Karlsruhe Institute of Technology

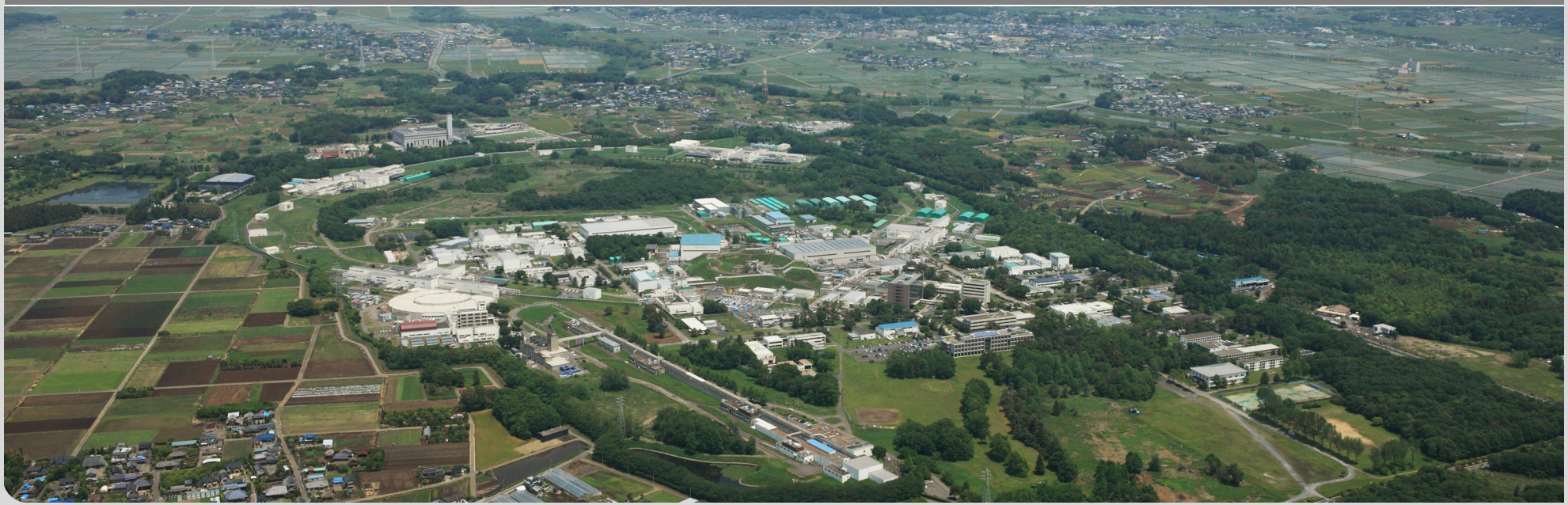
Belle II

Vertexing and Impact Parameter Study

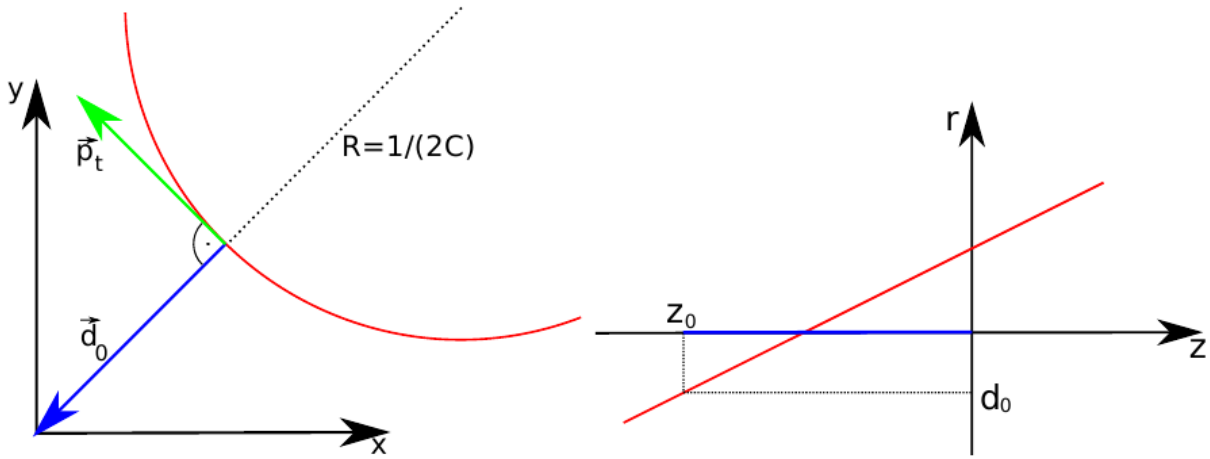
Some results from a bachelor thesis

Christian Pulvermacher, for Markus Prim | June 13th 2013

INSTITUT FÜR EXPERIMENTELLE KERNPHYSIK (IEKP)



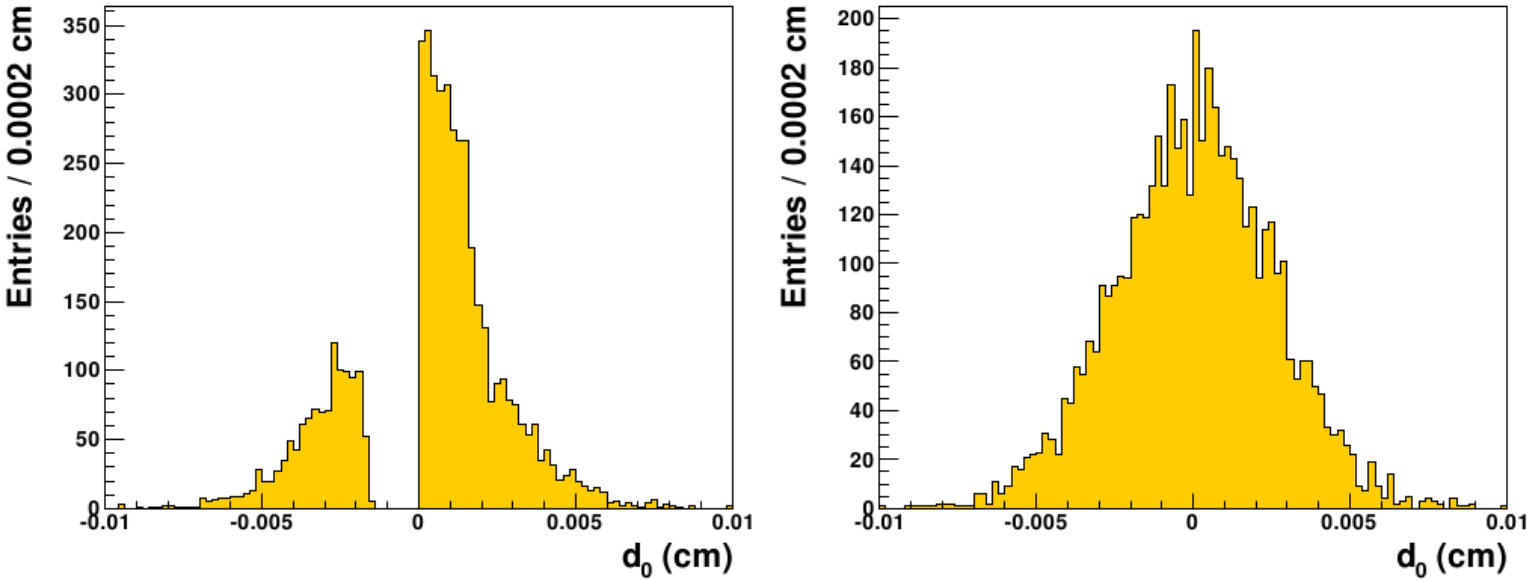
Definitions



Definition of perigee parameters

- Resolution defined as RMS_{90} of deviation of reconstructed perigee parameters from MC origin
- Setup: Used PXD and SVD `TrueHits` for study, Gaussian smearing applied to `PXDTrueHits` was varied; with MCTrackFinder and GenFitter from r5140 (March), plus corrections

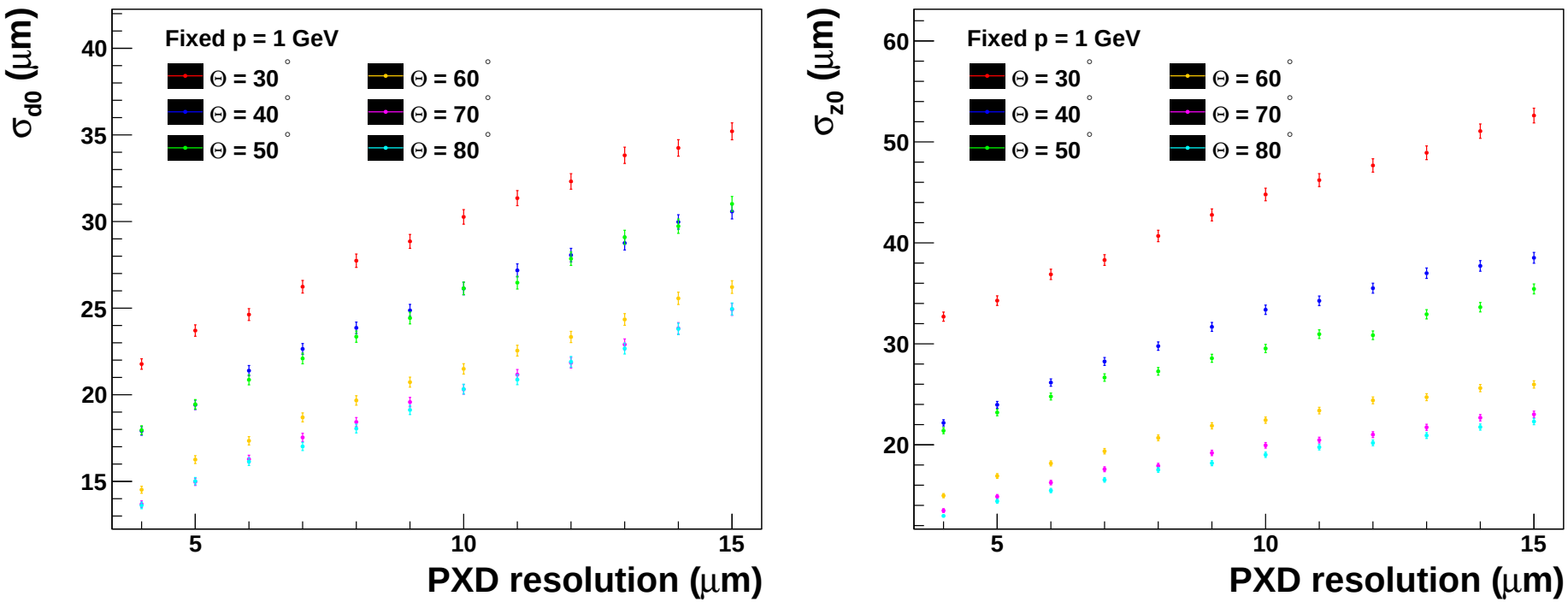
Calculation of impact parameter d_0 was flawed, fix provided. Not yet included in Genfitter as `TrackFitResult` doesn't currently store perigee parameters.



(a) (b)

Figure 4.3.: Histograms with old (a) and new (b) $\vec{d_0}$ sign assignment.

Resolution Dependency of Impact Parameters



Dependency of d_0 (left) and z_0 (right) resolution on the PXD resolution for different polar angles Θ with a fixed track momentum of 1 GeV

Dependency on Pseudo-Momentum

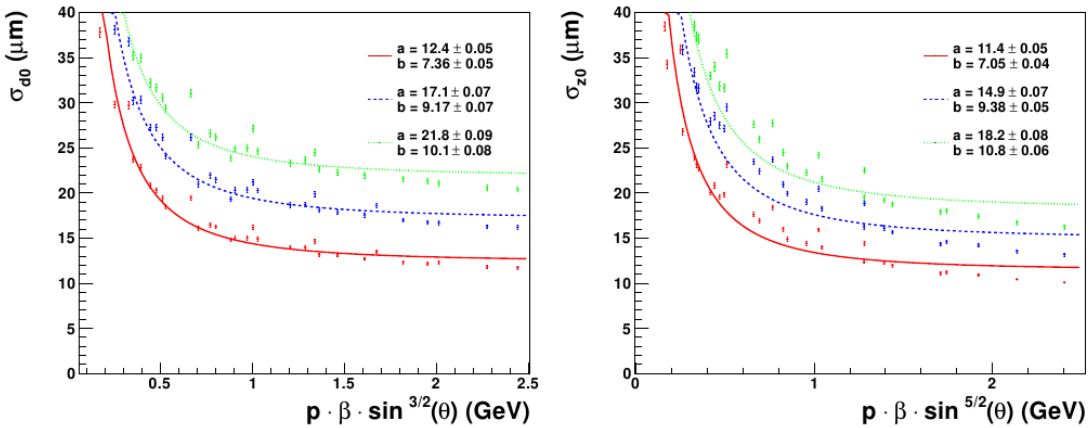
New variables to include effect of detector material:

$$\tilde{p}_{\mathrm{d}_0} = p \cdot \beta \cdot \sin^{3/2}\Theta,$$

$$\tilde{p}_{\mathrm{z}_0} = p \cdot \beta \cdot \sin^{5/2}\Theta,$$

Parametrisation:

$$\sigma_{\mathrm{d}_0,\mathrm{z}_0} = \sqrt{(a)^2 + \left(\frac{b}{\tilde{p}_{\mathrm{d}_0,\mathrm{z}_0}}\right)^2},$$



(a) (b)

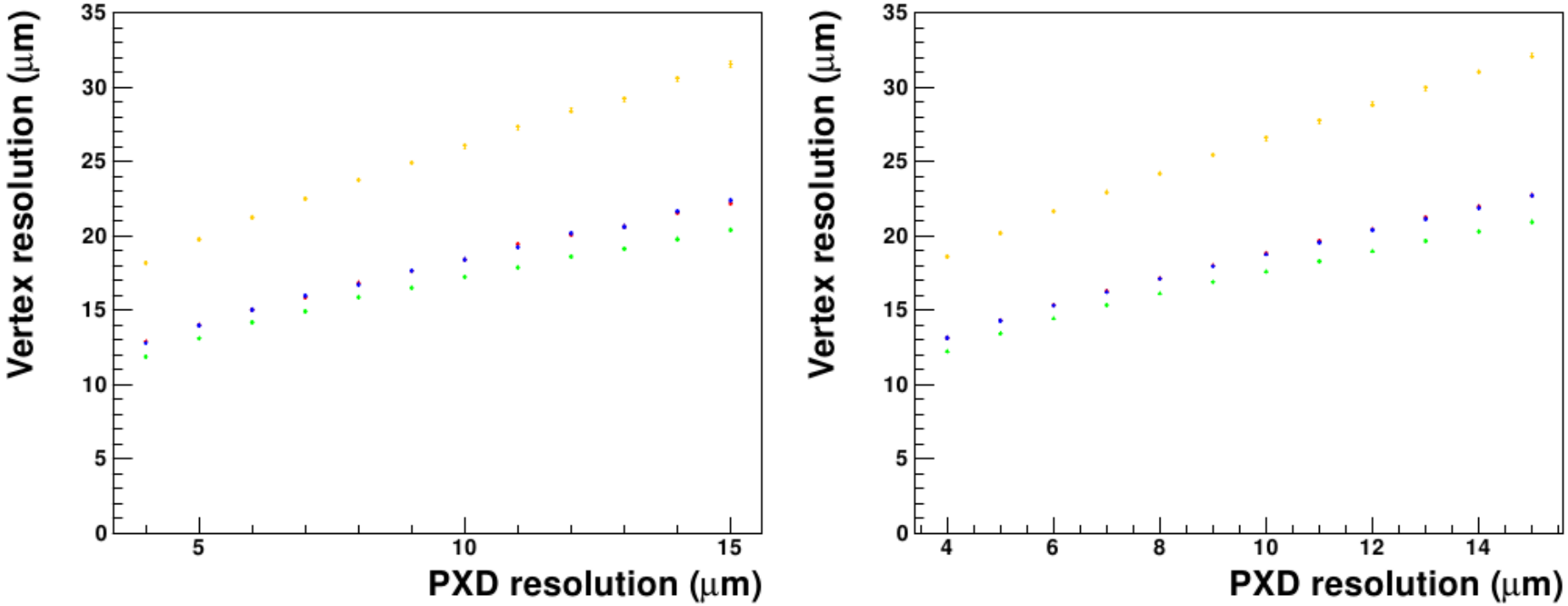
Figure 5.3.: Resolution of (a) d_0 and (b) z_0 for PXD resolutions of 15 μm (dotted green), 10 μm (dashed blue) and 5 μm (solid red).

Vertex Resolution Study

$$\Upsilon(4S) \to B^0\overline{B}^0 \to (J/\psi K^0_S)(\pi^0\pi^0) \to (\mu^-\mu^+ K^0_S)(\pi^0\pi^0) \to (\mu^-\mu^+(\pi^0\pi^0))(\pi^0\pi^0)$$
$$\Upsilon(4S) \to B^+B^- \to (K^+K^-K^+)(\mu^-\overline{\nu}_\mu)$$

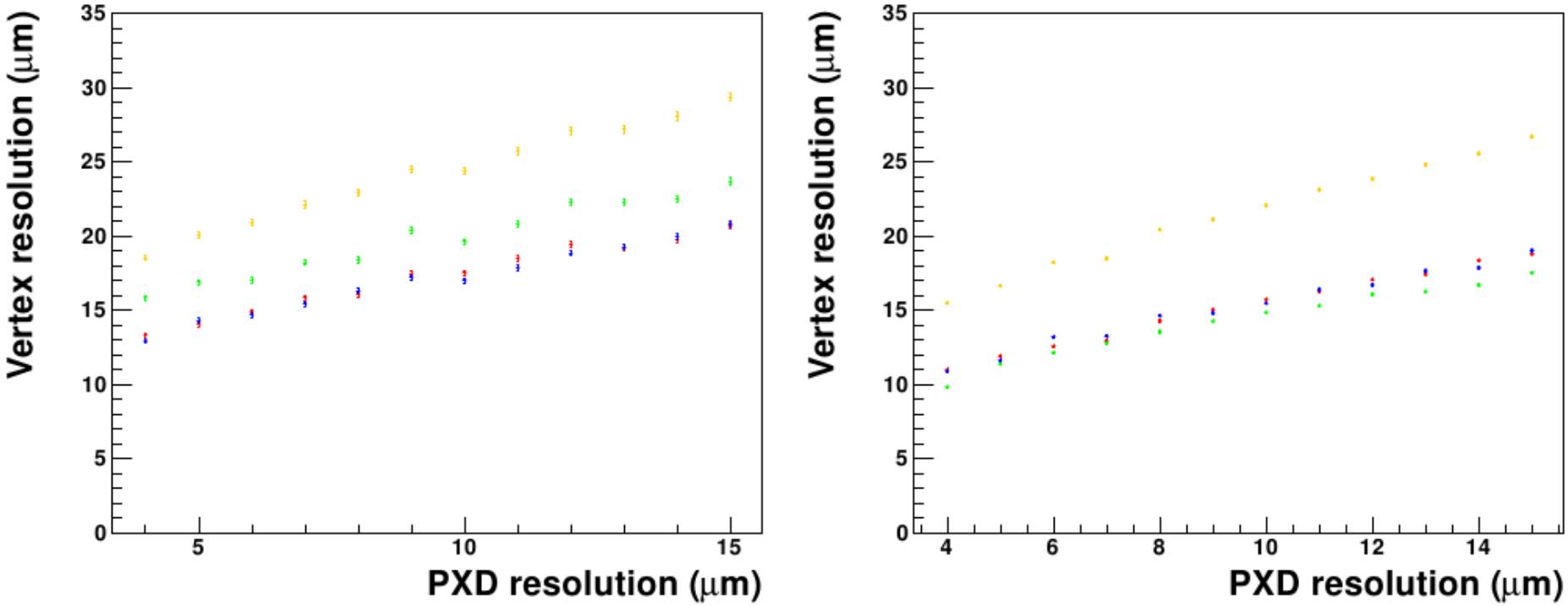
- Two decays with two or three visible tracks to be combined into a vertex
- Simulation also includes CDC
- Compared performance of `KFit` and `GFRave`
- Vertex resolution defined as difference between MC and reconstructed vertex, in $\Delta x, \Delta y, \Delta z$ and $\Delta d = \sqrt{(\Delta x)^2 + (\Delta y)^2}$.

Vertex Resolution Study – 2 Tracks



Vertex resolution for KFit (left) and GFRave (right): Δx, Δy, Δz and Δd

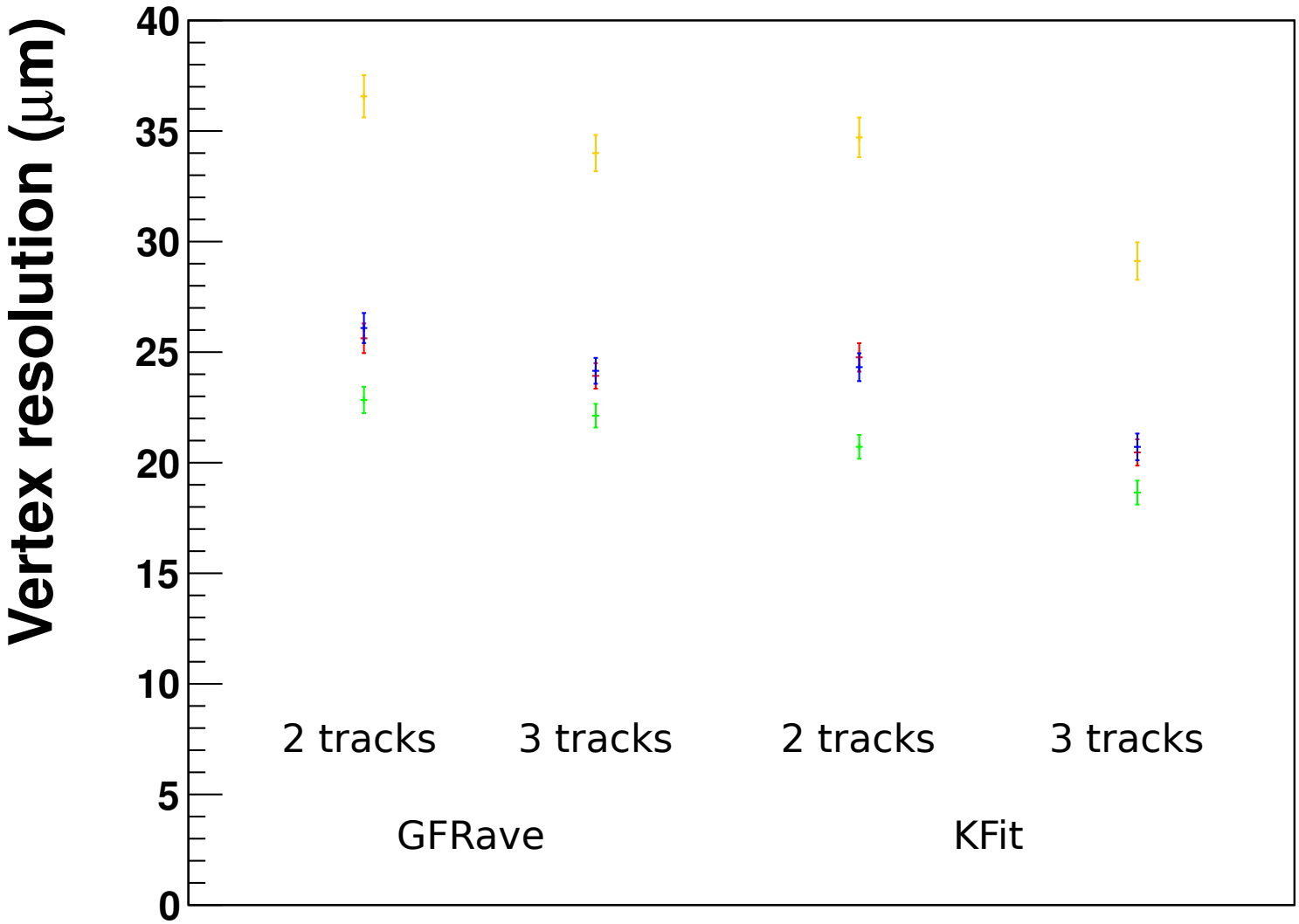
Vertex Resolution Study – 3 Tracks



Vertex resolution for KFit (left) and GFRave (right): Δx, Δy, Δz and Δd

Vertexing with Full Digitisation and Clusterisation

Vertex resolution using r5727, with PXD and SVD digitisation and clustering:



Summary and Conclusions

- Studied impact parameter and vertex resolution
- For a fixed pixel resolution of $15\mu m$, impact parameter resolution is much better than Belle values for low track momenta, for higher momenta about 1.2 (1.7) times better for d_0 (z_0)
- Vertex resolution greatly improved compared to Belle (c.f. $\sigma_z = 61\mu m$ for $J/\Psi \to \mu^-\mu^+$)

- Vertexing: Some problems with KFit in *KKK* channel, seems fixed now
- KFit now slightly better than GFRave
- Resolution somehow worse in current basf2 revision (even with TrueHits) – needs more study