

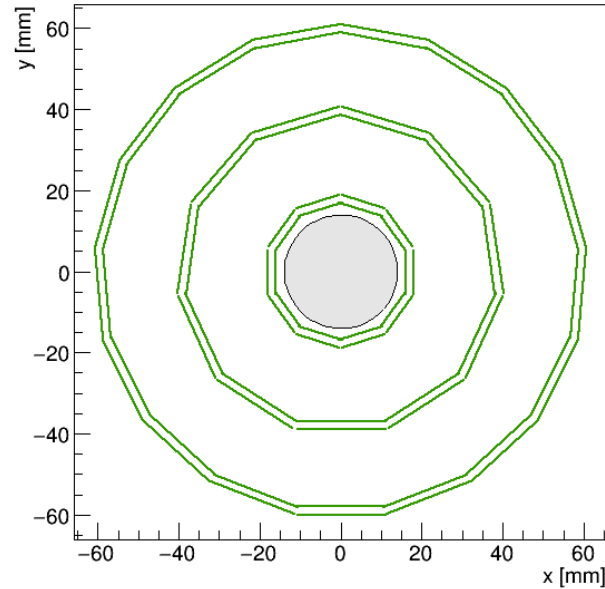
Status of Vertex Detector Layout Optimization

Zeng Hao

2019/12/16

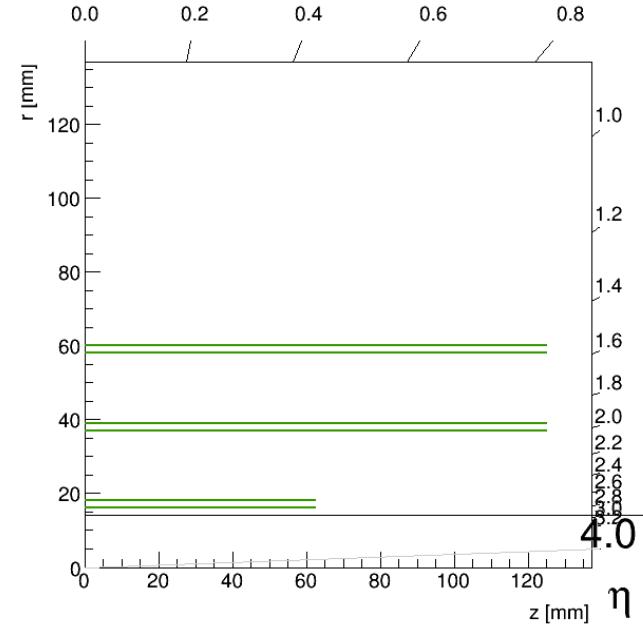
Pixel geometry simulation results

- CDR vertex detector geometry



XY Section of the tracker barrel. - [\(png\)](#) - [\(pdf\)](#) - [\(root\)](#)

	R (mm)	$ z $ (mm)	$ \cos \theta $	σ (μm)
Layer 1	16	62.5	0.97	2.8
Layer 2	18	62.5	0.96	6
Layer 3	37	125.0	0.96	4
Layer 4	39	125.0	0.95	4
Layer 5	58	125.0	0.91	4
Layer 6	60	125.0	0.90	4

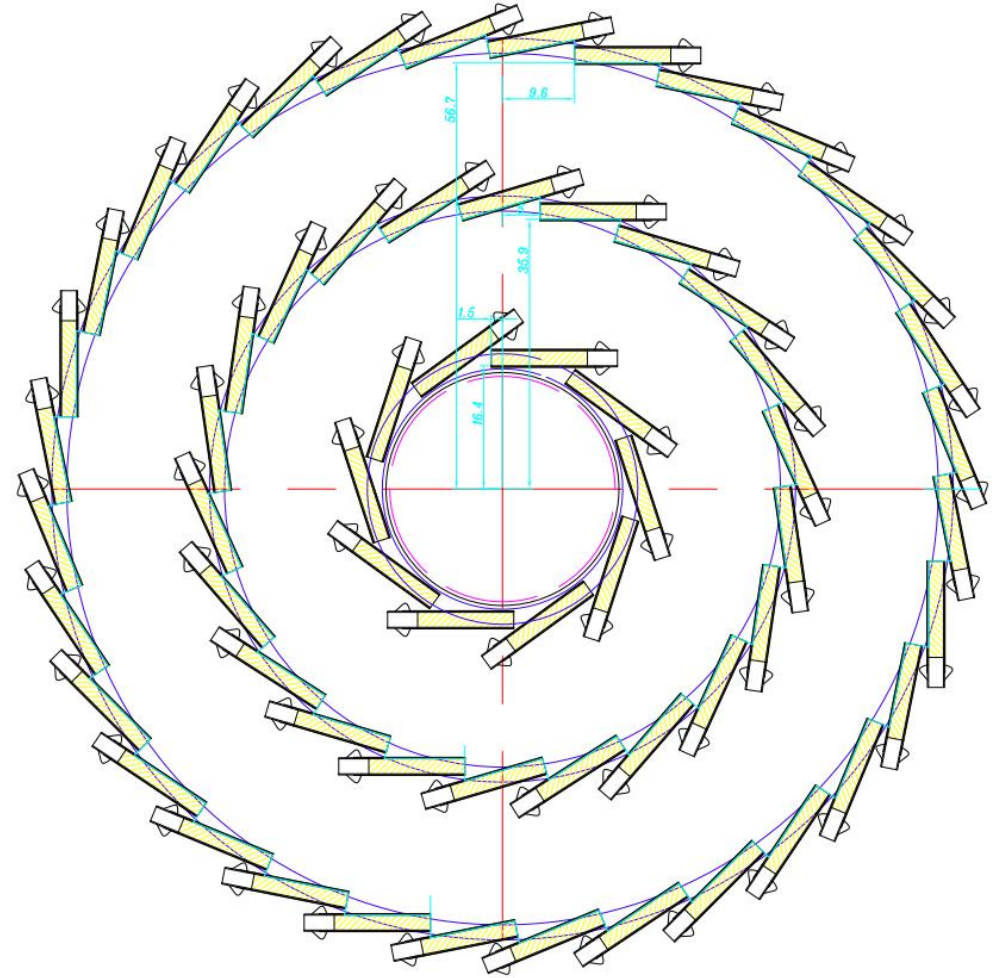


RZ positions of the barrel modules. - [\(png\)](#) - [\(pdf\)](#) - [\(root\)](#)

Barrel : PXB1							Total
Layer	1	2	3	4	5	6	
r	16.004	18.004	37.003	38.995	57.989	59.995	
z_{max}	62.500	62.500	125.000	125.000	125.000	125.000	
# rods	10	10	11	11	17	17	
# mods	40	40	88	88	136	136	528

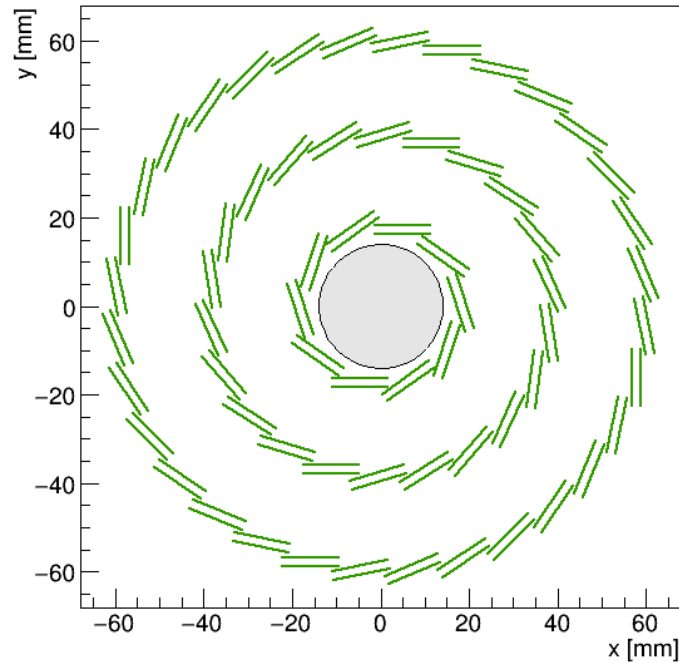
Pixel geometry simulation results

- Prototype V1 design:
 - Come from Fu Jinyu
 - three layers with double-sided ladder
 - Only need to rotate one ladder around Z axis at a fixed angle to cover the whole barrel
 - Sensors are on both sides of the yellow slash region



Pixel geometry simulation results

- Prototype V1 geometry

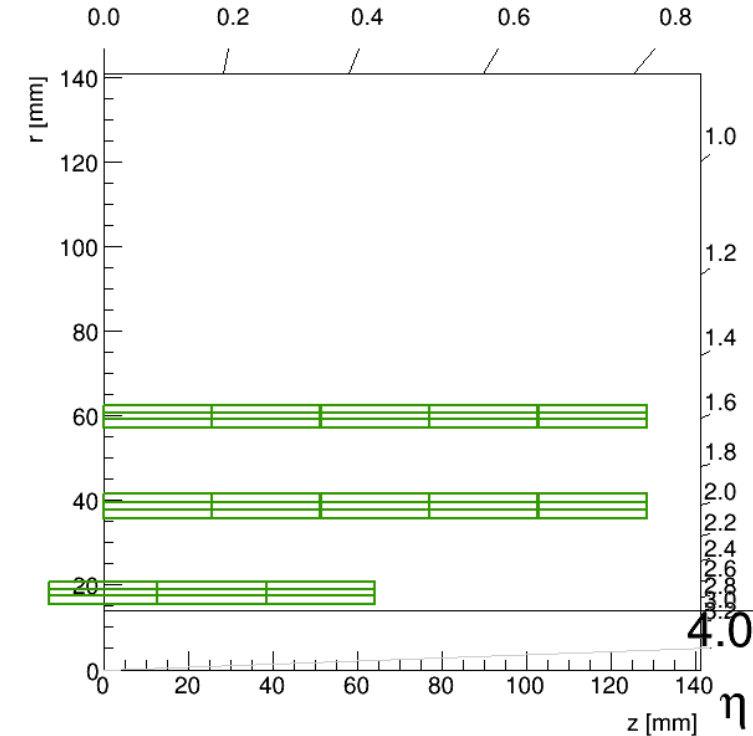


Skewed layer

XY Section of the tracker barrel. - ([png](#)) - ([pdf](#)) - ([root](#))

	numRods	R(mm)	skewAngle(rad)	module width(mm)
Layer 1	10	17.11637	0.290338	12.8
Layer 2	10	19.04127	0.260264	12.8
Layer 3	22	37.66656	0.307478	12.8
Layer 4	22	39.57739	0.292183	12.8
Layer 5	32	58.91426	0.275036	12.8
Layer 6	32	60.84152	0.266108	12.8

Calculated value



RZ positions of the barrel modules. - ([png](#)) - ([pdf](#)) - ([root](#))

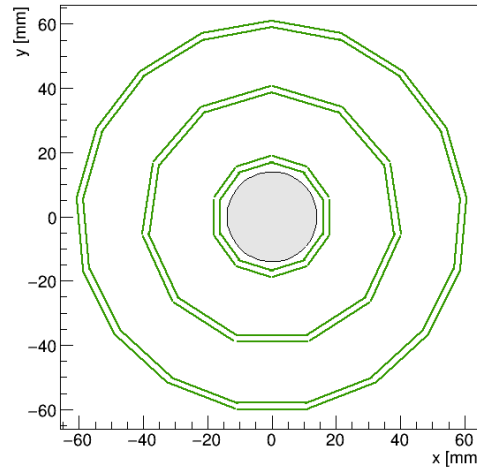
Barrel : PXB1							Total
Layer	1	2	3	4	5	6	
r	17.116	19.041	37.667	39.577	58.914	60.842	
z_max	64.200	64.200	128.450	128.450	128.450	128.450	
# rods	10	10	22	22	32	32	
# mods	50	50	220	220	320	320	1180

Output value of tkLayout

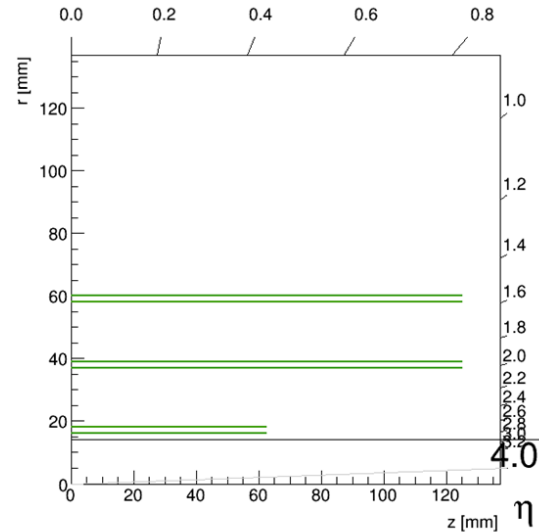
Pixel geometry simulation results

- Comparison

CDR



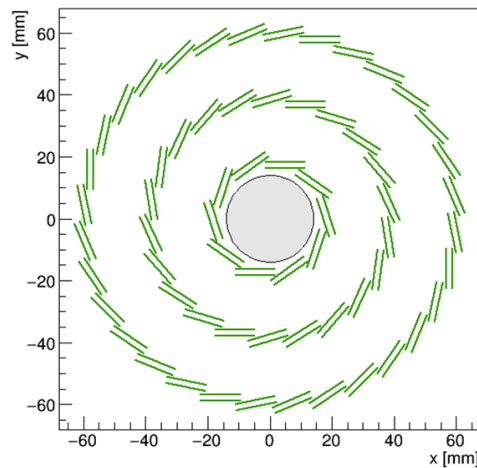
XY Section of the tracker barrel. - ([png](#)) - ([pdf](#)) - ([root](#))



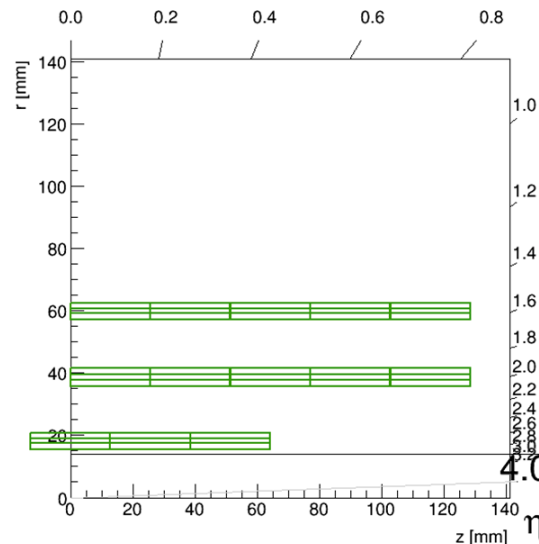
RZ positions of the barrel modules. - ([png](#)) - ([pdf](#)) - ([root](#))

Barrel : PXB1							Total
Layer	1	2	3	4	5	6	
r	16.004	18.004	37.003	38.995	57.989	59.995	
z_max	62.500	62.500	125.000	125.000	125.000	125.000	
# rods	10	10	11	11	17	17	
# mods	40	40	88	88	136	136	528

Prototype V1



XY Section of the tracker barrel. - ([png](#)) - ([pdf](#)) - ([root](#))

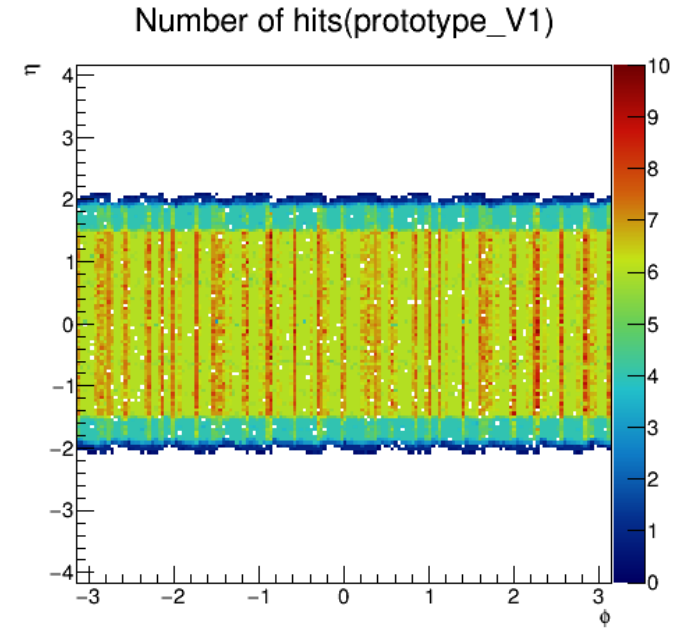
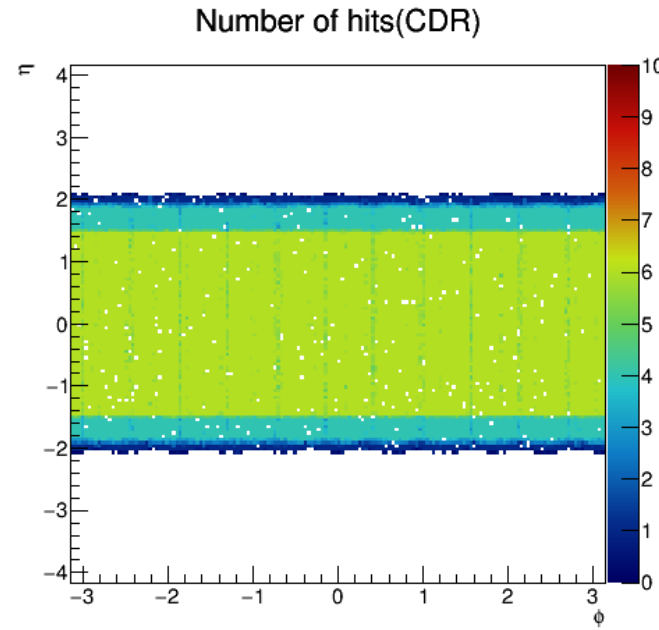
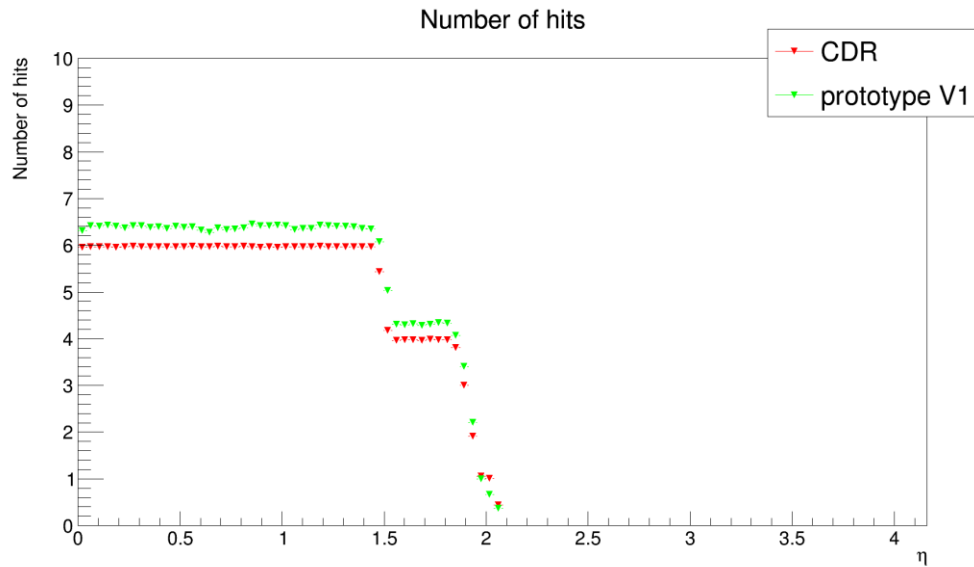


RZ positions of the barrel modules. - ([png](#)) - ([pdf](#)) - ([root](#))

Barrel : PXB1							Total
Layer	1	2	3	4	5	6	
r	17.116	19.041	37.667	39.577	58.914	60.842	
z_max	64.200	64.200	128.450	128.450	128.450	128.450	
# rods	10	10	22	22	32	32	
# mods	50	50	220	220	320	320	1180

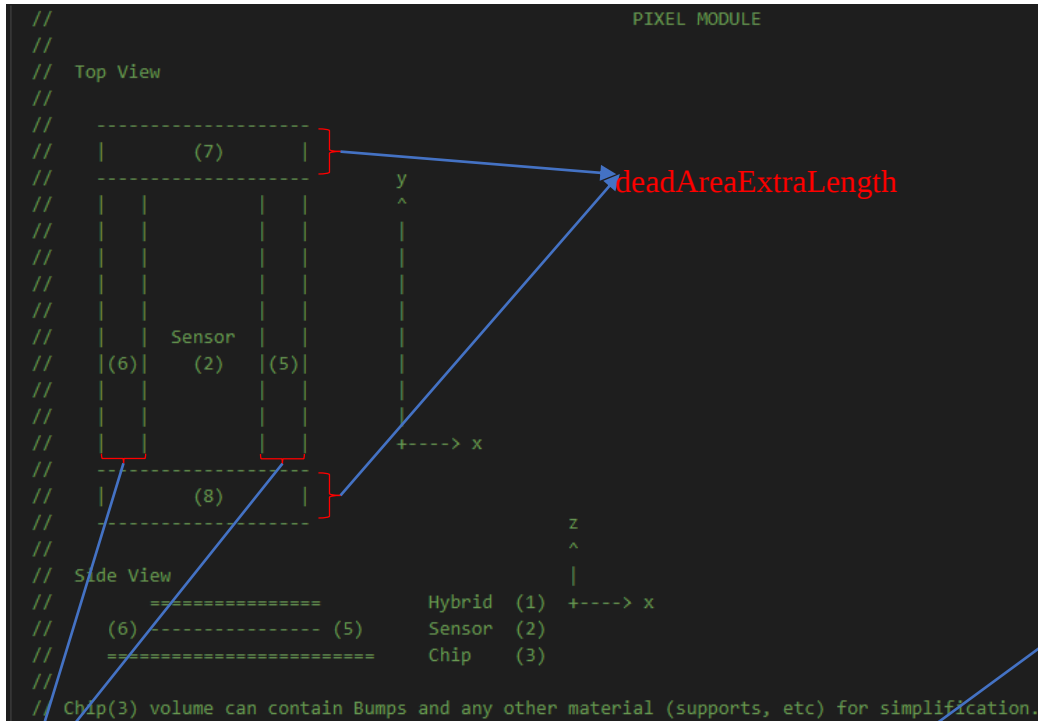
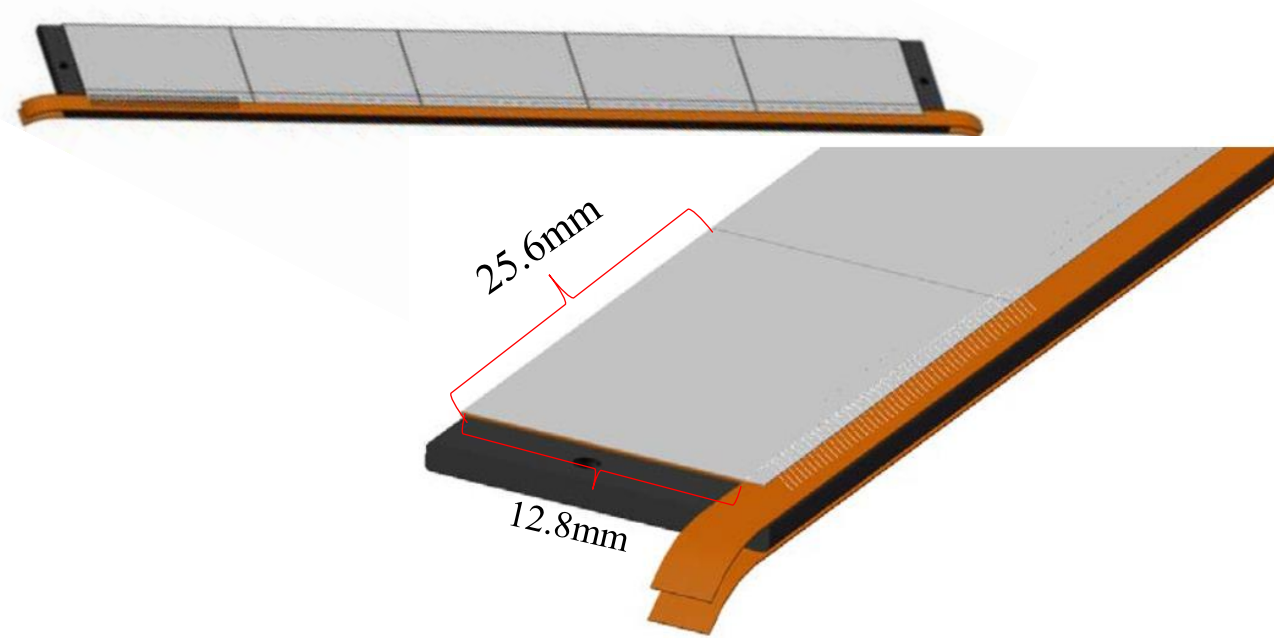
Pixel geometry simulation results

- Hit coverage



	R (mm)	$ z $ (mm)	$ \cos \theta $	σ (μm)	η
Layer 1	16	62.5	0.97	2.8	2.09
Layer 2	18	62.5	0.96	6	1.95
Layer 3	37	125.0	0.96	4	1.95
Layer 4	39	125.0	0.95	4	1.83
Layer 5	58	125.0	0.91	4	1.53
Layer 6	60	125.0	0.90	4	1.47

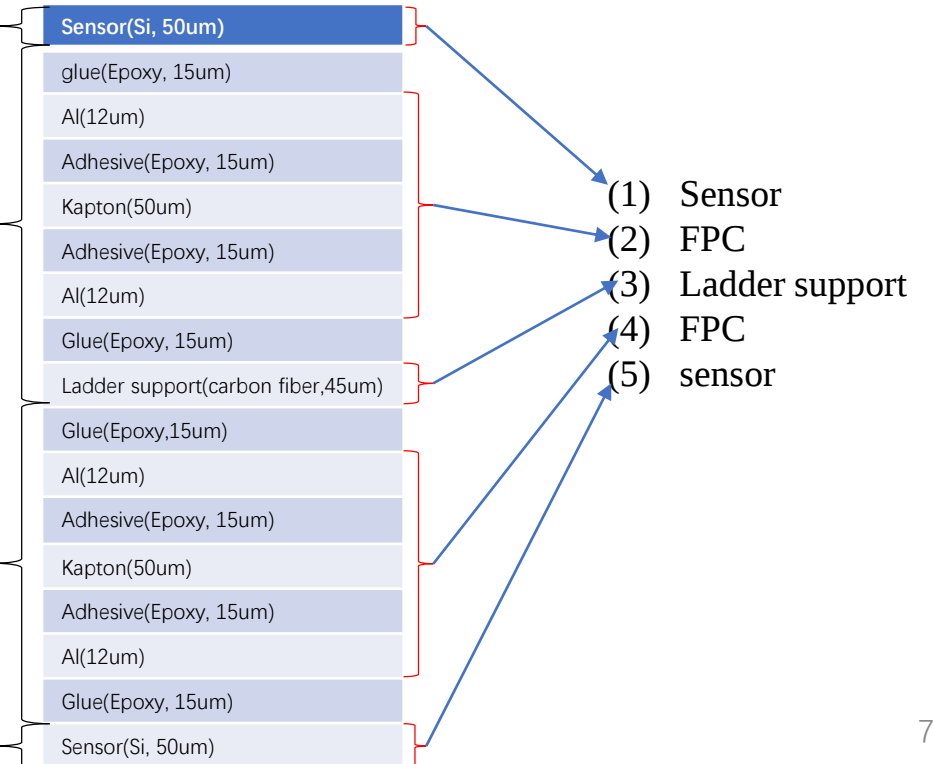
Adding material



Top view:
Only consider the sensor
area: 12.8mm × 25.6mm
Not consider the sensor
dead area and electronics

Outer pixel module:
Sensor (2)
Chip (3)

inner pixel module:
Hybrid (1)
Sensor (2)



Material budget

Components details:

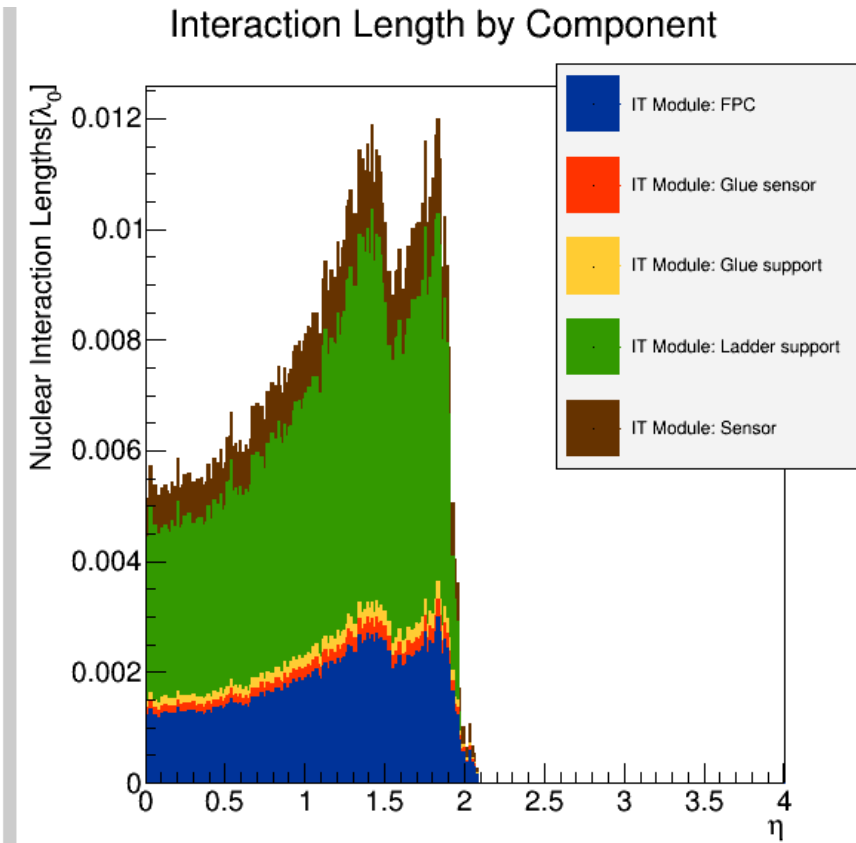
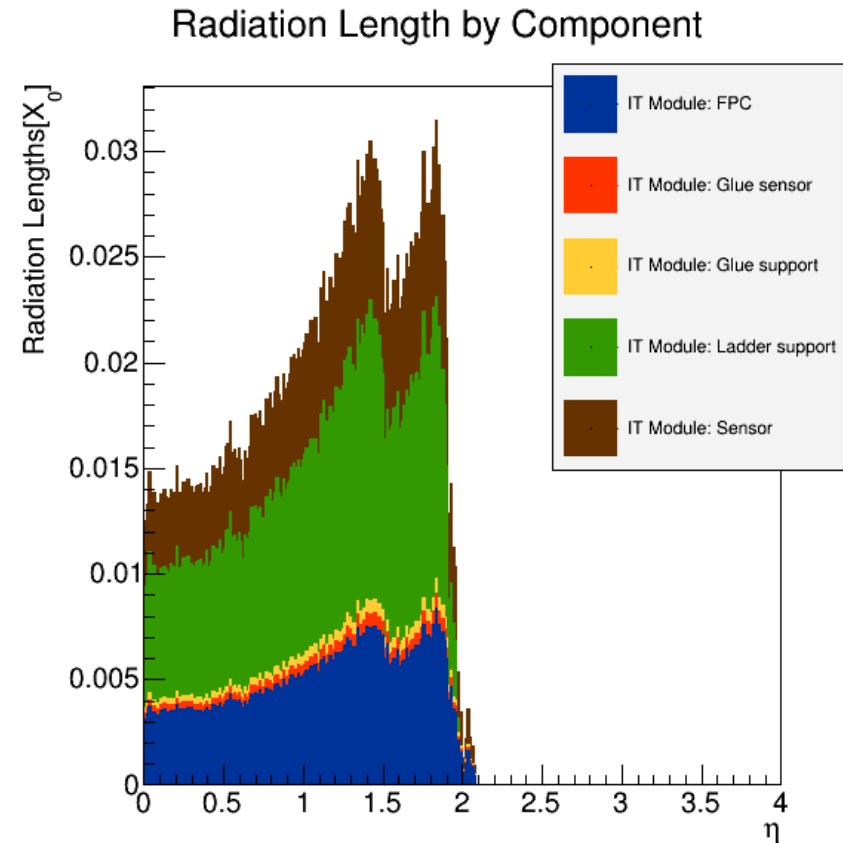
Average ($\eta = [0, 4.0]$)	Radiation length	Interaction length
IT Module: FPC	0.00256	0.00092
IT Module: Glue sensor	0.00021	0.00010
IT Module: Glue support	0.00021	0.00010
IT Module: Ladder support	0.00444	0.00221
IT Module: Sensor	0.00256	0.00052
Services	0.00000	0.00000
Supports	0.00000	0.00000

CDR:

- Material budget below 0.15% X_0 per layer;

$$0.15\% \times 6 = 0.9\% < 0.01$$

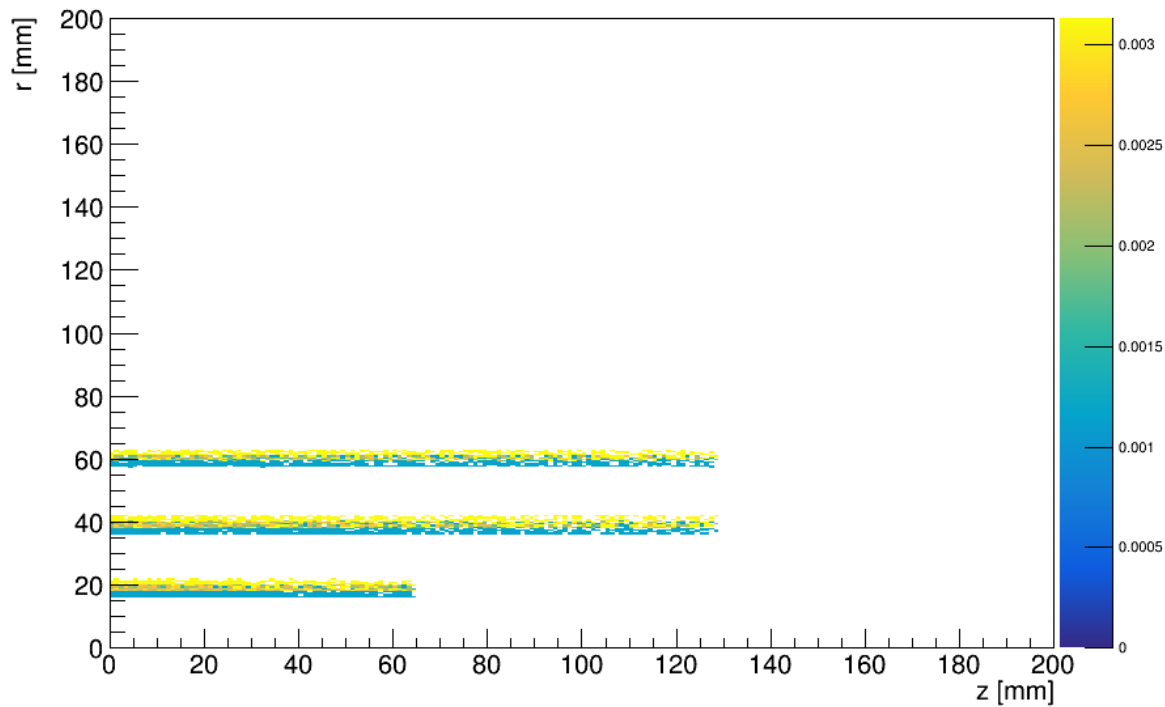
We still have too much material!



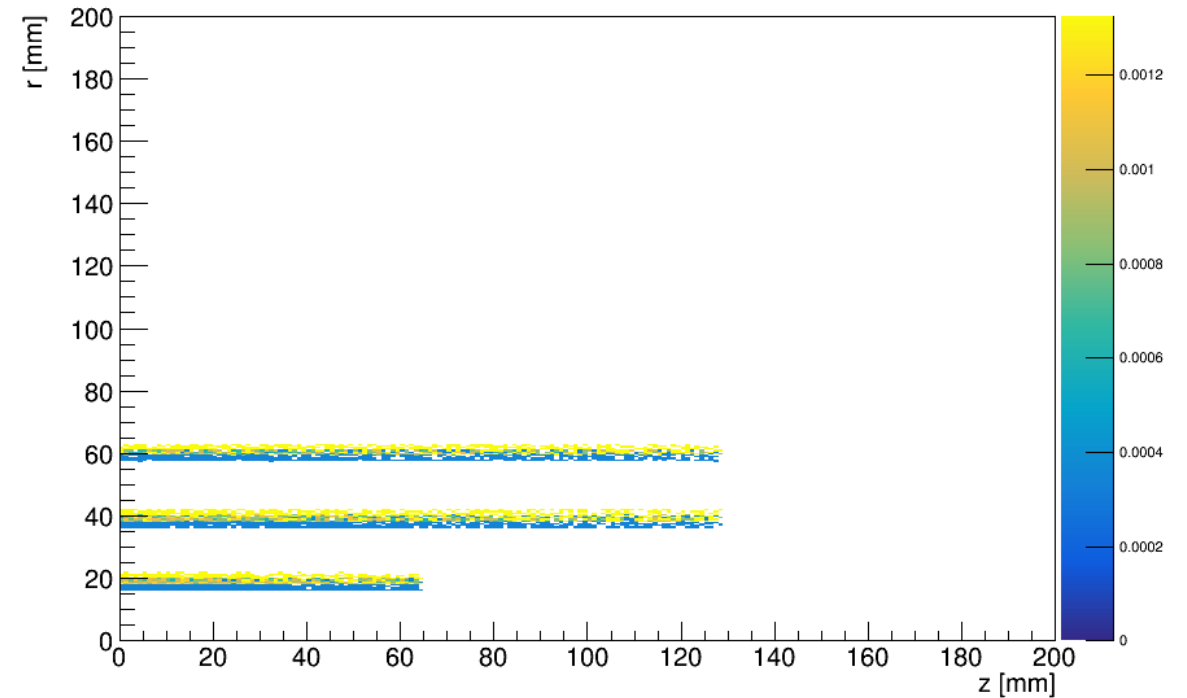
Material budget

Material distribution:

Radiation length map

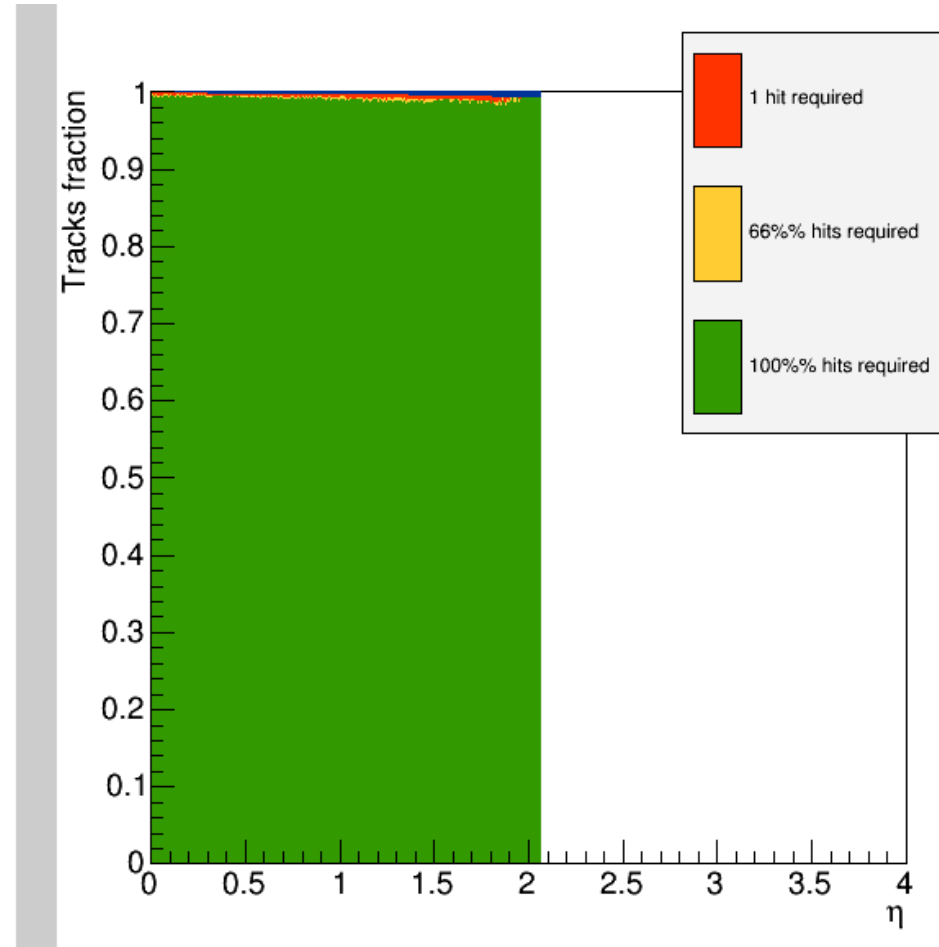
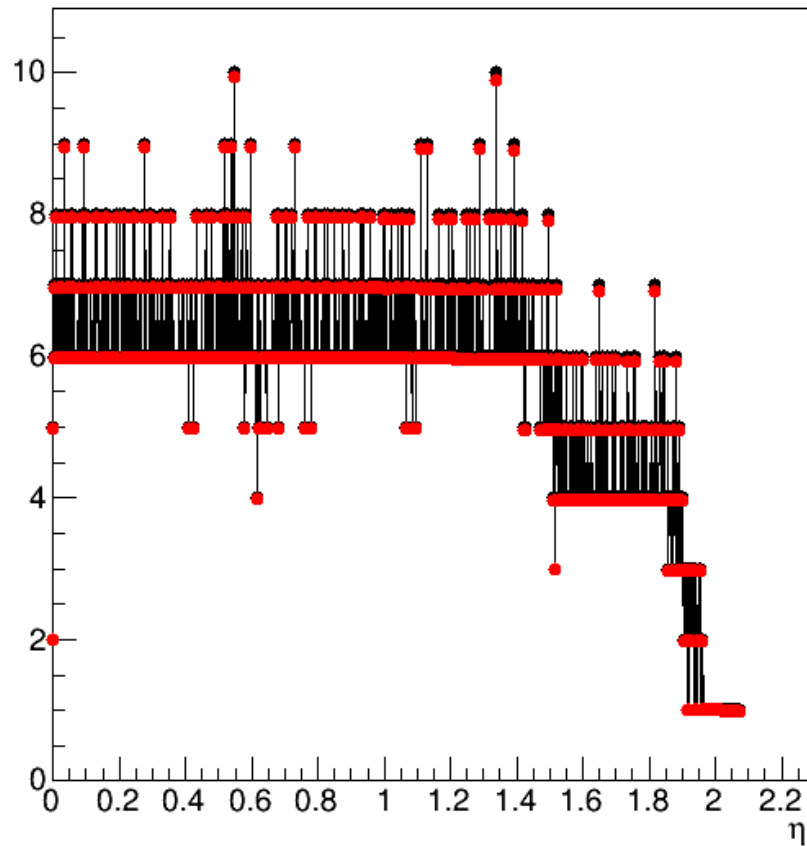


Interaction length map



Material budget

Nuclear interactions:



Material budget

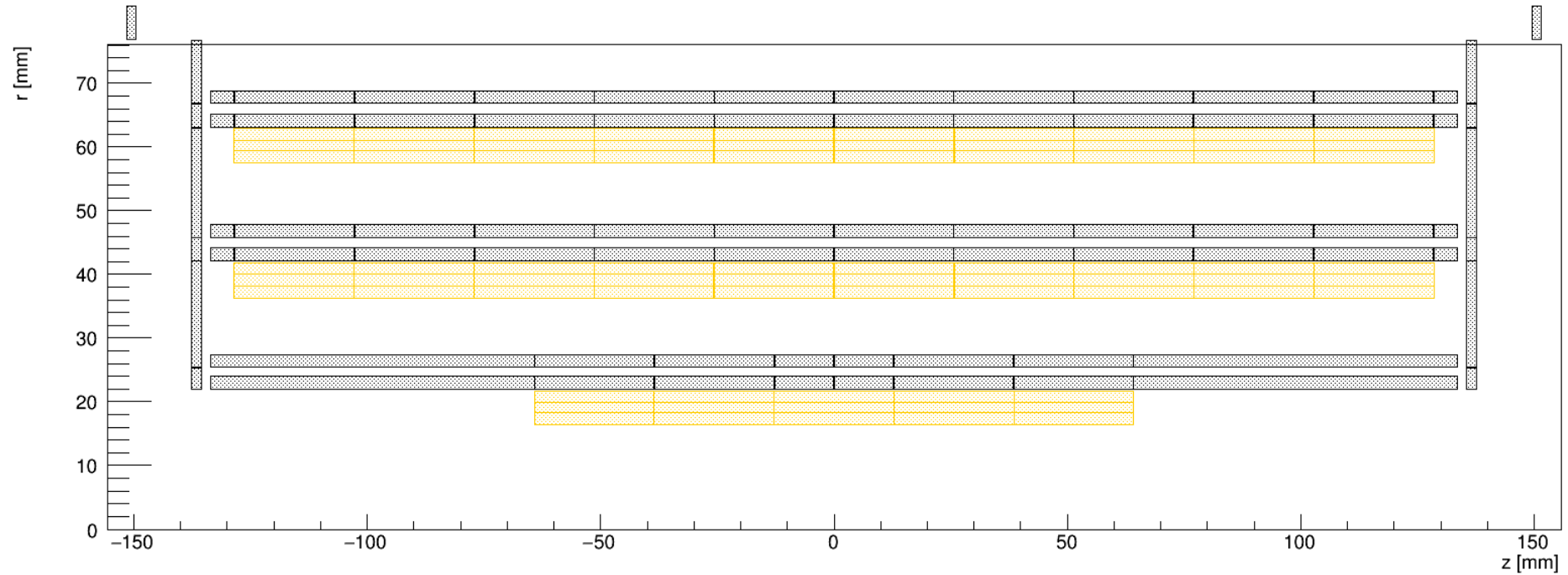
Weight(pixel):

pxb1

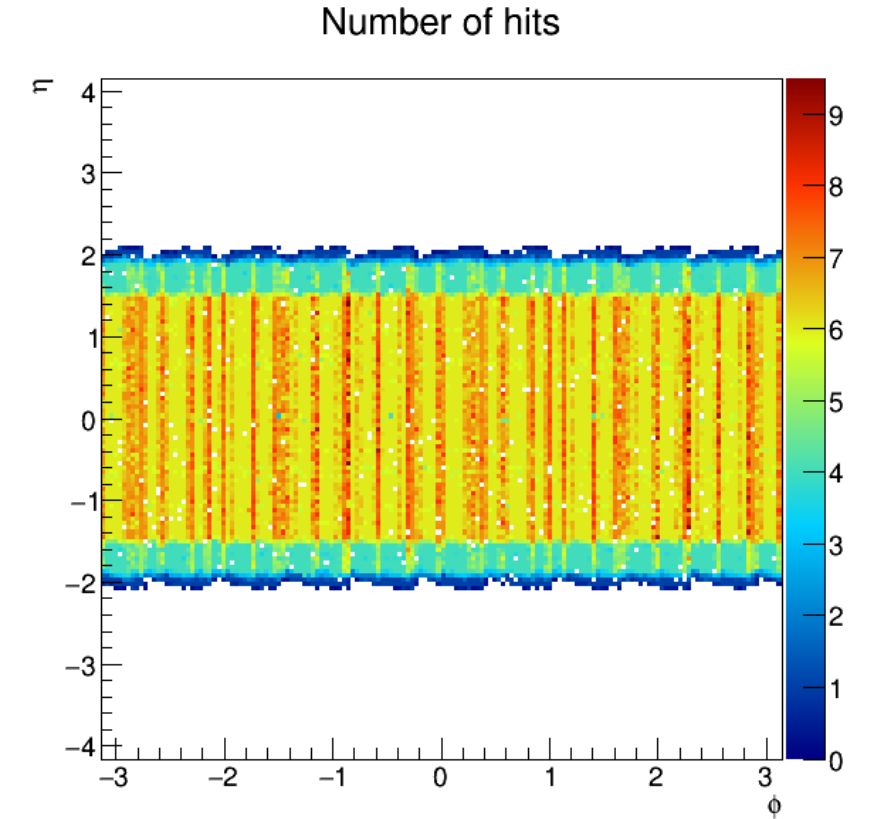
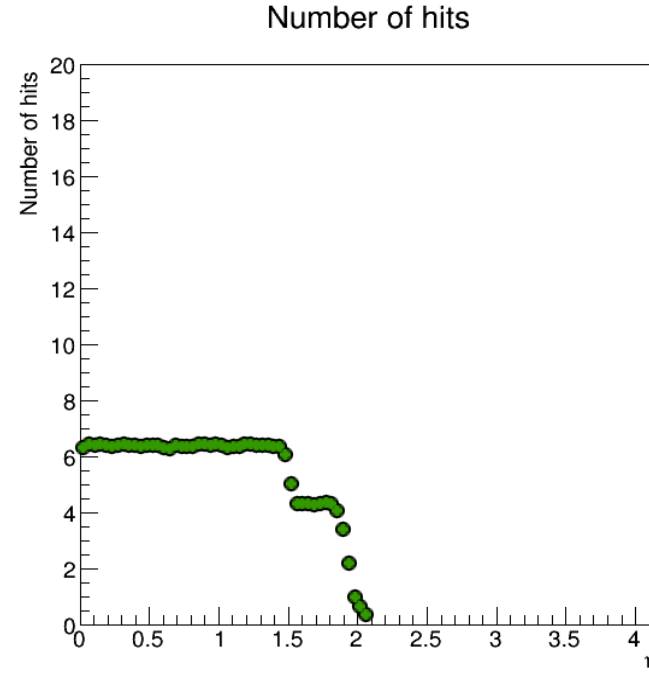
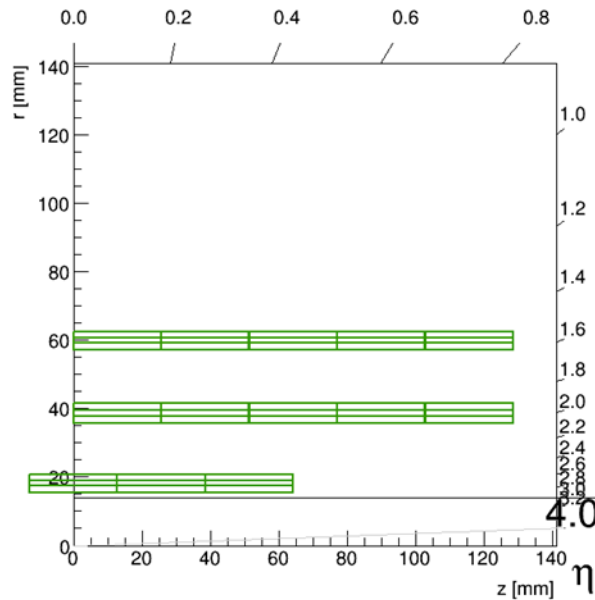
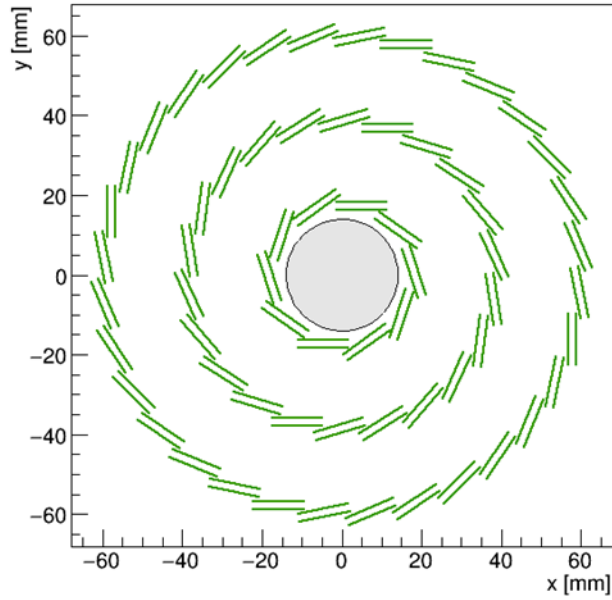
MODULE	mass (kg)
IT Module: FPC	0.1
IT Module: Glue sensor	0.0
IT Module: Glue support	0.0
IT Module: Ladder support	0.2
IT Module: Sensor	0.0
TOTAL MODULE	0.3
TOTAL PXB1	0.3

grand total (kg): 0.284519

All material volumes, (RZ) view



Prototype V1

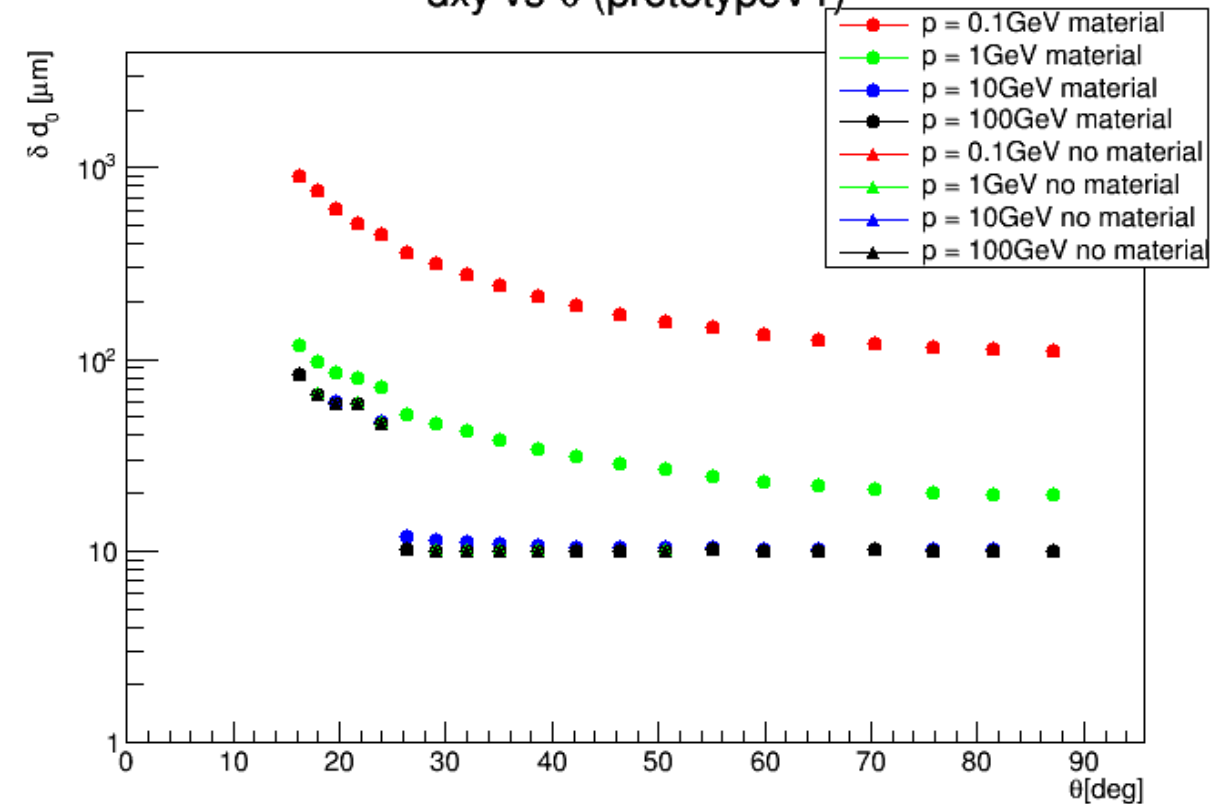


Barrel : PXB1							Total
Layer	1	2	3	4	5	6	
r	17.116	19.041	37.667	39.577	58.914	60.842	
z_max	64.200	64.200	128.450	128.450	128.450	128.450	
# rods	10	10	22	22	32	32	
# mods	50	50	220	220	320	320	1180

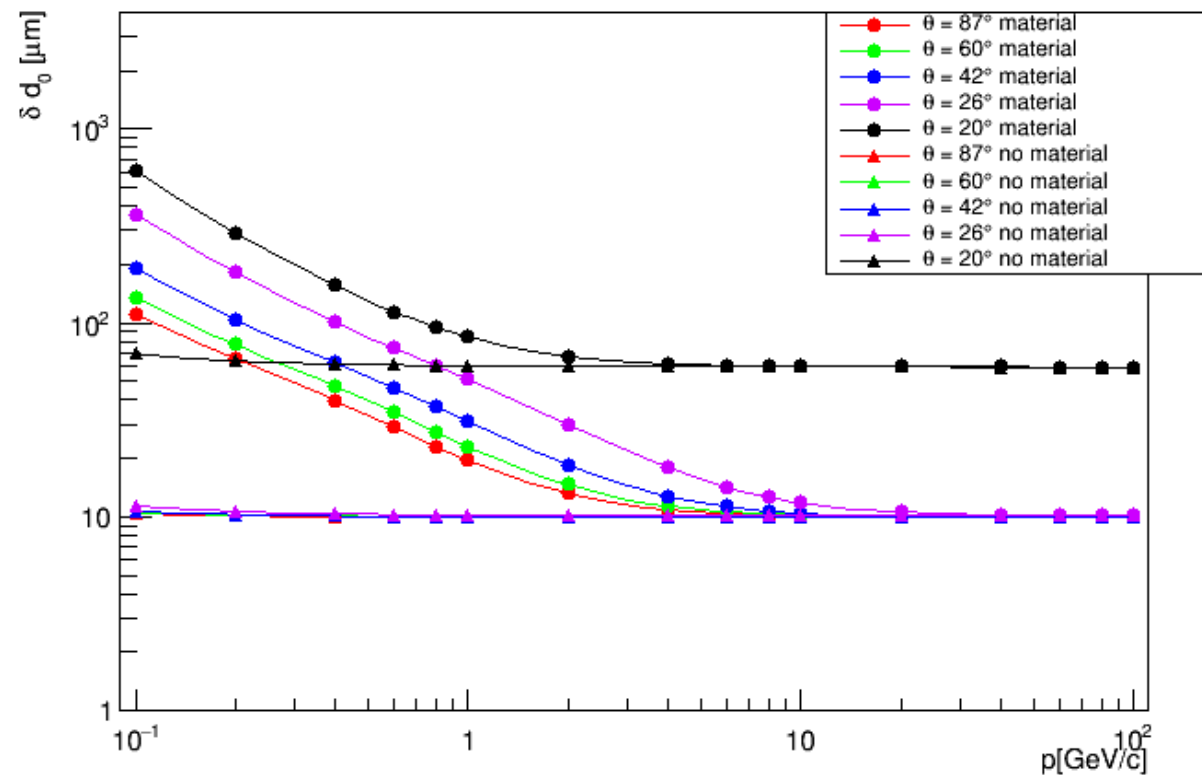
Prototype V1

Impact parameter resolution plots:

dxy vs θ (prototypeV1)

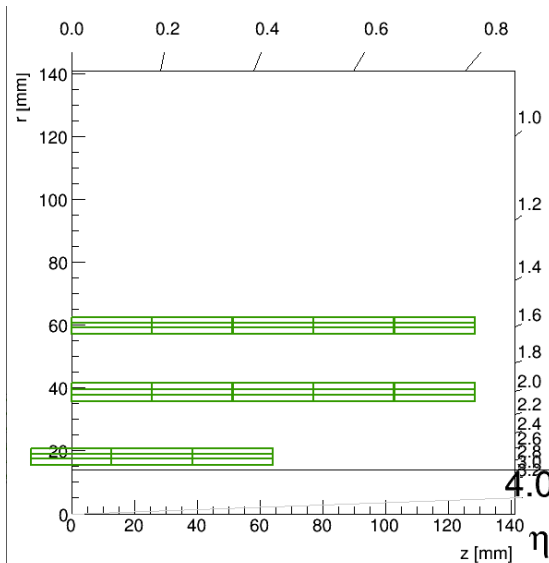
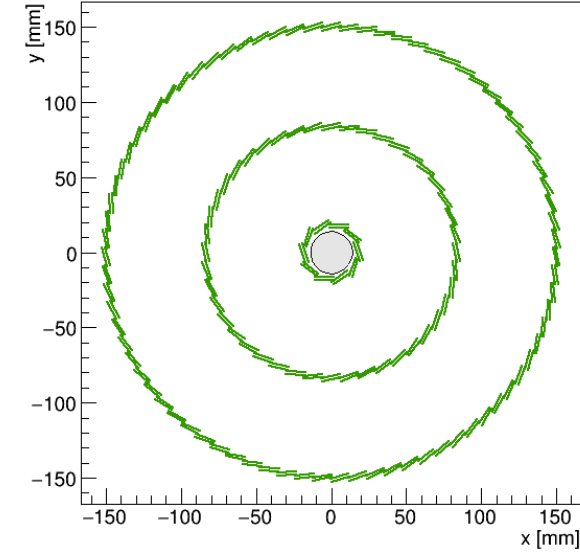
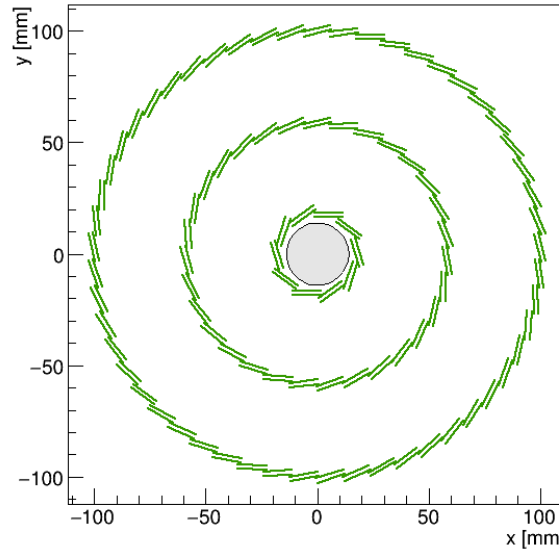
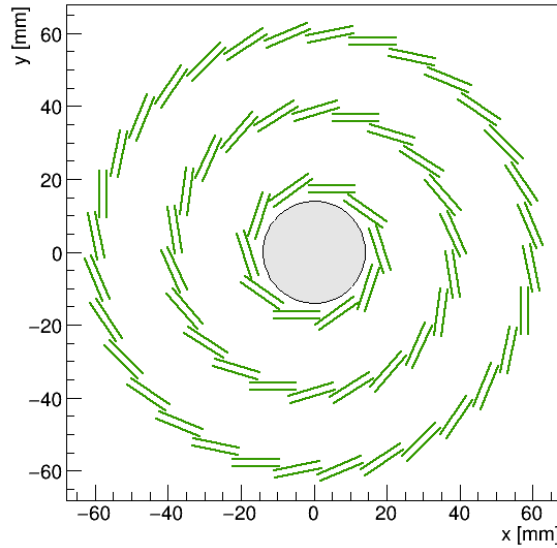


dxy vs momentum (prototypeV1)

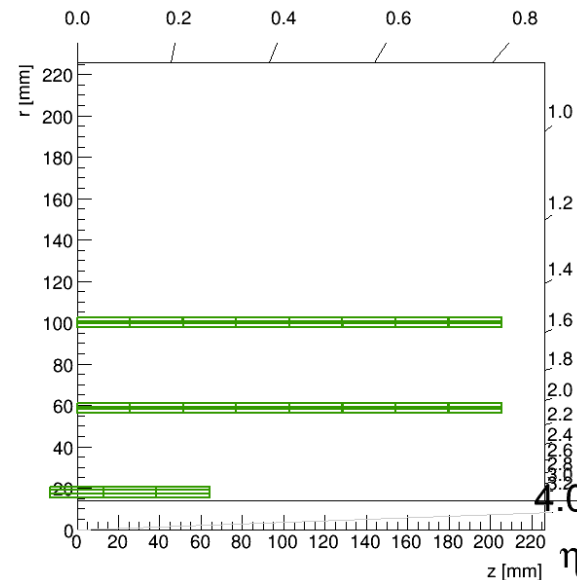


Geometry comparison

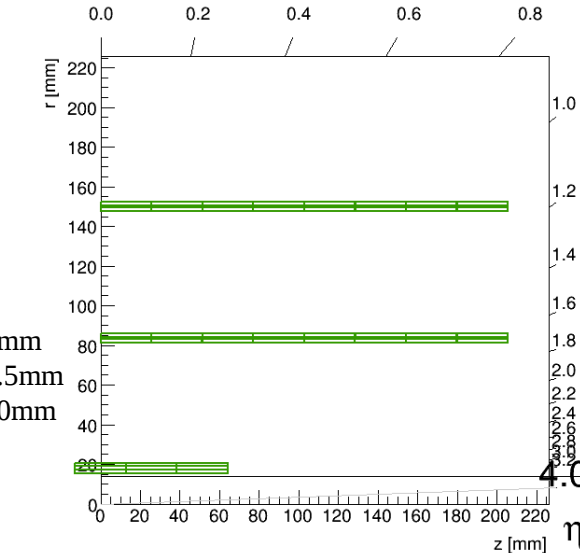
- Detector size



Layer 1: 18mm
Layer 2: 38mm
Layer 3: 60mm

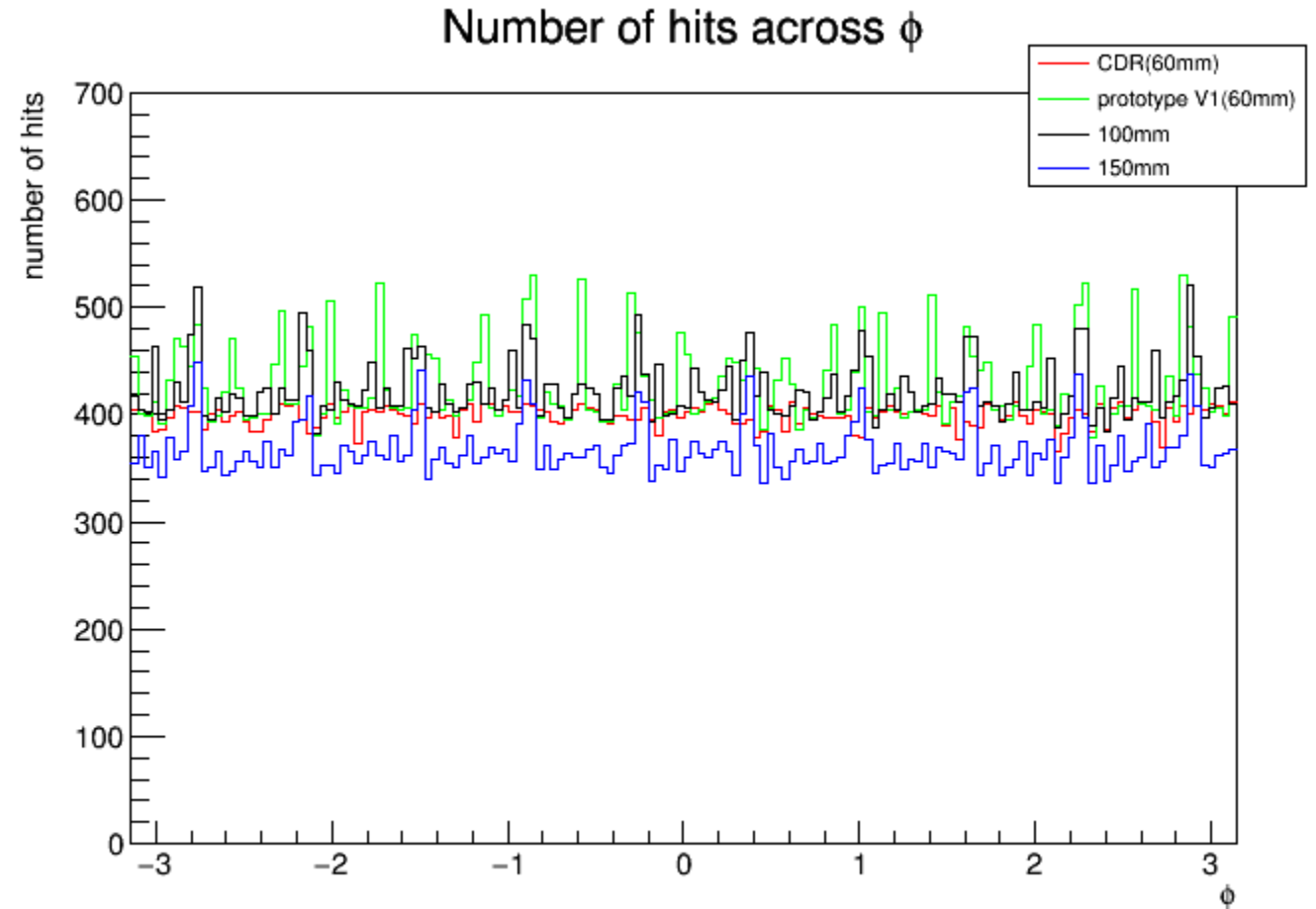
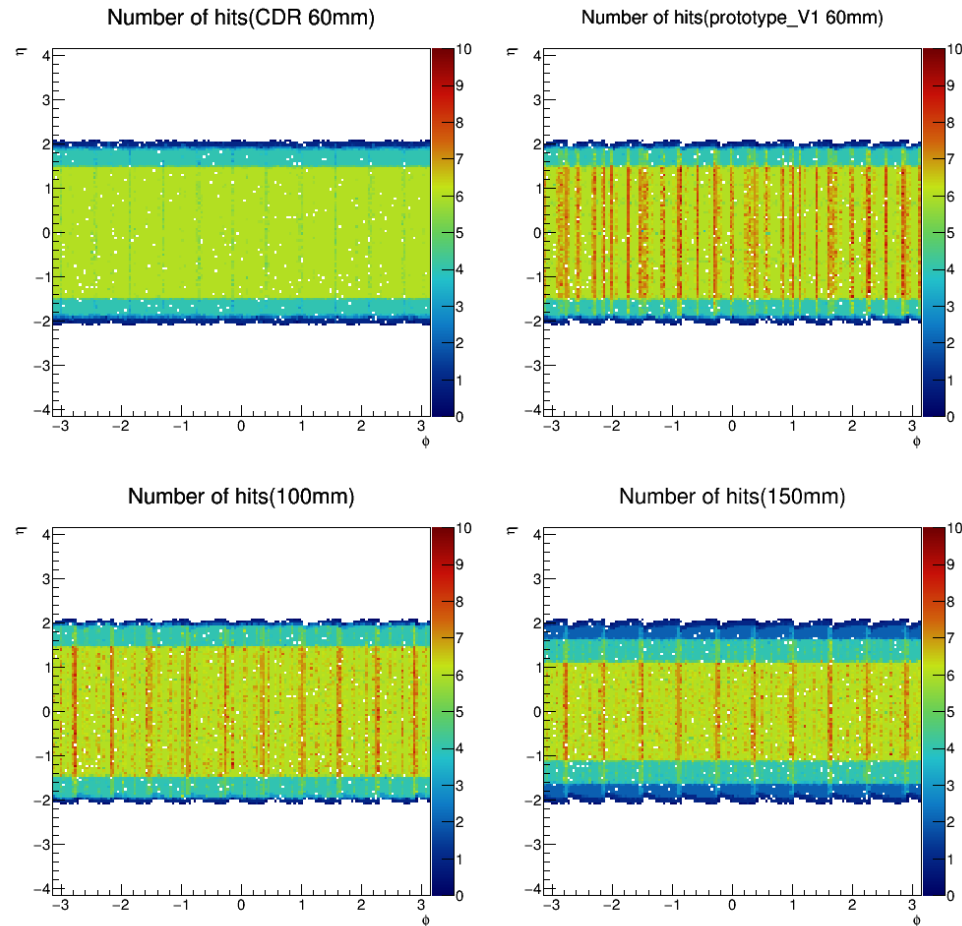


Layer 1: 18mm
Layer 2: 58.5mm
Layer 3: 100mm



Layer 1: 18mm
Layer 2: 83.5mm
Layer 3: 150mm

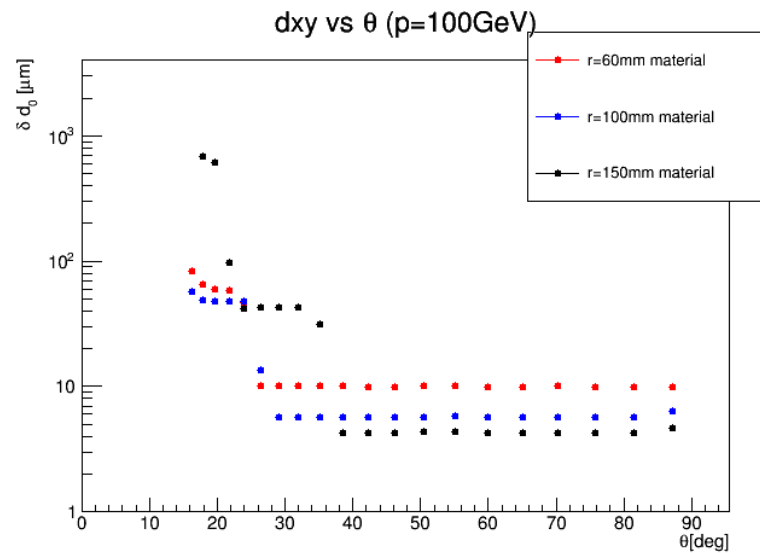
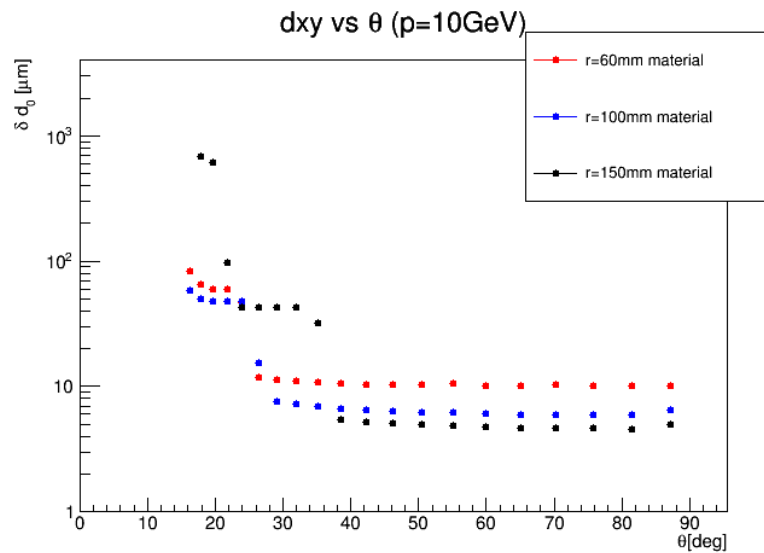
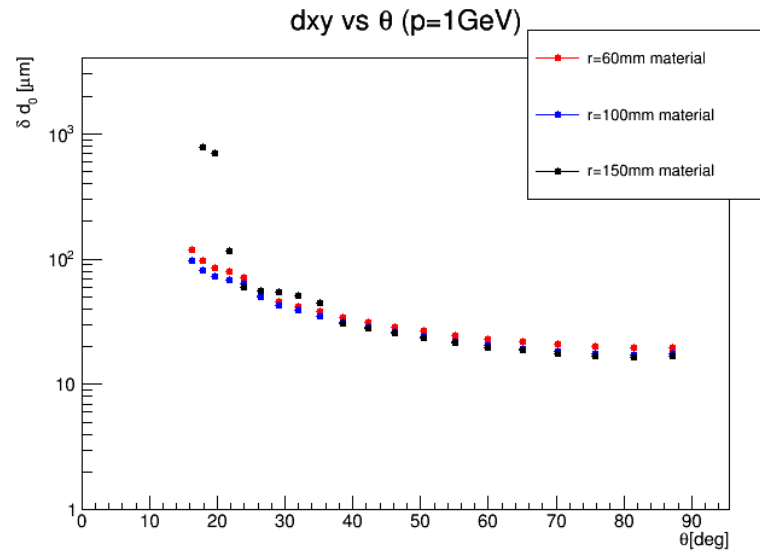
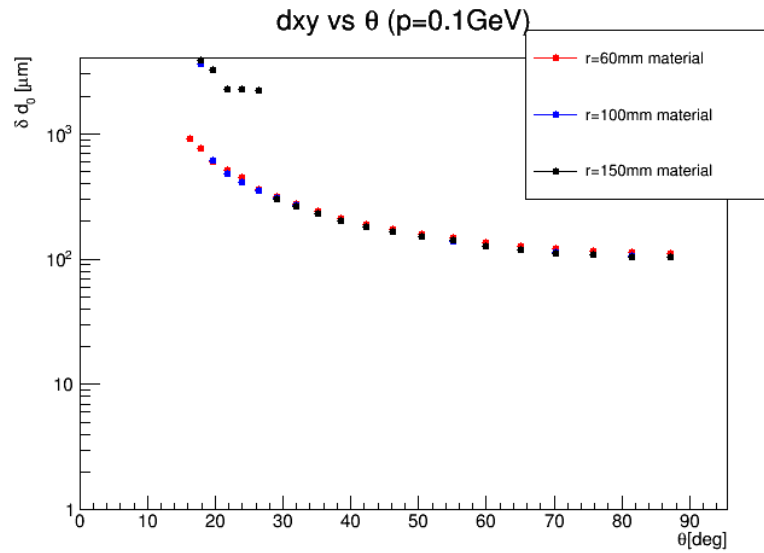
Hit coverage comparison



increase radius, number of stripes approaches 10.
Equal to the number of ladders of the first layer.

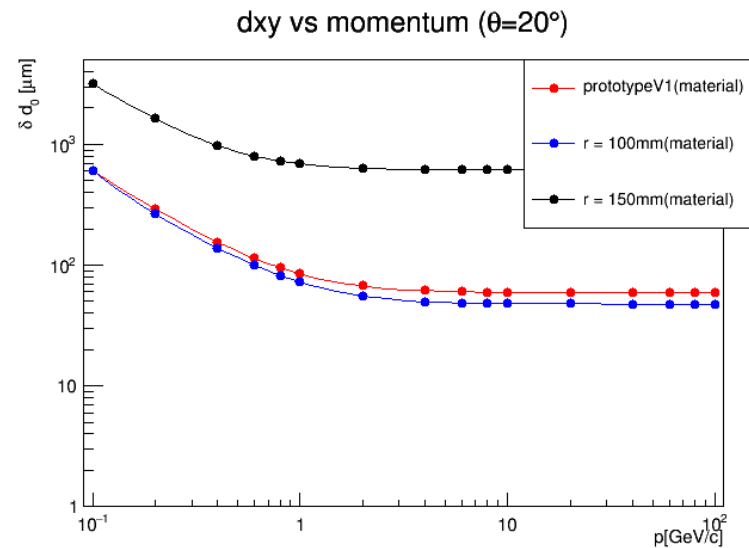
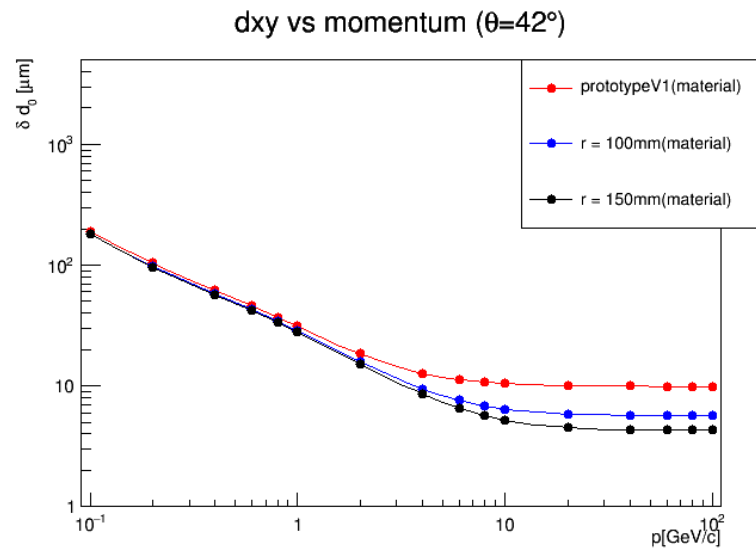
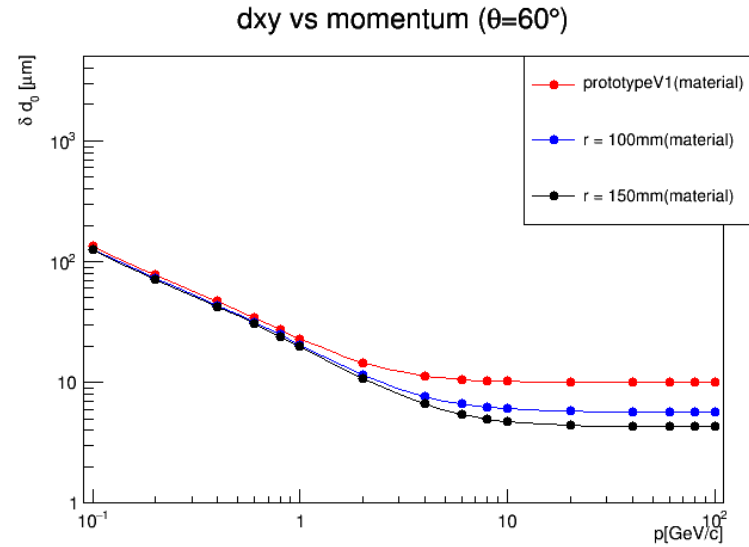
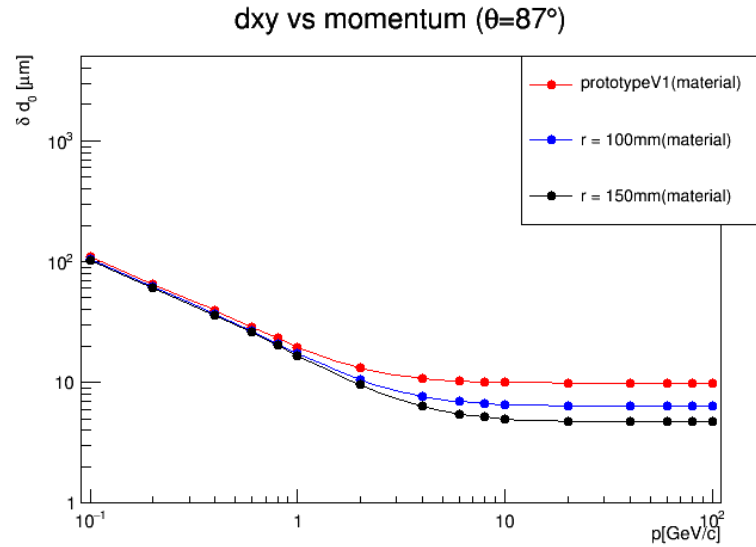
Geometry comparison

- Detector size(resolution across θ)



Geometry comparison

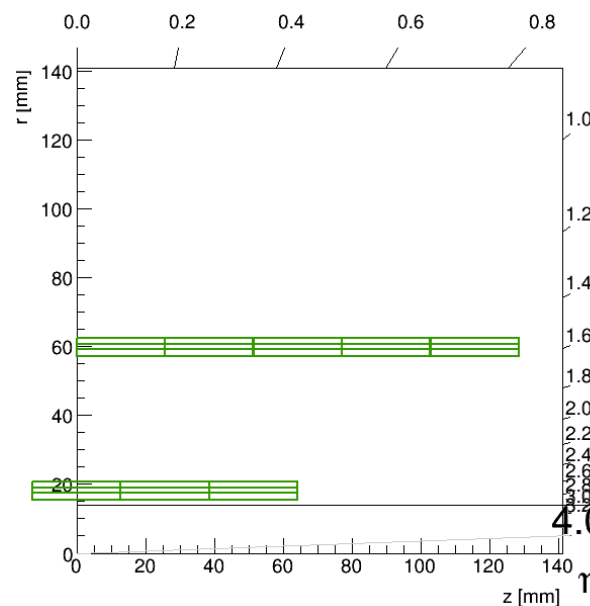
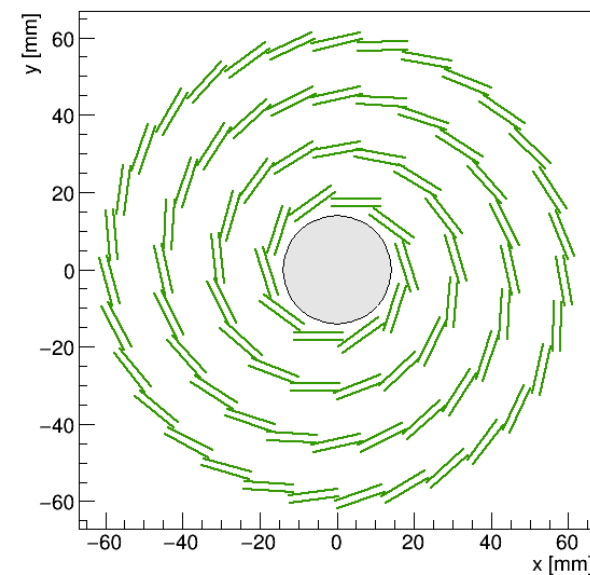
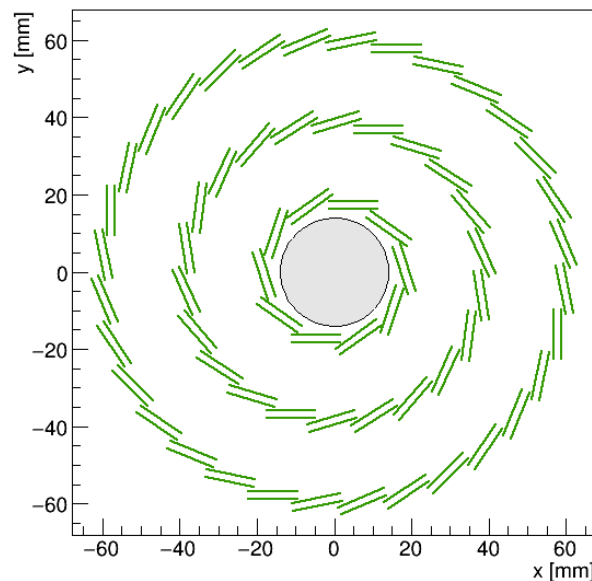
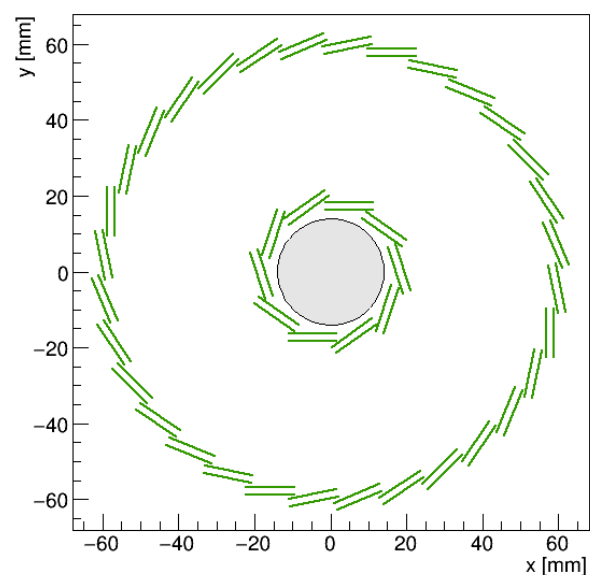
- Detector size(resolution across p)



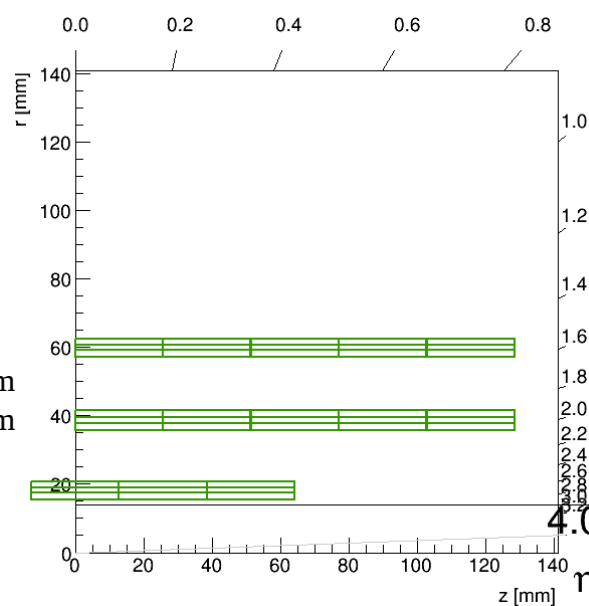
Detector become larger,
resolution will be better.

Geometry comparison

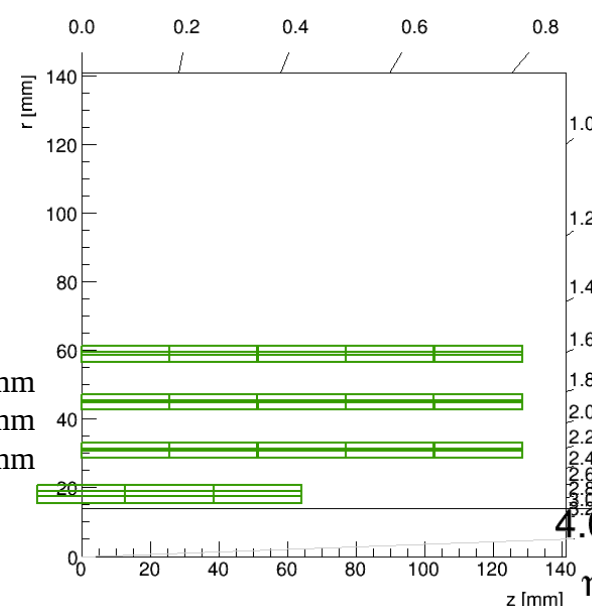
- Different number of layers



Layer 1: 18mm
Layer 3: 59mm



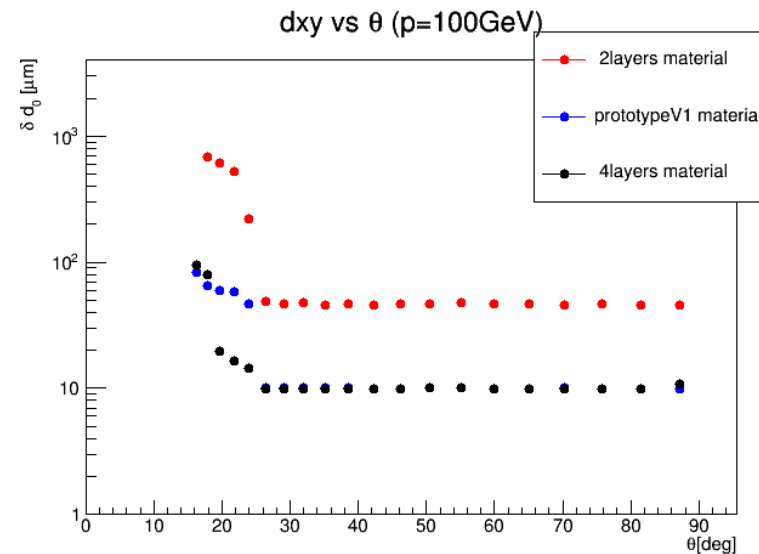
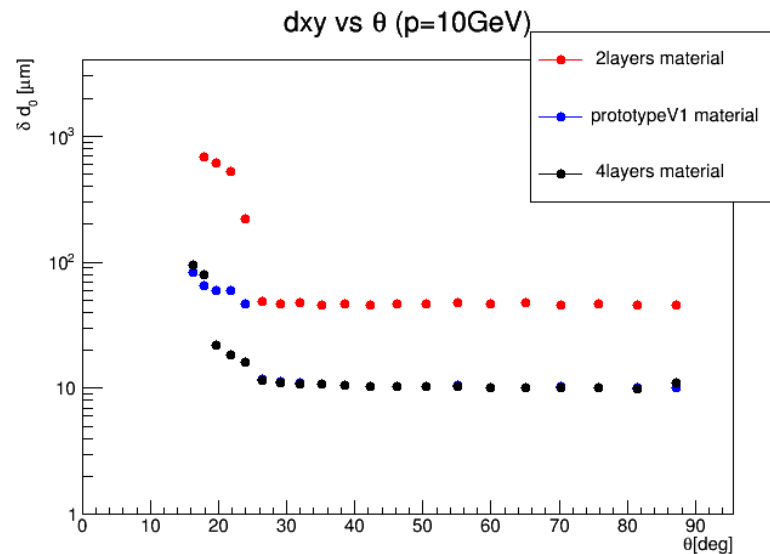
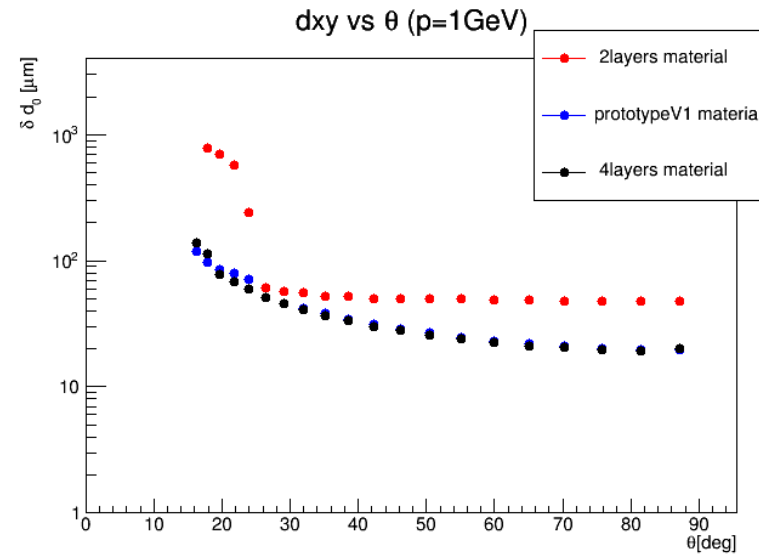
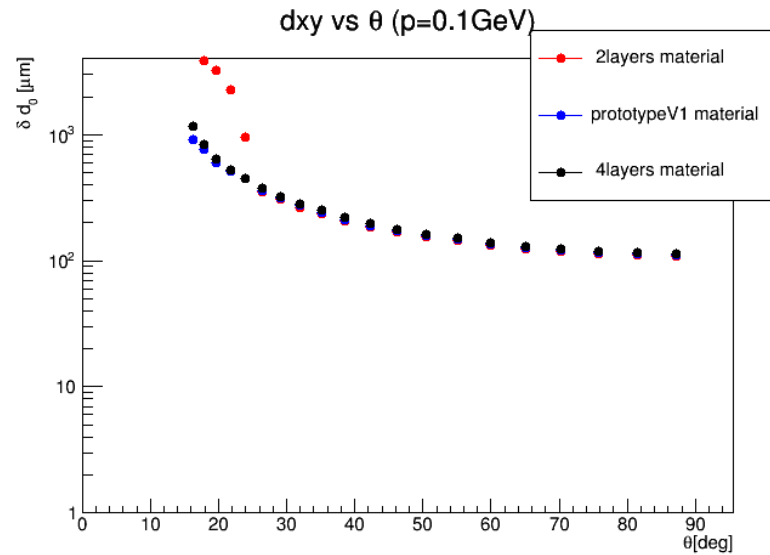
Layer 1: 18mm
Layer 2: 38mm
Layer 3: 60mm



Layer 1: 18mm
Layer 2: 31mm
Layer 3: 45mm
Layer 4: 59mm

Geometry comparison

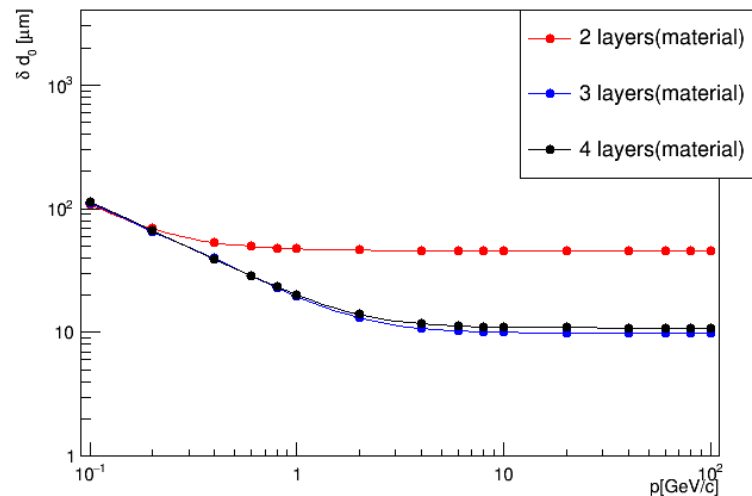
- Different number of layers(resolution across θ)



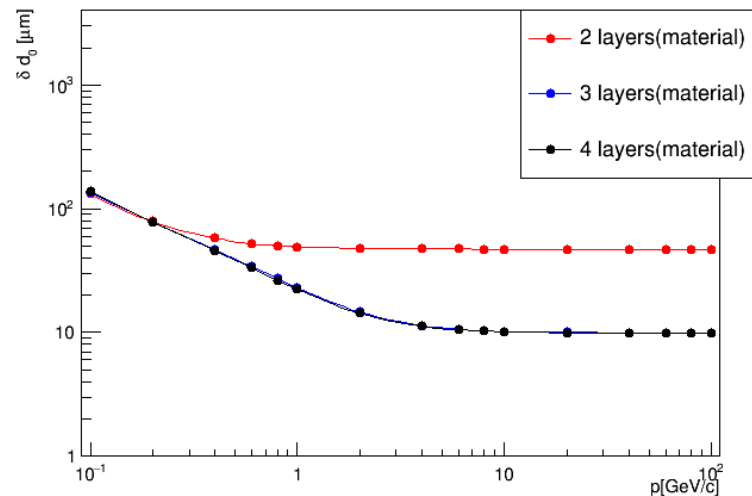
Geometry comparison

- Different number of layers(resolution across p)

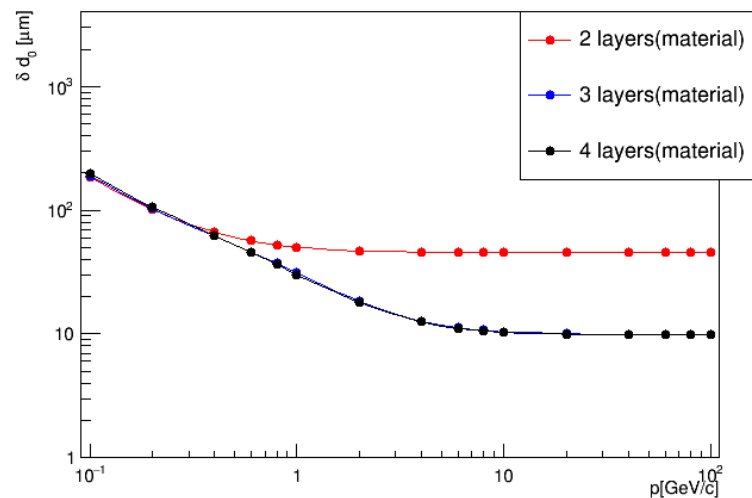
dxy vs momentum ($\theta=87^\circ$)



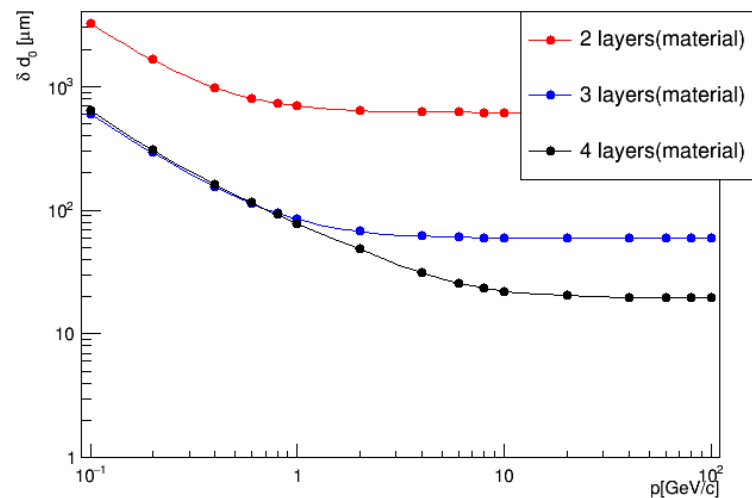
dxy vs momentum ($\theta=60^\circ$)



dxy vs momentum ($\theta=42^\circ$)



dxy vs momentum ($\theta=20^\circ$)

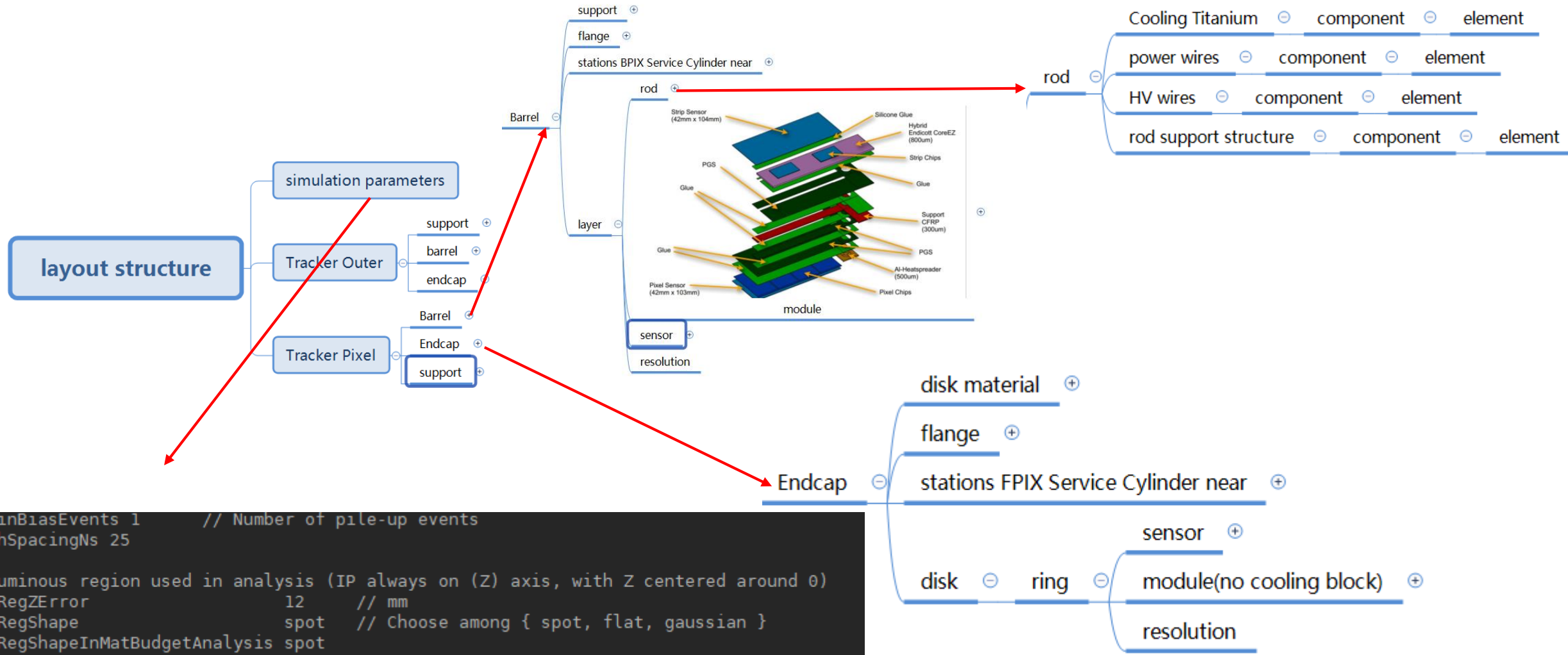


Thank you!

Backup

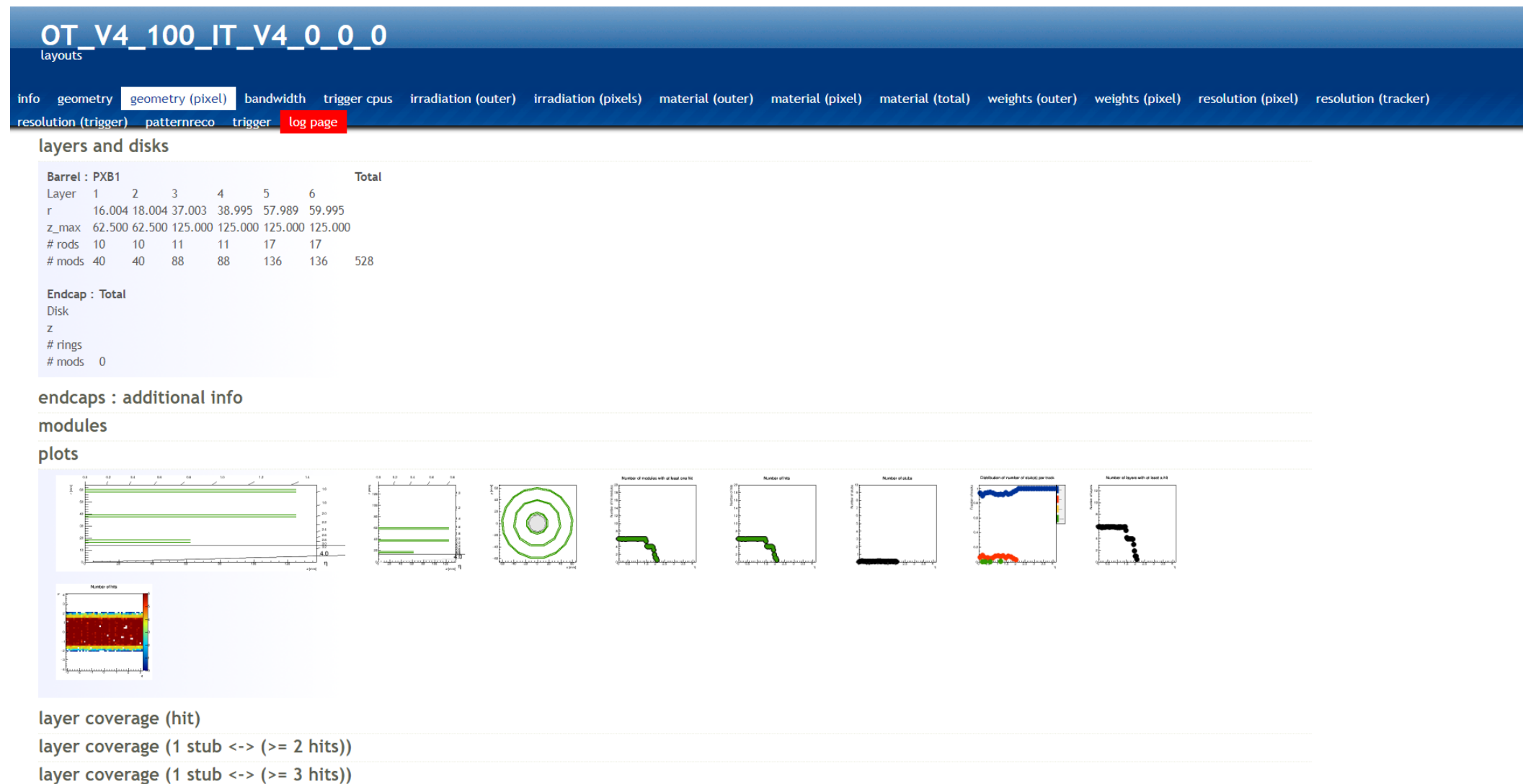
Introduction of tkLayout

- Layout Configuration Structure



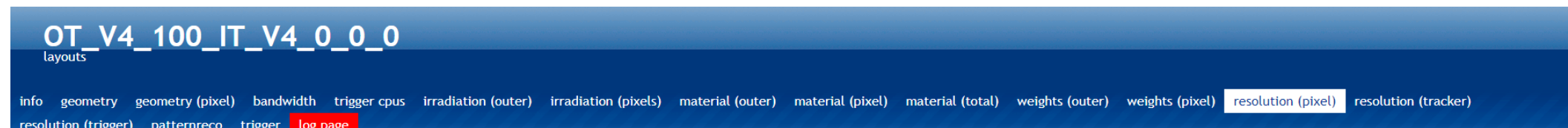
Introduction of tkLayout

- Output webpage:

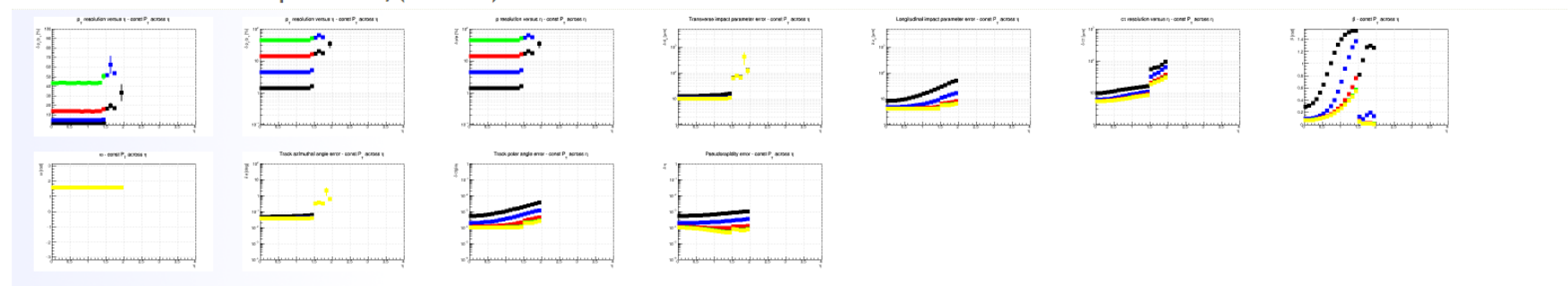


Introduction of tkLayout

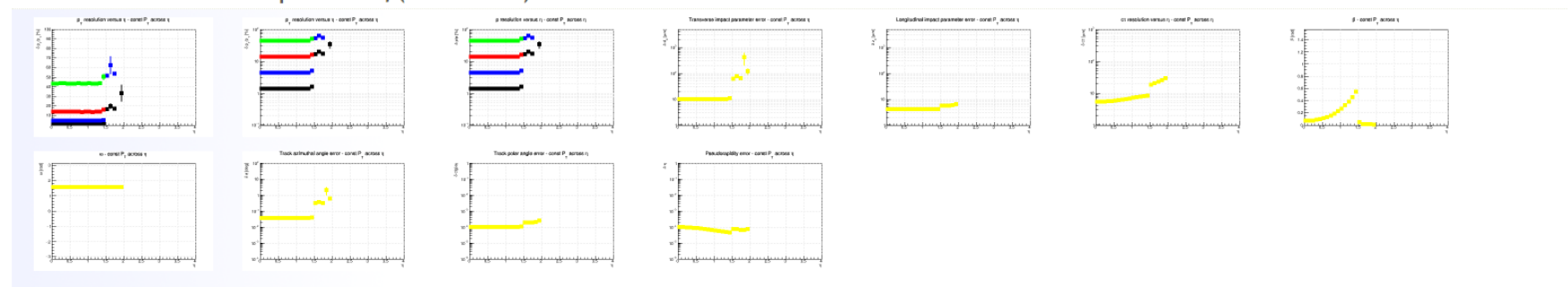
- Output webpage:



track resolution for const pt across η (material)



track resolution for const pt across η (no material)



track resolution for const p across η (material)

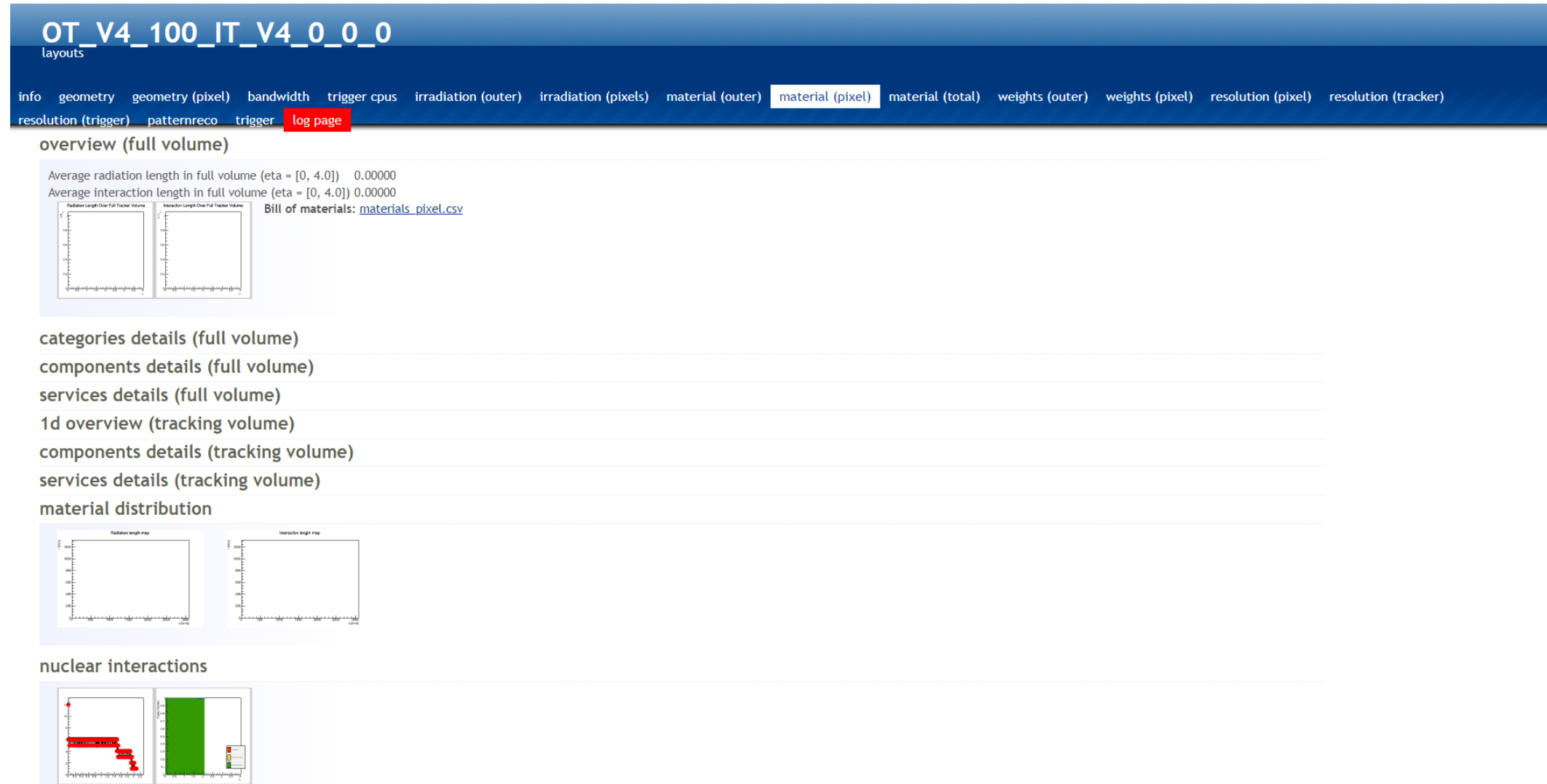
track resolution for const p across η (no material)

summary - const pt across η

Region: C I F VF VVF
Min η : 0.001 0.8 1.6 2.4 3.2

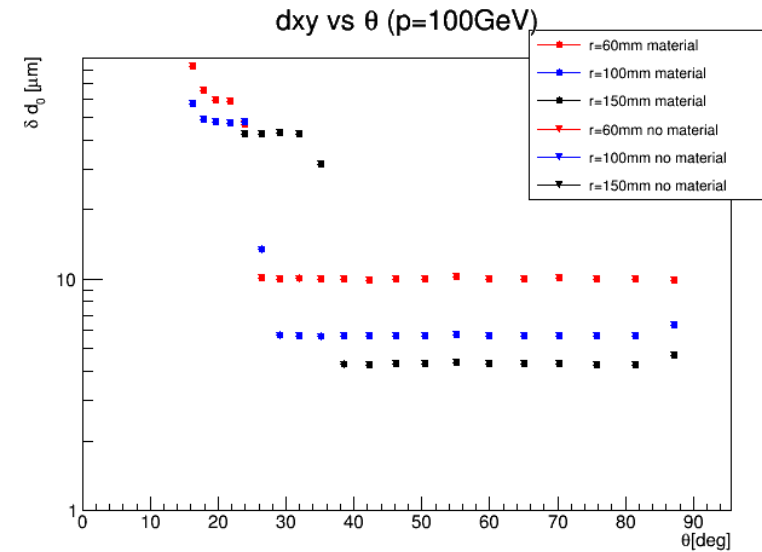
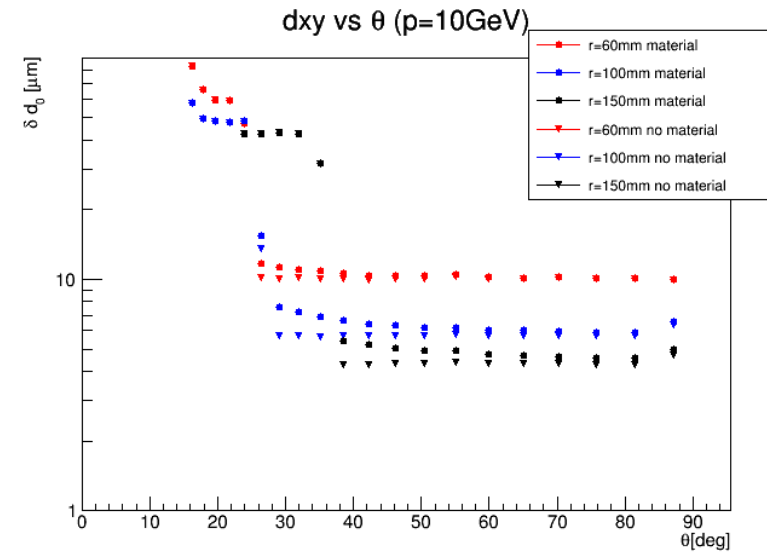
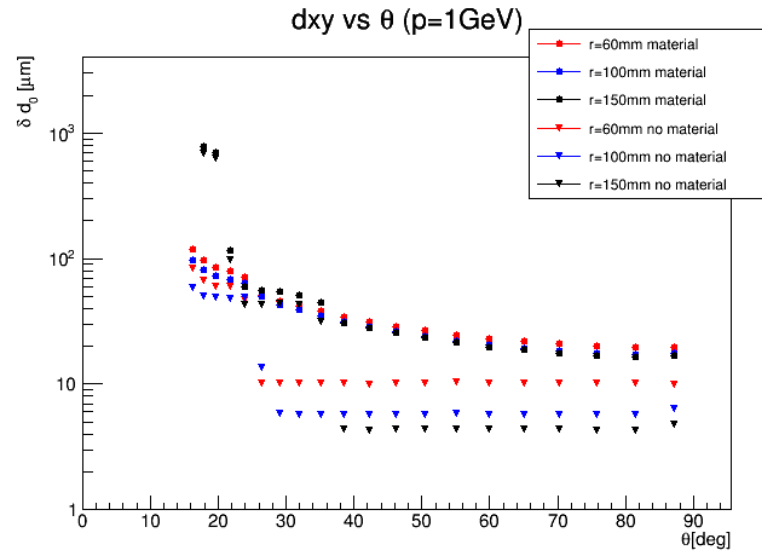
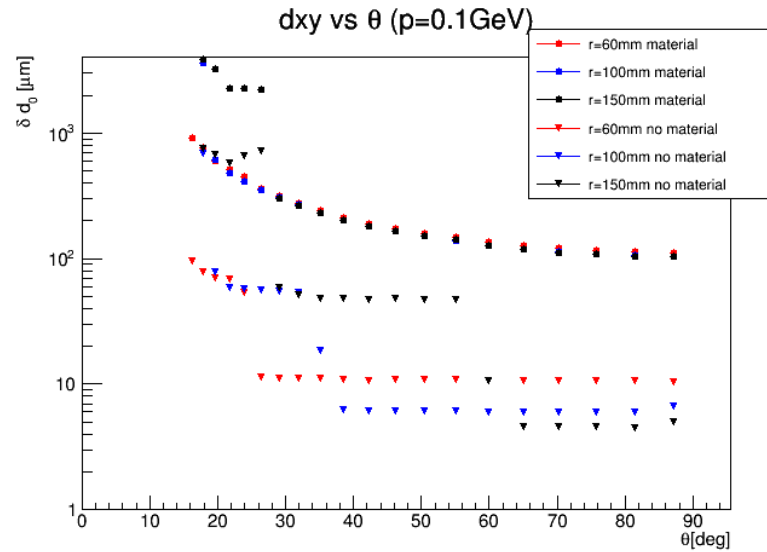
Introduction of tkLayout

- Output webpage:



Material vs no material

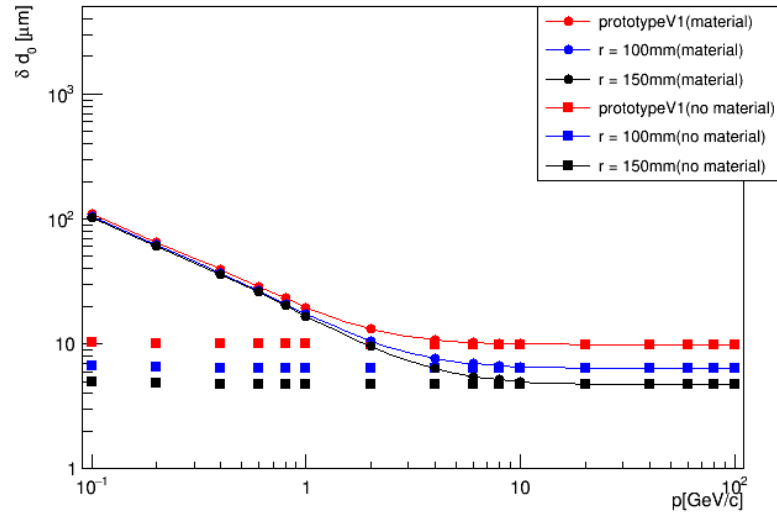
- Detector size(resolution across θ)



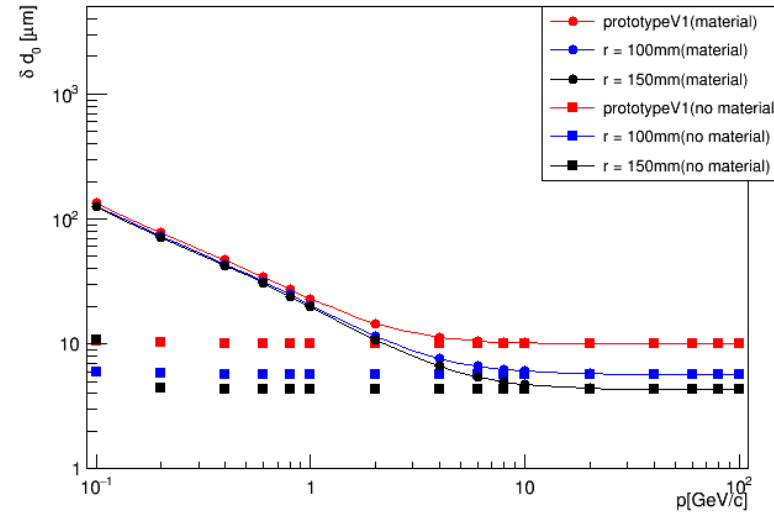
Material vs no material

- Detector size(resolution across p)

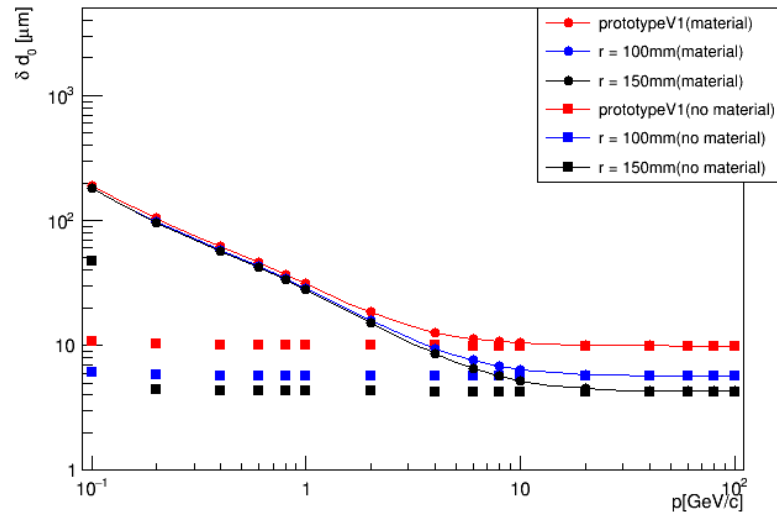
dxy vs momentum ($\theta=87^\circ$)



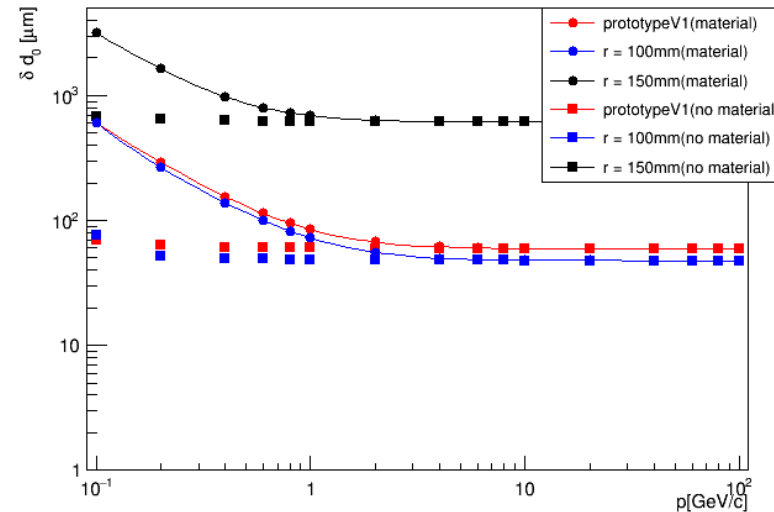
dxy vs momentum ($\theta=60^\circ$)



dxy vs momentum ($\theta=42^\circ$)

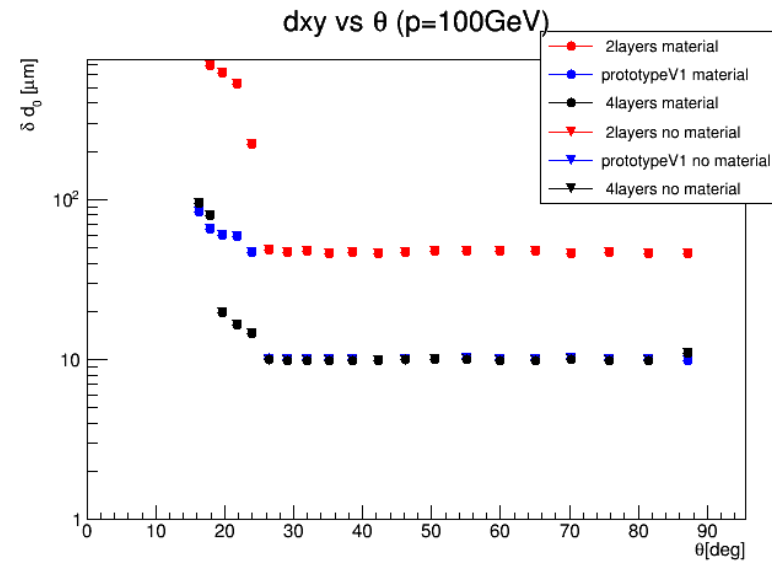
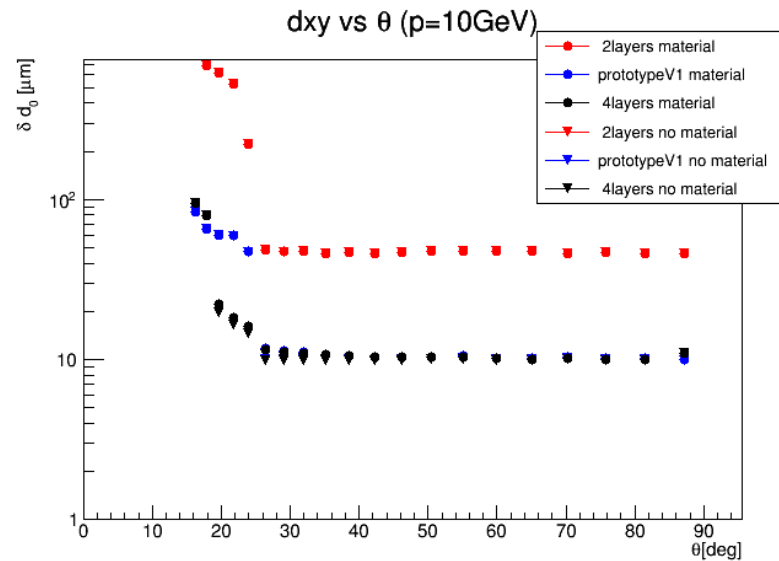
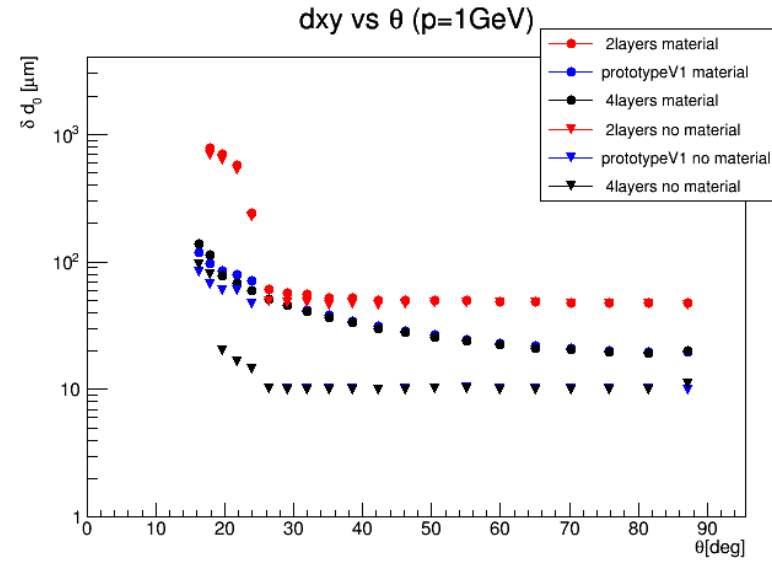
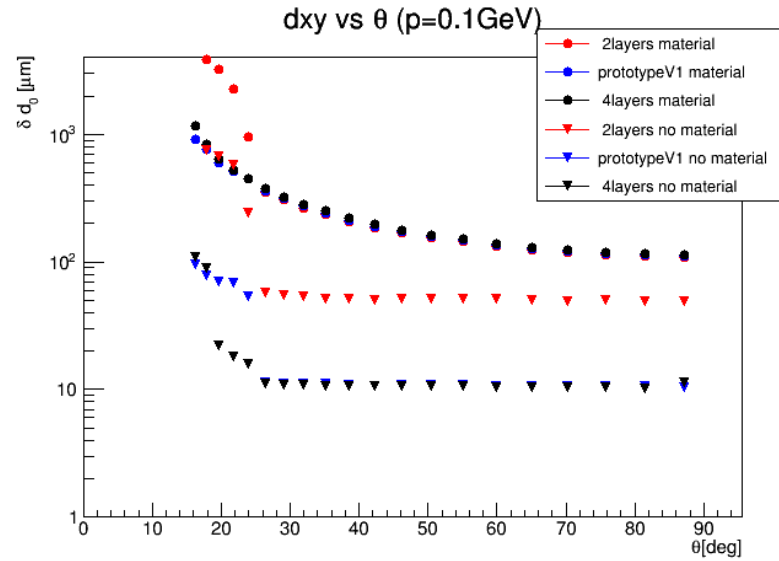


dxy vs momentum ($\theta=20^\circ$)



Material vs no material

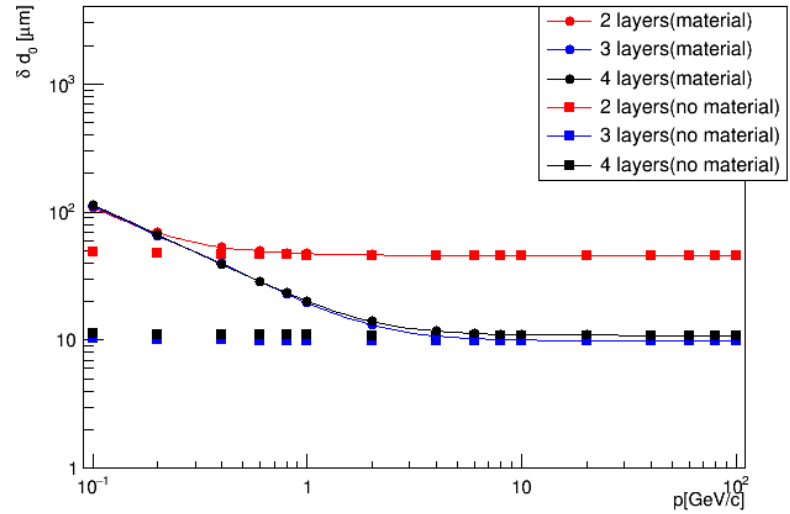
- Different number of layers(resolution across θ)



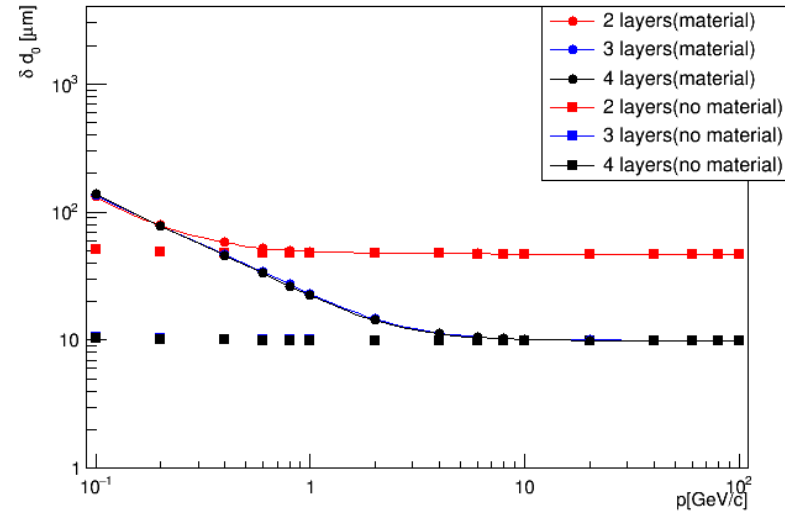
Material vs no material

- Different number of layers(resolution across θ)

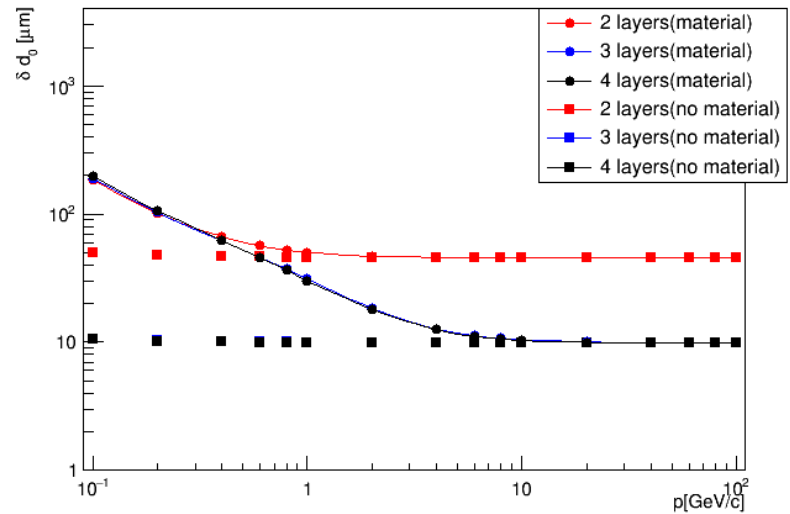
dxy vs momentum ($\theta=87^\circ$)



dxy vs momentum ($\theta=60^\circ$)



dxy vs momentum ($\theta=42^\circ$)



dxy vs momentum ($\theta=20^\circ$)

