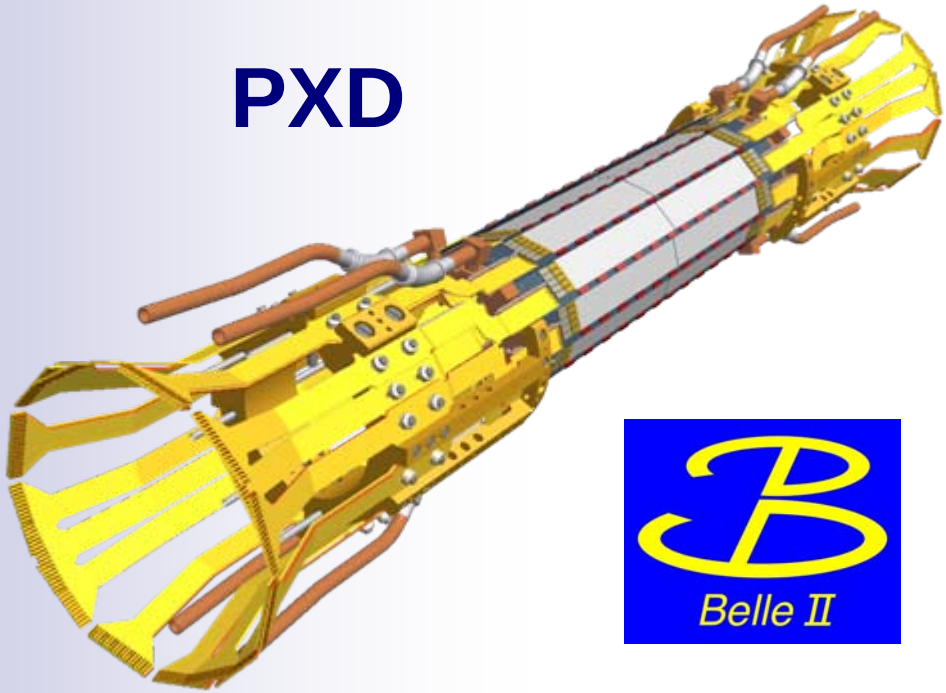
Benchmark Physics Performance Sensor Thickness

PXD



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Content

- Reminder of Performance Studies at Prague meeting
- Physics Performance vs. Sensor Thickness
- Summary and Conclusions

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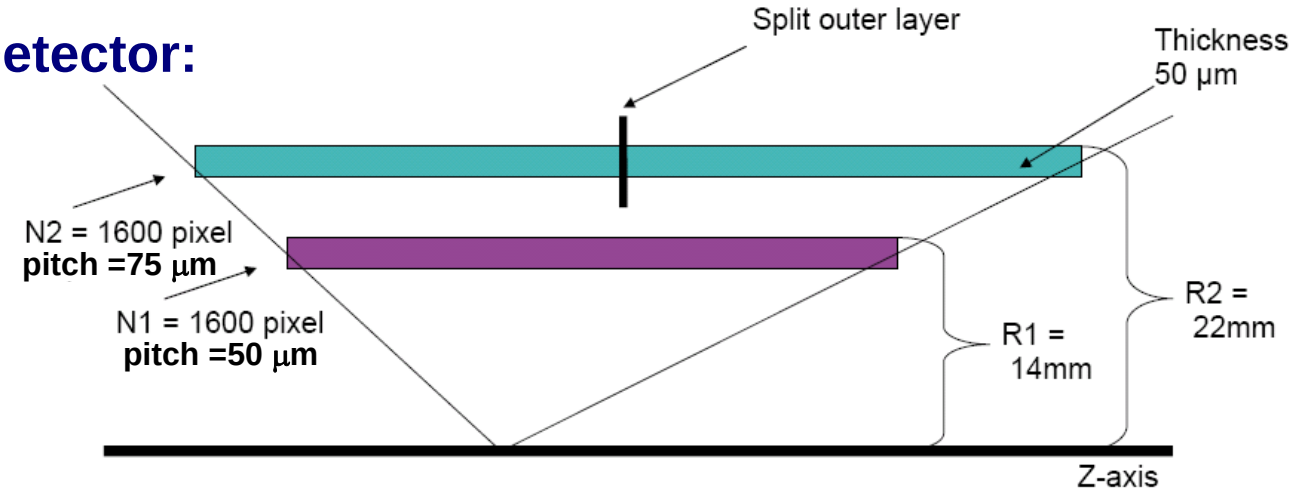
Baseline Setup

Beam: SuperKEKB nano-beam option:

4GeV e^+ on 7GeV e^-, crossing angle 83mrad, angle LER B-field 15.55mrad
Detector axis parallel to B- field, 1.5T

,

Baseline Detector:



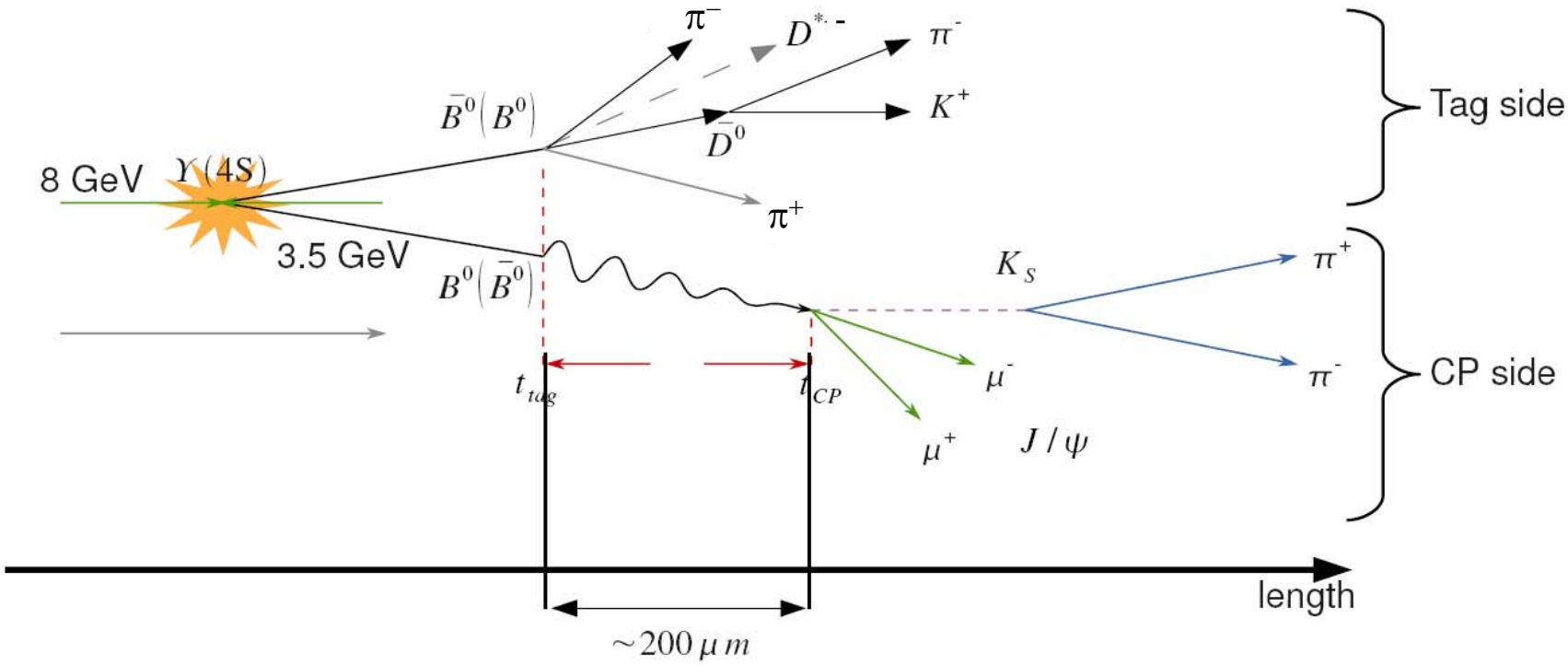
Detector Variations:

- Study 1: variation of inner radius R1 = 13 mm
- Study 2: variation of sensor thickness d = 75 um
- Study 3a: variation of number of pixels and readout speed N1 = 800 pixel
- Study 3b: variation of number of pixels and readout speed N1 = N2 = 800 pixel
- Study 4: Optimal but still conceivable PXD) R1 = 13mm; N1 = N2 = 2000 pixel
- Study 5: break the inner layer

Physics Study: Golden Channel

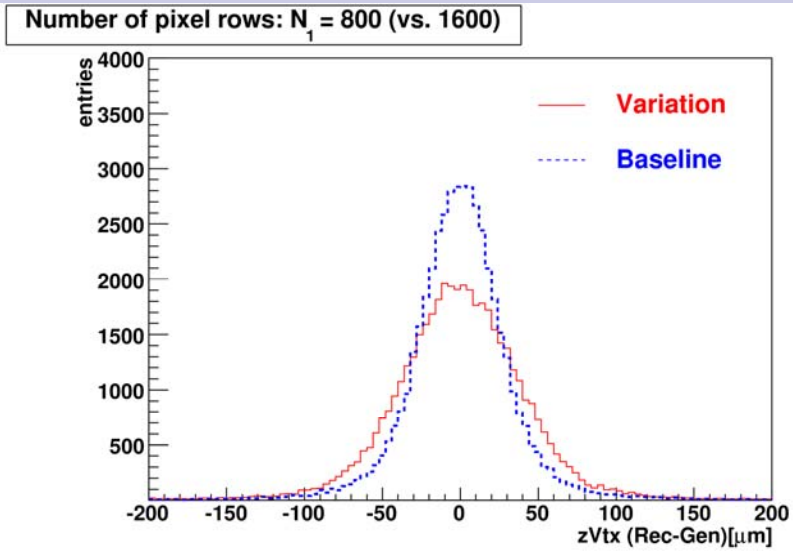
- Aim: Evaluate PXD options with realistic physics benchmark process
- Vertex resolution key to all CP violation measurements

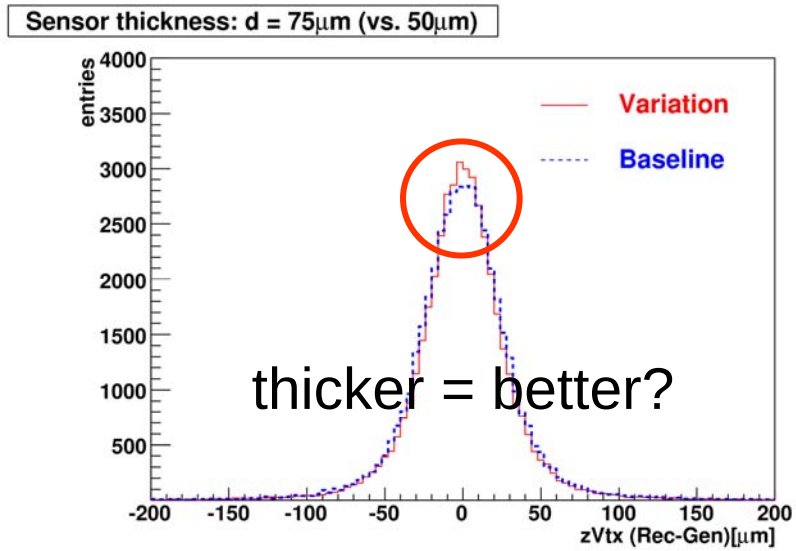
  ➔ Study “Golden Channel”:

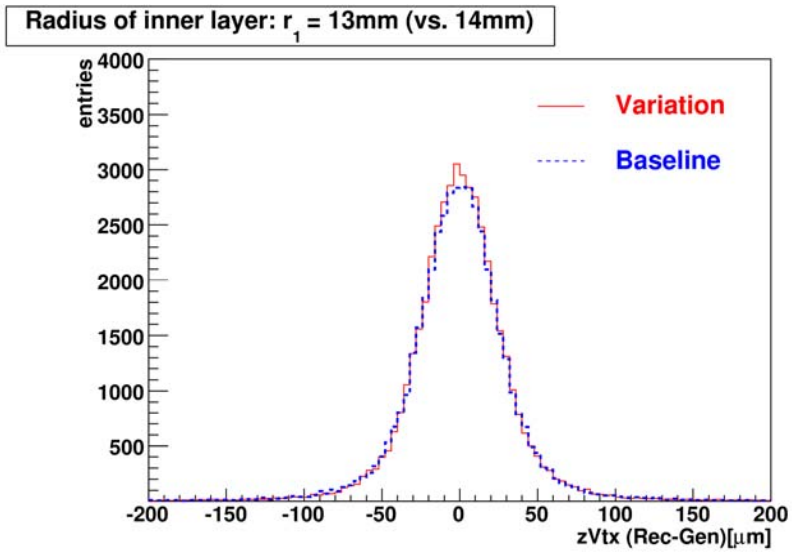


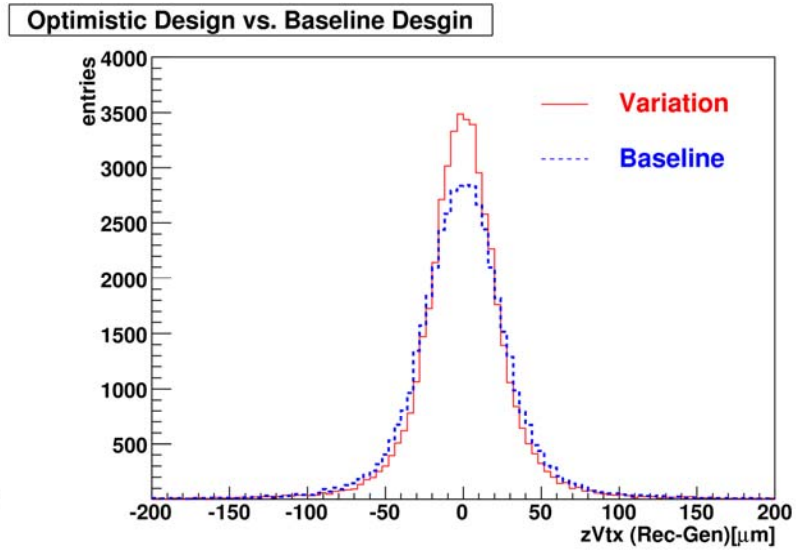
High precision vertexing essential for this type of measurements

J/ψ z-Vertex Resolution









Same trends (less prominent) for D^0 back extrapolated to beamline

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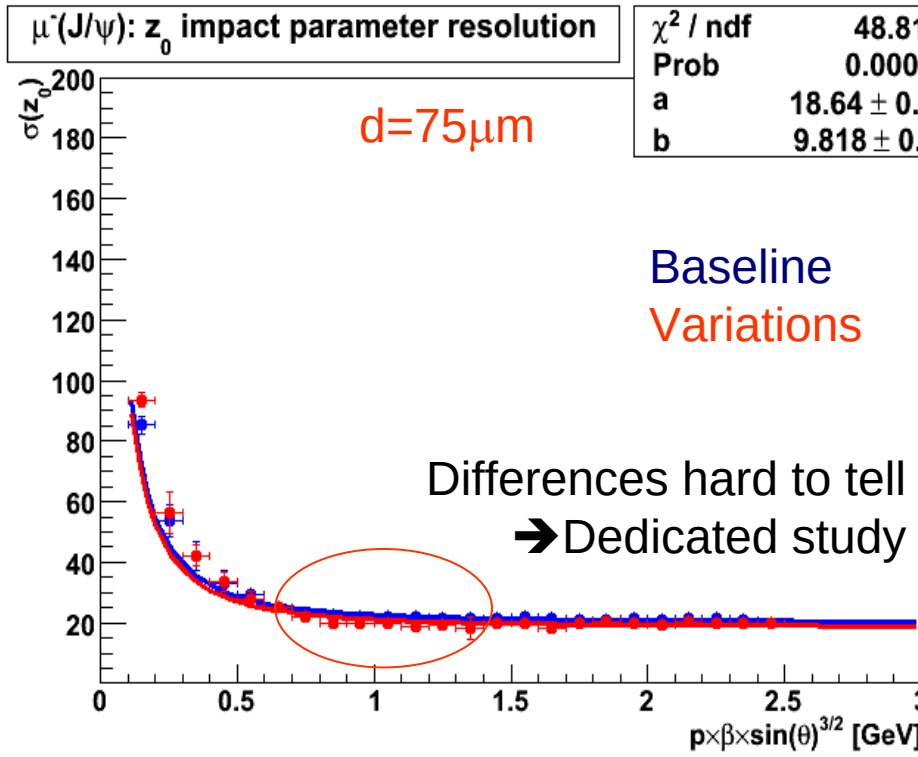
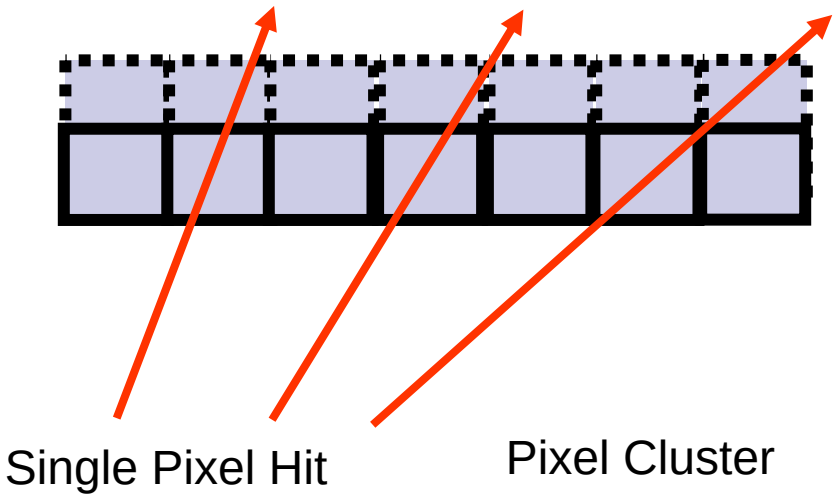
Why is thicker better?

- Contrary to expectation:
  less material
  →less multiple scattering
  →better performance

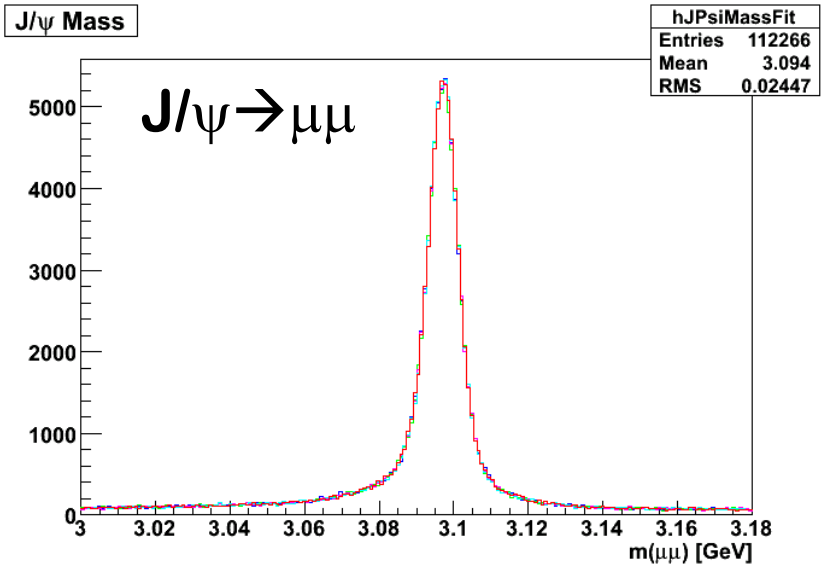
z0 impact of muon in J/Ψ

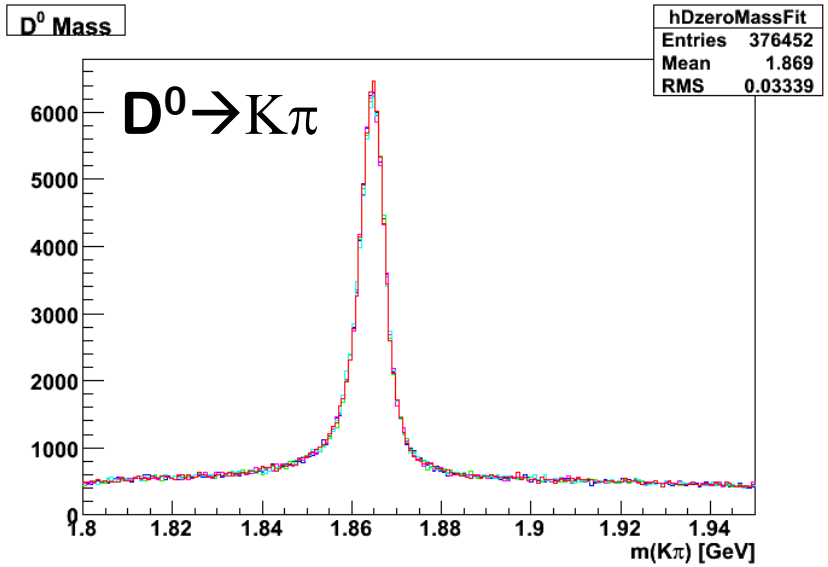




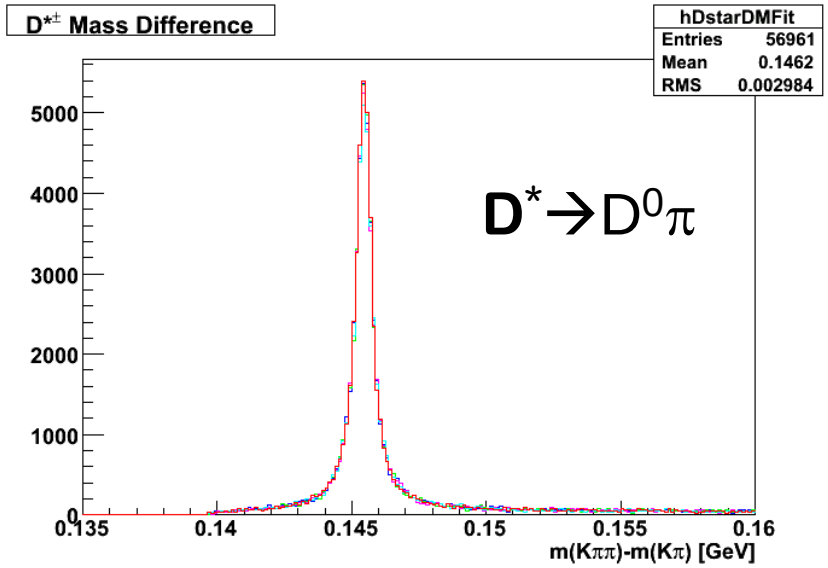
Better position resolution if charge is shared between a few pixels

Reconstructed Candidates: Mass Plots

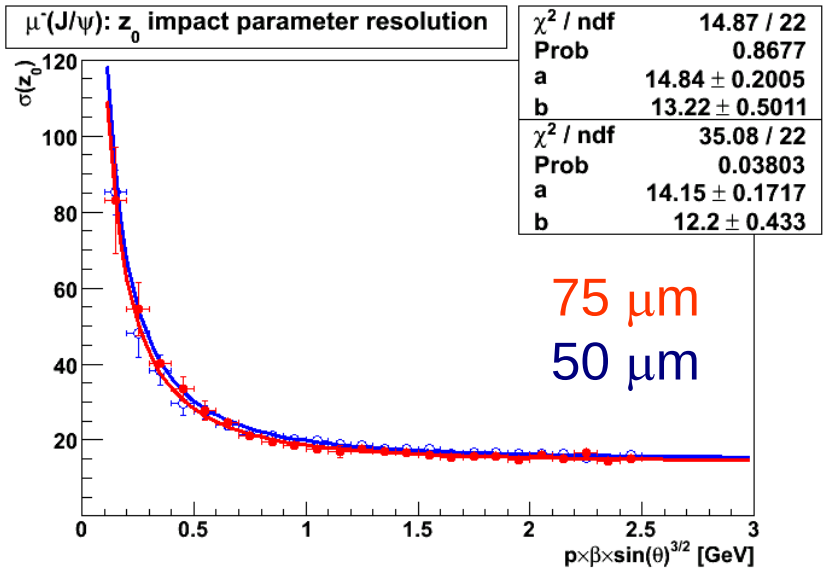


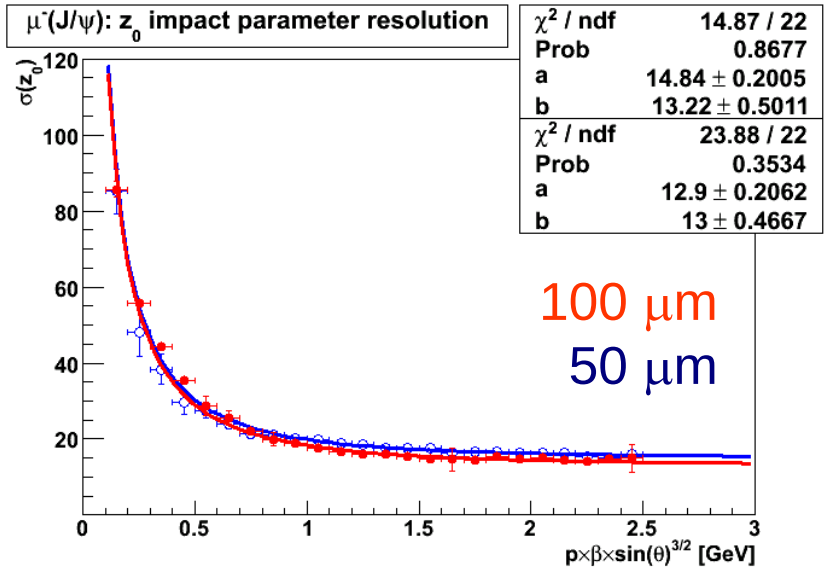


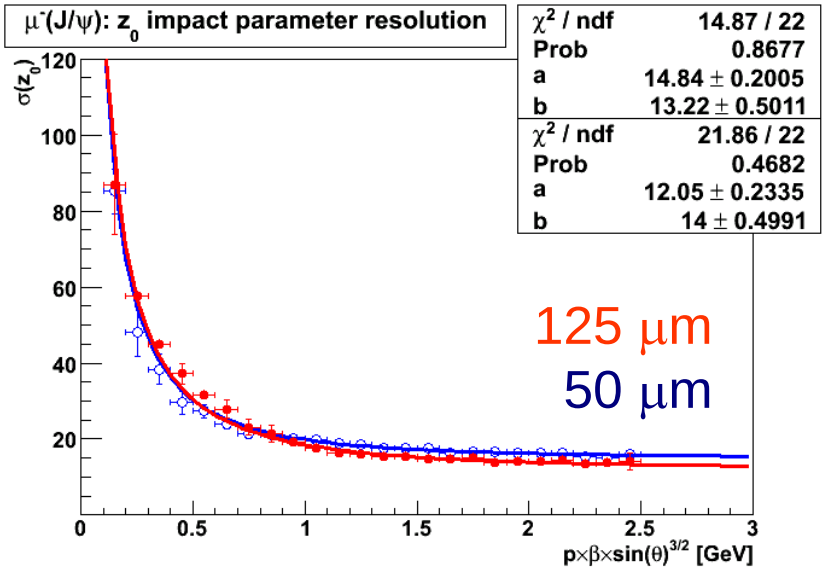
- J/ψ and D^0 Masses and D^{*+} mass differences
- similar signal yields and background levels for all sensor thicknesses
- Very loose track quality criteria

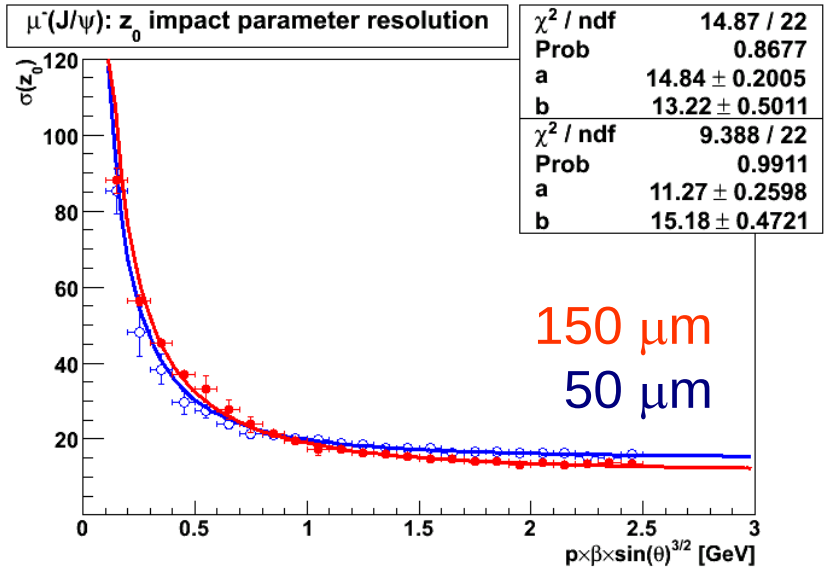


Sensor Thickness Scan: z0 ($\mu_{J/\psi}$)









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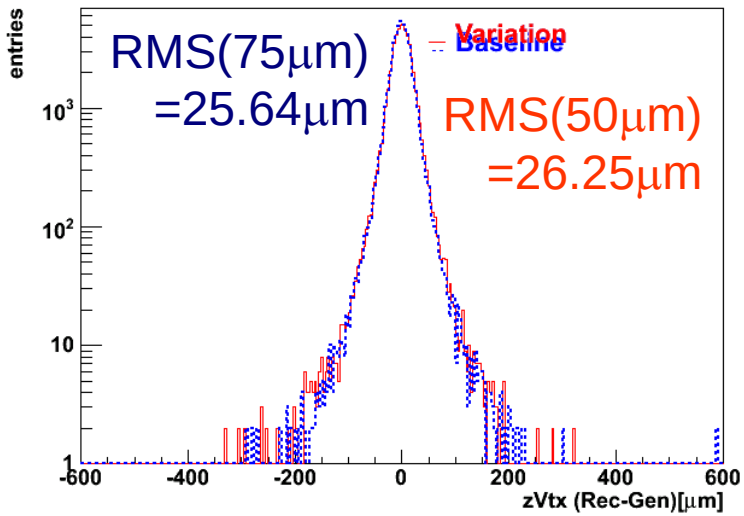
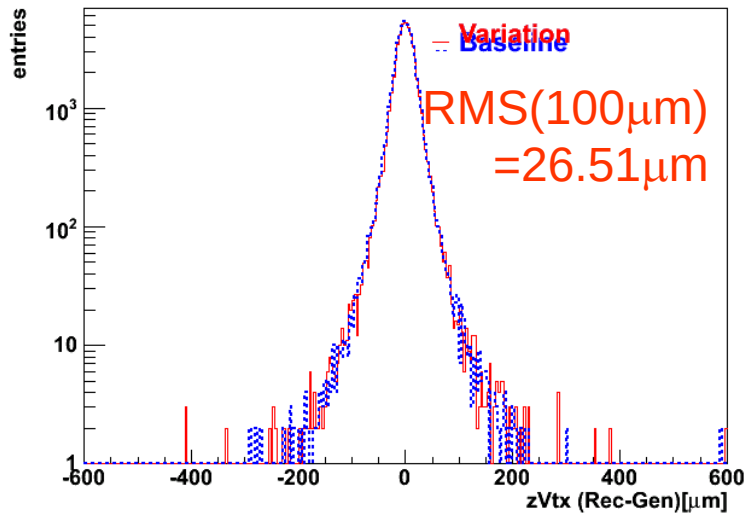
J/ψ z-Vertex Resolution

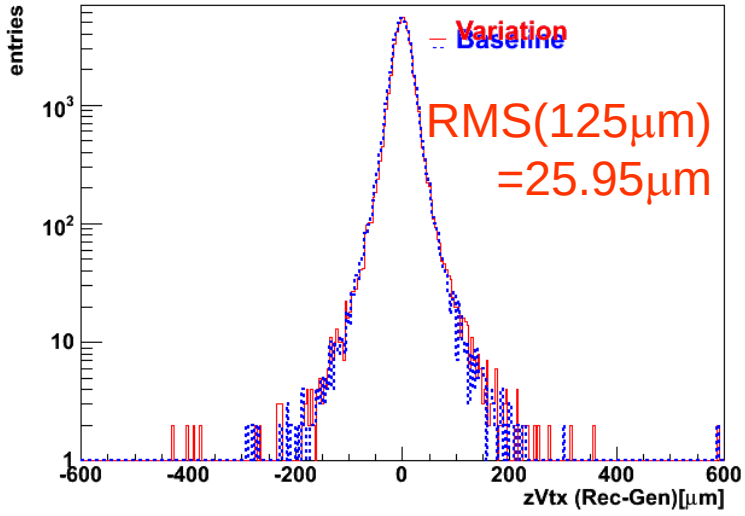
Sensor thickness: d = 50μm



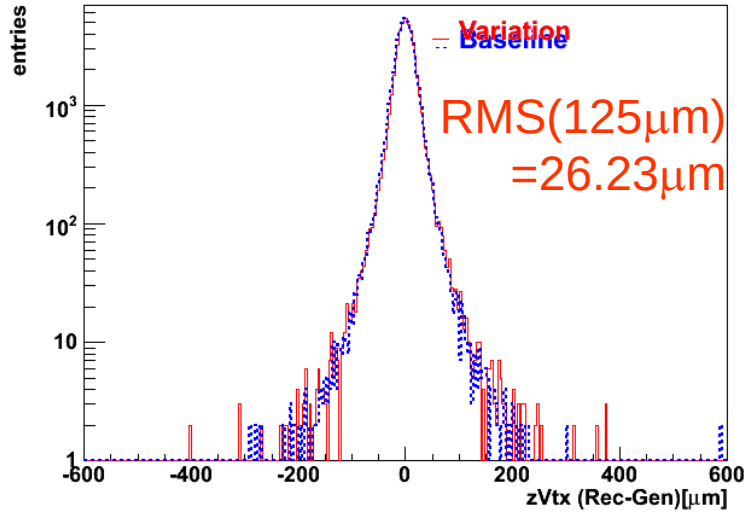
Sensor thickness: d = 100μm



Sensor thickness: d = 125μm

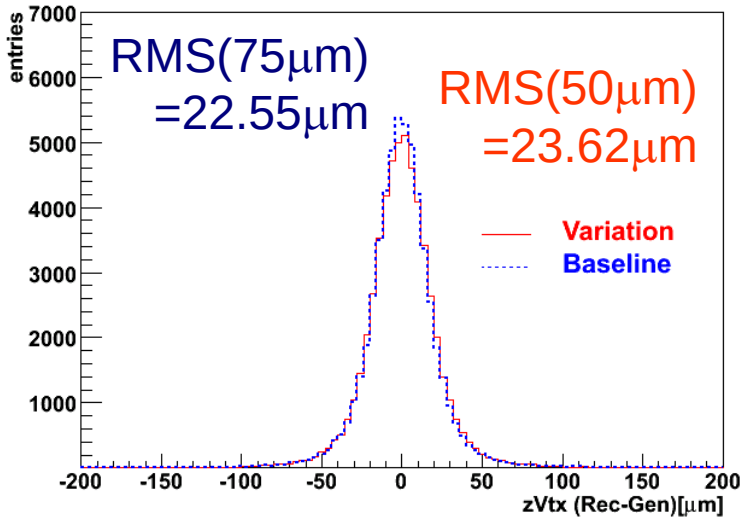


Sensor thickness: d = 150μm

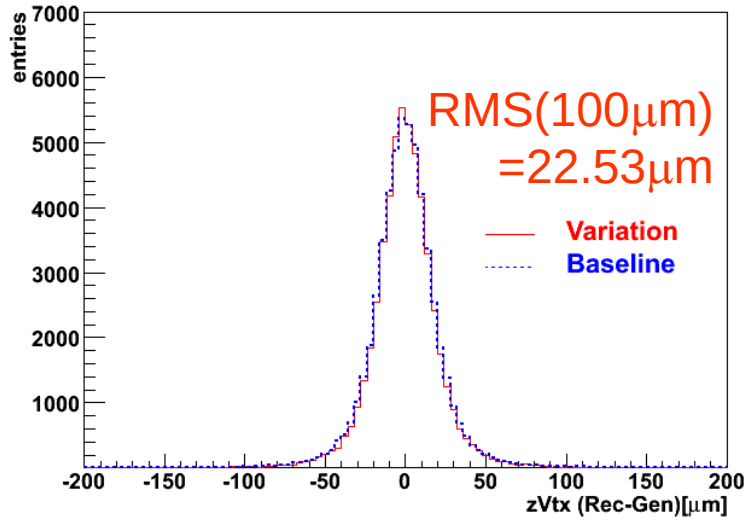


J/ψ z-Vertex Resolution (lin)

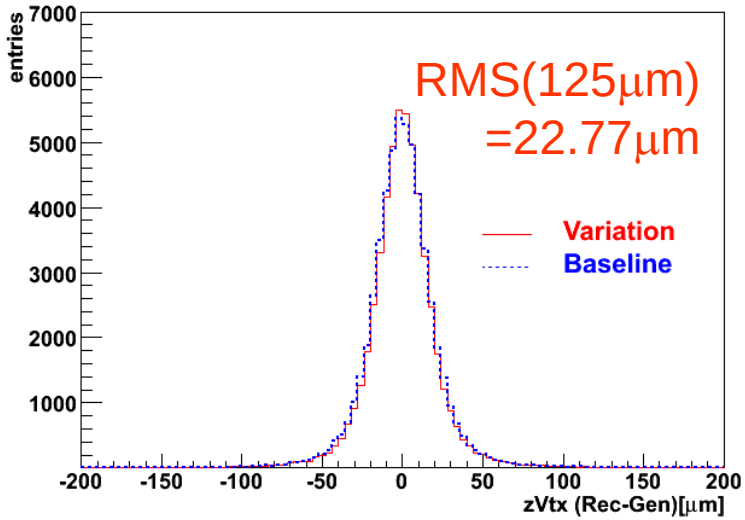
Sensor thickness: d = 50μm



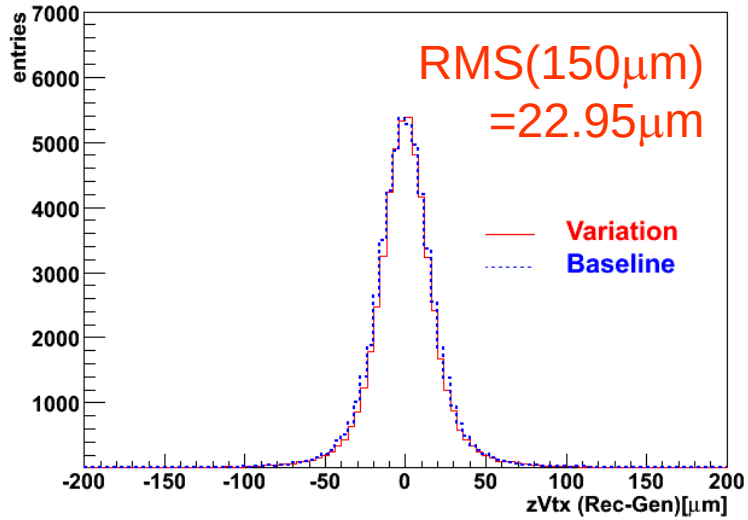
Sensor thickness: d = 100μm



Sensor thickness: d = 125μm



Sensor thickness: d = 150μm



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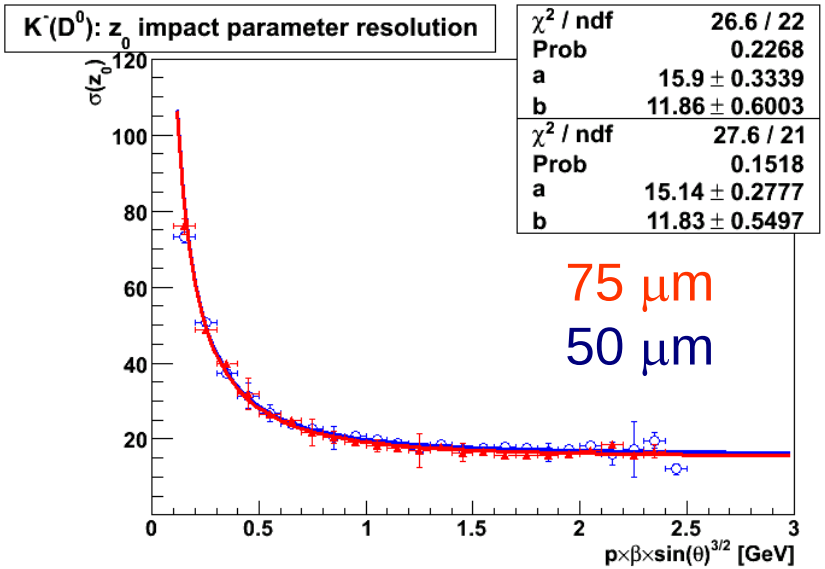
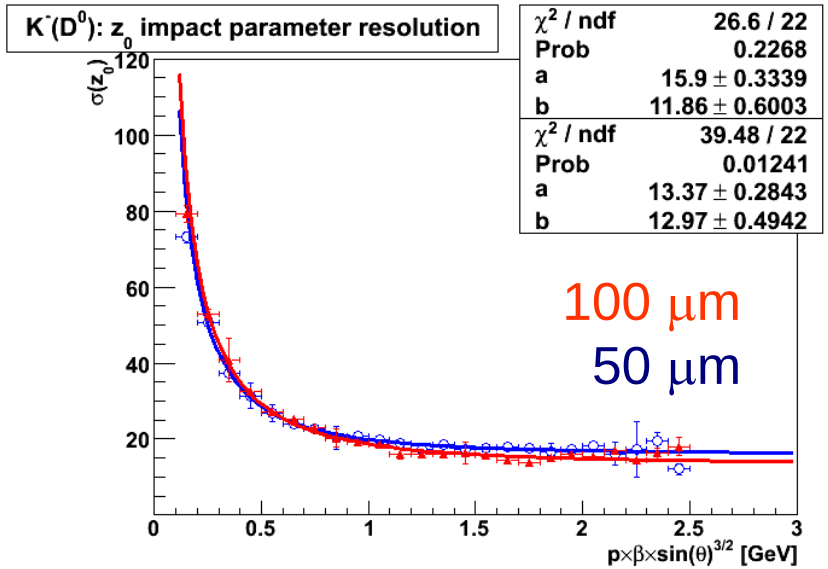
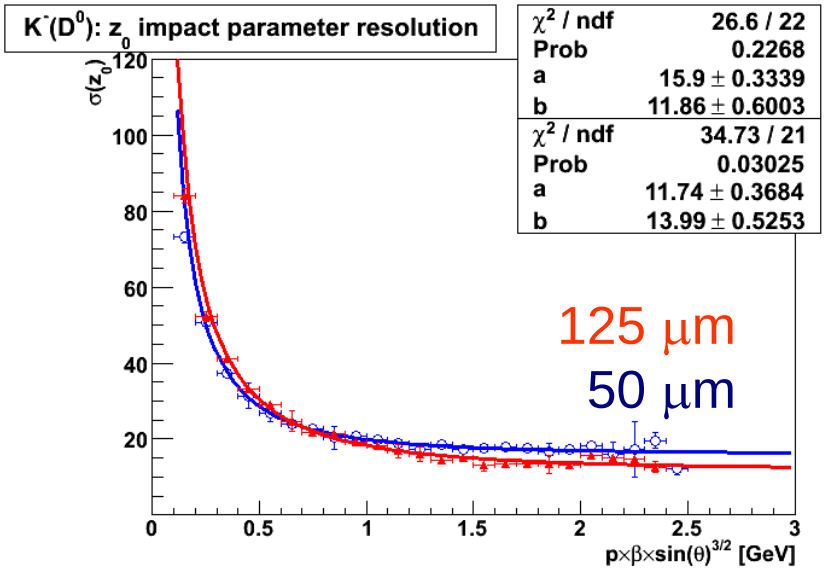
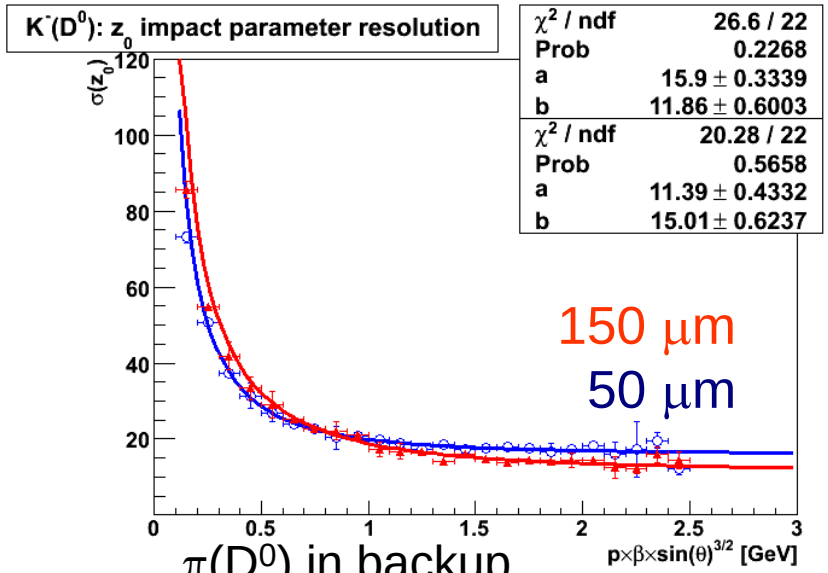
Tag-Side: $K^-(D^0)$ z0-Impact









π(D⁰) in backup

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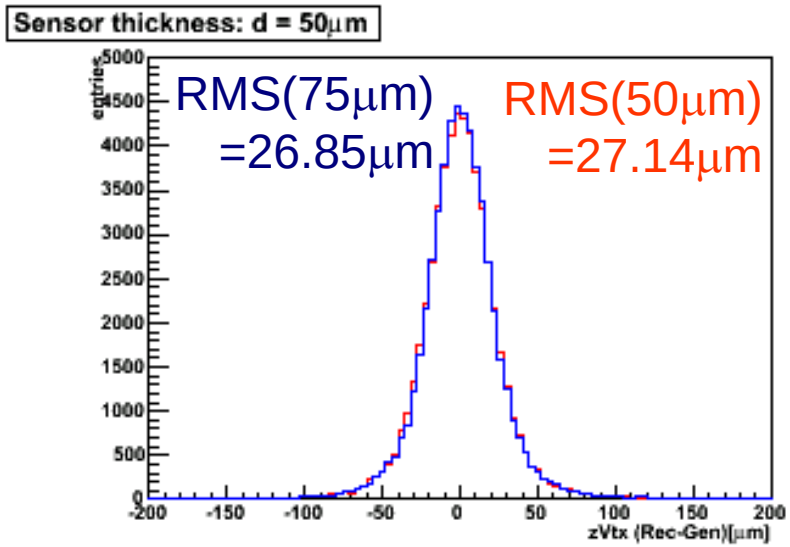
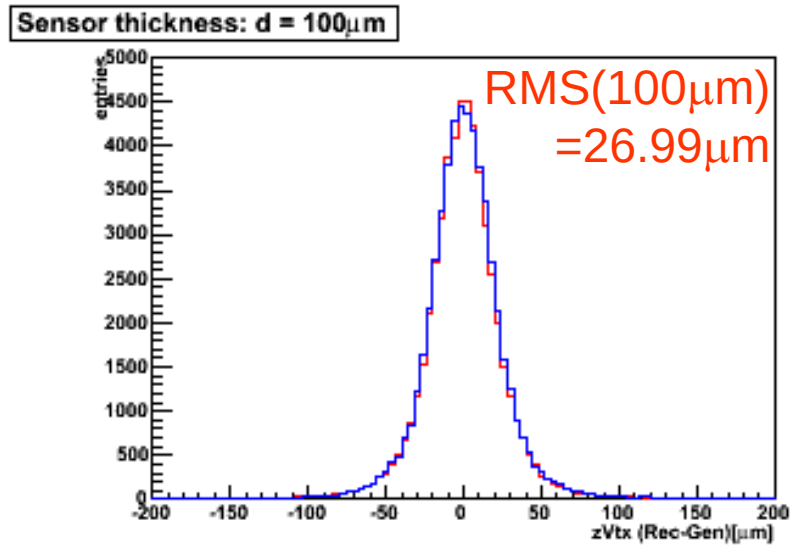
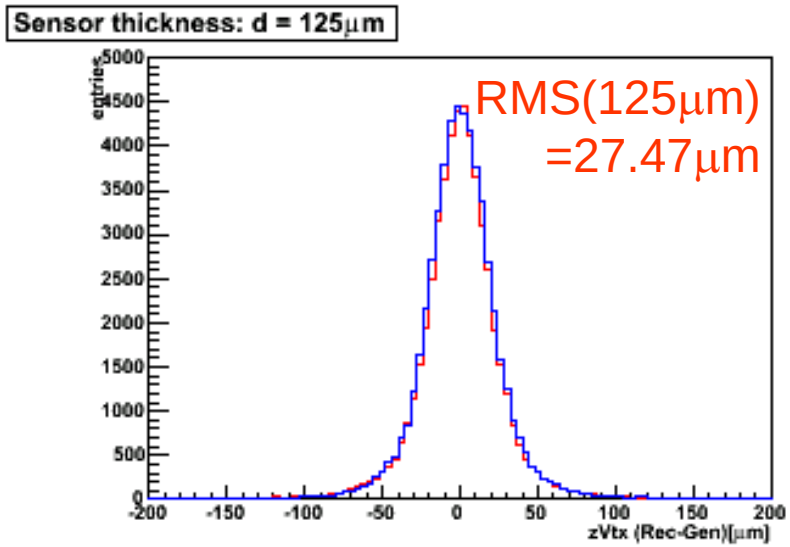
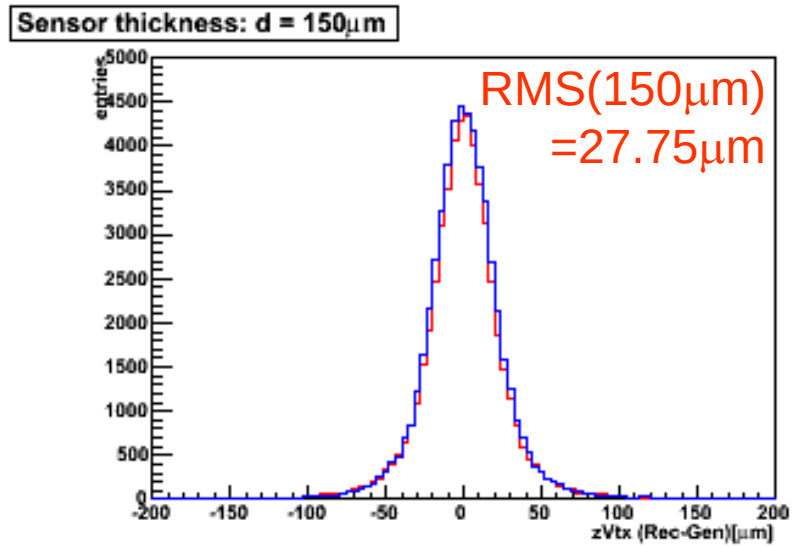
D0 z-Vertex Resolutions

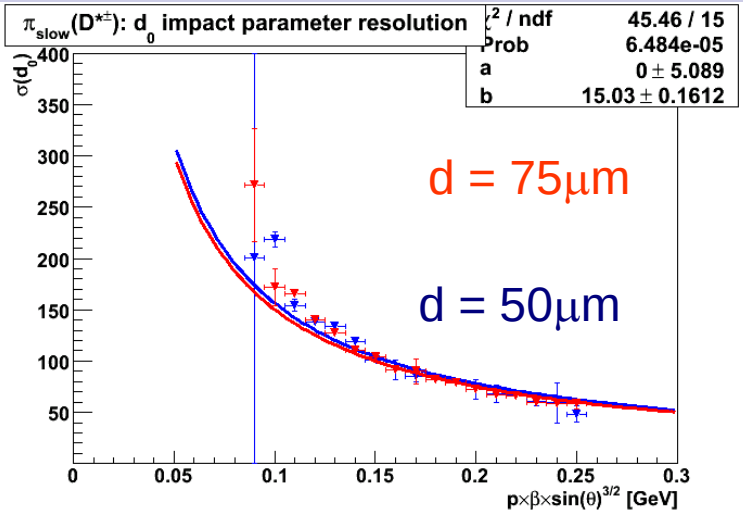


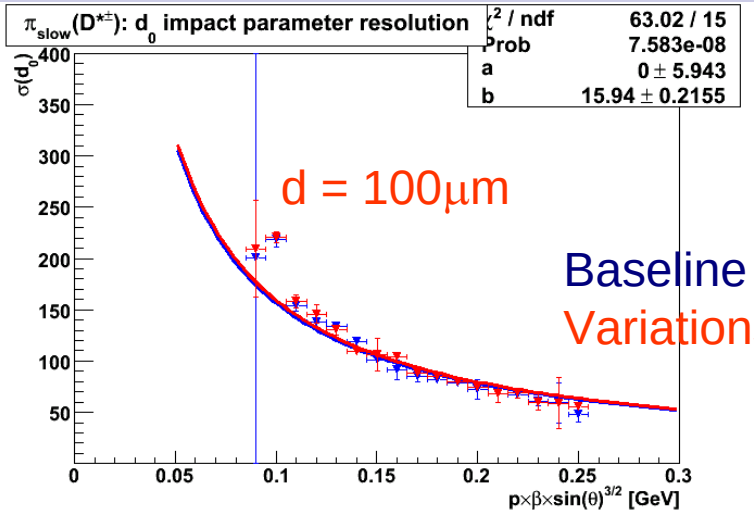


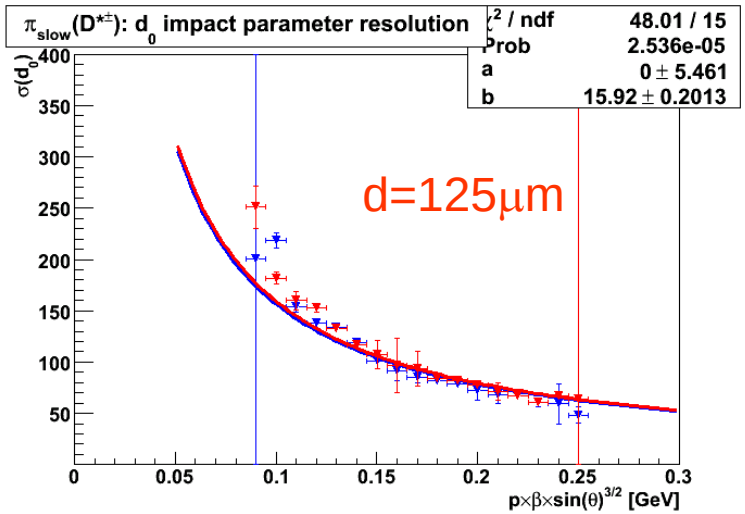


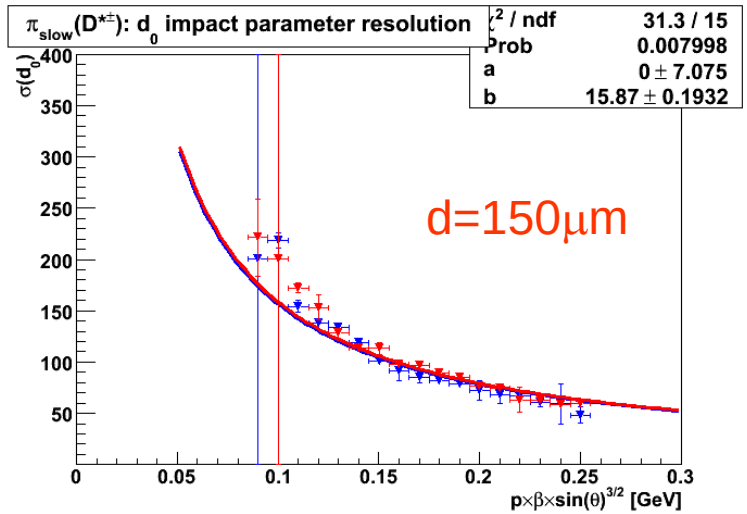


Performance: Low momentum tracks: Track Impact Parameter of π_{slow} (D^{*+})







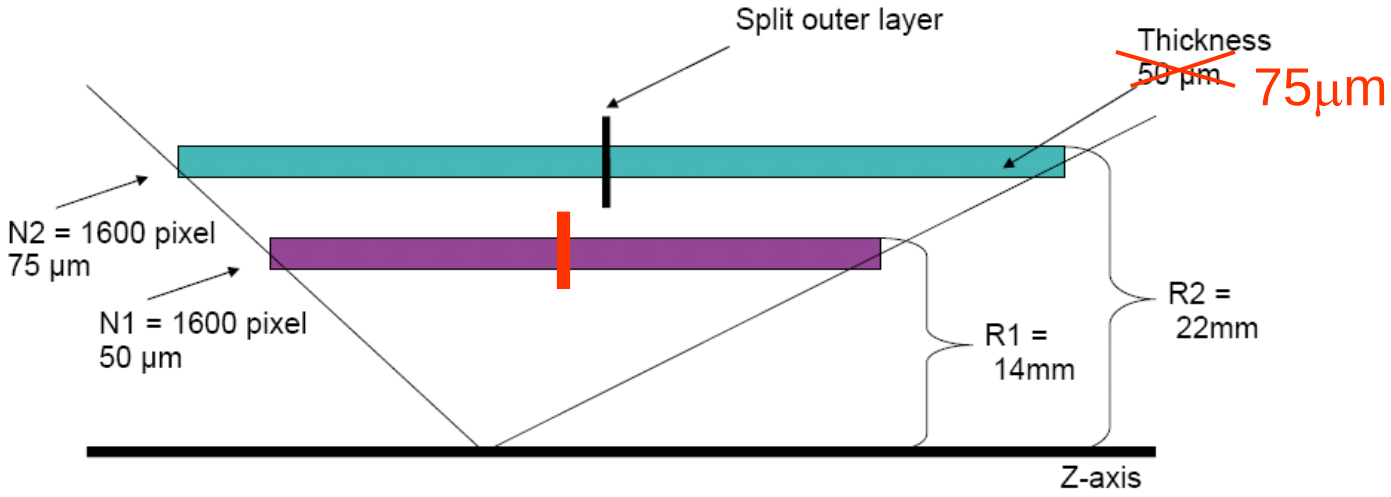


Dedicated study of D* ➔ see next talk

Summary & Conclusions

- Change of Sensor Thickness from 50 to 75 μm gives equally good (if not better) physics performance
- no significant improvement for physics benchmark with sensors thicker than 75μm

- Belle II baseline PXD (Prague meeting) close to optimum
- Improved baseline



- Split inner layer
- Sensor thickness 75μm

Backup Slides

- Masterplan
- pi+ z0 Impact Parameter

Master Plan for Optimization Study

A.) Establish analysis chain in Belle framework: BASF

well-proven tool box for Physics analysis in Belle

1. Generate events (EvtGen)
2. Simulate events (Belle Geometry)
3. Analyze events (BASF / ROOT)

B.) Implement analysis in ILC framework: Mokka/Marlin = LCIO

tool box for detector optimization studies

1. Interface EvtGen output
2. Simulate events with ILC framework setup for Belle geometry
3. Reconstruct decays (LCIO/ROOT)

Comparison of A and B establishes baseline for optimization study

Status @ B2GM4

C.) Rerun B.) for various Belle II detector (and beam) scenarios for various physics channels

NEW

Tag-Side: $\pi^+(D^0)$ z0-Impact