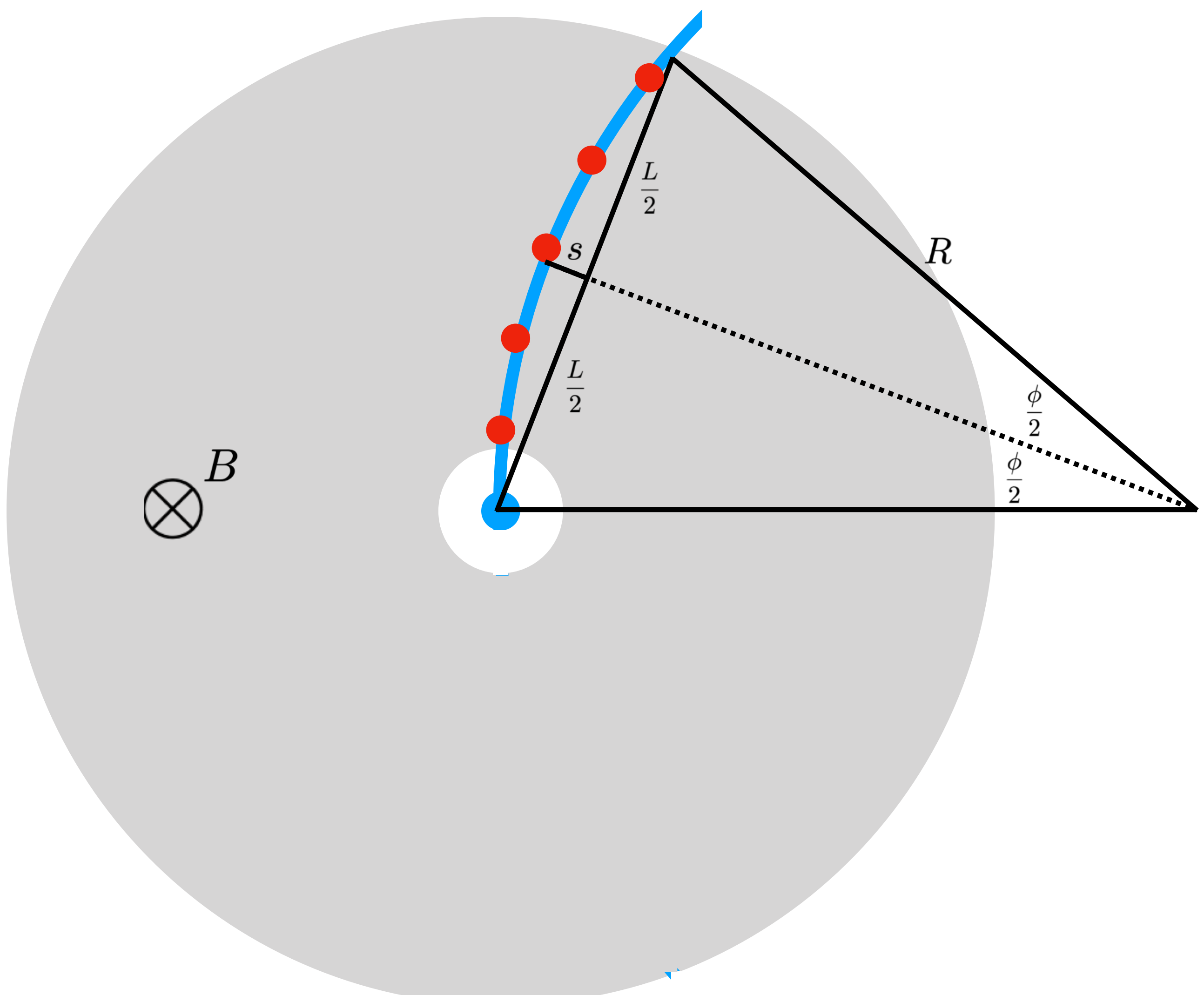
Q: How does tracking work near the interface of barrel and disks

A:

- The interface of barrel and disks is intended to be projective where this is practical;
- The further aim is that tracking can be performed standalone with either the barrel active volumes or the disk active volumes so as to avoid having to track across the inactive material associated with support and services - this is not fully realized in the current 5 disk configuration and that may need to be addressed;
- Vertexing performance is driven primarily by the innermost barrel layers. For this reason, they have larger angular acceptance than the outer barrel layers; this presents a trade-off with the desire not to track across services for (part of) the acceptance of the disks;

Q: How is the disk placement and number optimized?
A: Basically, by a tradeoff of performance and acceptance

The basics can be captured by straightforward considerations. Imagine a view along the beam and a helical track model inside a solenoidal field. Then,



$$p_{\mathrm{T}}\,[\mathrm{GeV}] = 0.3B\,[T]\;R\,[m]$$

$$s = R - R\cos\frac{\phi}{2} \approx R\frac{\phi^2}{8} \qquad \phi = \frac{L}{R}$$

Hence,

$$\frac{\Delta p_{\mathrm{T}}}{p_{\mathrm{T}}} = \frac{\Delta R}{R} = \frac{\Delta\phi}{\phi} \approx \frac{\Delta s}{L^2}\cdot\frac{8p_{\mathrm{T}}}{B}$$

In other words, a good (transverse) momentum resolution requires:

- a large path length *L* (scales as L^2)
- a large magnetic field (scales as *B*)
- good Sagitta measurement.

$$\Delta s = \frac{\Delta_{r\phi}}{8}\sqrt{\frac{720}{N+5}}$$ (Glückstern, 1963)

Note, however, that multiple scattering through the material of the disks matters.

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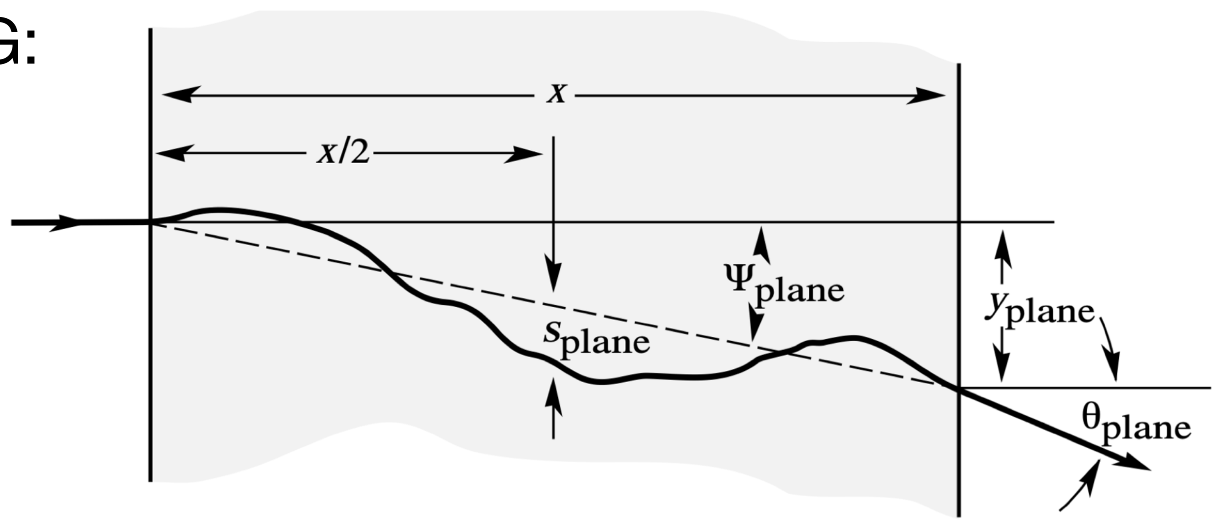
Regarding the multiple scattering contribution,

PDG:



$$\Delta\phi \approx \frac{14\,\mathrm{MeV}}{p}\sqrt{L/X_0}$$

$$p = \frac{p_\mathrm{T}}{\tan\theta}$$

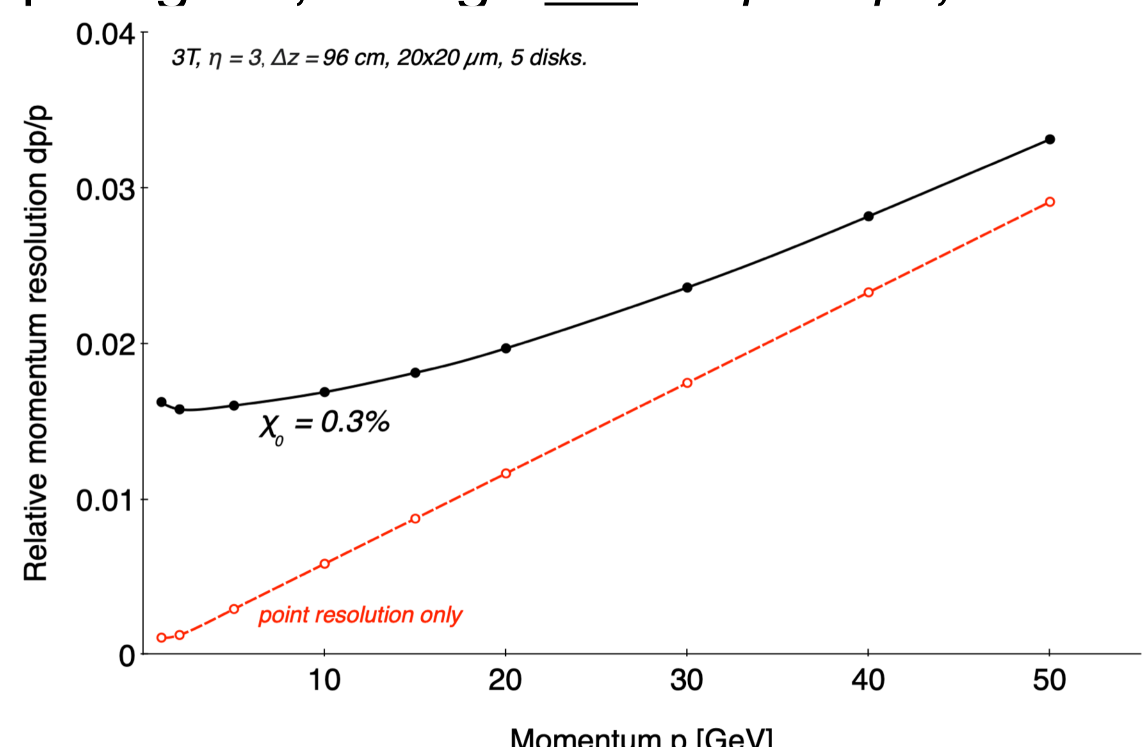
$$\left.\frac{\Delta p_\mathrm{T}}{p_\mathrm{T}}\right|_{\mathrm{m.s.}} \approx \frac{14\,\mathrm{MeV}}{p}\sqrt{\frac{L}{X_0}}\cdot\frac{R}{L} = \frac{14\,\mathrm{MeV}}{p}\sqrt{\frac{1}{LX_0}}\frac{p_T}{eB}$$

Hence, the m.s. contribution depends on the dip-angle θ, though *not* on p or p_T, and

$$\frac{\Delta p_\mathrm{T}}{p_\mathrm{T}} = a\cdot\frac{p_\mathrm{T}}{BL^2} \oplus b(\theta)\cdot\frac{1}{B\sqrt{LX_0}}$$

For forward angles, m.s. is the limiting component in d*p/p for much of the p range.*

There is, indeed, a subtle correlation of m.s. and the dip angle measurement (not explicitly considered in the arguments presented here).



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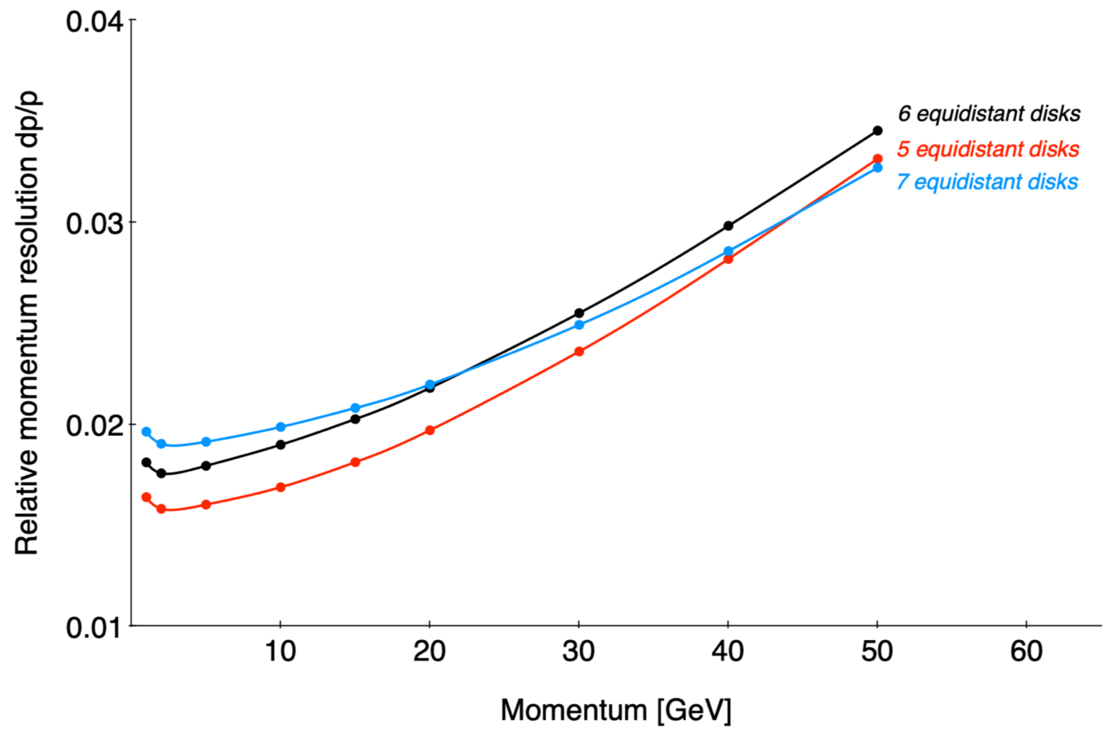
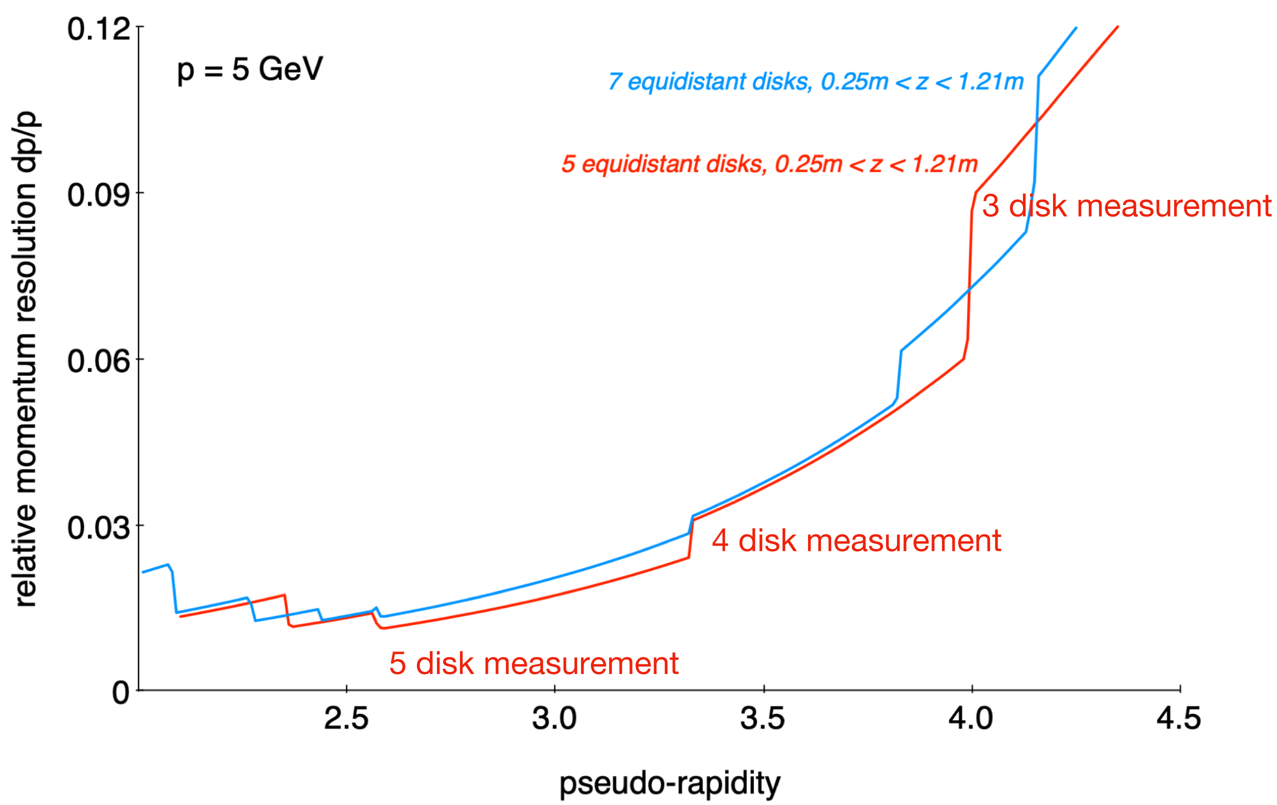
Performance wise, $$\frac{\Delta p_{\mathrm{T}}}{p_{\mathrm{T}}} = a \cdot \frac{p_{\mathrm{T}}}{BL^2} \oplus b(\theta) \cdot \frac{1}{B\sqrt{LX_0}}$$

n_{disk} increases measurement-points *and* material

We believe 5—7 disks presents a reasonable trade-off; an odd number tends to capture the Sagitta point and is thus preferred.





An equidistant configuration is *not* truly optimal in capturing the Sagitta, but avoids *acceptance issues* (illustrated on the left for 5—7 disks; details are geometry-dependent),

Viable ways to improve dp/p etc. are to increase L available for tracking and/or reduce material; increasing points within the same L or other technology are *not*.