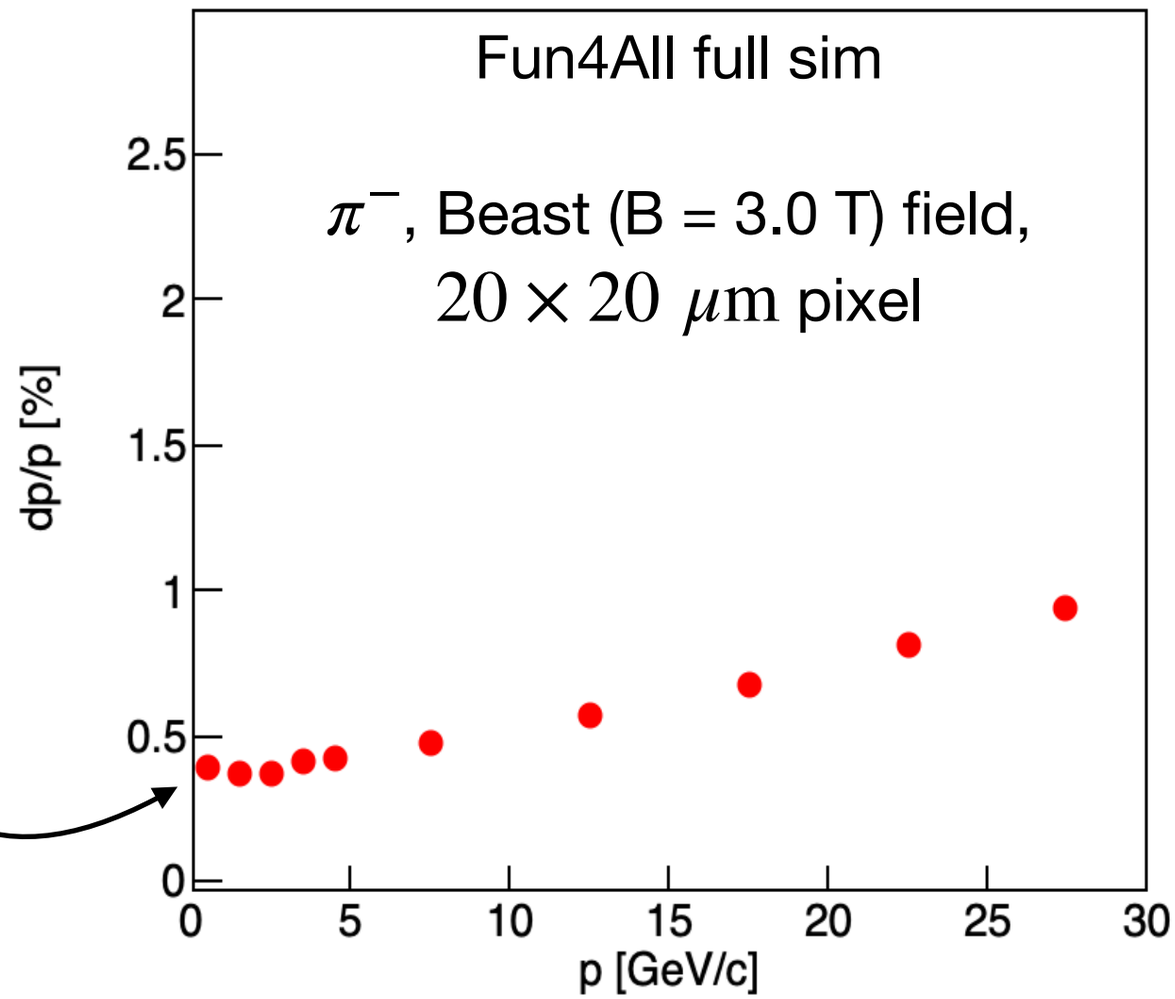


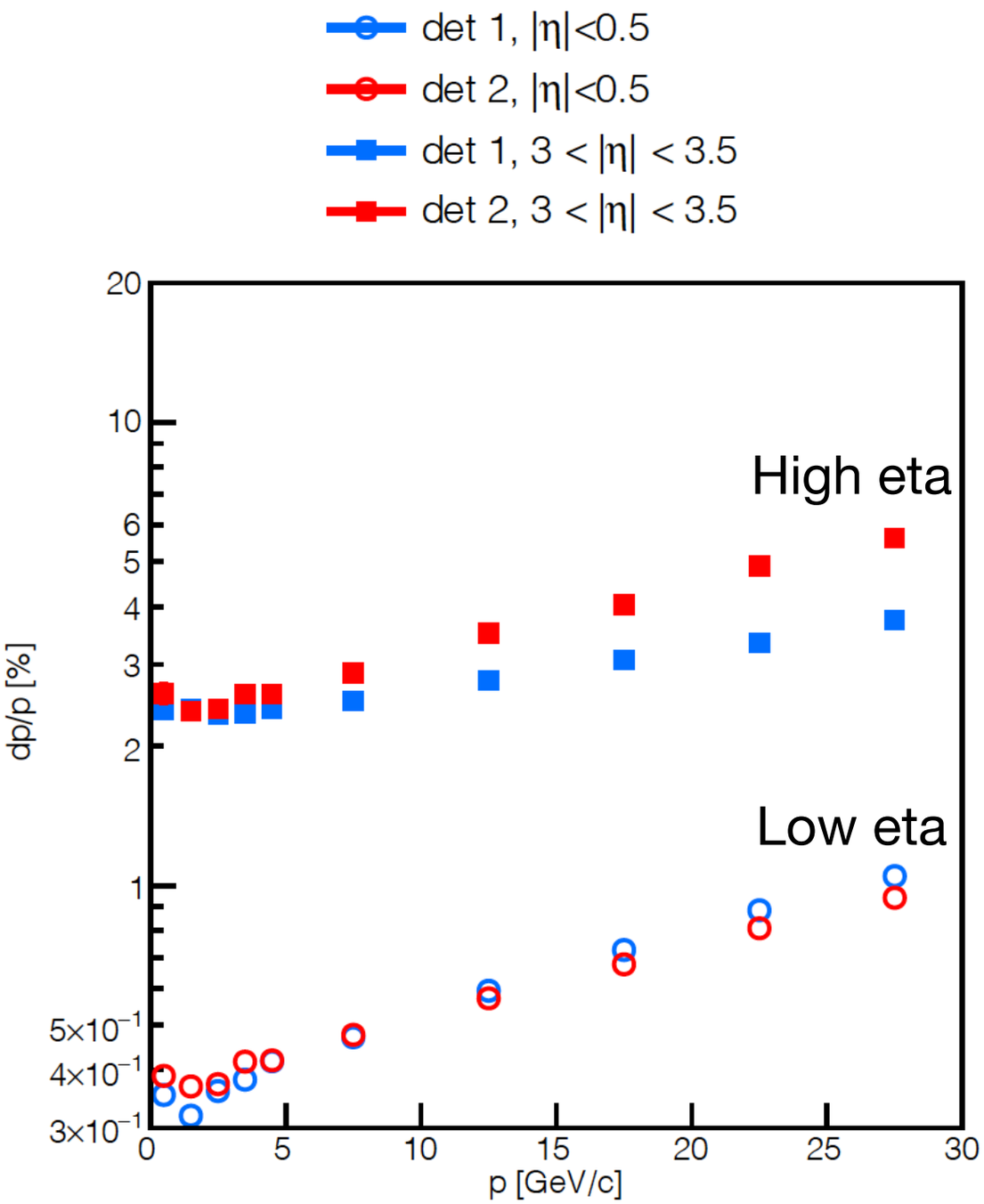
Event generation:
vertex: (0,0,0)
momentum: (0,30 GeV/c)
$|\eta|$: (0,4)
ϕ: (0,2π)

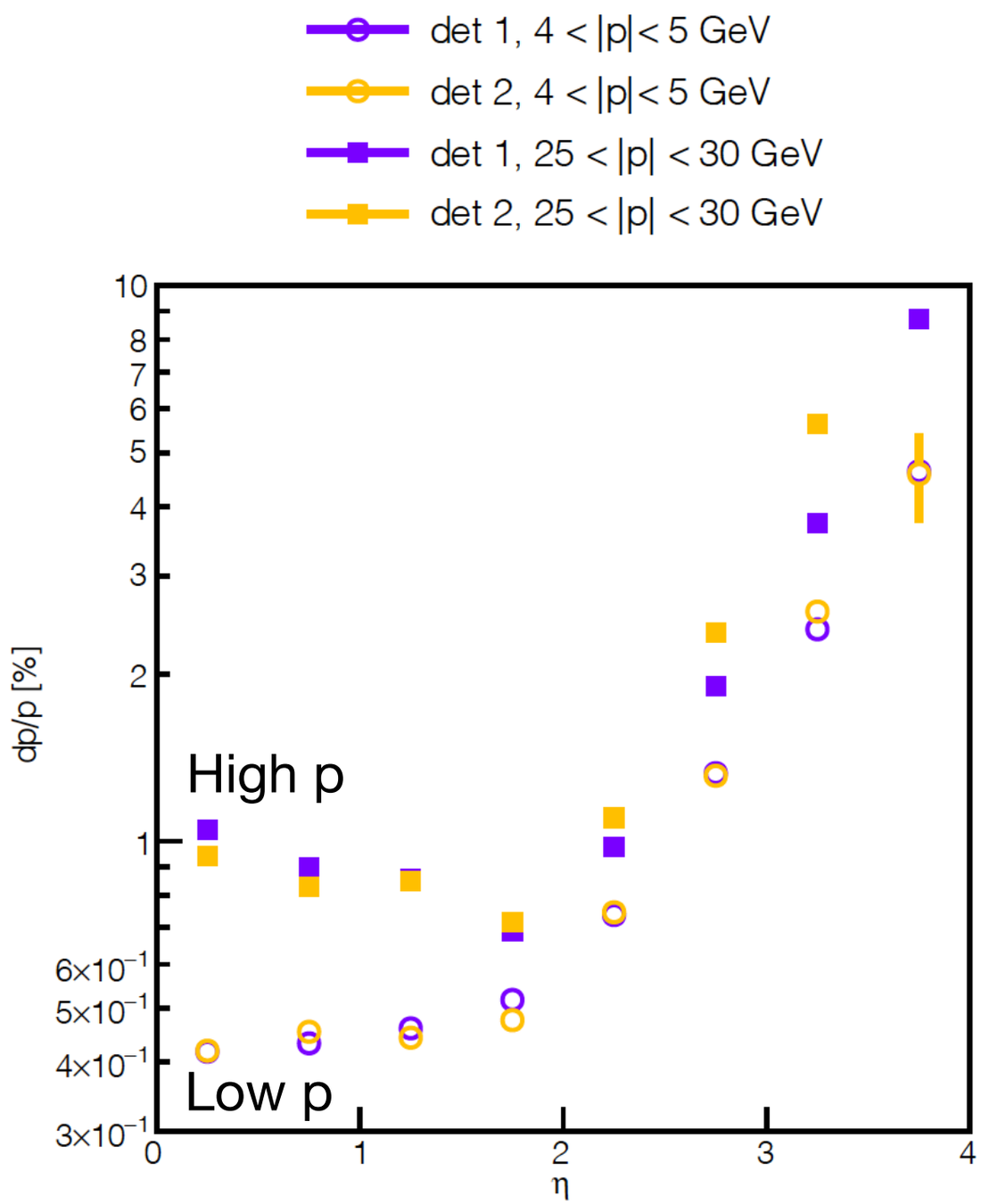
Momentum resolution comparison

π^-, Beast (B = 3.0 T) field, 20×20 μm pixel

det 1 ≡ original geometry, det 2 ≡ updated geometry

* compare filled to filled and open to open



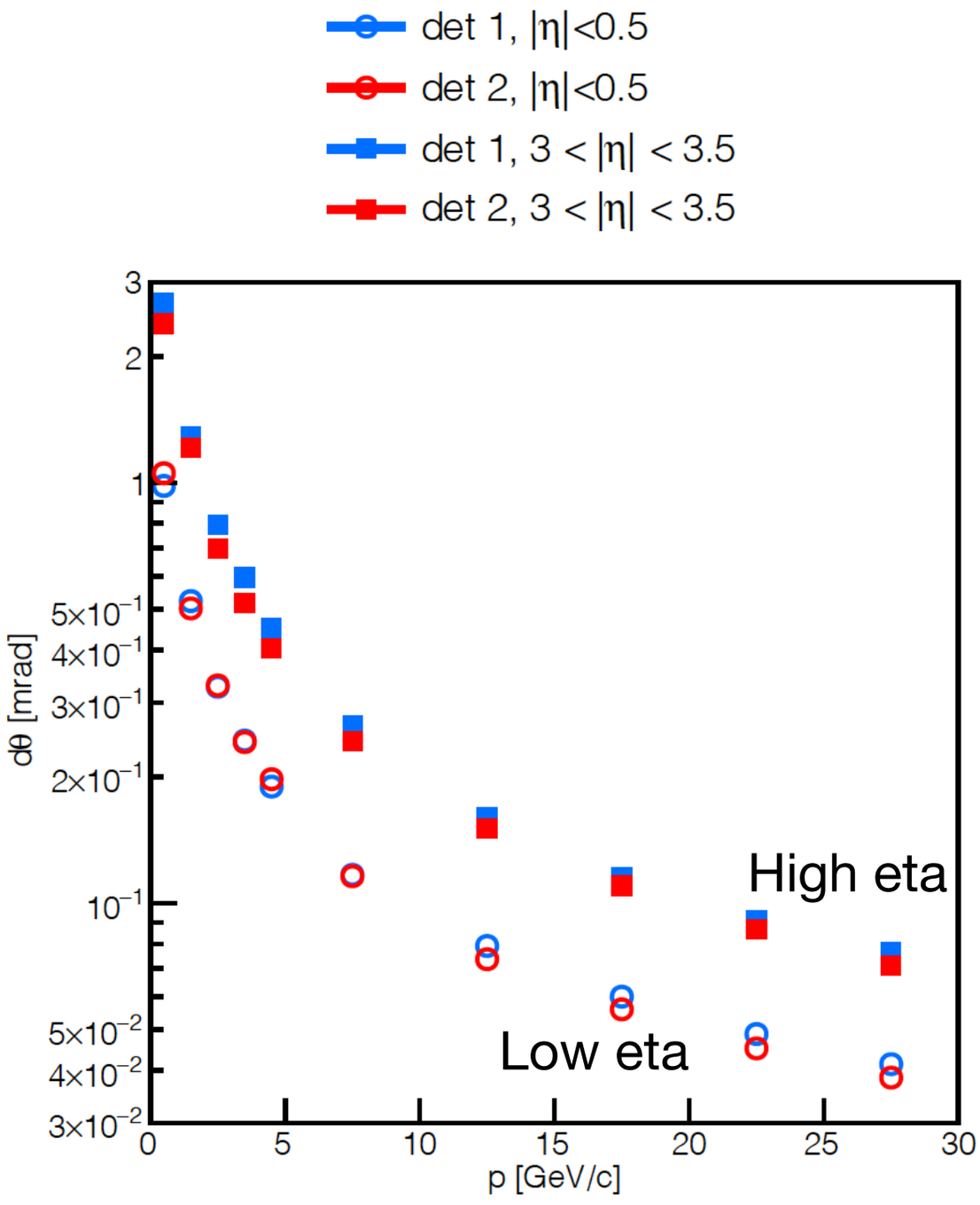


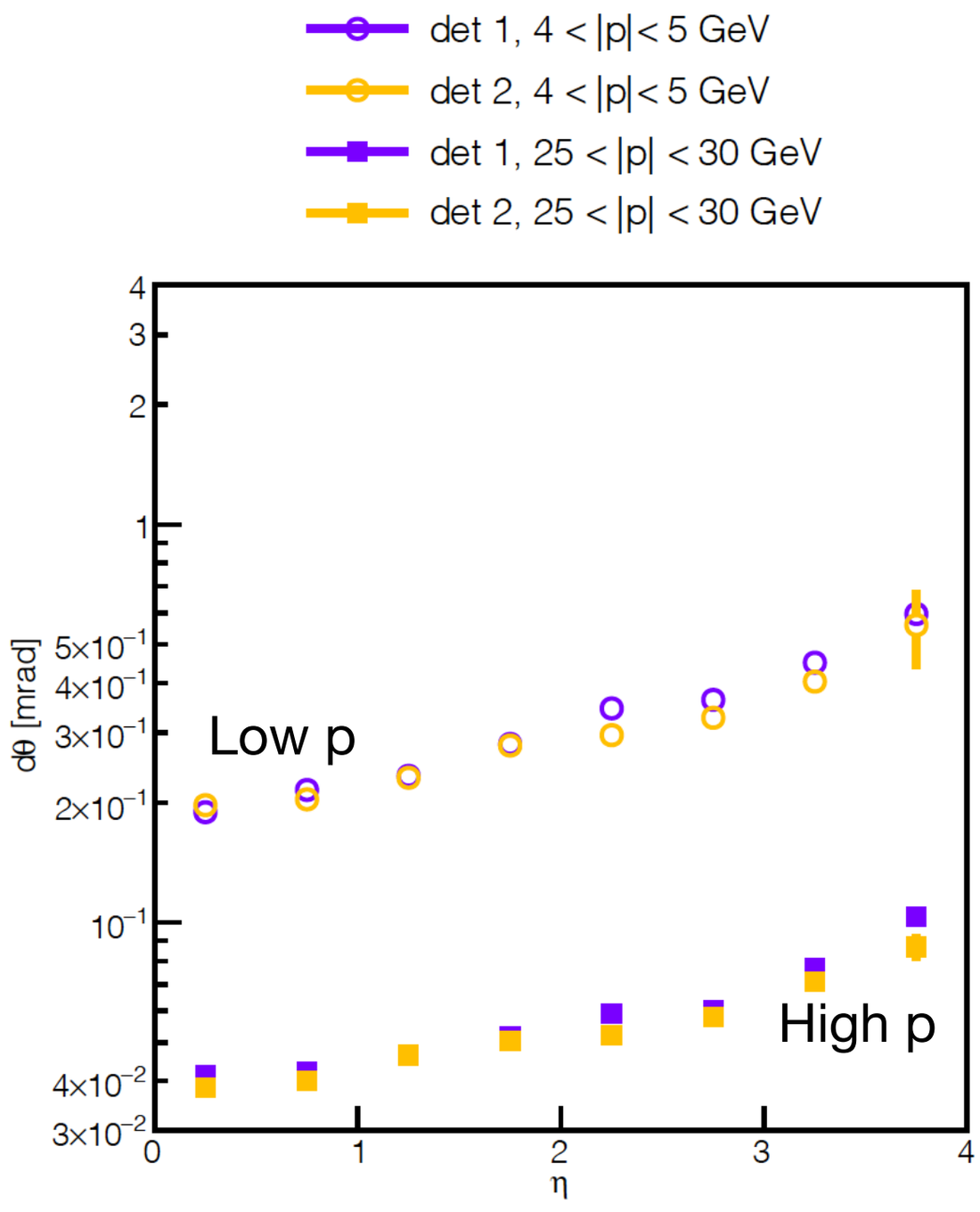
Polar resolution comparison

π^-, Beast (B = 3.0 T) field, 20×20 μm pixel

det 1 ≡ original geometry, det 2 ≡ updated geometry

* compare filled to filled and open to open



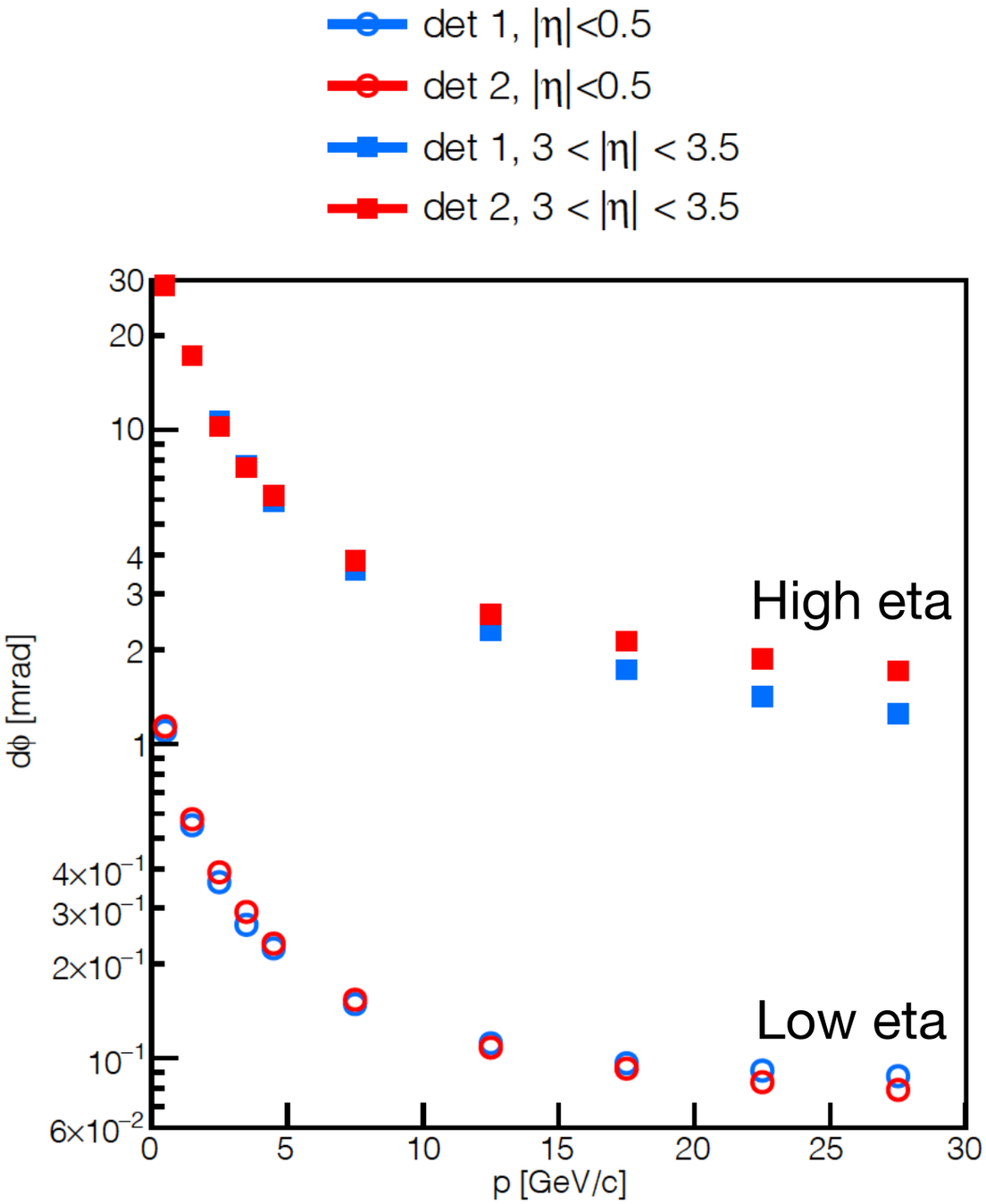


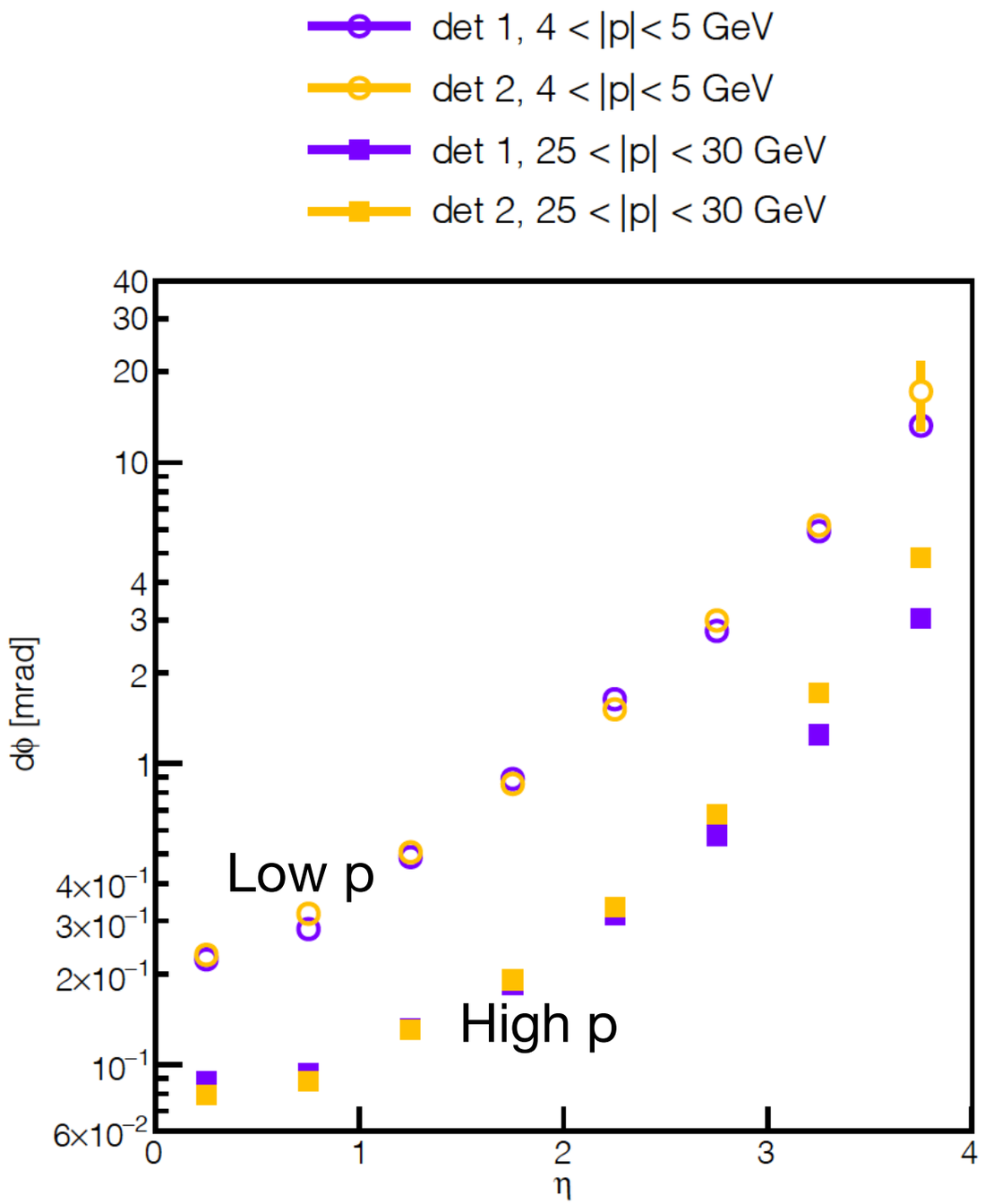
Azimuthal resolution comparison

π^-, Beast (B = 3.0 T) field, 20×20 μm pixel

det 1 ≡ original geometry, det 2 ≡ updated geometry

* compare filled to filled and open to open

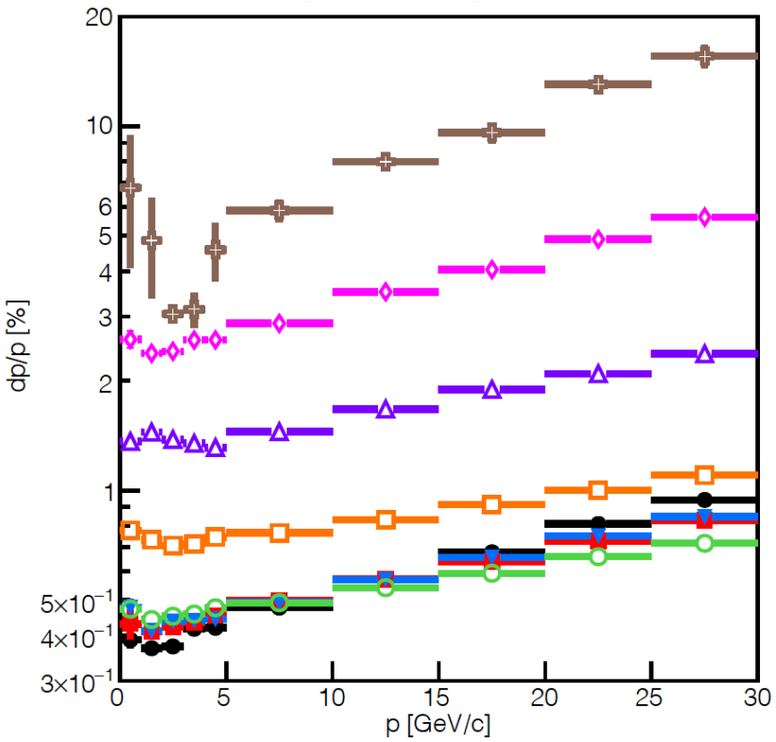


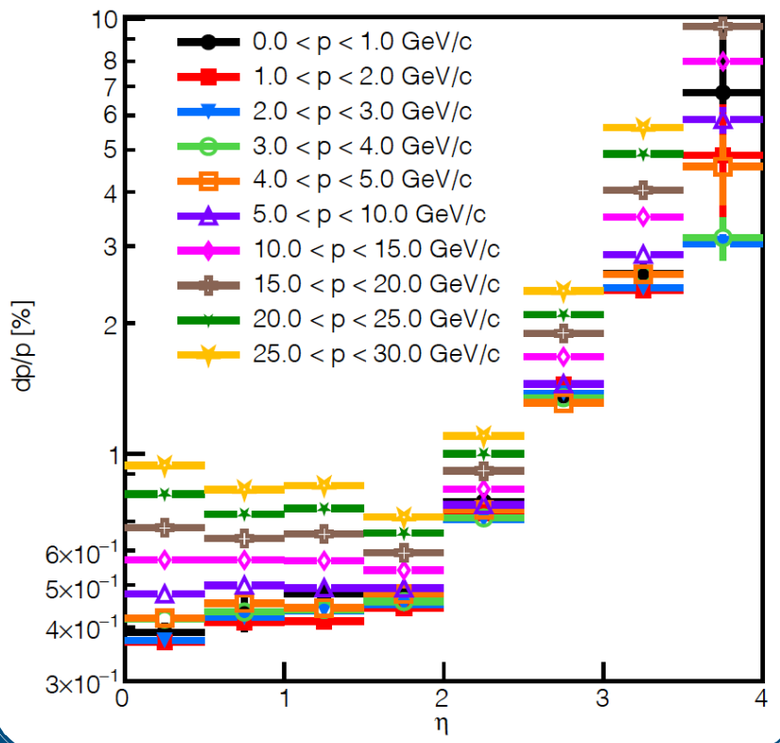


Single-particle resolution

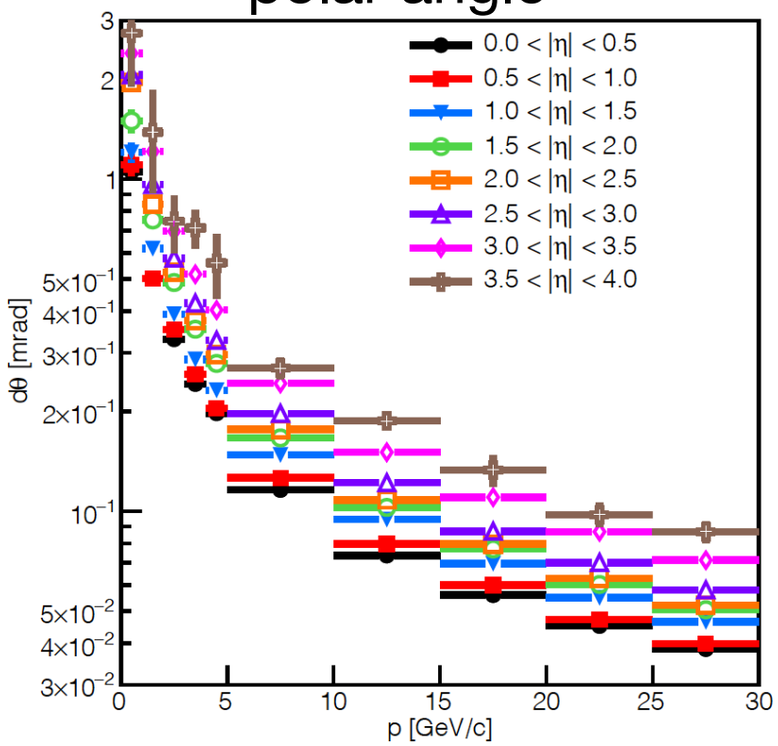
π^-, Beast (B = 3.0 T) field, 20×20 μm pixel

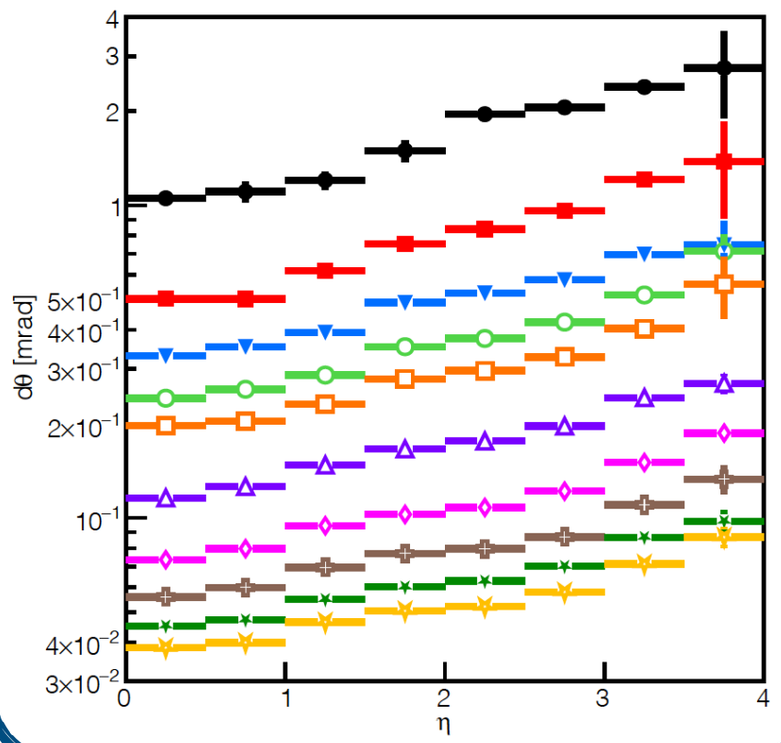
Momentum



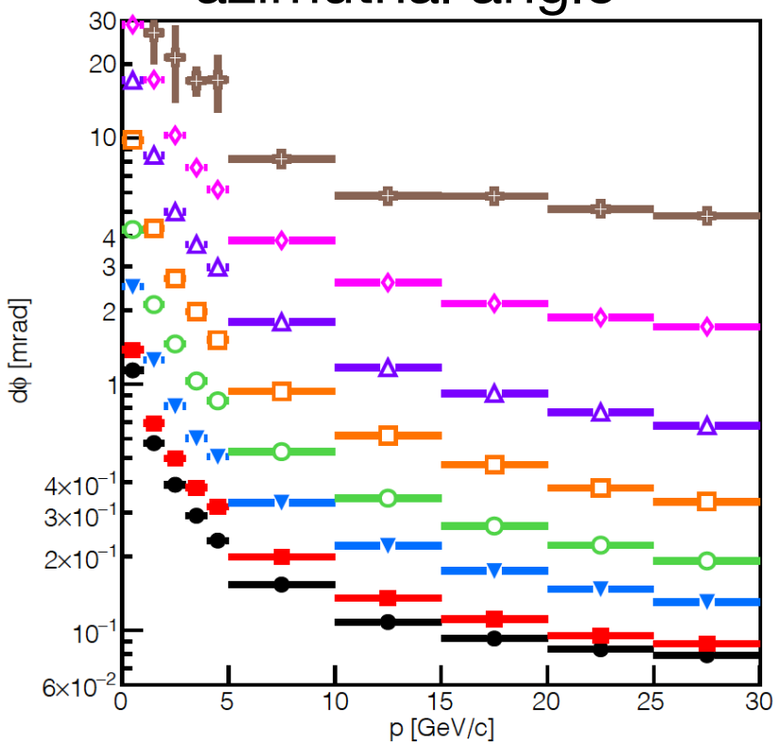


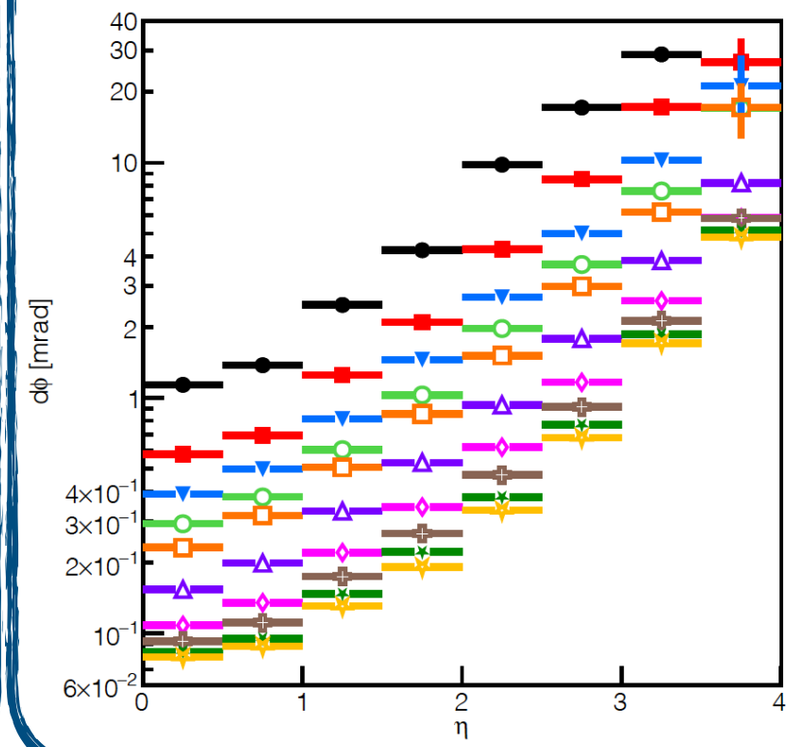
polar angle





azimuthal angle





Summary

- Updated All-Si tracker geometry to accommodate new beampipe
  - Barrel:
    - outer two layers kept identical to previous geometry
    - inner two layers increased in radii to fit beampipe
    - middle two layers positioned following fast-simulation results
  - Disks:
    - increased inner radii to fit beampipe
    - chips increased in width to avoid stave gaps

- Studied single-particle resolutions
  - No significant resolution deterioration

Next step:

- Check vertex resolution