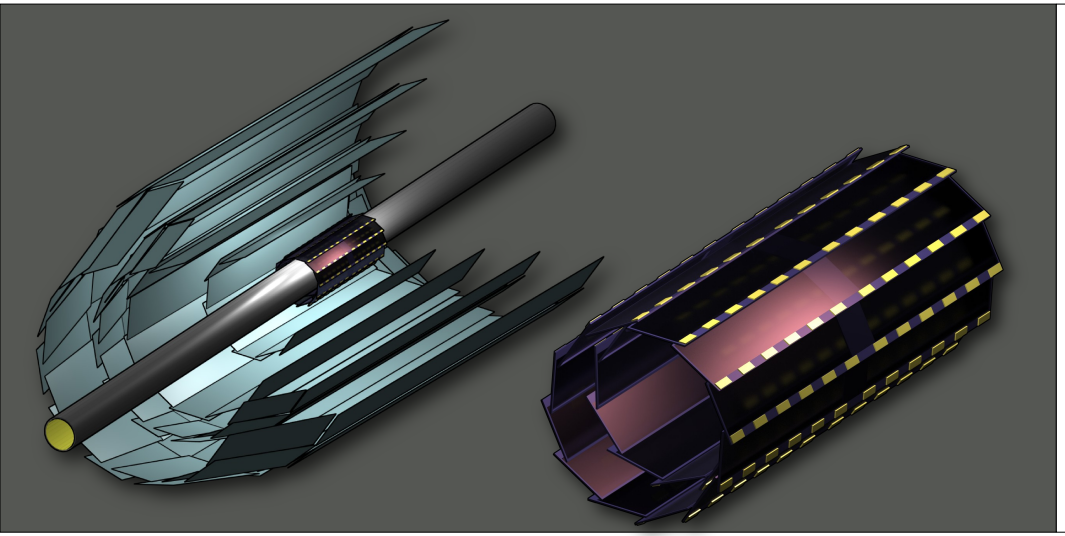
Optimization Studies with Single Tracks



Andreas Moll
Kolja Prothmann
Zbynek Drasal

Max Planck Institute for Physics

Belle II PXD/DEPFET Meeting
27/01/2010

Excellence Cluster Universe

Belle II

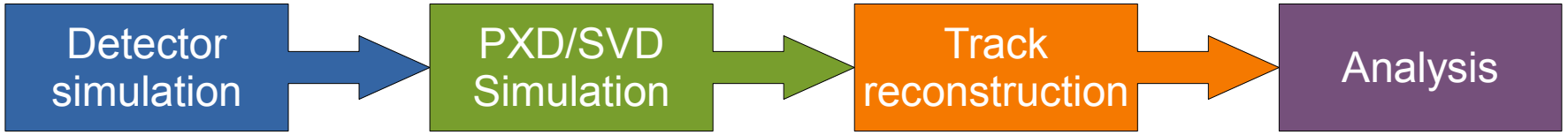
Max-Planck-Institut für Physik
(Werner-Heisenberg-Institut)

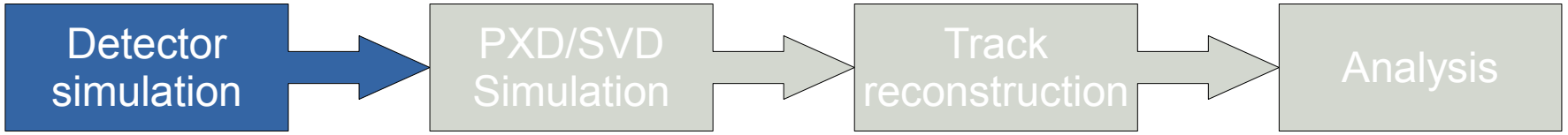
- Detector/Sensor simulation and track reconstruction
- Method used to get the resolution of the impact parameter
- Detector models studied
- Analysis procedure
- Results

Goal:

- Study optimization of PXD using single tracks and impact parameters

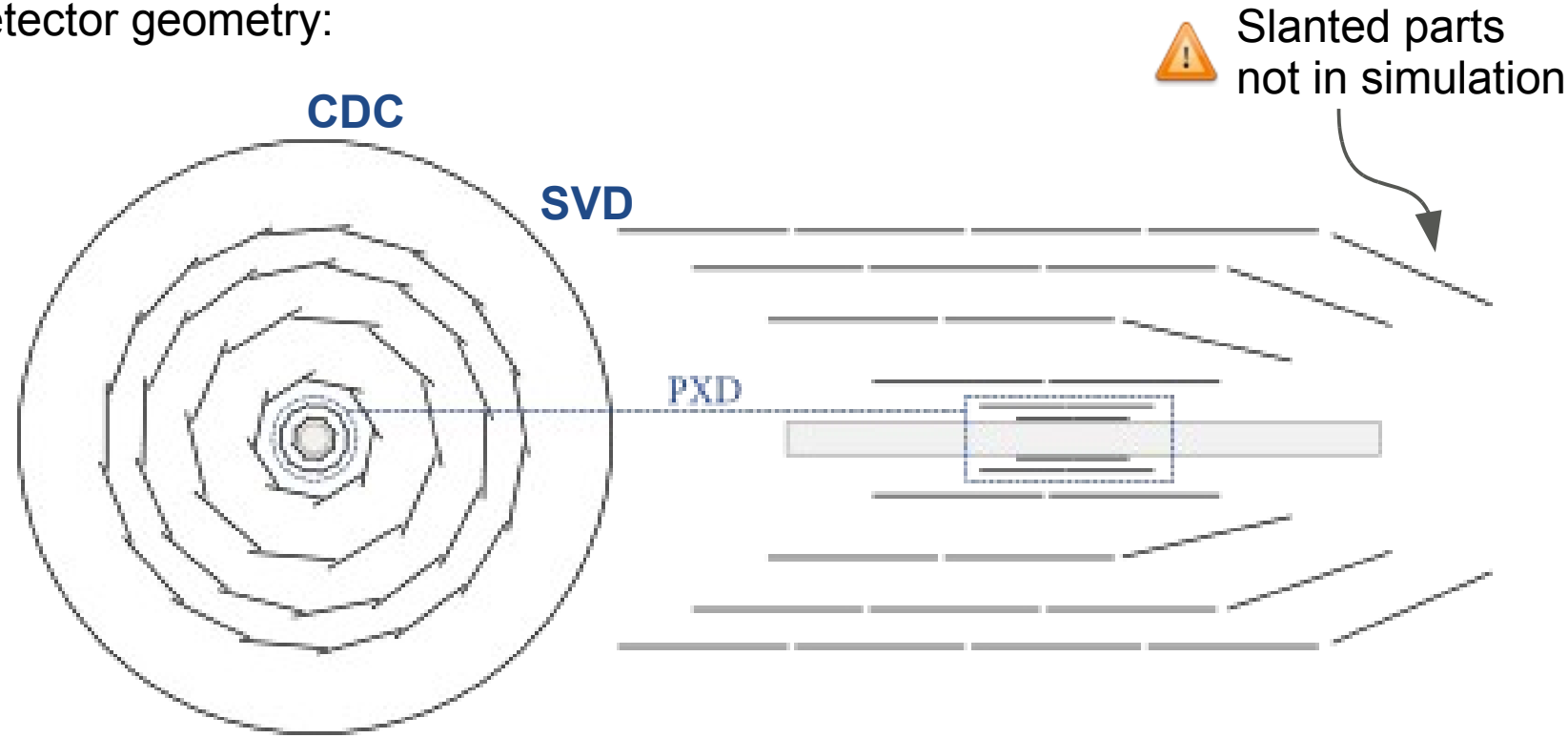
Optimization chain

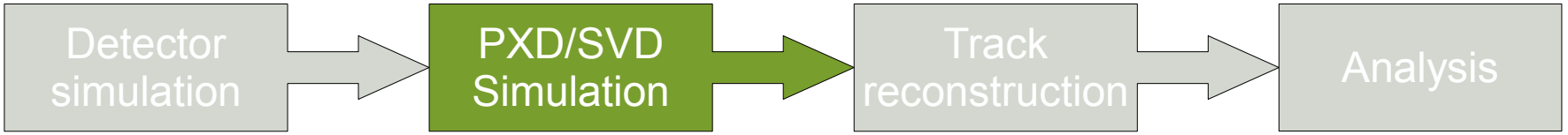




Detector simulation software: **Mokka** (geant4 based, ILC framework)

Belle II detector geometry:





Simulation of DEPFET sensor signal:

Ionization points generated (energy loss fluctuation added + electron-hole pairs created)

Signal points generated:

drift of electron-hole pairs

drift path calculated

Lorentz shift in magnetic field + diffusion sigma calculated

Electronic noise added (100 e^-)

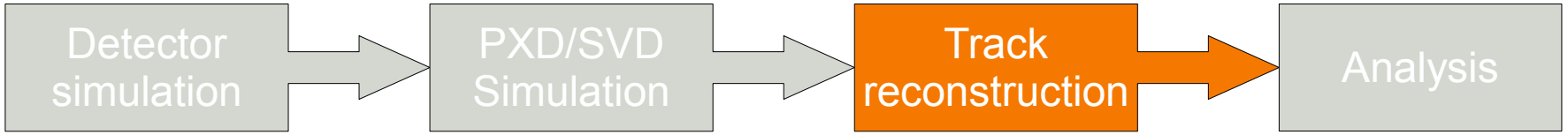
Digitization and **Clustering** separated

Perform clustering after digitization of all hits

Landau energy deposit not taken from geant4 instead parameter from MIP used.

Benjamin Schwenker changed this (see his talk yesterday)

Already started discussion on how to merge his code with our code.

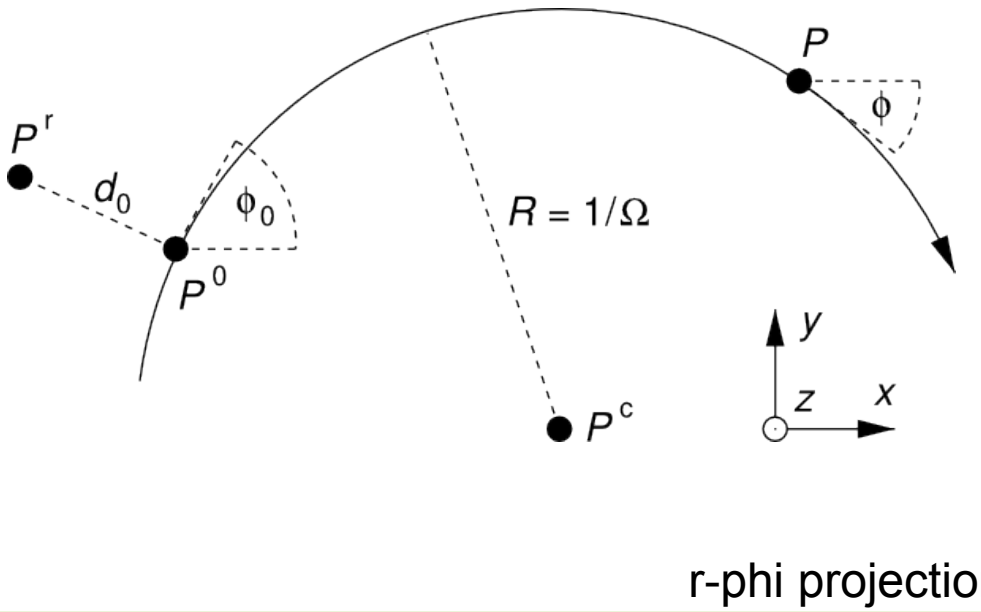


Tracking performed in **Marlin** (ILC framework)

- Silicon (PXD, SVD) tracking + CDC tracking
- Merge Silicon and CDC tracks
- Tracks with impact parameters (+ its errors)

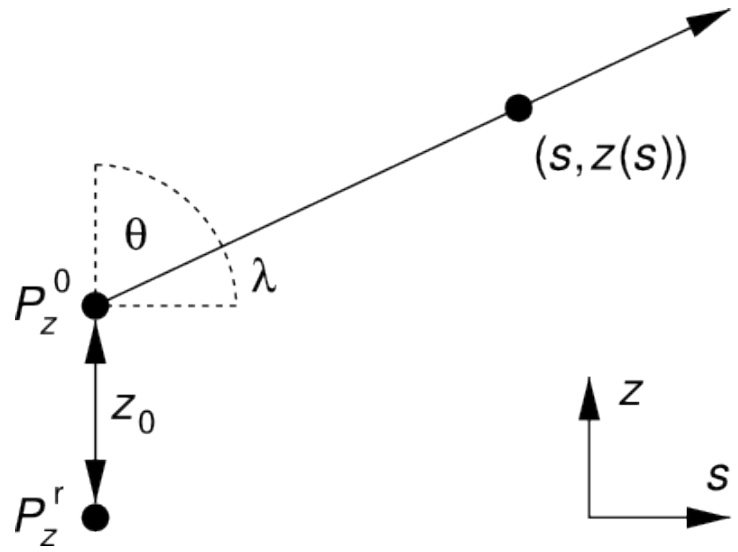
Definition impact parameter:

d0



r-phi projection

z0



arclength-z projection

Detector simulation → PXD/SVD Simulation → Track reconstruction → Analysis

Agreed in common resolution fitting method

Function: $$\sigma_{vtx} = N\left[\frac{(1-f_1-f_2)}{\sqrt{2\pi\sigma^2}}\exp\left(\frac{-(x-\mu)^2}{2\sigma^2}\right)+\frac{f_1}{2\lambda_1}\exp\frac{-|x-\mu|}{\lambda_1}+\frac{f_2}{2\lambda_2}\exp\frac{-|x-\mu|}{\lambda_2}\right]$$

1. Do pre-fit of Gaussian with 2 * RMS and around mean
2. Add exponential functions and refit

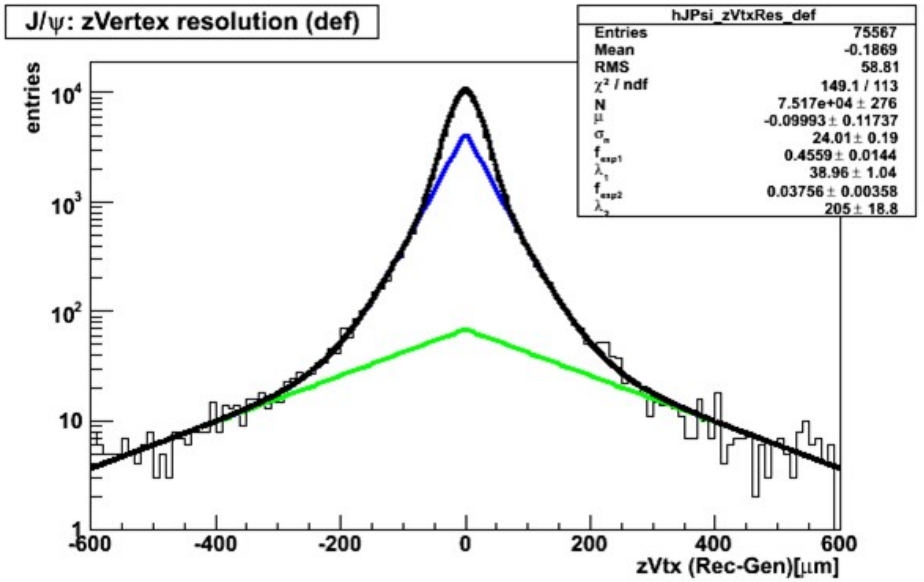
Resolution is characterized by

Core: width of Gaussian (e.g. σ=24μm)

Tail: fraction of histogram entries

outside 3σ-window, independent of fit details on tail.

Example:



Check **reliability** of our simulation software:

PXD optimization software

ILC framework

Mokka (geant4)
SiStripDigi, SiStripClus
SiliconTracking, FullLDCTracking

BELLE detector implemented
by Prague/Munich for
optimization purposes

Belle simulation/analysis software

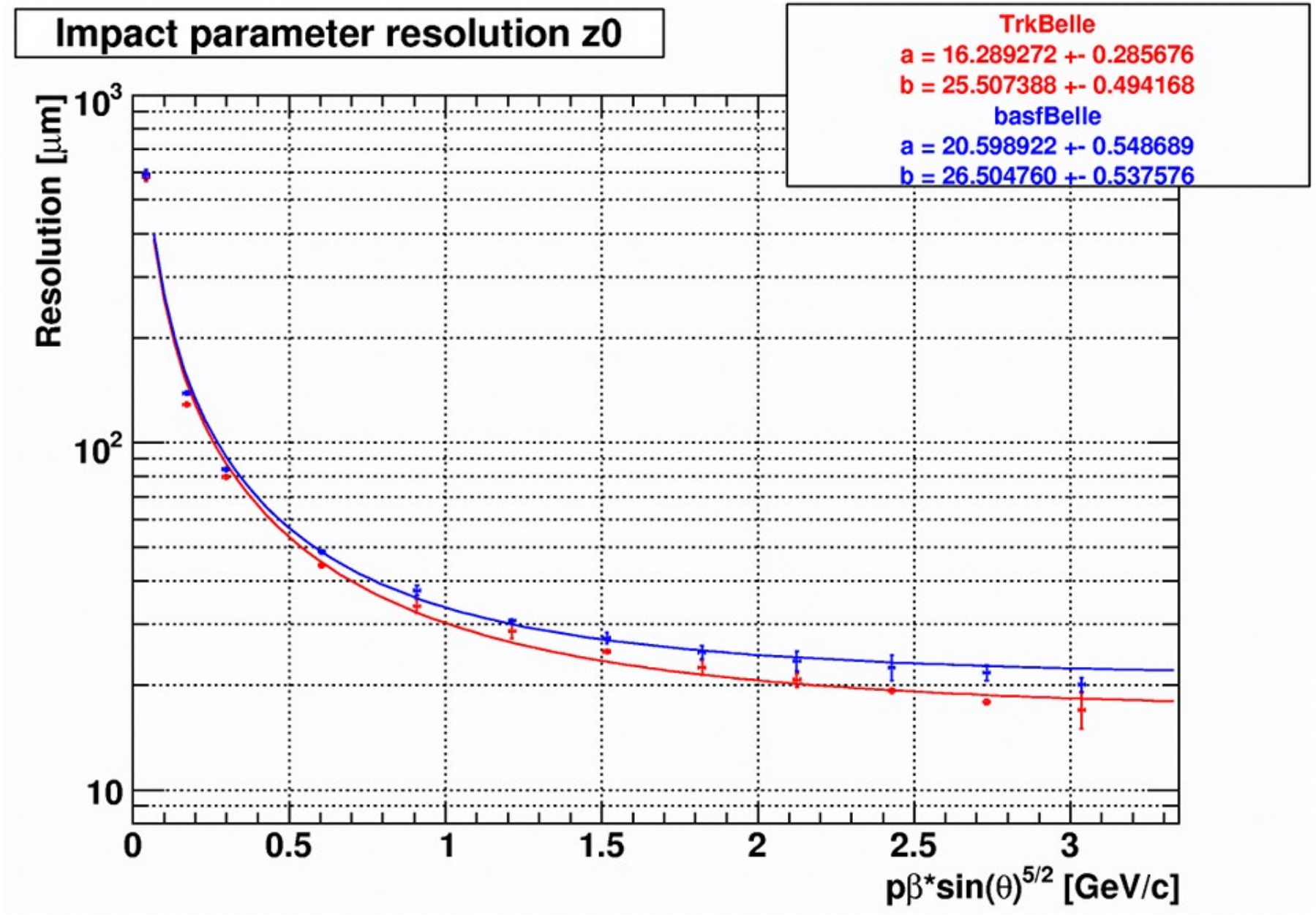
BASF

gsim (geant3)
recsvd, calsvd
trasan, trak

BELLE detector implemented
by KEK mainly for physics analysis.

Very well tested and validated
BELLE detector simulation

Produce single muon tracks with the same parameters
in both frameworks for the BELLE detector



✓ Good agreement of Belle and ILC software

Constant pixel size, 1600 pixels, Pixel size: 1. layer: **50 x 47.7 µm** 2. layer: **50 x 73.4 µm**

800 pixels, Pixel size: 1. layer: **50 x 95.4 µm** 2. layer: **50 x 146.8 µm**

	thickness	rad 1. layer	rad 2. layer	# 1. layer	# 2. layer
	50 µm	14 mm	22 mm	1600	1600
	50 µm	13 mm	22 mm	1600	1600
	50 µm	14 mm	22 mm	800	800
1. layer split	50 µm	14 mm	22 mm	1600	1600
	50 µm	13 mm	22 mm	1600	1600
	50 µm	14 mm	22 mm	800	1600
	75 µm	14 mm	22 mm	1600	1600

Base line

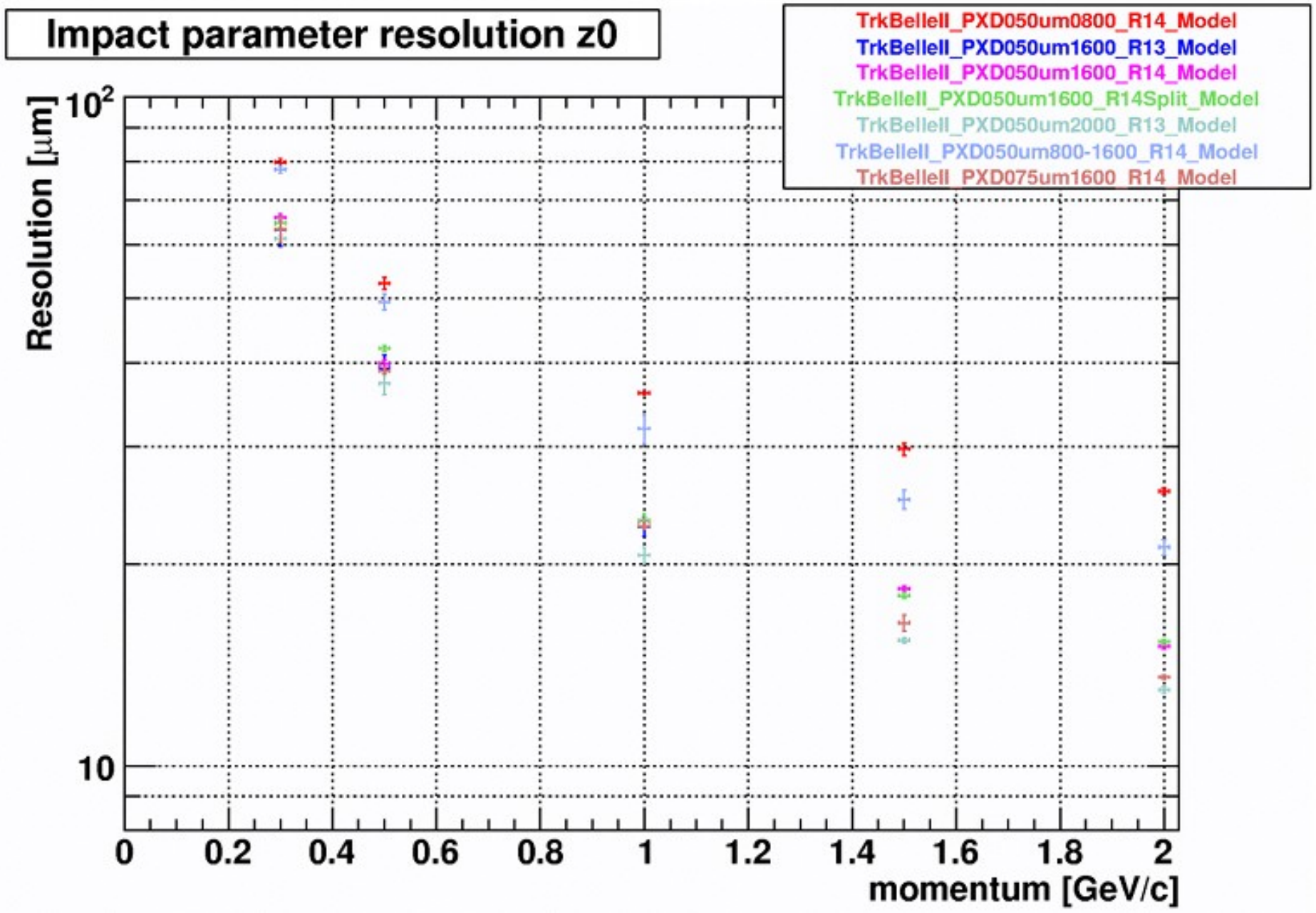
Momentum (GeV)

0.3 **2.5**
0.5 **3.0**
1.0 **3.5**
1.5 **4.0**
2.0 **4.5**

Angles (degree) + 1 degree smearing

35.0
55.0

Angle: 55.0 degree



Angle: 55.0 degree

Momentum	0.5 GeV [µm]	1.0 GeV [µm]
50 µm, 800x800, 14	53.43	36.04
50 µm, 800x1600, 14	50.28	31.90
50 µm, 1600x1600, 14, Split	42.41	23.93
50 µm, 1600x1600, 14	41.26	23.59
75 µm, 1600x1600, 14	40.71	22.97
50 µm, 1600x1600, 13	40.92	23.59
50 µm, 2000x2000, 13	38.96	21.57

Base line

Best

- ILC optimization framework validated (against BASF)
- Single track study for 7 different PXD models
- Separation of Digitization and Clustering in PXD
- Smaller pixels have the biggest influence

Next steps:

- Use physics background