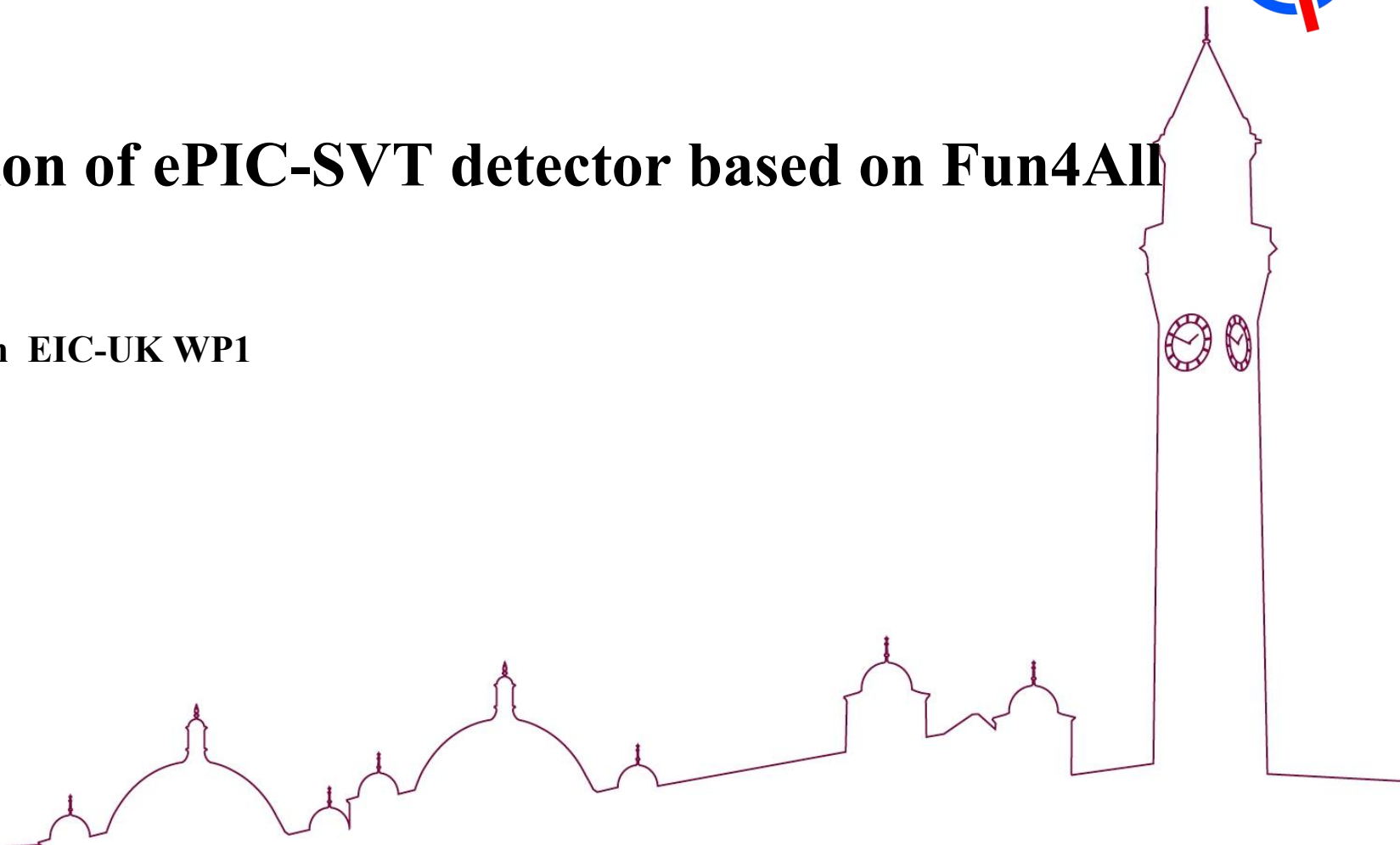
UNIVERSITY OF BIRMINGHAM | SCHOOL OF PHYSICS AND ASTRONOMY

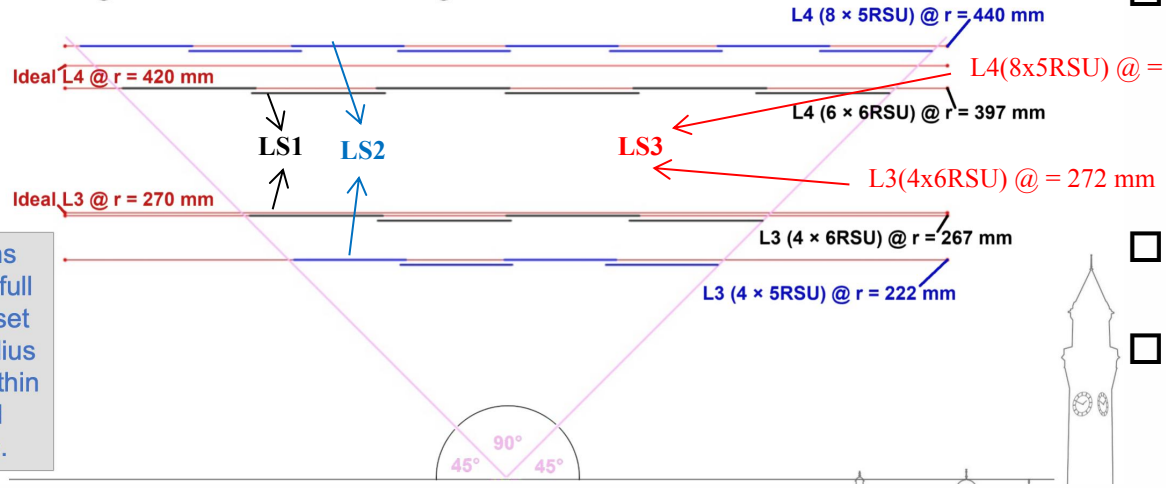
The simulation of ePIC-SVT detector based on Fun4All

Long LI on behalf on EIC-UK WP1
Oxford University
03/10/2024

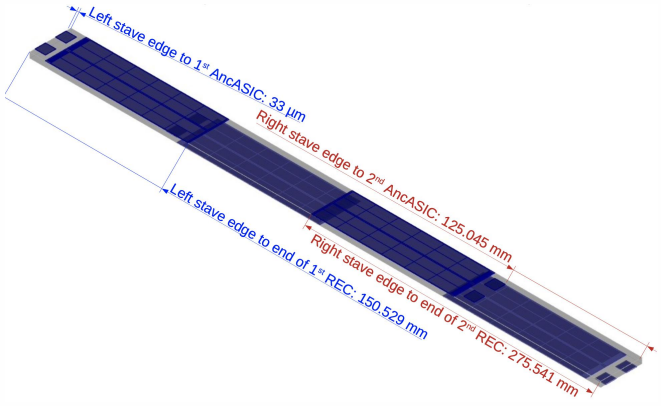


Motivation

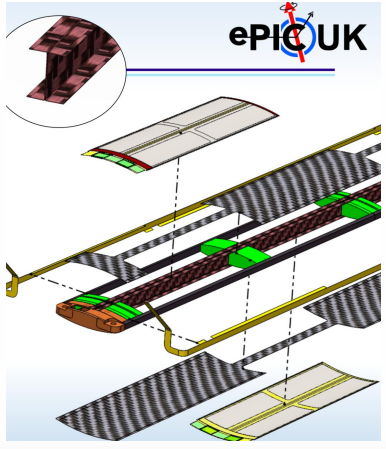
With the change to the stave lengths, what would be the best radii*?



* Stave lengths overlapped for full coverage and set to minimum radius they could fit within the expected support cone.



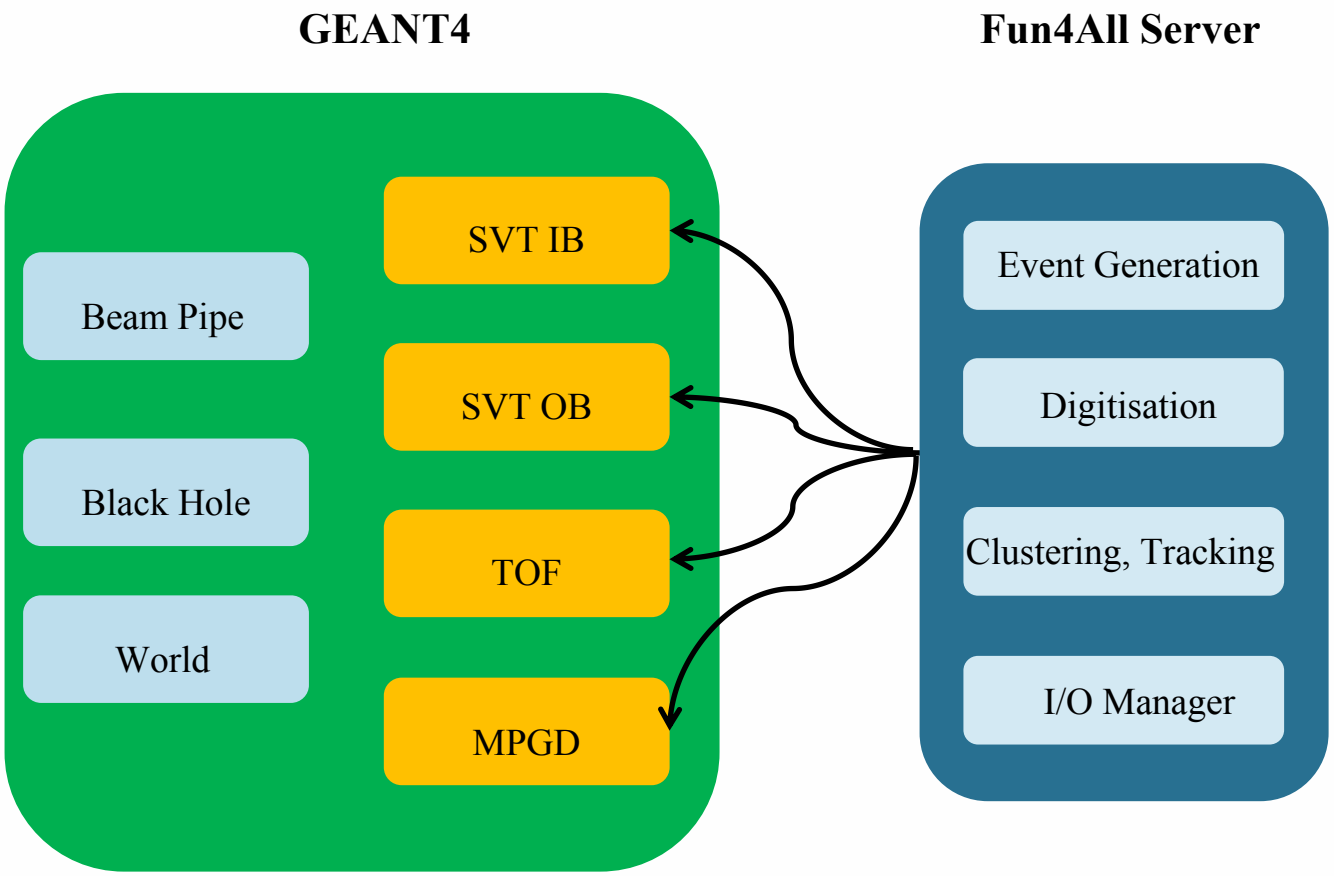
Flat OB from James



Curved OB from Adam

- Goal
  - Comparison of the potential OB layout scheme.
  - Comparison of the Curved and flat OB layers.
- Toolkit
  - Fun4All (Fast simulation)
- Input Parameters
  - Detailed Geometry description of SVT OB layers.
  - Particle in simulation
    - Pi-
    - 0.2 - 20GeV
    - $-0.88 < \eta < 0.88$
    - $-\frac{\pi}{2} < \varphi < \frac{\pi}{2}$

Brief Intro to Fun4All



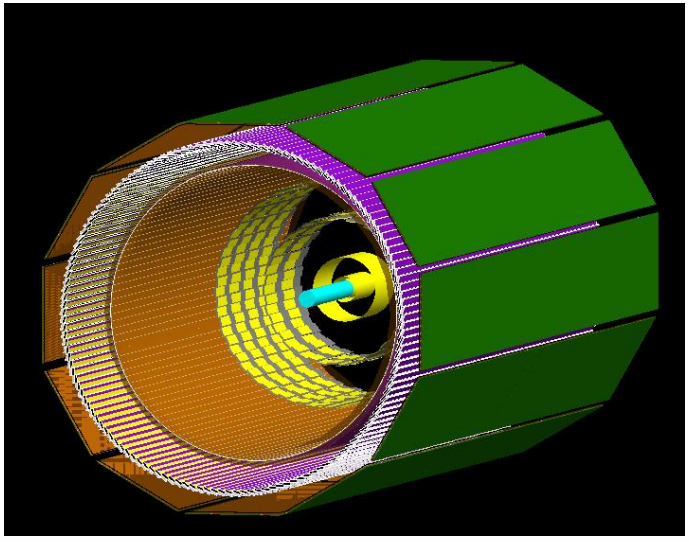
Fun4All

A light-weight ROOT + GEANT4 based EIC simulation framework originated from sPHENIX.

- ☐ Configured with ROOT macros
- ☐ Modular design - all detector are self contained
- ☐ Most EIC event generators are accessible
- ☐ Distribution as singularity container + libraries in cvmfs
- ☐ Fast simulation (< 10 mins for 10k events, > 40 mins needed in eic-shell full simulation)

For more.

Geometry description of Tracking system in Fun4All



Beam pipe

SVT-IB

SVT-OB

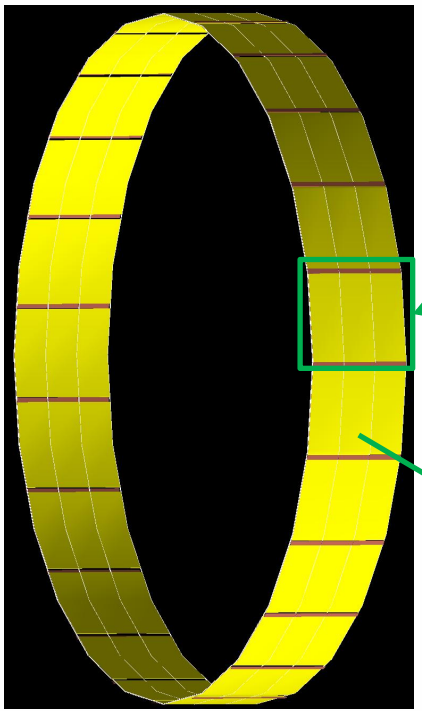
MPGD

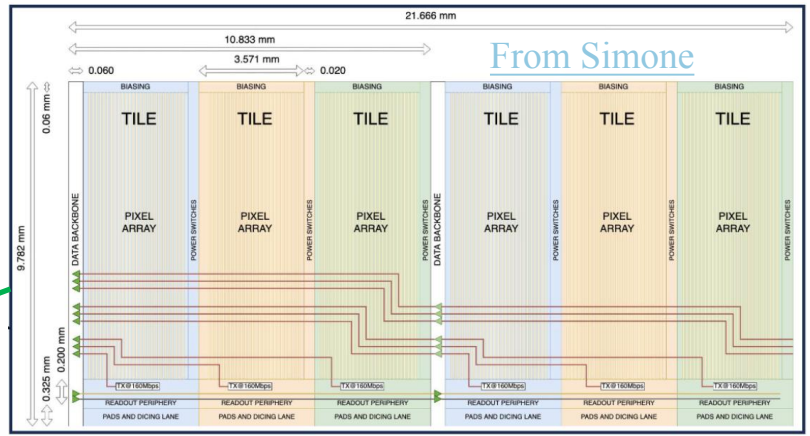
AC-LGD TOF

- Generic beam pipe for EIC in Fun4All
- Construct SVT detectors in Geant4 with 2 potential OB layout
- Construct MPGD & TOF detector in Geant4 with default parameters in eic-shell

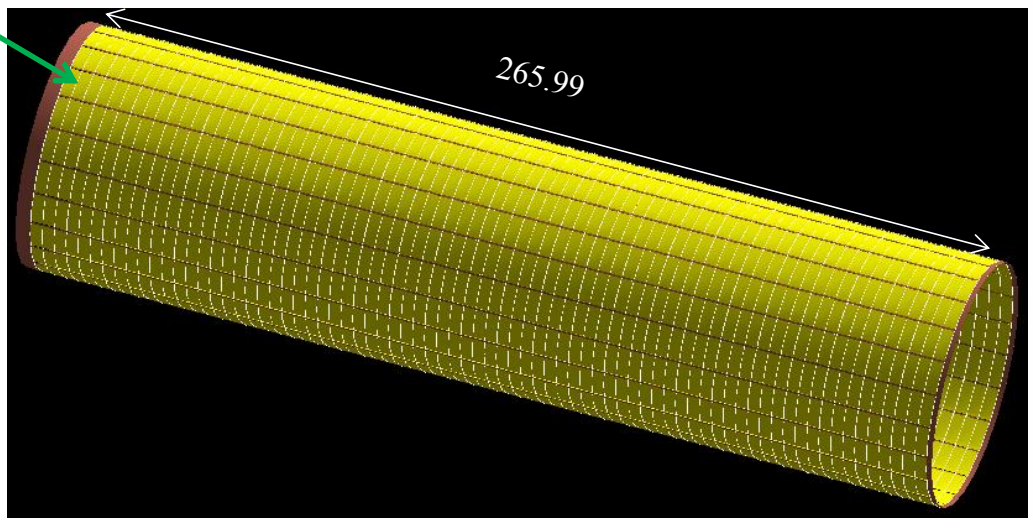
Name	radius [mm]	X_0 [%]
Beam pipe	31	0.22
SVTIB	36, 48, 120	0.05
SVTOB	267, 397 LS1	0.25, 0.55
	222, 440 LS2	
	272, 424 LS3	
MPGD	550, 725	0.6,1.2
TOF	646	0.8

Geometry description of SVT IB layers

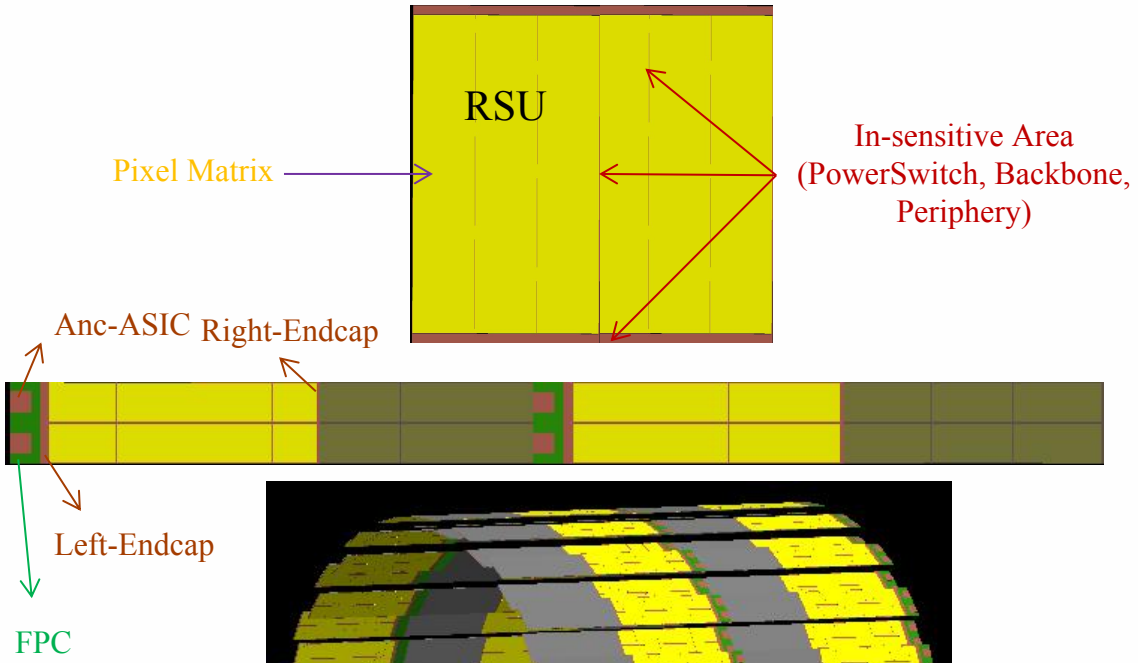


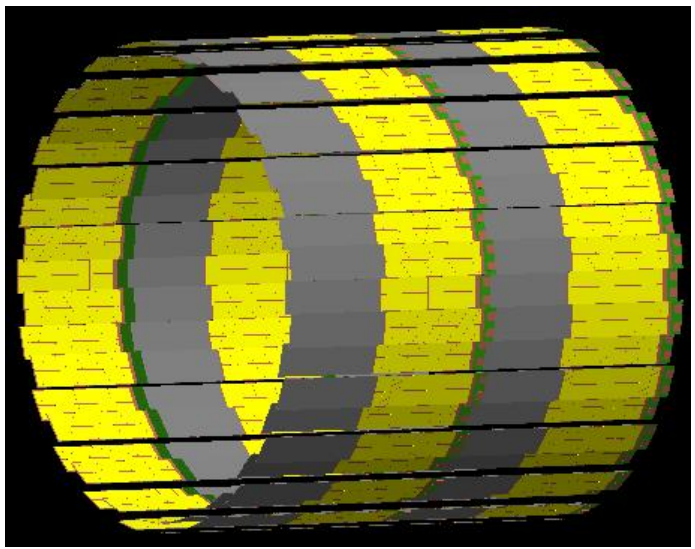


Name	Value
Length	260.0 mm
#RSU in Z	12
LEC length	4.5 mm
REC length	1.5 mm



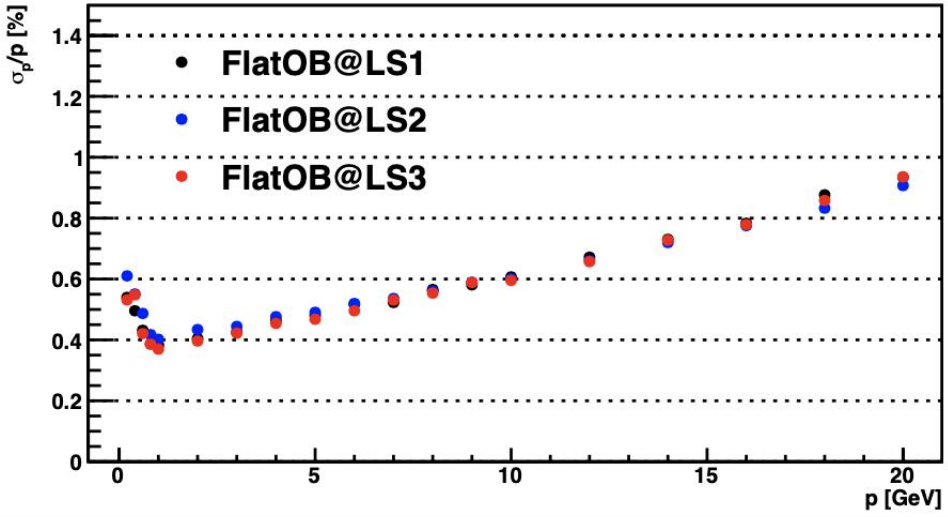
Geometry description of Flat OB layers

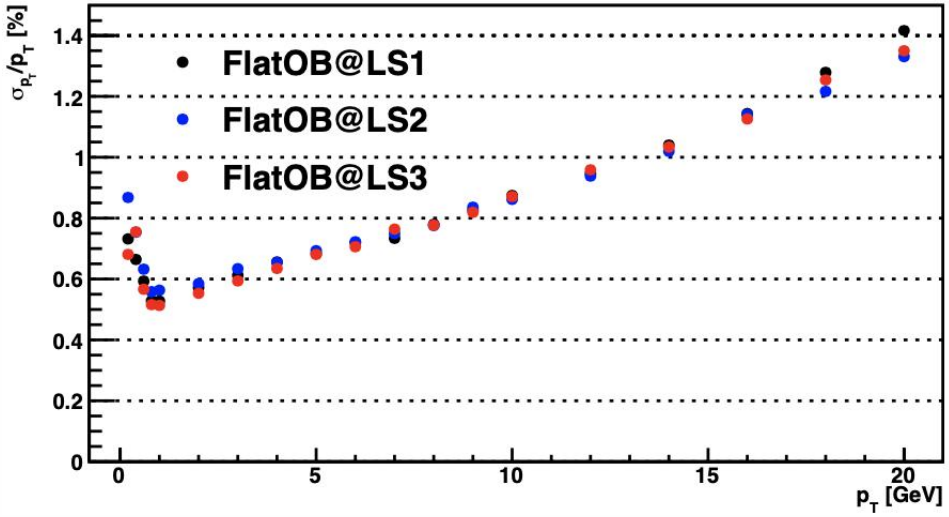




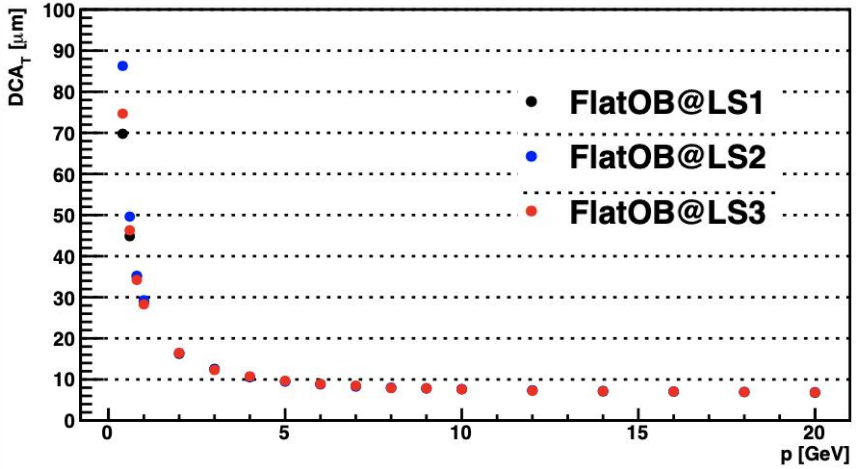
Name	Value
Carbon Stave	532.0(798.0)×39.2×0.53 mm3 LS1
	445.3(890.6) ×39.2 ×0.53 mm3 LS2
	532.0(890.6) ×39.2 ×0.53 mm3 LS3
#LAS per stave	4(6)
	4(8)
	4(8)
#RSU per LAS	6(6)
	5(5)
	6(5)
LAS	136.0 ×39.1 ×0.05 mm3
	114.3 ×39.1 ×0.05 mm3
	136.0(114.3) ×39.1 ×0.05 mm3

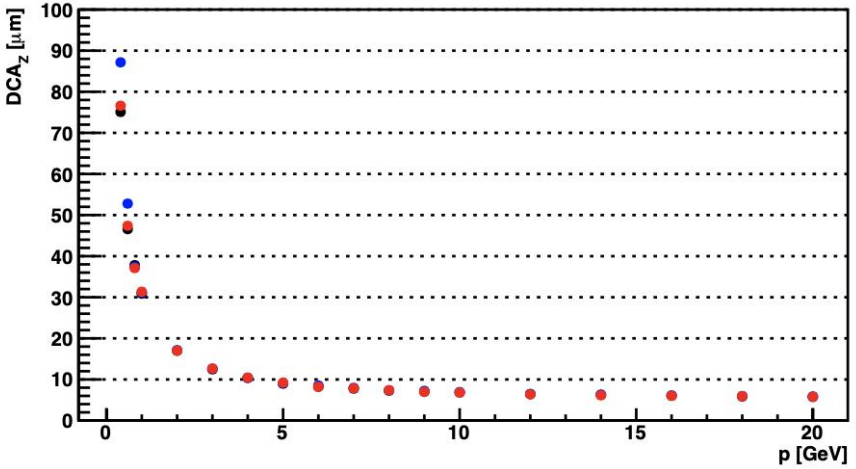
Comparison of Momentum resolution among Layout Schemes

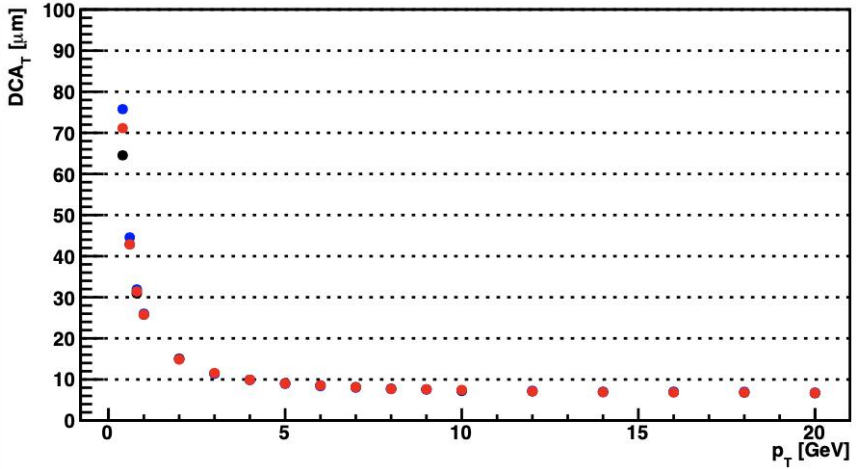


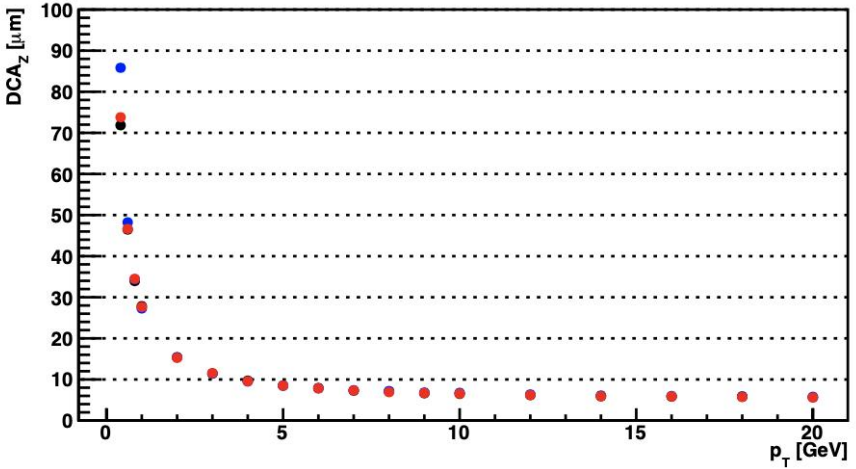


Impact Parameter resolution comparison among Layout Schemes

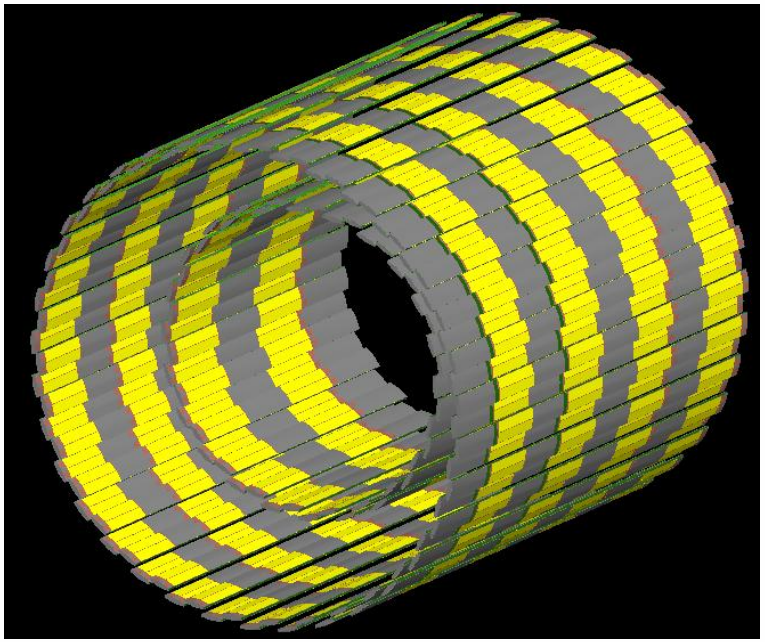






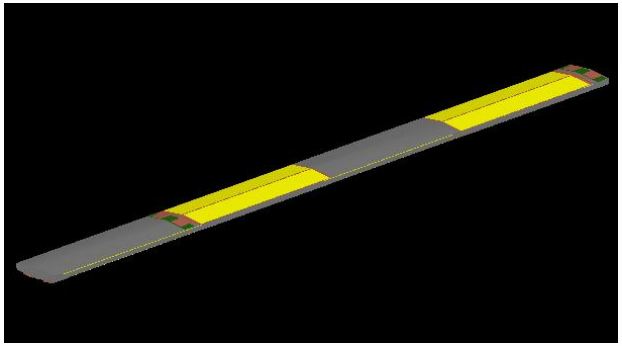


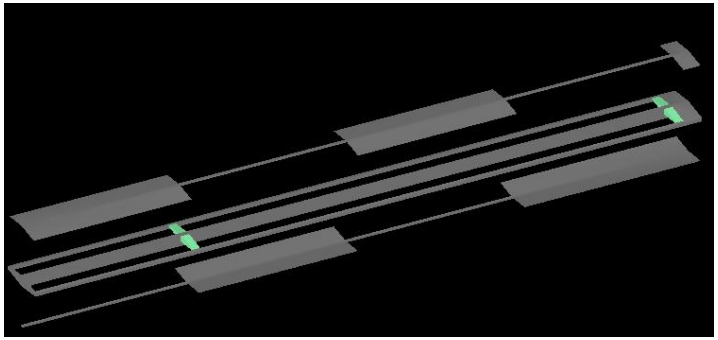
Geometry description of Curved OB layers



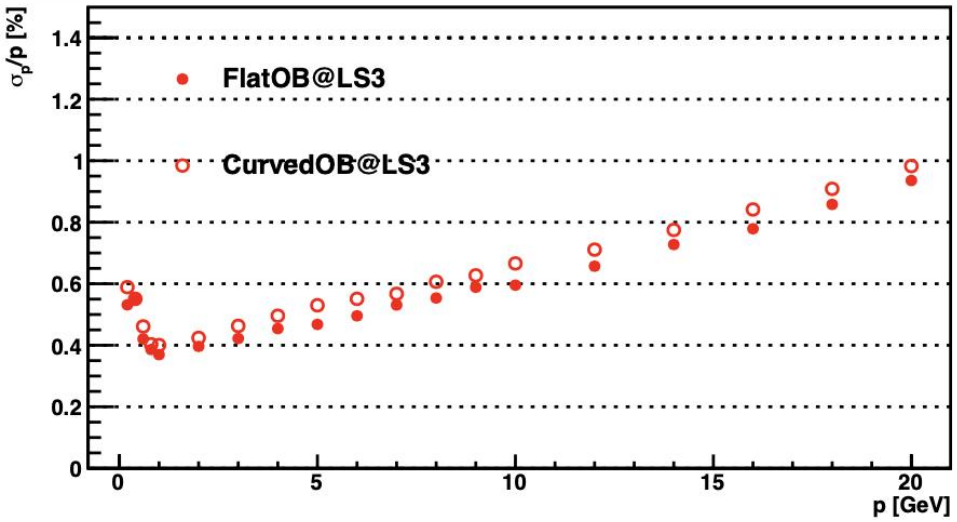
Centre Height	“CentreH” = 8.5 mm	“CentreH_half” = “CentreH” / 2 (= 4.25 mm)
Edge Height	“EdgeH” = 3.51 mm	“EdgeH_half” = “EdgeH” / 2 (= 1.755 mm)
Curved Surface Diameter	“CurveDiam” = 180.23 mm	“CurveRad” = “CurveDiam” / 2 (= 90.115 mm)
# L4 Staves	“L4Staves” = 70	“L4Staves_half” = “L4Staves) / 2 (= 35)
# L3 Staves	“L3Staves” = 46	“L3Staves_half” = “L3Staves) / 2 (= 23)
Ideal L4 Radius	“L4Rad” = 424 mm	
Ideal L3 Radius	“L3Rad” = 272 mm	
Radius Offset	“RadOffset” = 3 mm	
HU Pads & Dicing Space	“HU_Pads” = 325 um	
HU Readout Periphery	“HU_RO” = 200 um	
'HU Biasing Space	“HU_Bias” = 60 um	
HU Width	“HU_Width” = 9.782 mm	
RSU Readout & Pads	“RSU_RO_and_Pads” = “HU_Pads” + “HU_RO” (= 525 um)	
RSU Bias Backbone	“RSU_Bias” = “HU_Bias” * 2 (- 120 um)	
HU Active Width	= “HU_Width” - (“HU_Pads” + “HU_RO” + “HU_Bias”) (= 9.179 mm)	
Stave's Central Active Width	“ActiveWidth_centre” = 9.1779 mm	
Stave's Edge Active Width	“ActiveWidth_edge” = 9.0743 mm	

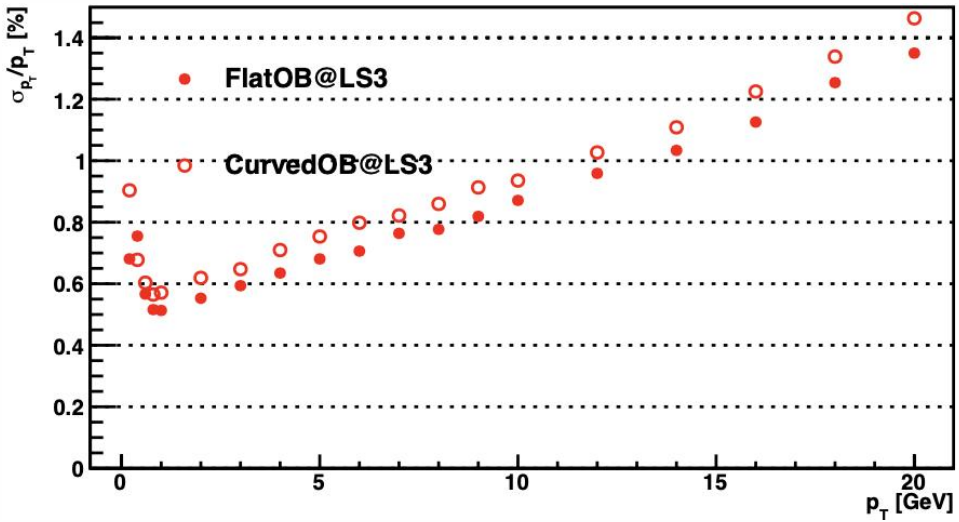
https://indico.bnl.gov/event/23878/contributions/93119/attachments/55368/94740/24-06-19_ePIC_SVT_OB_JGlover_r1.pdf



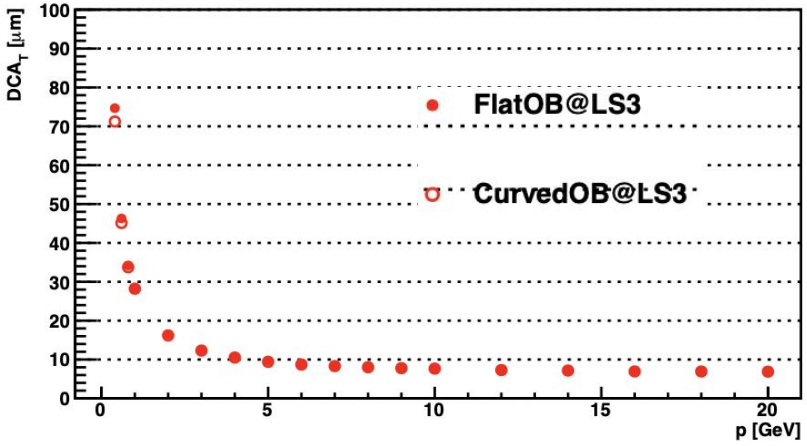


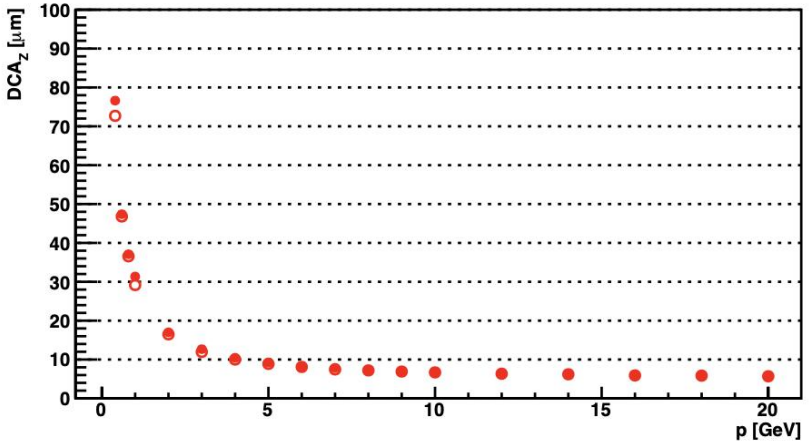
Momentum resolution comparison between flat/curved OB @ LS3

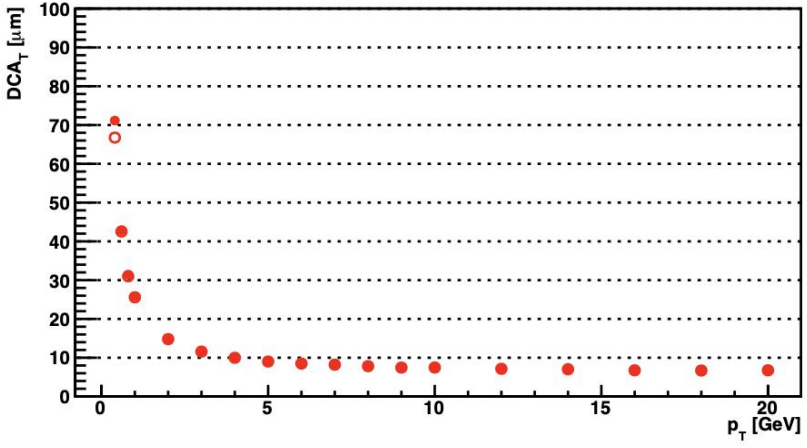


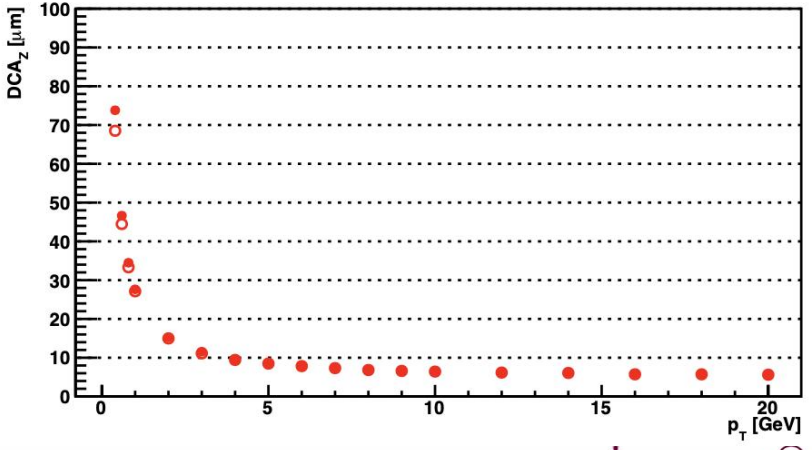


IP resolution comparison between flat/curved OB @LS3









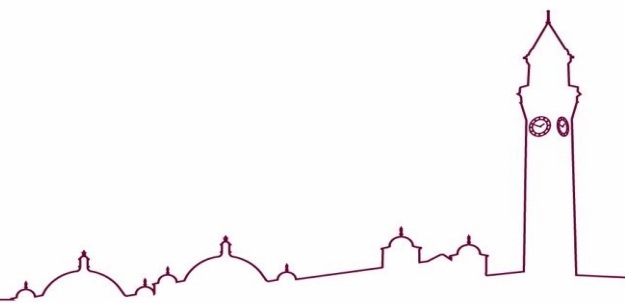
Summary & Outlook

- Summary
  - A tracking system is established in Fun4All framework, using the same parameter as that in eic-shell.
  - The Flat/curved OB Stave and 2 OB layout schemes are implemented in Fun4All.
  - Insensitive area added to the IB & OB LAS.
  - Momentum/Spatial parameters extracted from residual distribution and results are comparable to that of eic-shell. See backups
  - No significant difference in Momentum resolution observed among Layout Shemes.
  - Visible deference in spatial resolution observed at very lower momentum range, and schemes with small spacing between OB layers(LS2 & LS3) gain advantage.
  - Flat OB scheme achieves better performance in momentum resolution, but the geometry is less detailed. Results can be comparable if a more detailed Flat OB geo is available.

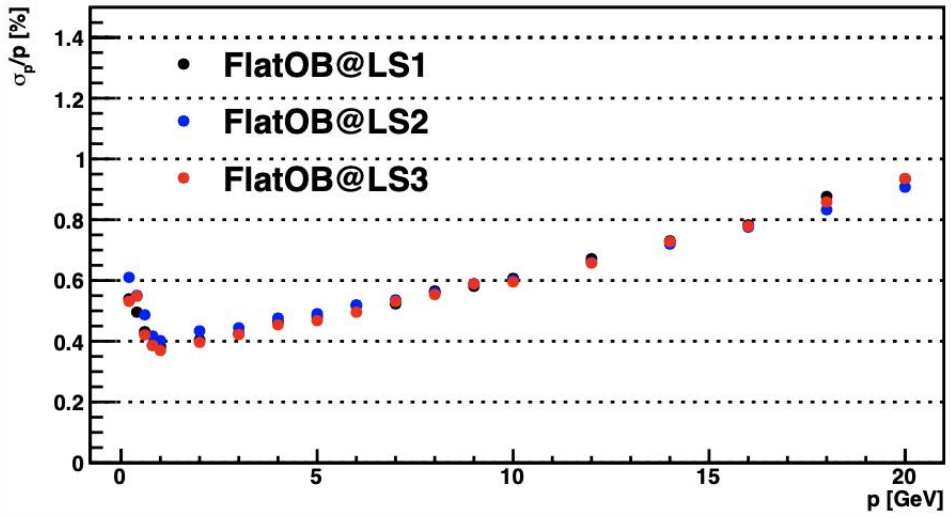
- Outlook
  - More detailed IB/OB geometry description (such as detailed Flat OB geometry).
  - Contribute to DD4HEP simulation collaborating with ePIC soft & tracking group.

Thanks!

Back up

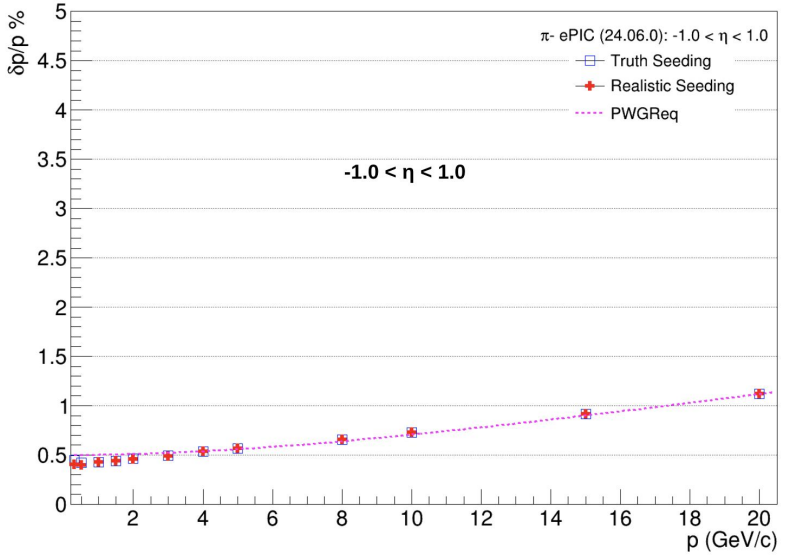


Momentum resolution comparison with eic-shell



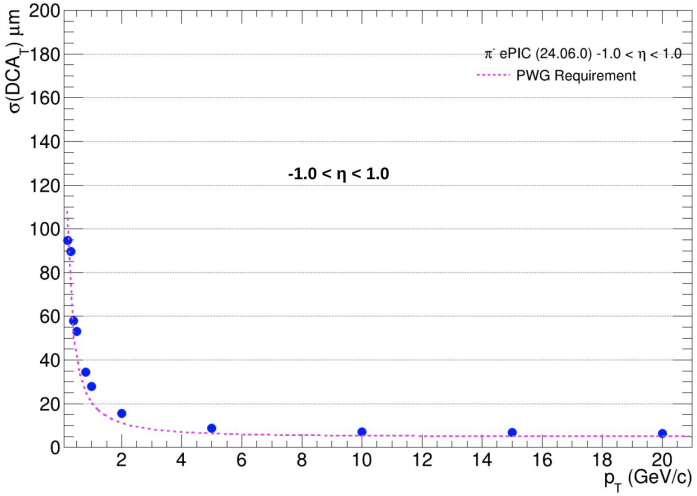
From Shyam

Momentum Resolutions (Truth/Real Seed)



Spatial resolution comparison with eic-shell

DCA$_T$ Resolutions



DCA$_z$ Resolutions