EIC FST Simulation

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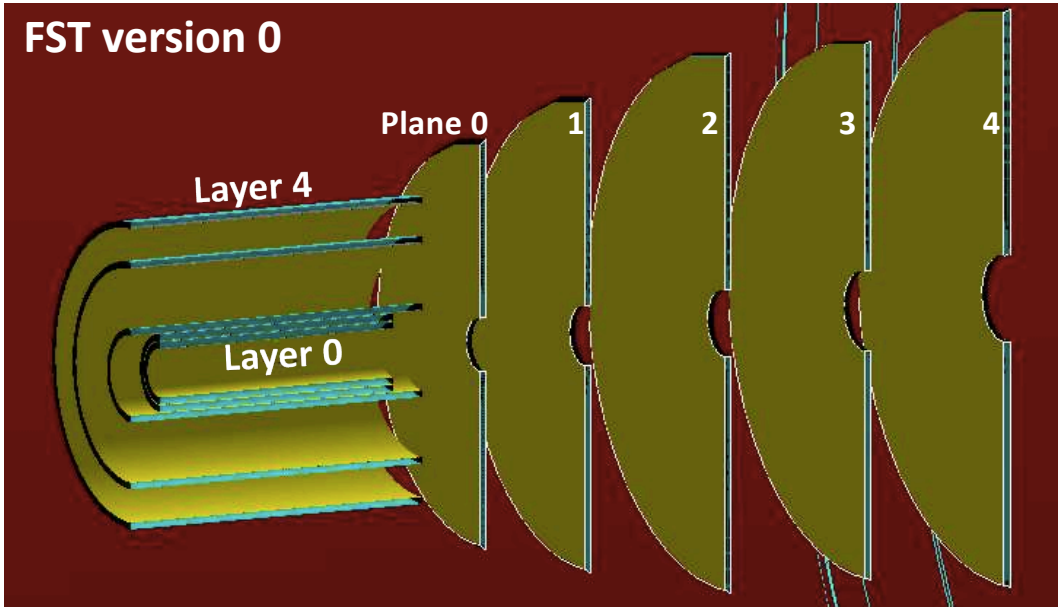
Outline

- Update on FST design
- Distance of closet approach (DCA) resolution
- Material scan with updated detector geometry

Thanks Jin for the help in the Fun4all simulation!

Detector Initial Design in Fun4all

Babar magnet with a peak at 1.4 T magnetic field



Barrel layer

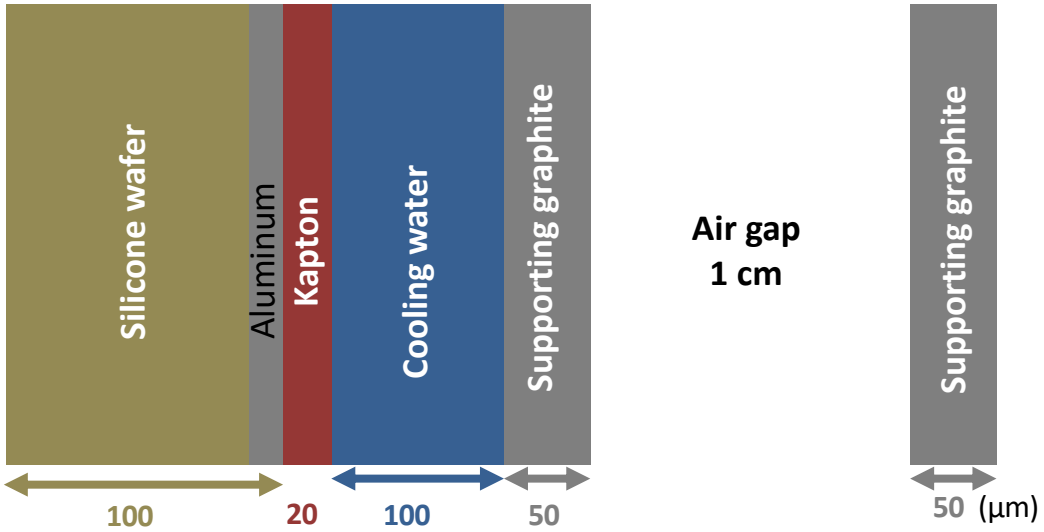
Layer	Half length (cm)	r (cm)
0	20	3.64
1	20	4.81
2	25	5.98
3	25	16
4	25	22

Plane detector

Plane	z (cm)	r_{in} (cm)	r_{out} (cm)
0	35	4	30
1	53	4.5	35
2	77	5	40
3	101	6	40
4	125	6.5	43

Detector Initial Design in Fun4all

Material sublayers of the plane detectors (arbitrary scale)

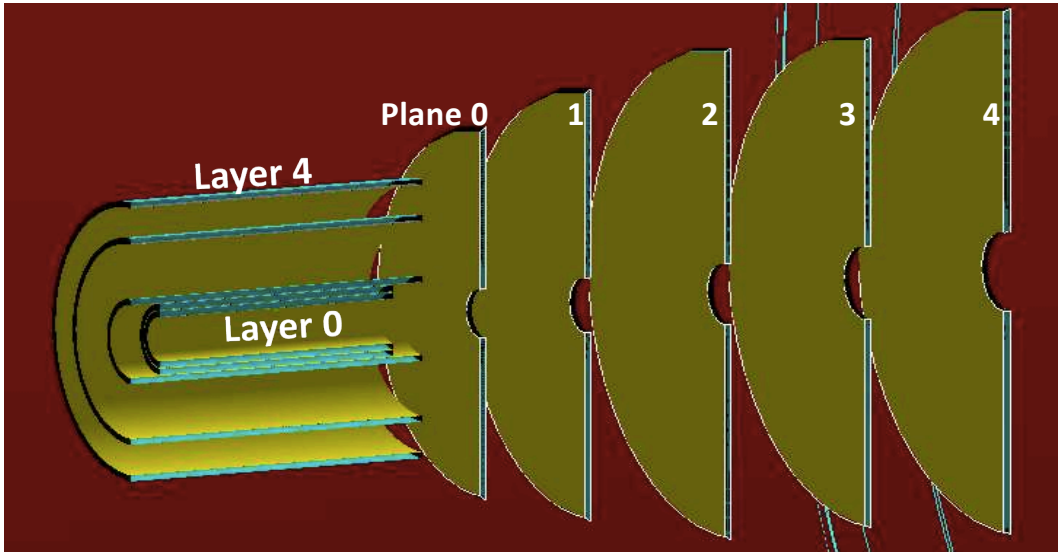


Pixel Pitch

Barrel \ FST	10um	20um	30um
10um	✓ Same	✓	✓
20um	✓	✓ Same	✓
30um	✓	✓	✓ Same

Updated Versions of FST Design

Version 0



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Plane detector

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0	35	4	30
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2	77	5	40
3	101	6	40
4	125	6.5	43

100um thick silicon wafer in both barrel and FST

Version 1: modify the outer radius of the plane 0 and 1

Plane detector

Plane	z (cm)	r_{in} (cm)	r_{out} (cm)
0	35	4	**25**
1	53	4.5	**36**
2	77	5	40
3	101	6	40
4	125	6.5	43

100um thick silicon wafer in the layer 3 & 4 of the barrel, 50um thick silicon wafer in the rest of barrel and FST

Version 2: move the last plane (plane 4) from Version 0 far back to z=2.7m to improve detector performance at large pseudorapidity

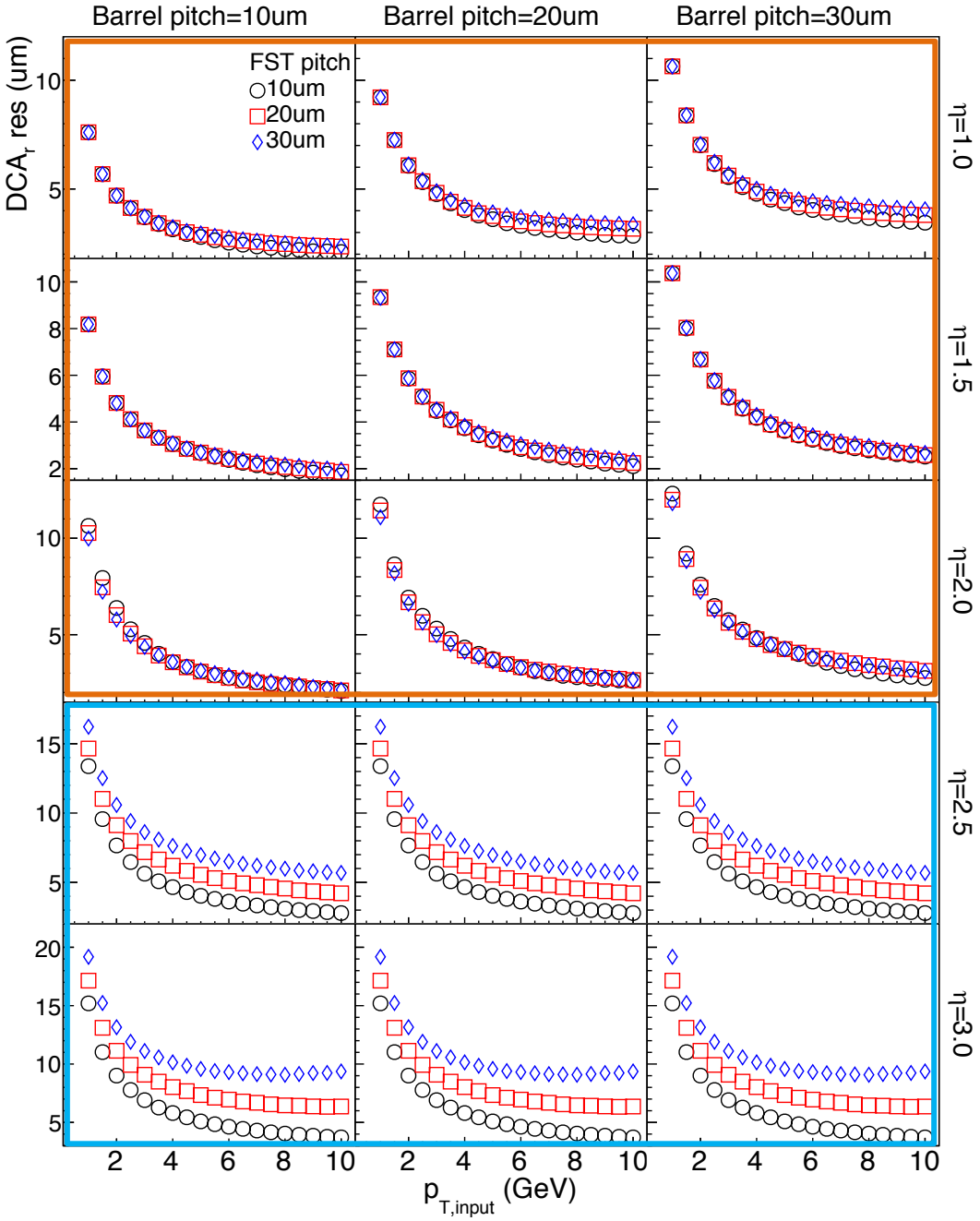
Plane detector

Plane	z (cm)	r_{in} (cm)	r_{out} (cm)
0	35	4	30
1	53	4.5	35
2	77	5	40
3	101	6	40
4	**270**	6.5	43

100um thick silicon wafer in the layer 3 & 4 of the barrel, 50um thick silicon wafer in the rest of barrel and FST

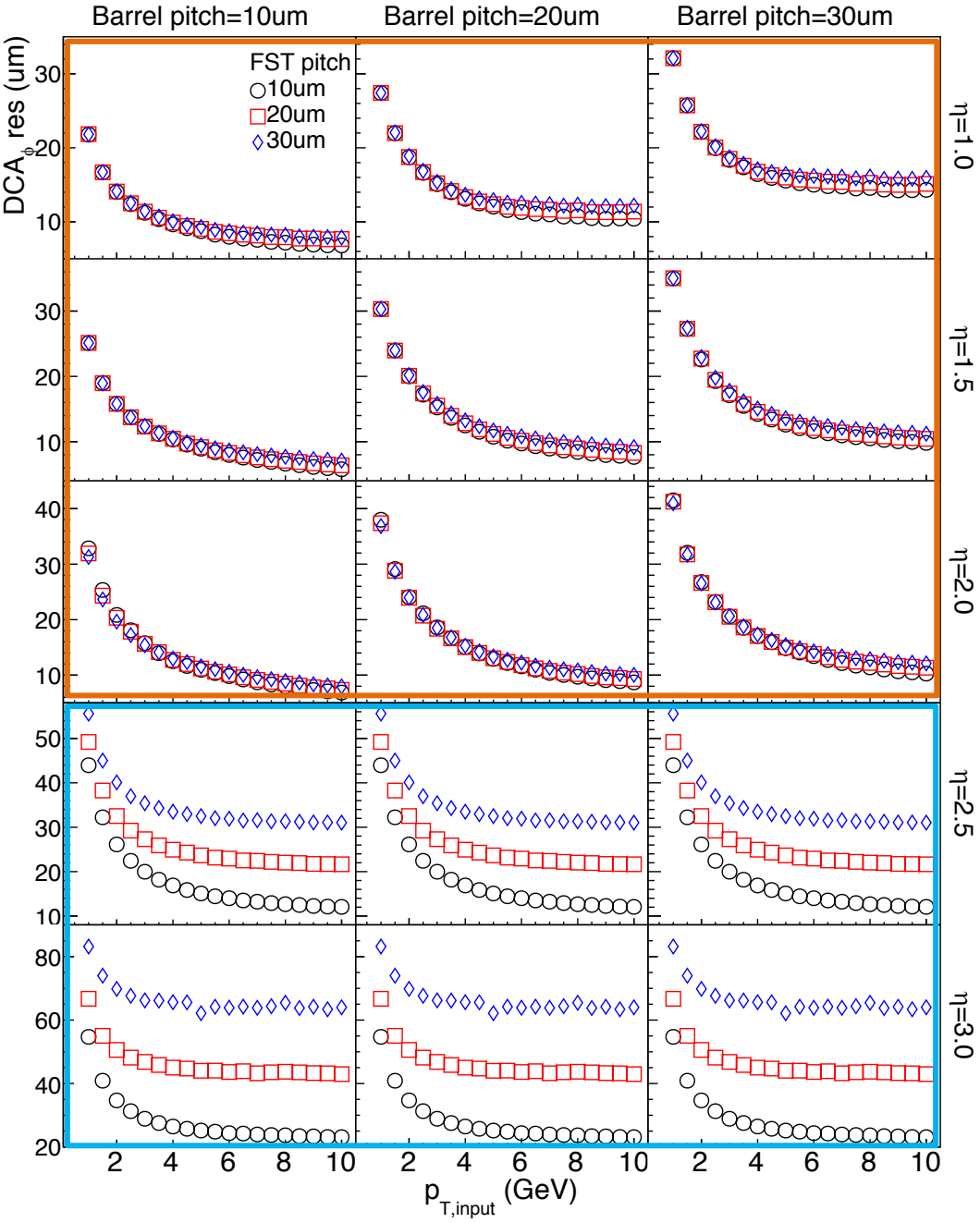
Simulation Setup

- Event configuration:
  - 10 π- per event.
  - Vertex (0,0,0), no smeared resolution. Vertex reconstruction number of degree of freedom (nDof) =1
  - 10k events in each p⊗η bin.
- Track configuration:
  - Momentum: 1-10 GeV with a 0.5 GeV increment (shown in this presentation). Expand to 30 GeV with 2.5 GeV increment.
  - Pseudorapdity: 1-3 with a 0.5 increment.
  - Hit efficiency at 95%.



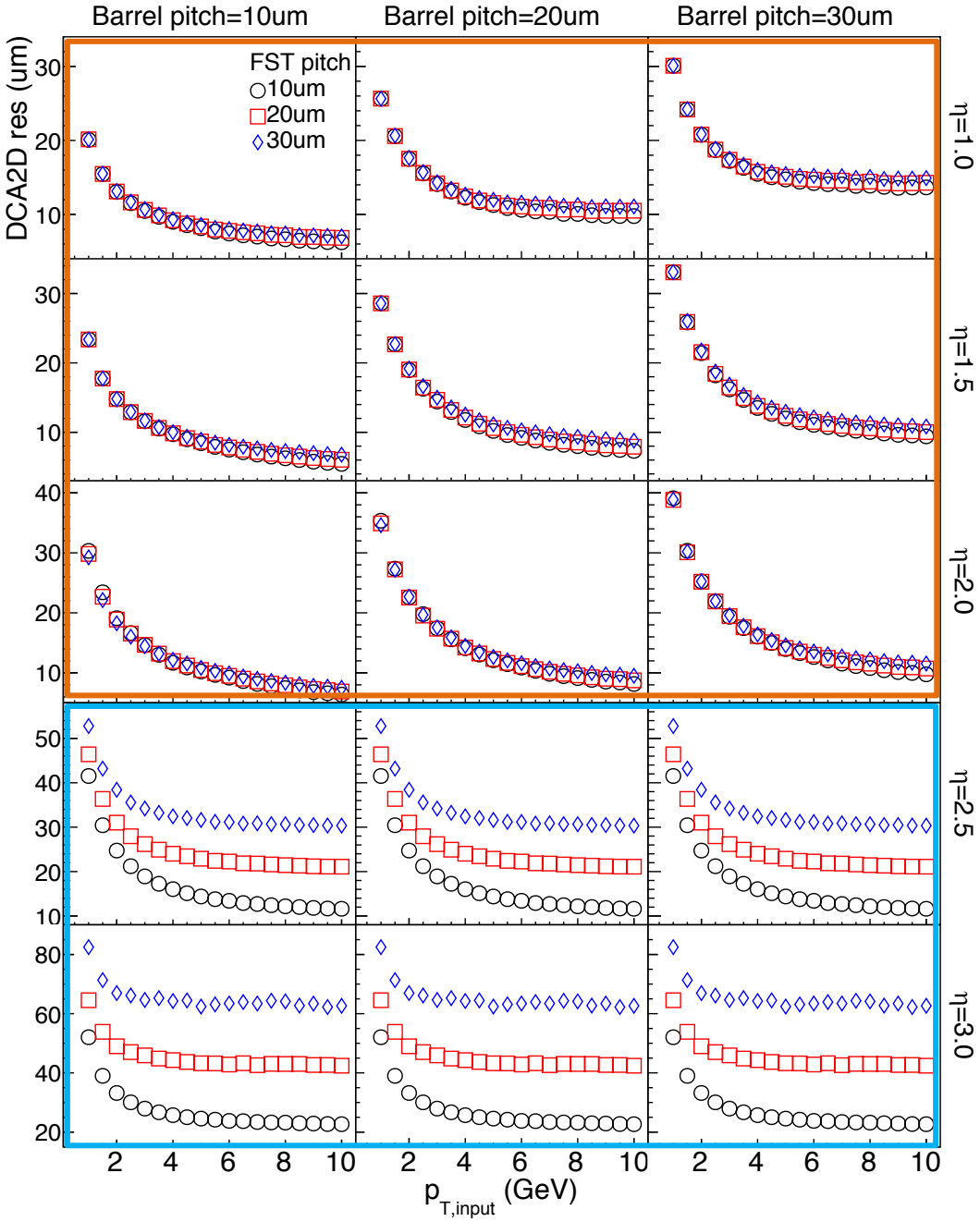
DCA_r Resolution (Verion0 with 100um thick silicon sensor)

- Definition $DCA_r = pca_T \cdot p_T$
- DCAr resolution is within 20um
- The DCAr resolution improved by 1-2 um at small pseudorapidity with the use of smaller pixel pitch at the barrel
- At large pseudorapidity, the resolution depends on the FST pixel pitch



DCA$_\phi$ Resolution (Verion0 with 100um thick silicon sensor)

- Definition $\mathrm{DCA}\varphi = pca_T \times p_T$
- DCA$_\phi$ resolution is within 80um
- The DCA$_\phi$ resolution improved by about 3um at small pseudorapidity with the use of smaller pixel pitch at the barrel
- At large pseudorapidity, the resolution depends on the FST pixel pitch. The resolution difference between FST pixel pitch is between 20-40um at high p$_T$

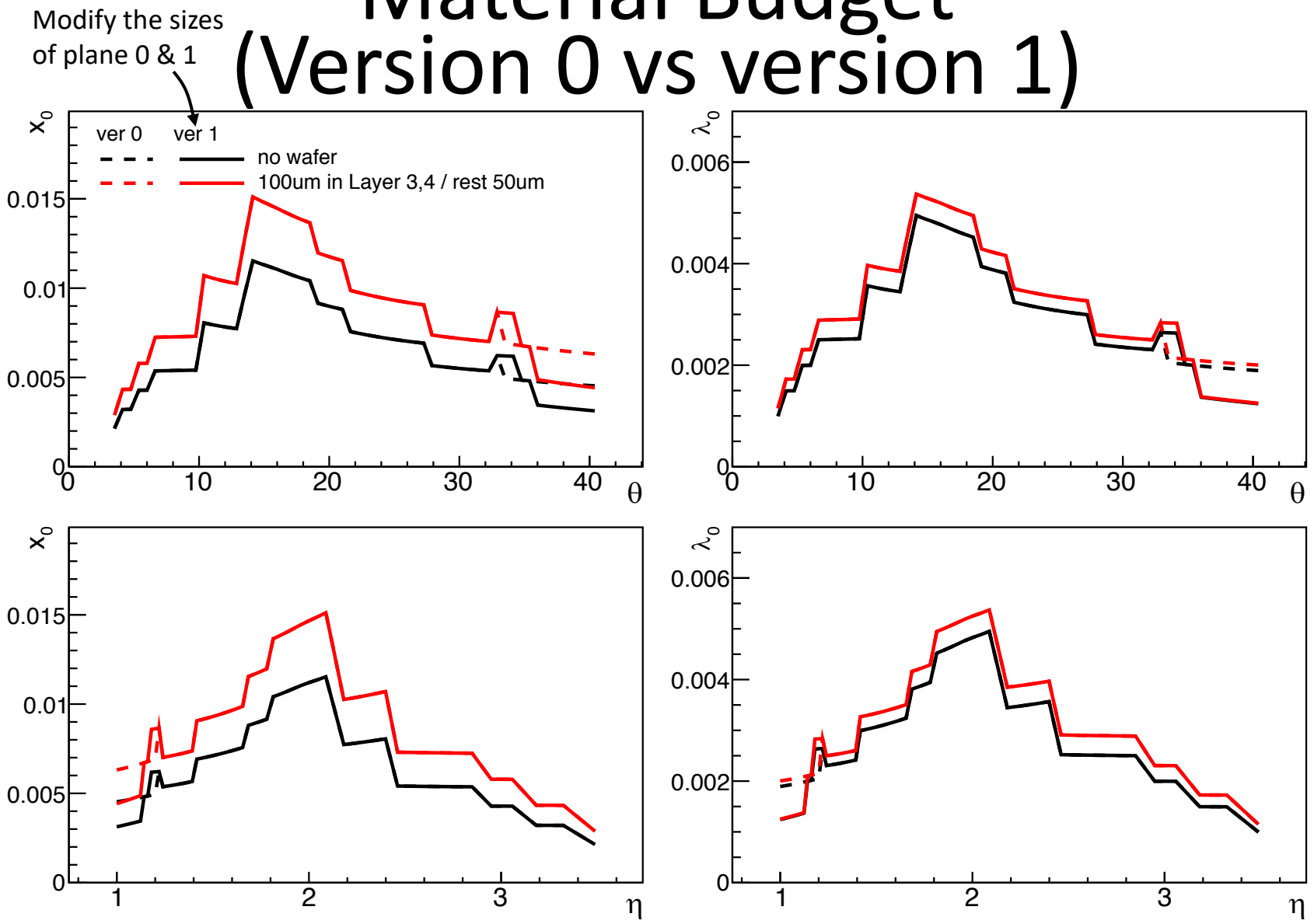


DCA2D Resolution (Verion0 with 100um thick silicon sensor)

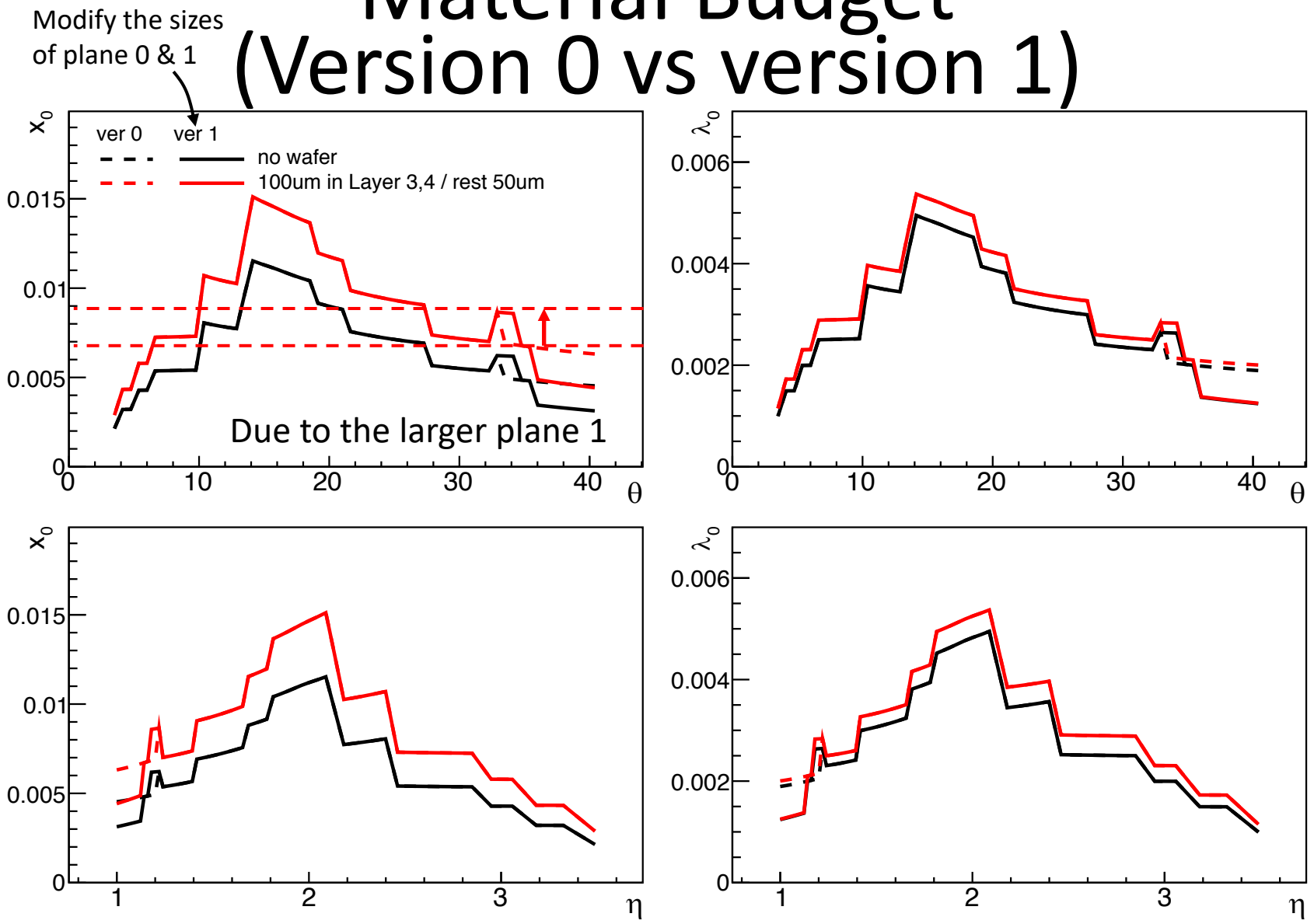
- Definition $\mathrm{DCA2}D = p_T \times pca_z$
- DCA2D resolution is within 90um
- The DCA_ϕ resolution improved by about 2um at small pseudorapidity with the use of smaller pixel pitch at the barrel
- At large pseudorapidity, the resolution depends on the FST pixel pitch. The resolution difference between FST pixel pitch is between 10-20um at high p_T

Material Scan

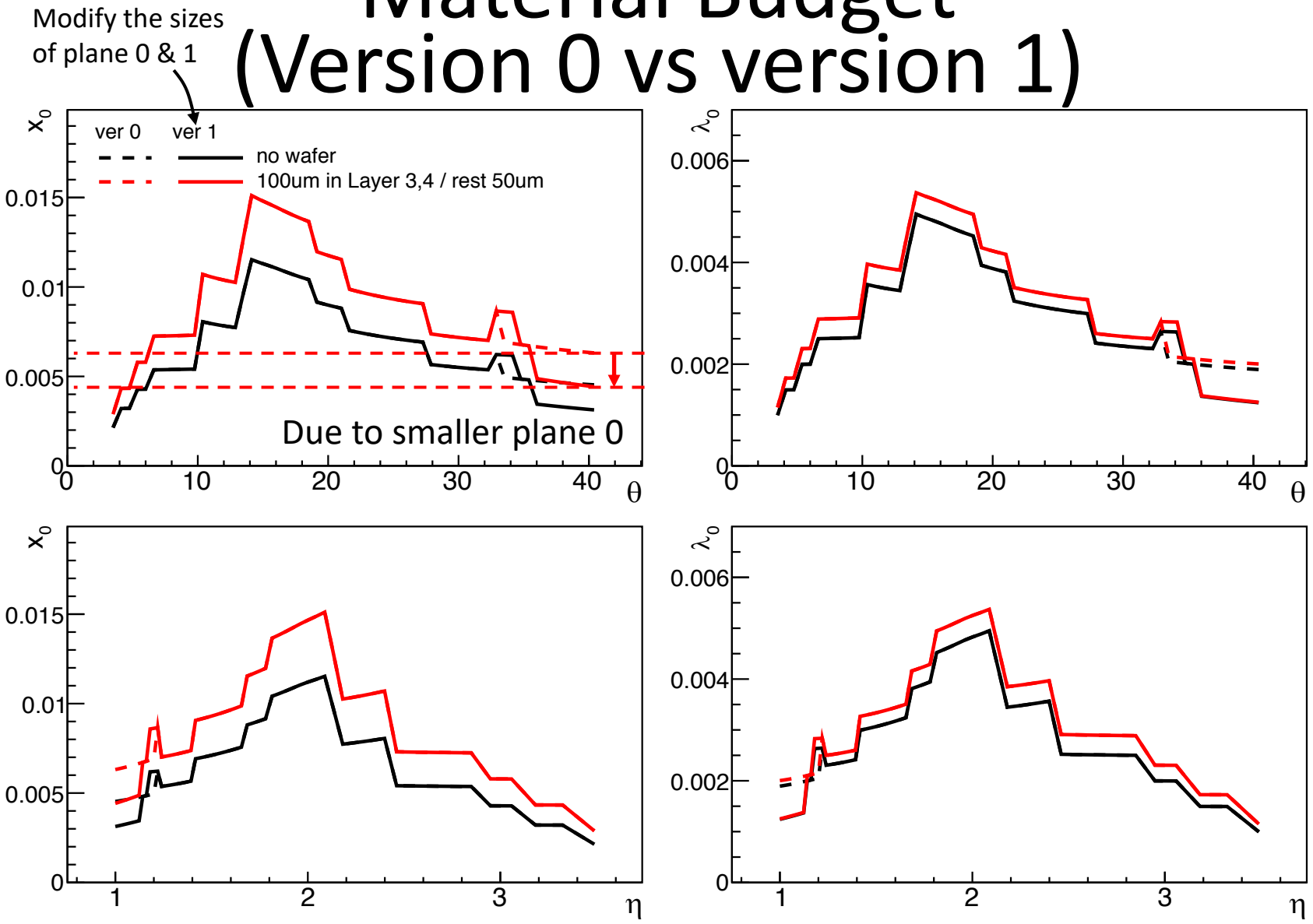
Material Budget (Version 0 vs version 1)



Material Budget (Version 0 vs version 1)

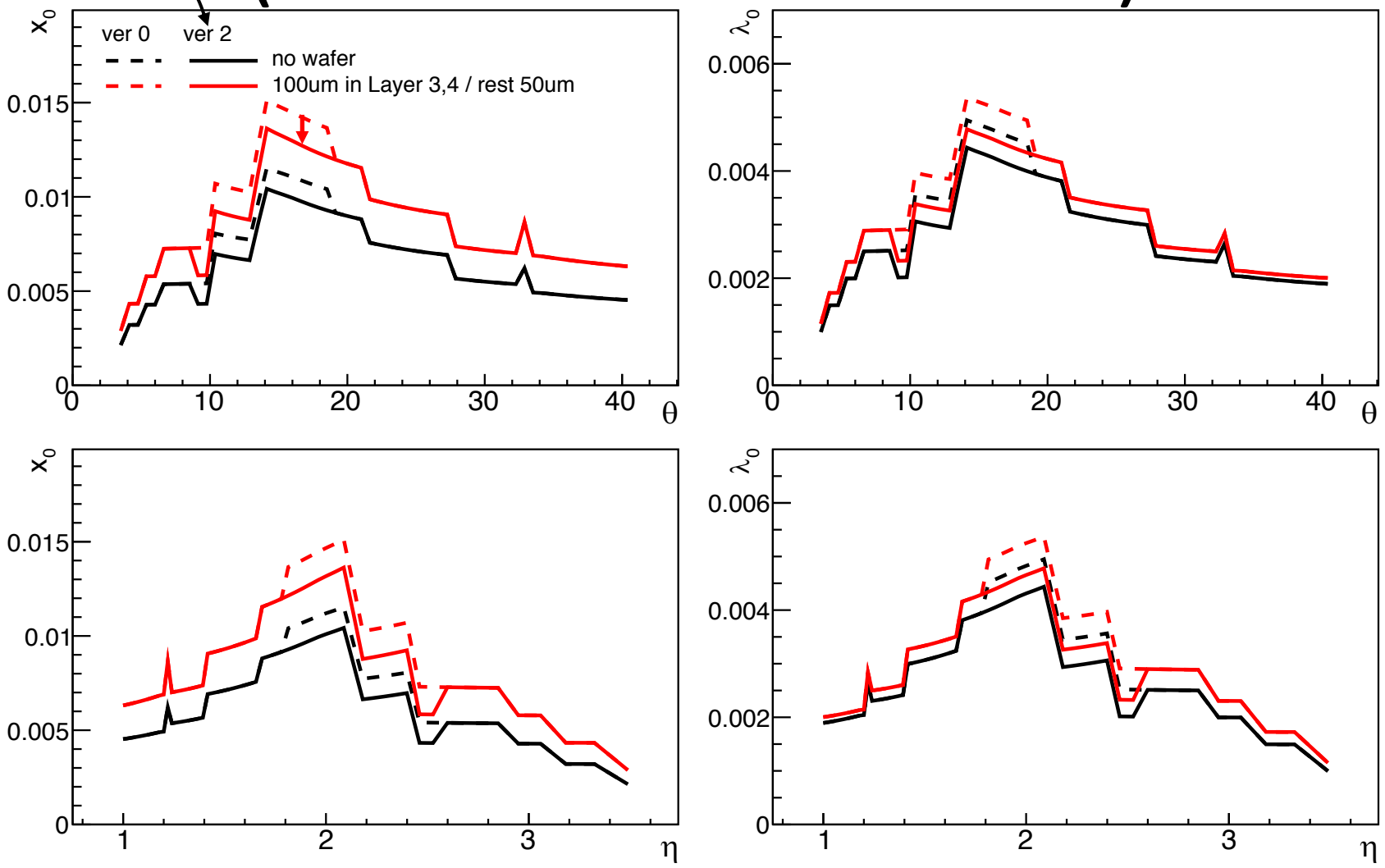


Material Budget (Version 0 vs version 1)



Material Budget (Version 0 vs version 2)

Put plane 4 at z=2.7m



Summary

DCA resolution

- DCA_r < 20um
- DCA_ϕ < 80um
- DCA2D < 90um
- DCA resolution depends on the barrel (FST) pitch size at small (large) η

Material Scan with updated geometries

The differences between the updated geometries and the version 0 design are about 0.2% at specific η/θ range

To-do List

- Fine tune the new geometries
- DCA resolution and momentum resolution using the new FST geometries
- Number of degree of freedom study in vertex reconstruction
- Tracking efficiency study
- Detector performance in a 3T magnetic field
- Technical notes