Estimation of momentum resolution

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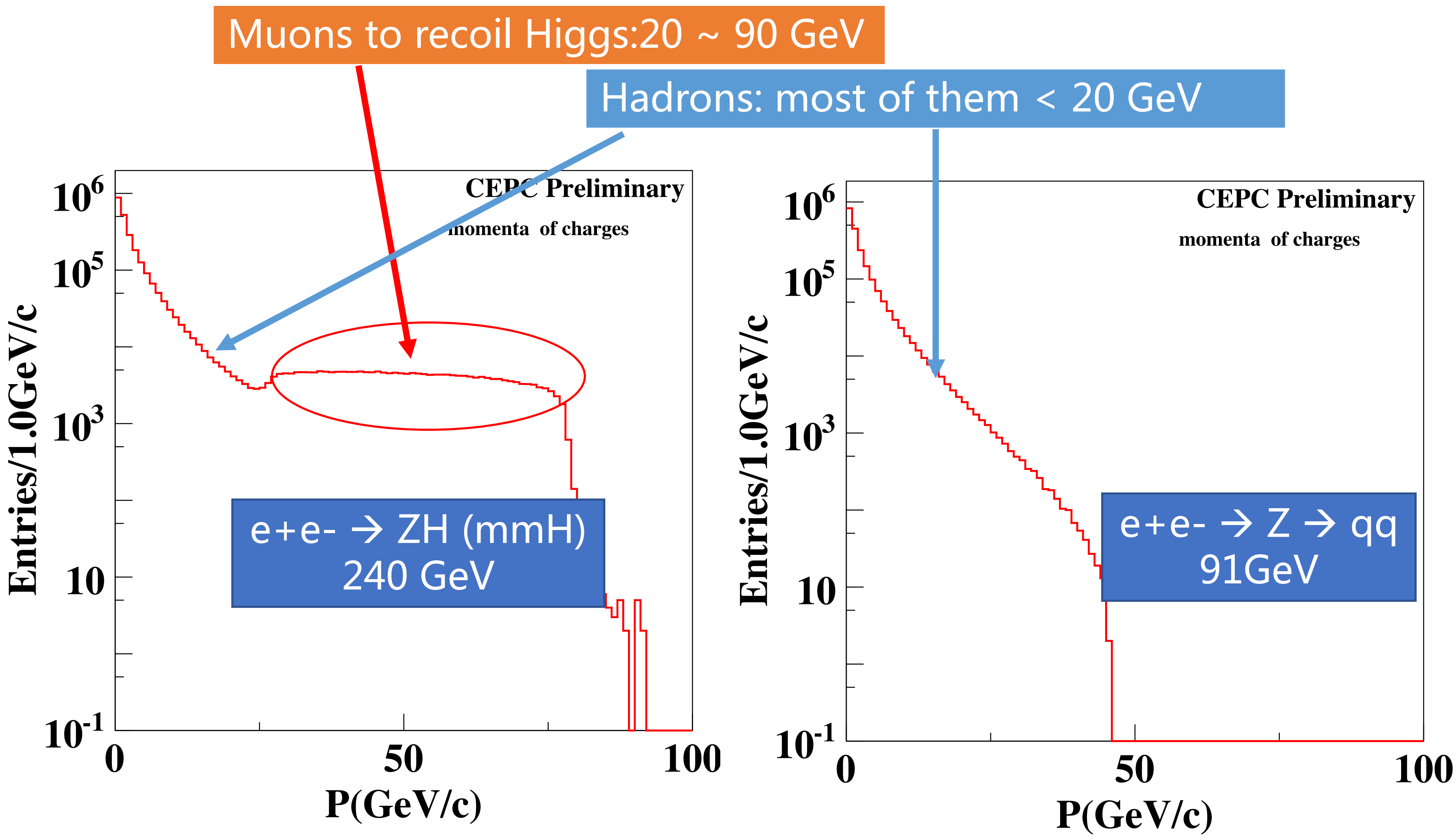
Momentum distribution of charged tracks @ 240 & 91 GeV

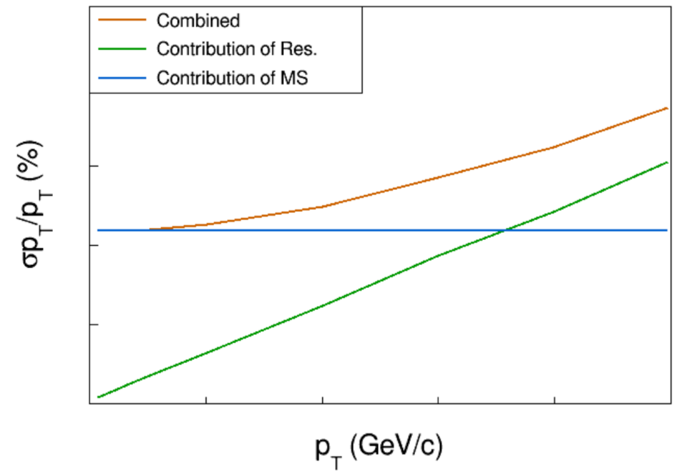


Formulas of Pt resolution

$$\frac{\sigma P_T}{P_T} = a \cdot P_T \oplus \frac{b}{sin^{1/2}\theta}$$

$$\frac{\sigma P_T}{P_T}\Big|_{Res.} = \frac{\sigma_{r\phi} P_T}{0.3BL^2}\sqrt{\frac{720}{N+5}}$$

$$\frac{\sigma P_T}{P_T}\Big|_{MS} = \frac{0.0136\,(GeV/c)}{0.3\beta BL}\sqrt{\frac{X}{X_0 \sin\theta}}$$

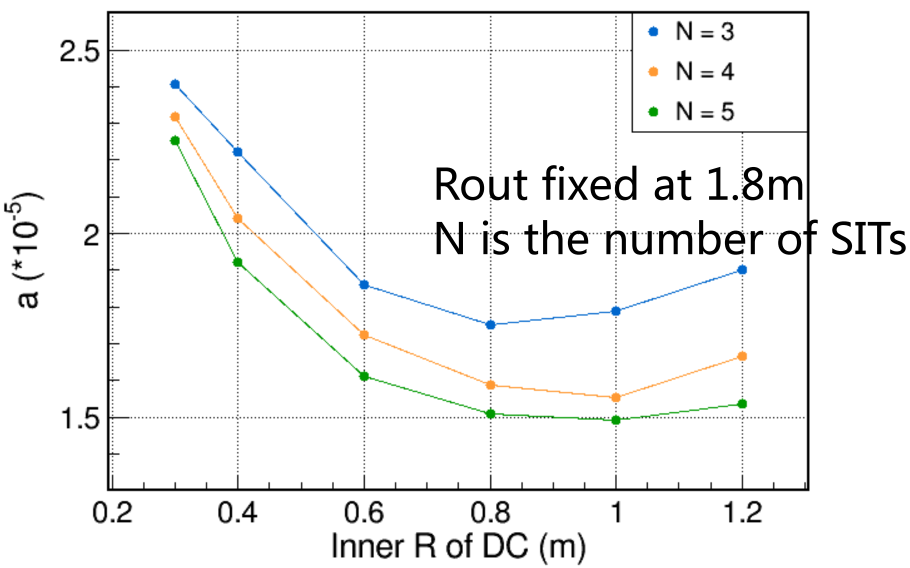


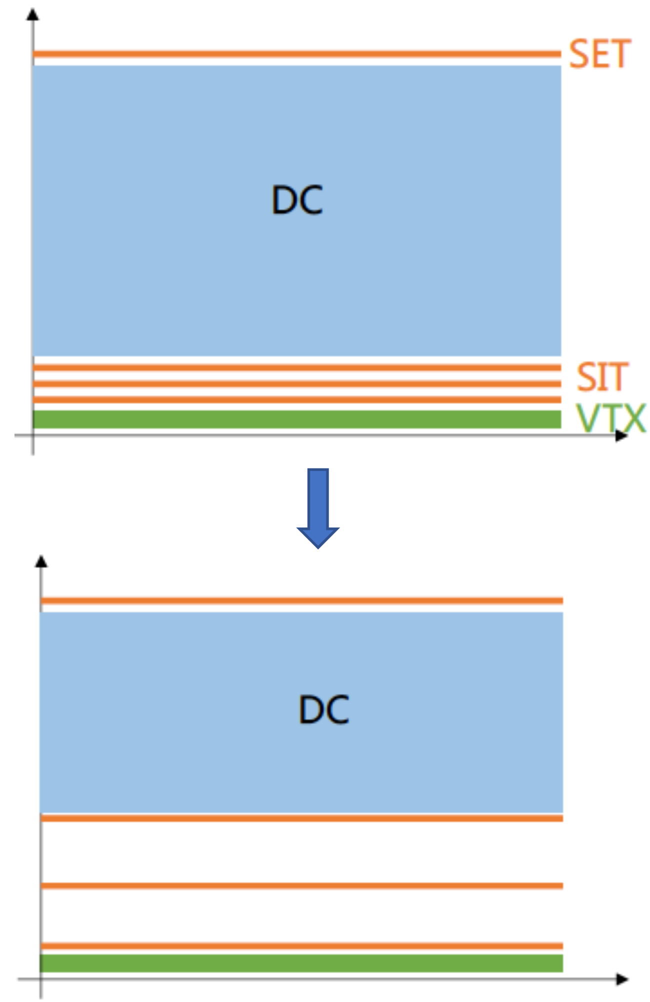
Contribution from measurements

$$\frac{\sigma P_T}{P_T}\Big|_{Res.} = a \cdot P_T$$

- An accurate estimation of a could be achieved with the least square fit
- a could be improved by optimizing the size of DC

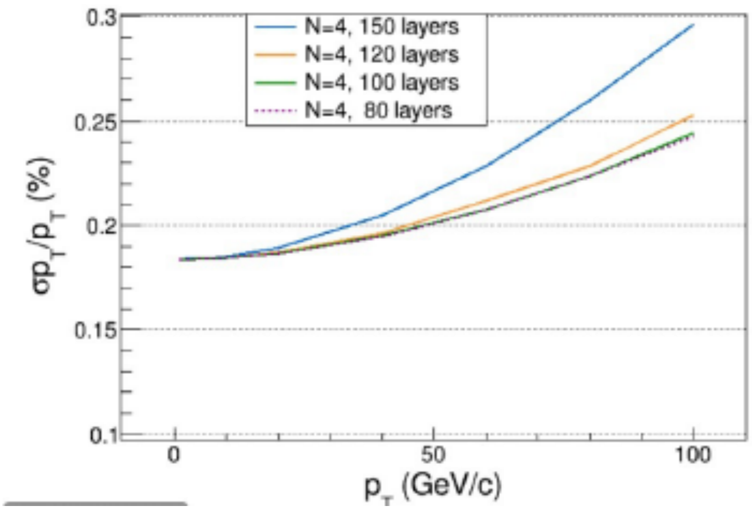
a vs DC size

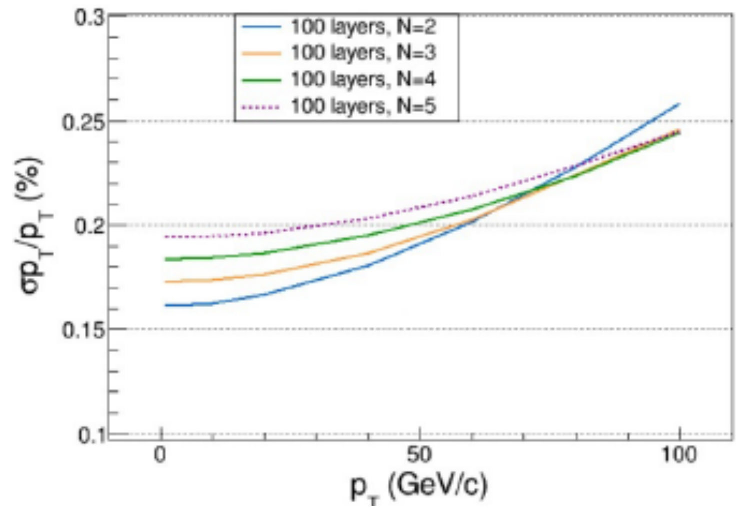




Previous results

Xin's talk in Yangzhou workshop





a is estimated by LSF
b is calculated with formula (not accurate)

$$\frac{\sigma P_T}{P_T}\Big|_{MS} = \frac{0.0136\,(GeV/c)}{0.3\beta BL}\sqrt{\frac{X}{X_0 \sin\theta}}$$

Application of LDT

- LDT applied to improve the precision of tracking fast simulation

The LiC Detector Toy fast simulation program

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The "LiC Detector Toy" (LDT) is a fast single-track simulation and reconstruction tool, aiming at the optimization of tracking detector design, i.e. geometric layout and amount of material. Its implementation is based on the MATLAB system, with a user-friendly graphic user interface. The simulation can handle cylindrical and planar detector layers, where the detector setup is defined in human-readable text files. Simulated helix tracks are reconstructed with a Kalman filter including statistical tests. A key feature is an intuitive possibility to repeat simulation runs, yielding curves

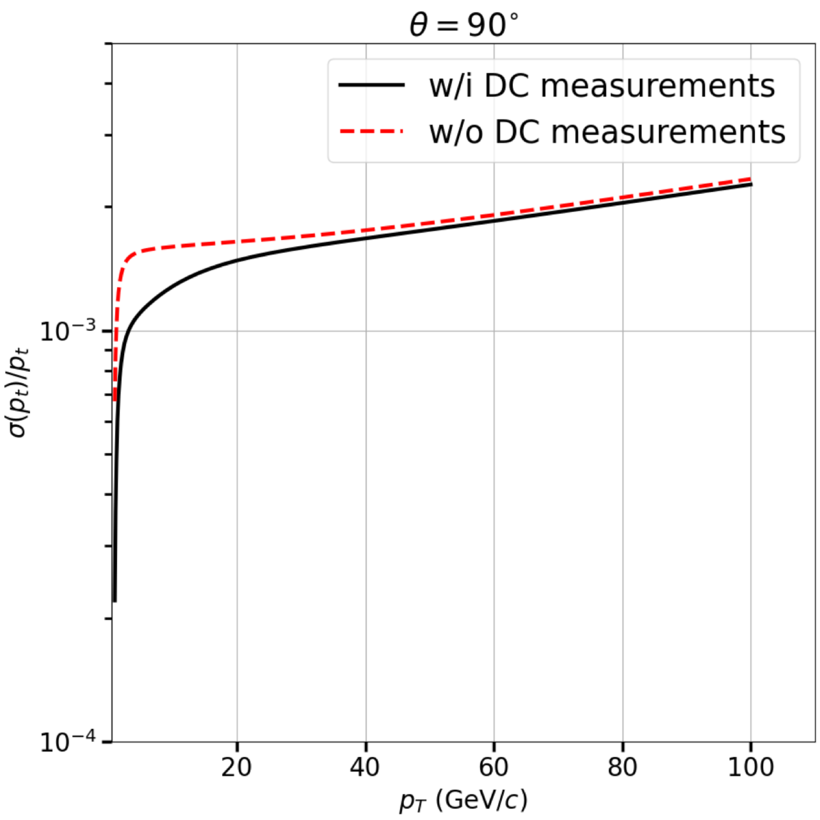
Update DC parameters according to Mingyi' s numbers for # of layers = 100

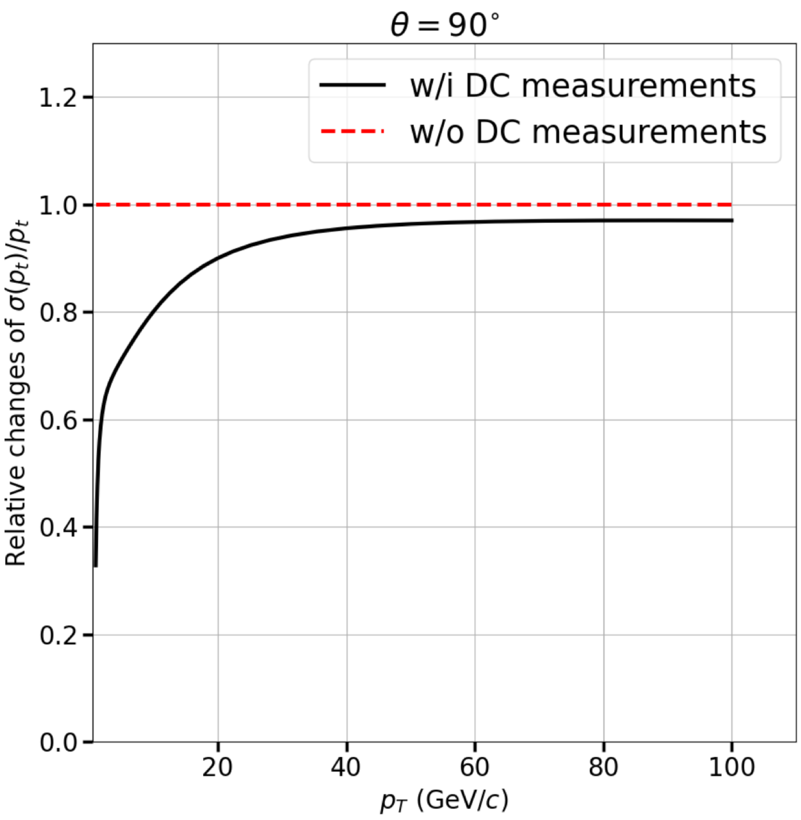
Sub detector	# layers	R (mm)	Resolustion (μm)		Material (%X_0)
			r-ϕ	z	
Beam pipe	1	14(10)	---	---	0.15
VXD	6		2.8/6/4/4/4/4	2.8/6/4/4/4/4	0.15/layer
VXD shell	1	65	---	---	0.15
SIT	4	Uniformly ..	7.2	86.6	0.65/layer
DC inner wall	1	798-800	---	---	0.104
DC (cell 1x1cm^2)	100	800-1800	100	2000	0.0116/layer
DC outer wall	1	1800 -1808	--	---	1.346
SET	1	1810	7.2	86.6	0.65
Total	115	---	---	---	7.06

Total X0 > 7%
(5.35% at Yangzhou workshop)

Role of DC in measuring Pt

δR= 1000 mm, # of layers=100



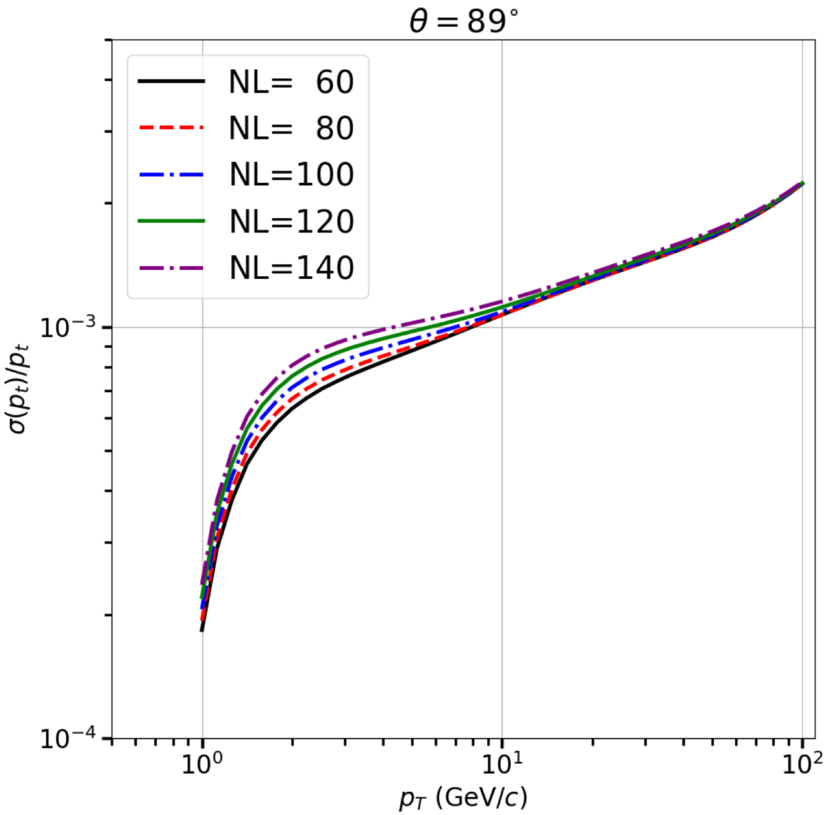


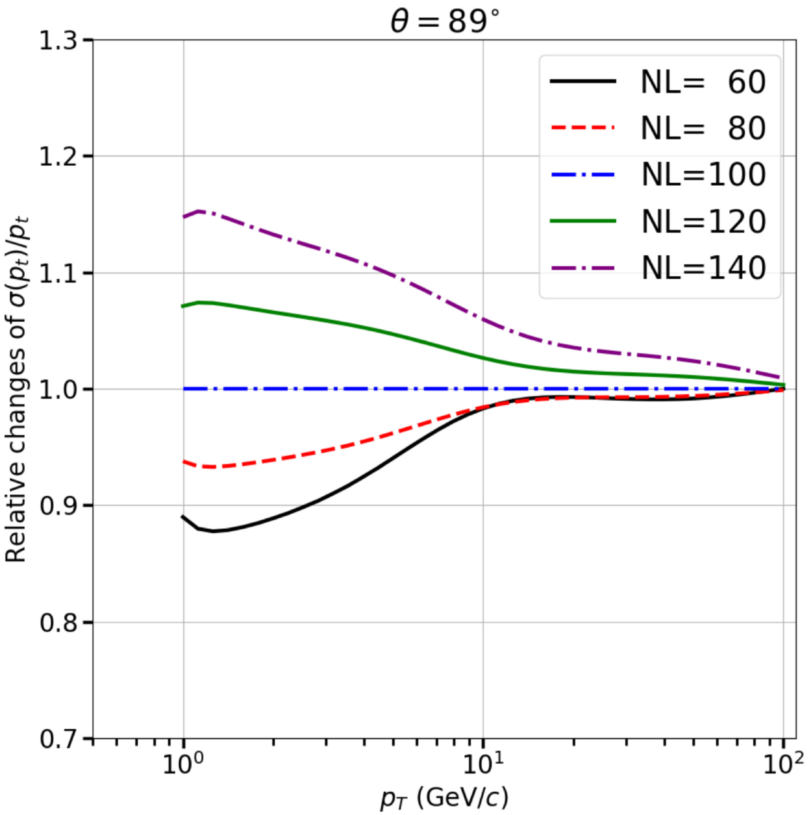
Role of DC in measuring Pt

Fixing δR = 1000 mm, changing # of layers

Equivalent to changing cell size

Takes 100 layers as reference





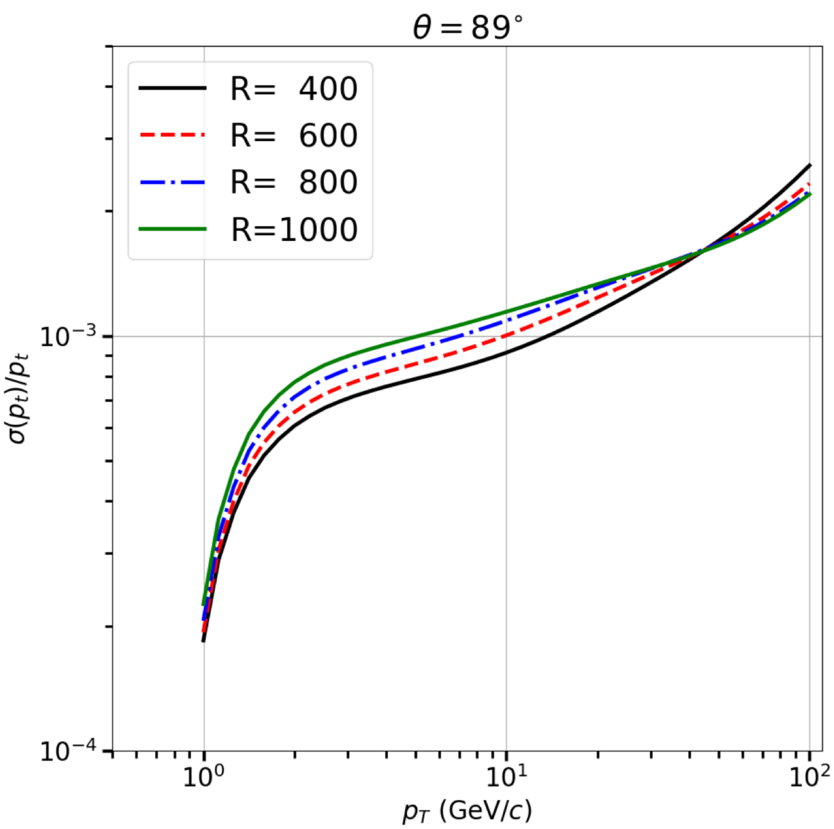
Less layers achieve better momentum measurement

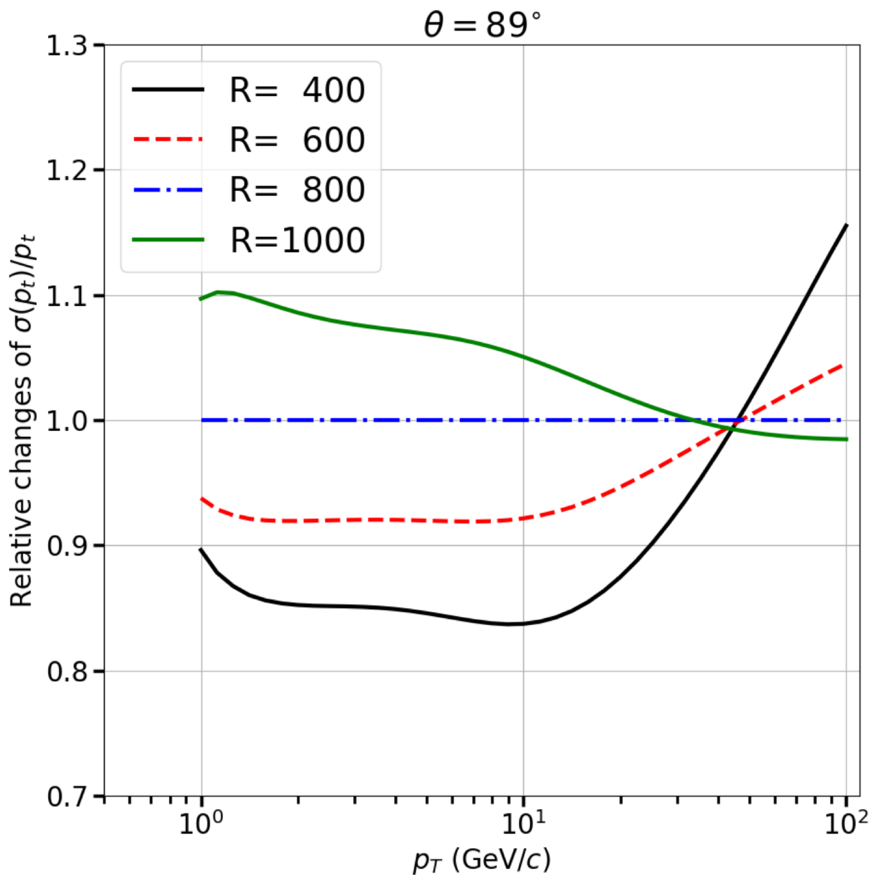
Role of DC in measuring Pt

Changing Rin with fixing # of layers = 100

Larger DC volume means larger cell size

800 mm (1000mm thick) as the reference



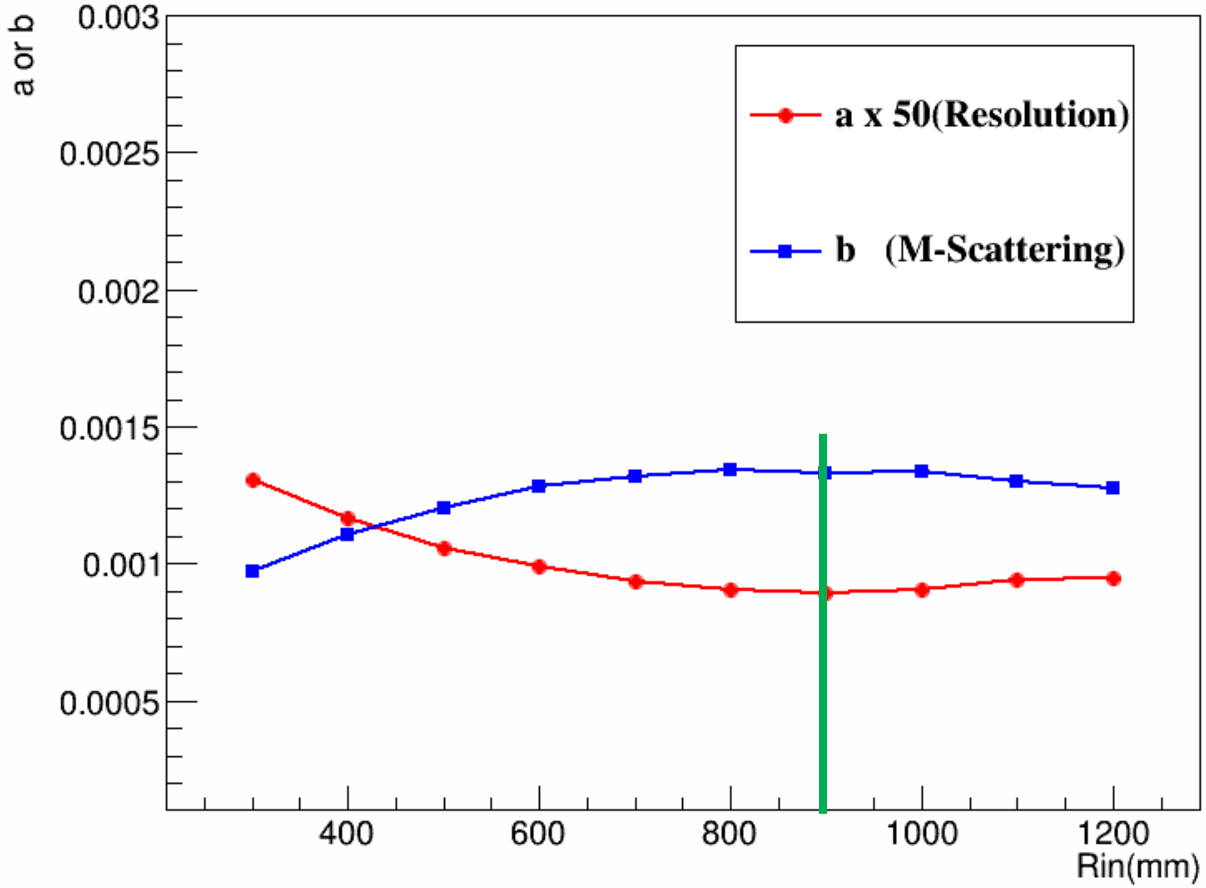


Larger DC volumes achieve better momentum measurement at low pt region (~40 GeV: critical point)

☐ thickness (# of layers) or inner radius of DC

Changing Rin with fixing cell size

Larger DC volume means more cells

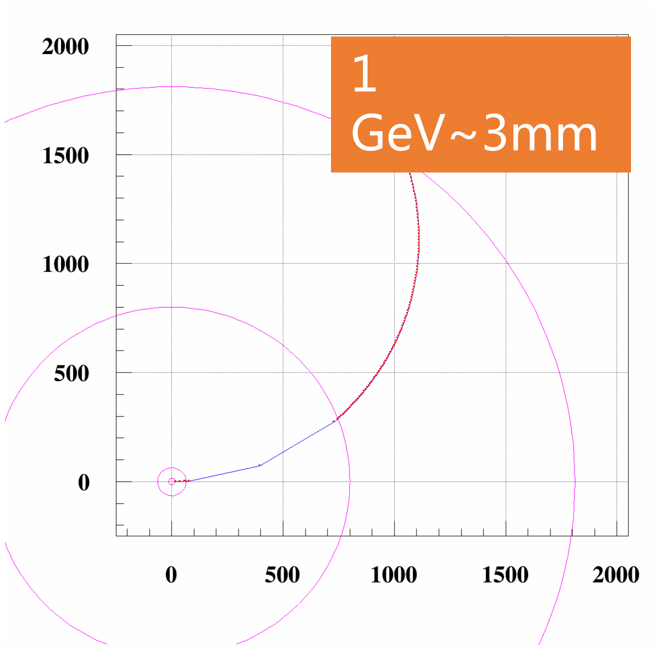


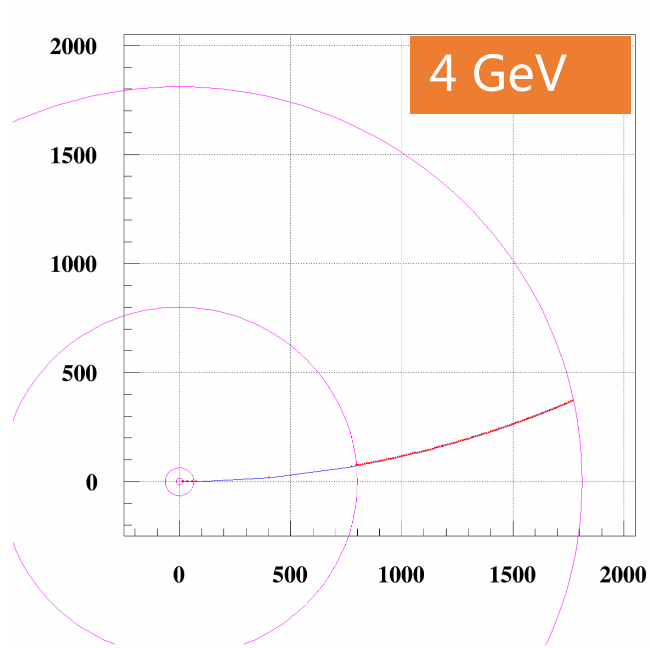
The a consistent with Linghui's study

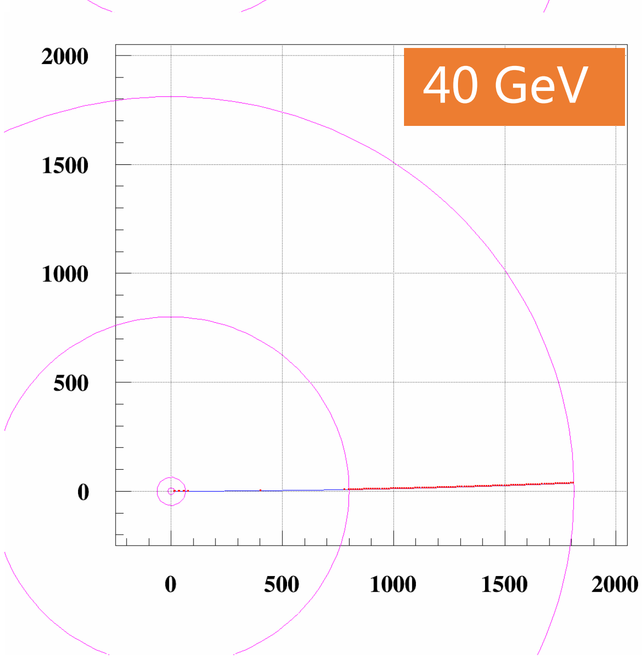
Summary

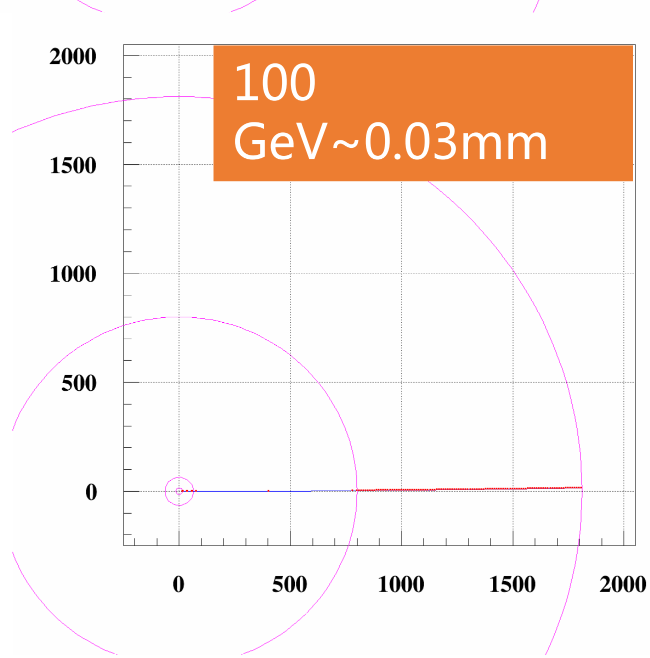
- Calculation with the classic formula can not give a good estimation of MS effect in low Pt range
- LDT was applied to improve the tracker optimization.
- Further study ongoing to understand the behavior in low Pt range
- To be checked with other simulation tools

Tracks and spatial spread due to MS





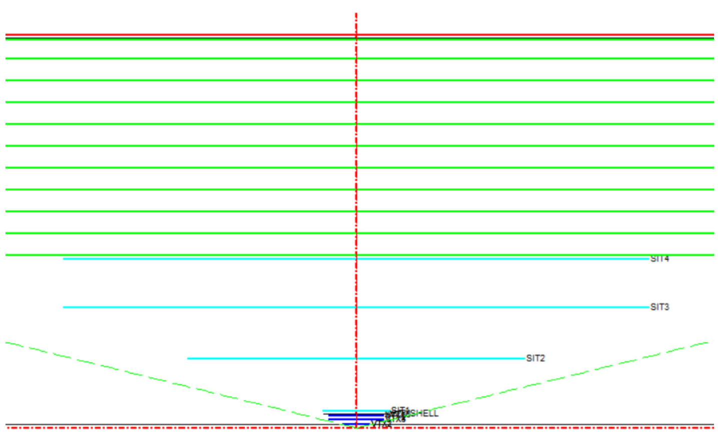




Tracking system

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
- dR 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