PERFORMANCE STUDIES

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LPNHE, Paris VI&VII

Talk given at the SilC workshop, Paris, 2-3 February 2006

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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- $\sigma(1/p) = (330/B) \sin\theta\sigma(\rho)$ (ie. $\sigma(p) = (330/B)\, p^2 \sin\theta\sigma(\rho)$)

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- 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 ∼30 %.

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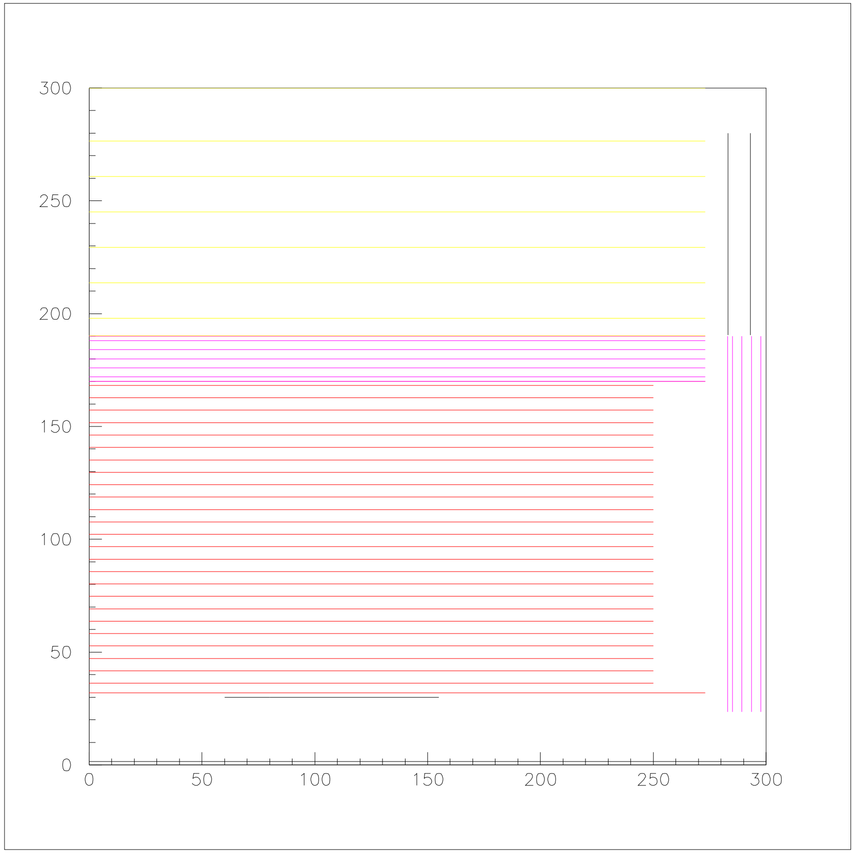
Lets see what the TPC alone gives. As an example: $R_{inner} = 36.2$cm $R_{outer} = 168.2$ cm, (ie $L = 132$cm), $Z_{max} = 250$ cm, $B = 4$T, σ_{point} =60 μ, 25 layers.



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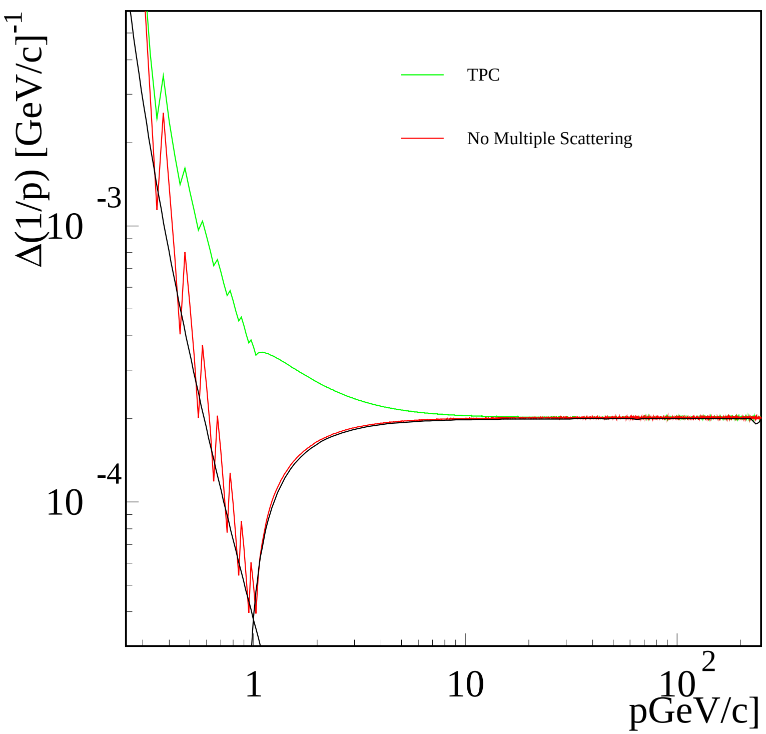

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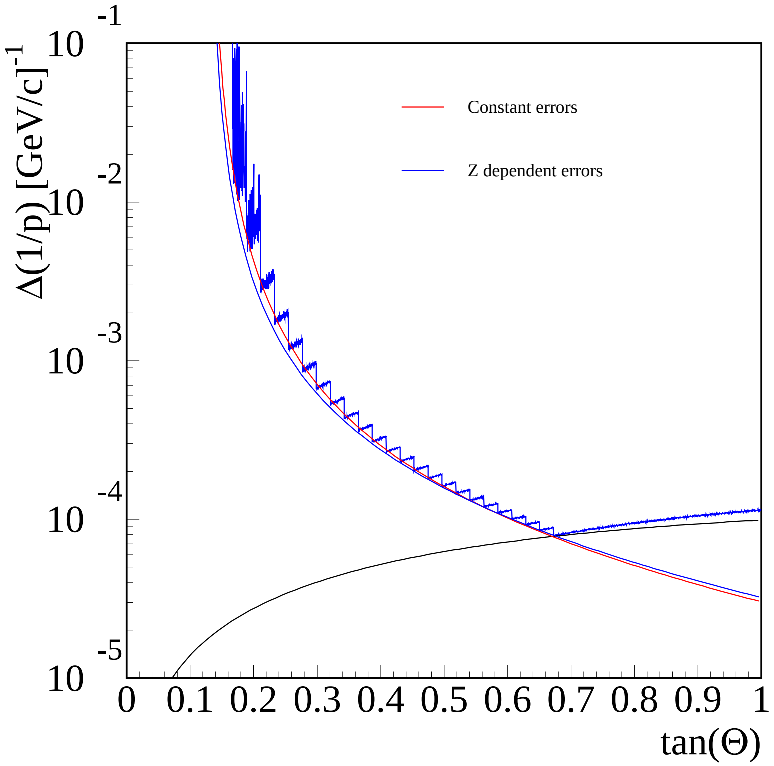

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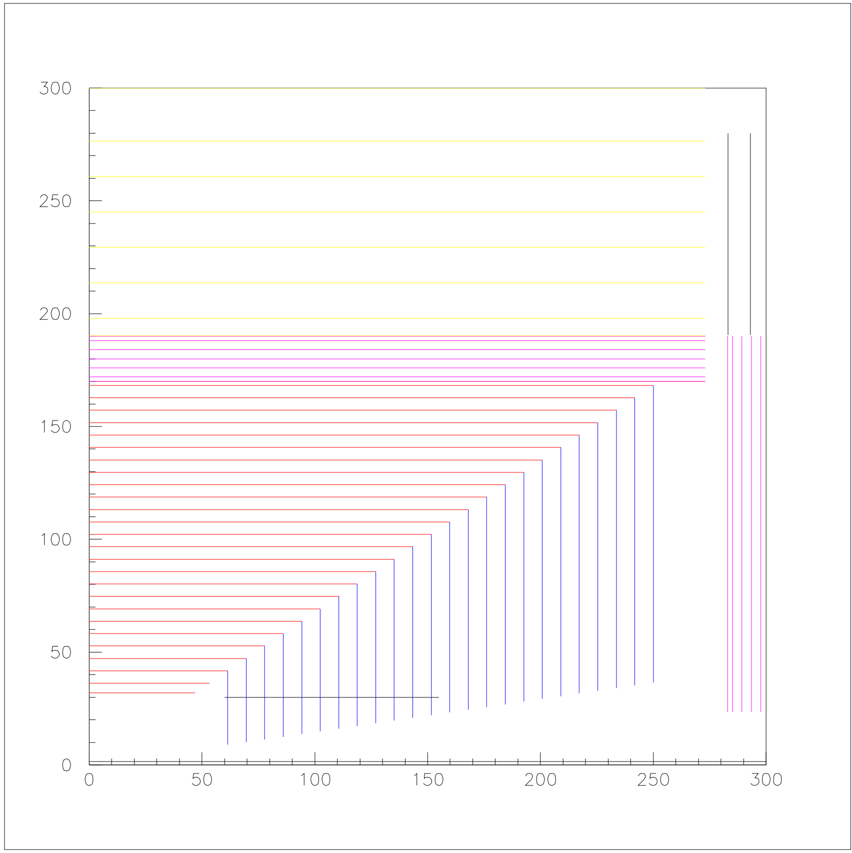

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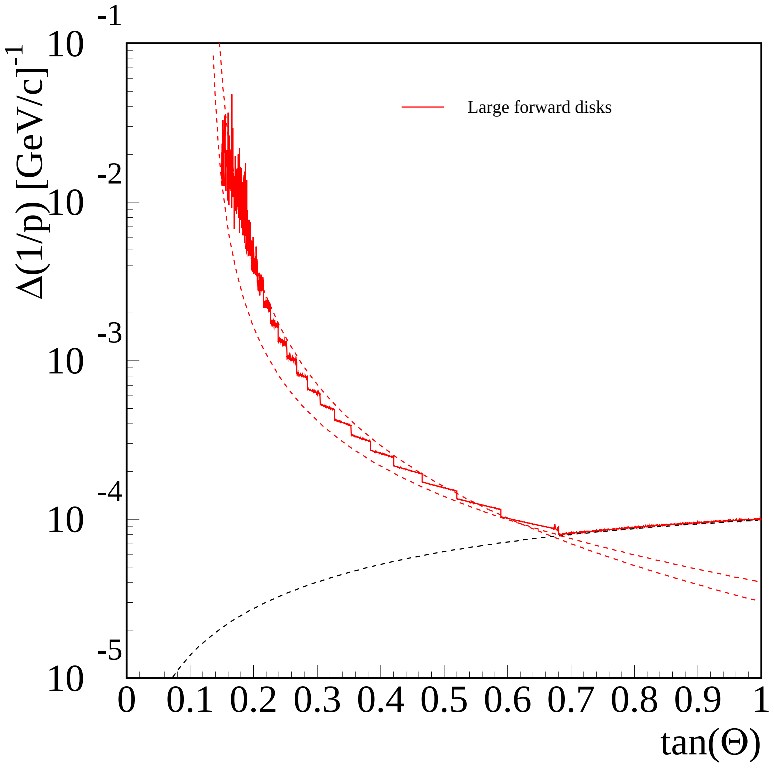

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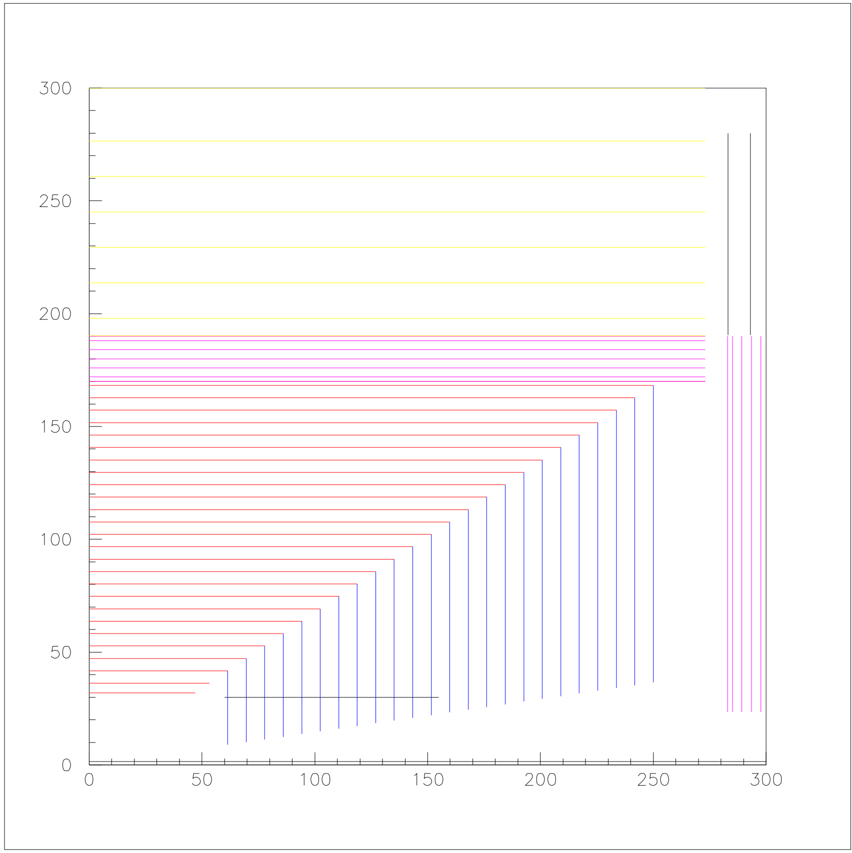

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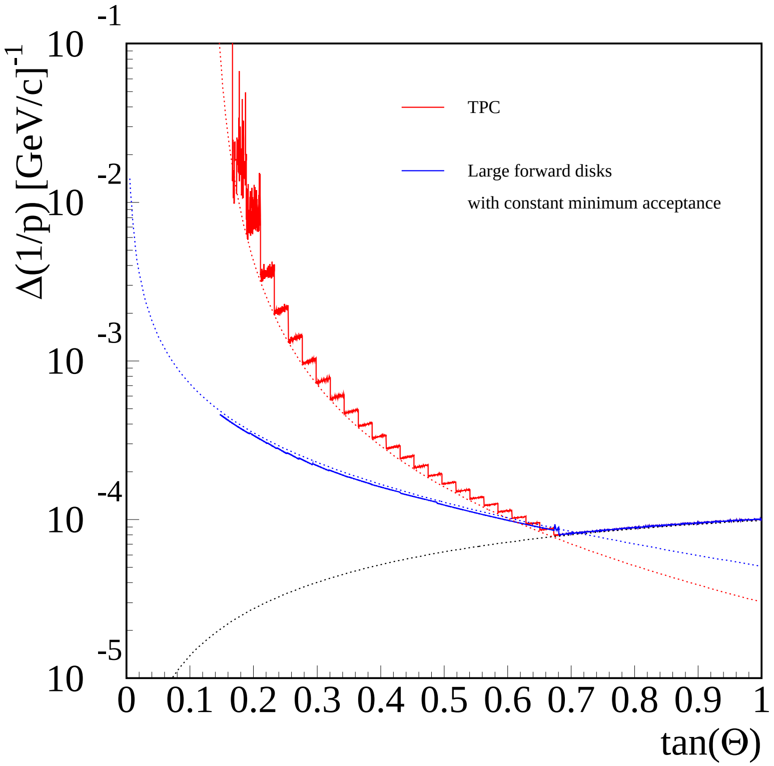

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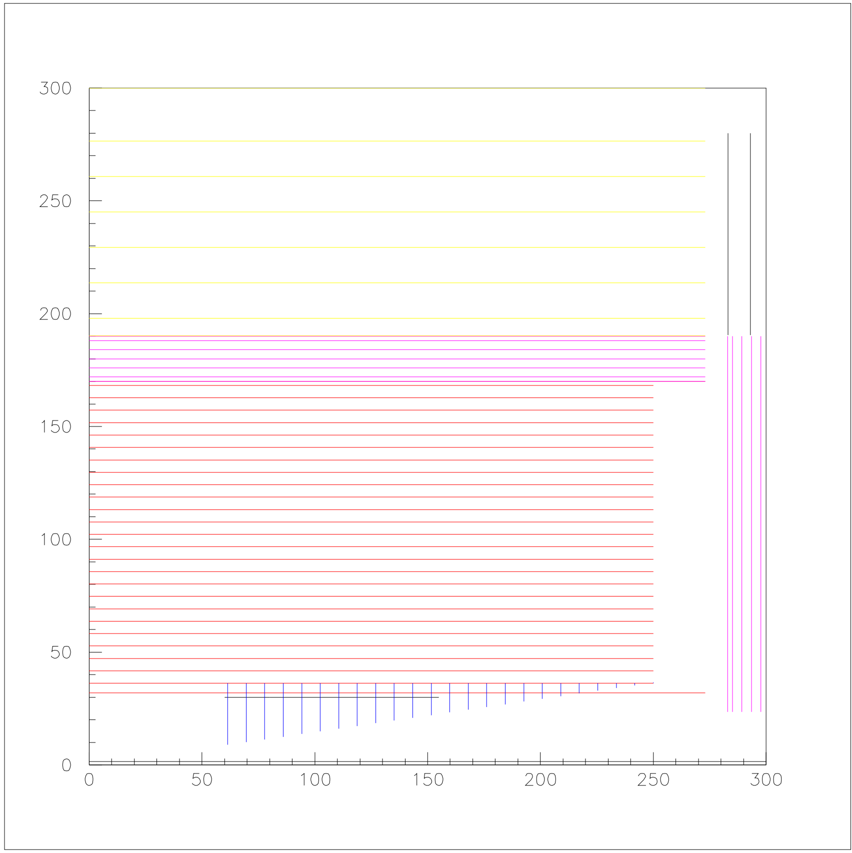

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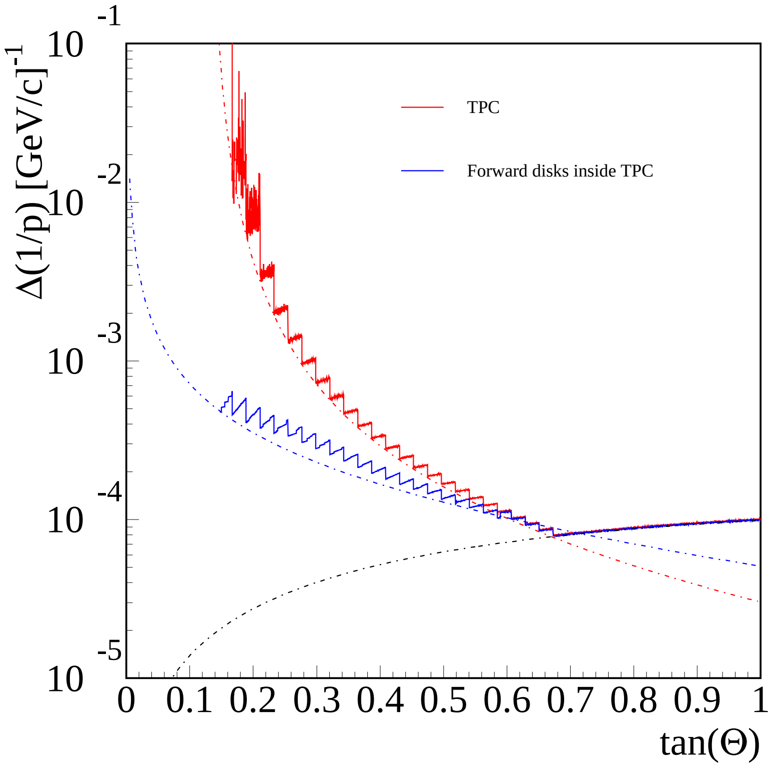

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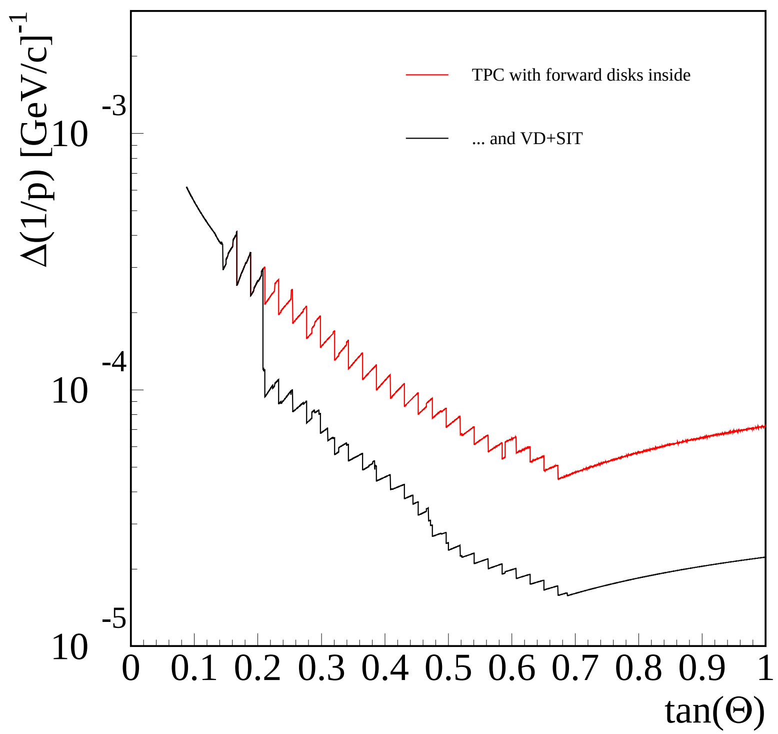
- Vertex detector and SIT: The *effective L* increases from 88 cm to 146 cm, ie $1/L^2$ decreases by a factor 2.8. The *start-point is now "fixed"* so $\sigma(S)$ decreases by 10 %. Expect a factor 3



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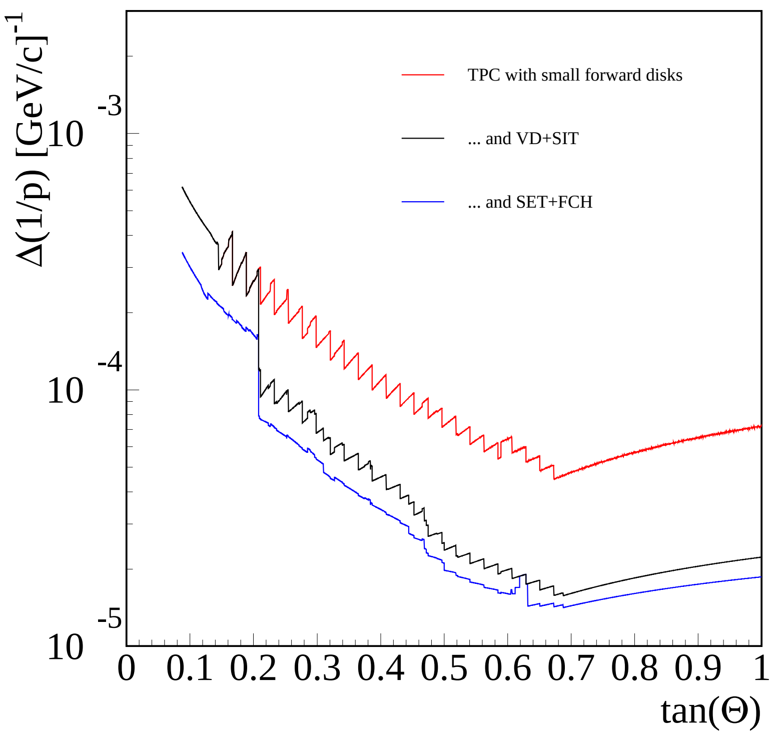

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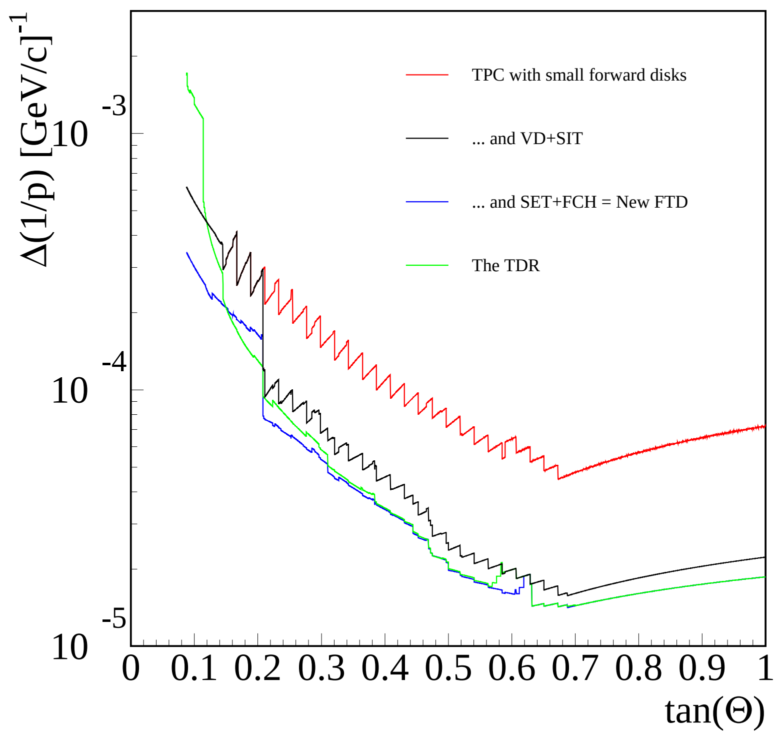
- The base-line LDC ("TDR"): Differs in the geometry of the FTD



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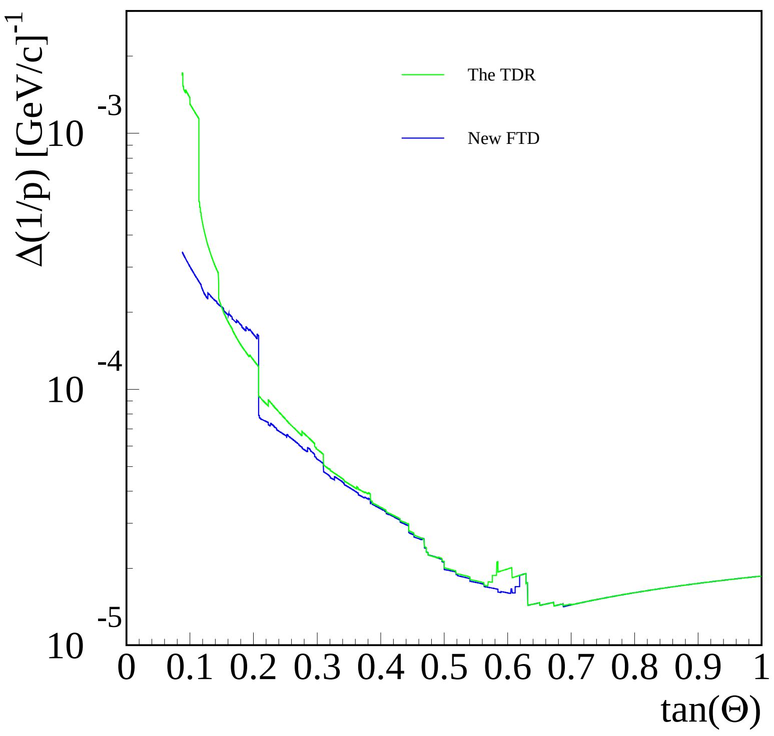

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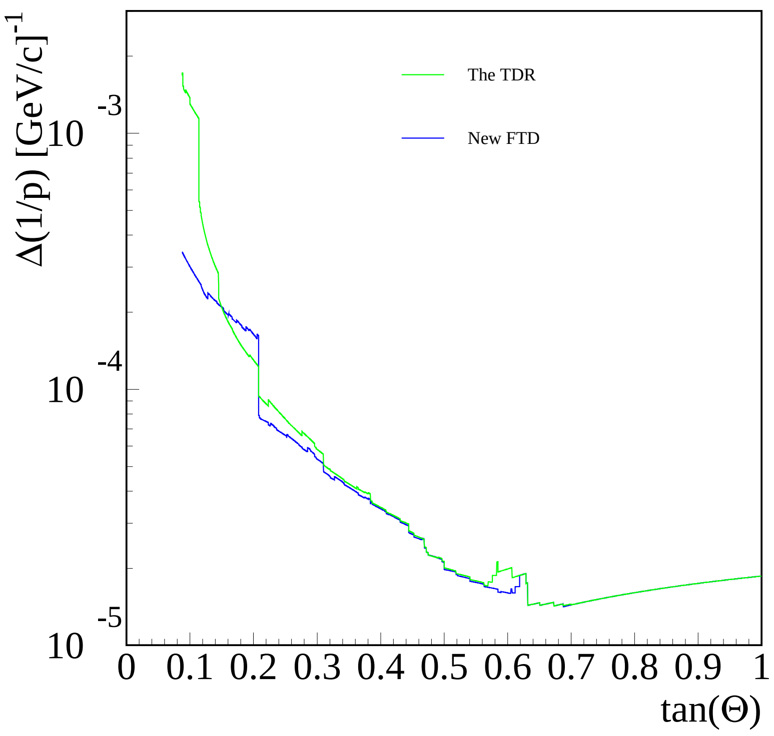

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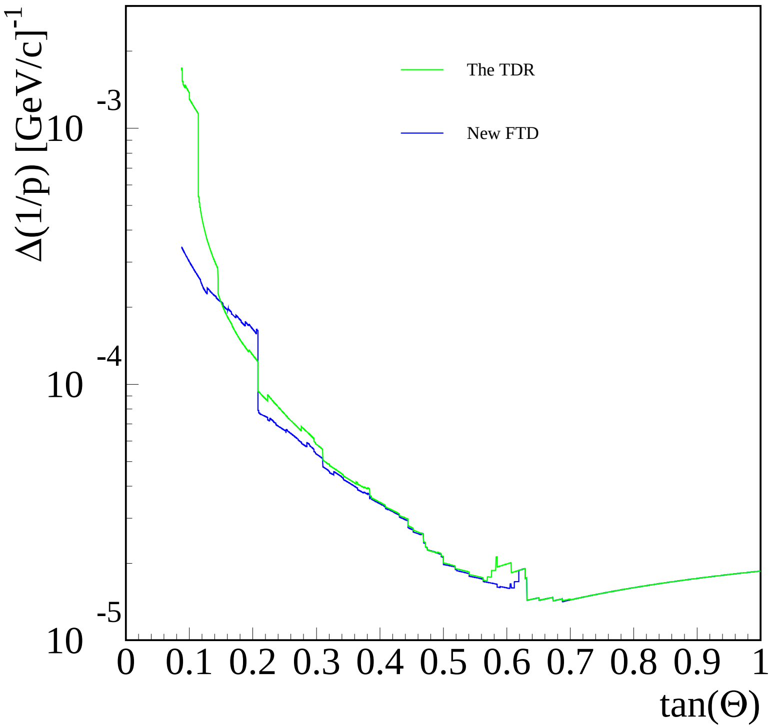

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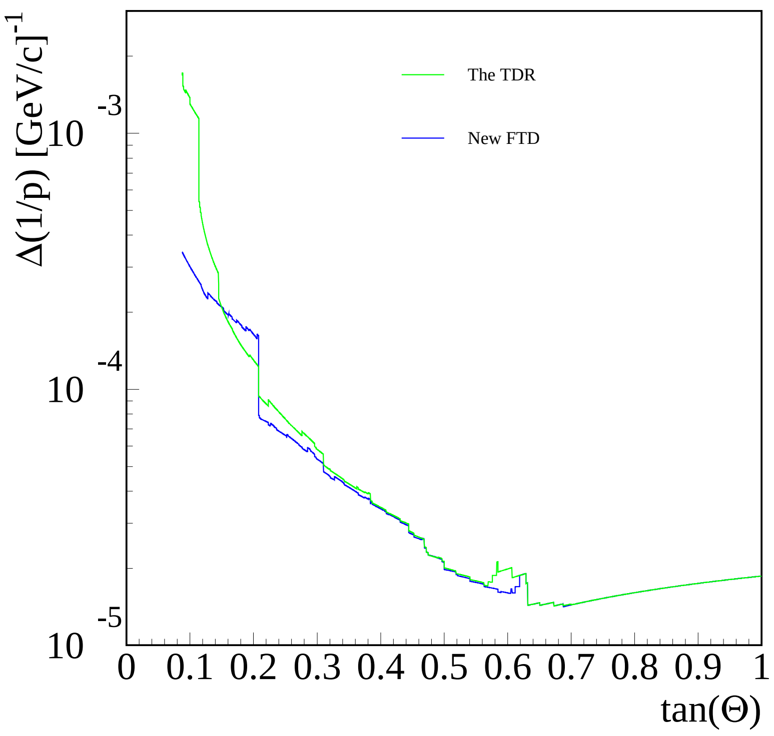

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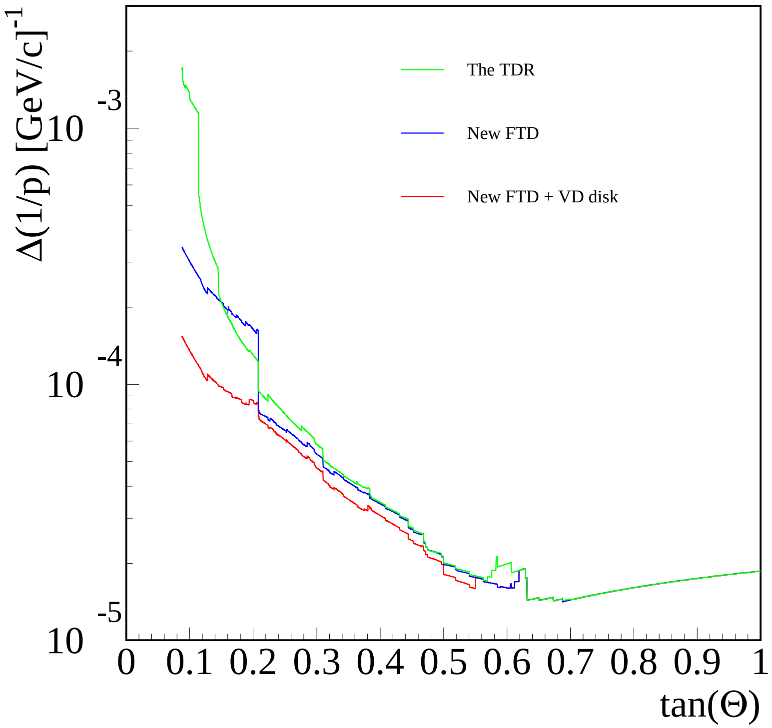

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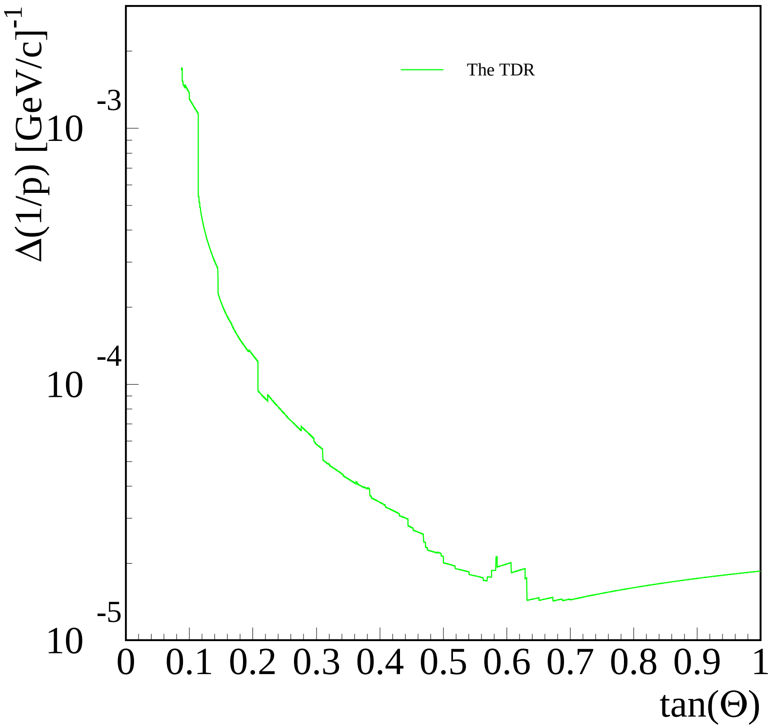

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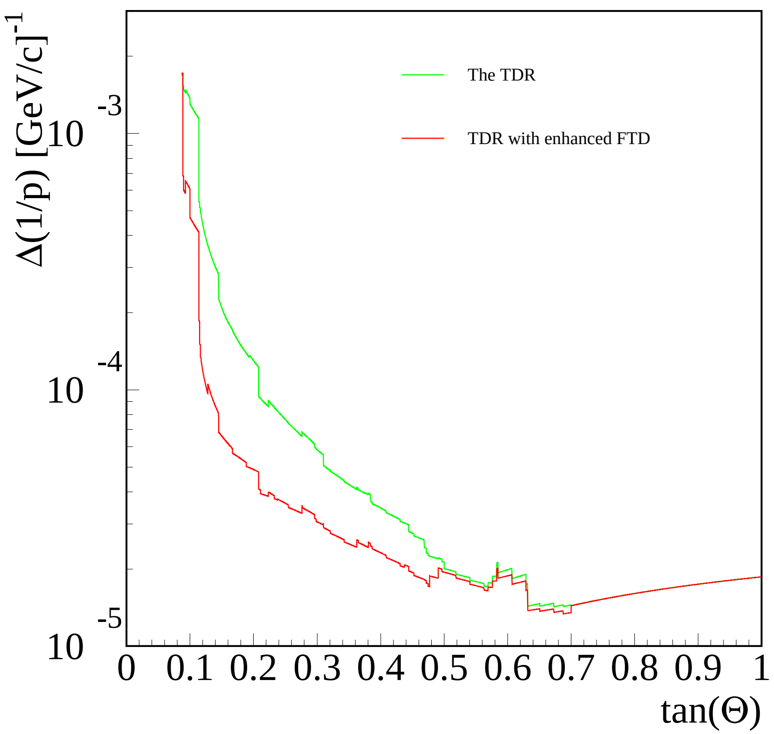

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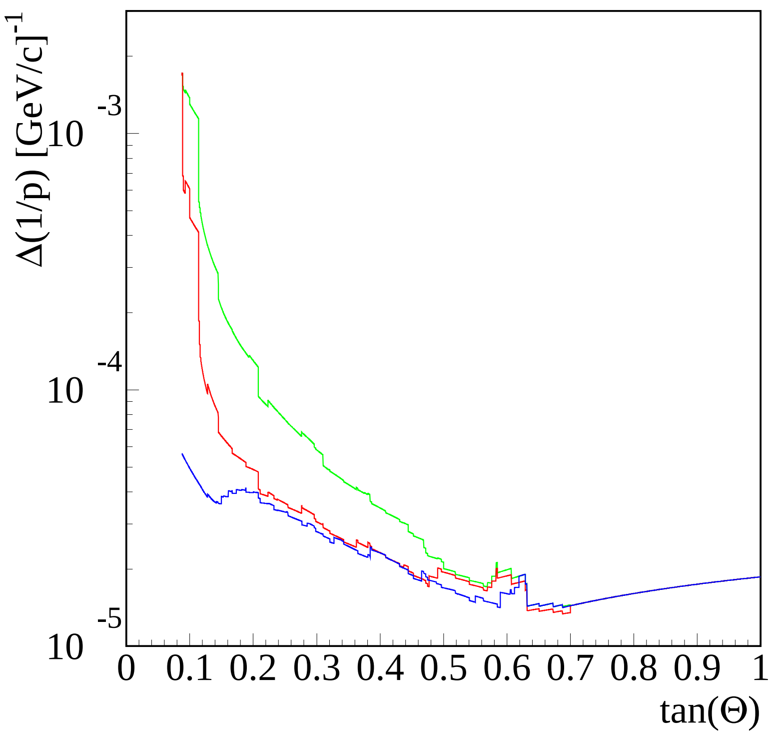
- The redesign, with the 12 discs replaced by discs with 7μresolution.



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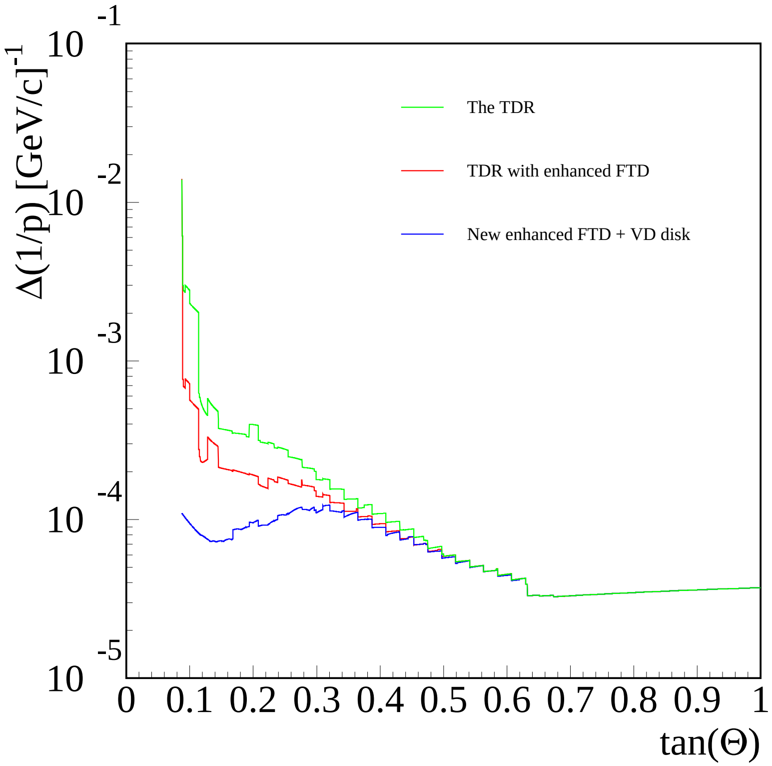

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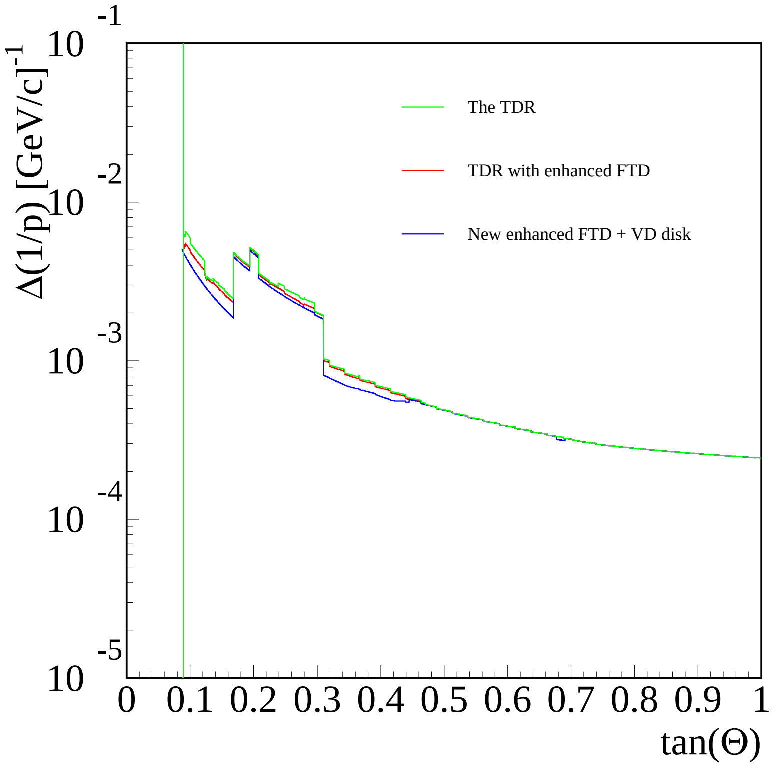
- 2.5 GeV: Dominated by multiple-scattering. The bump is the VD electronics and support



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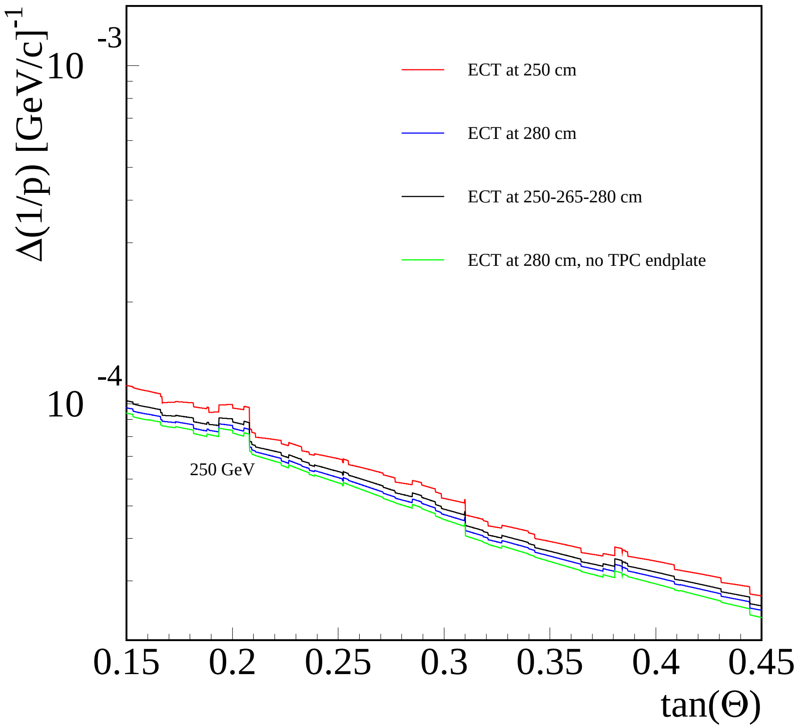

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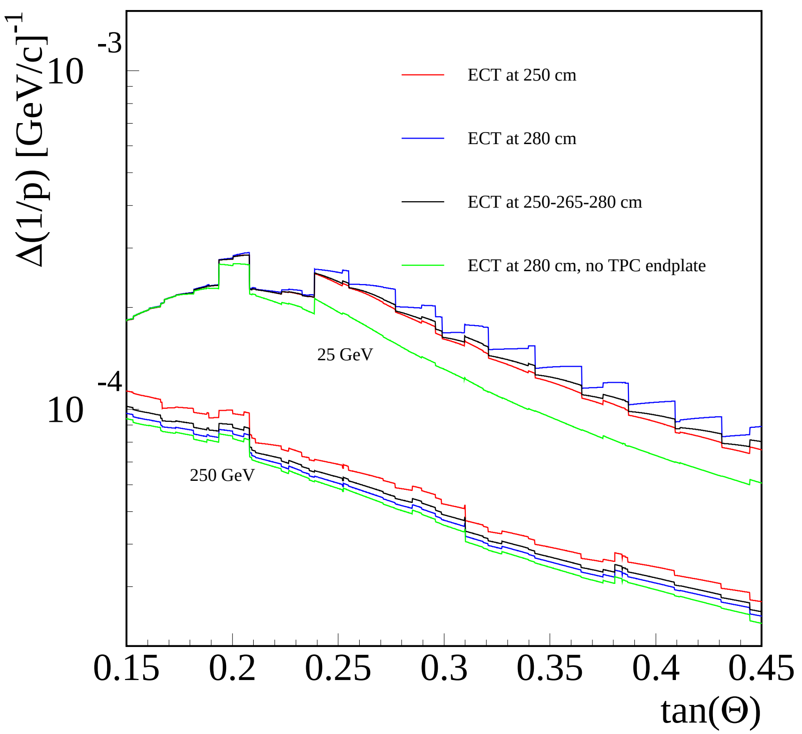

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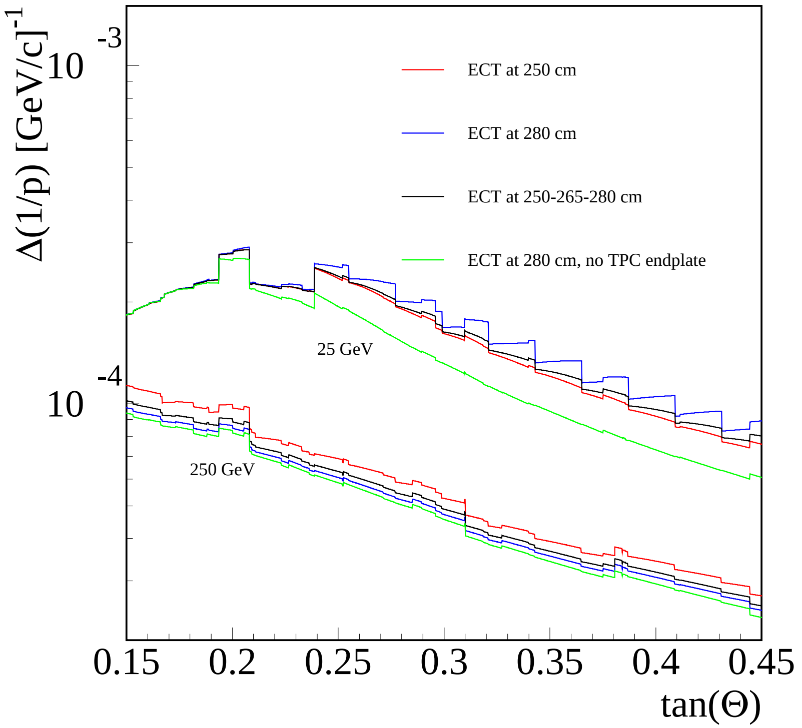
It is best to have a very precise point close a scattering surface



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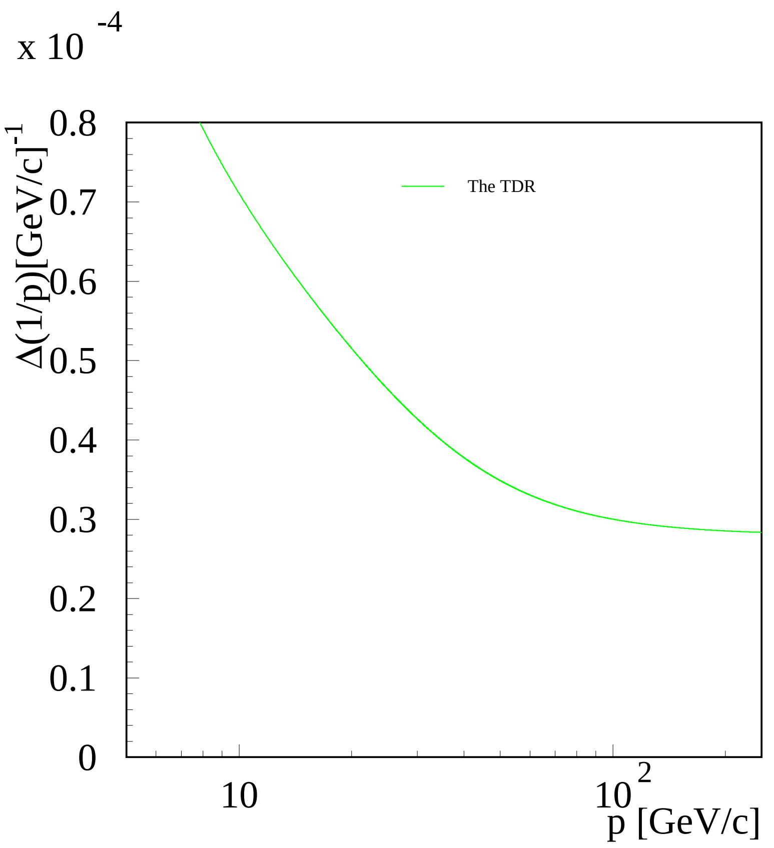

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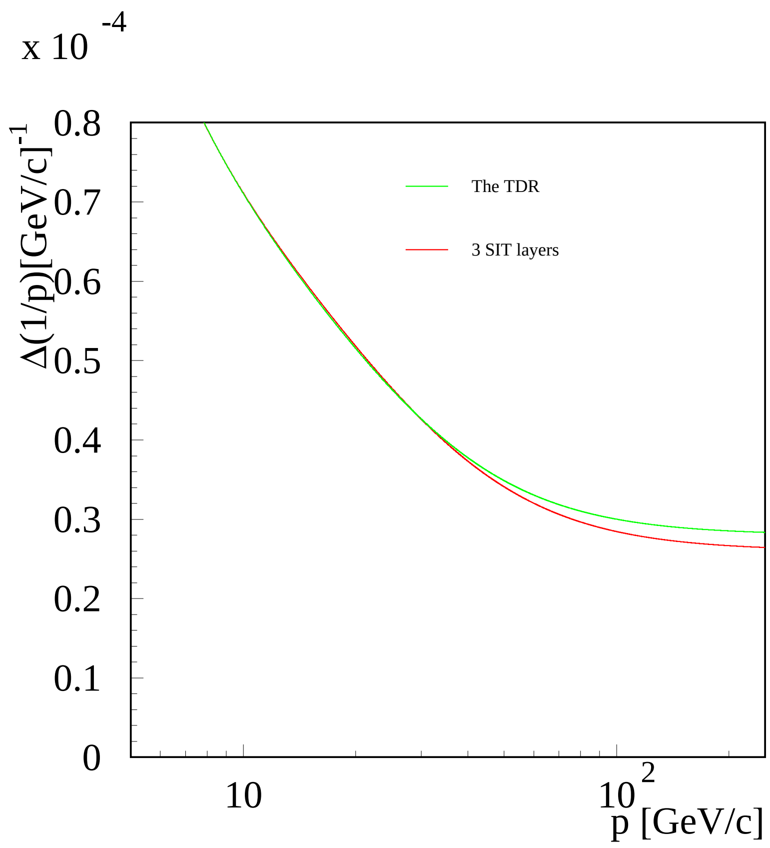

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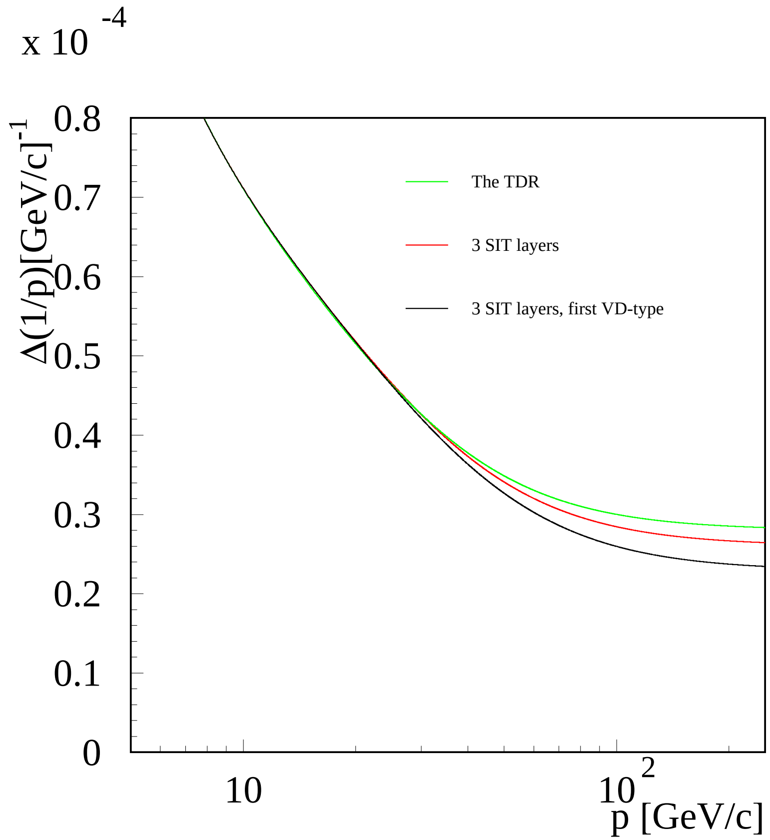

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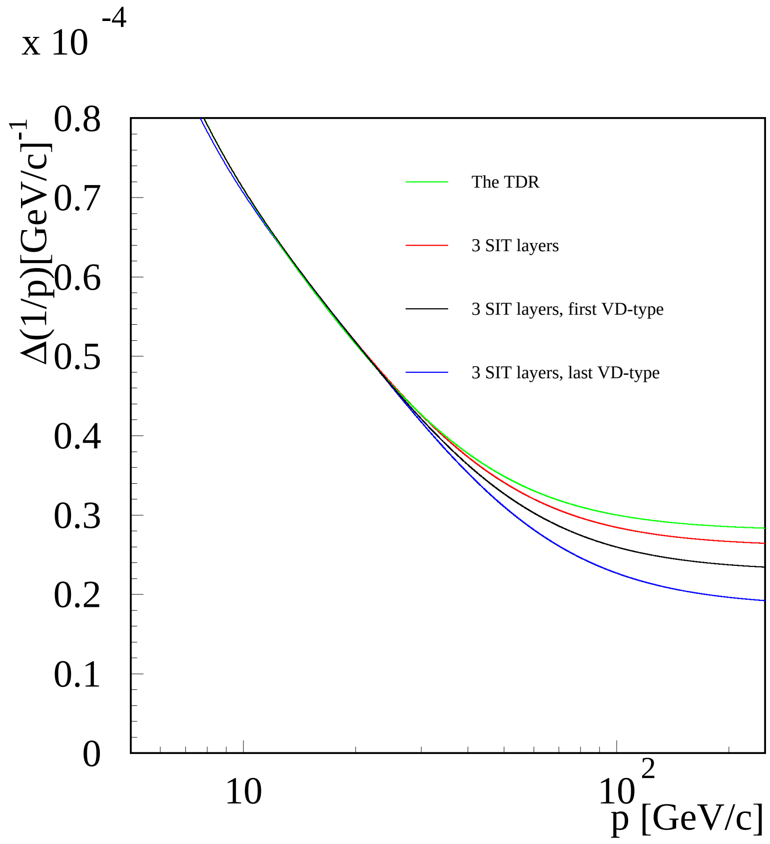

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- 3 layers with the inner-most of VD-type (4 μ)
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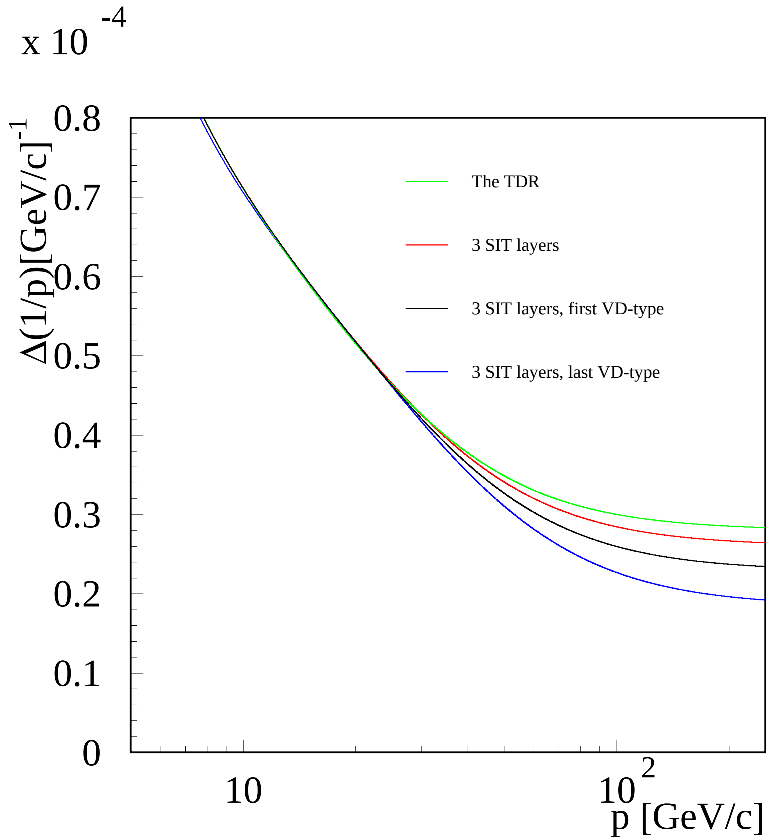
It is best to have a very precise point close a scattering surface



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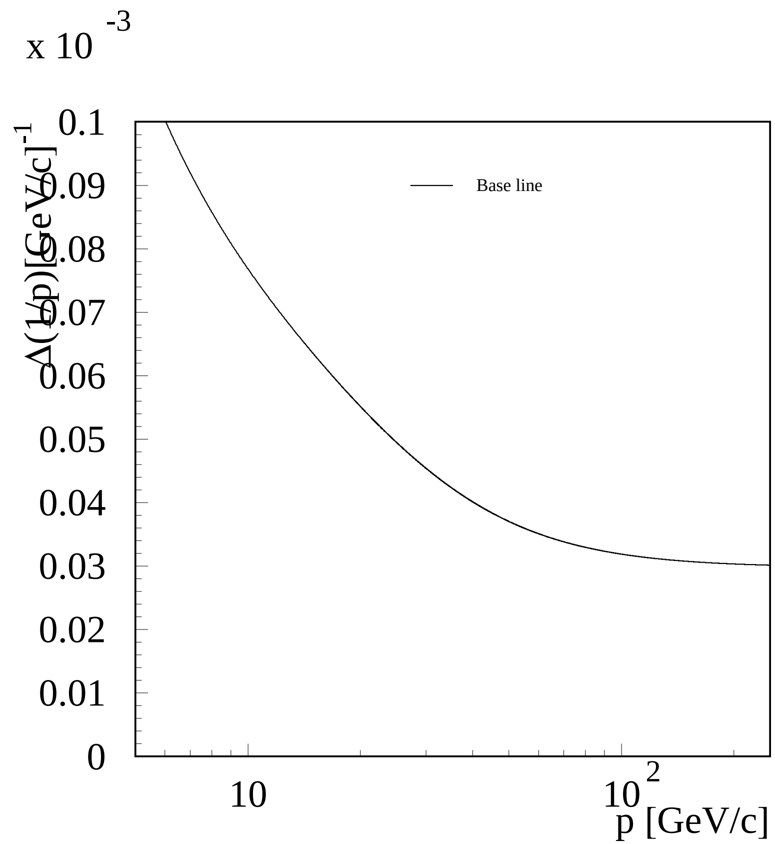

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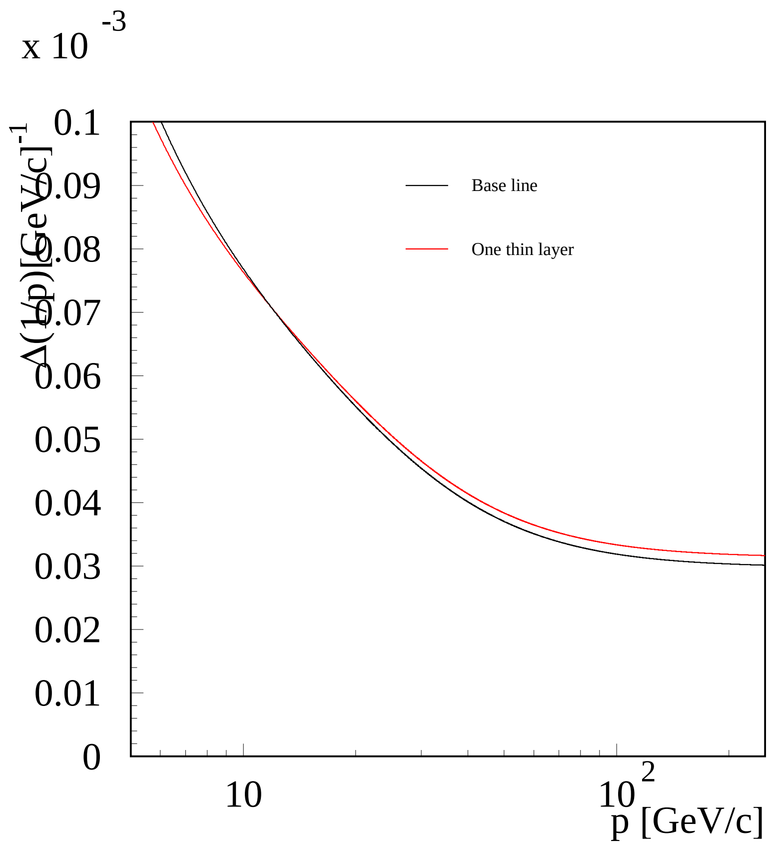

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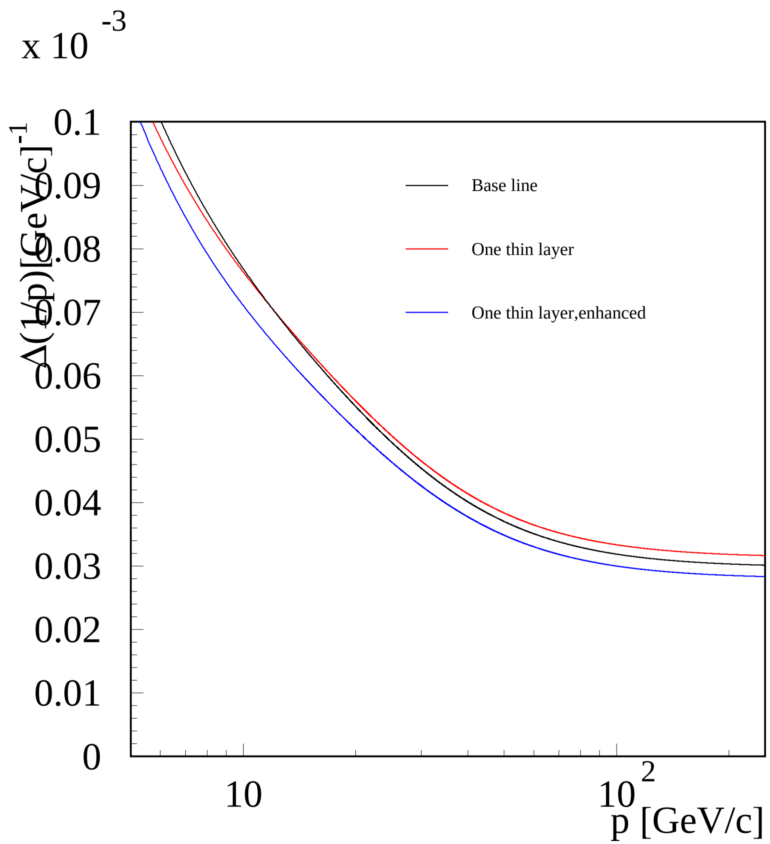

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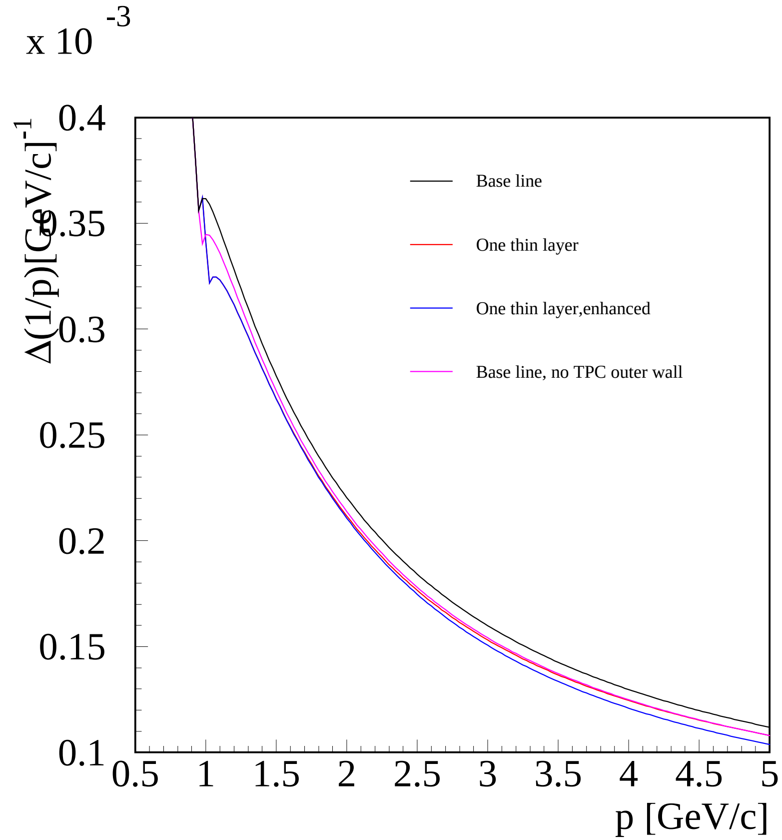

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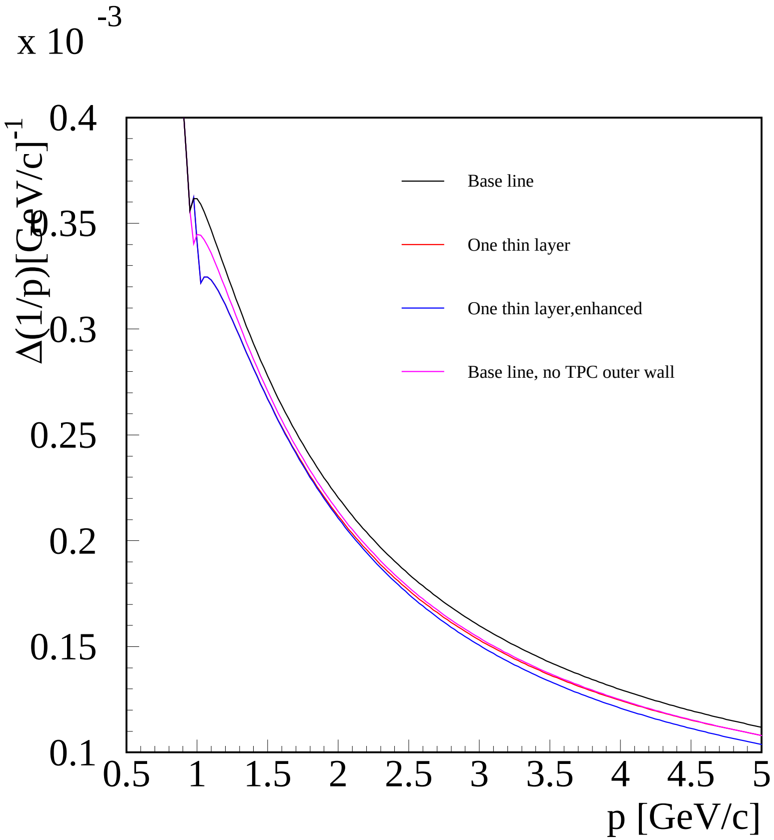
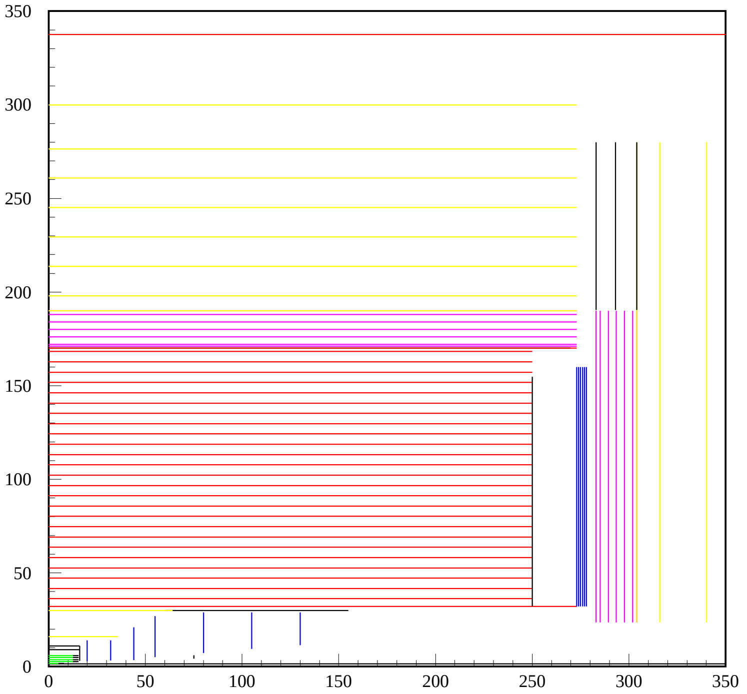
Scattering makes little difference, since the SET is quite short. At high momentum, the $1/L^2$-factor favours pushing the SET as far out as possible, and at lower momenta, it is more worthwhile to retain as much as possible of the TPC lever-arm.



A smaller detector ?

Can a shrunk detector be designed to retain the same tracking performance?



A smaller detector ?

Can a shrunk detector be designed to retain the same tracking performance? This has been studied comparing the TDR with Henri's proposal, ie

- TPC $|Z_{max}| = 270$ cm $\rightarrow$ 220cm.
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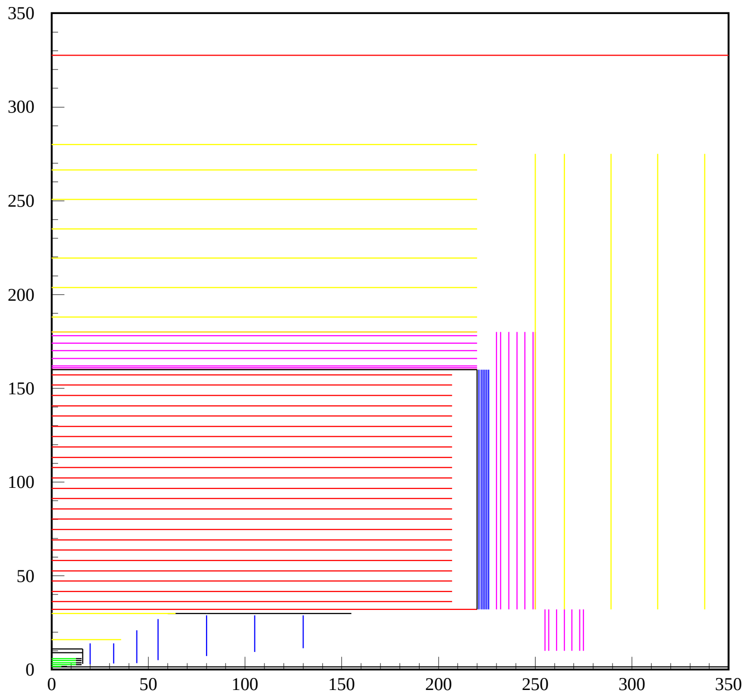
All other properties identical.



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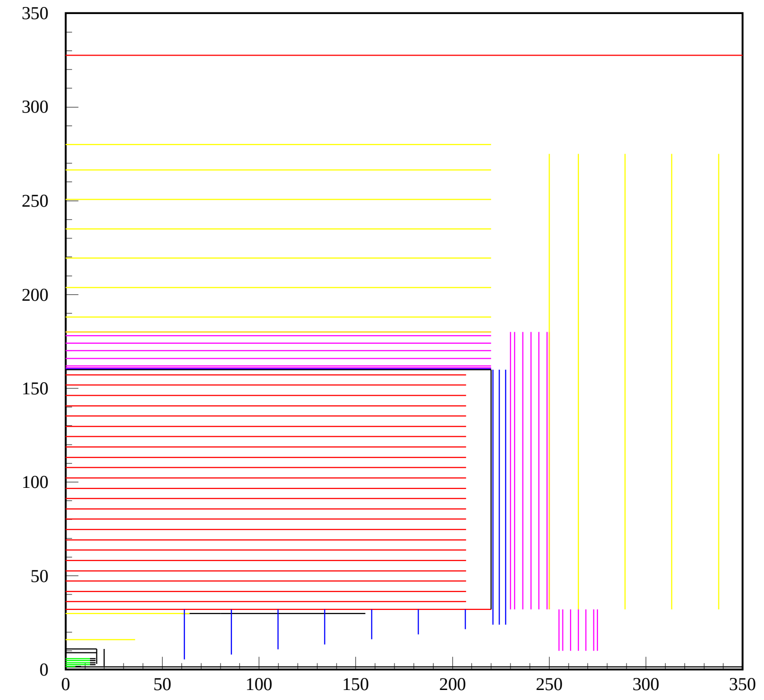

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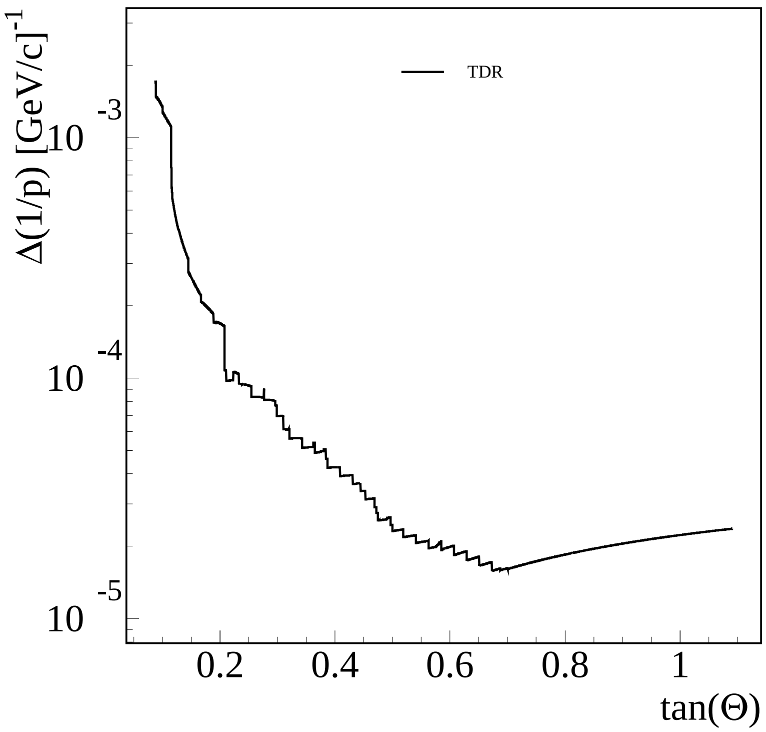

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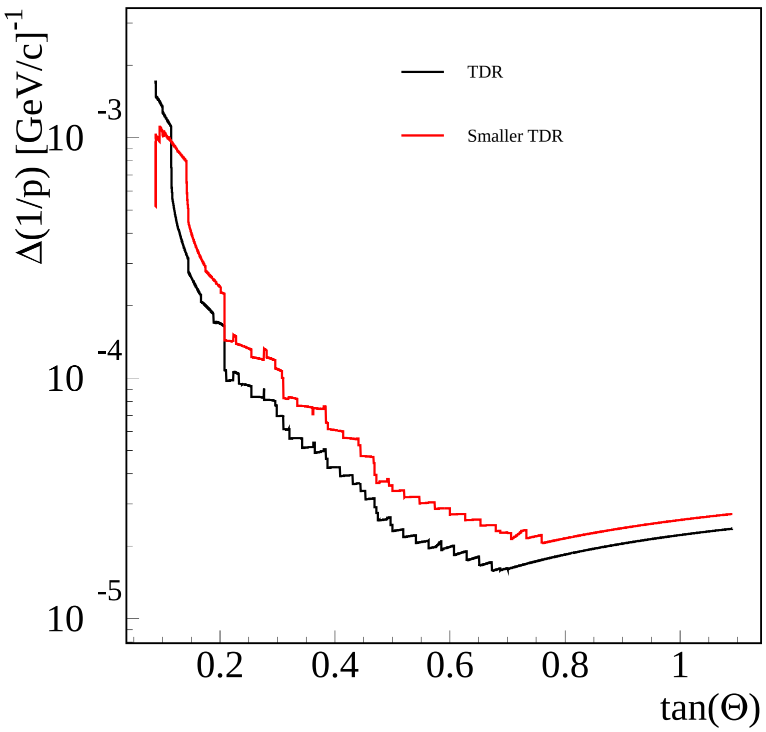

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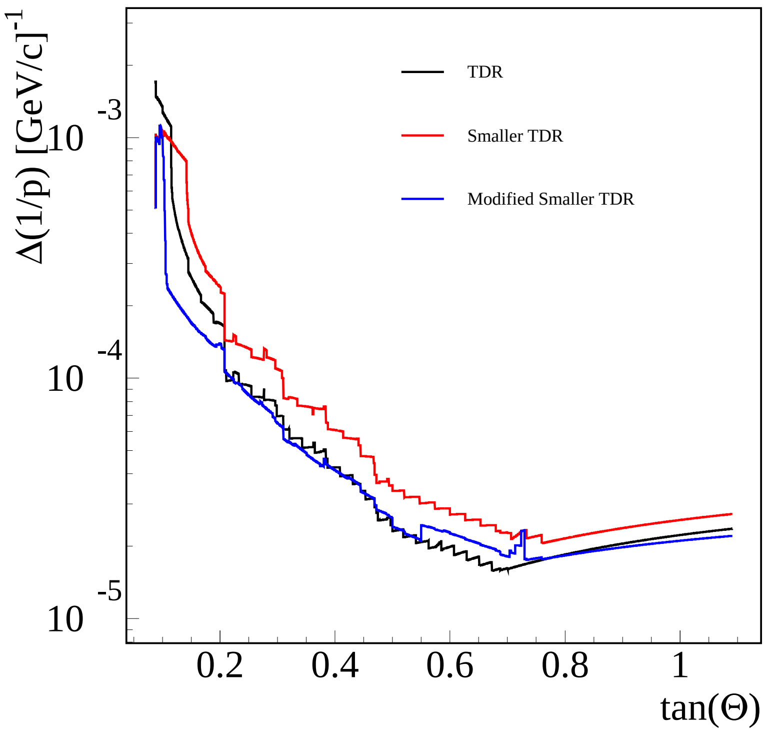

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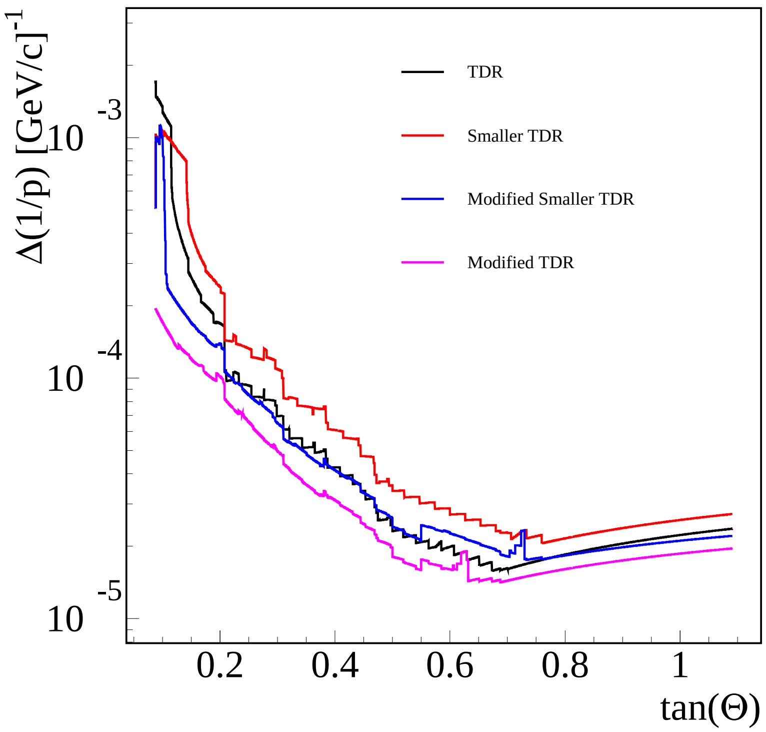

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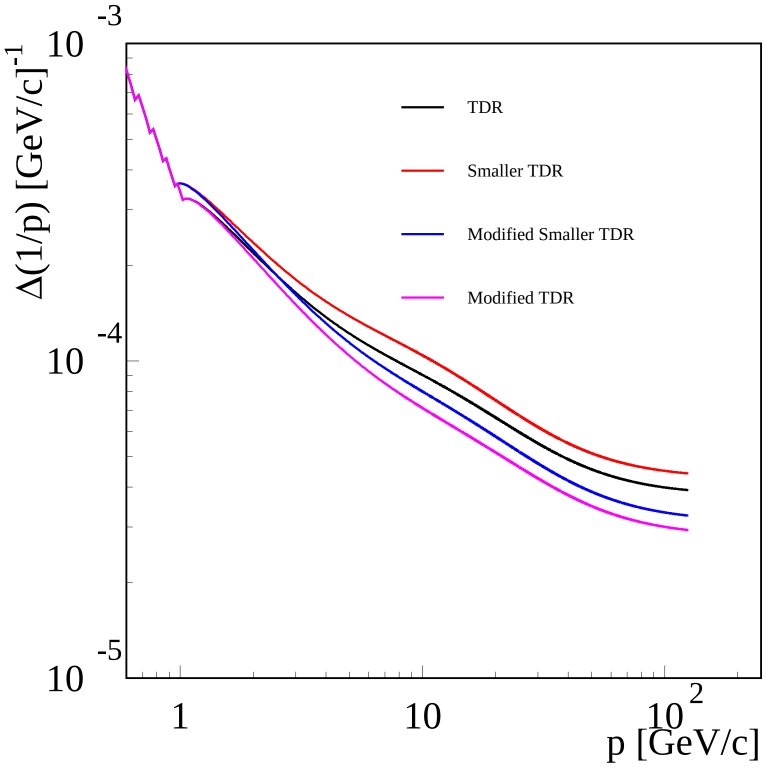
... and the momentum resolution in the barell is even better!



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