Test Tracker Options

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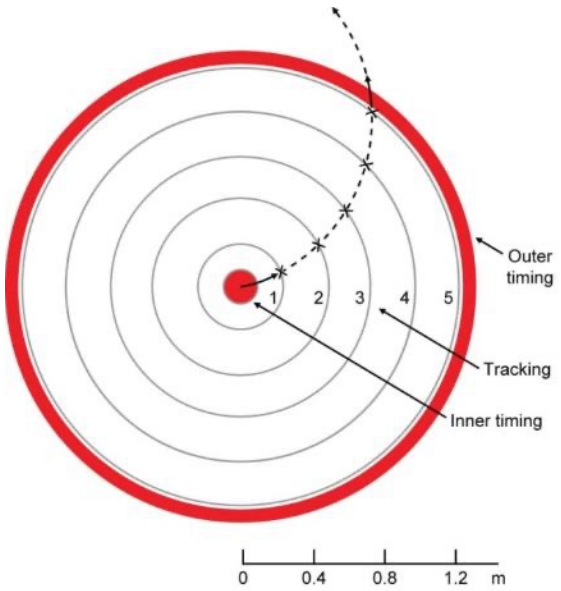
Compressed Tracker

- **How much will a ring imaging detector expand the radius of a potential tracker + PID system?**
- **See also Chris' presentation**



K Stefanov, Pixel tracker for SiD, LCWS2021

(first proposed at LCWS Sendai, 2008)

- **Tracking layers** are ~0.6% X_0 per layer
- 50 μm pixels, 5-bit amplitude digitisation, giving 5 μm precision in rϕ and z
  - This needs to be simulated – delicate balance between thickness of epi layer and depletion depth
- <100 W dissipation, so air cooled
- **Timing layers** (150 μm pixels, O(ns)) are close to ECAL, so material less critical
- 500 W dissipation, so air cooling may be OK (based on recent CLIC studies)
- Layout of Barrels 1-5 directly follow the old SiD microstrip tracker. It may be possible to reduce somewhat the radius of the pixel tracker, while preserving adequate performance for physics (to be simulated).

Introduction

- Calculate Tracking Performance based on Gluckstern formula
  - https://www.sciencedirect.com/science/article/pii/S0168900218310362?via%3Dihub

- Some time ago, Charlie and Myself developed a project with a rotation student at SLAC (Feng Chen) to write a tool encoding the analytical calculation of tracking parameter resolutions
- The code is available here:
  - https://github.com/slaclab/TrackingResolution

- I just modified it to study our compressed tracker options
  - Only accounting for tracking layers in the barrel
    - Thus, all plots are for eta=0
  - Magnetic Field at 5 Tesla, mass = muon

Comparison with previous SiD Tracker

SiD Vertexing+Tracking Detector

```
#X0   xyRes[m]   zRes[m]   radialPos[m]
#SiD based on ILC TDR https://arxiv.org/pdf/1306.6329.pdf
#vertexing detector (section 2.2 for position and for the material "The simulation described in the following chapters assume
s 0.1% radiation length per layer excluding cables and 20 x 20 µm pixels for the forward tracker disks"
0.001 5.0e-6 5.0e-6 0.014
0.001 5.0e-6 5.0e-6 0.022
0.001 5.0e-6 5.0e-6 0.035
0.001 5.0e-6 5.0e-6 0.048
0.001 5.0e-6 5.0e-6 0.060
#tracking detector (section 3.2 for position, 3.3.1 for material "Excluding overlaps, the material presented by a single barr
el layer is approximately 0.9% X0 for tracks at normal incidence")
#strips of 25um in the sensitive direction, so we use 7um pitch
0.009 7.0e-6 1.0e-4 0.22
0.009 7.0e-6 1.0e-4 0.47
0.009 7.0e-6 1.0e-4 0.72
0.009 7.0e-6 1.0e-4 0.97
0.009 7.0e-6 1.0e-4 1.22
```

Strange Detector: same vertexing as SiD + squarePixelTracker

```
#X0   xyRes[m]   zRes[m]   radialPos[m]
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0.001 5.0e-6 5.0e-6 0.035
0.001 5.0e-6 5.0e-6 0.048
0.001 5.0e-6 5.0e-6 0.060

#tracking detector (using same positions as SiD)
0.006 5e-6 5e-6 0.22
0.006 5e-6 5e-6 0.47
0.006 5e-6 5e-6 0.72
0.006 5e-6 5e-6 0.97
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0.009 7.0e-6 1.0e-4 0.97
0.009 7.0e-6 1.0e-4 1.22
```

Is this z resolution reasonable?

Strange Detector: same vertexing as SiD + squarePixelTracker

```
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0.006 5e-6 5e-6 1.22
```
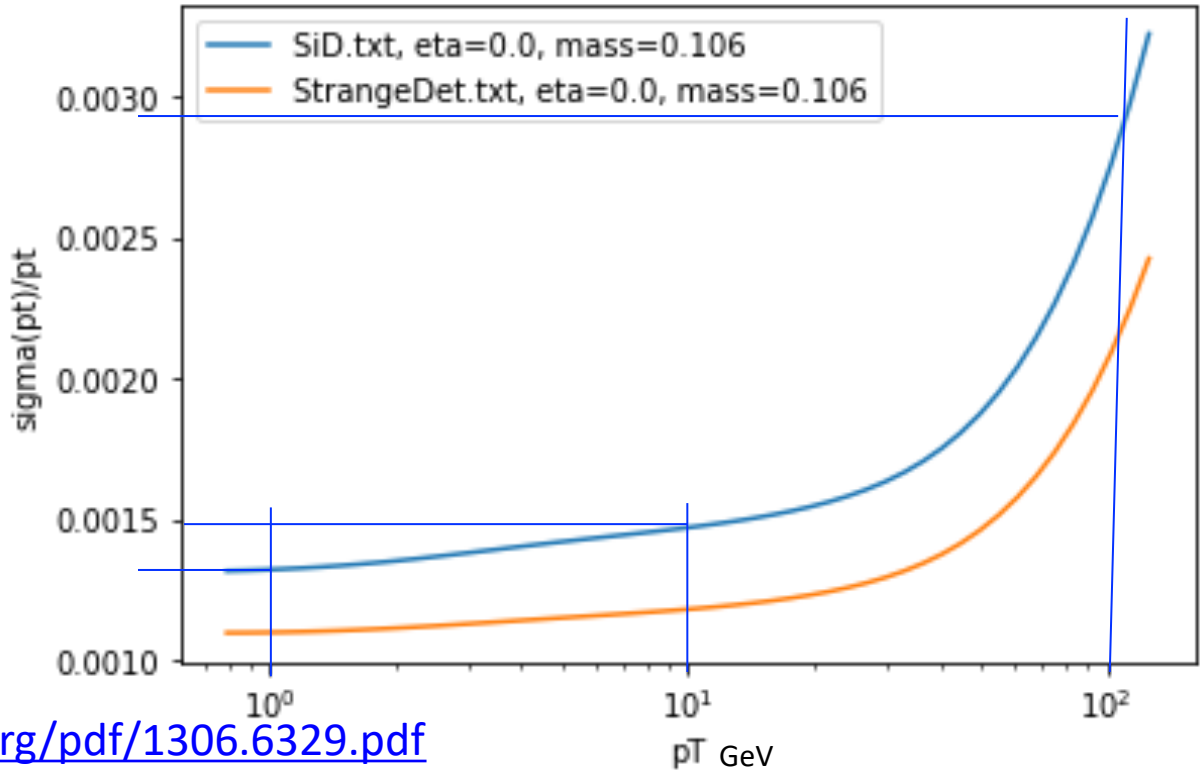

Same position as in SiD, only changes are: rad length & resolutions

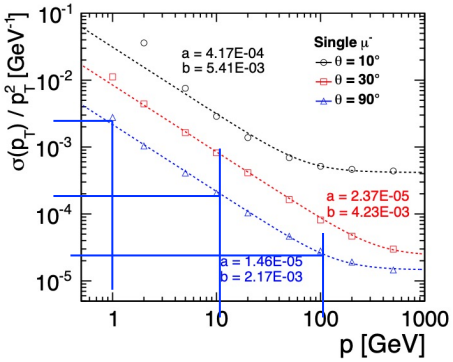
Momentum Resolution

B = 5 T



https://arxiv.org/pdf/1306.6329.pdf

Figure II-3.9
Normalised transverse momentum resolution for single-muon events in SIDLOI3 as function of momentum. The dashed lines indicate a fit to the parametrisation given in Equation II-3.1.



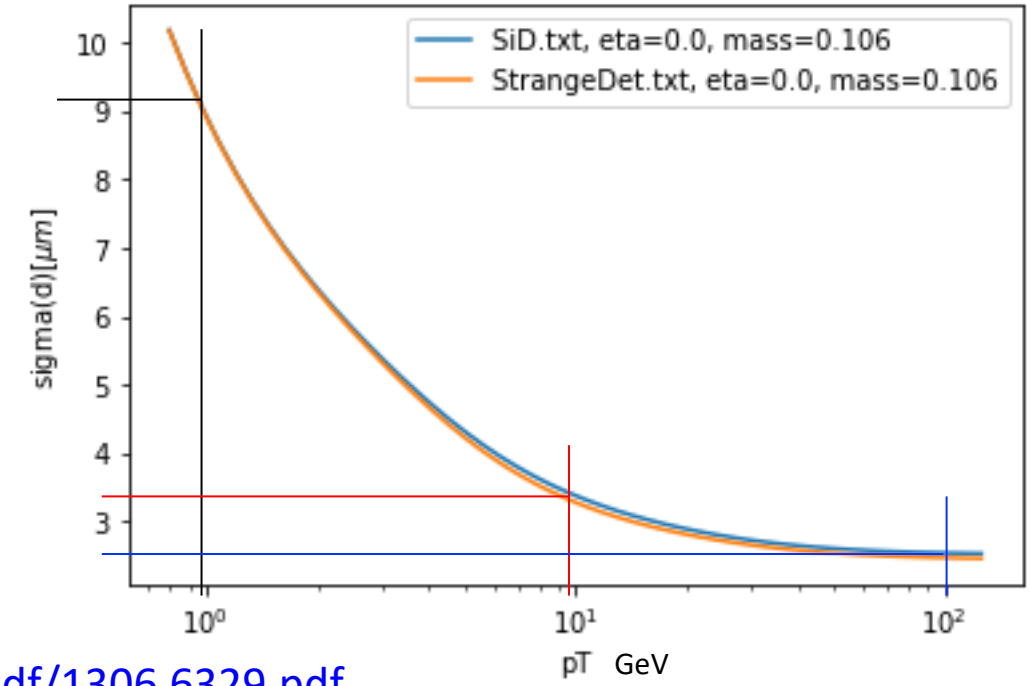
Theta=90 → theta=0, so focus on blue line for comparison

Results from our tool are compatible with ILC TDR

(please note that ILC TDR shows sigma(pT)/pt2, while we show sigma(pT)/pt)

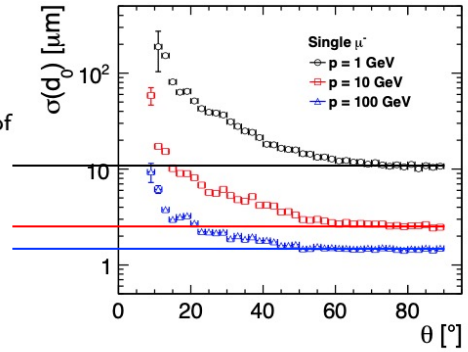
d0 Resolution

B = 5 T



https://arxiv.org/pdf/1306.6329.pdf

Figure II-3.10
Impact parameter resolution $\sigma(d_0)$ (left) and $\sigma(z_0)$ (right) for single muon events in SIDLOI3 as function of the polar angle θ.

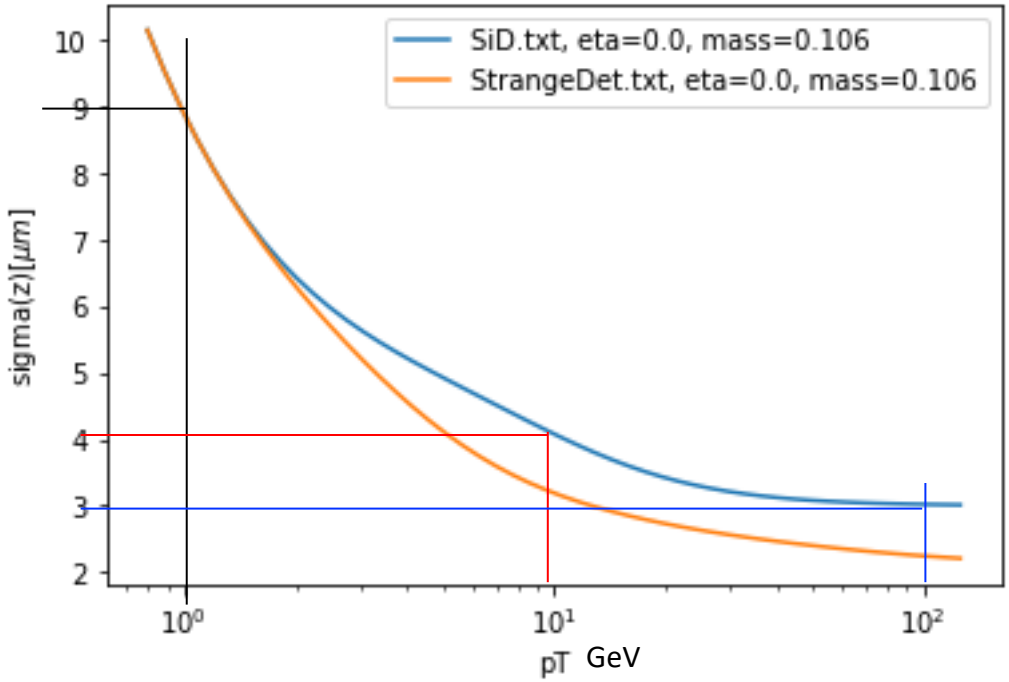


Theta=90 → theta=0

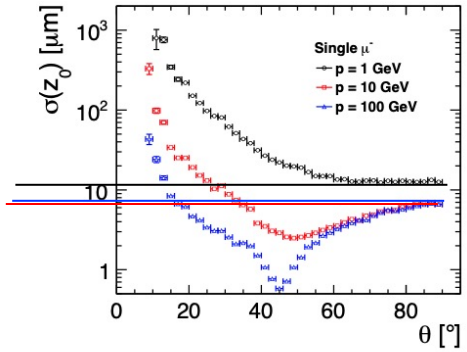
Results from our tool are compatible with ILC TDR

z Resolution

B = 5 T



https://arxiv.org/pdf/1306.6329.pdf

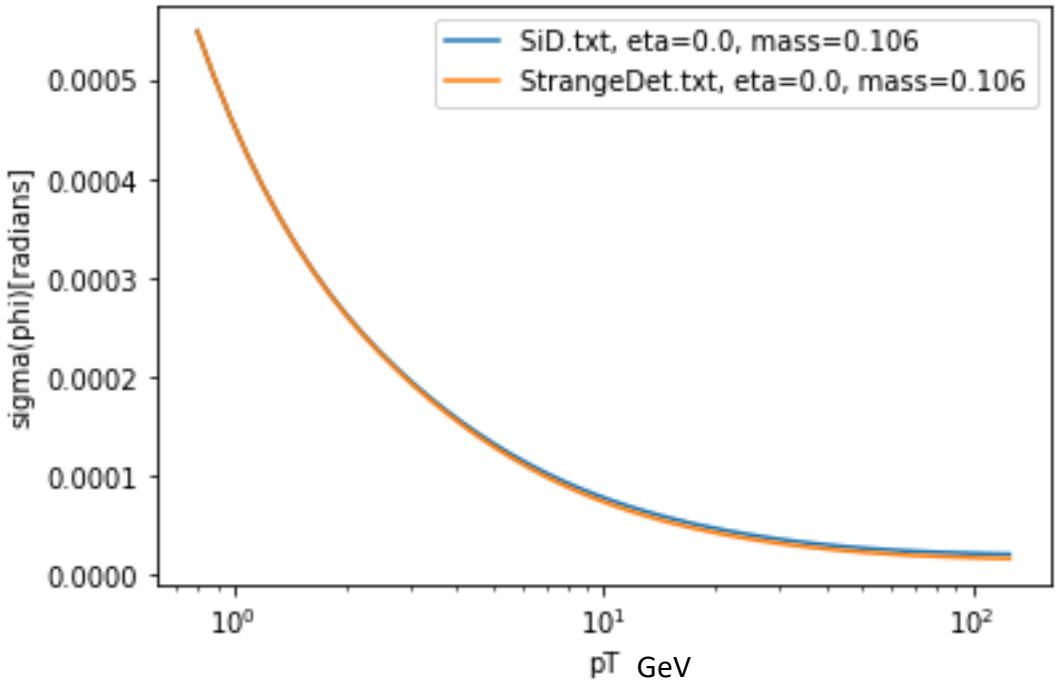


Theta=90 → theta=0

Results from our tool are compatible with ILC TDR at low pT, not very precise at higher momentum

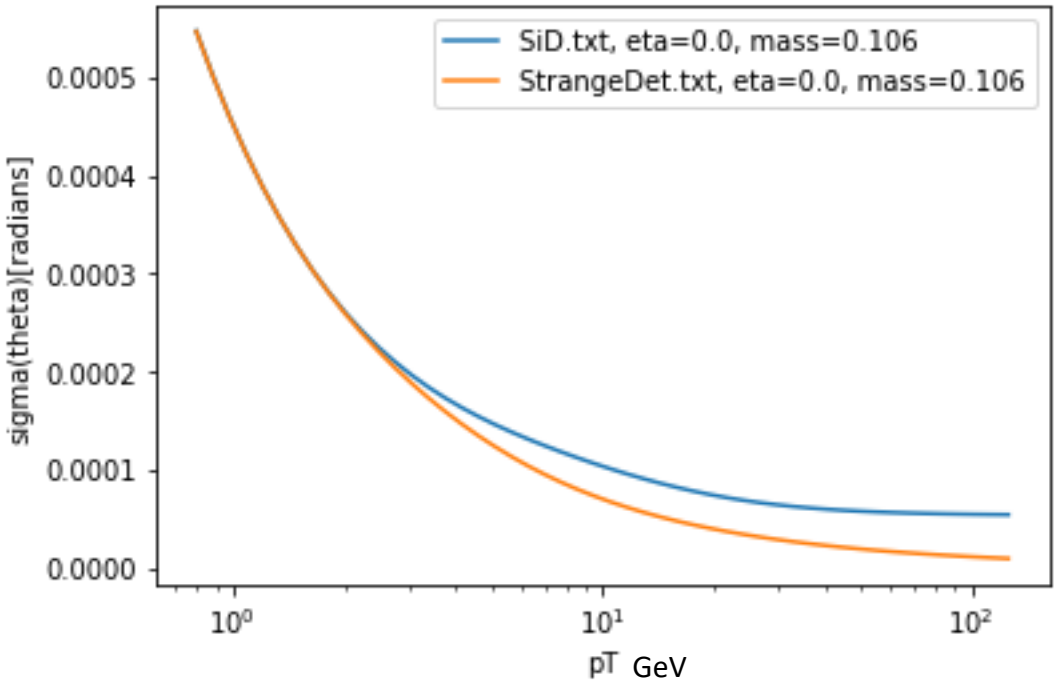
phi Resolution

B = 5 T



theta Resolution

B = 5 T



Next Steps

- Move layers to see if we can retain performance & gain 25 cm space
- Add timing layers to account for their material thickness