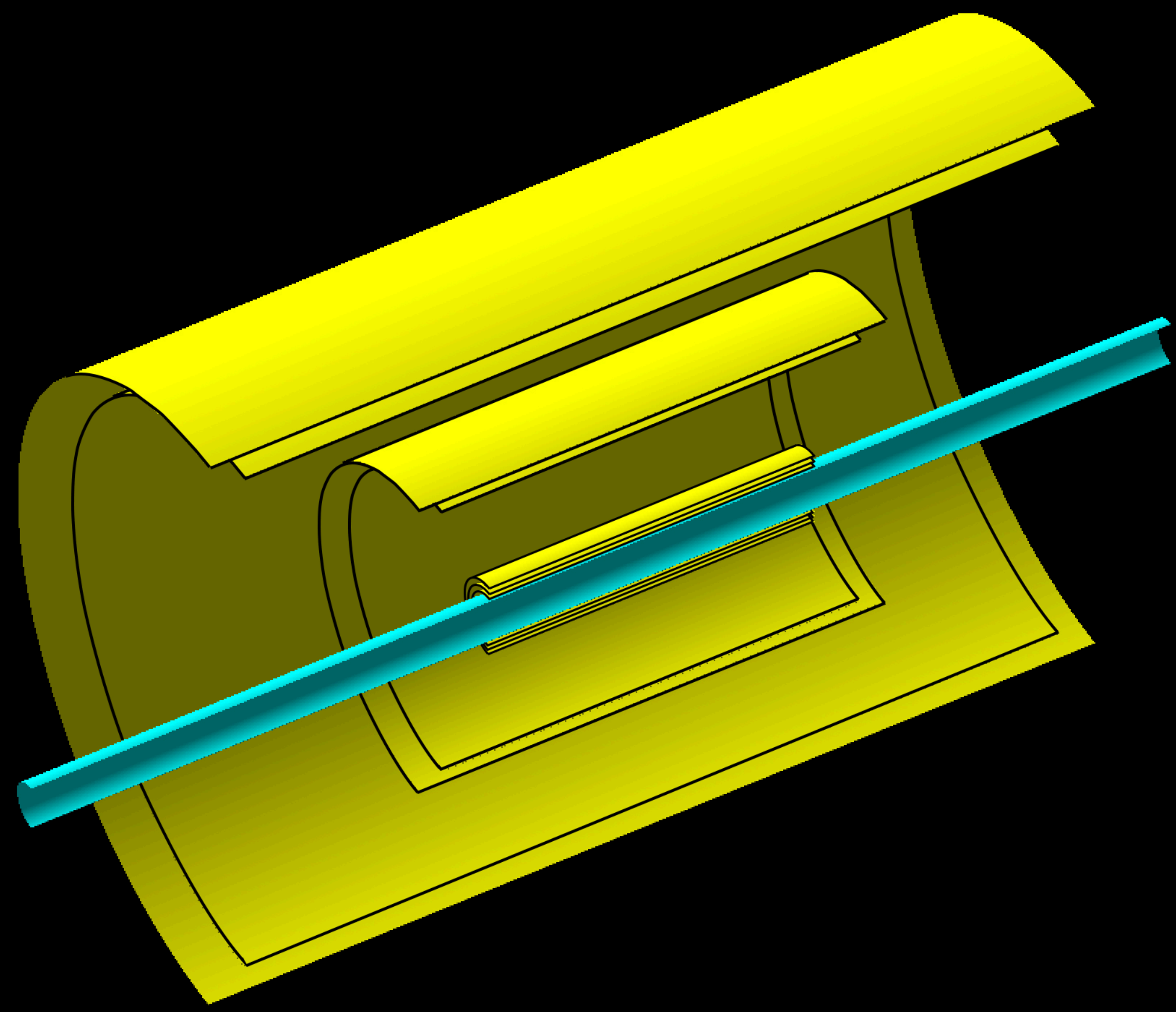
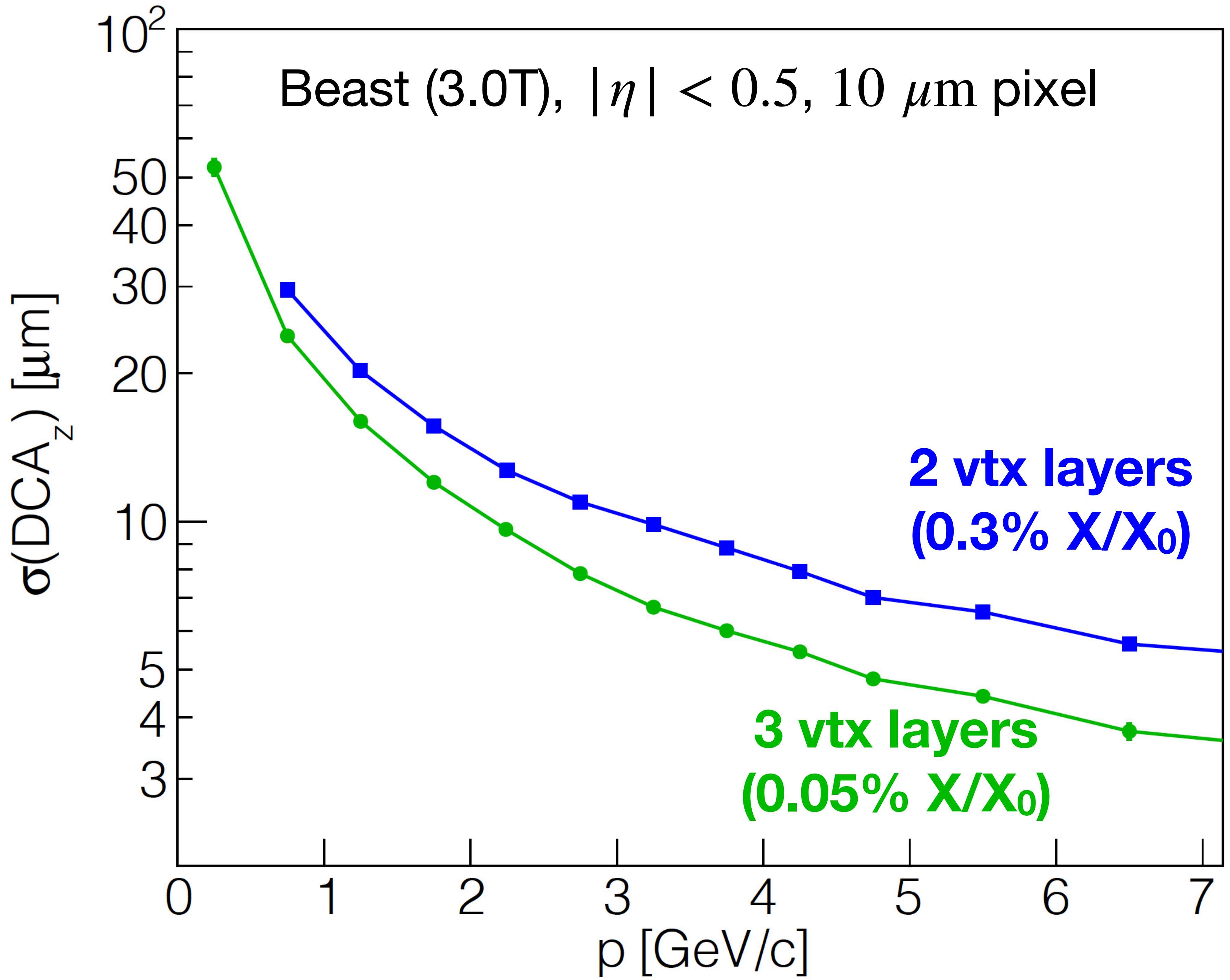
Vertexing-configuration study

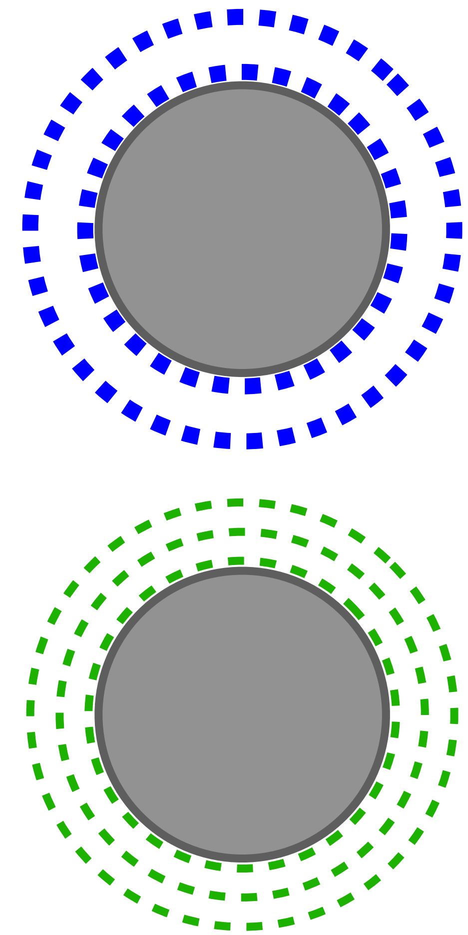


Rey Cruz-Torres
LBNL EIC Meeting
10/13/2020

Motivation

Design of optimal vertexing-layer configuration for All-Silicon tracker



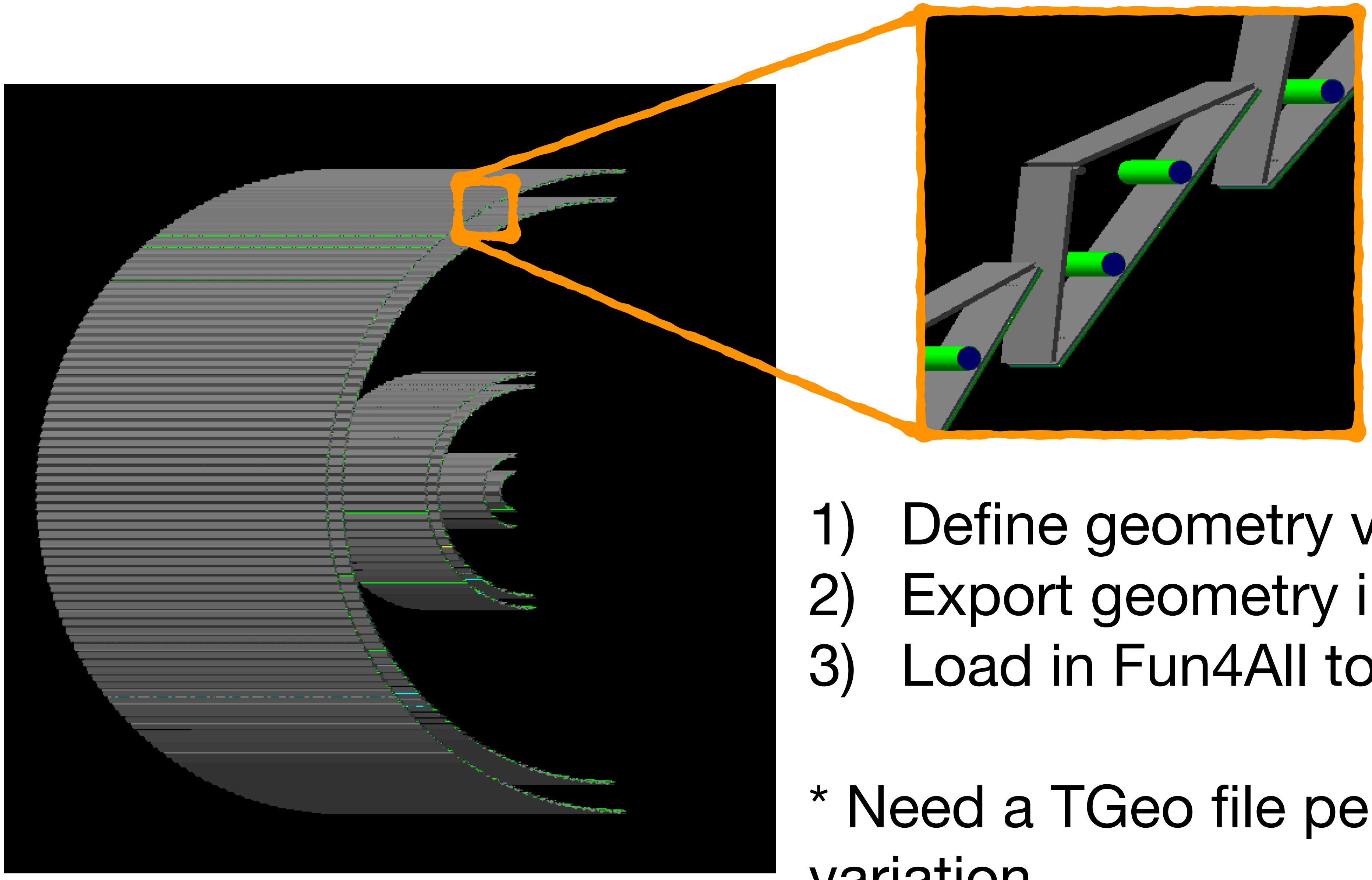


Two parameters (#layers and material budget) changing from blue to green

Introduction and goals

Design of optimal vertexing-layer configuration for All-Silicon tracker

Doing these checks with ‘standard’ All-Si tracker is costly



1) Define geometry variations in EICroot
2) Export geometry in TGeo format
3) Load in Fun4All to run simulations

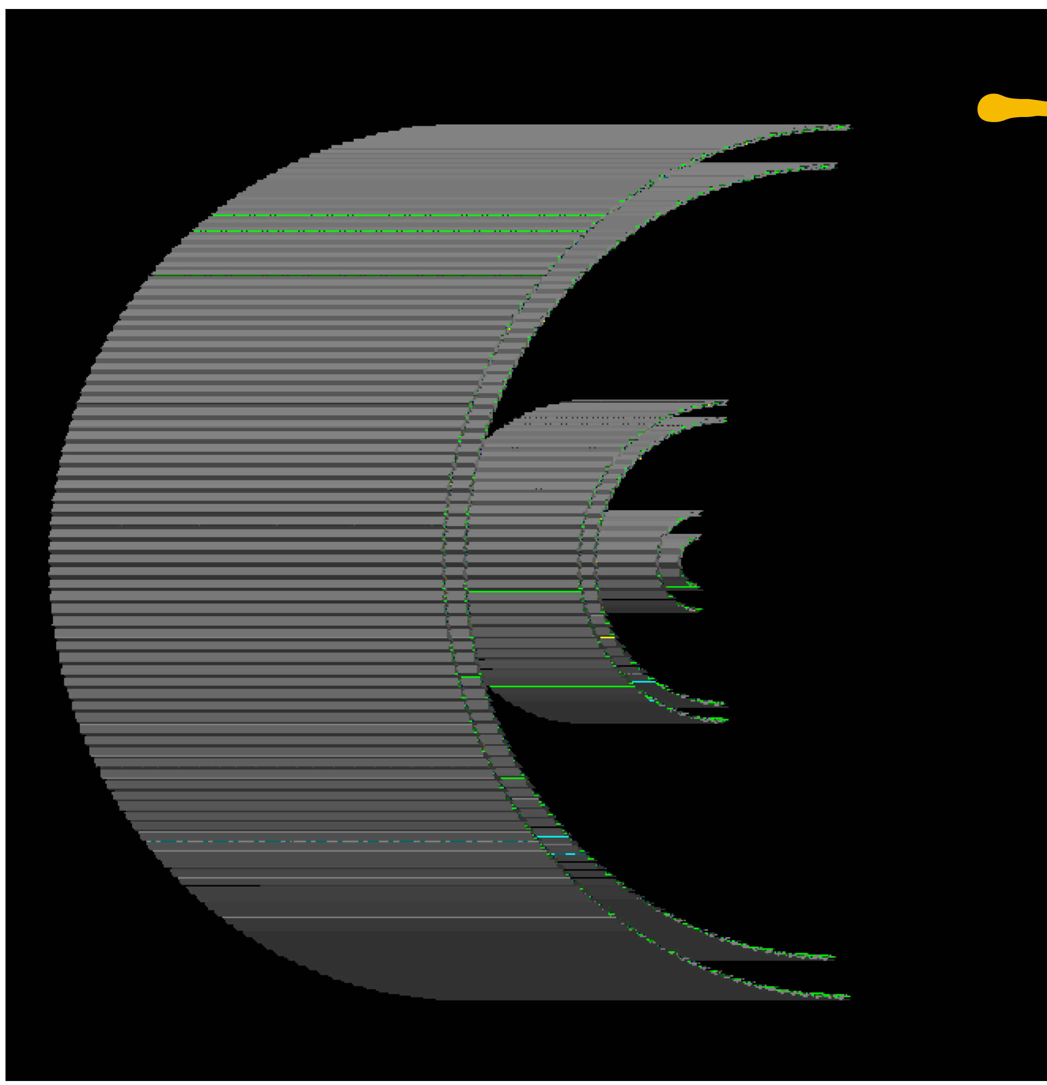
* Need a TGeo file per geometry variation

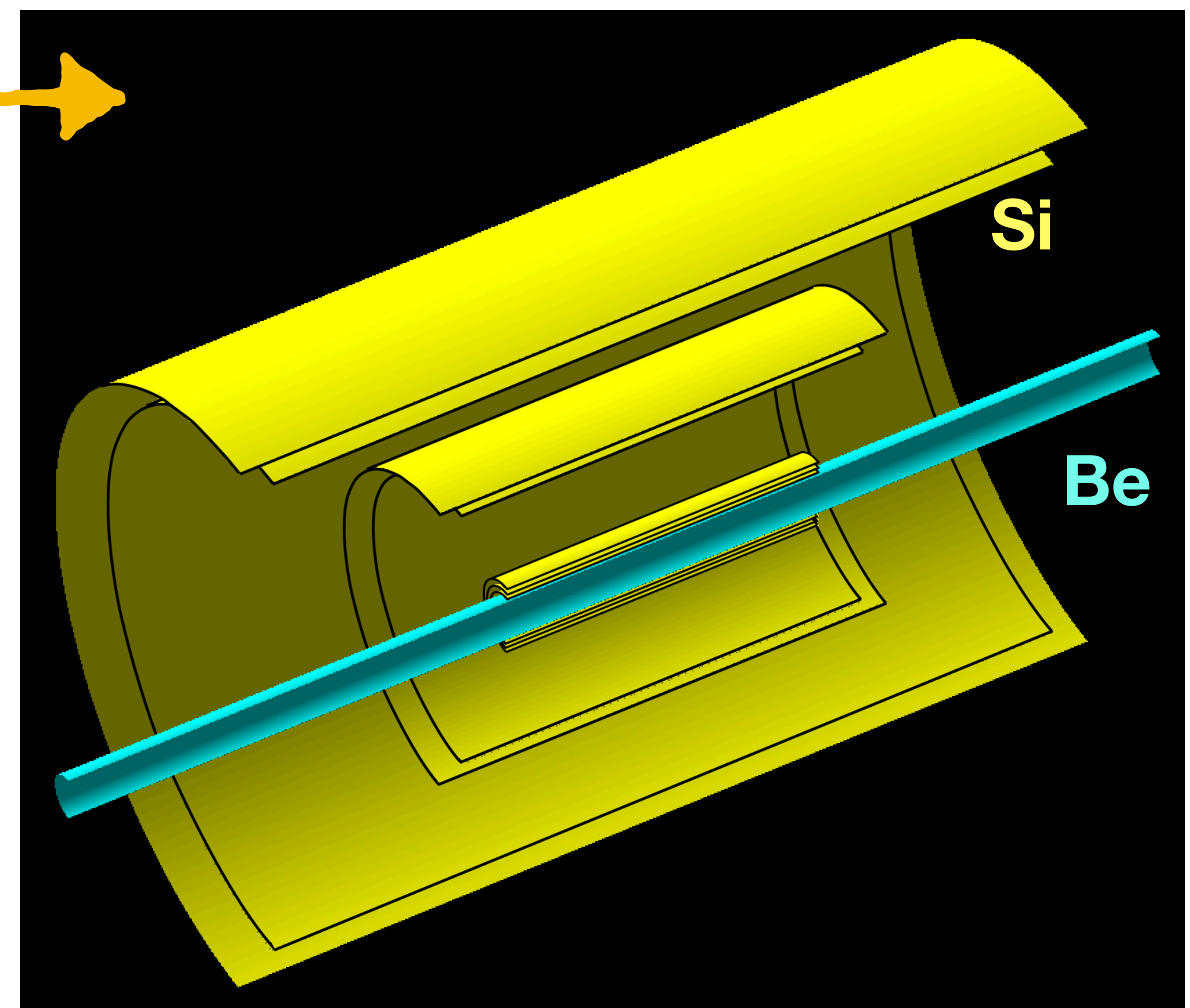
Introduction and goals

Design of optimal vertexing-layer configuration for All-Silicon tracker

Doing these checks with ‘standard’ All-Si tracker is costly

Solution: define simplified geometry directly in Fun4All → capture the essential features but with more flexibility to ‘tweak’ detector parameters



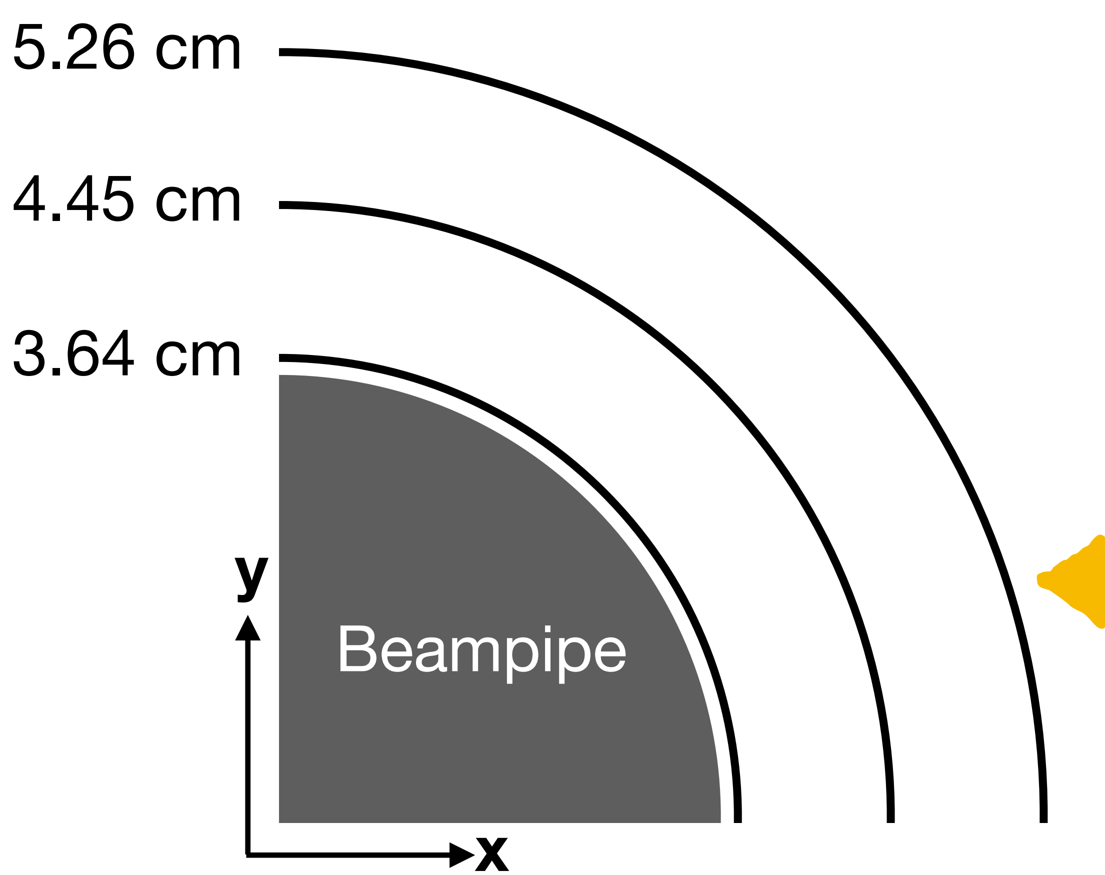


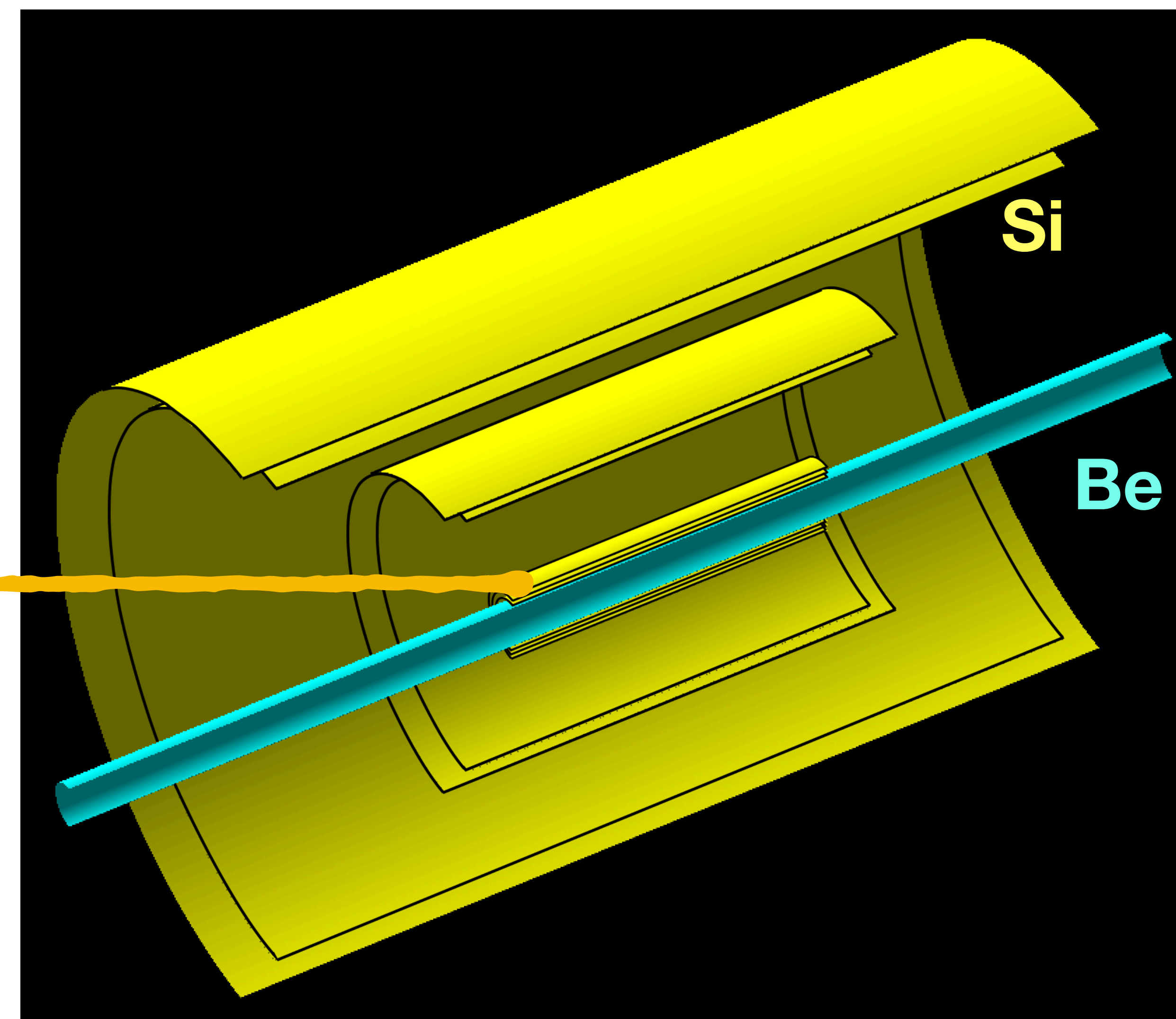
Introduction and goals

Design of optimal vertexing-layer configuration for All-Silicon tracker

Doing these checks with ‘standard’ All-Si tracker is costly

Solution: define simplified geometry directly in Fun4All → capture the essential features but with more flexibility to ‘tweak’ detector parameters





- 0.05% X/X0 -> vertexing layers
- 0.55% X/X0 -> tracking layers

Outline

1) Performance of different vertexing configurations
2) Comparison to fast simulations
3) Comparison to physics “requirements”

Outline

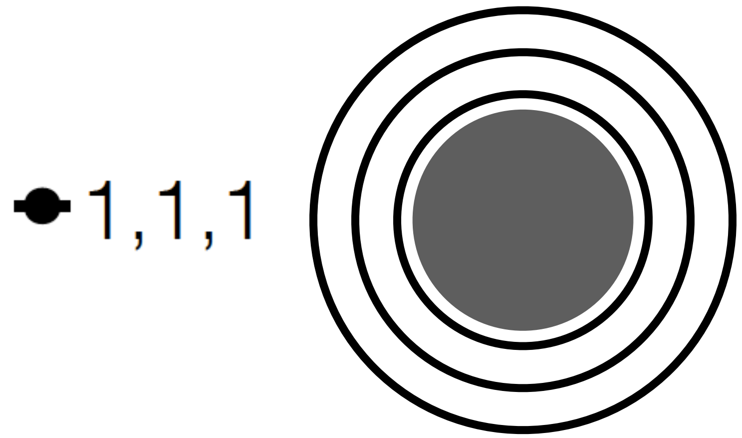
1) Performance of different vertexing configurations

2) Comparison to fast simulations

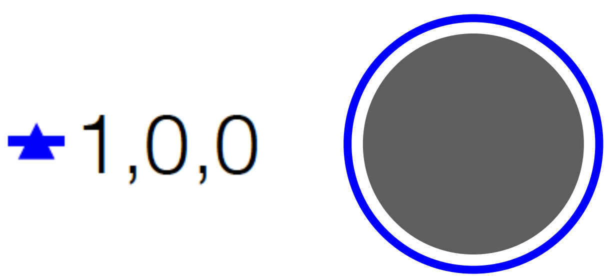
3) Comparison to physics “requirements”

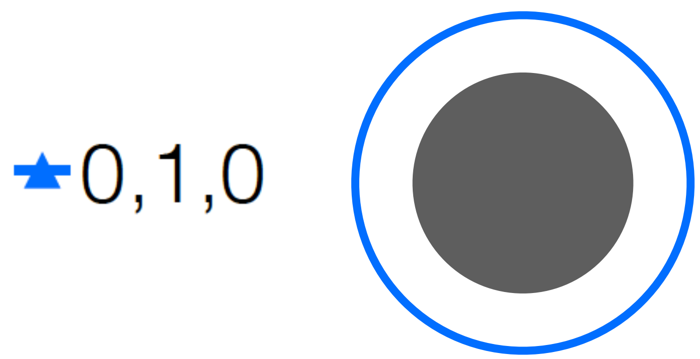
$2^3 - 1$ possible vertexing combinations

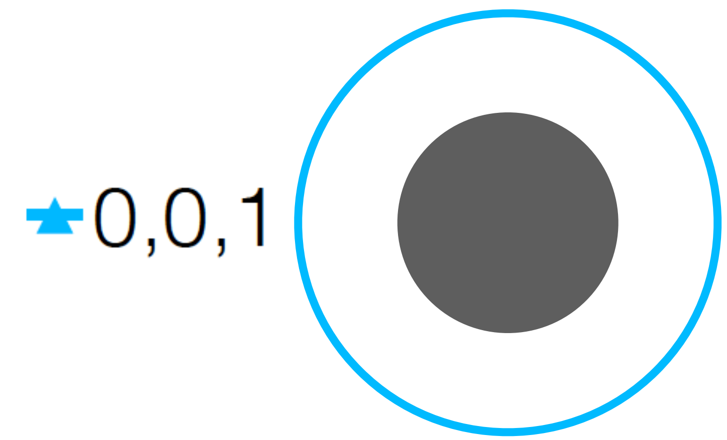
Three vtx layer turned on:



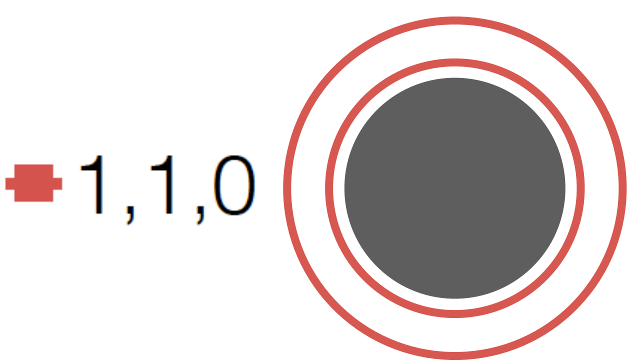
One vtx layer turned on:

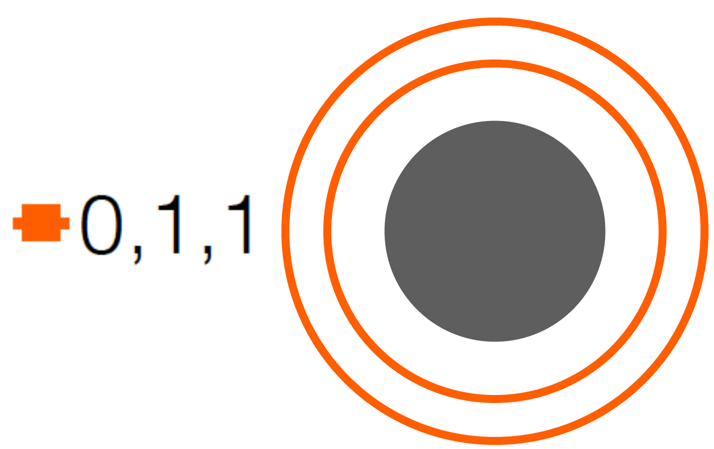


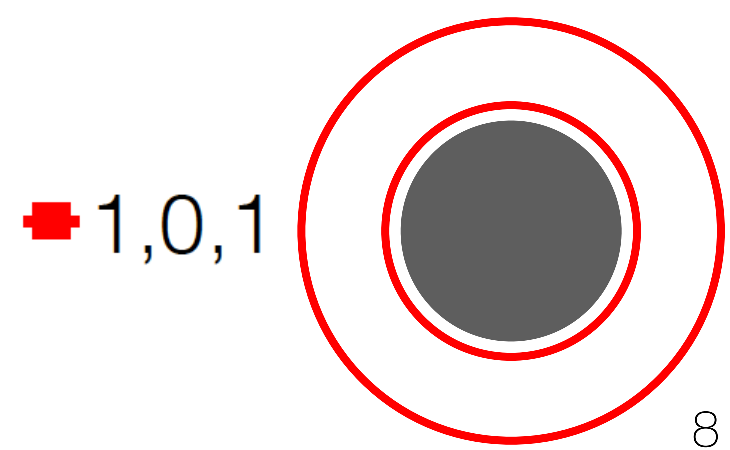


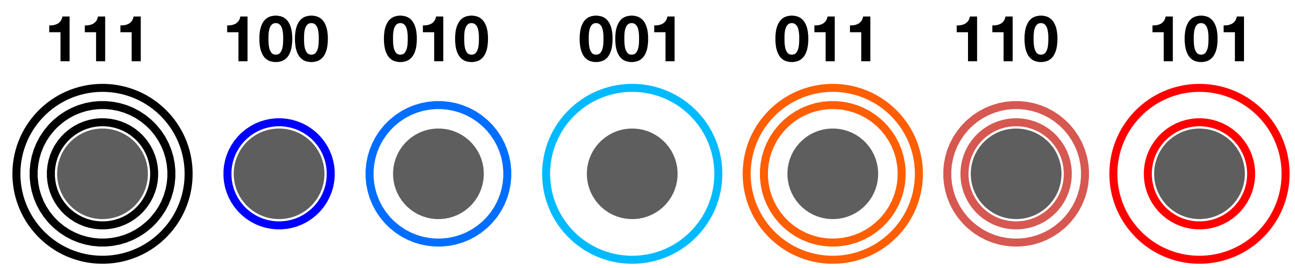


Two vtx layers turned on:

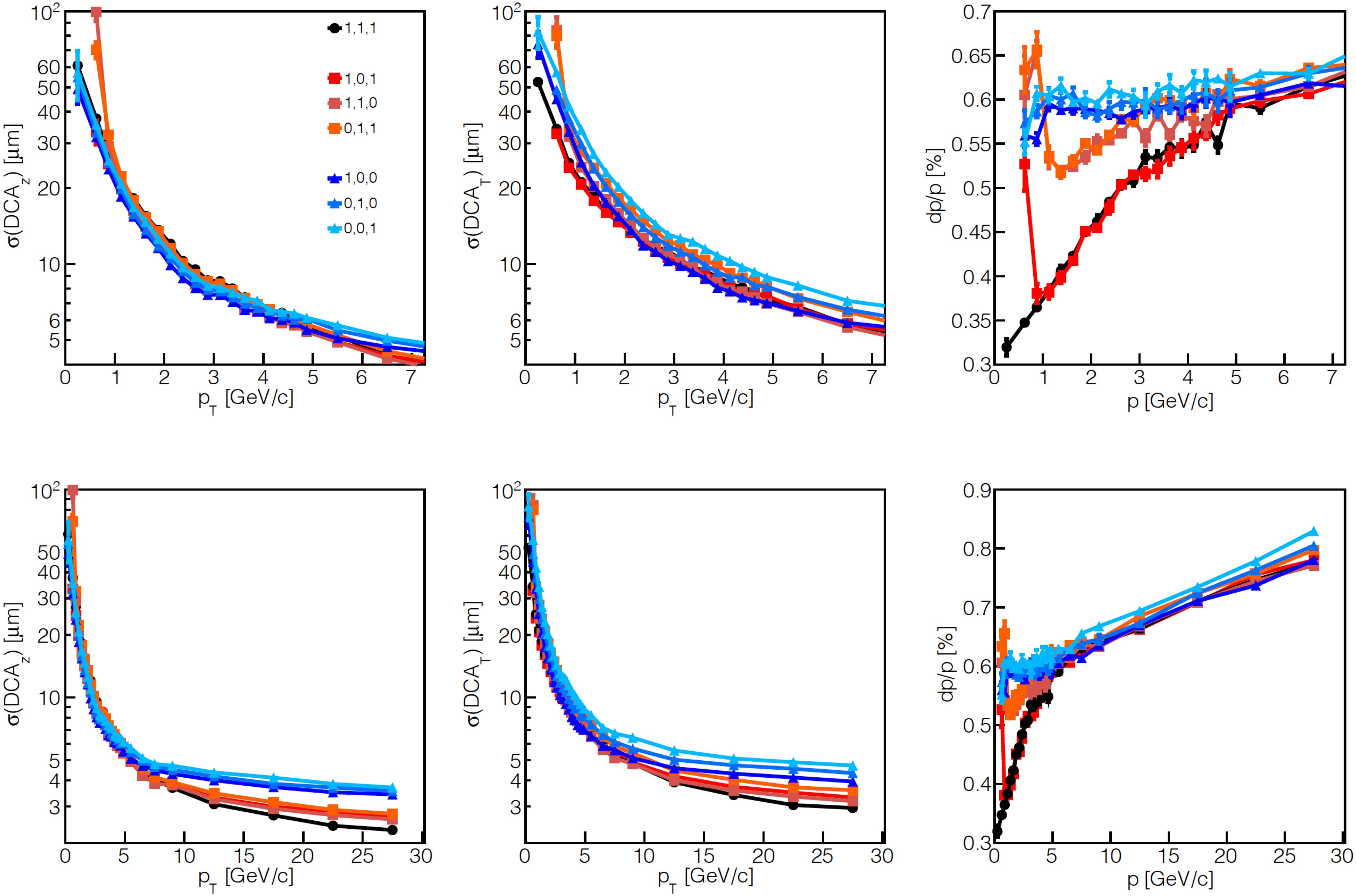


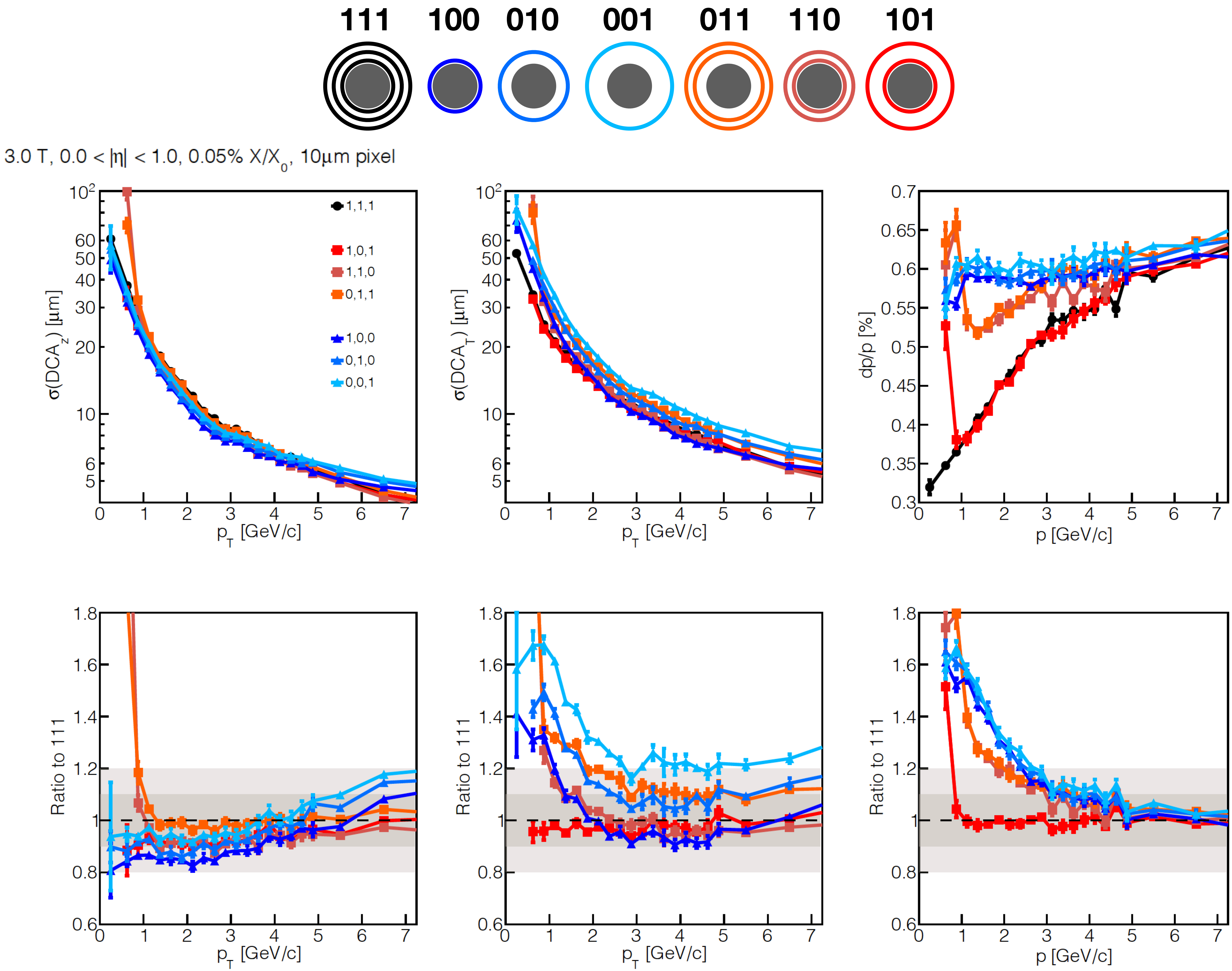






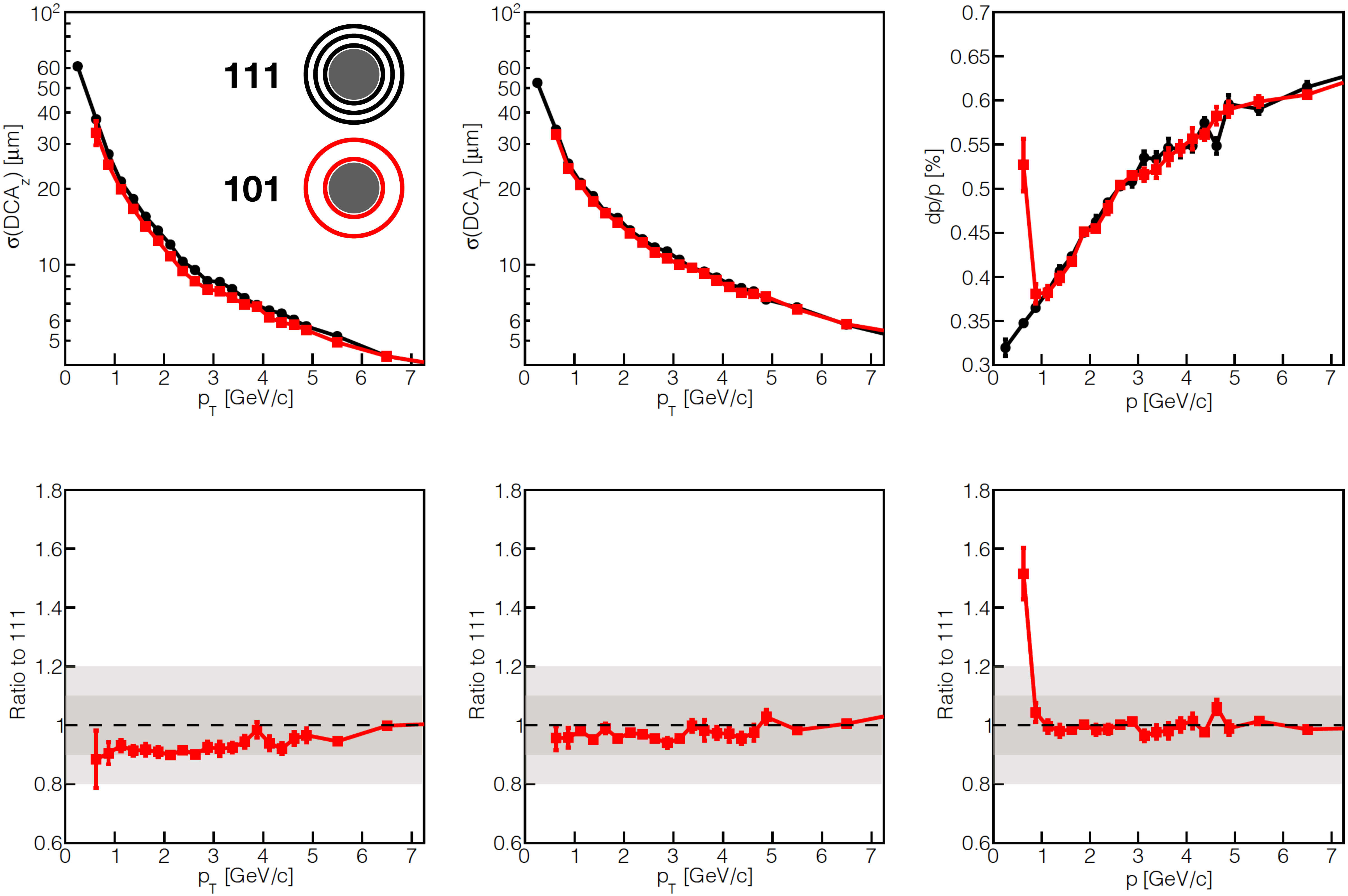
3.0 T, $0.0 < |\eta| < 1.0$, 0.05% X/X_0, 10μm pixel




111
100
010
001
011
110
101
3.0 T, 0.0 < |η| < 1.0, 0.05% X/X0, 10μm pixel
1,1,1
1,0,1
1,1,0
0,1,1
1,0,0
0,1,0
0,0,1
σ(DCAz) [μm]
σ(DCAT) [μm]
dp/p [%]
Ratio to 111
pT [GeV/c]
p [GeV/c]

Main configurations:

3.0 T, $0.0 < |\eta| < 1.0$, 0.05% X/X_0, 10μm pixel

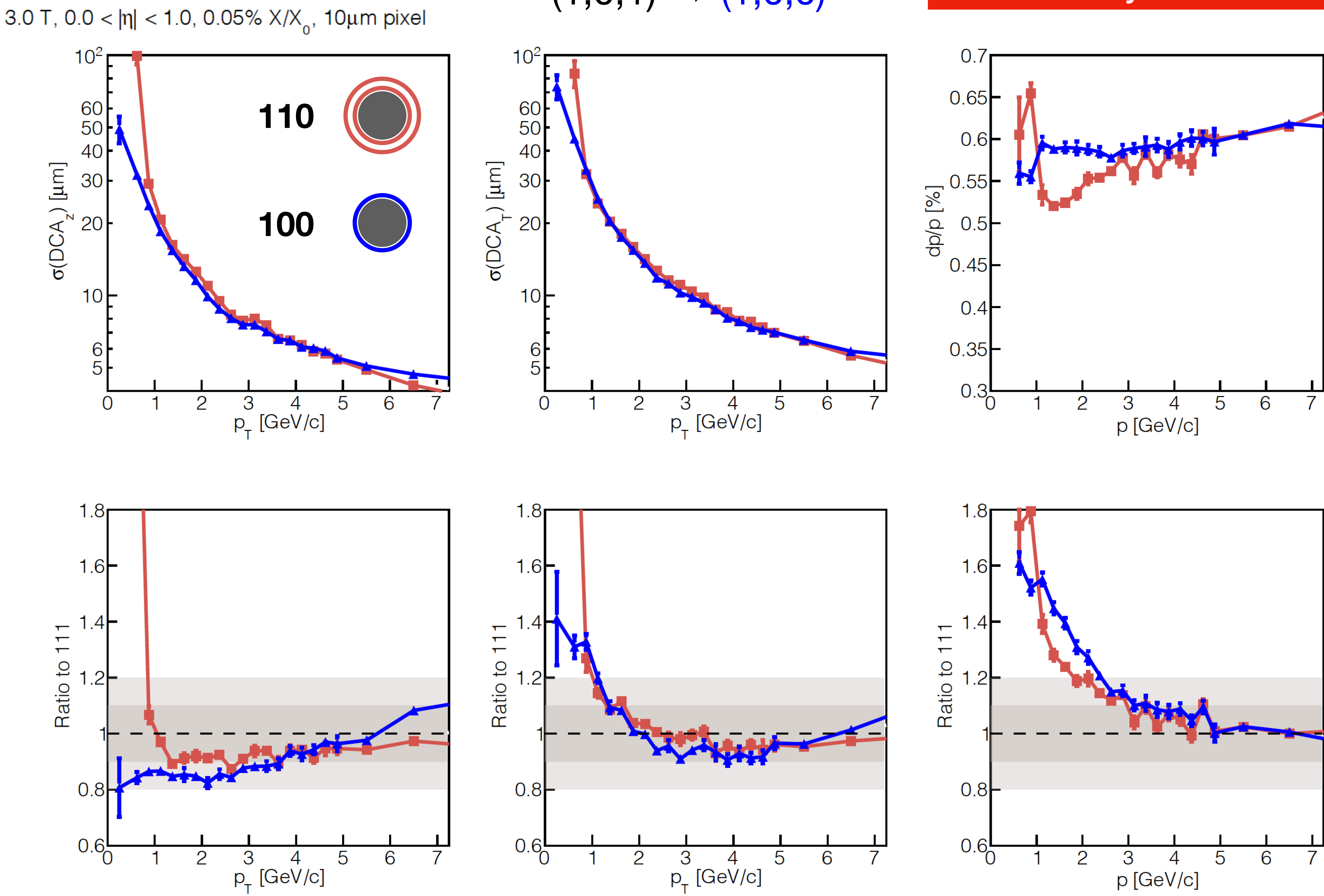


If the **outer** layer fails:

(1,1,1) → (1,1,0)

(1,0,1) → (1,0,0)

* layers "turned off" are actually removed

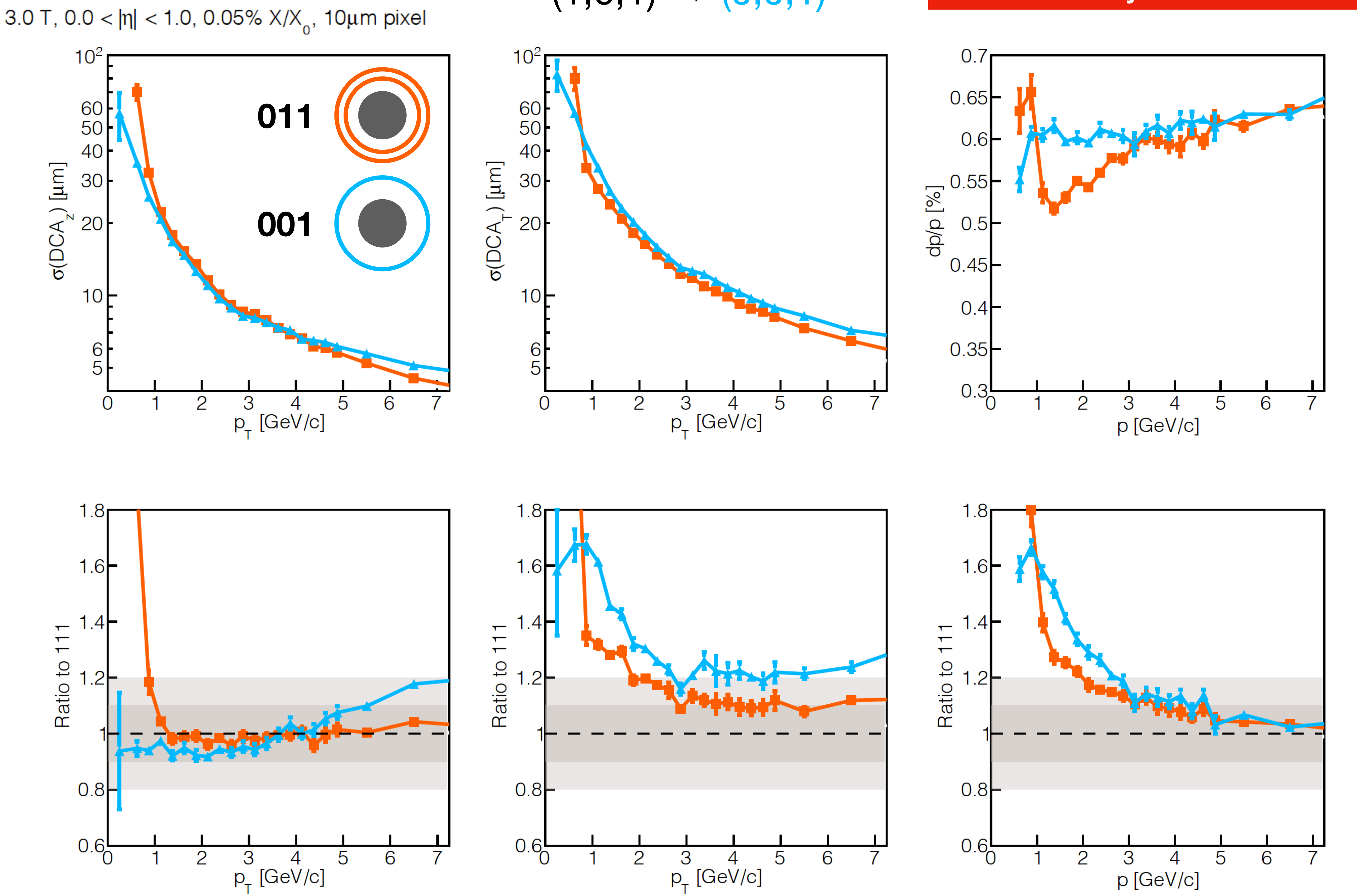


If the **inner** layer fails:

(1,1,1) → (0,1,1)

(1,0,1) → (0,0,1)

* layers "turned off" are actually removed



Outline

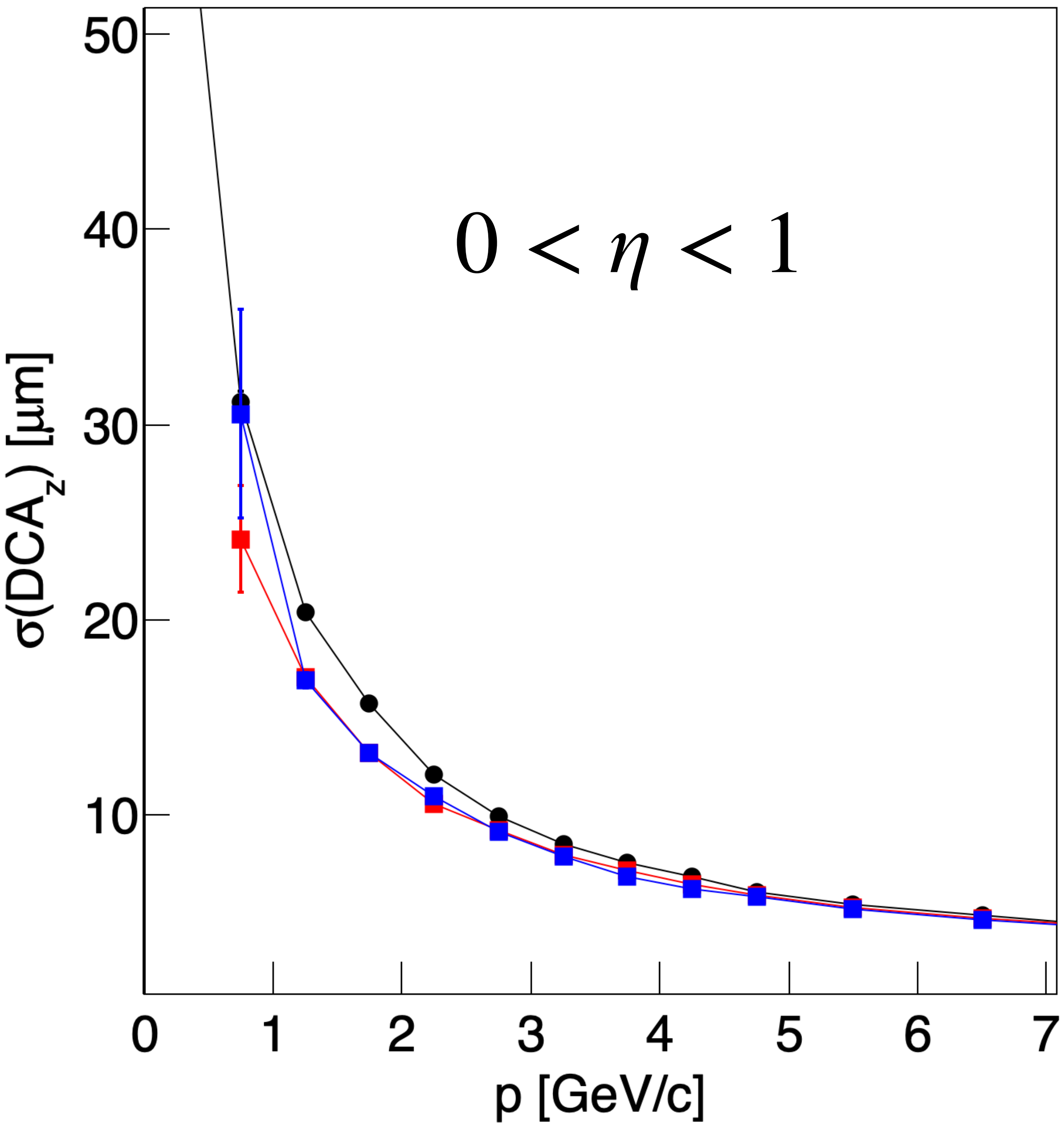
1) Performance of different vertexing configurations

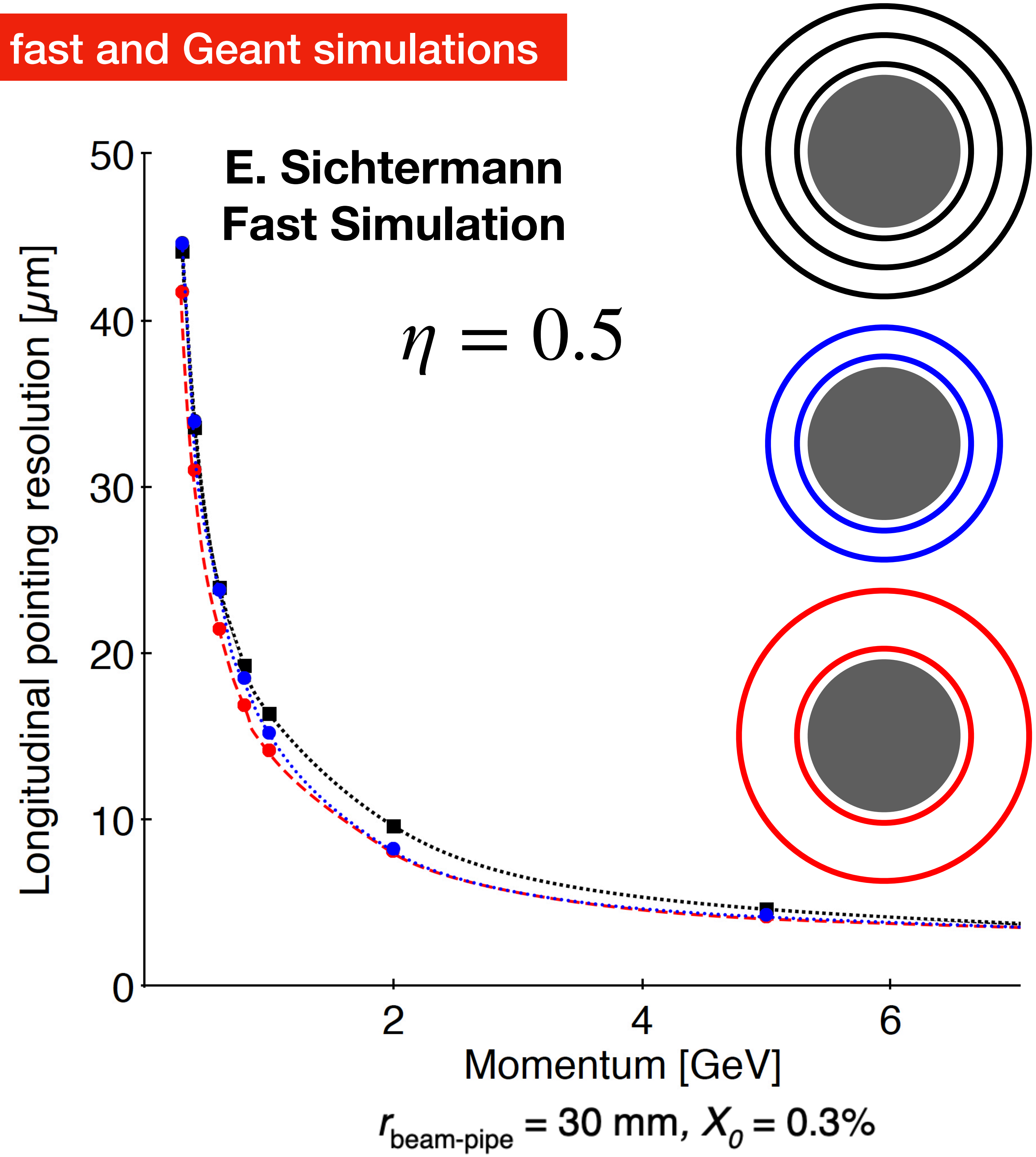
2) Comparison to fast simulations

3) Comparison to physics “requirements”

Comparison to fast simulations

Agreement between fast and Geant simulations



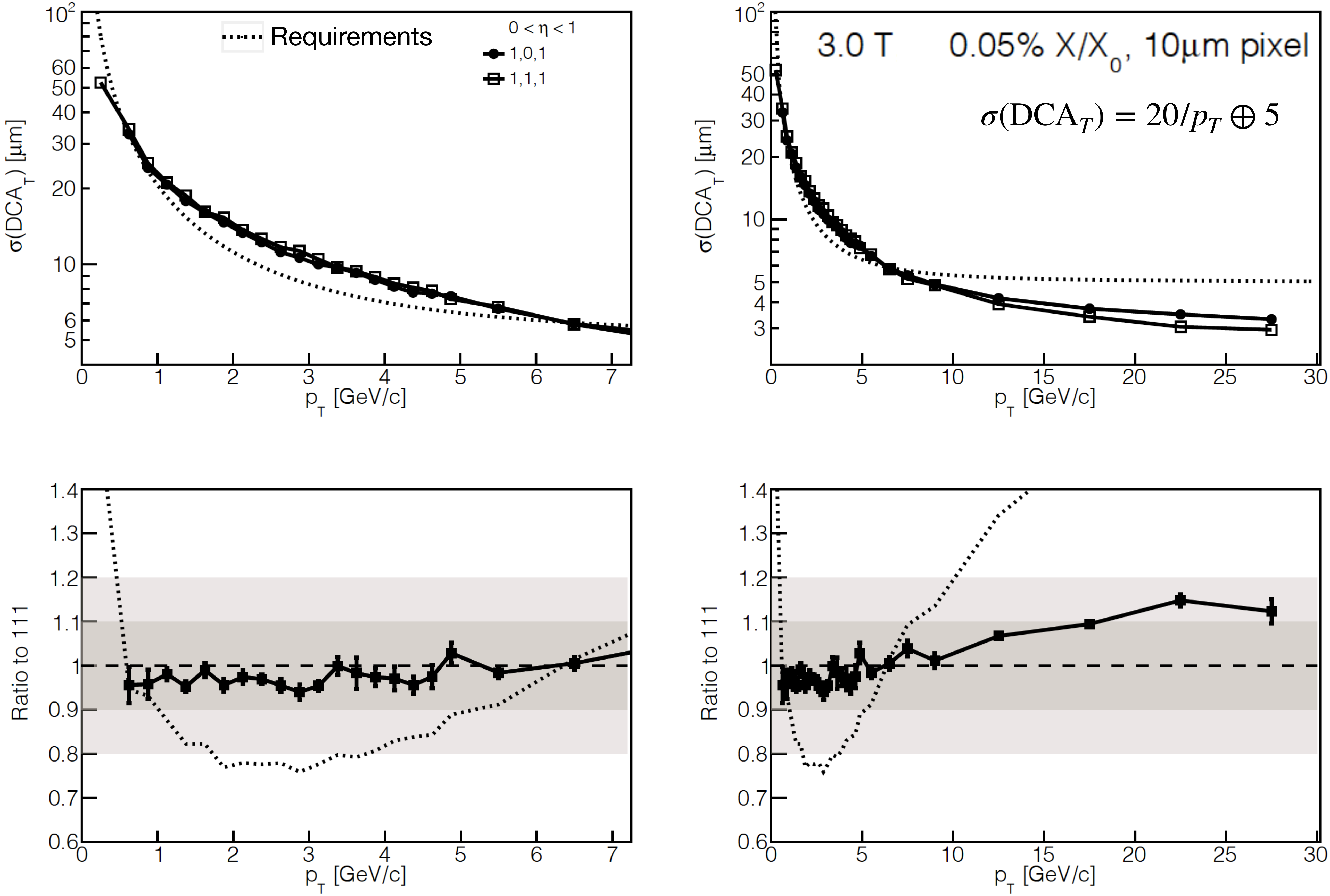


B=3.0T, $10\ \mu$m pixel, vtx 0.05% X/X$_0$, barrel 0.5% X/X$_0$

Outline

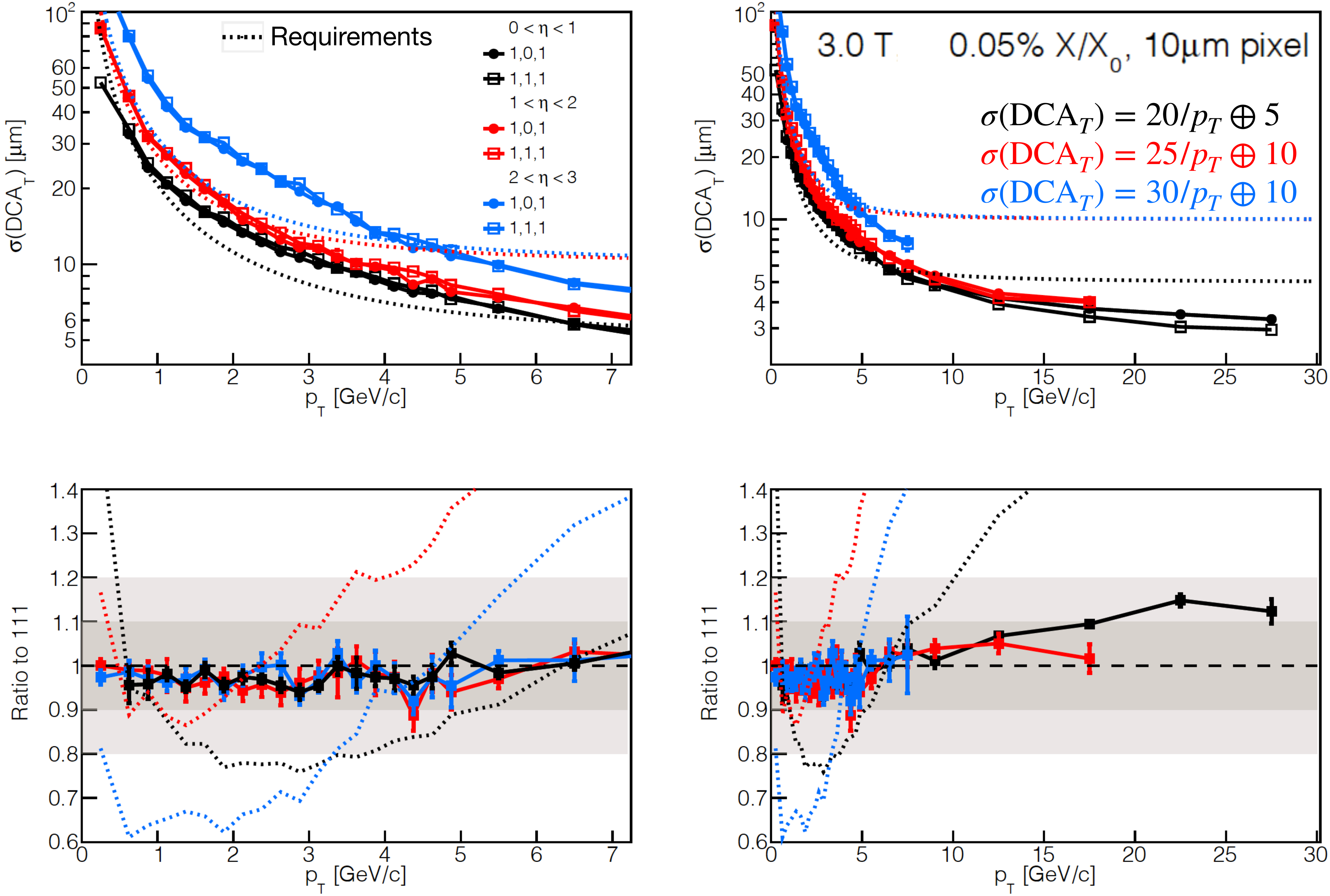
1) Performance of different vertexing configurations
2) Comparison to fast simulations
3) Comparison to physics “requirements”

Comparison to physics “requirements”



parametrizations: https://indico.bnl.gov/event/9297/

Comparison to physics "requirements"

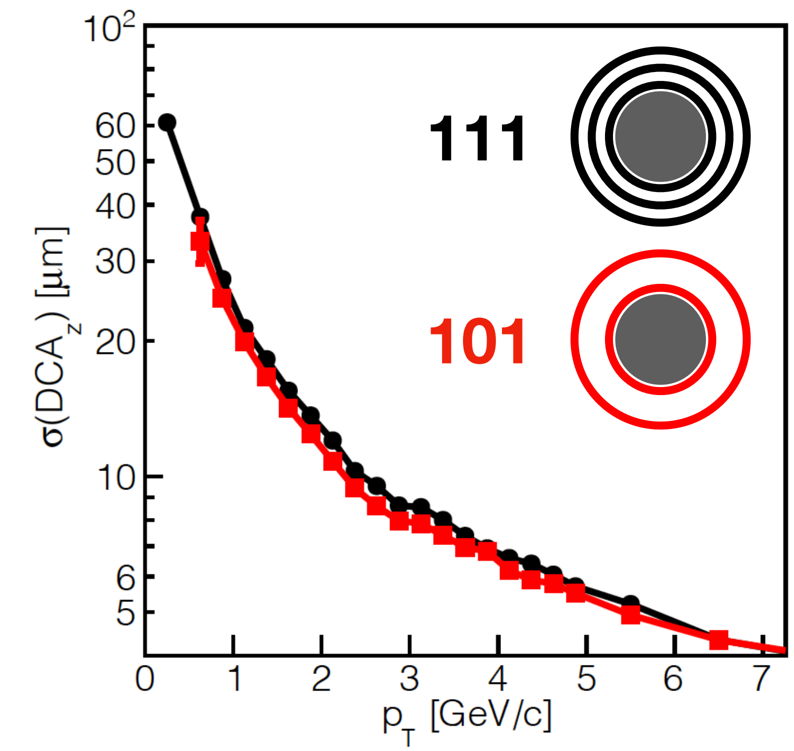


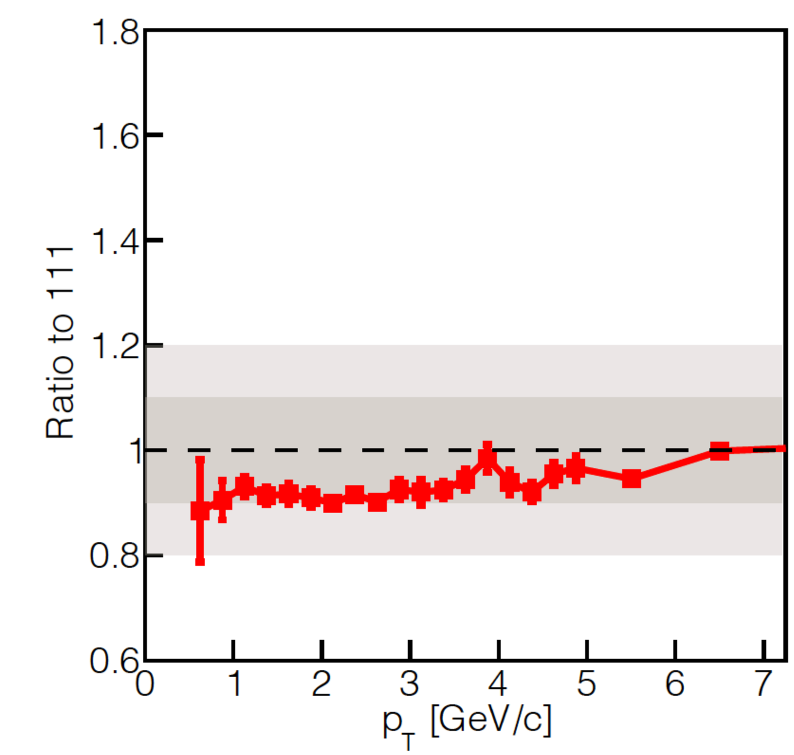
parametrizations: https://indico.bnl.gov/event/9297/

Summary and Conclusions

For $p_T < 6$ GeV/c

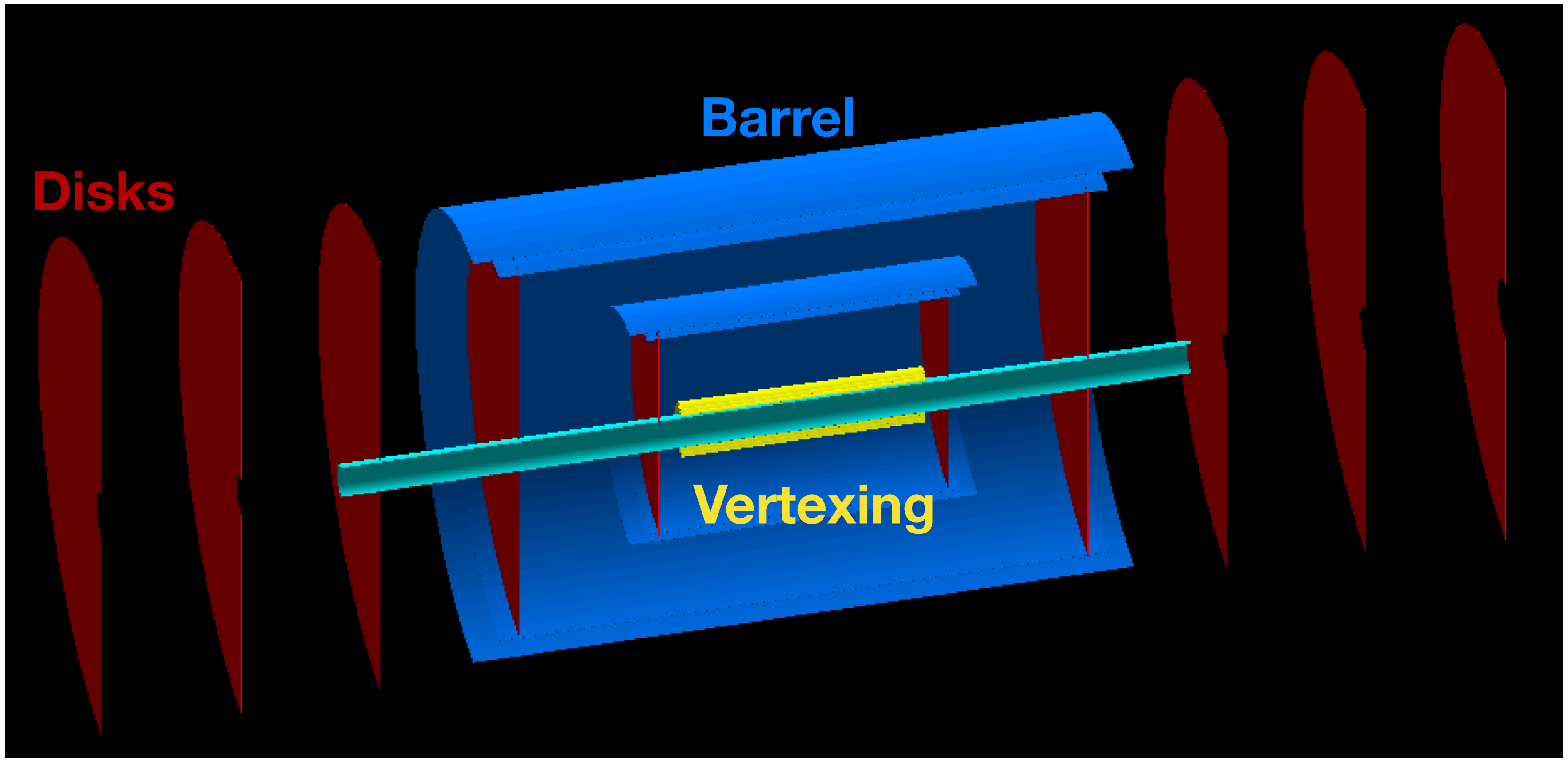
- Found small (<10%) differences between 111 and 101 configurations.
- Overall, 101 offers slightly better DCA resolutions.
- 111 only outperforms 101 when the outer layer fails (but differences are still small).
- 101 also cheaper (+less material budget)



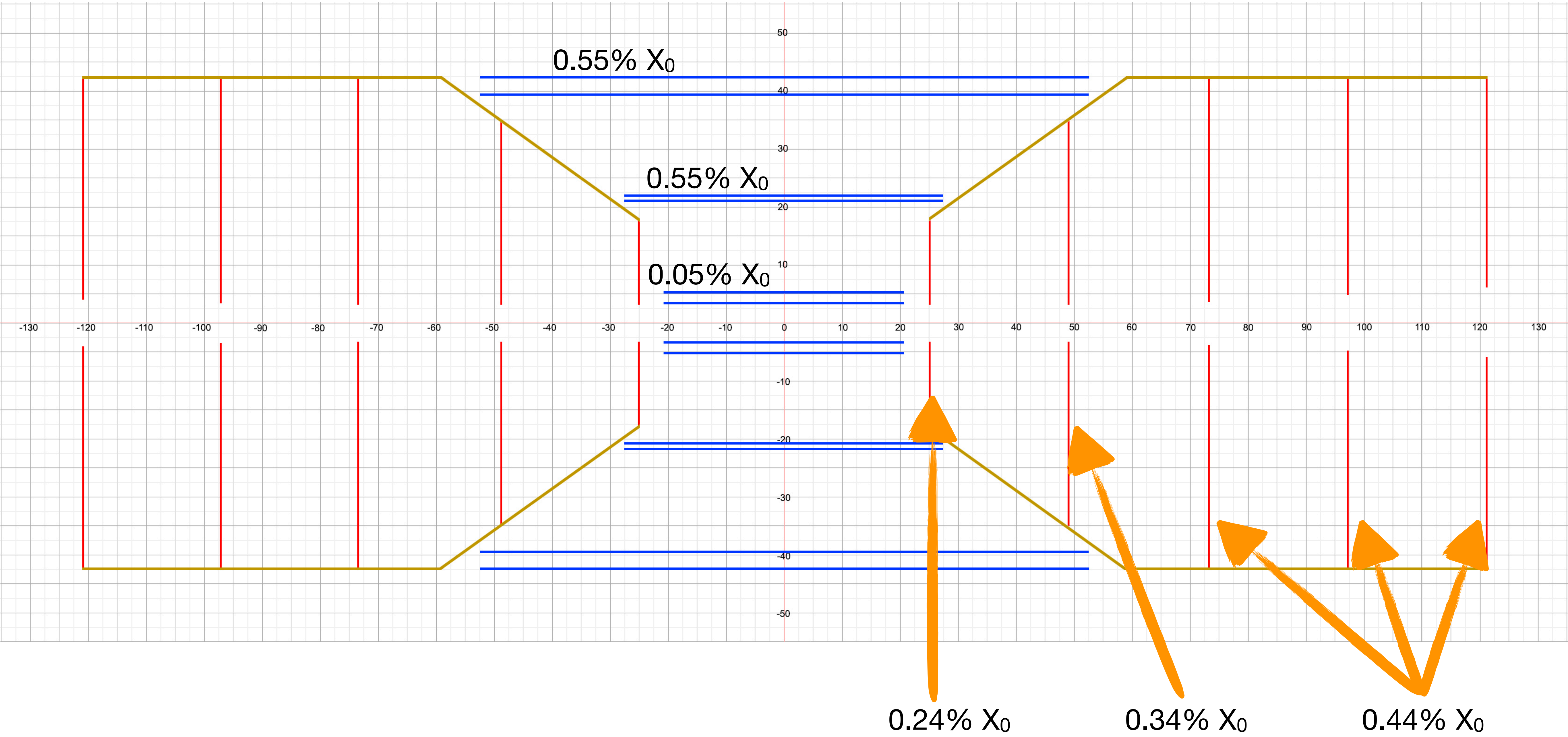


Ad: Simplified geometry

- Full all-silicon tracker geometry (except for aluminum support structure) implemented in Fun4All.
- Easily modifiable
- Each layer is made of Si (scaled to the appropriate material budget)



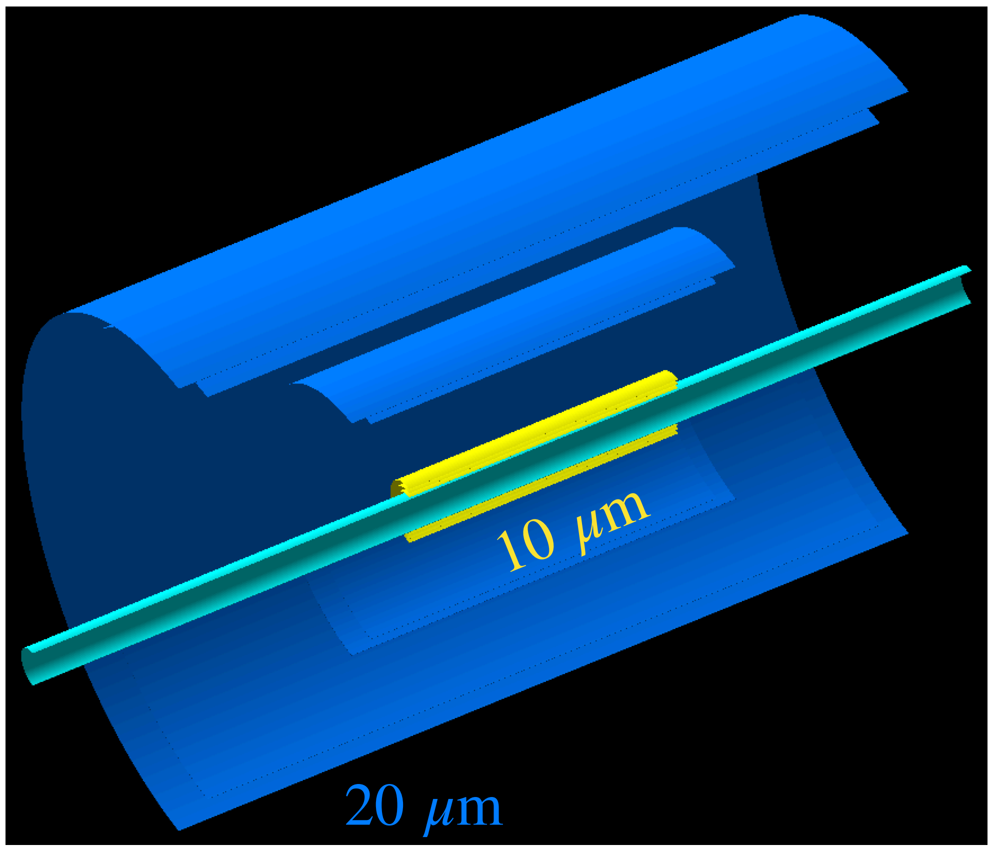
Proposed detector baseline



Backup

Effect of misalignment on vertexing

Added capability to have different pixel sizes in different layers to study effect of outer-layer misalignments



No significant differences found (consistent with fast simulations)