Resolution estimates for various VTX geometries

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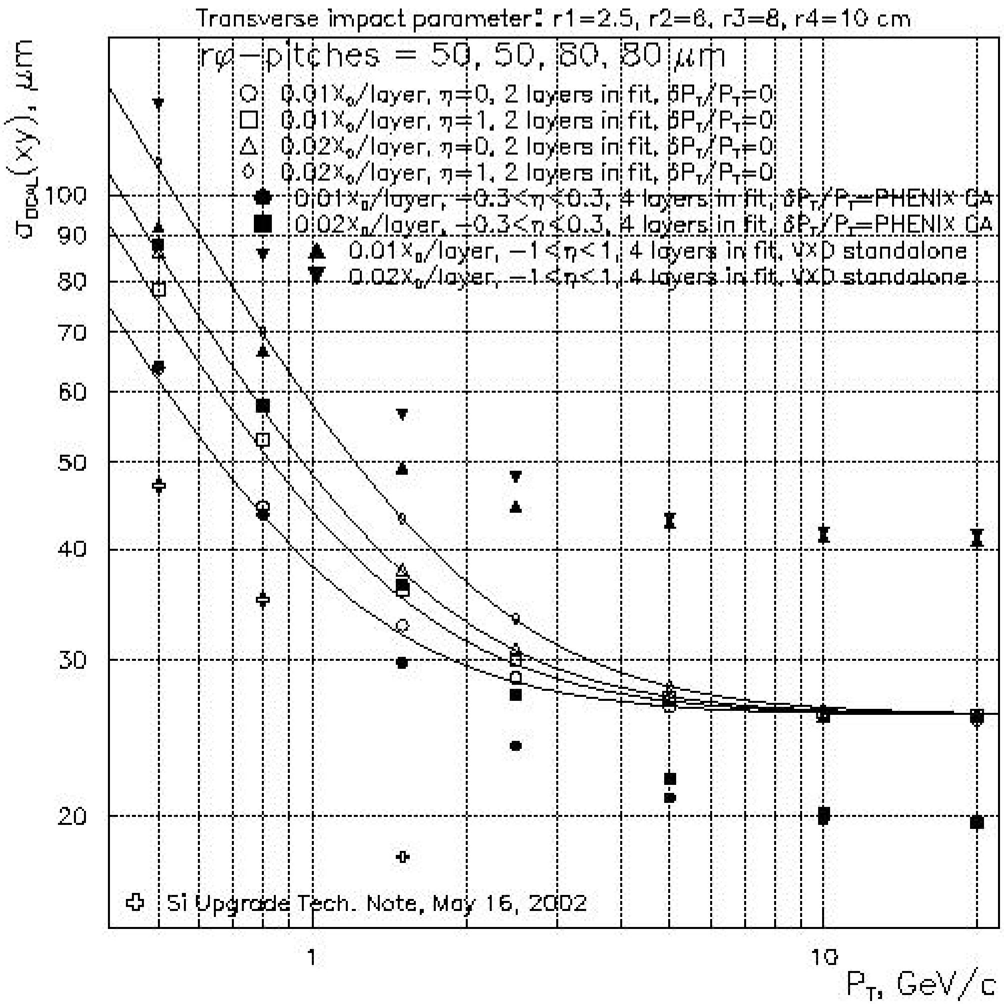
Simulation model:

- **Geometry**: Parallel flat tracking layers.
- **Particle trajectories** in the *uniform magnetic field* **generated**, taking into account *small angle multiple scattering* (β=1) in the *detector material*, *beam pipe*, *air, etc*. Ionization and radiation energy losses ignored.
- The positions of the track crossing points in each layer randomly Gaussian smeared with the respective design *position resolutions.*
- The **vertex transverse position resolution (**σ_{xy}**)** used to evaluate momentum resolutions for primary tracks, has been assumed (arbitrarily guessed) at *20* μm. However, the DCA resolutions are NOT convoluted with the vertex resolution, i.e. it is assumed that the vertex position in X-Y-plane is known precisely ($\sigma_{xy}=0$).
- For the **helical trajectory reconstruction**, the *full initial covariance matrix* has been used, taking into account *cross-correlations* of the track crossing points in the tracking layers *due to multiple scattering*.
- Pixel sensor: $\sigma_{r\varphi}$ ***= 50/√12 = 14 µm,*** σ_z ***= 425/√12 = 123 µm, total thickness = 0.01***X_0.
- Strip sensor: $\sigma_{r\varphi}$ ***= 80/√12 = 23 µm,*** σ_z ***= 1000/√12 = 290 µm, total thickness = 0.02***X_0.
- *Notations:* e.g. *p25p50s100s140 means: Pixels at R = 25 & 50 mm* and *Strips at R = 100 & 140 mm.*

What should be expected on the base of earlier simulations?

Impact parameter resolution, B = 9 kGs



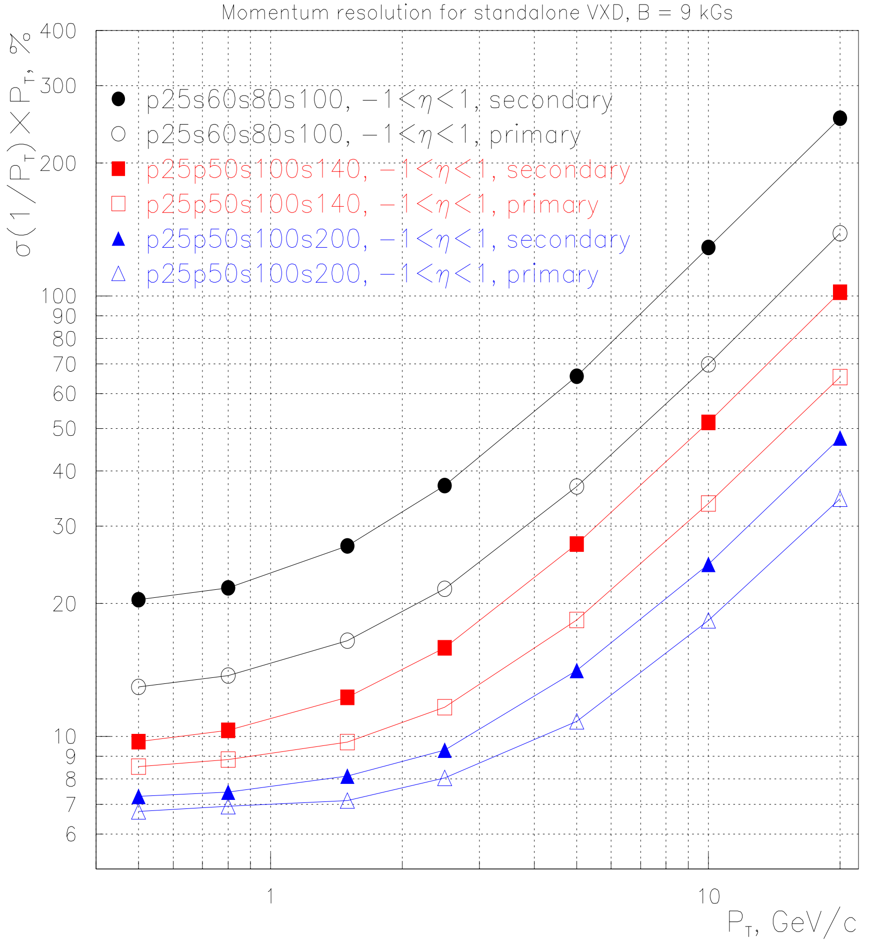
Consistency check, using 2-layer formula for DCAL:

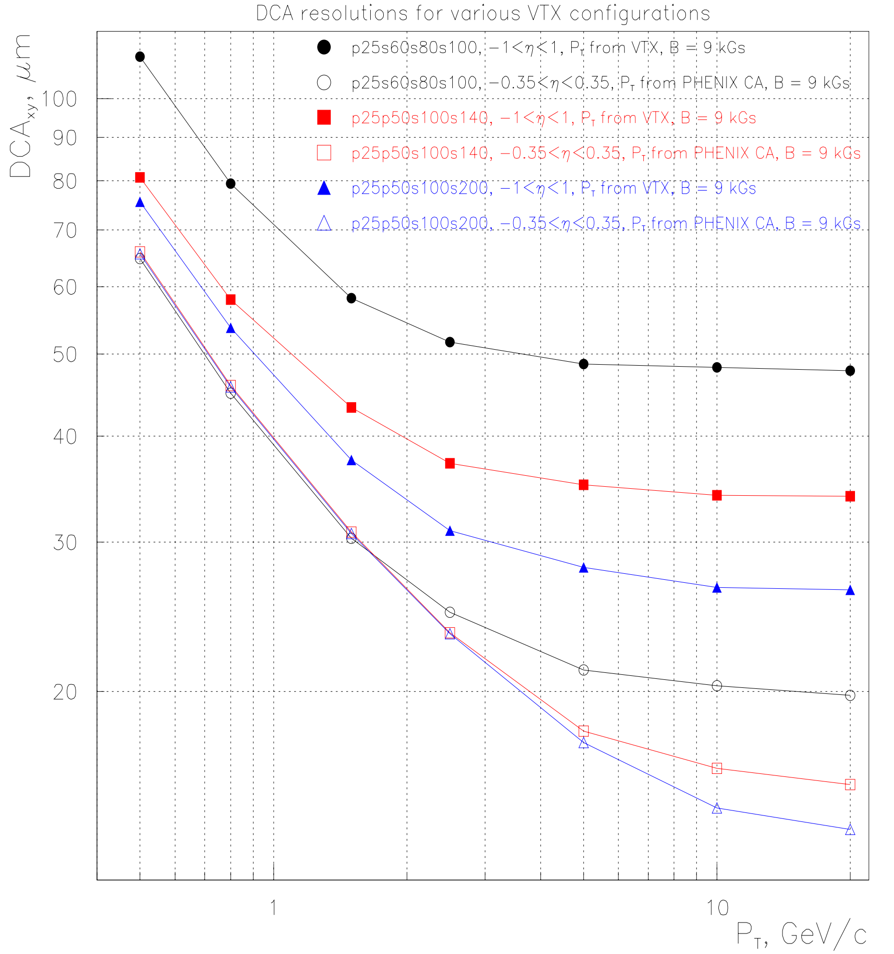
$$\sigma_{DCAL}^2 = \frac{\sigma_1^2 r_2^2 + \sigma_2^2 r_1^2}{(r_2 - r_1)^2} + \vartheta_{ms}^2 \frac{r_1^2}{\sin^2\theta}$$

- $\sigma 1$ and $\sigma 2$ *are for* $r\varphi$-resolutions in the layers 1 and 2 (*$r\varphi$-pitch/√12*);
- ϑ_{ms} is the multiple scattering angle in the 1st layer;
- θ is the polar angle.

The DCAL resolutions for **"zero field"** *(~150 Gs)* are the same as for *B = 9 kGs*

These simulations:





Summary:

- **Momentum resolution**: the improvement of the momentum resolution for the standalone VTX is apparent for the geometries with the outer layers at larger radii.
- **DCA resolution:** The DCA resolution becomes beter for the standalone VTX as its diameters increases. However, if momentum is measured externally, using PHENIX Central Arm (or magnetic field in the VTX region is zero), a noticeable improvement of the DCA resolution takes place only at $P_T \geq$ 3-5 GeV/c.

Conclusion:

- The benefits for improvement the momentum and DCA resolutions from a larger diameter VTX are of a questionable significance and value and should be weighted against other important characteristics such as the larger (pseudo-) rapidity coverage, robust pattern recognition, occupancy, etc., most of which cannot be realistically assessed, using only toy simulation tools.
- The serious investments toward the development of the full scale VTX simulation and analysis software now (yesterday?!), including tracking, is a must!