Optimizing tracker with wires taken into account

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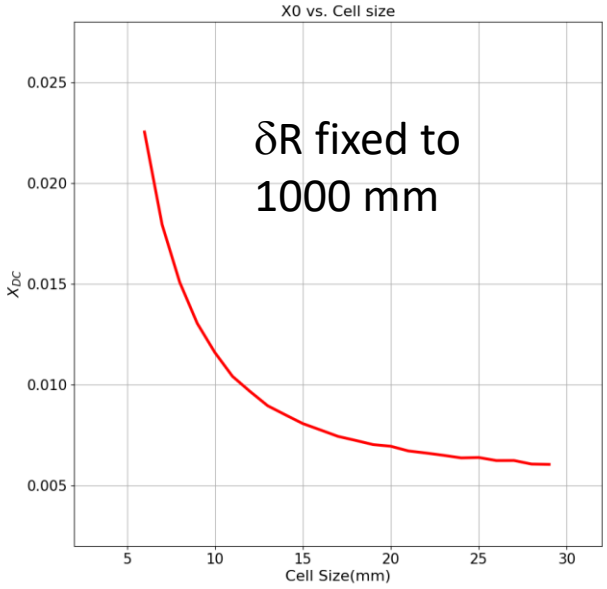
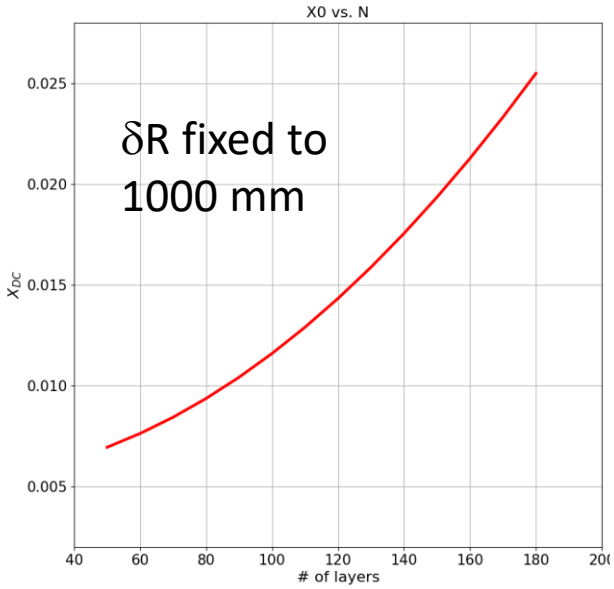
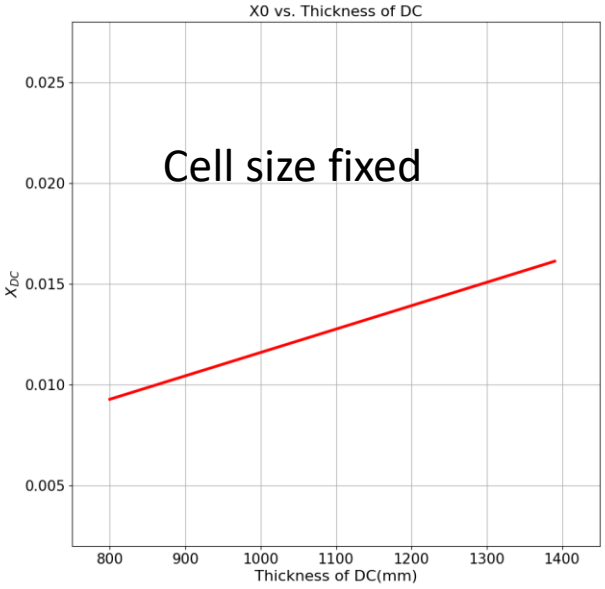
Sep. 17th, 2021

Total X of DC changing according to cell size, # of layers, and the thickness of DC

- 1000 mm gas : 0.0054%
- Wires (1+3) of a 10x10mm cell: 0.0062%







Update DC materials according to Mingyi's numbers

Sub detector	# layers	R (mm)	Resolustion (μm)		Material (%X_0)
			r-φ	z	
Beam pipe	1	14(10)	---	---	0.15
VXD	6		2.8 / 6 / 4 / 4 / 4 / 4	2.8 / 6 / 4 / 4 / 4 / 4	0.15 per layer
VXD shell	1	65	---	---	0.15
SIT	4	TBD	7.2	86.6	0.65 per layer
DC inner wall	1	TBD	---	---	0.104
DC (cell 1x1cm^2)	100	TBD	100	2000	0.0116 per layer
DC outer wall	1	1805	--	---	1.346
SET	1	1810	7.2	86.6	0.65
Total	115	---	---	---	7.06

Total X0 > 7%
(5.35%)

Calculation tool

- Formulae in NIM A 910 (2018) 127–132

$$\mathbf{C}_a = (\mathbf{G}^T \mathbf{R}^{-1} \mathbf{G})^{-1}$$

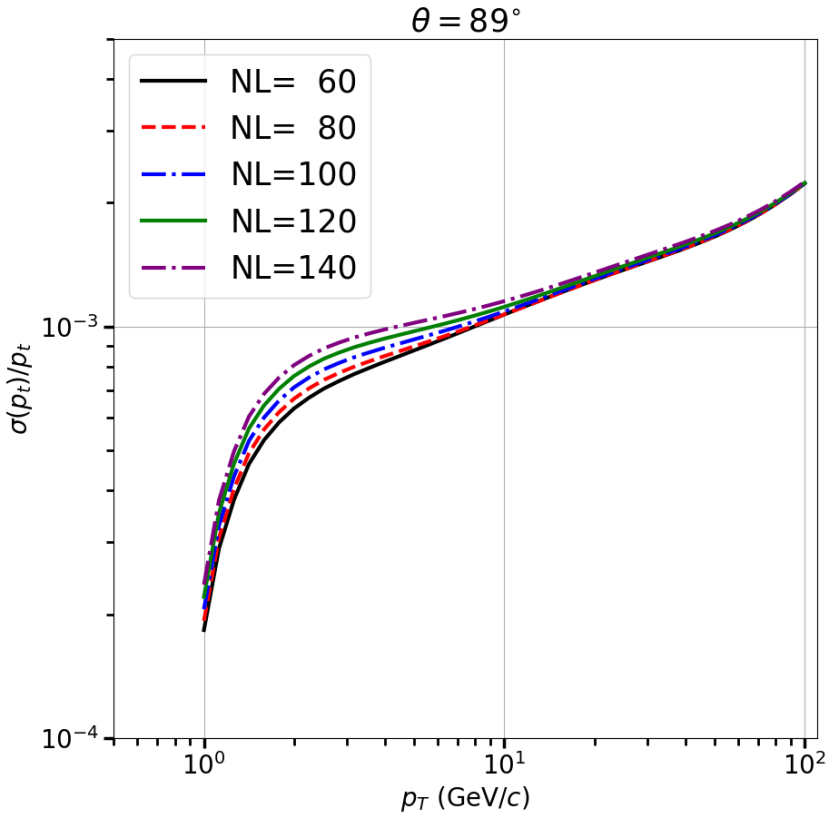
  - Helix model
  - Error matrix built from the resolutions and materials
  - Derivatives calculated with AutoGrad in PyTorch
  - Matrix manipulated by numpy

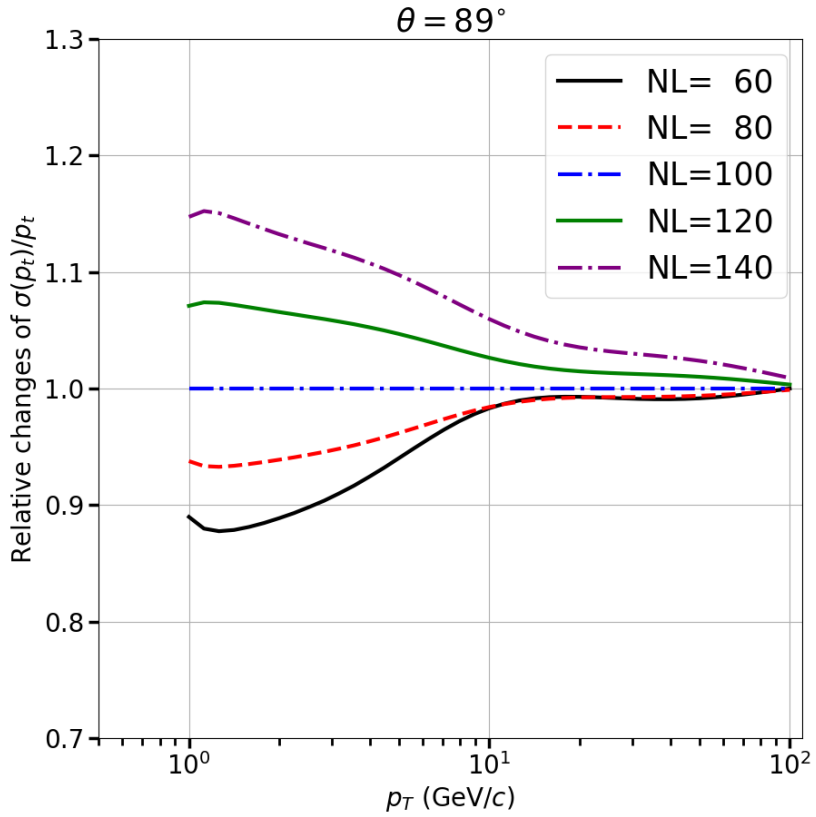
Pt

Fixing δR = 1000 mm, changing # of layers

Equivalent to changing cell size

Takes 100 layers as reference



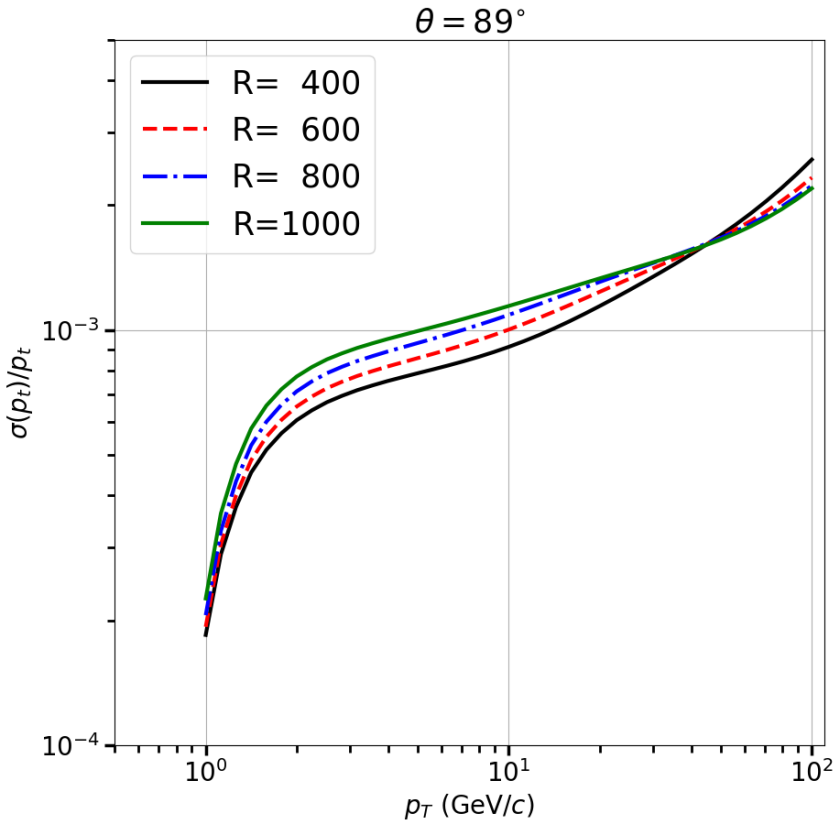


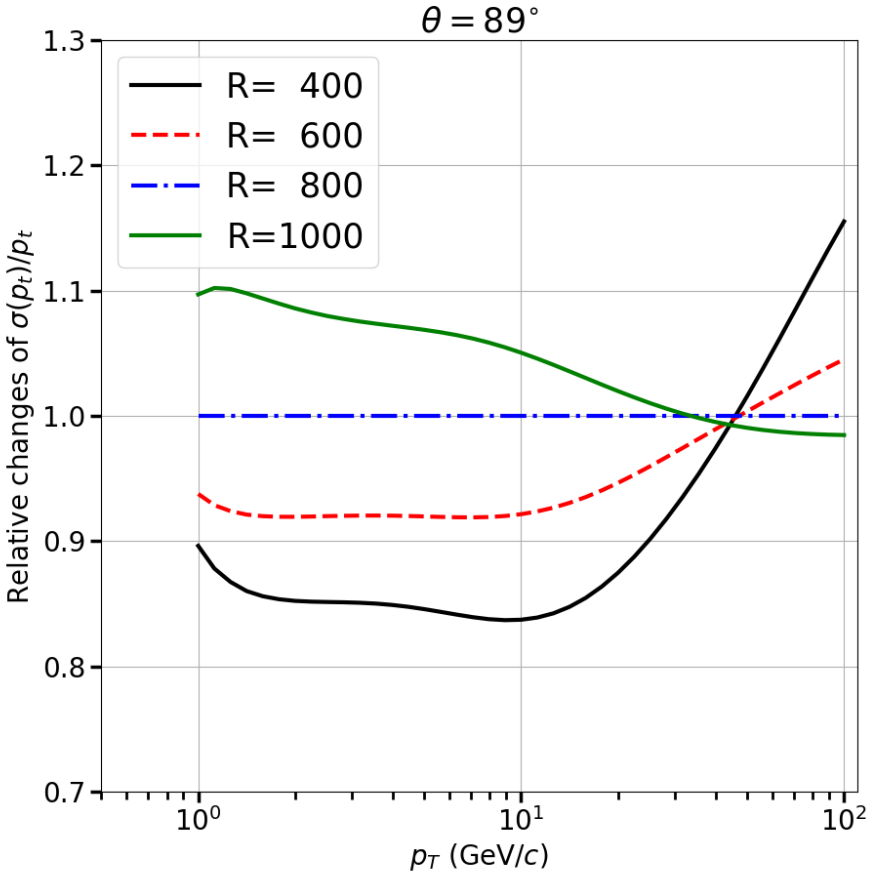
Pt

Changing Rin with fixed # of layers = 100

Larger DC volume and larger cell size

Takes 800 mm (1000mm thick) as the reference

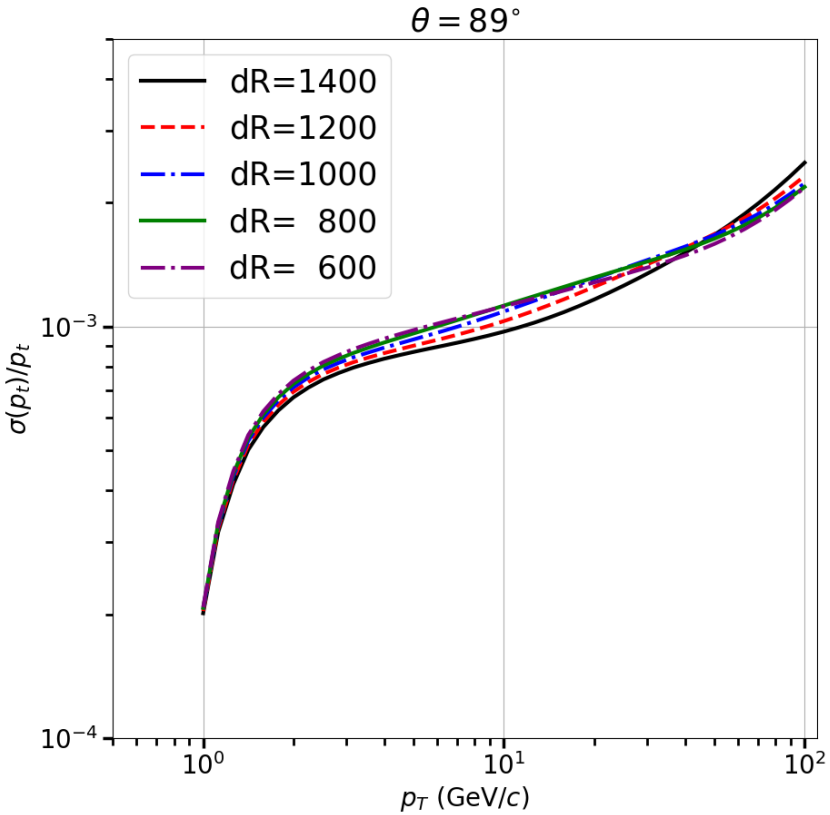


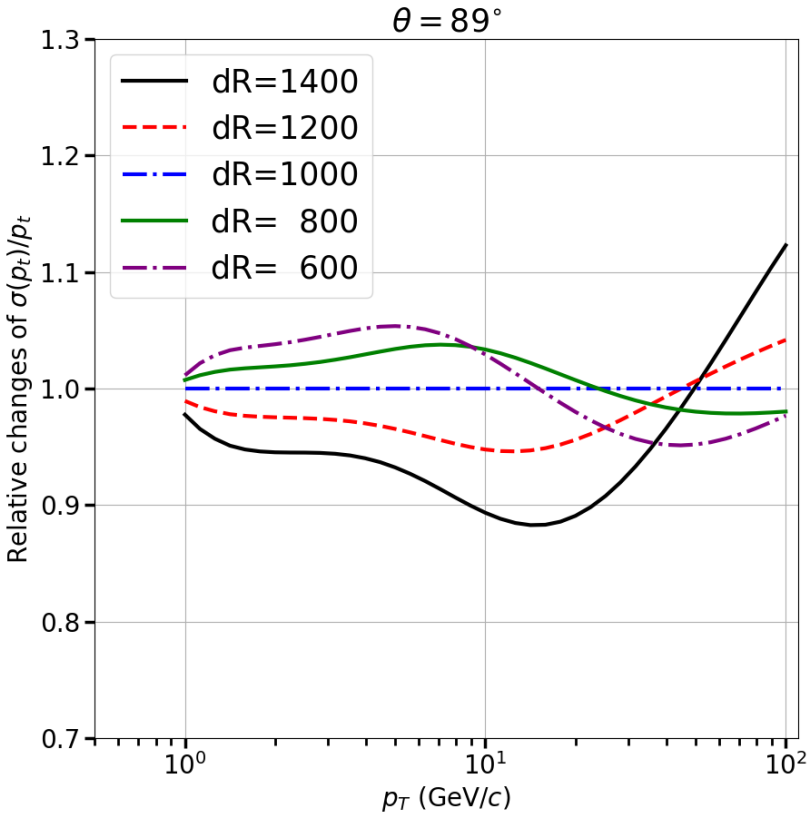


Pt

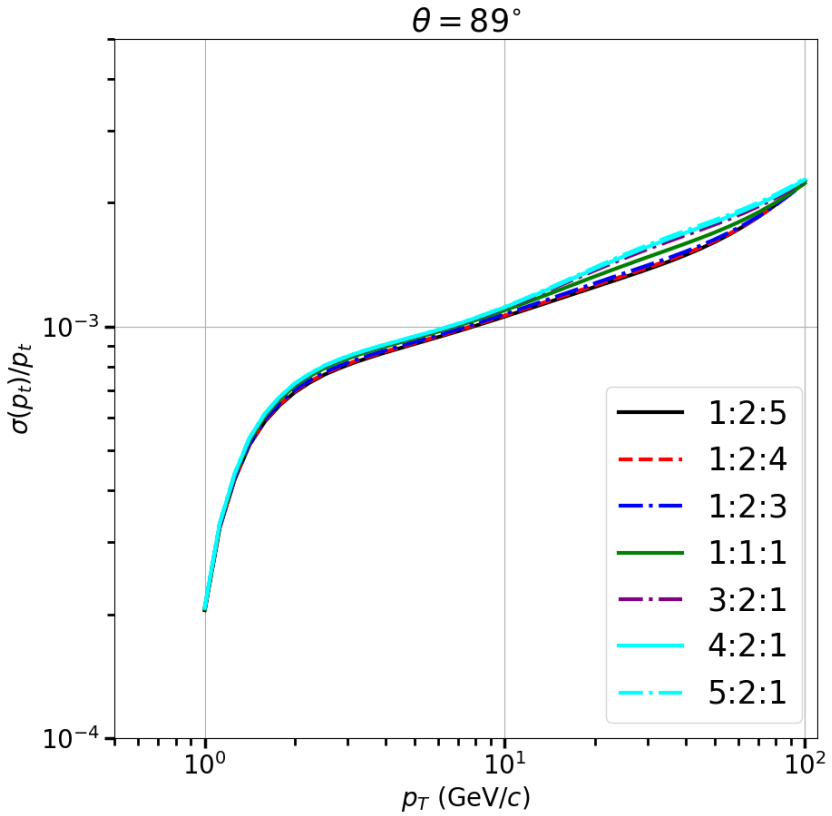
Changing Rin with cell size fixed to 10 mm

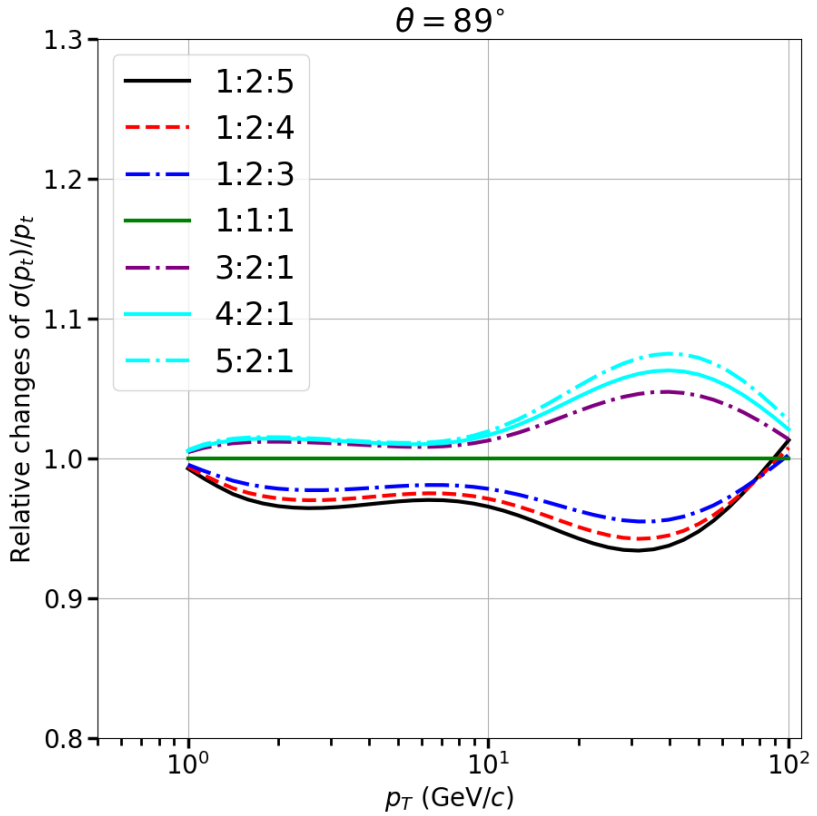
Takes 800 mm(1000 mm thick DC) as reference



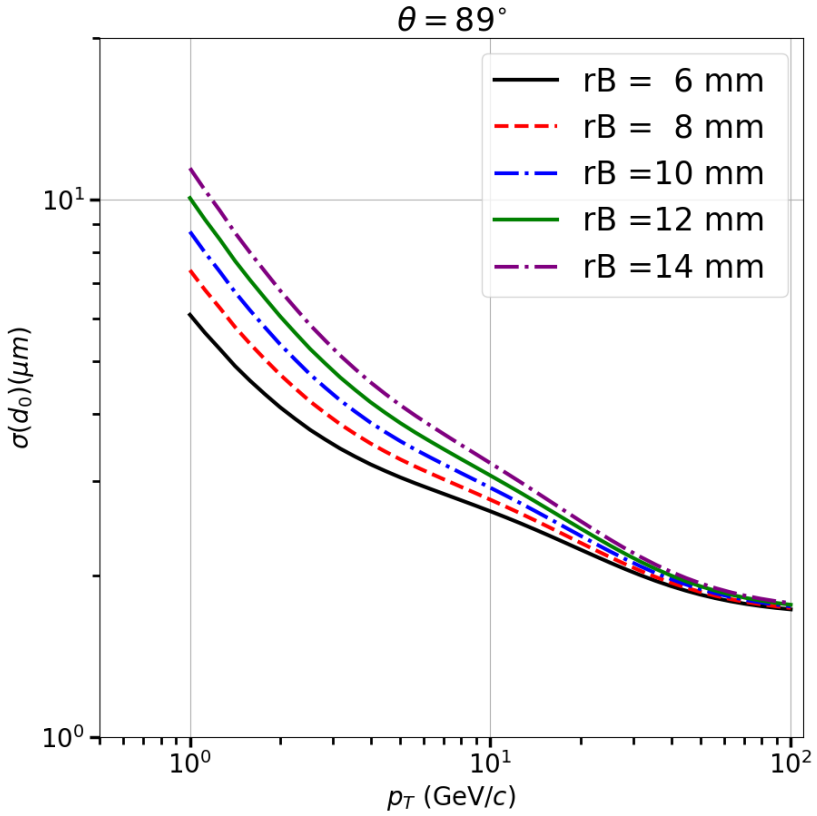


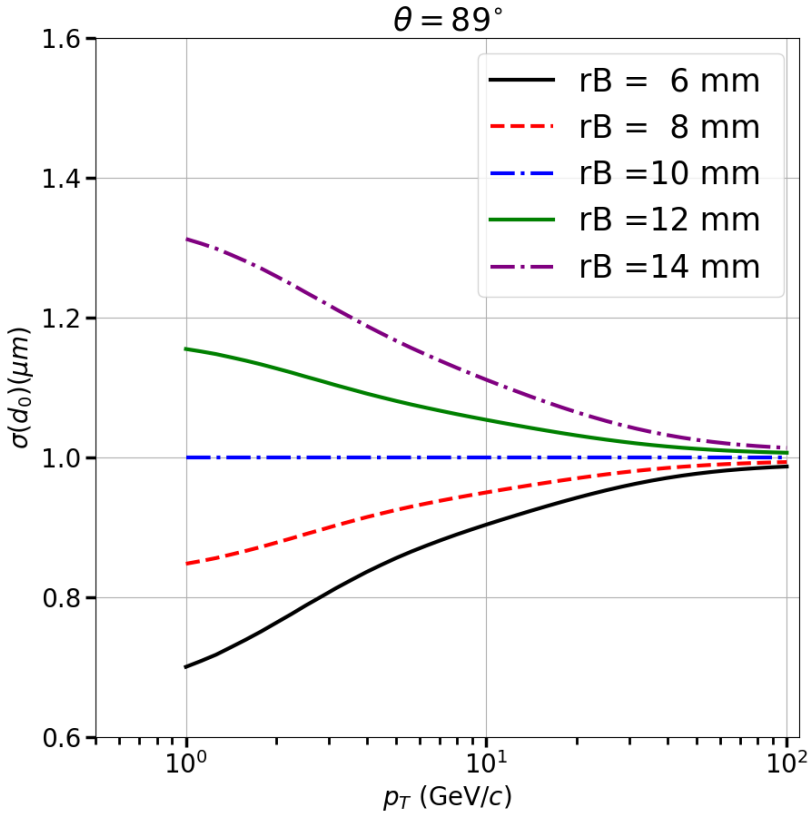
Pt
Spaces of SIT layers
Takes equal space as reference





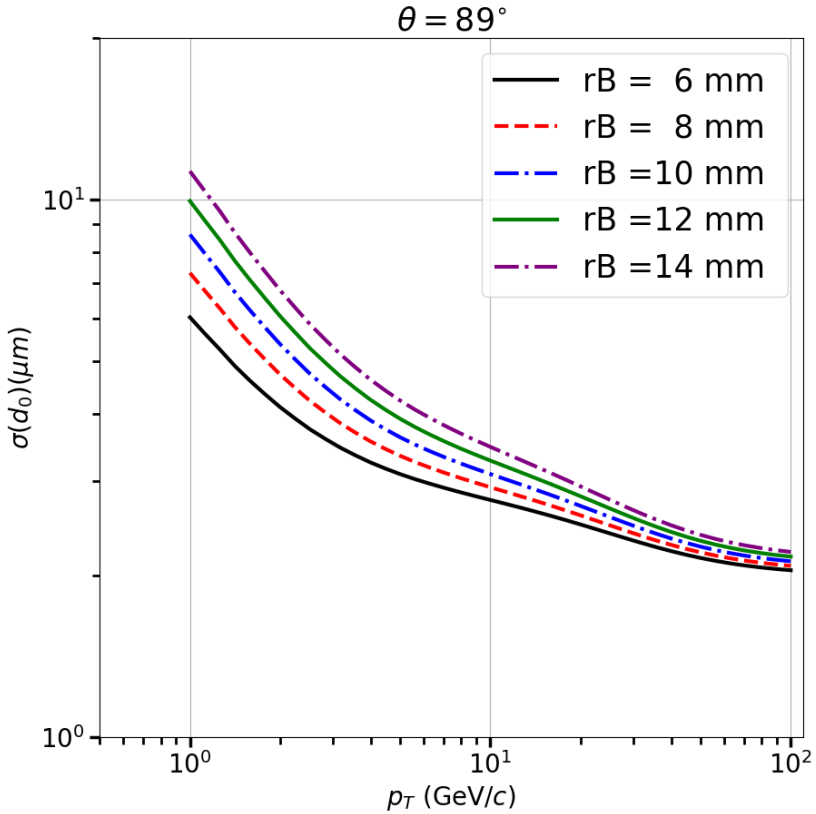
d_0
Change the radius of beam pipe
Takes 10mm as the reference

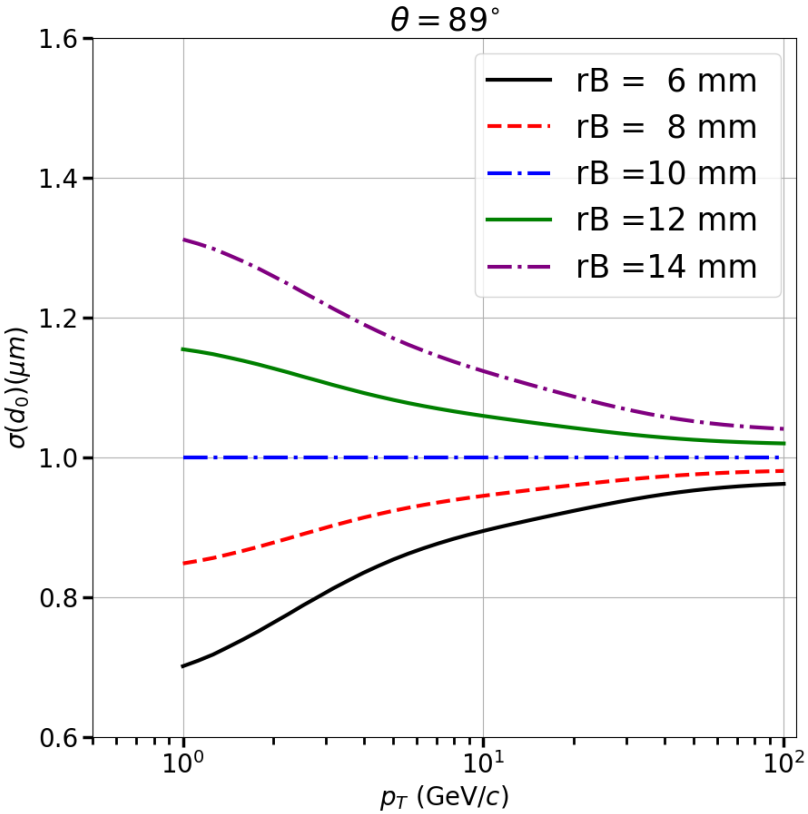




The 1st layer pixel is at 12 mm: 4/12 = 33%

z_0
Change the radius of beam pipe
Takes 10mm as the reference



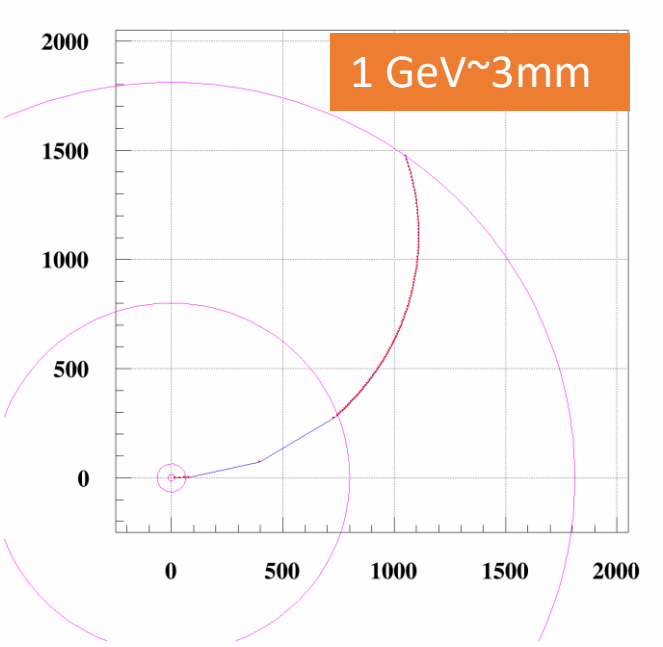


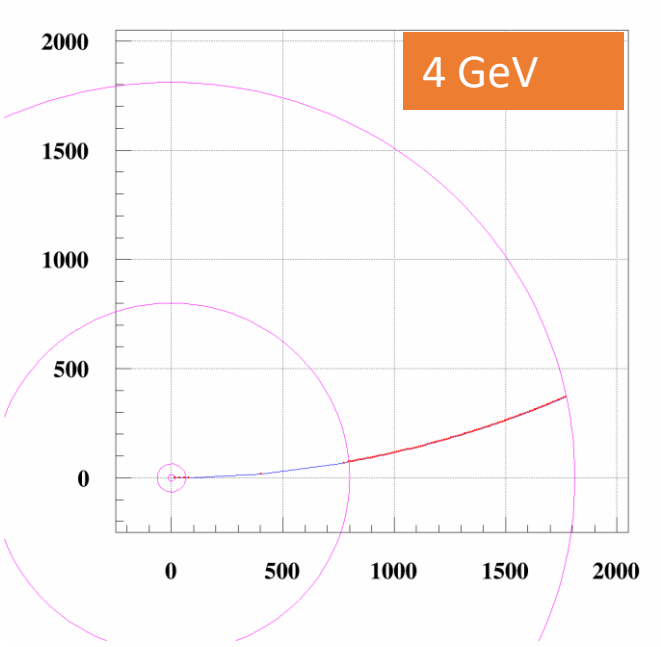
The 1st layer pixel is at 12 mm: 4/12 = 33%

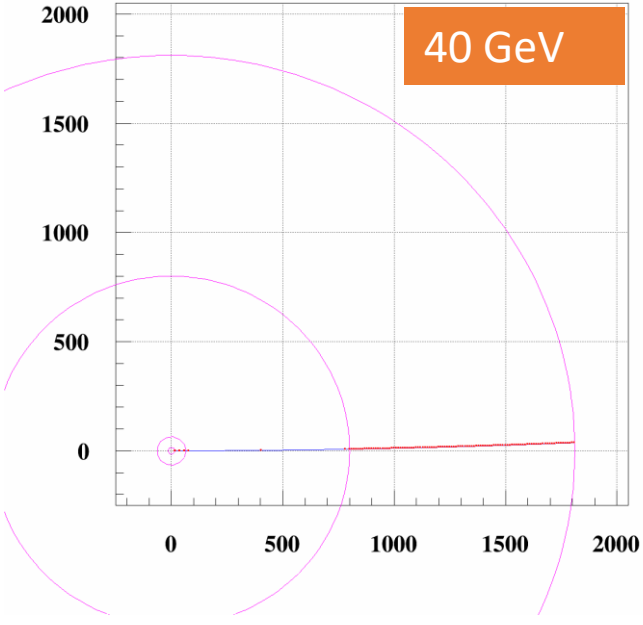
Summary

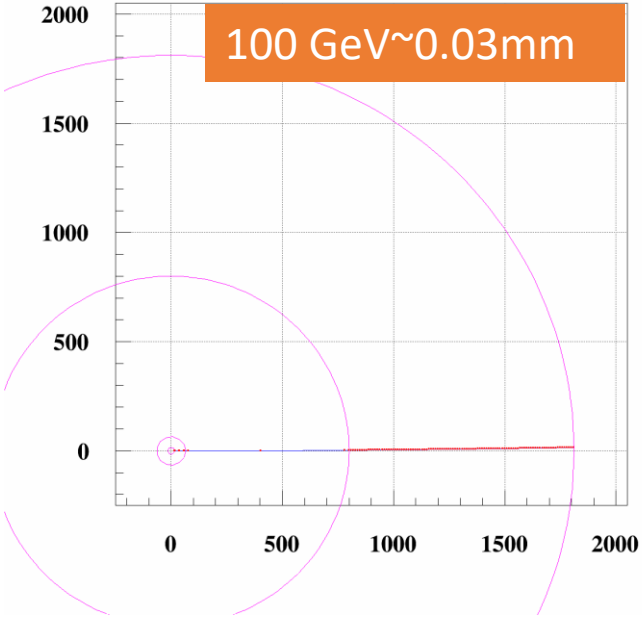
- Update barrel tracker layout with fast calculation, favors
  - Less number of layers of DC to save materials
  - SIT to inward
  - Bigger DC volume
  - Smaller beam pipe will benefit to impact parameters
- To be checked with other simulation tools

Tracks and spatial spread due to MS

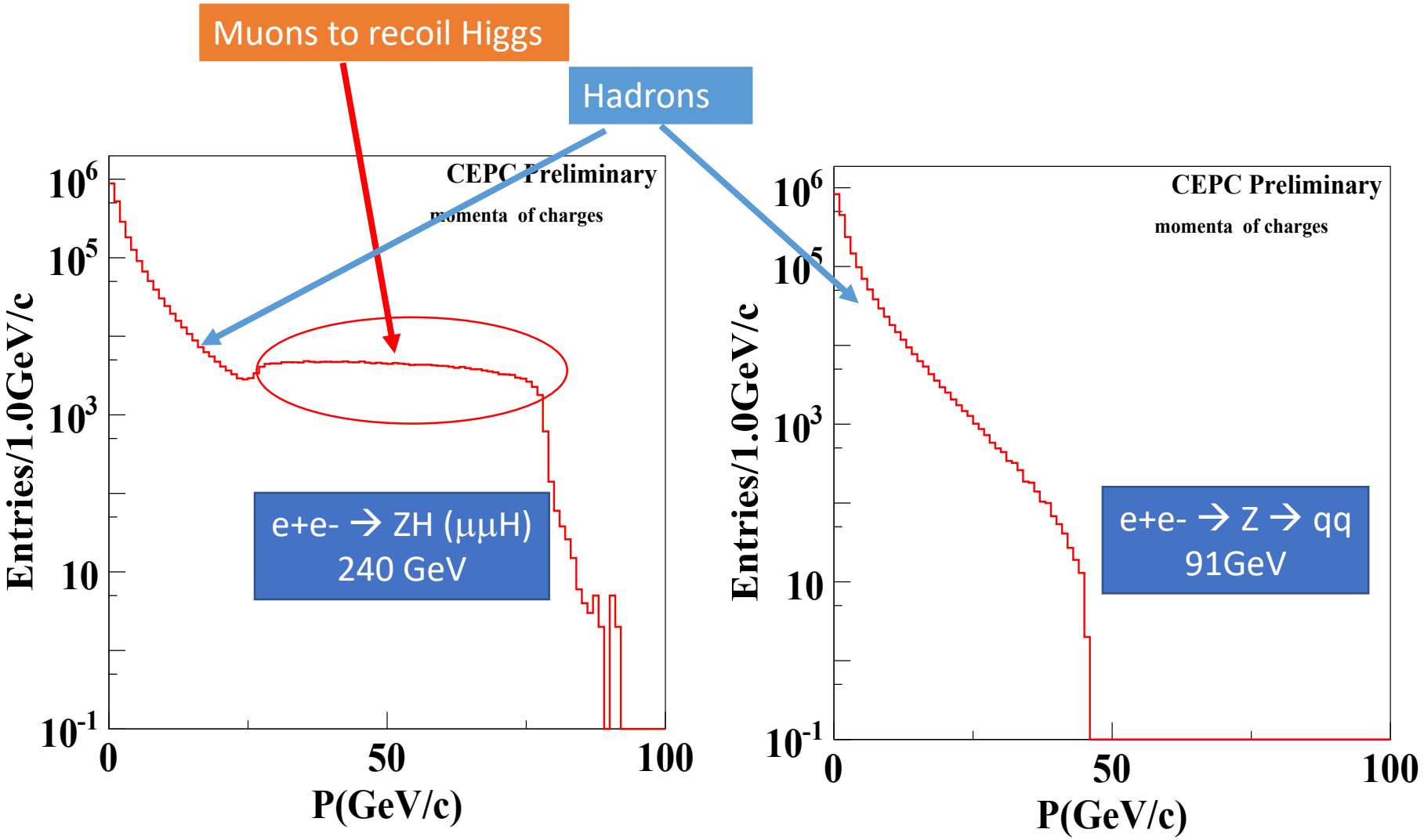








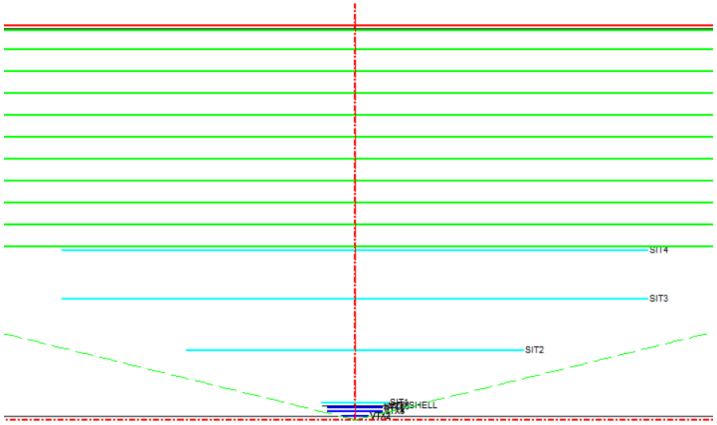
Momentum distributions @ 240 & 91 GeV



Tracking system

From Xin's Yangzhou talk, starting point

Sub detector	N layers	Resolustion (μm)		Material budget (%X_0)
		r-ϕ	z	
VXD	6	2.8 / 6 / 4 / 4 / 4 / 4	2.8 / 6 / 4 / 4 / 4 / 4	0.15 per layer
SIT	4	7.2	86.6	0.65 per layer
DC (cell 1x1cm^2)	100	100	2000	1.2
SET	1	7.2	86.6	0.65
Total	111	--	--	5.35



- VXD keeps unchanged
- 4 SITs
- δR of the DC =1 m
- 1 SET

Updates of DC parameters from Mingyi

R (mm)	L of wires(mm) (cosθ=0.83)
1800	5356.8
1750	5208.0
1700	5059.2
1600	4761.6
1500	4464.0
800	2380.8

cell size(mm^2)	# of layers	# of Cells	T_S (10^3 kg)	T_F (10^3 kg)
10x10	100	81 682	14.8	47.4
15x15	67	36 303	6.6	21.1
18x18	56	25 210	4.6	14.6
20x20	50	20 420	3.7	11.8

R extension	800-1800 mm
Inner wall	0.2 mm (X/X0=0.00104)
Outer wall	2.6 mm (X/X0=0.01346) (averaged results)
Diameter of field wire	50μm (Gold-plated Aluminum) (X/X0=0.0036 for 10x10 cell)
Diameter of signal wire	20μm (Gold-plated Tungsten) (X/X0=0.0026 for 10x10 cell)
Square cell（F:S = 3:1）	BESIII-Like MDC
Cell size	10, 15, 18, 20 mm
Longest wire （cosθ=0.83）	5357mm
Gas：He/iC4H10	He/iC4H10=80:20

- 0.000116 / each layer vs. 0.000054 for 10x10 cell
- 0.000123 / each layer vs. 0.000081 for 15x15 cell
- 0.000139 / each layer vs. 0.000108 for 20x20 cell