Progresses of tracker optimization

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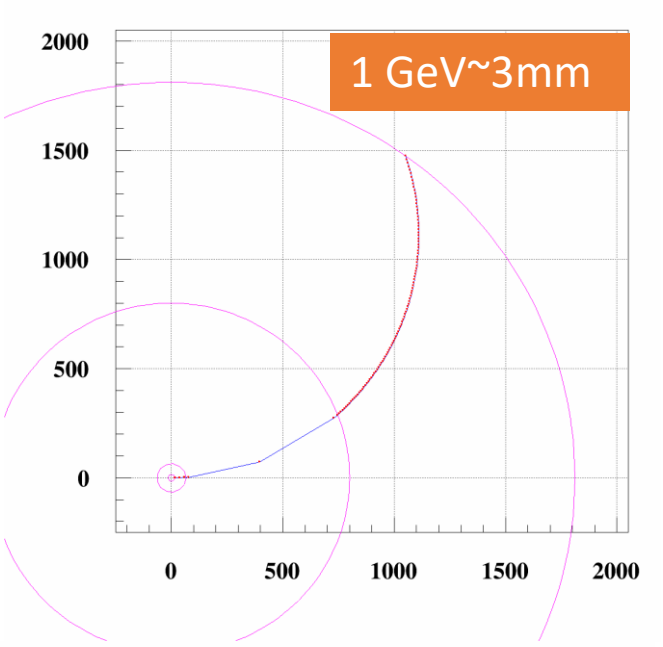
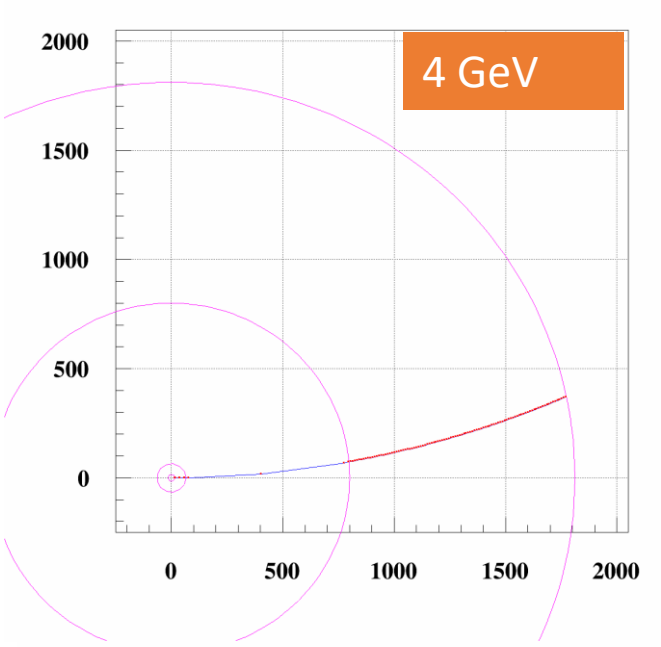
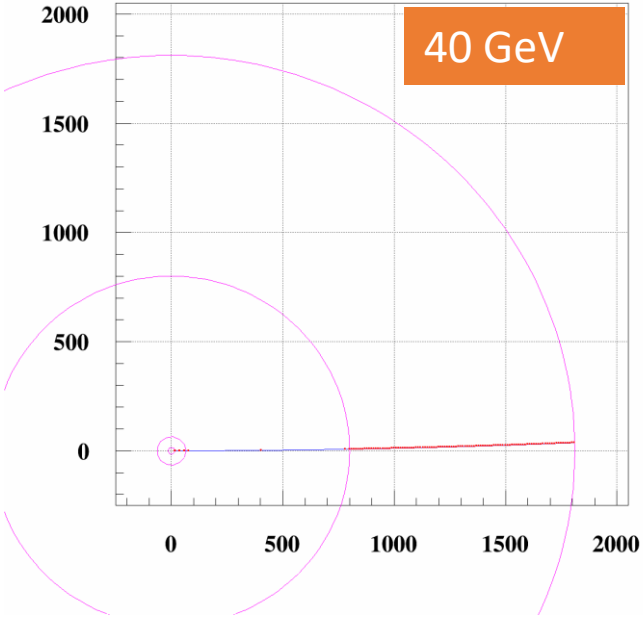
PID tracker

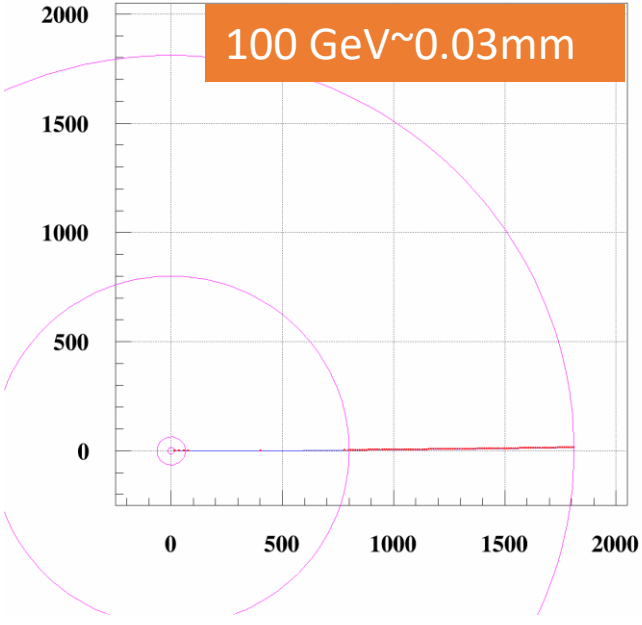
- ✓ The tracker must meet the requirements of
  - ☐ EW precision physics : jet energy resolution, tagging, …
  - ☐ Flavor study: narrow resonances
- ✓ To achieve the best performances for both PID & tracking
  - ☐ Tracker volume, # of layers, layout, and so on
- ✓ To optimize tracker according to *p* and *impact parameter* measurement
  - ☐ Spatial resolution
  - ☐ Multiple scattering
  - ☐ Layout of tracker layers

Tracks and spatial spread due to MS

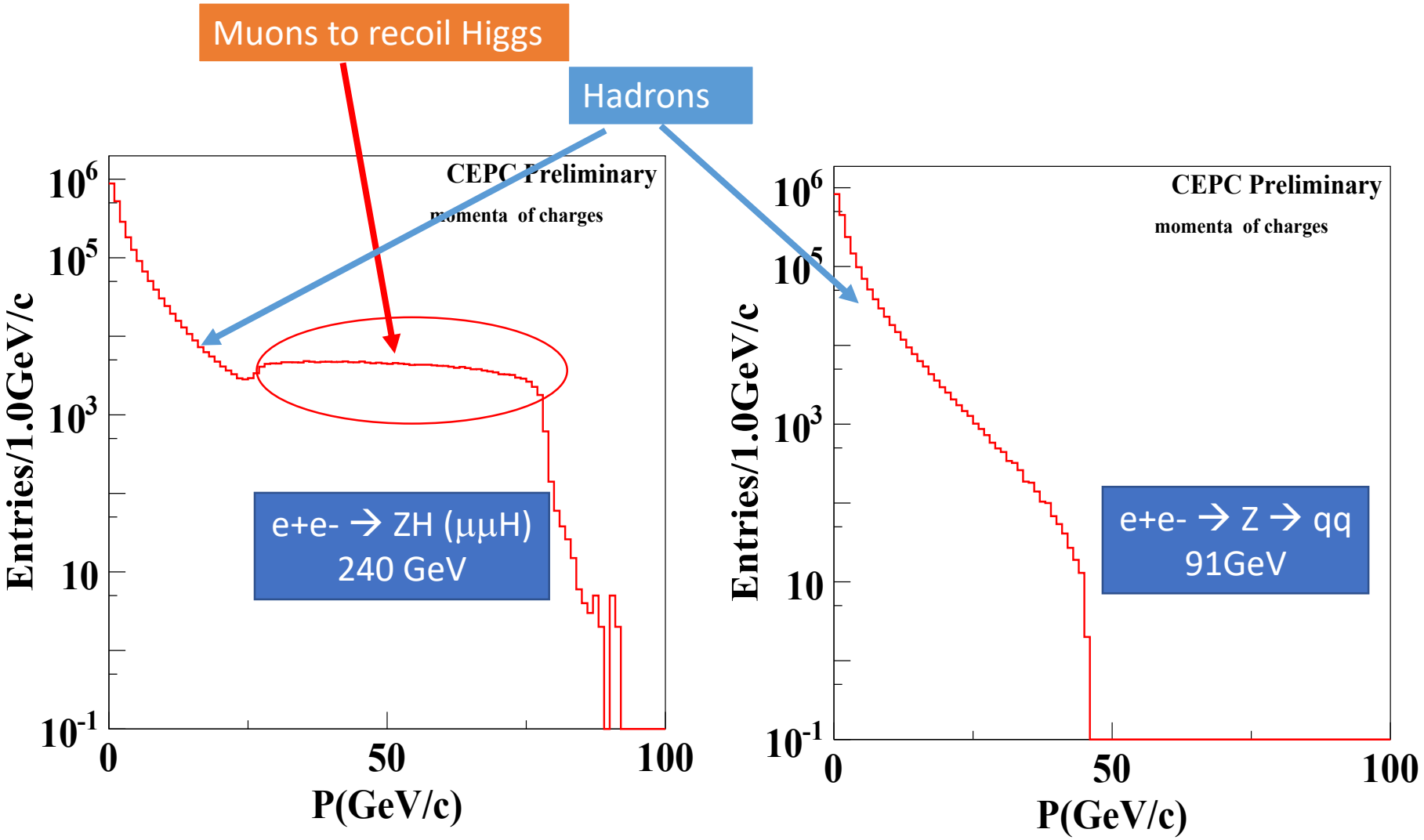








Momentum distributions @ 240 & 91 GeV



PID

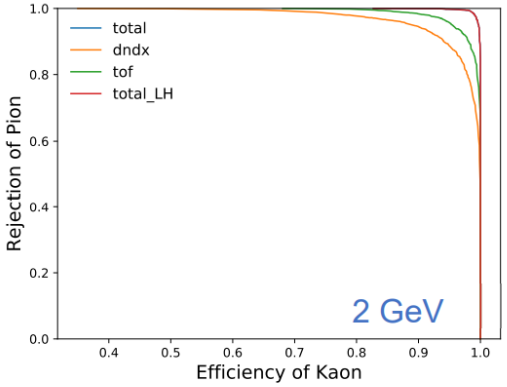
Shuiting, Guang & Linghui

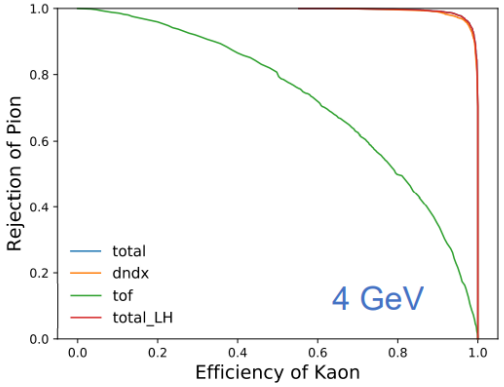
- A drift chamber of δR = 1 m provides 100 measurements

K/pi separation can achieve 3(2) σ for 10(20) GeV/c

ROC curve

- An intuitive way of comparing different classification methods
- Likelihood = $\frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}\chi_t^2} * \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}\chi_{\frac{dN}{dx}}^2}$
- dN/dx is very effective for PID at high momentum



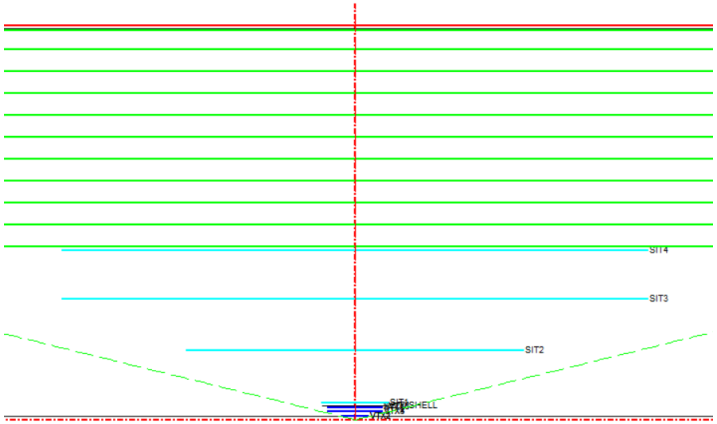


- 2/4 GeV/c kaon & pion performance
- Consistent value of
  - total : from chi2 probability.
  - total_LH: from Likelihood ratio.

Tracking system

From Xin's Yangzhou talk, starting point

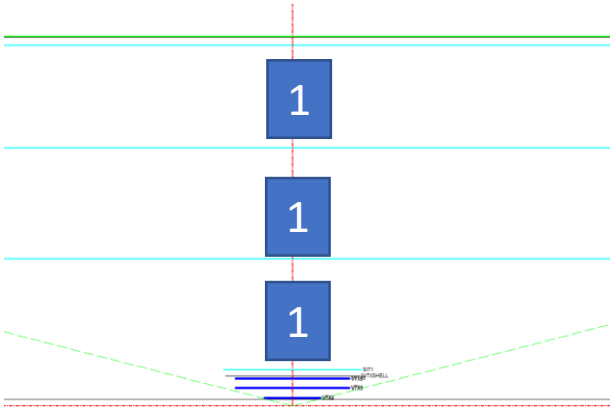
Sub detector	N layers	Resolustion (μm)		Material budget (%X_0)
		r-ϕ	z	
VXD	6	2.8 / 6 / 4 / 4 / 4 / 4	2.8 / 6 / 4 / 4 / 4 / 4	0.15 per layer
SIT	4	7.2	86.6	0.65 per layer
DC (cell 1x1cm^2)	100	100	2000	1.2
SET	1	7.2	86.6	0.65
Total	111	--	--	5.35

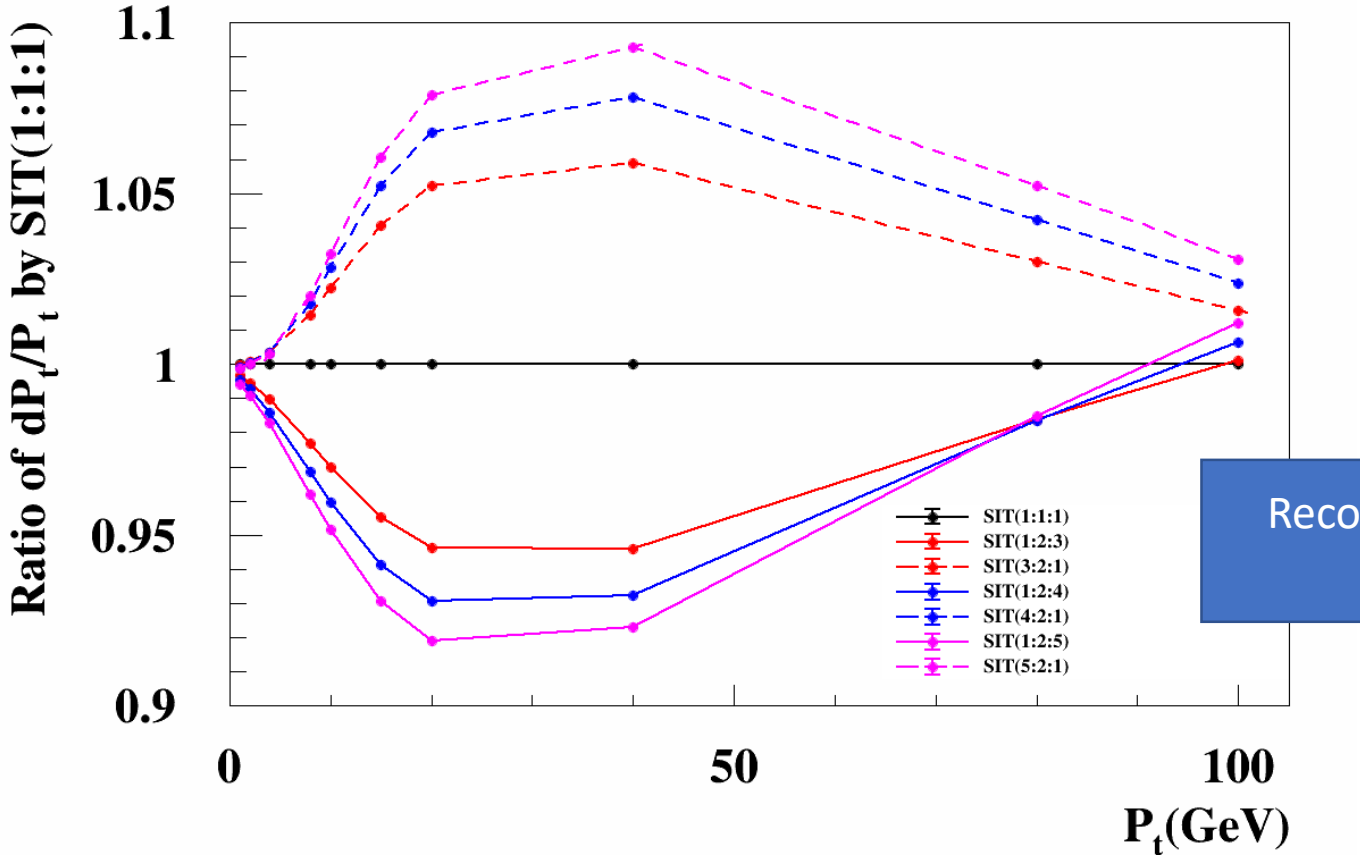


- VXD keeps unchanged
- 4 SITs
- δR of the DC =1 m
- 1 SET

Optimize SIT layout

- Layers at 78 and 800mm fixed
- Only two layer can move
- Better resolution if layers approach beamline

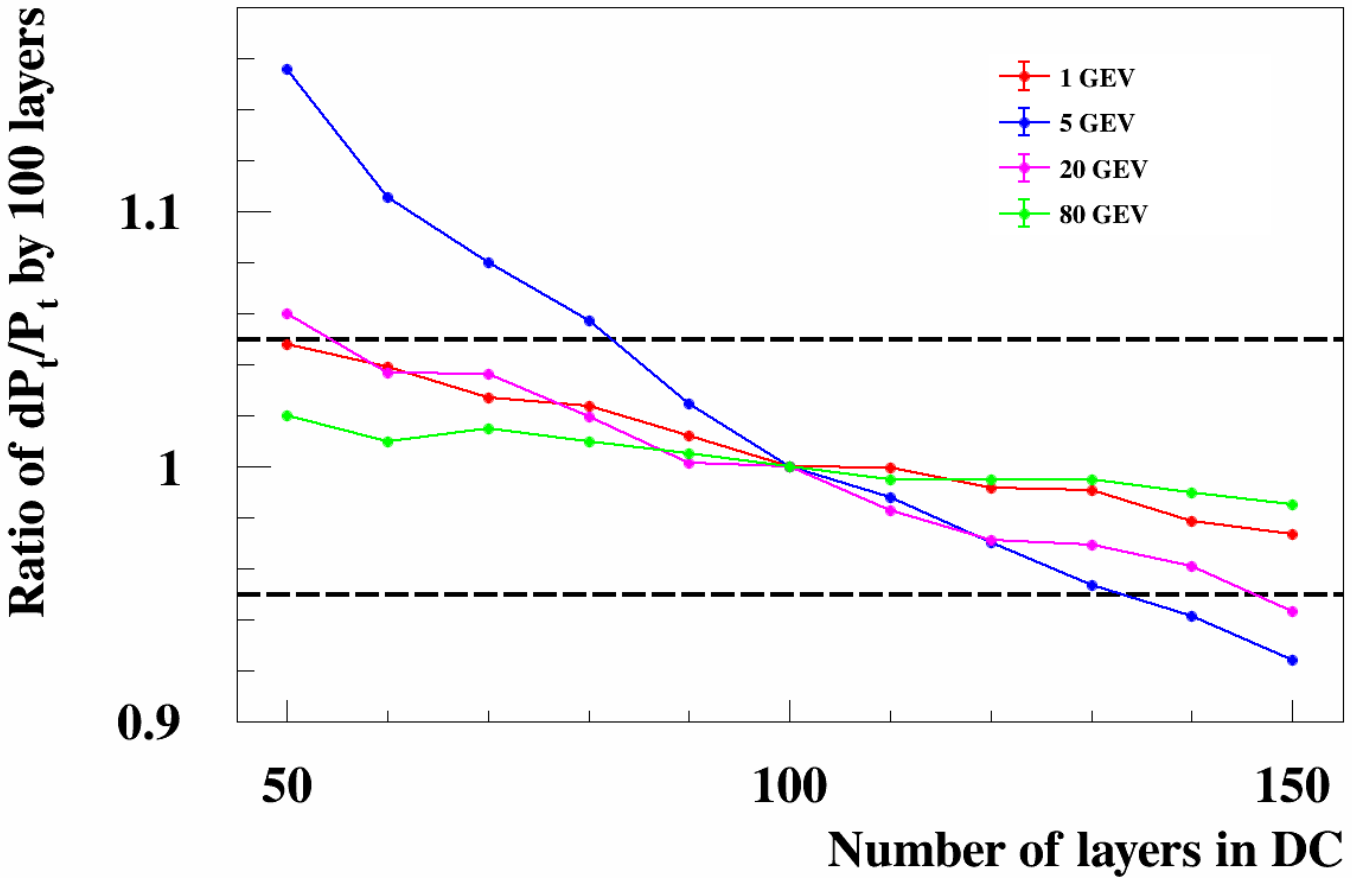




Recommendation: 1:2:4

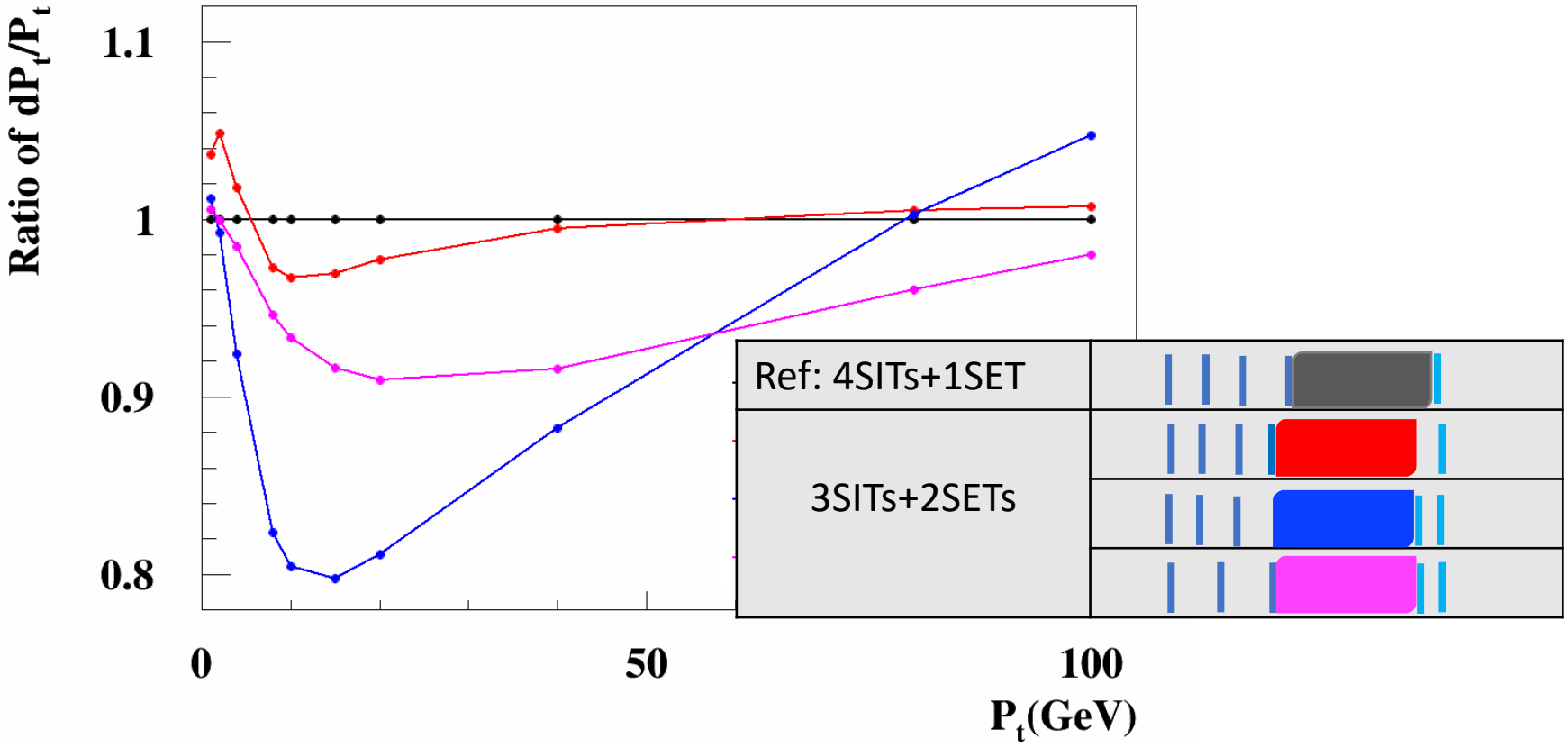
Optimize # of DC layers

- Xin=0.2%X_0, Xout=1%X_0
- Xgas=0.0034%X_0 averaged by # of layers
- 80-120 layers: changes within 5%
- 5 GeV tracks more sensitive: more or less hits matter



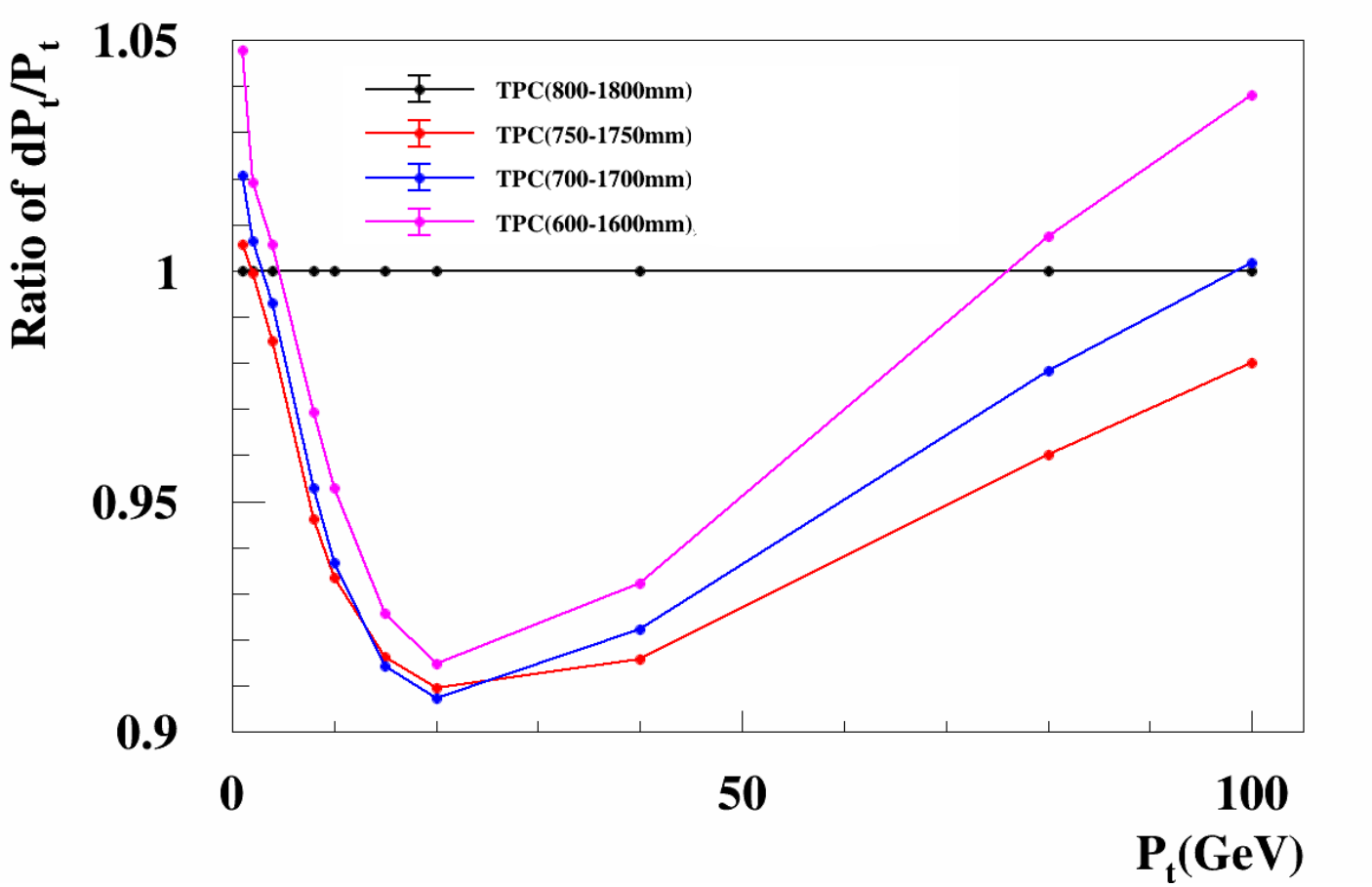
3 SITs and 2 SETs

- 1 layer SIT moved outside DC improve momentum resolution
- 5-10% improvement



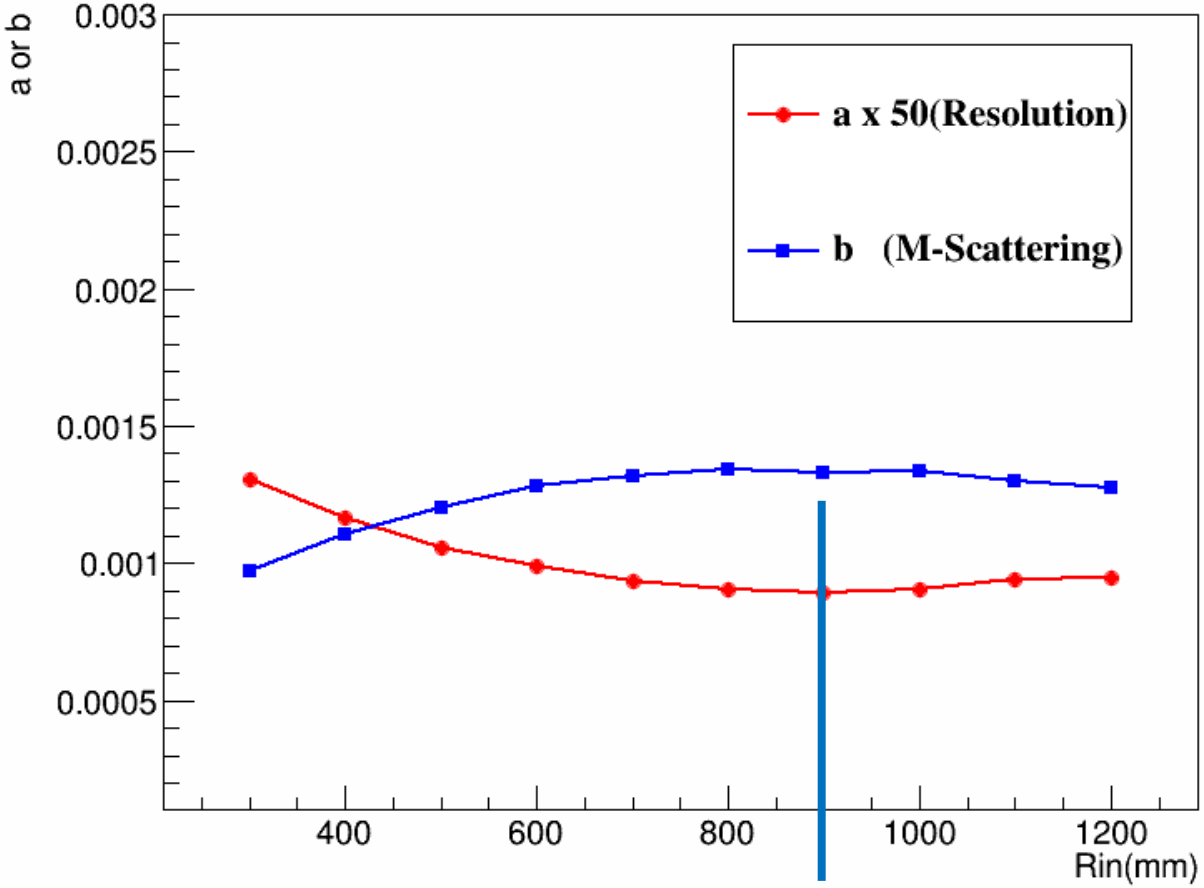
Position of DC for 3 SITs & 2SETs, δR fixed to 1000 mm

- DC as far as possible from beamline
- Overall improvement, especially for 10-40 GeV



thickness (# of layers) or inner radius of DC

- Changes of the inner radius of DC (Thickness of DC)
- The X of gas taken into account, 1 cm cell (depends on δR)
- Favors smaller inner radius if X taken into account, b is the dominant term for momentum measurement



The a consistent with Linghui' s study

Summary

- Some preliminary conclusions
  - SIT layers favor to be near to beamline except the two fixed layers
  - 3 SITs + 2 SETs gets better p resolution
  - DC tends to be far from beamline if δR fixed
  - DC favors lager δR, i.e, more layers within 4SITs+1SET scheme
- Combined all the above together and give the optimized design
- All need more understanding with alternative methods and validation with full simulation