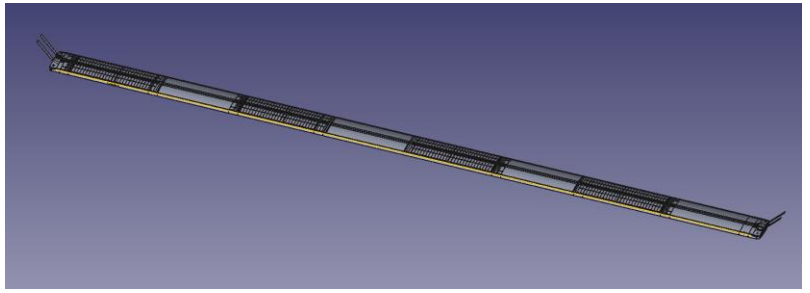
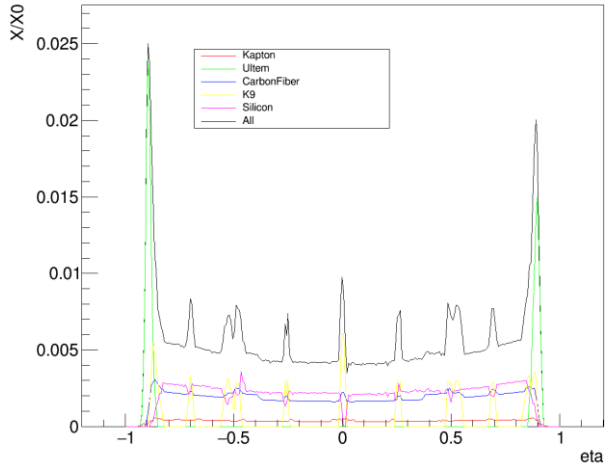
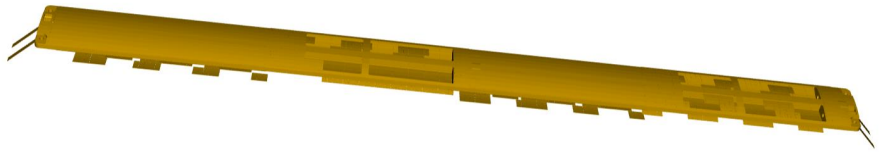
ePIC SVT – Simulation Updates and Next Steps

Sam Henry, *Tuna Tasali, Long Li*





- Simulation software and the SVT outer barrels
- Simulations with Fun4All (Long Li)
- Converting CAD to DD4HEP (Tuna Tasali)
- Material thickness mapping
- Update to epic simulation geometry
- Tracking performance studies
- Next steps



ePIC UK

UNIVERSITY OF OXFORD

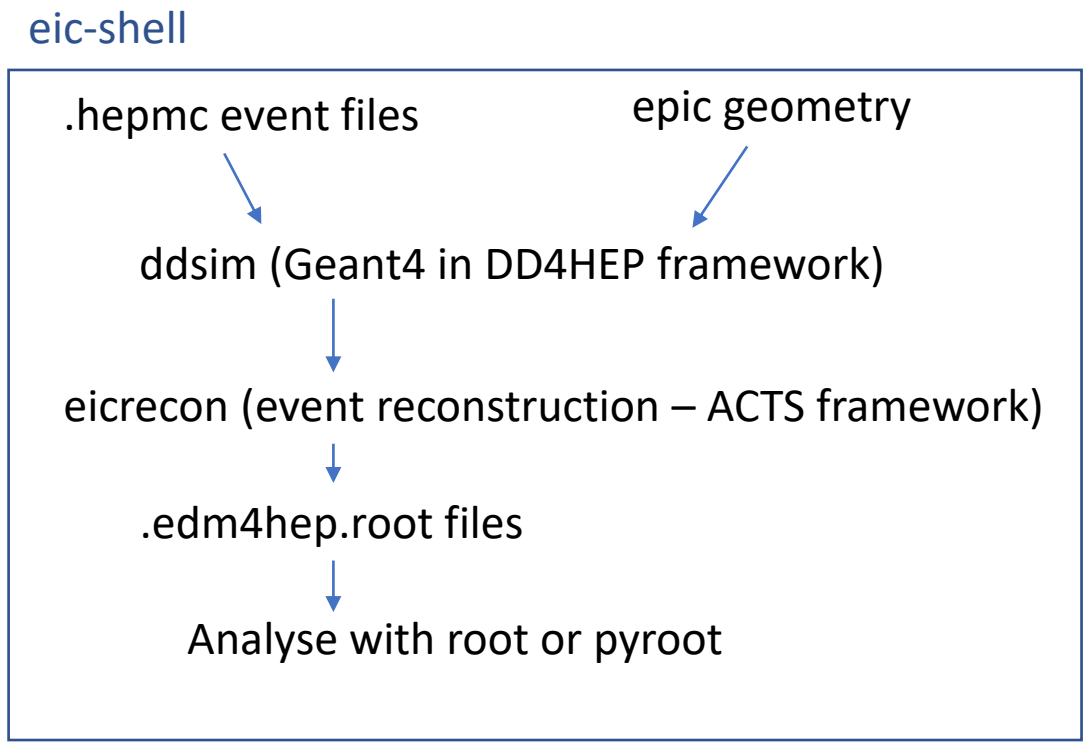
ePIC Simulation Software

Repositories:

EPIC Geometry: https://github.com/eic/epic
EICRecon: https://github.com/eic/EICrecon
EDM4eic: https://github.com/eic/EDM4eic
DD4hep: https://github.com/AIDAsoft/DD4hep

Tutorials:

https://www.youtube.com/@eicusergroup1532
https://eic.github.io/tutorial-setting-up-environment/
https://eic.github.io/tutorial-geometry-development-using-dd4hep/
https://eic.github.io/tutorial-simulations-using-ddsim-and-geant4/
https://eic.github.io/tutorial-jana2/
https://eic.github.io/tutorial-analysis/
https://github.com/cipriangal/eicGenTutorials

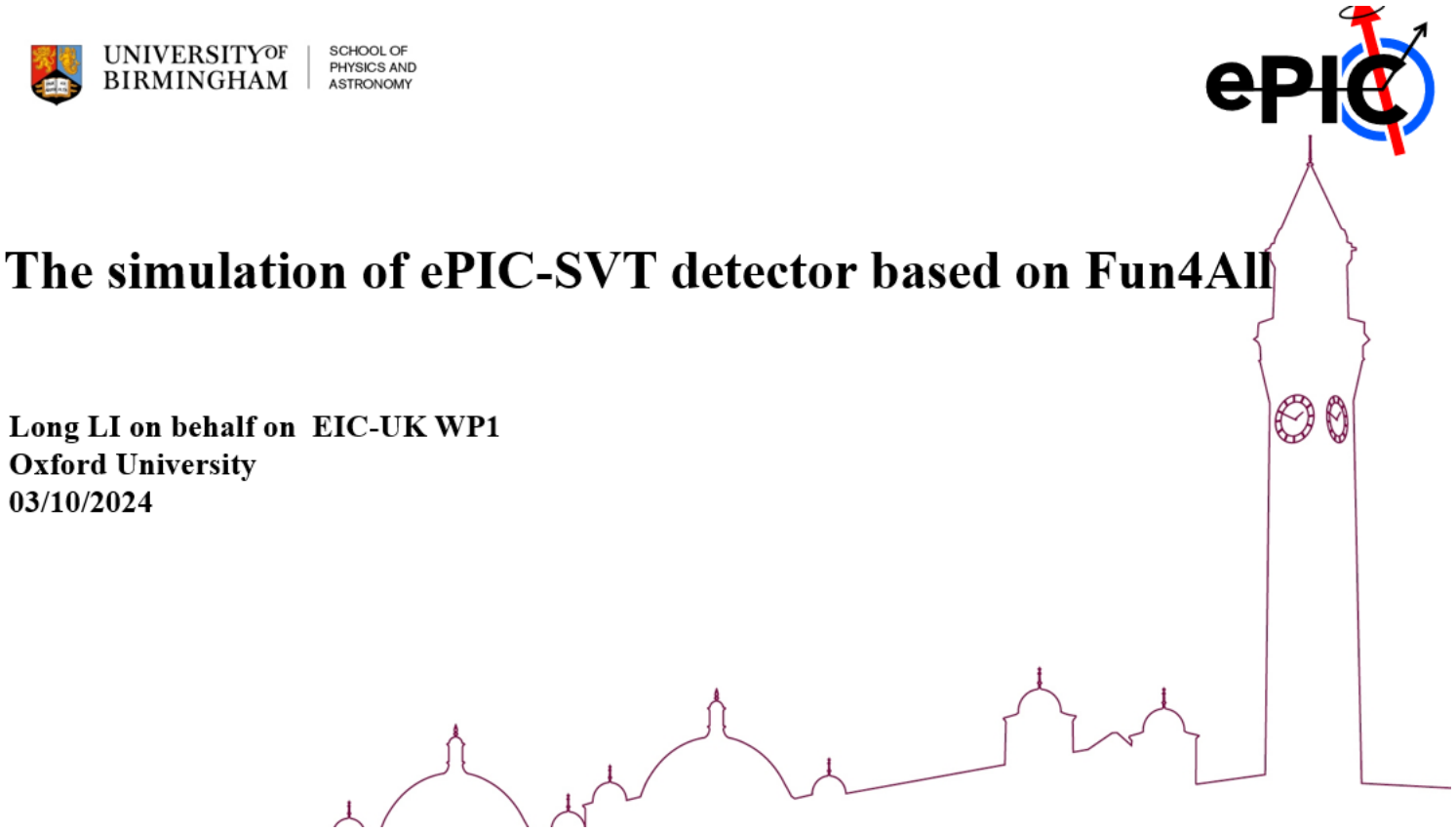


Mattermost forum: https://chat.epic-eic.org/ (helpdesk channel)
Software and computing mailing list: https://lists.bnl.gov/mailman/listinfo/eic-projdet-compsw-l

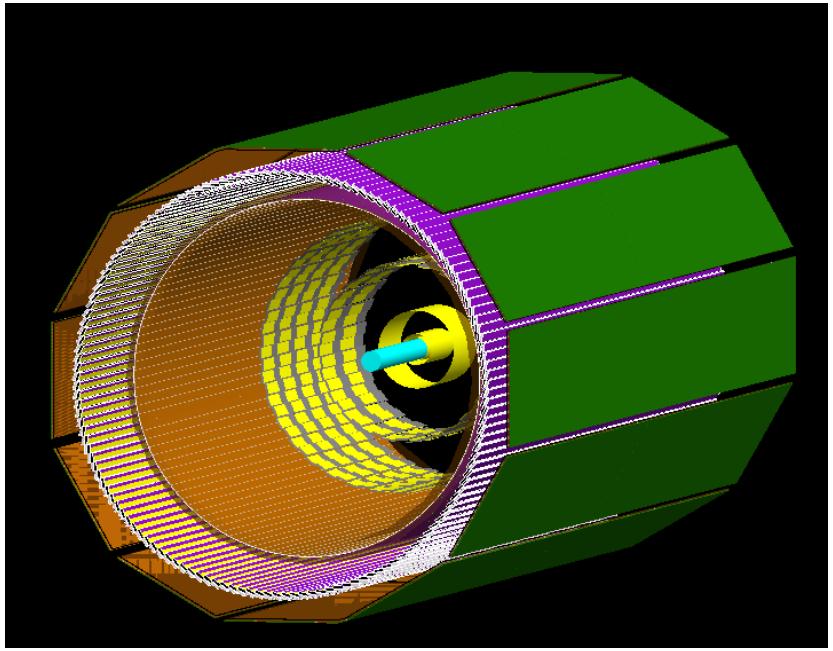
SVT Simulation – first results with Fun4All

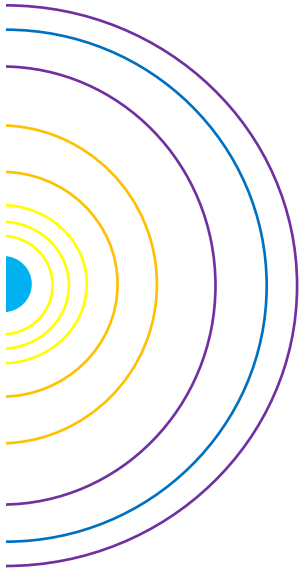
https://indico.bnl.gov/event/24804/contributions/97254/attachments/57706/99121/ePIC_SVT_simulation_F2F_Oxford_241003.pdf

See slides by Long Li:



Geometry description of Tracking system in Fun4All

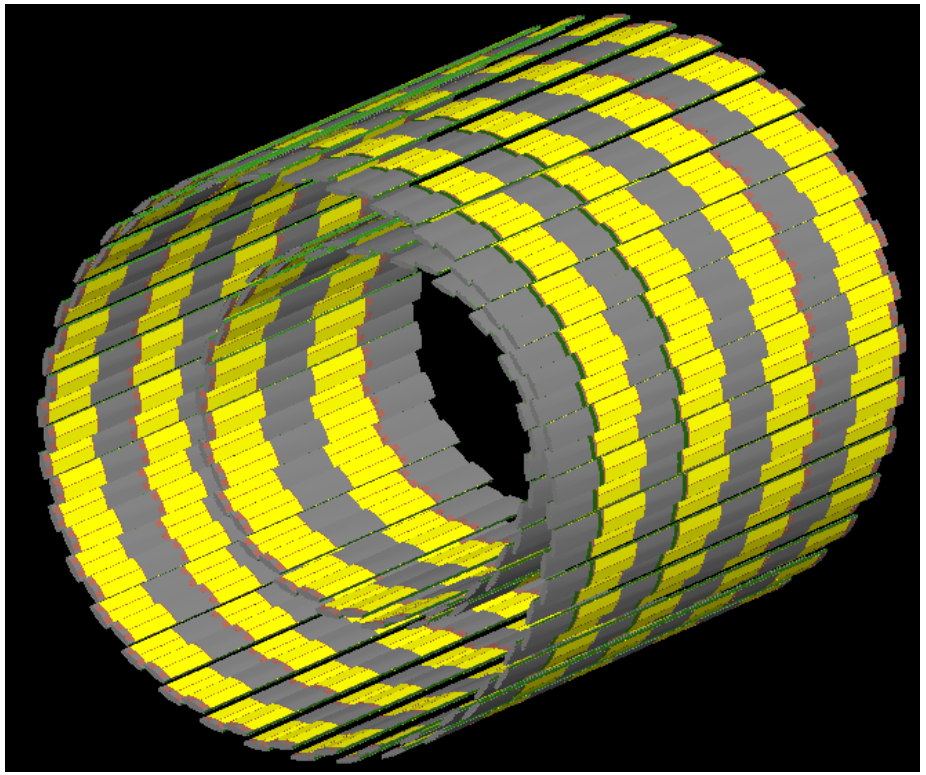




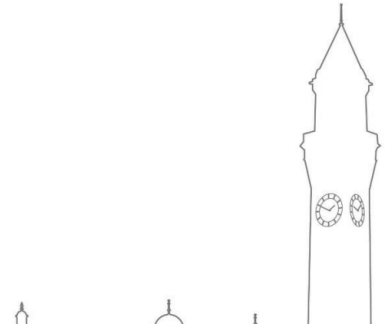
- Generic beam pipe for EIC in Fun4All
- Construct SVT detectors in Geant4 with 2 potential OB layout
- Construct MPGD & TOF detector in Geant4 with default parameters in eic-shell

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

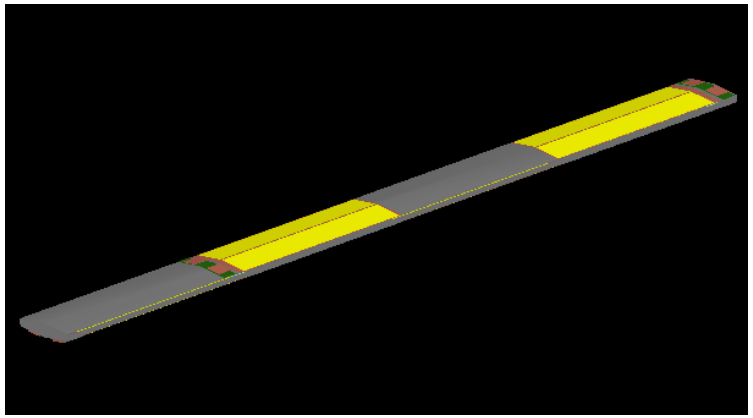
Geometry description of Curved OB layers

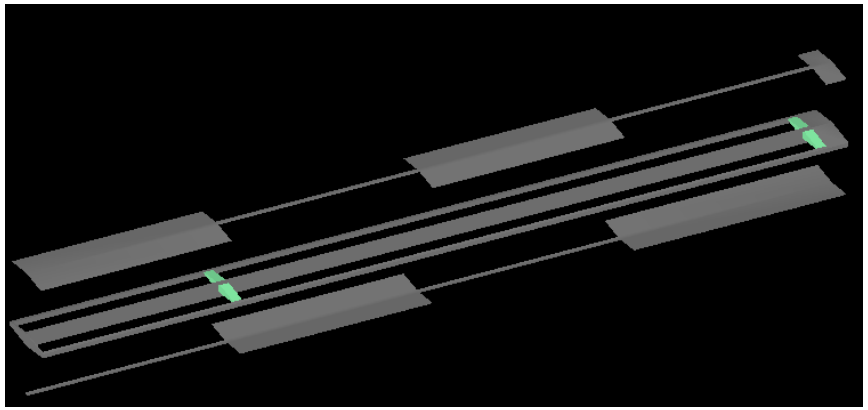


Centre Height	"CentreH" = 8.5 mm	"CentreH_half" = "CentreH" / 2 (= 4.25 mm)
Edge Height	"EdgeH" = 3.51 mm	"EdgeH_half" = "EdgeH" / 2 (= 1.755 mm)
Curved Surface Diameter	"CurveDiam" = 180.23 mm	"CurveRad" = "CurveDiam" / 2 (= 90.115 mm)
# L4 Staves	"L4Staves" = 70	"L4Staves_half" = "L4Staves) / 2 (= 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	

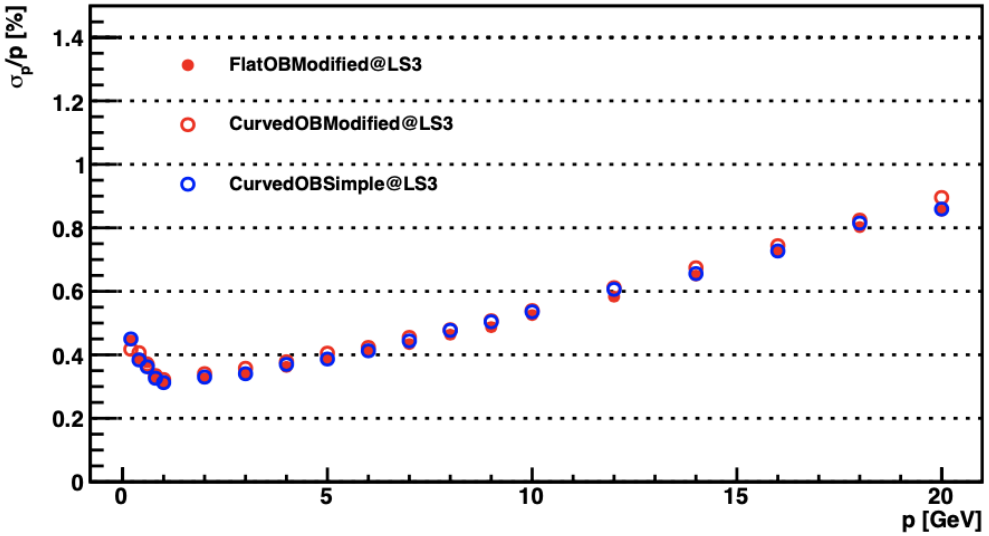


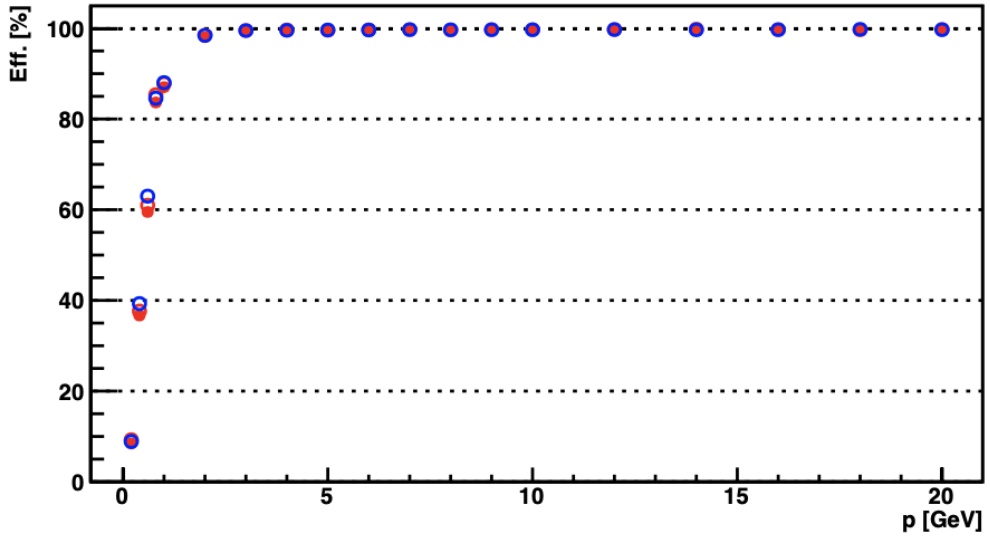
https://indico.bnl.gov/event/23878/contributions/93119/attachments/55368/94740/24-06-19_ePIC_SVT_OB_JGlover_r1.pdf

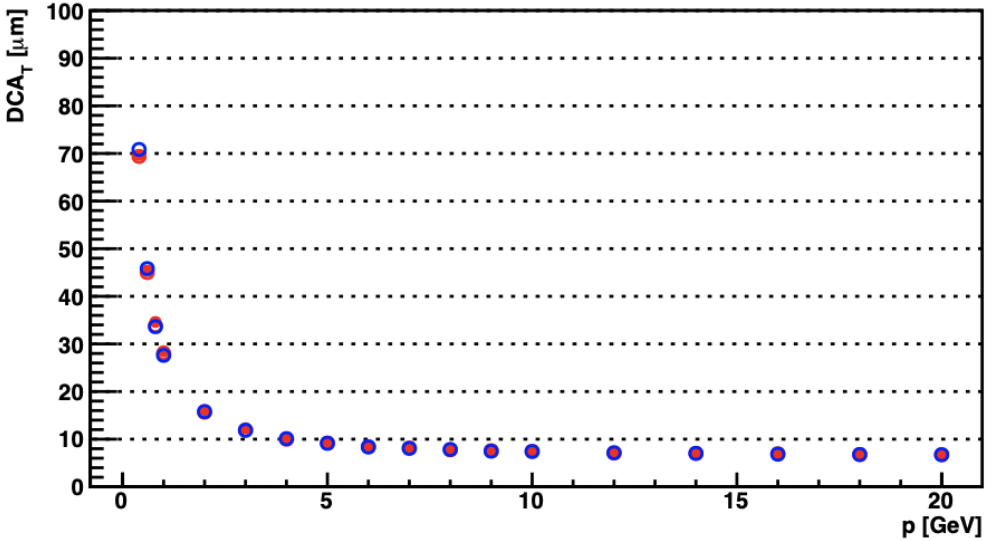


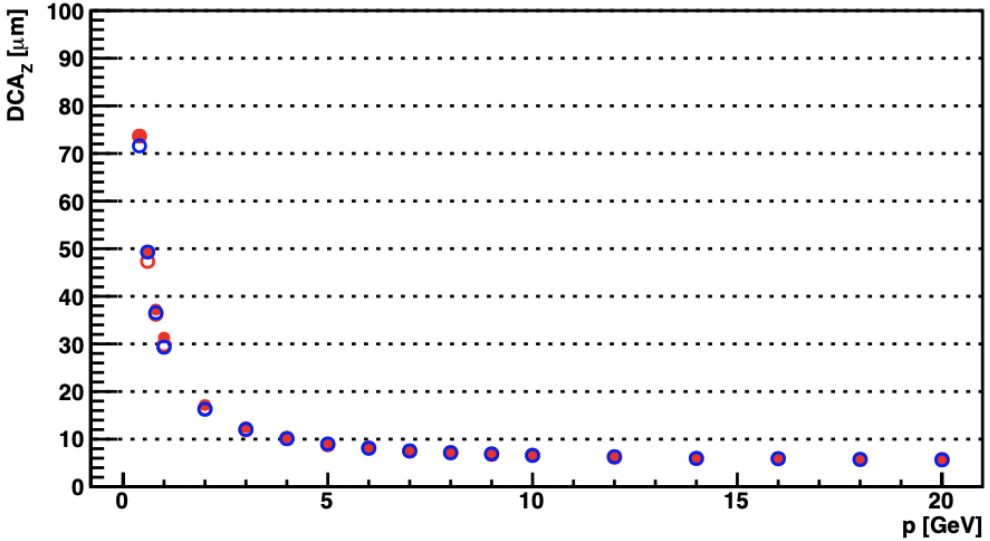


Results with modified OB Geometry







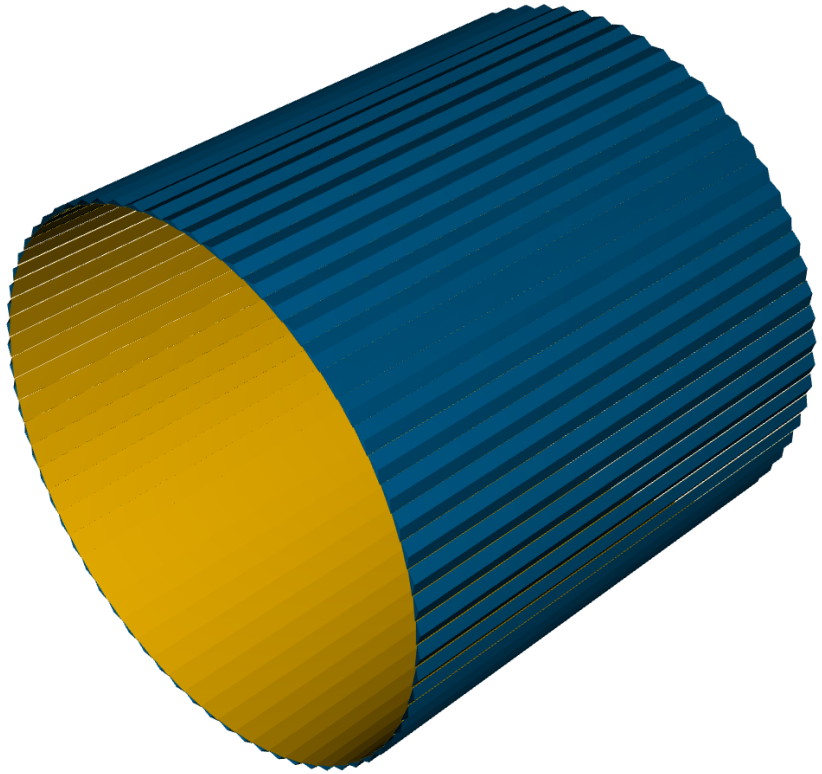


SVT – standard epic geometry

- Simple model of L3, L4 barrels
- Flat staves
- Layers of silicon, carbon fibre, aluminium to give material thickness
- X/X0 = 0.25% (L3)
- X/X0 = 0.55% (L4)

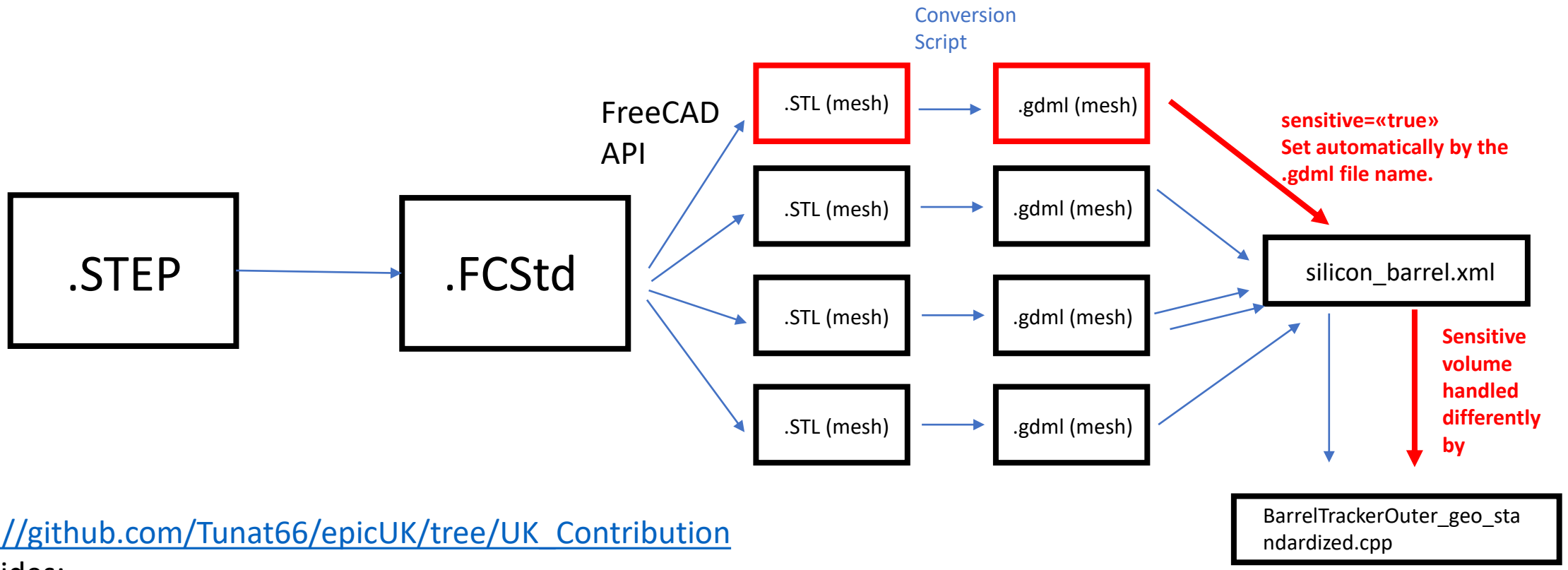
- Tracking performance benchmark analysed by Shyam Kumar

- Tracking group now wish to update geometry and freeze it to run simulations for TDR



ePIC SVT – detailed geometry from CAD files

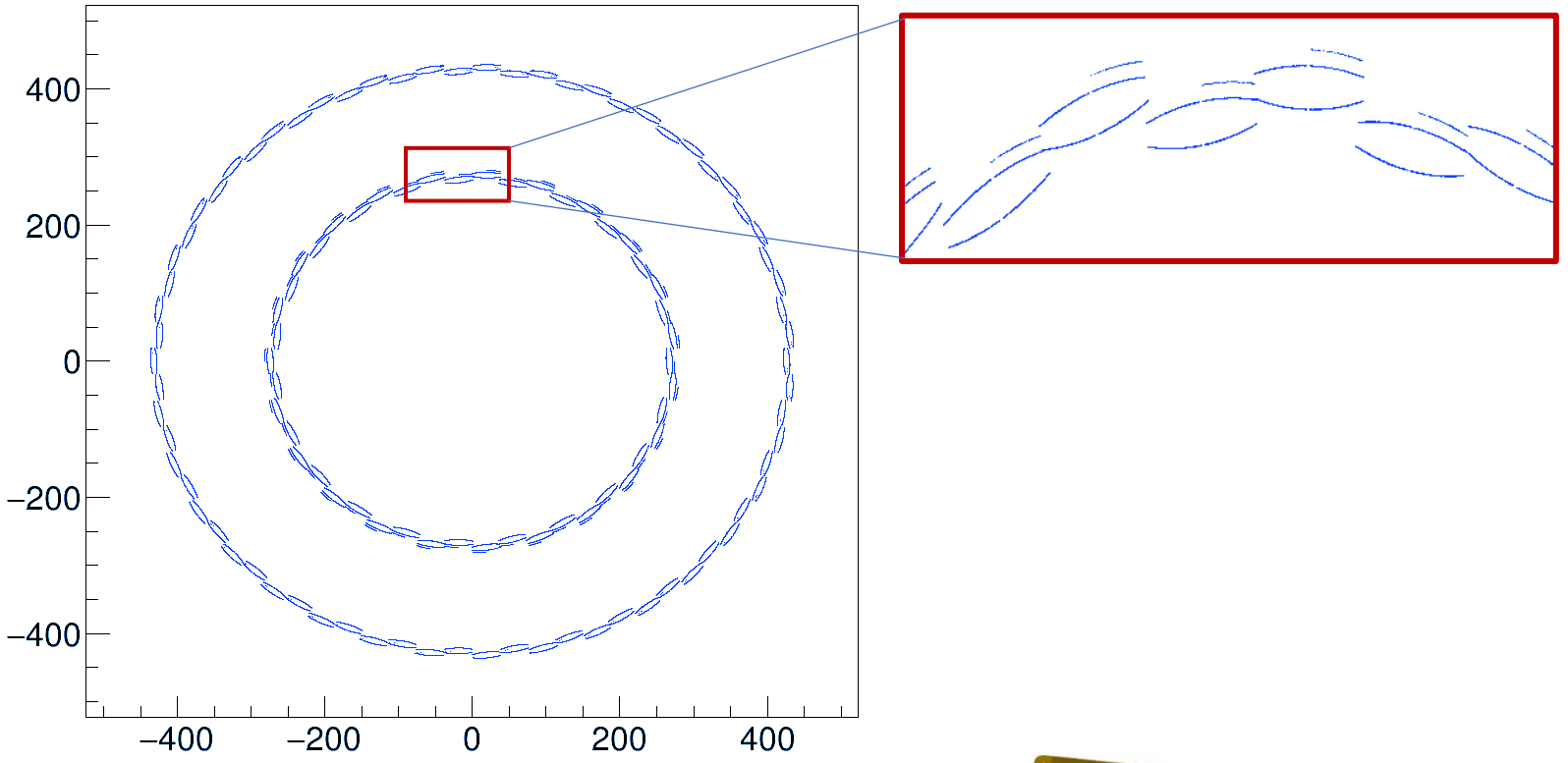
- Project work by Oxford intern student Tuna Tasali
- (Mostly) automated process to convert CAD files to DD4HEP geometry

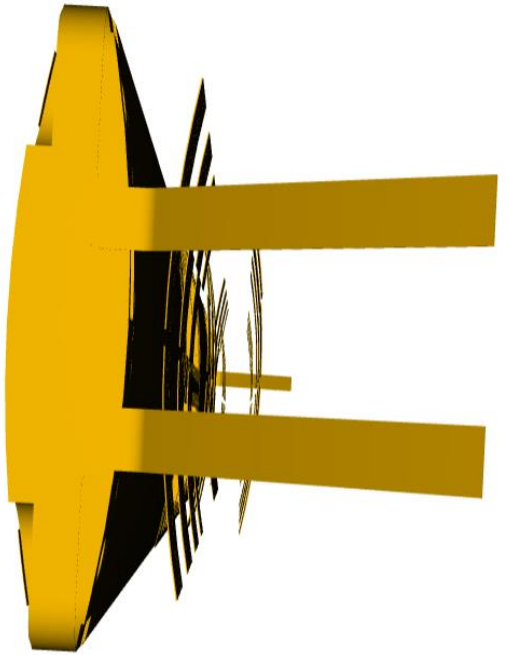


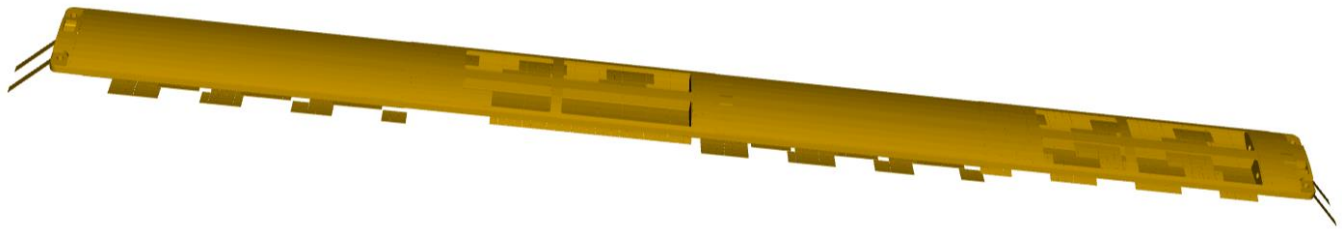
https://github.com/Tunat66/epicUK/tree/UK_Contribution

See slides:
https://indico.bnl.gov/event/23274/contributions/96308/attachments/57308/98404/InternationalPresentation_CADDesignsInDD4Hep.pptx

ePIC SVT – detailed geometry from CAD files

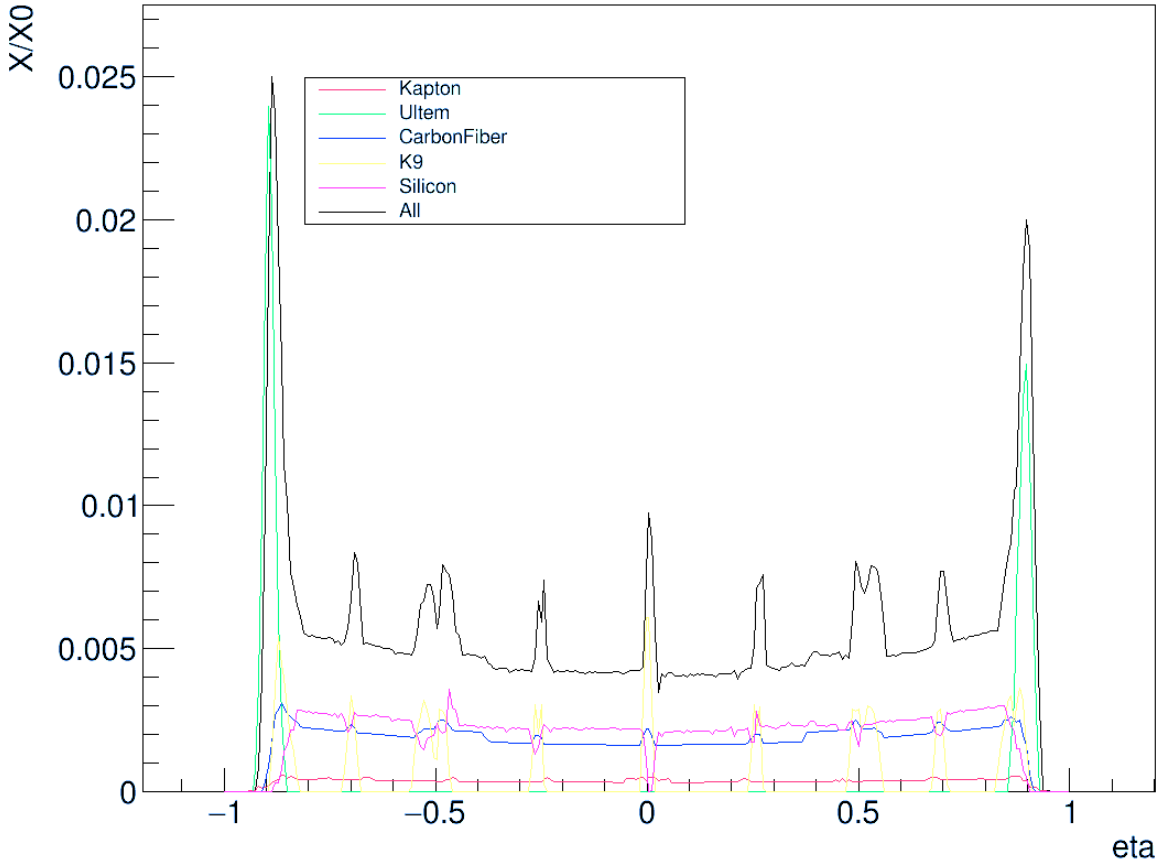




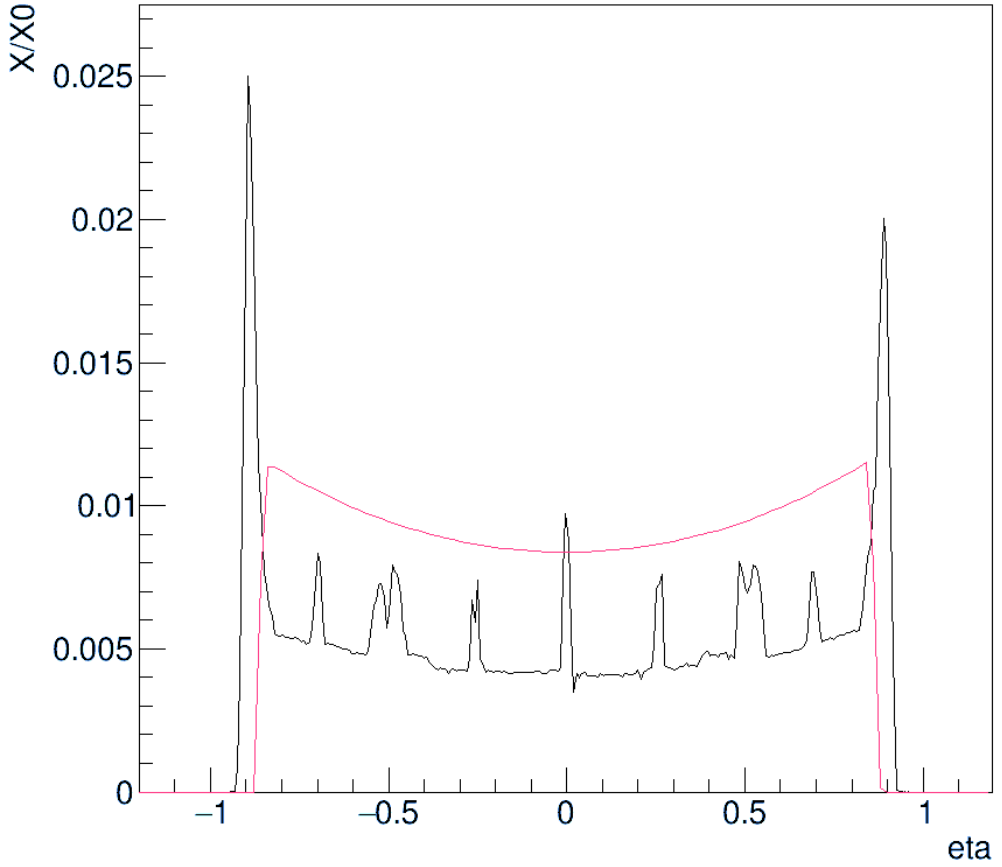


ePIC SVT – Material Thickness

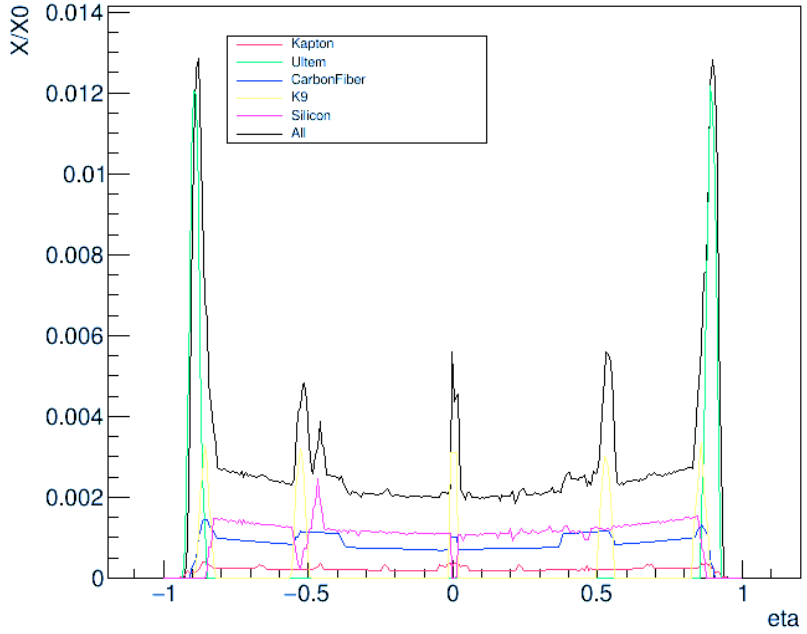
Using epic/bin/g4MaterialScan_to_csv script by Chao Peng

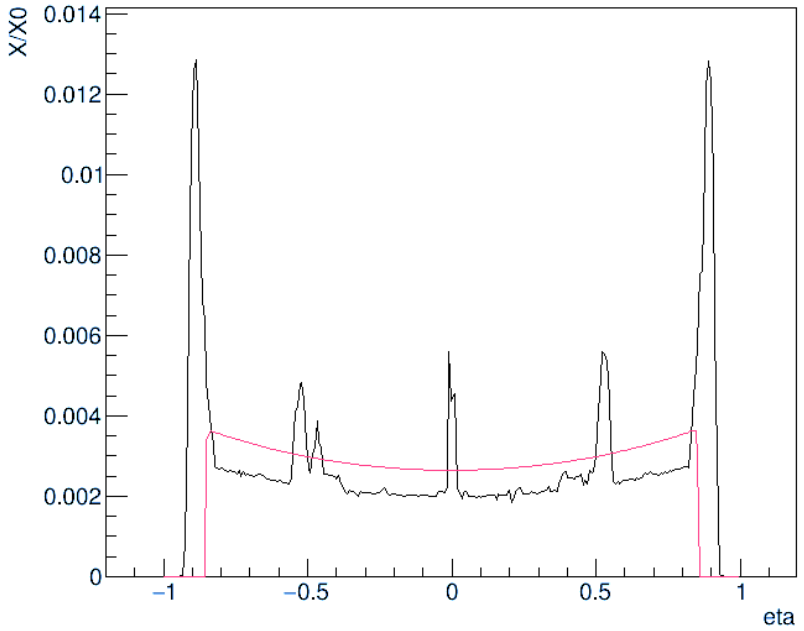


Lower baseline thickness than standard geometry



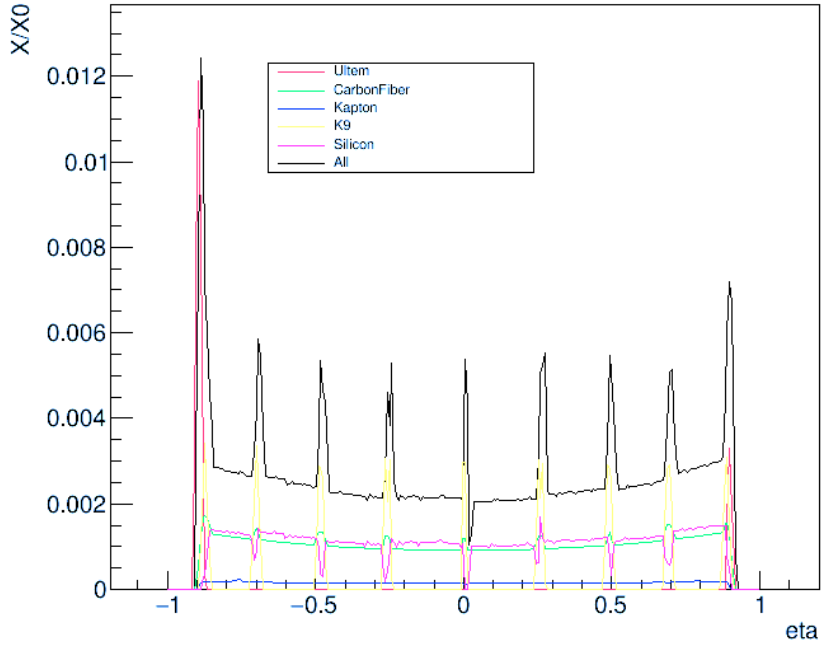
L3

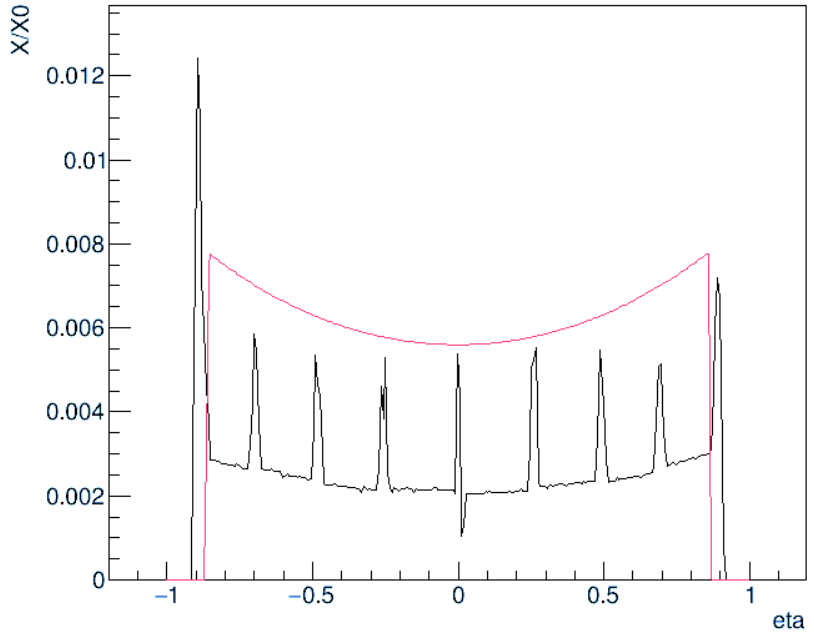




Average ratio: 0.85

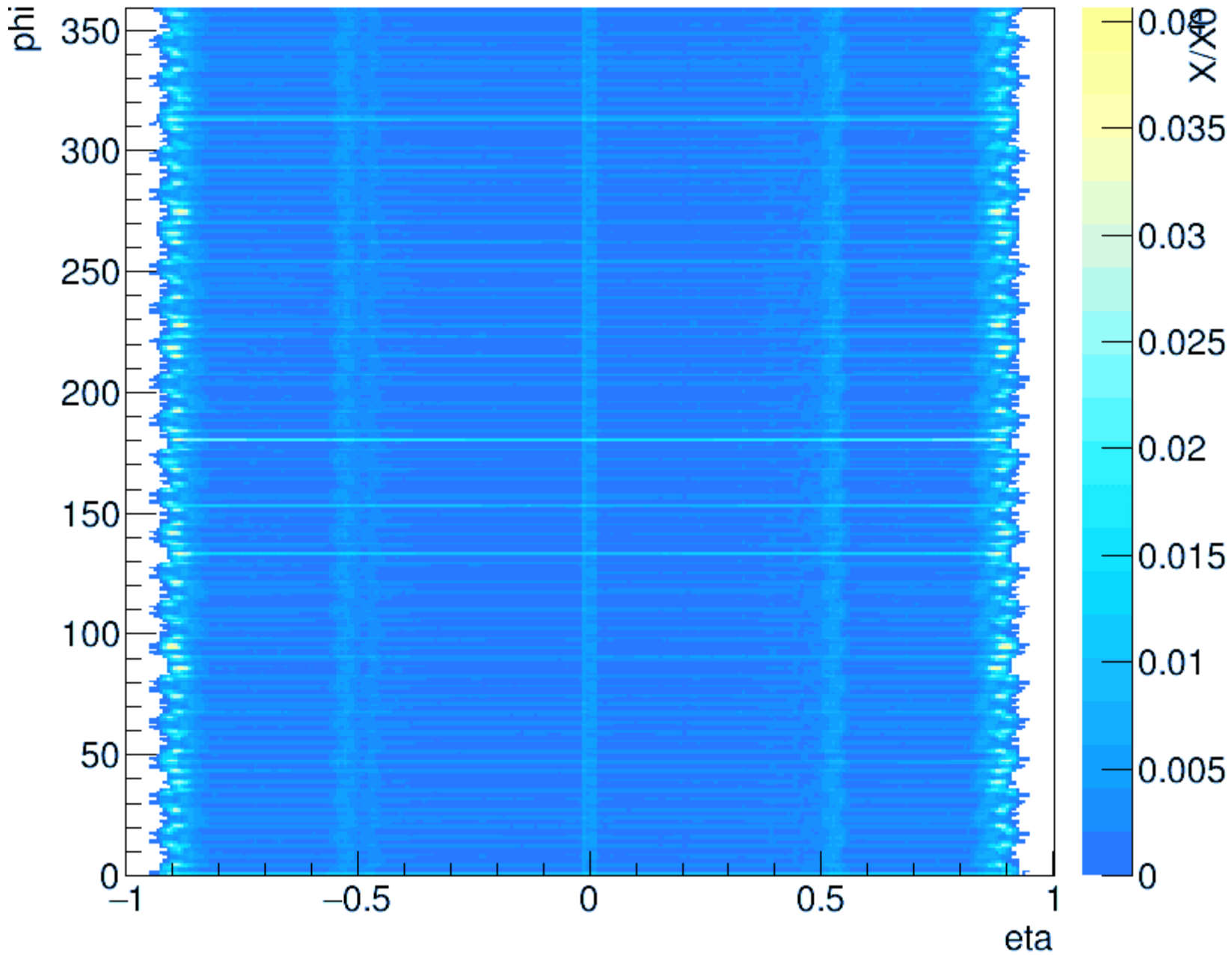
L4



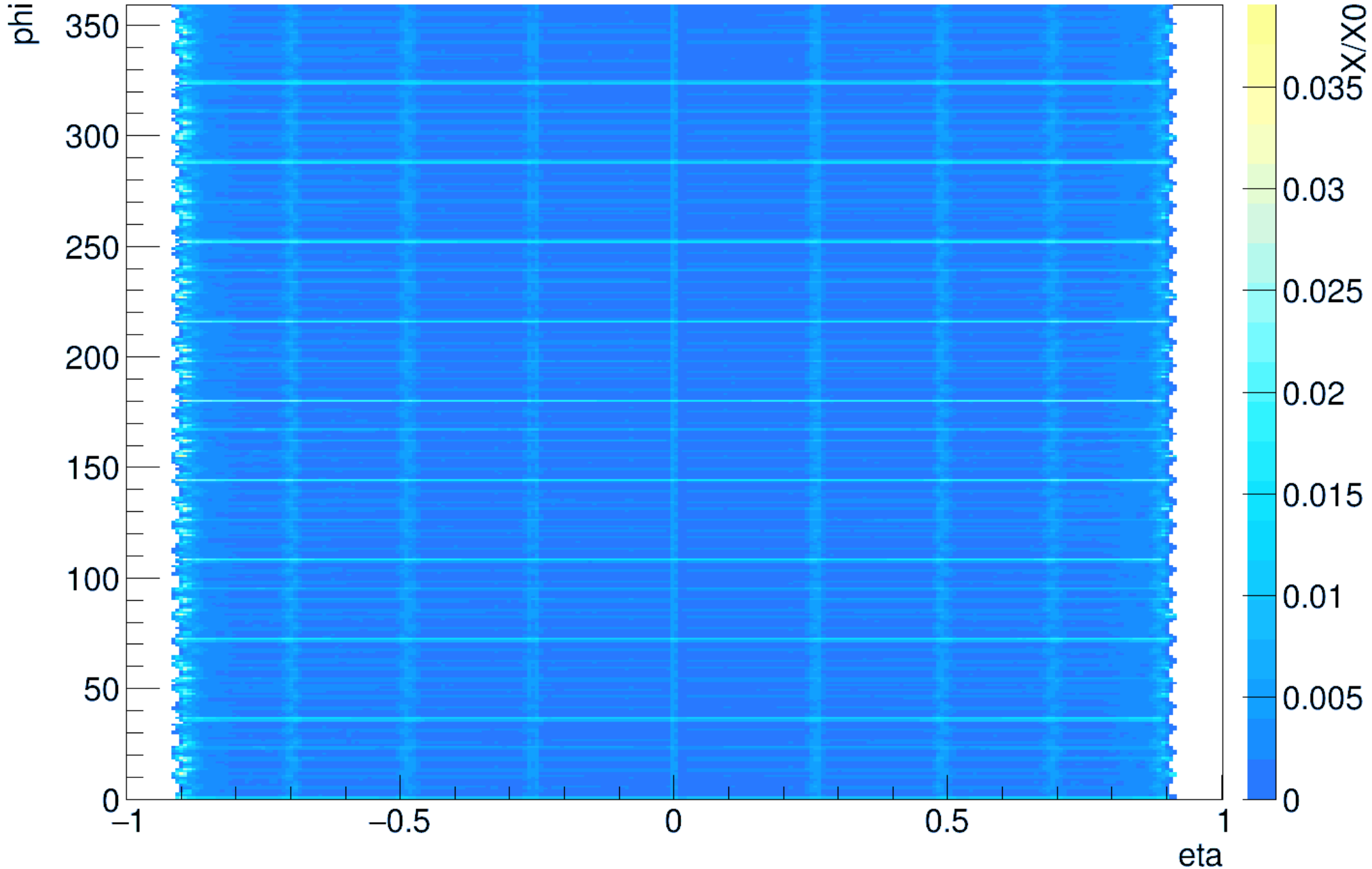


Average ratio: 0.42

L3


phi
350
300
250
200
150
100
50
0
−1
−0.5
0
0.5
1
eta
0.04
X/X0
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0

L4


phi
350
300
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200
150
100
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0
−1
−0.5
0
0.5
1
eta
X/X0
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0

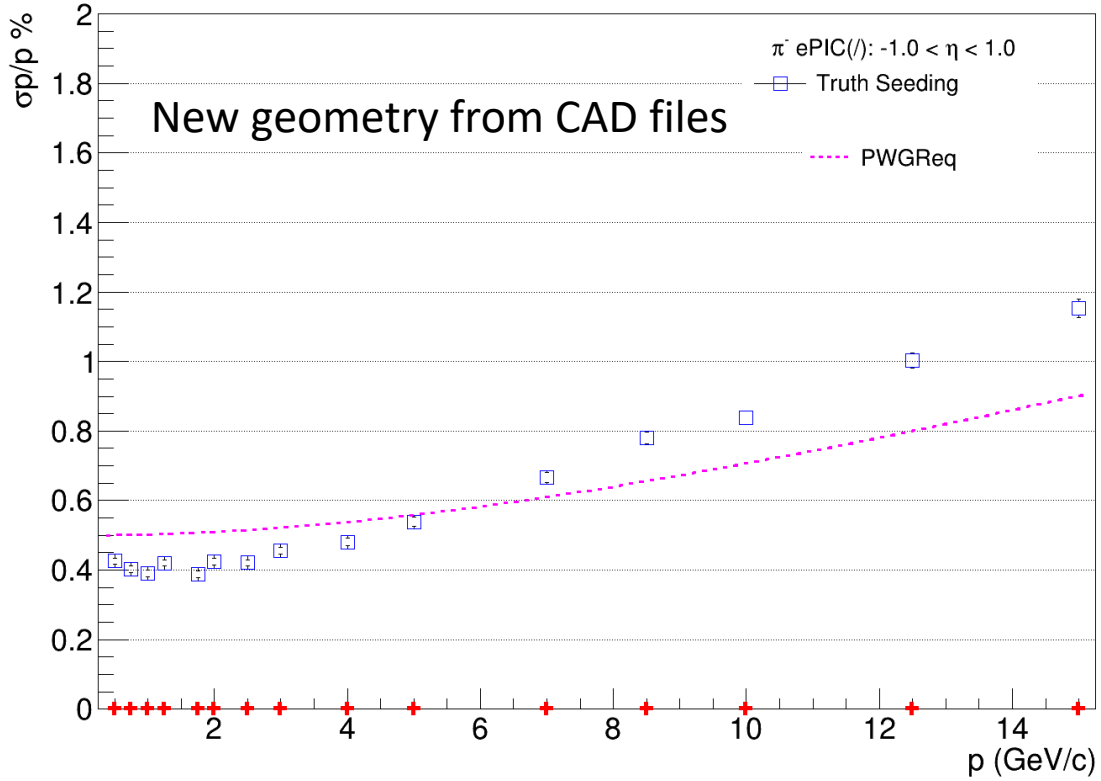
Summary / Change to epic geometry

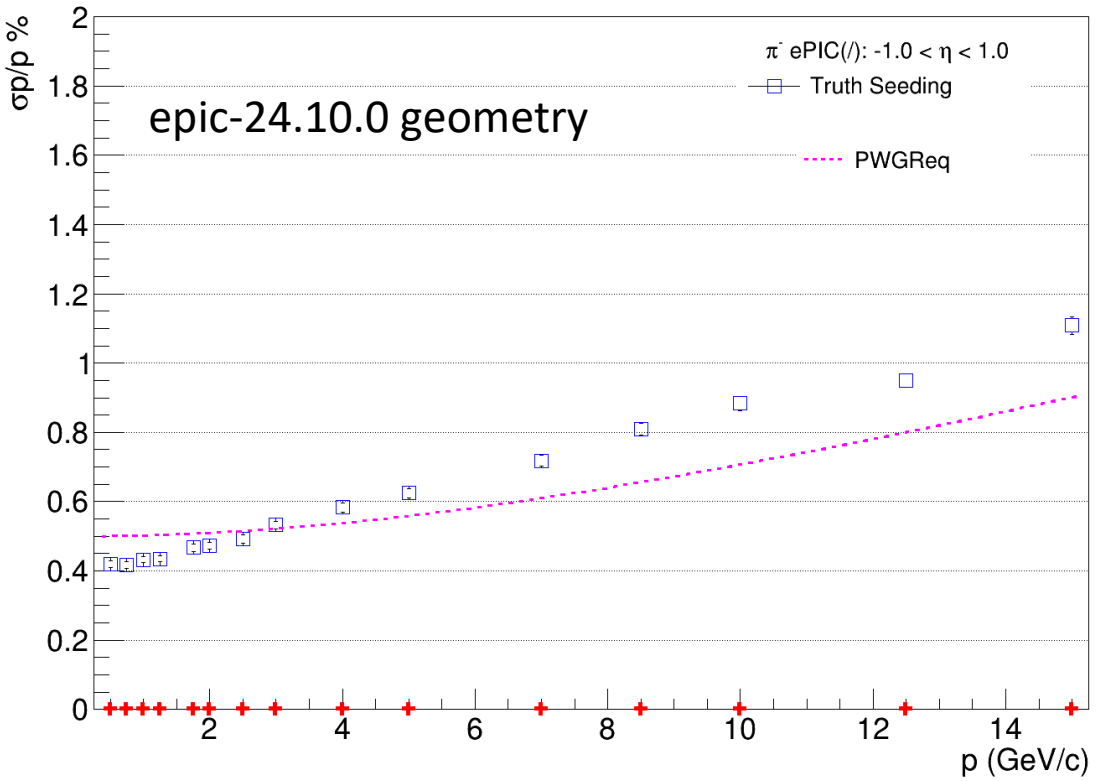
- Simulations show material thickness in CAD design is significantly less than in design specs and standard epic geometry
- Simulations show similar thickness for L3,L4
- Is this reliable? There are bugs, but it seems about right
- But doesn't include glue, bonding wires, additional support material …
  Will this be significant?

- Options:
  - Reduce thickness of aluminium layer in epic geometry to match average X/X0 of detailed simulation?
  - Reduce thickness of L4 aluminium layer to give X/X0=0.25% (to match L3)?
  - Keep the existing model?

ePIC SVT simulation test results

Using tracking performance benchmark script by Shyam Kumar, epic_craterlake_tracking_only.xml
https://github.com/eic/detector_benchmarks/tree/master/benchmarks/tracking_performances





Run time: 92±25 minutes

Run time: 10±3 minutes

Running ddsim and eicrecon on 10,000 events

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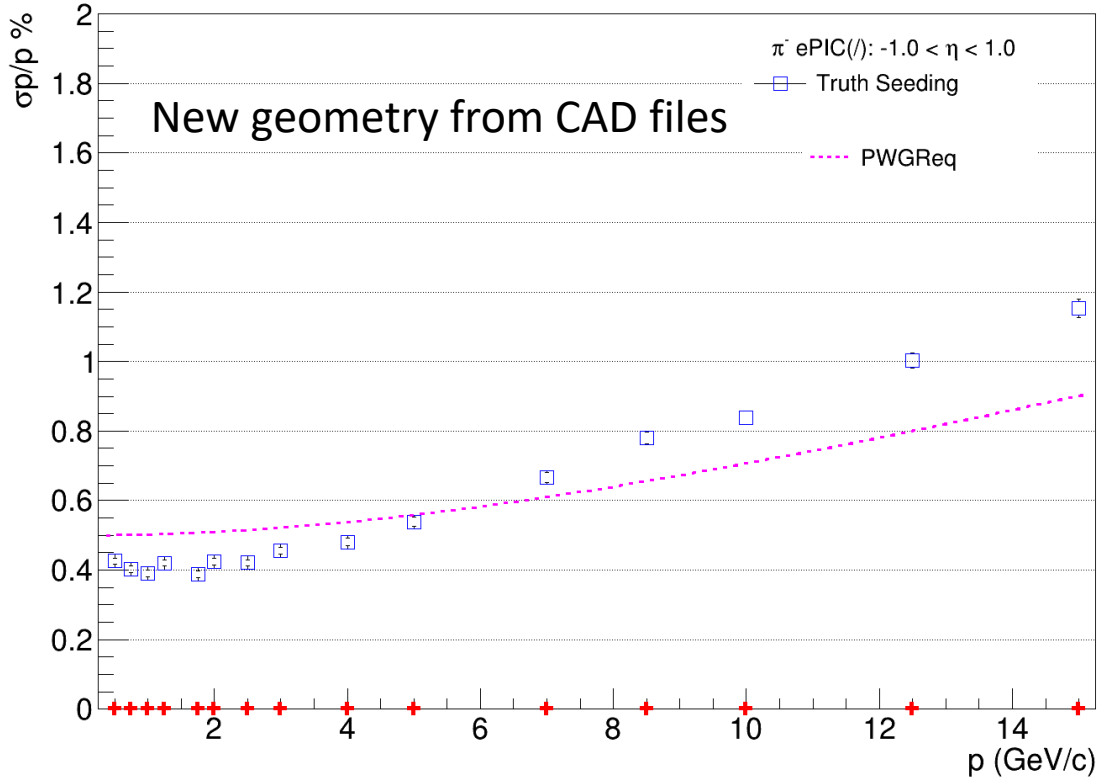
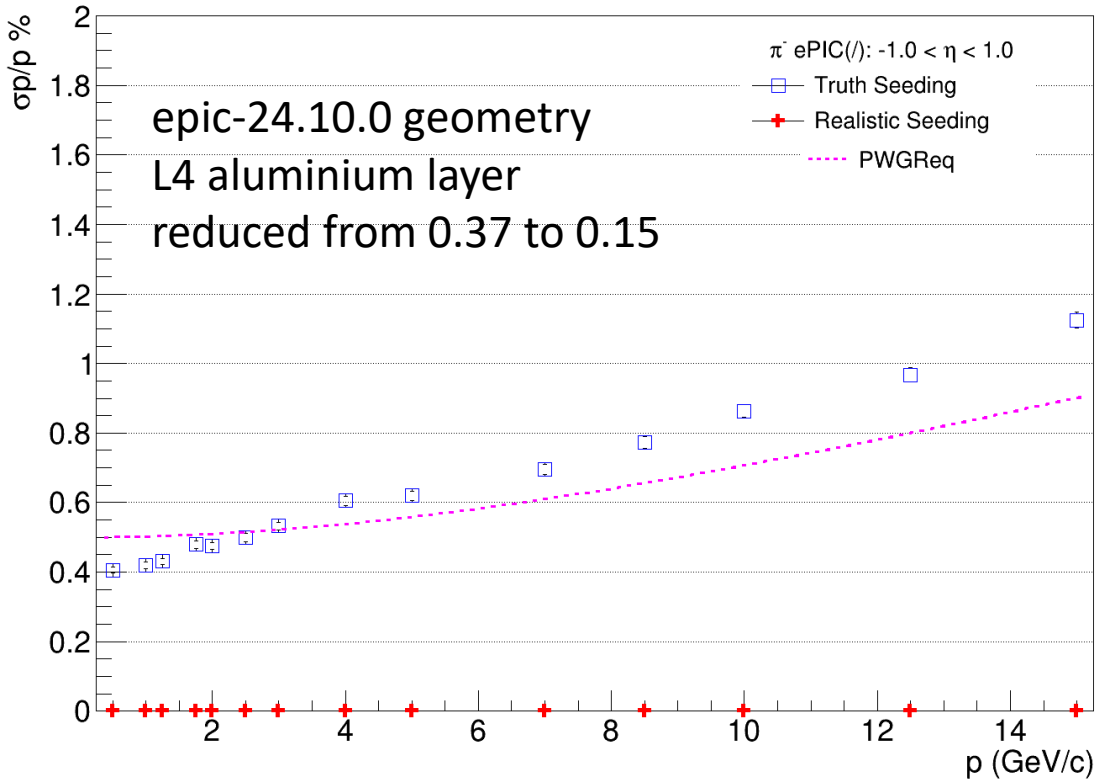
https://github.com/eic/detector_benchmarks/tree/master/benchmarks/tracking_performances





Run time: 92±25 minutes

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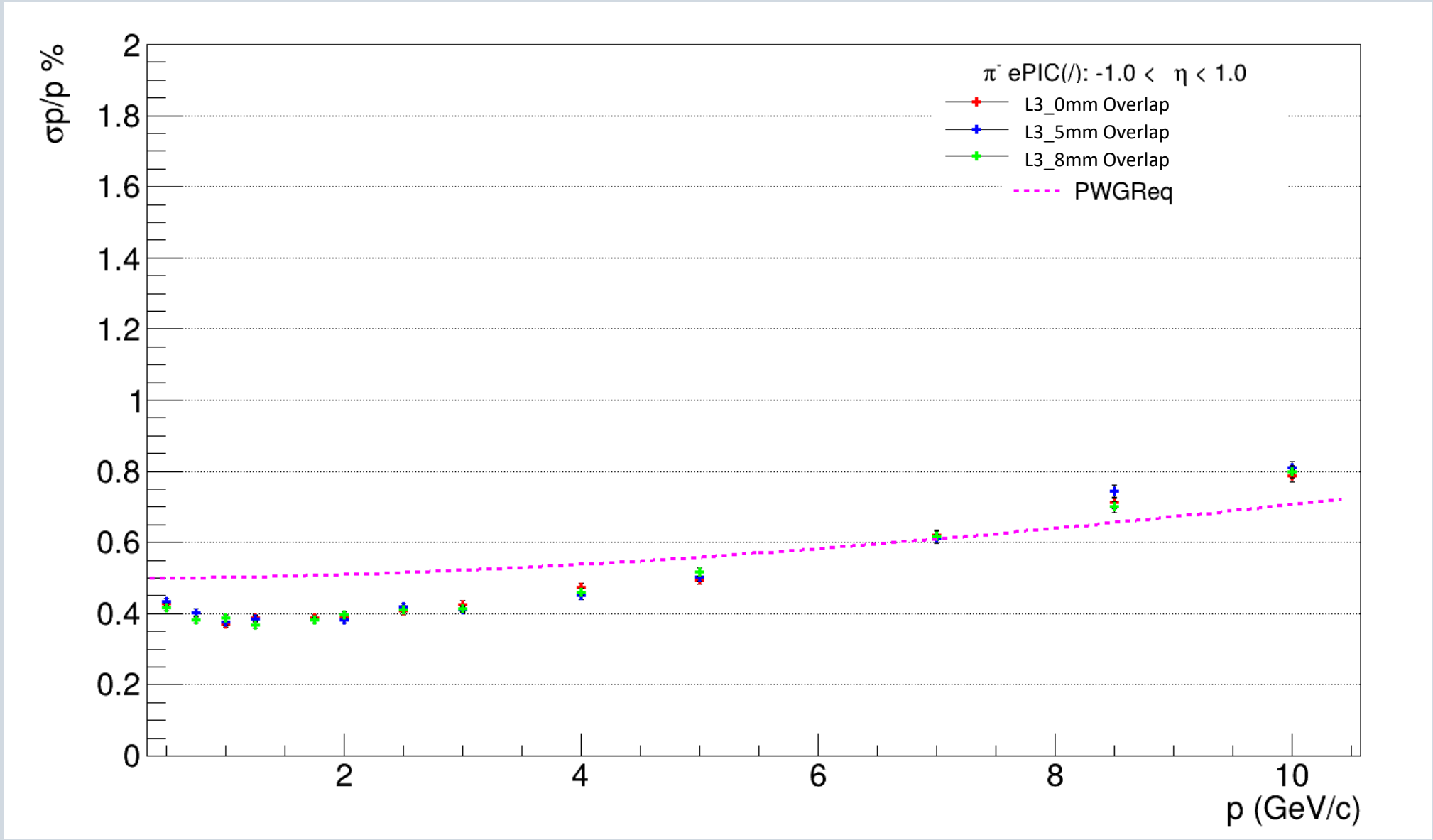
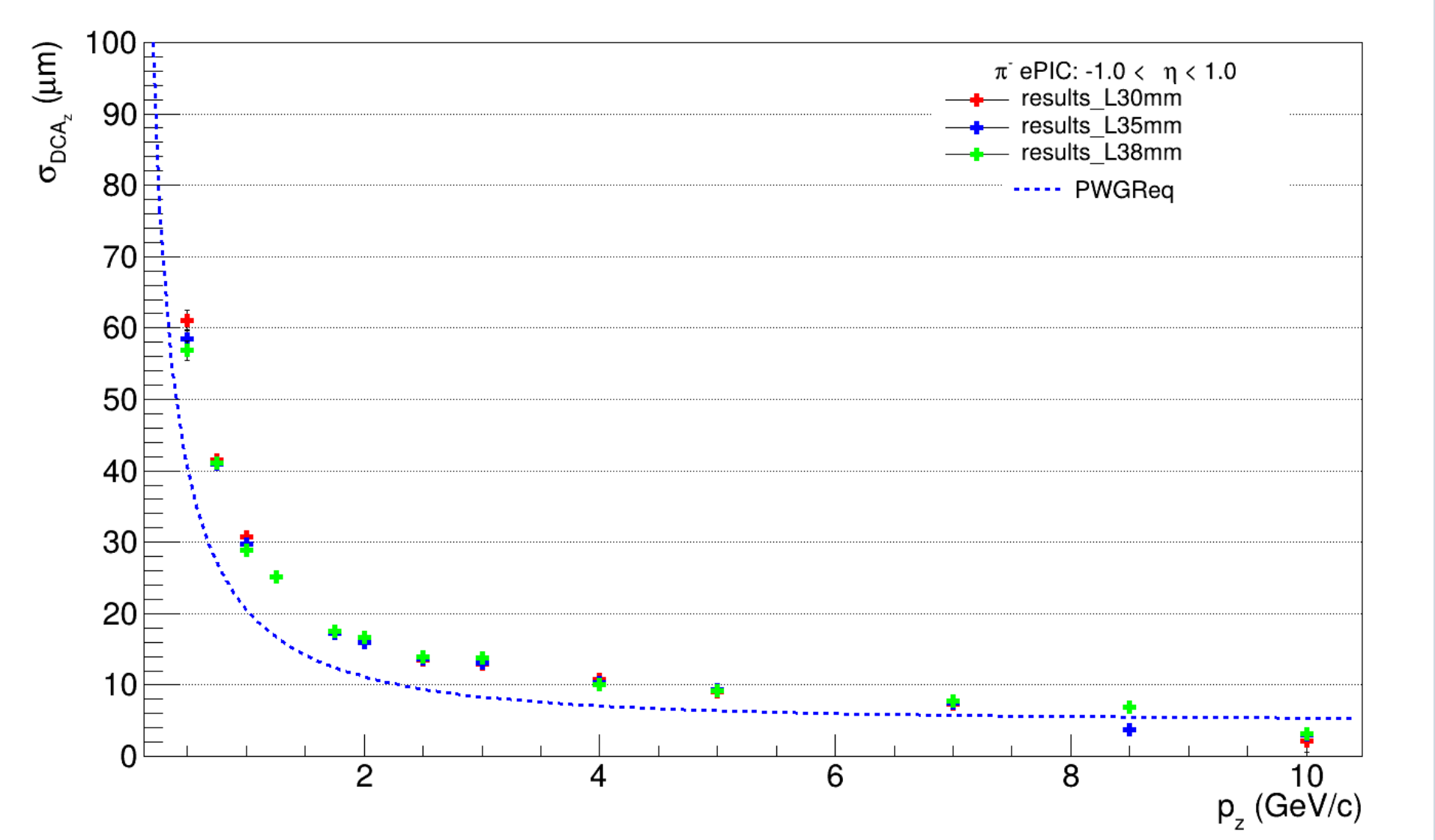
Running ddsim and eicrecon on 10,000 events

Overlap Study (in L3 only): deltap/p

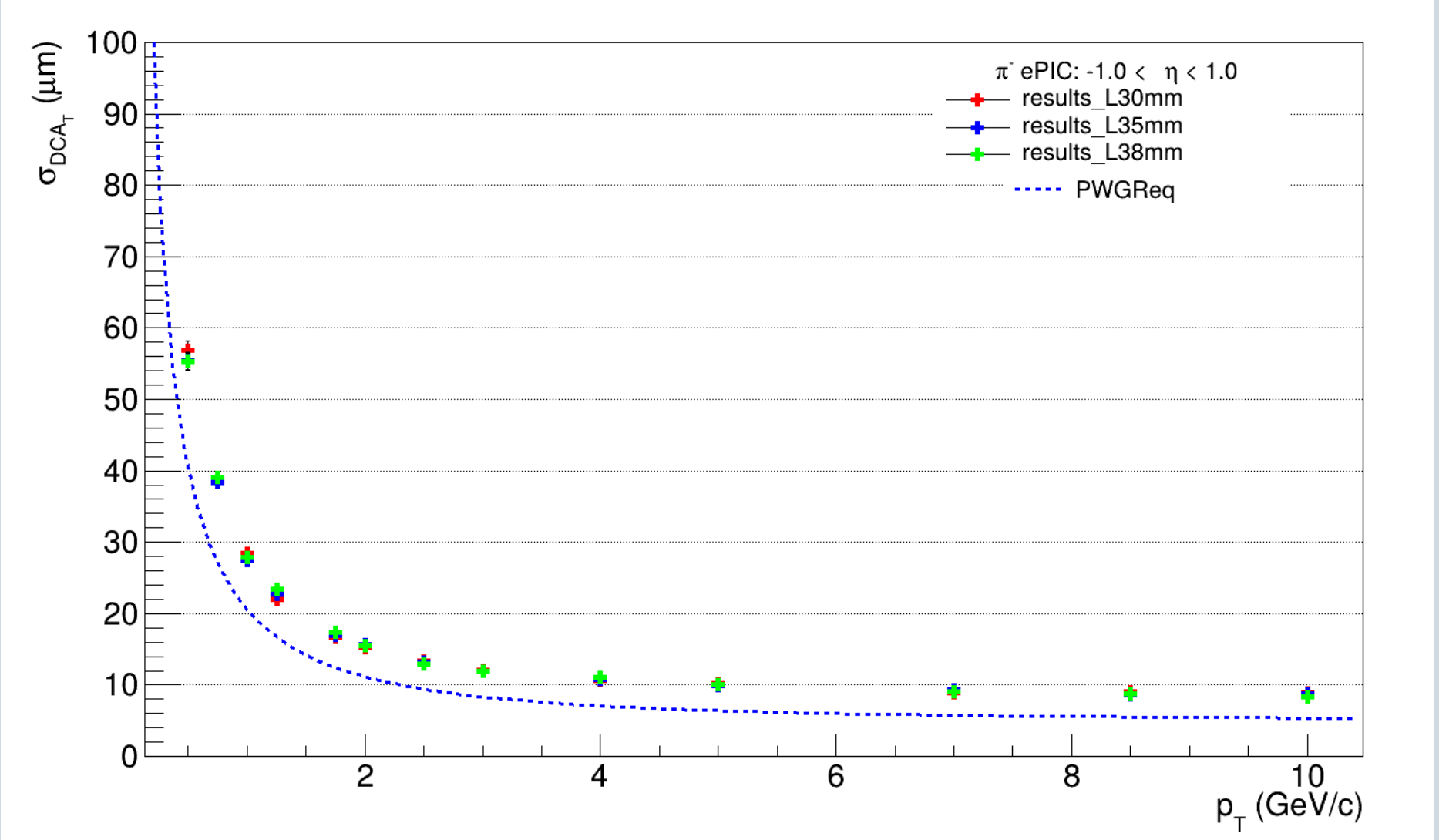


Pion momentum:
0.5-10GeV/c

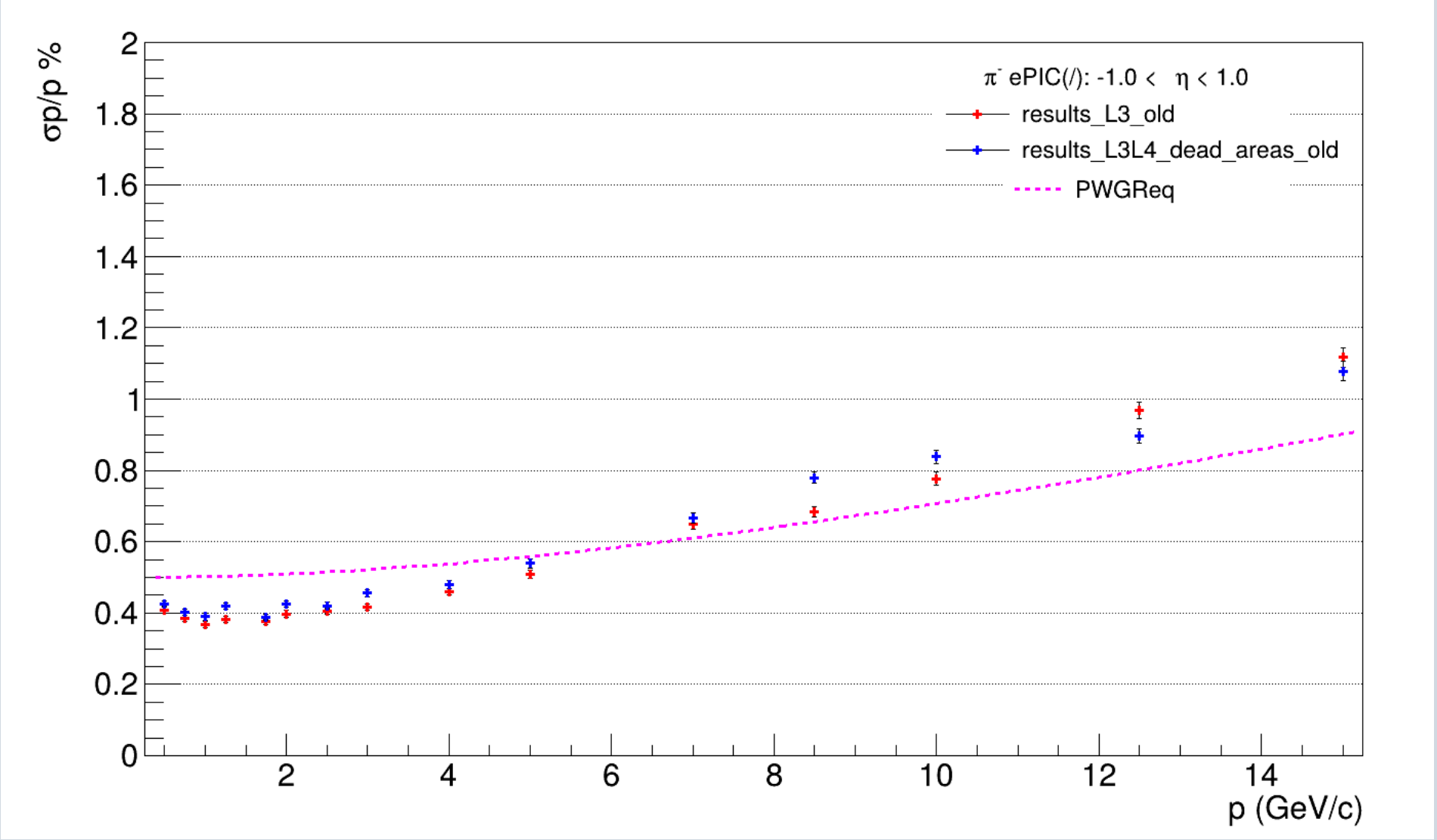
Overlap Study (in L3 only): dca_z



Overlap Study (in L3 only): dca_T



Sensitive Area Study (both layers)



ePIC SVT Simulations: Next Steps

- Debug code
- Index CAD design files with version numbering
- Further investigation of tracking performance on detector design
- Create more accurate simplified geometry for routine simulations
- When do we need detailed geometry?
- Further develop techniques to convert CAD files to DD4HEP