

# PERFORMANCE STUDIES

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**LPNHE, Paris VI&VII**

Talk given at ECFA -ILC workshop, Vienna, 14-17 November 2005

# Outline

- How to design and optimise Your own ILC detector on the back of an envelope:
  - Why size matters.
  - Only a TPC: Analytical calculations and fast simulation
  - Adding the rest: VD+SIT, SET, forward trackers
- Leading to:
  - A modest proposal
- Detailed studies of the SIT-SET-ECT
- Conclusions

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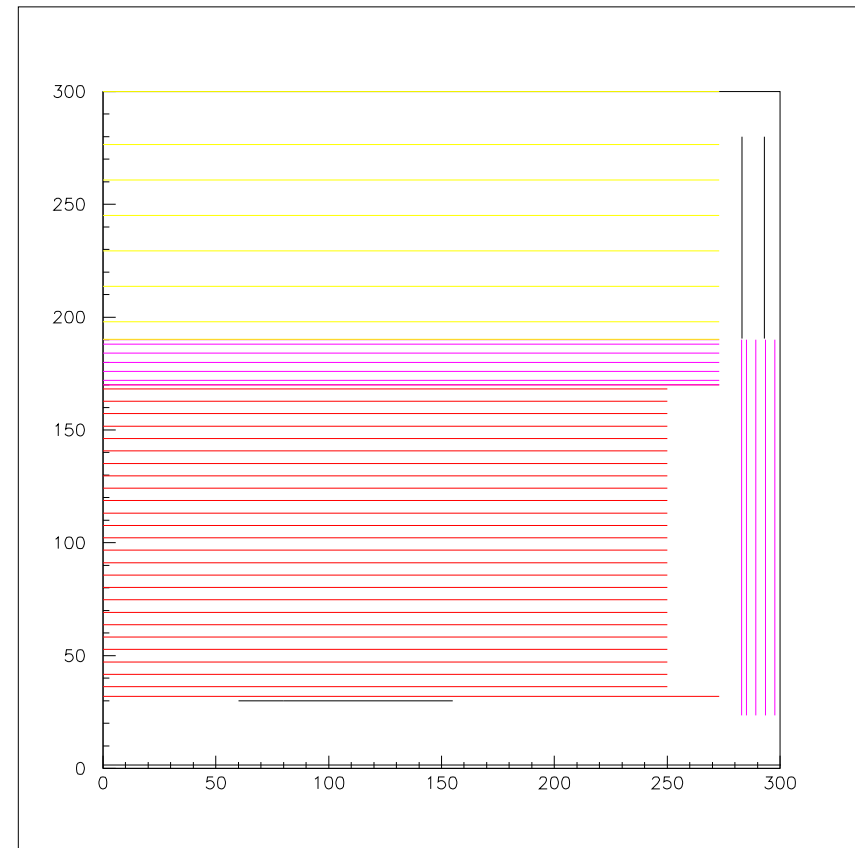
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- Three points, first and last point “fixed”:  $\sigma(S) = \sigma_{point}$
- Many points, all with the same error:
  - group the points in the first, second and third thirds.
  - Then  $\sigma(S) \approx (\sigma_{point} / \sqrt{n/3}) \sqrt{6}/2$ .
  - L should be reduced by one third since the first point is in the middle of the first third, the last in the middle of the last third!

This simple rule is good to  $\sim 30\%$ .

# TPC alone

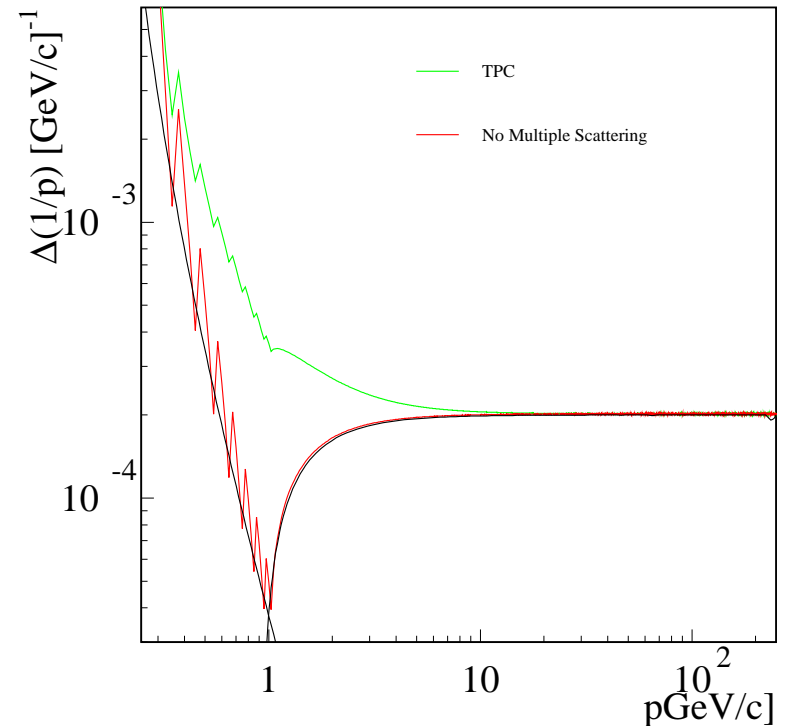
Lets see what the TPC alone gives. As an example:  $R_{inner} = 36.2\text{cm}$   $R_{outer} = 168.2\text{ cm}$ , (ie  $L = 132\text{cm}$ ),  $Z_{max} = 250\text{ cm}$ ,  $B = 4\text{T}$ ,  $\sigma_{point} = 60\ \mu$ , 25 layers.



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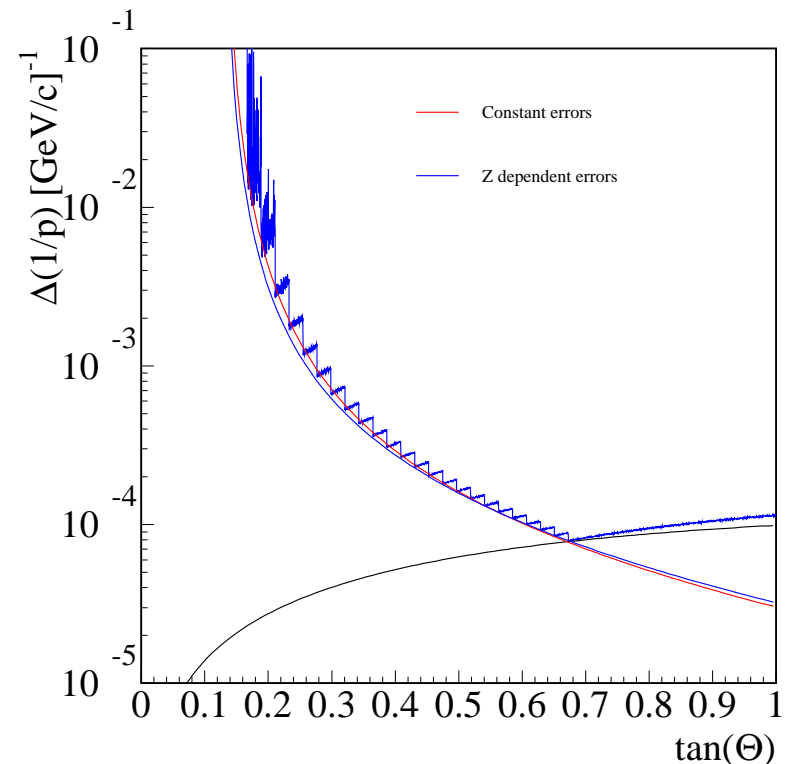
- Expect  $\sigma(1/p) \propto \sin\theta/L^2$  in the barrel, and  $\propto \sin\theta/(\tan^{5/2}\theta - (Z_{max}/R_{inner}))$  in the forward. The extra  $1/\sqrt{\tan\theta}$  because in the forward region,  $n_{points} \propto L$ . At  $90^\circ$ . The thu.mb-rule gives 35 % more than the exact result from SGV.



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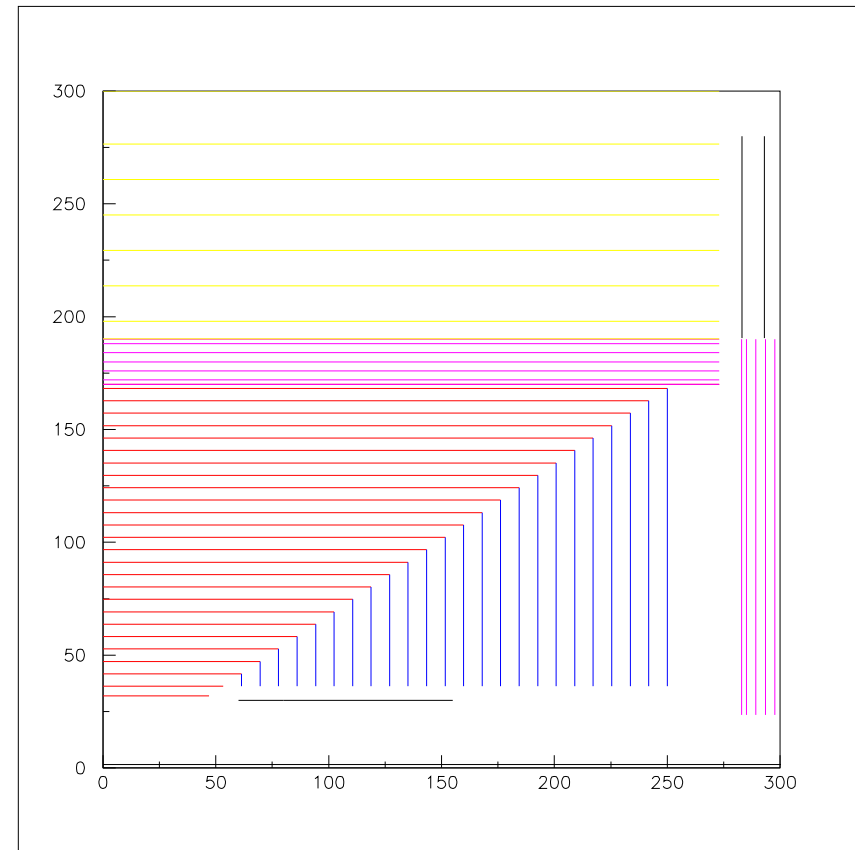




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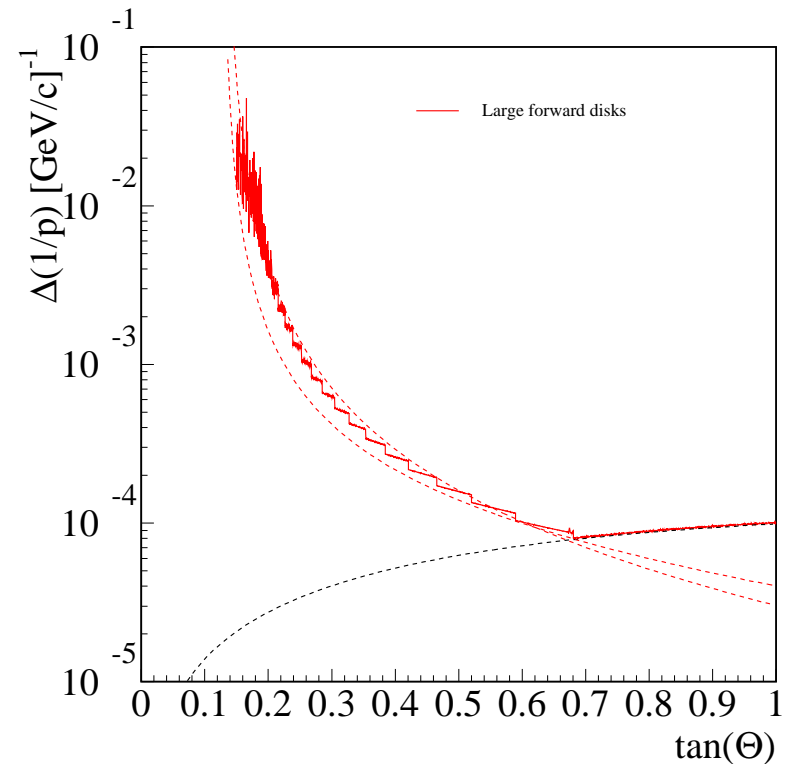
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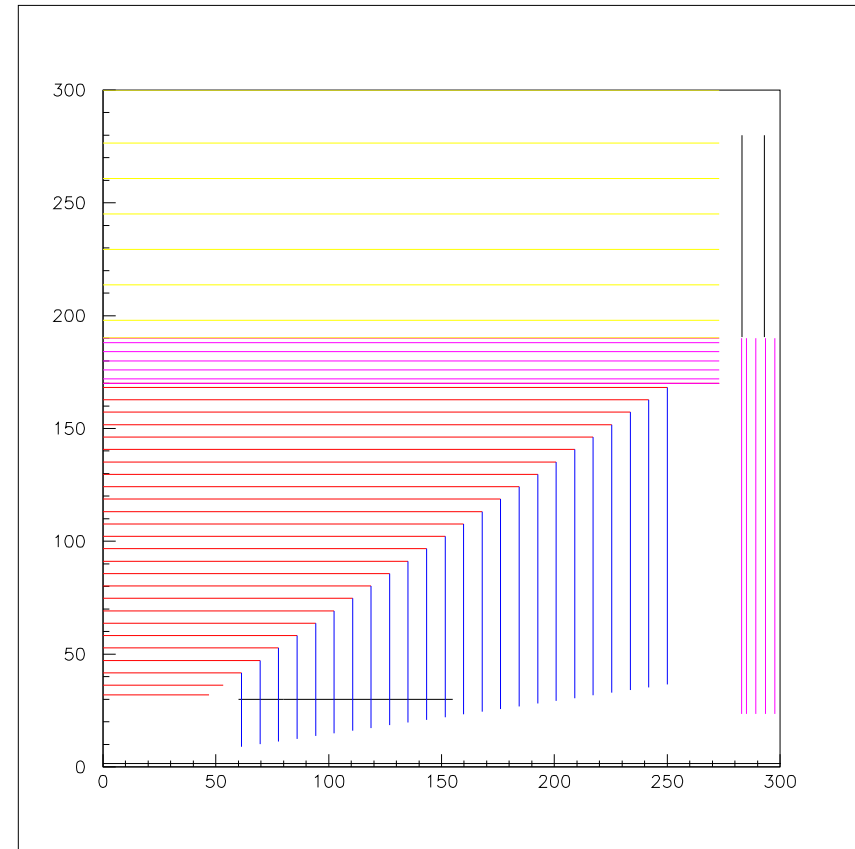
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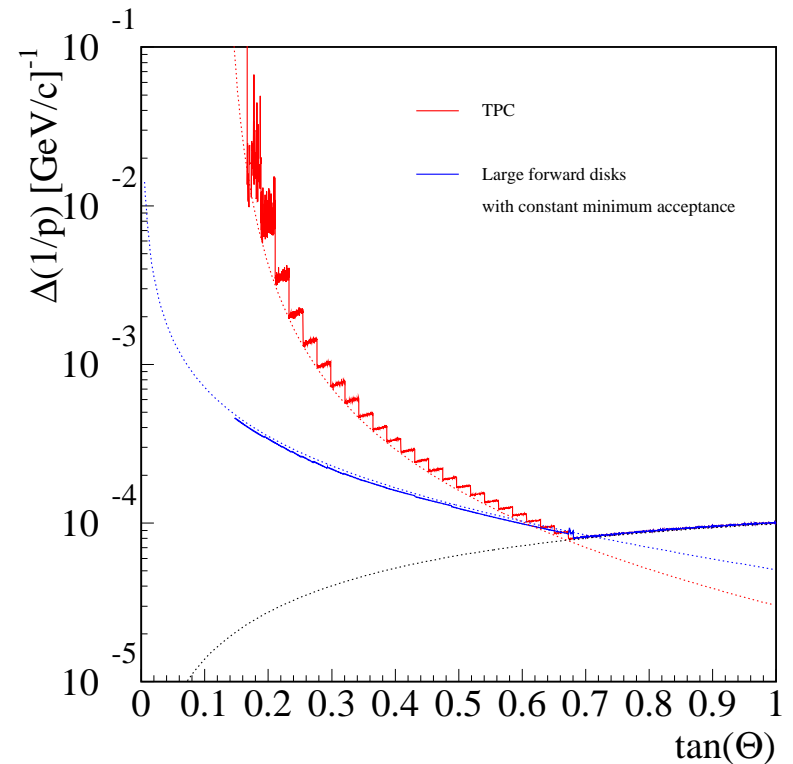
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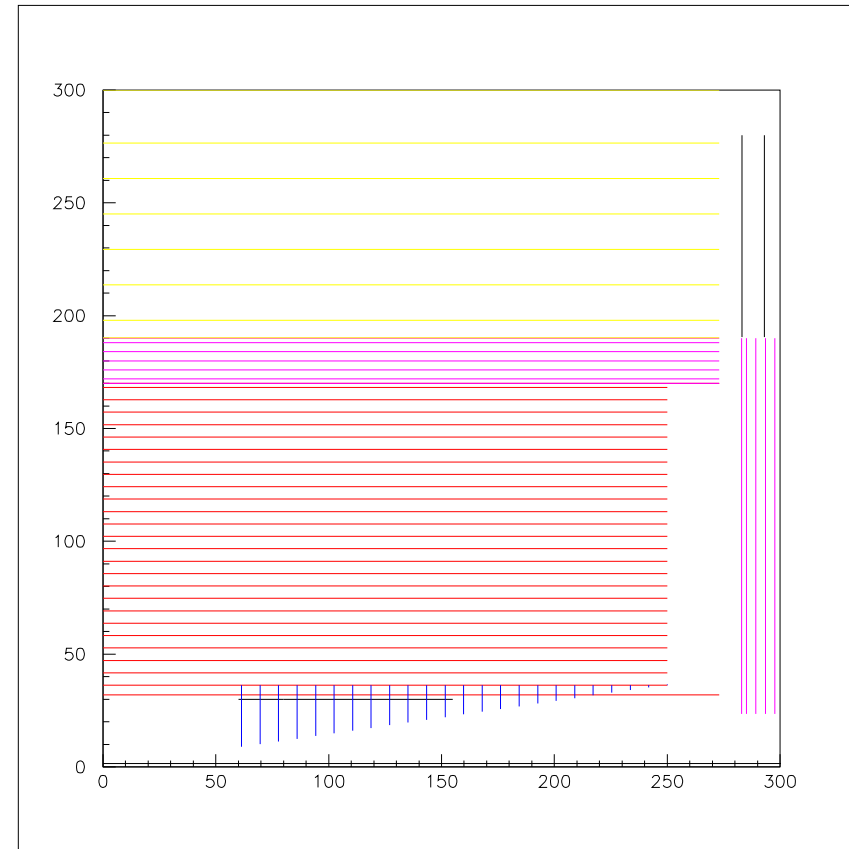
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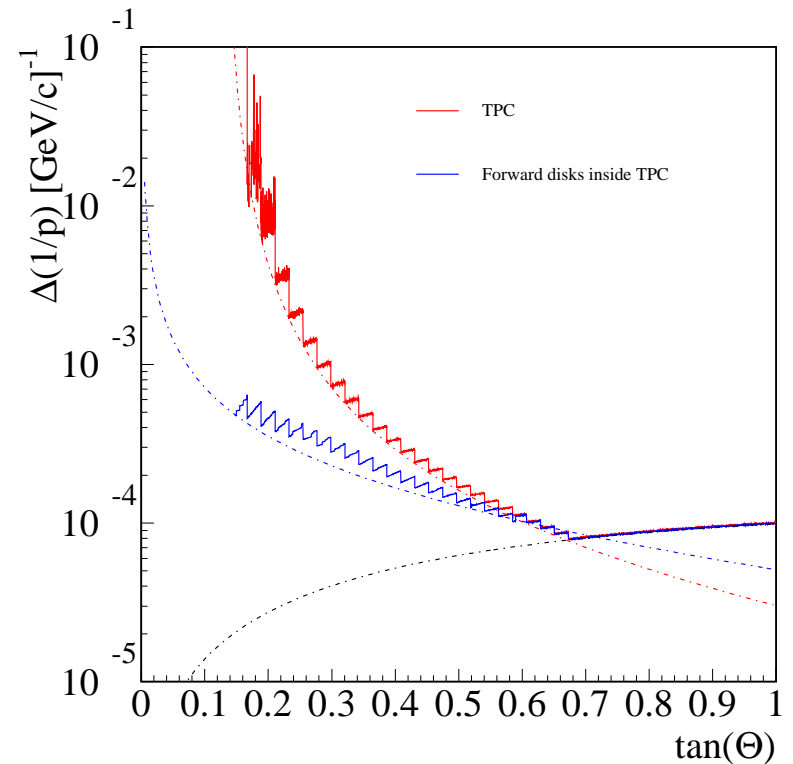
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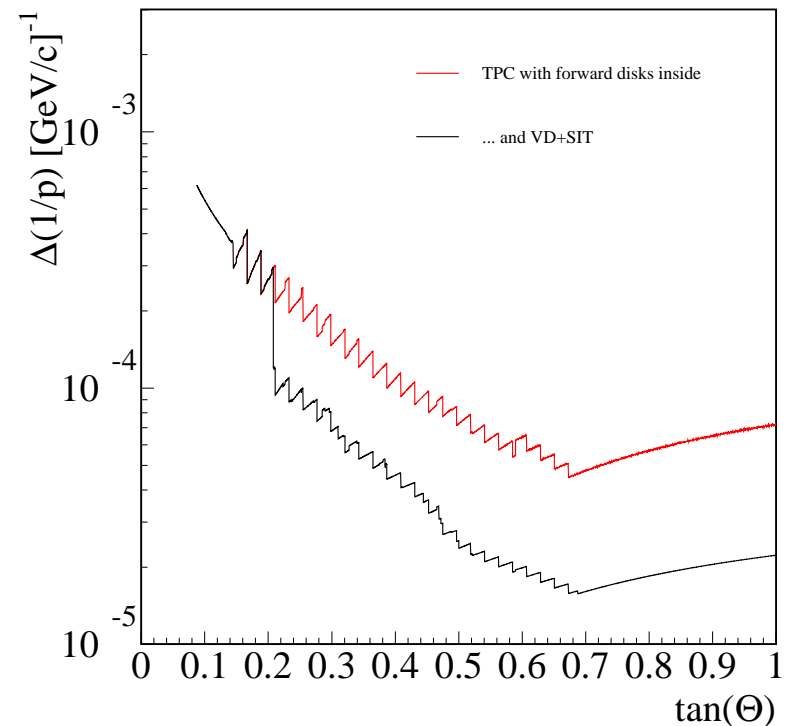
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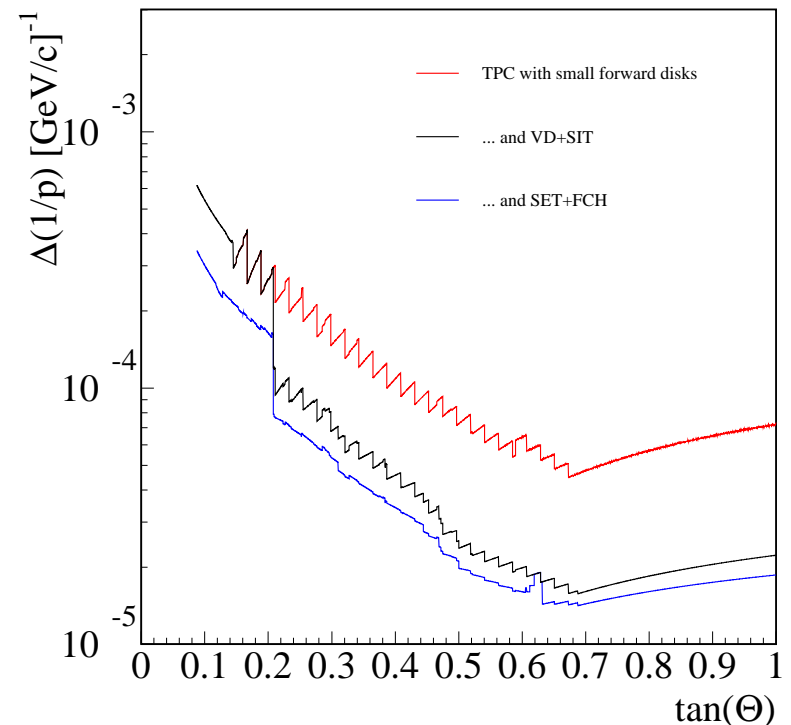




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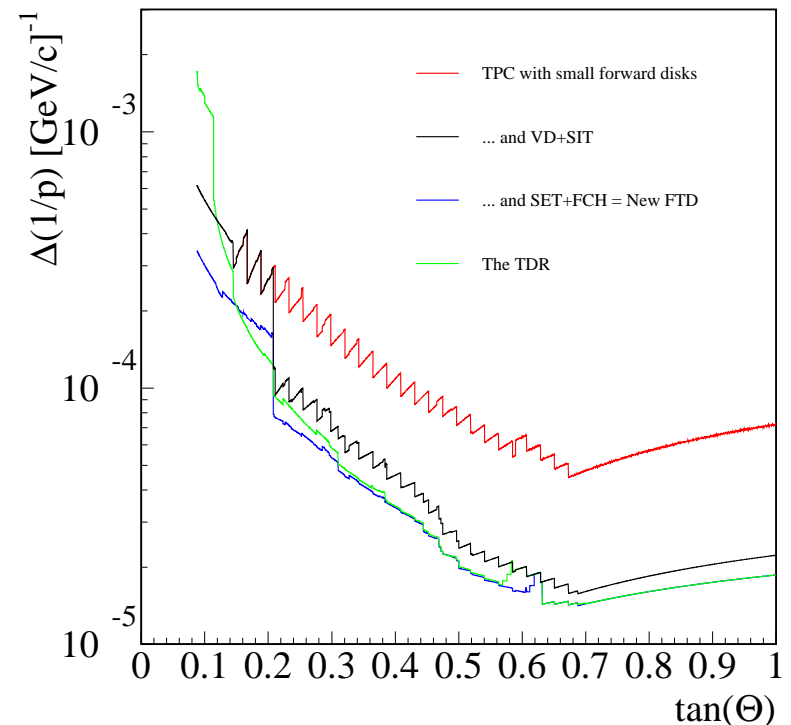
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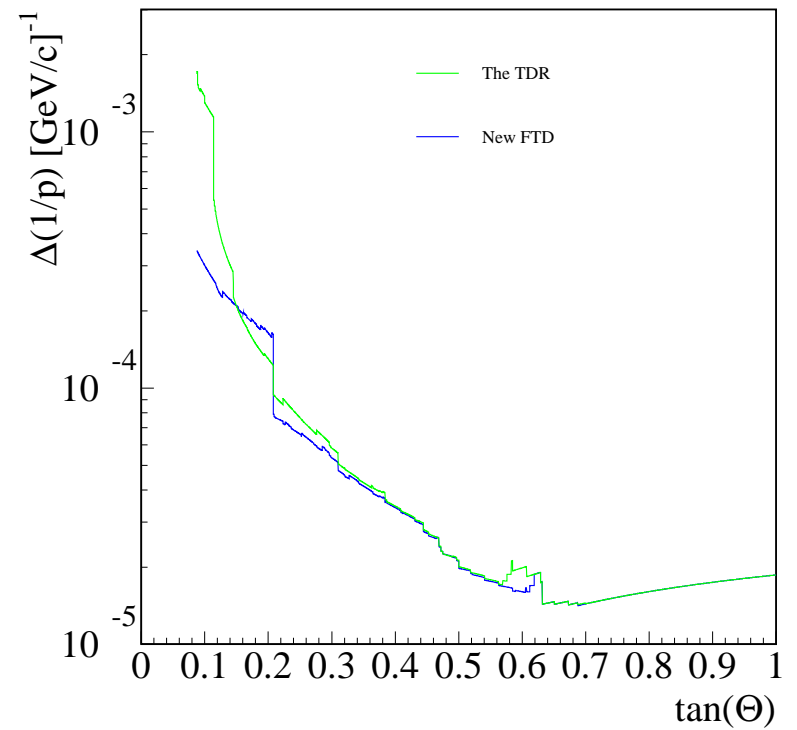
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- **SET:** *effective L* increases from 146 to 170 cm, and  $\sigma(S)$  decreases by 10 %. Expect 35% better. Forward chambers: similar to the SET
- The base-line LDC (“TDR”): **Differs in the geometry of the FTD**



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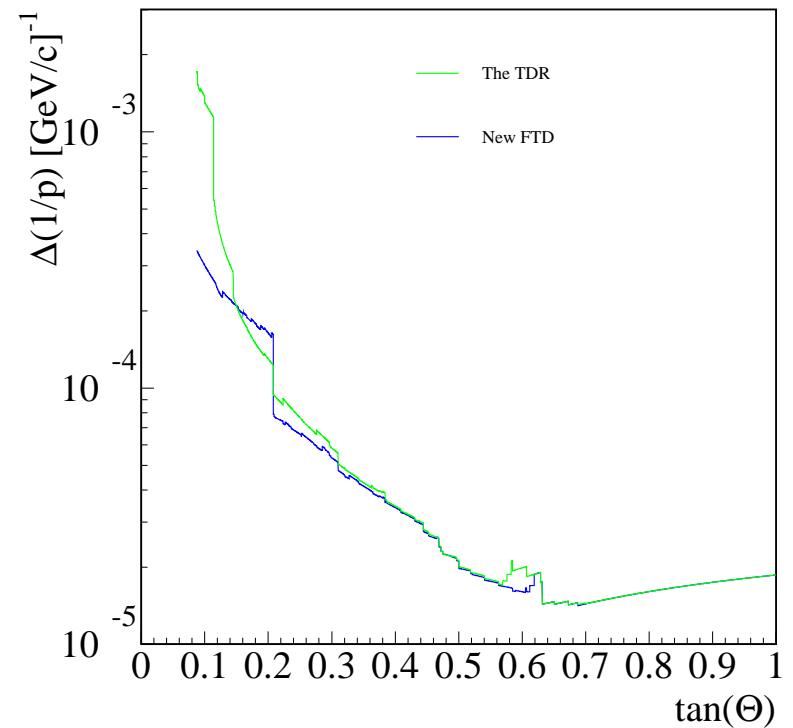
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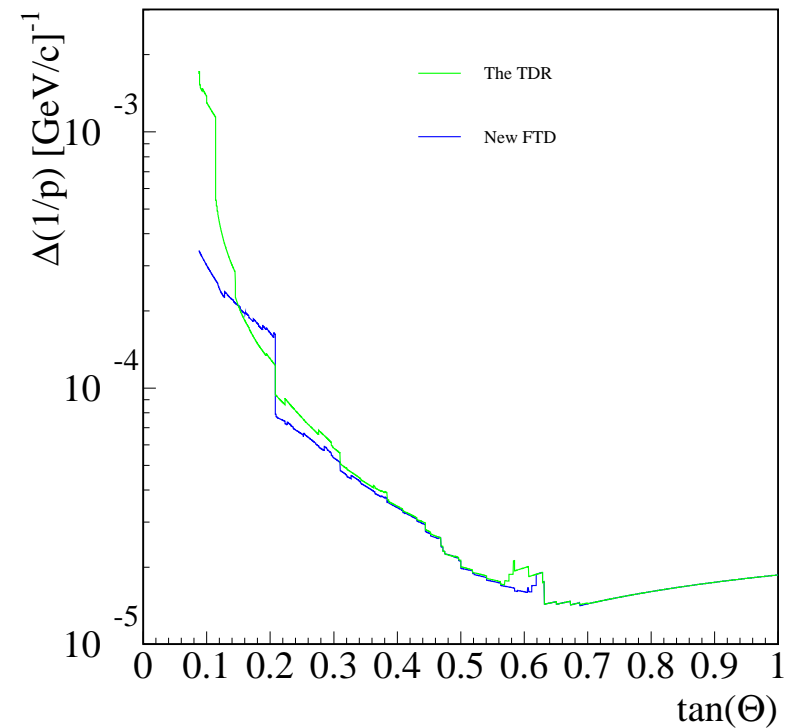
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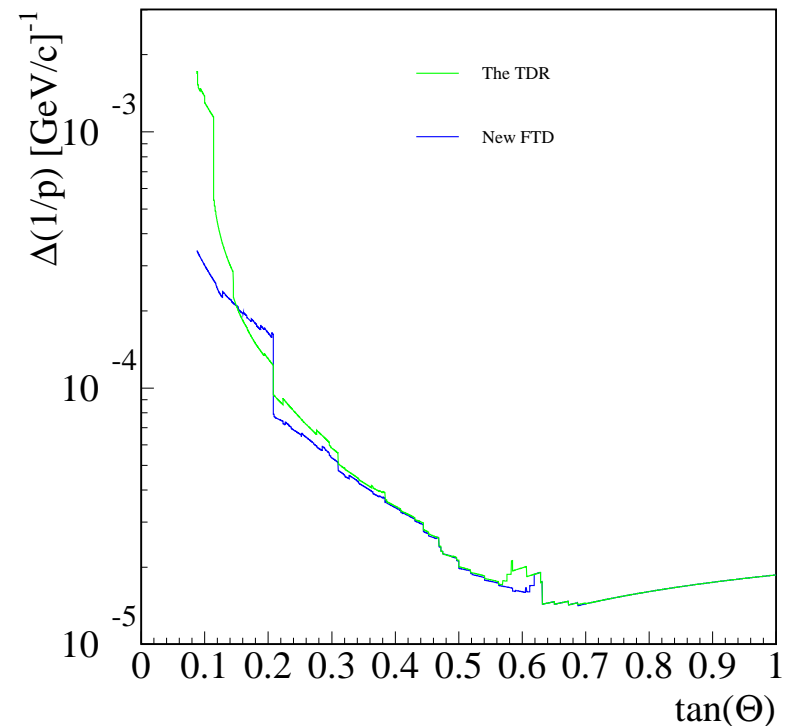
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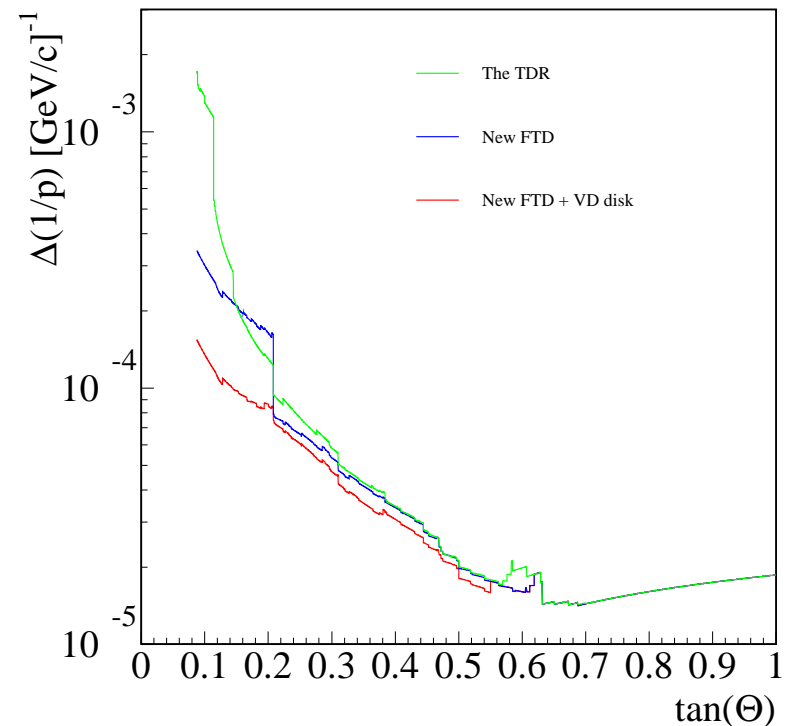
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- Remedy II: Add a *pixel disk* with  $\sigma_{point} = 4\mu$  just outside the VD



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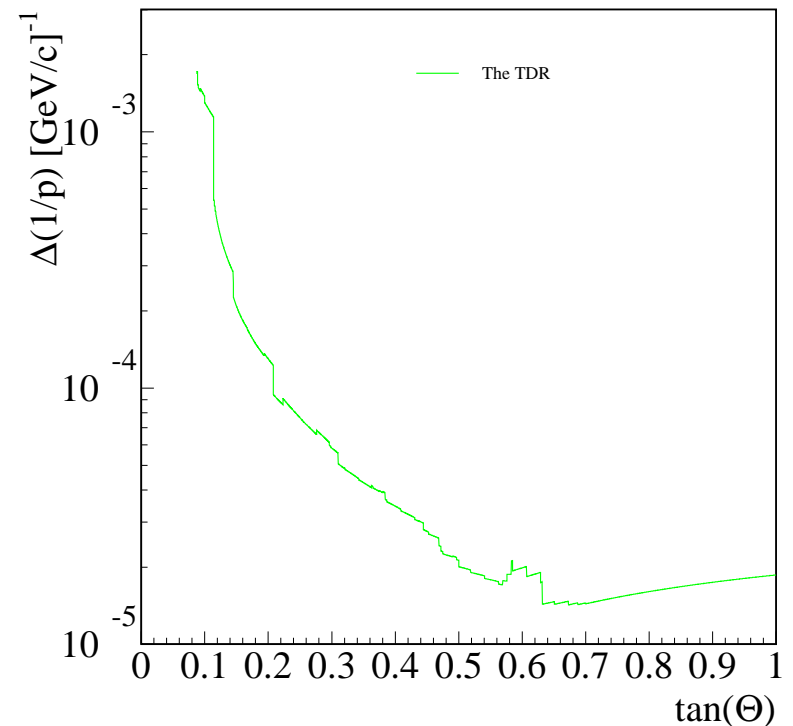
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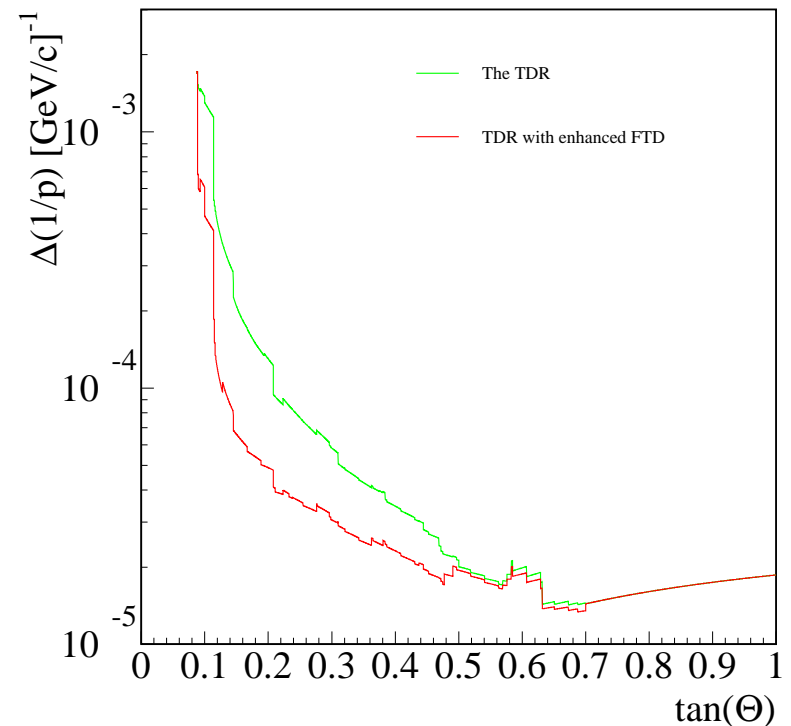
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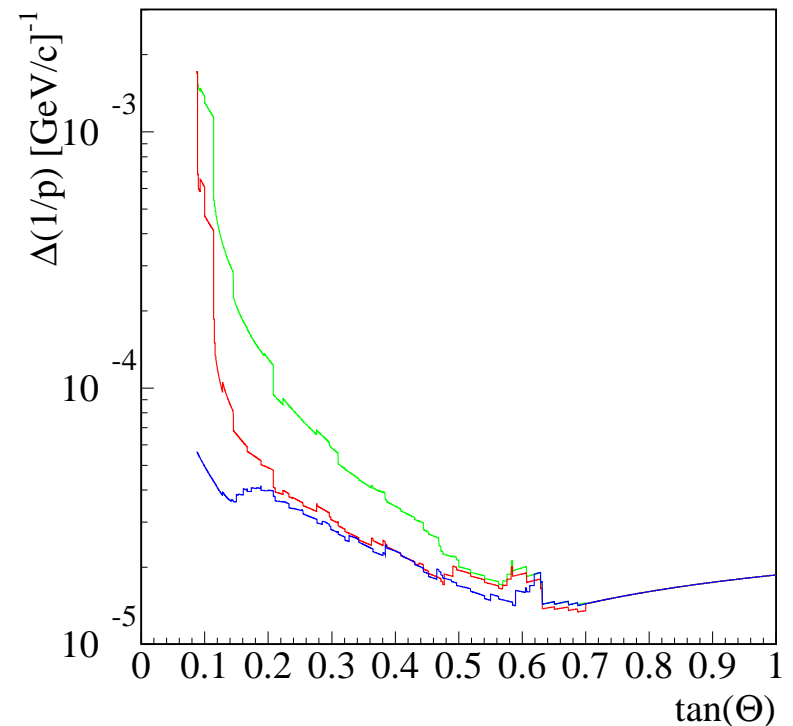
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- The redesign, with the 12 discs replaced by discs with  $7\mu$  resolution.



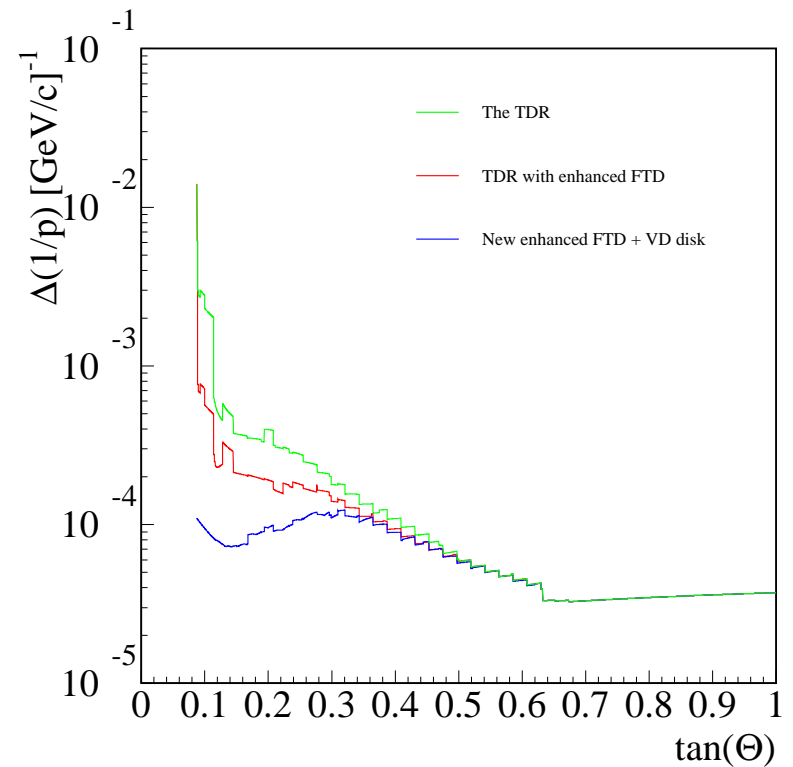
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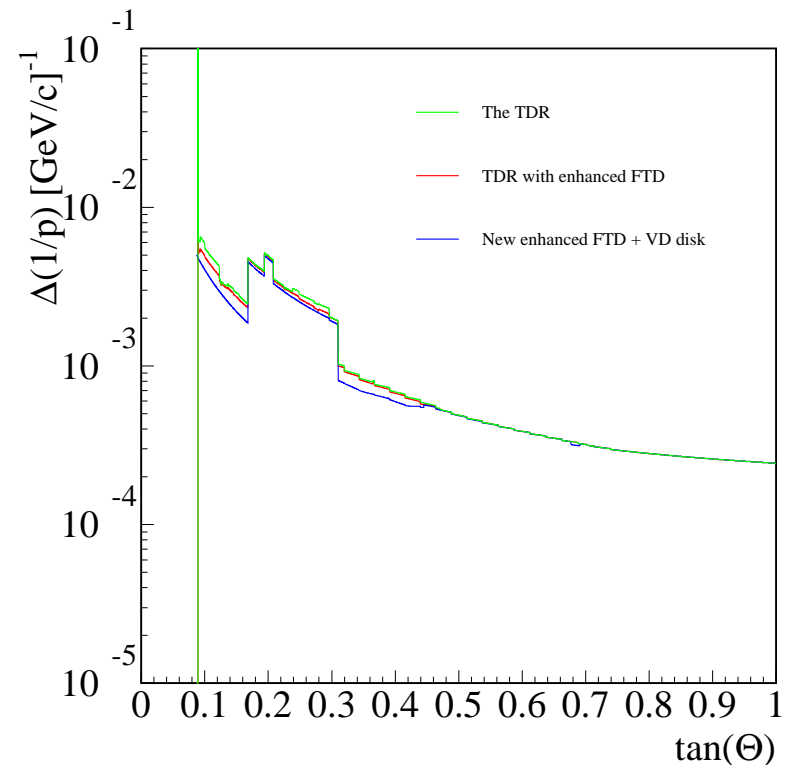
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- 25 GeV: The redesign is still much more performant at low angles
- 2.5 GeV: Dominated by multiple-scattering. The bump is the VD electronics and support



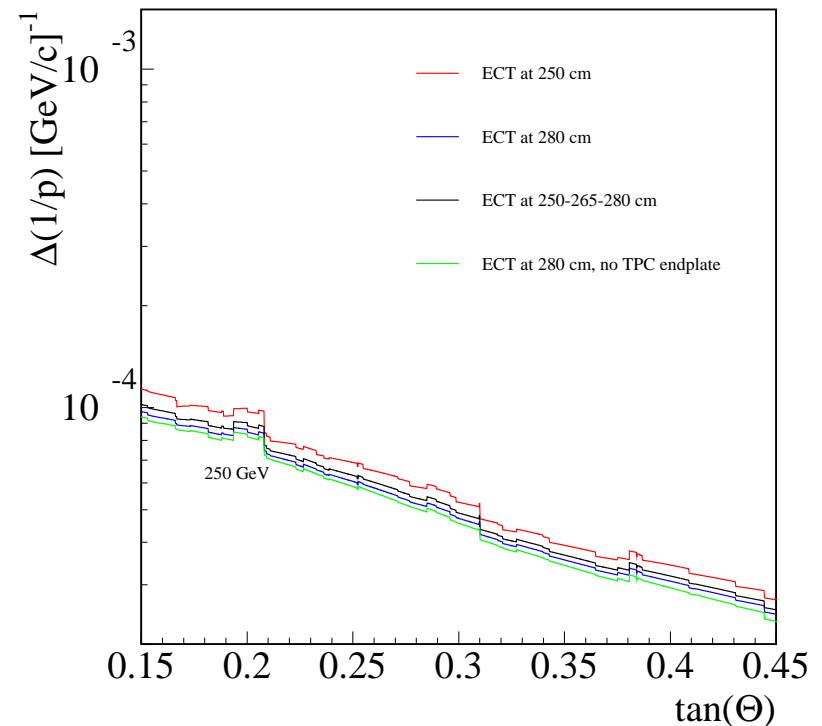
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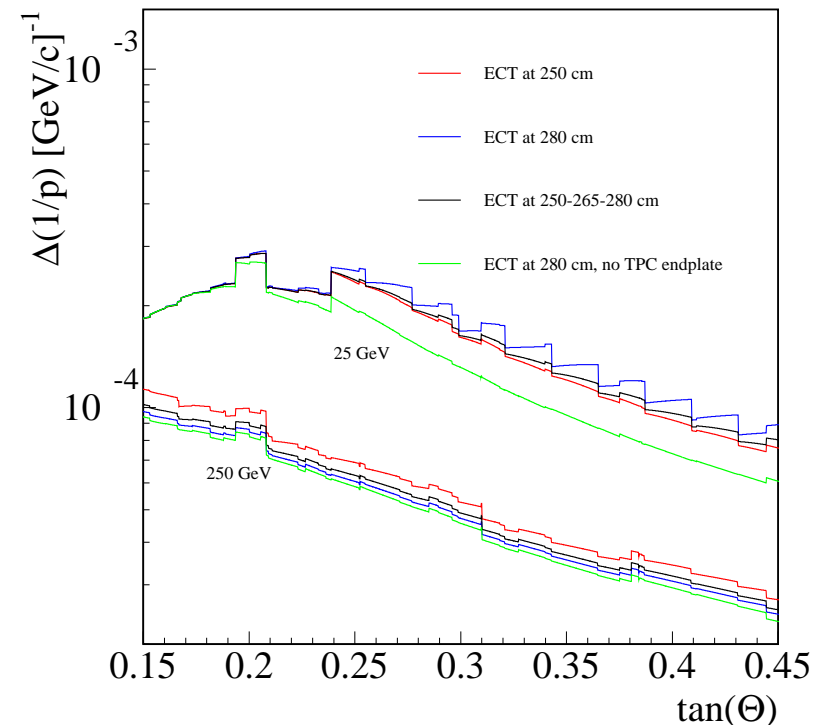




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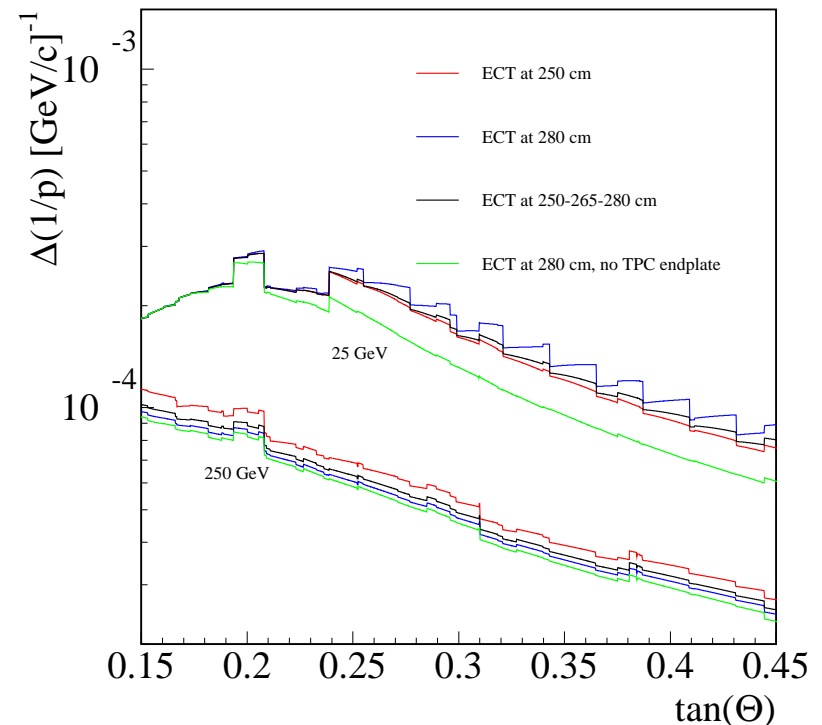


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It is best to have a very precise point close a scattering surface



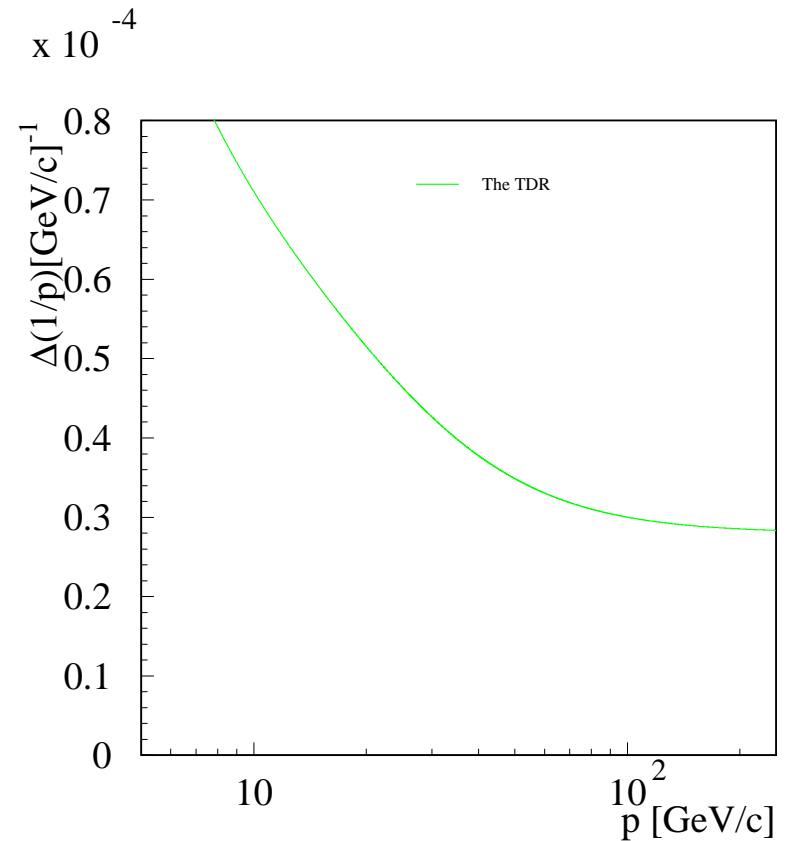
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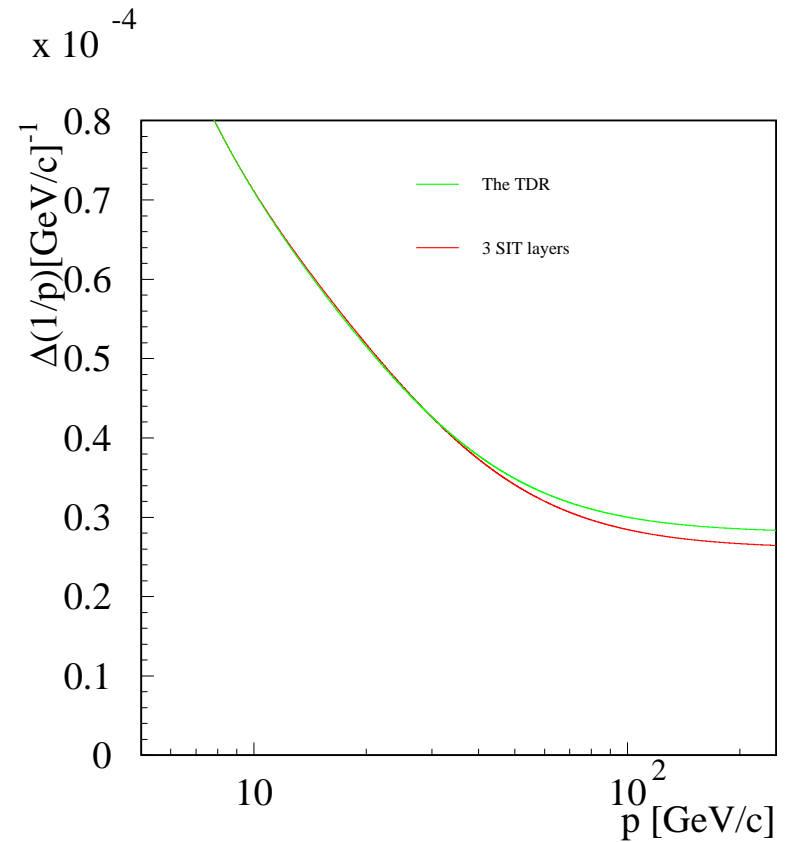
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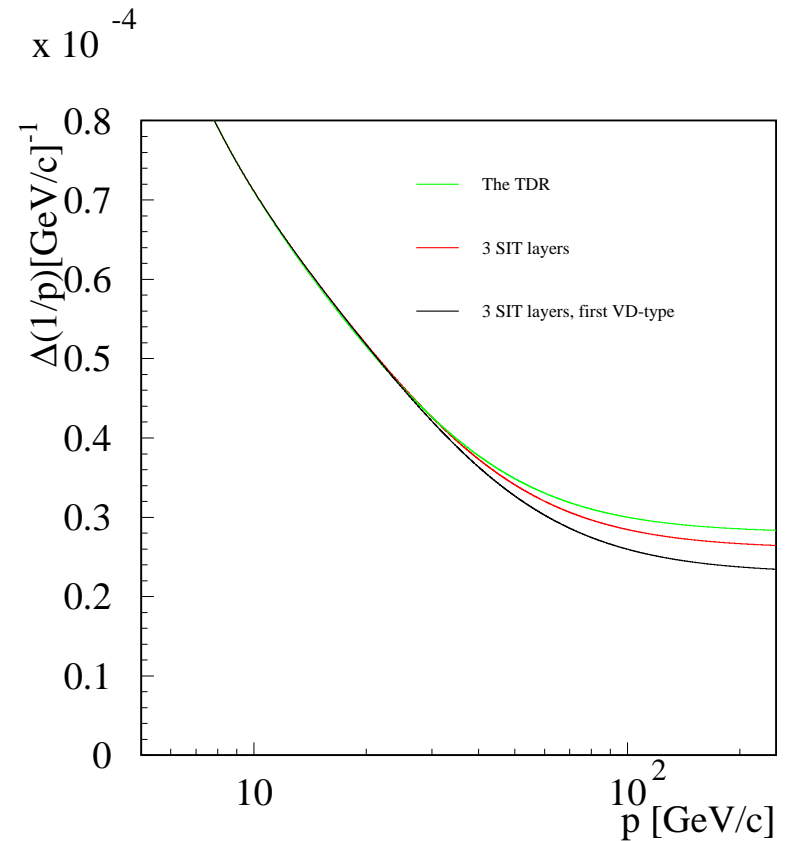
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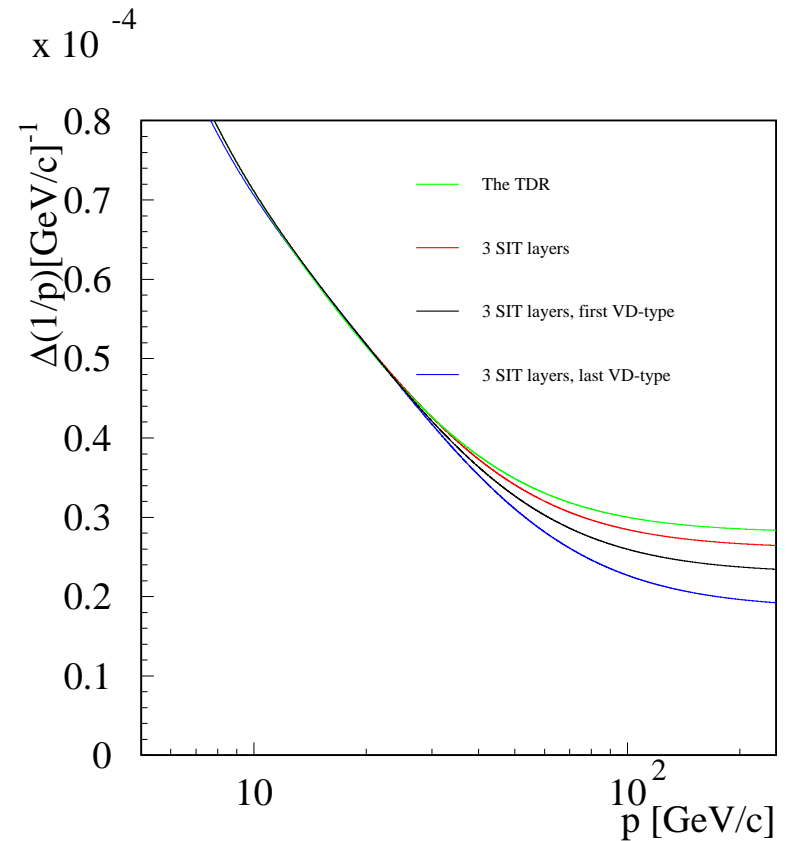
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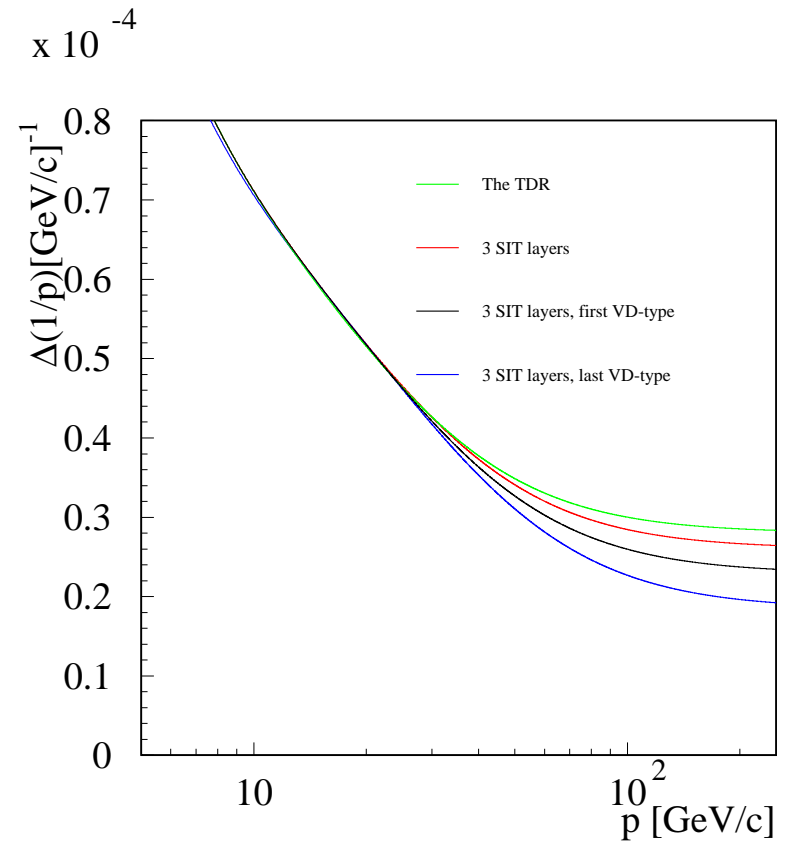


# Studies of the silicon envelope: SIT

Does it help to have more layers in the SIT. Or more precise ones?

- TDR
- 3 layers,
- 3 layers with the inner-most of VD-type ( $4 \mu$ )
- 3 layers with the outer-most of VD-type ( $4 \mu$ )

It is best to have a very precise point close a scattering surface





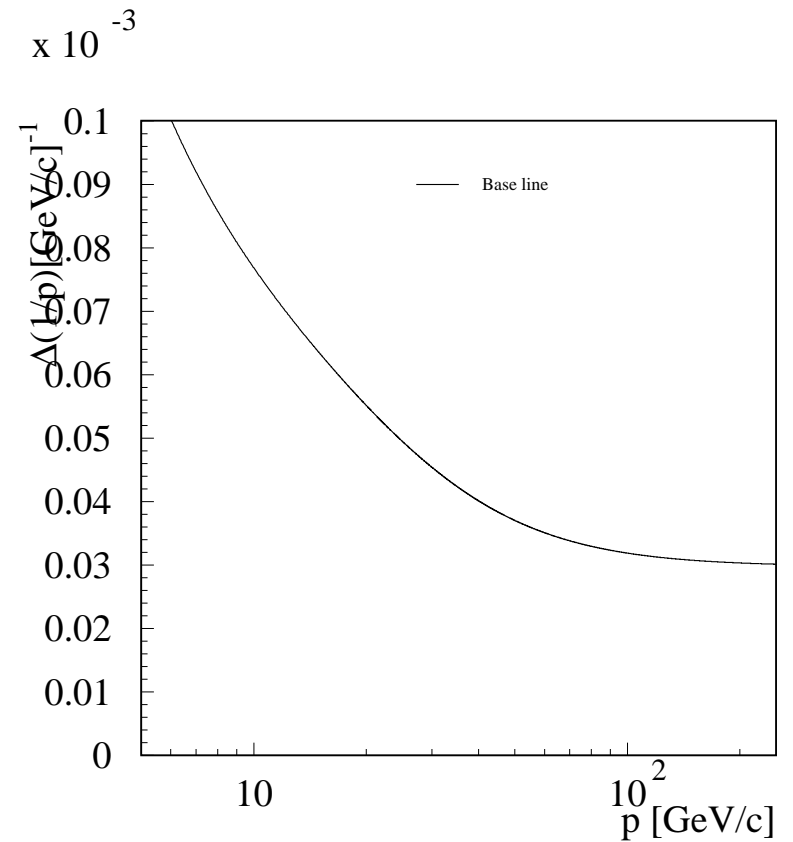
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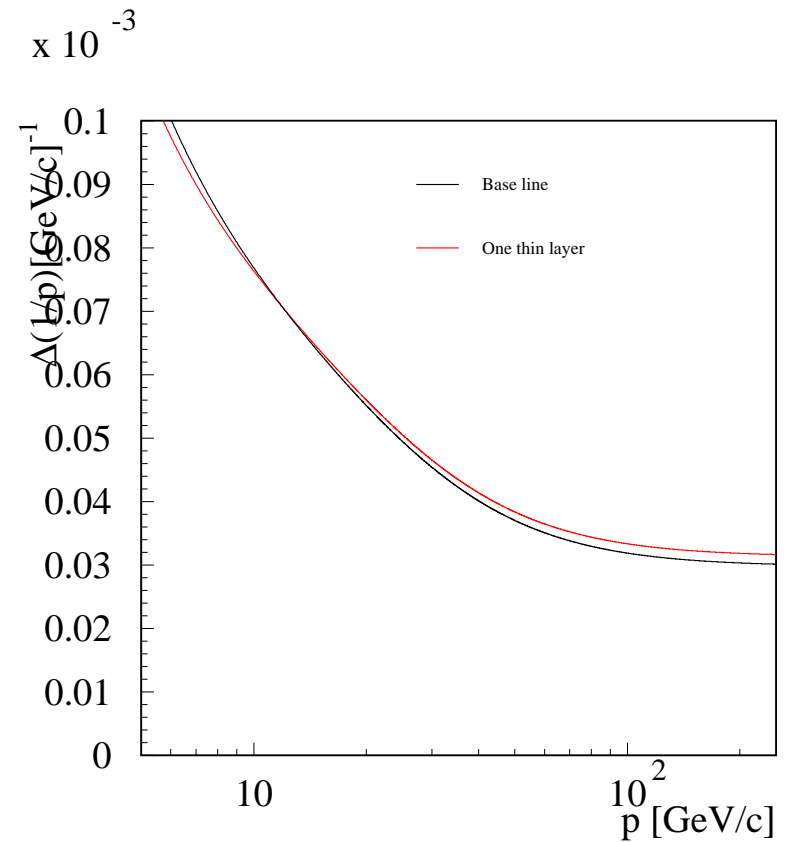
- TDR+SET: SET takes 10 cm of the TPC, and has three layers with 25  $\mu$ resolution



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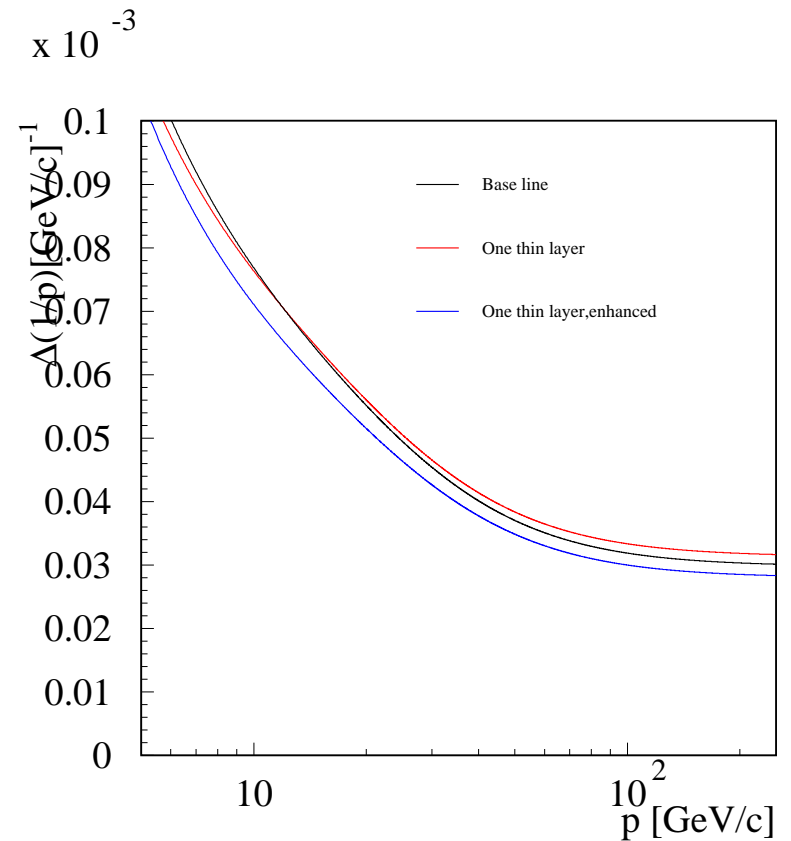
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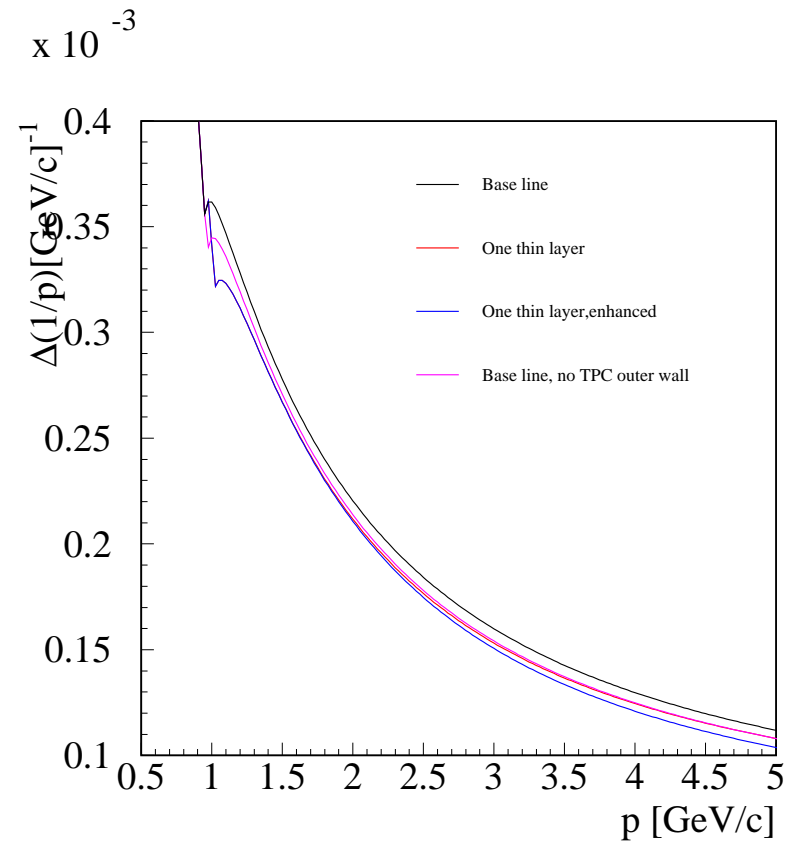
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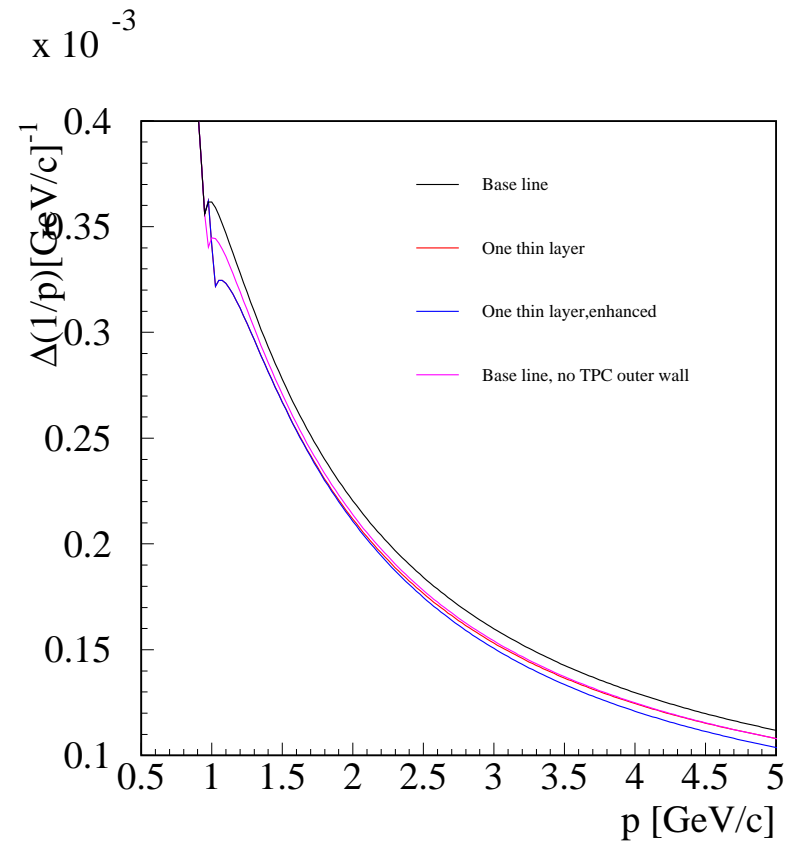


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Scattering makes little difference, since the SET is quite short. At high momentum, the  $1/L^2$ -factor favours pushing the SET as far out as possible, and at lower momenta, it is more worthwhile to retain as much as possible of the TPC lever-arm.



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- These results are based on fast simulation (SGV). Hence important **issues related to reconstruction are NOT addressed**