Effect of LGAD inside all-si tracker barrel

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To recap

- Interest from PID to potentially have a Low-Gain Avalanche Detector (LGAD) layer inside the active tracking volume of the all-silicon tracker.

- Having these detectors placed inside tracker worsens the tracker performance (more material -> more MS).

- Having these detectors at larger radii implies larger-area detectors, and limits their PID capabilities.

- Studied all-silicon tracker momentum-resolution impact of placing LGAD layers at different radii inside the all-silicon tracker barrel.

LGAD Material Budget and characteristics

Resolution: $500 \ \mu\text{m}/\sqrt{12}$

Component	Material	Thickness	X/X0 [%]
Silicon Sensor	Silicon	85 μm	0.091
Metal connection	Aluminum	0.15 mm	0.169
HDI	Kapton	0.2 mm	0.0700
Cooling	Water	1 mm	0.277
Support	Graphite	0.5 mm	0.259
Support Gap	Air	1 cm	0.003
Support	Graphite	0.5 mm	0.259
			1.13

All-silicon tracker barrel layout

All-silicon tracker layers

Barrel layer	radius [cm]
1	3.30
2	5.70
3	21.00
4	22.68
5	39.30
6	43.23
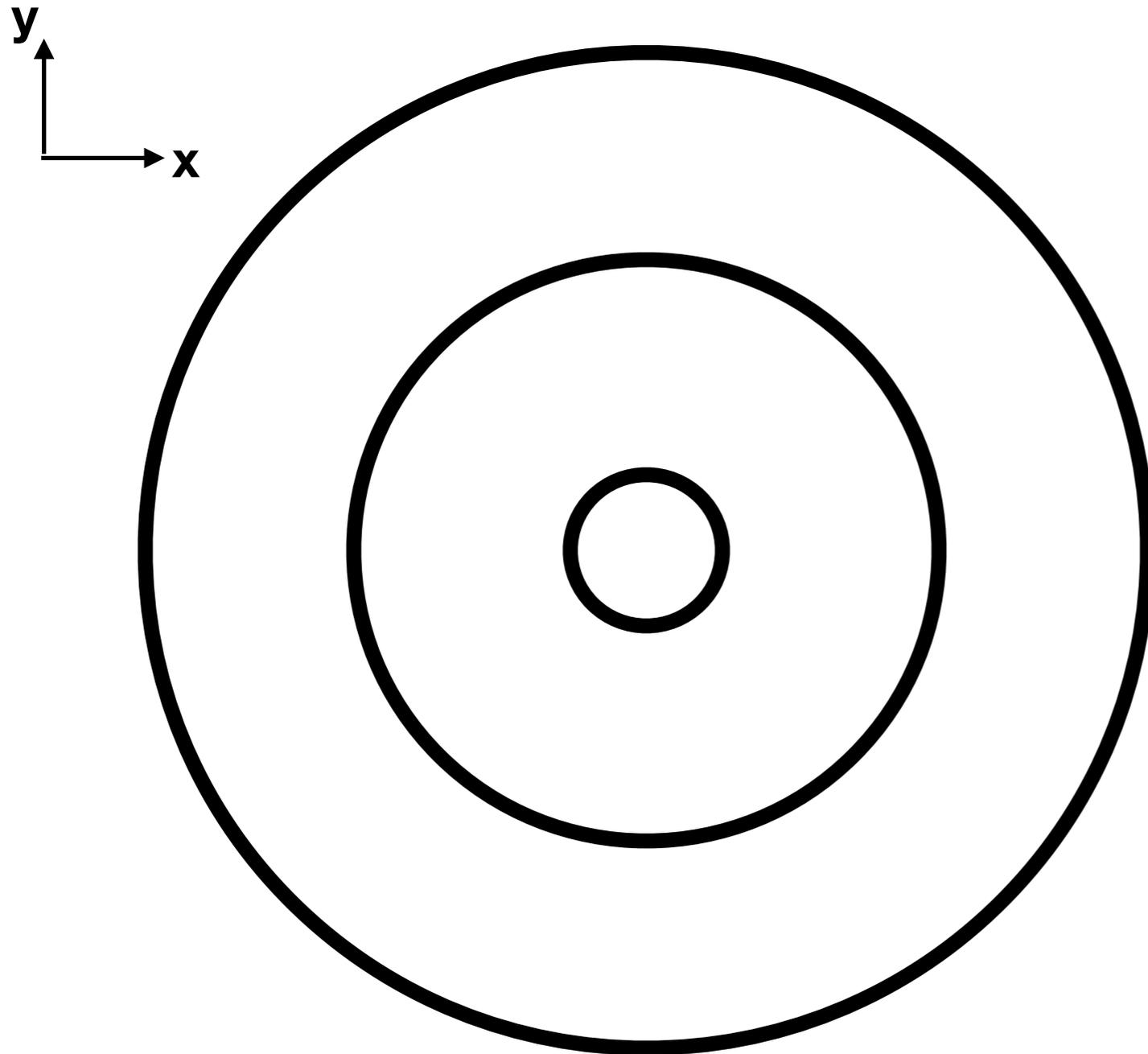
Black: all-si layers

LGAD Placement

All-silicon tracker layers

Barrel layer	radius [cm]
1	3.30
2	5.70
3	21.00
4	22.68
5	39.30
6	43.23

R_{LGAD} = 6.2 cm
R_{LGAD} = 12.6 cm
R_{LGAD} = 19.0 cm
R_{LGAD} = 23.2 cm
R_{LGAD} = 30.1 cm
R_{LGAD} = 37.0 cm
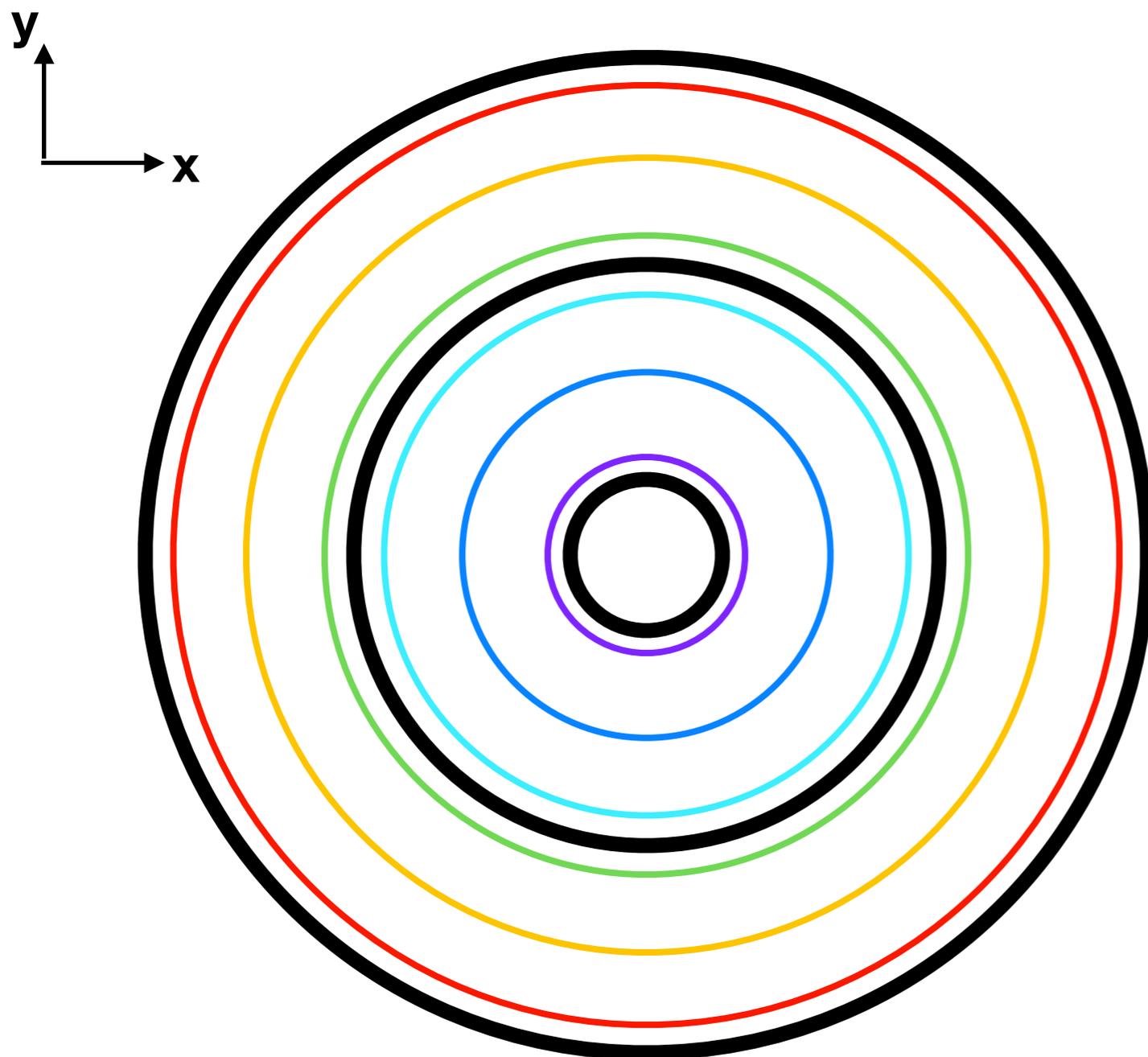
Black: all-si layers

Colored: different placements of LGAD

Placement of LGAD layer inside the tracking volume
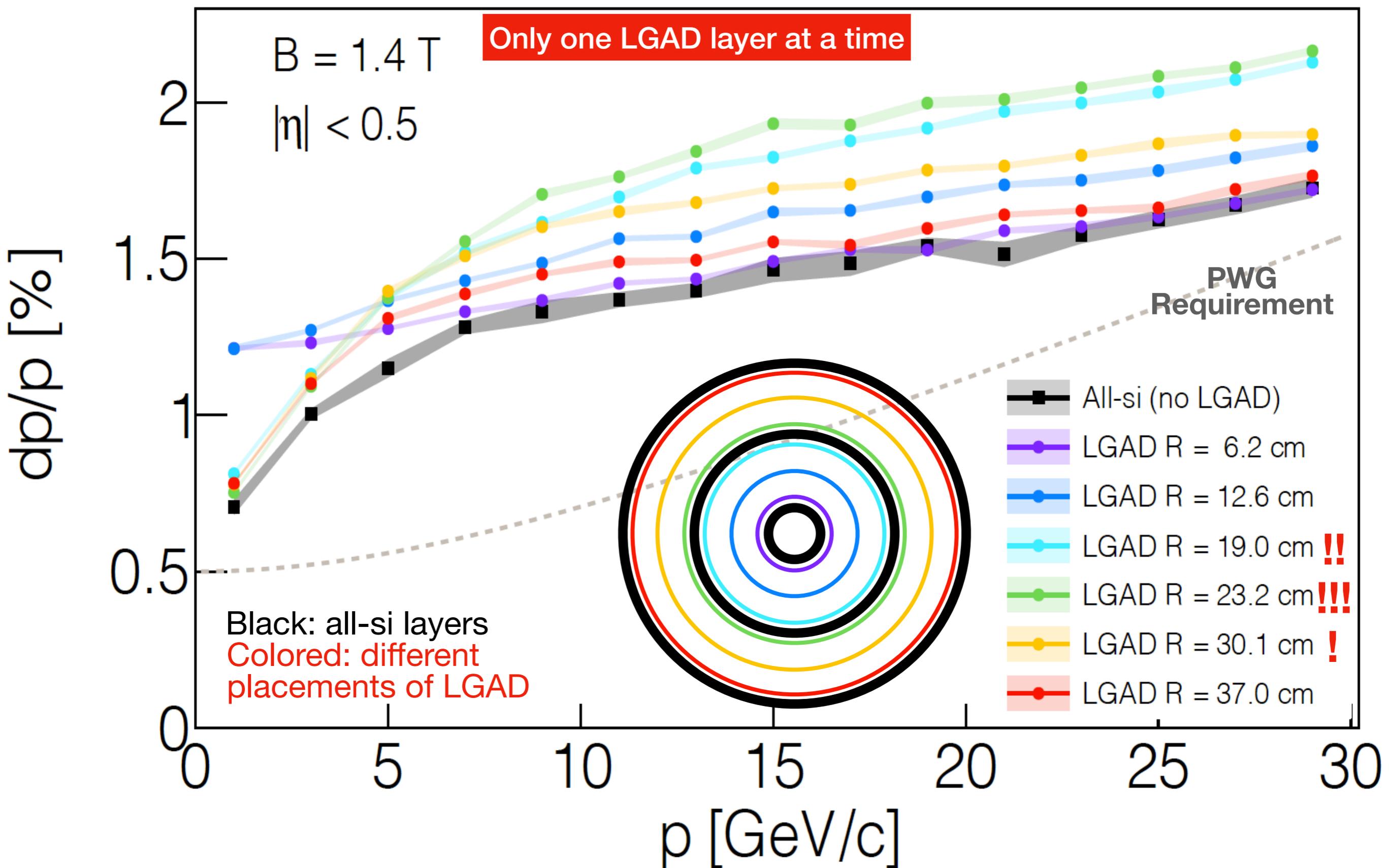
Summary and Conclusions

- Momentum resolution most (negatively) impacted when LGAD layer is placed near the central barrel layers

- As the LGAD layer is moved away from the sagitta (in either direction), its impact on the momentum resolution decreases

- For LGAD layers placed symmetrically about the sagitta, the momentum resolution in the configuration where the LGAD has a larger radius provides a systematically larger momentum resolution

- At low momentum, the smaller radii LGAD layers have a more significant impact on momentum resolutions

- This study does not take into account the extra material that would need to live within the tracker to service the LGAD layer

- Not shown, but also studied: whether the LGAD layers are included in the Kalman filter or not, the results don't change

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