

Sftware

GEANT4, Optimization

— Outline —

- . Optimization for baseline design
Inner layers / Outer layers
- . Optimization for Lol'04 design
- . Geant4-base detector simulation
IR / SVD / PXD
- . Physics Analyses
Vertex resolution for $B \rightarrow \pi^- \pi^+$
 ΔE and reconstructed mass for $B \rightarrow J/\psi K_s$
- . Software Status

Optimization

for Baseline design (1.5cm radius beam pipe + 6-layer SVD)

done with TRACKER and GEANT3-base Belle-standard gsim.

For inner layers

- . Inner radius and resolution
- . Beam background effect on front-end chip
- . Material thickness

For outer layers

- . S/N ratio and SVD-CDC track matching efficiency
- . Readout pitch
- . 5th layer position
- . Material thickness
- . Slanted sensors

Details can be found in the latest Study Report

<http://belle.kek.jp/~ushiroda/sbelle/StudyReport2008/draft/>

Inner Layers

To achieve better vertex resolution

Innermost layer should be located
as close to the beam pipe as possible

Innermost layer should be operable
under harsh beam background
(~15times higher than Belle)

High trigger rate (~10kHz)

Shorter shaping time

Pipeline readout

~35 (inner), ~16 (outer)
for Belle VA1
APV25 : ~4times worse

~10% Occ. (inner)
for Belle VA1

VA1 → APV25 equivalent chip, S/N gets worse

To make S/N better, chip-on-sensor is proposed

not preferred

Material increases

vertex resolution gets worse

Materials in innermost
layer is critical for vtx

Outer Layers

High trigger rate ($\sim 10\text{kHz}$)

Pipeline readout is needed

“APV25”

To increase the eff. for $B \rightarrow K^*\gamma$

SVD should be expanded

in the radial direction

(sensor would be longer

$R=16\text{cm}$

to keep the same acceptance)

$17 < \theta < 150$

channel increases

S/N gets worse

Slanted sensor

not yet optimized

wider pitch

unacceptable

CDC+SVD matching eff. gets worse

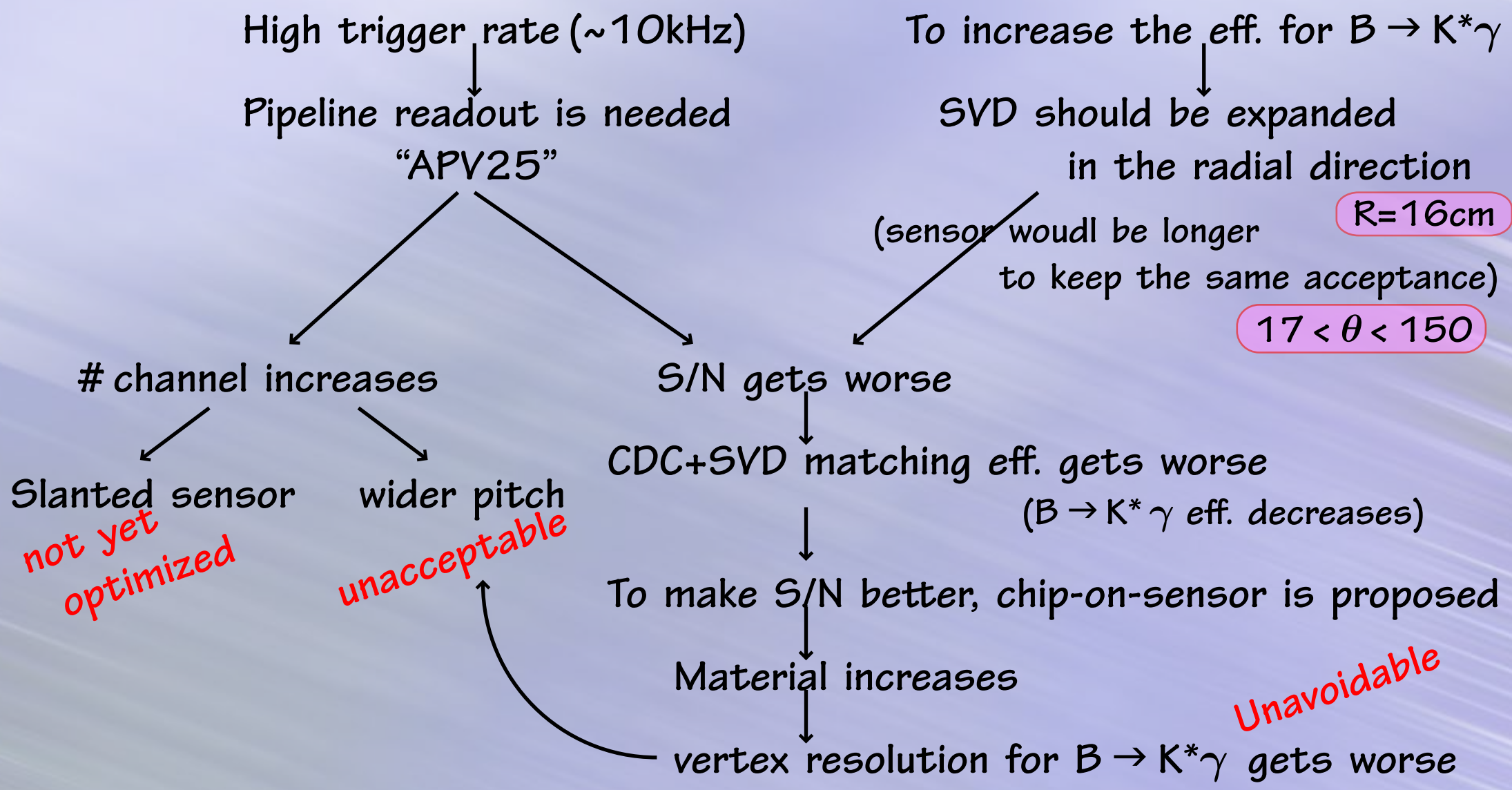
($B \rightarrow K^*\gamma$ eff. decreases)

To make S/N better, chip-on-sensor is proposed

Material increases

Unavoidable

vertex resolution for $B \rightarrow K^*\gamma$ gets worse



Optimization

for Baseline design (1.5cm radius beam pipe + 6-layer SVD)

done with TRACKER and GEANT3-base Belle-standard gsim.

For inner layers

- . Inner radius and resolution : 2.0cm, as well as Belle
- . Beam background effect on front-end chip : APV25 w/o chip-on-sensor
- . Material thickness : should be thin

For outer layers

- . S/N ratio and SVD-CDC track matching efficiency
- . Readout pitch : unacceptable
- . 5th layer position : 2cm inside of the outermost
- . Material thickness : no choice to keep better S/N
- . Slanted sensors : not optimized

Details can be found in the latest Study Report

<http://belle.kek.jp/~ushiroda/sbelle/StudyReport2008/draft/>

Optimization

for Lol'04 design (1.0cm radius beam pipe
+ 2-layer PXD + 4-layer SVD)

done with GEANT4-base full-detector simulation

For beam pipe

- . Au or Ti coating ?

For inner layers (PXD)

- . Inner radius

- . Beam background effect (X-ray?, particle BG, ...)

- . Material thickness

For outer layers (SVD)

- . S/N ratio and SVD-CDC track matching efficiency

- . Material thickness

- . # of readout channel

- . Slanted sensors

Just started!

Beam pipe

(P.Chen : NTU)

Status

in progress
not yet

To check the IR part installed in the current library

To modify the beam pipe structure

Au or Ti coating ?, thickness of Au ?

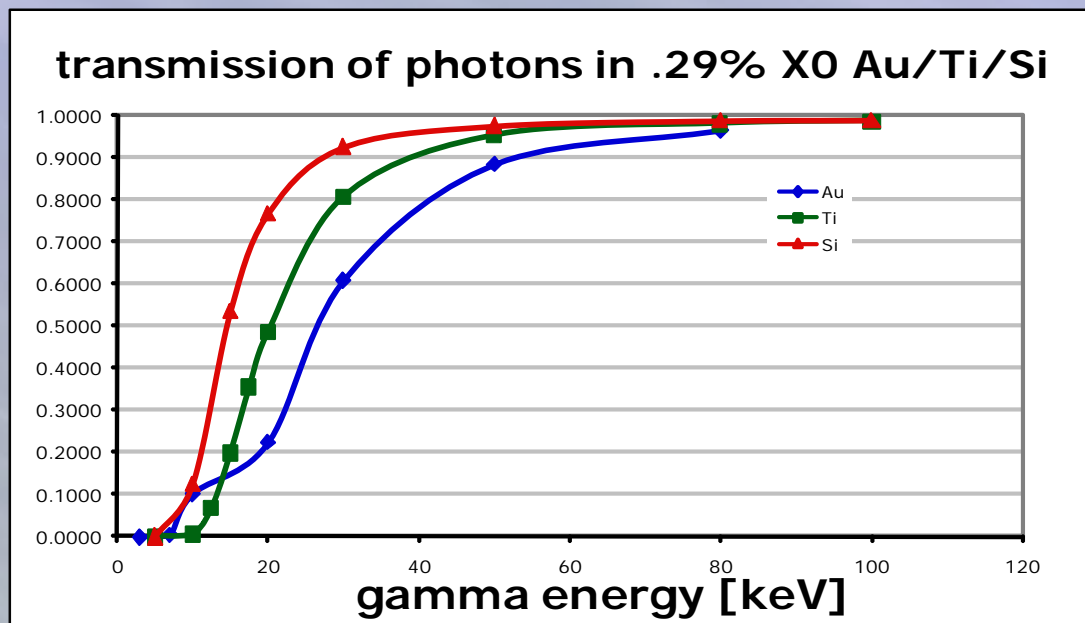
not yet

To check the effect of Synchrotron Radiation

e.x. Occupancy in SVD 1st layer

IR group will provide
beam background generator files
(M.Iwasaki : Tokyo U.)

(H.Hoedlmoser : Hawaii U)



SVD

(H.Kim : KNU)

Status

done To fix geometrical overlaps

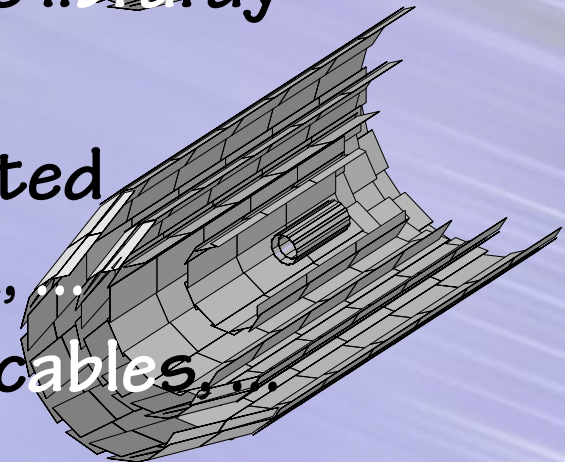
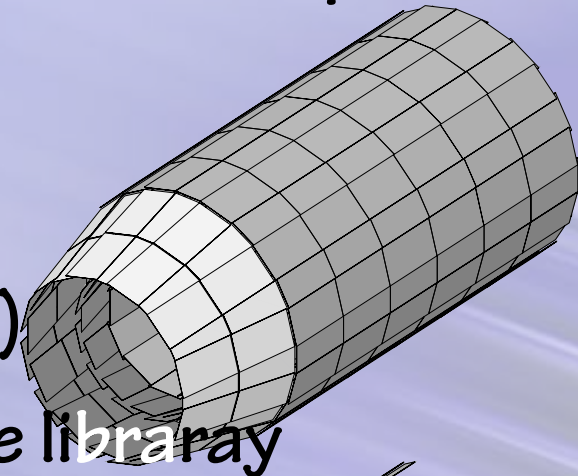
done To modify logical volume hierarchy
(standalone version)

in progress To incorporate tuned-design into Belle library

not yet To make more realistic output
drift time & diffusion are implemented
electric noise, capacitance network, ...

not yet To install support structure, cooling, cables, ...

bullet-shape SVD



PXD

(H.Hoedlmoser : Hawaii)

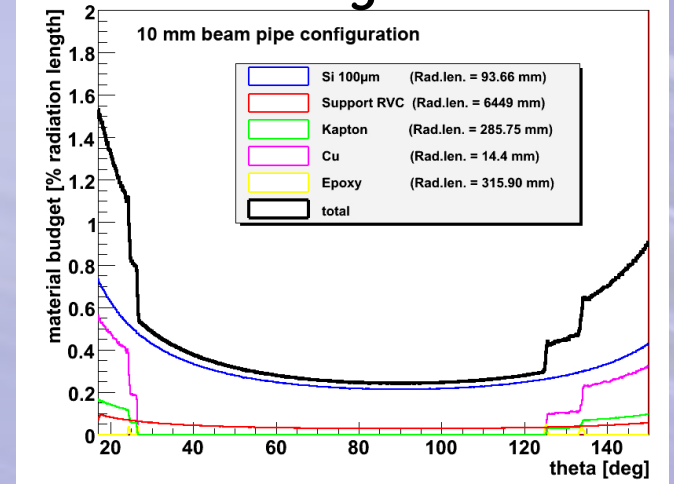
Status

done To implement geometry/hits/digitization
done To produce cluster

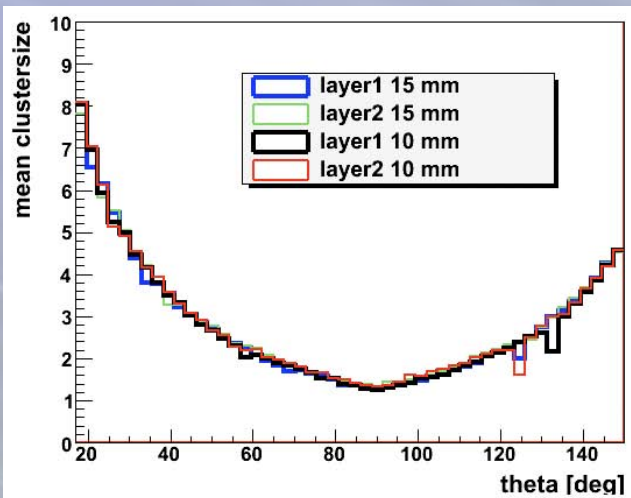
Standalone version

Material Budget vs. theta

Charge propagation
(drift time, diffusion,
Lorentz eff., channel noise...)
SR background study



Cluster size vs. theta



See sBelle note#0006

<http://belle.kek.jp/~ushiroda/private/cgi-bin/sBN/dl.cgi?id=0006>

in progress

not yet

To incorporate these in Belle library
To update tracking code

SFD

(K.F.Chen)

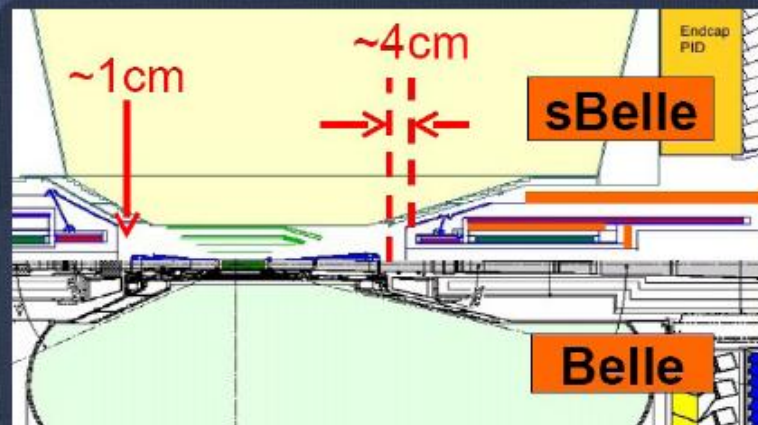
Super Forward Detector

- Minimum hypothesis & target:
A SFD for improving detector acceptance.

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(No direct contribution to main analysis, but as a veto detector)

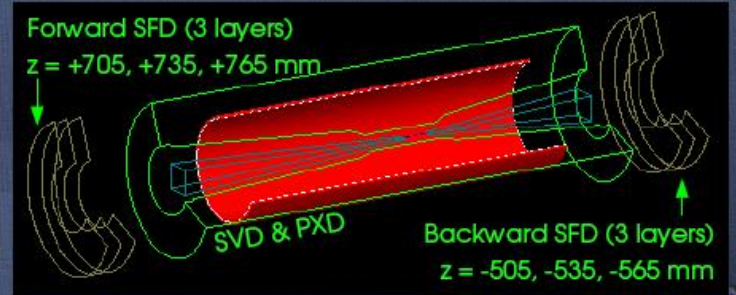
- Reject the prompt tracks from IP for the sBelle full-recon. analysis.
- However, we are actually out of space:



Geant4 Module

- Regardless of the space, we prepared a g4superb-sfd module. (as a copy of g4superb-pxd...)
- Assuming silicon pixel detector with large cells: **2mm x 2mm**.
- Preliminary geometry (sensors only at this moment...):

Sensor:



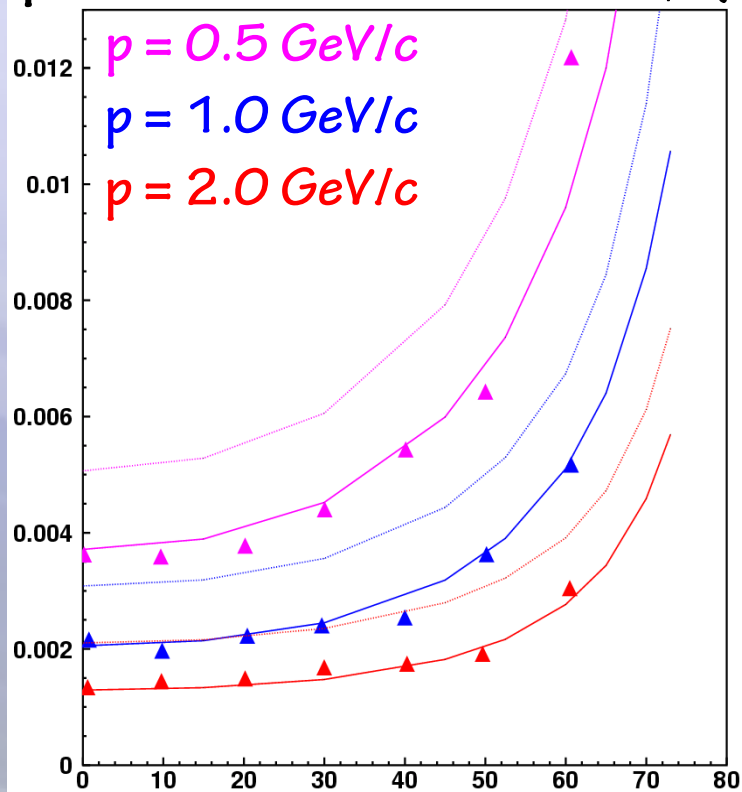
- Coverage: FW (5.3°–11.1°), BW(165.1°–172.7°)
- Produce two panther tables: DATSFDF_TRUEHIT, DATSFDF_CELL

Tracking

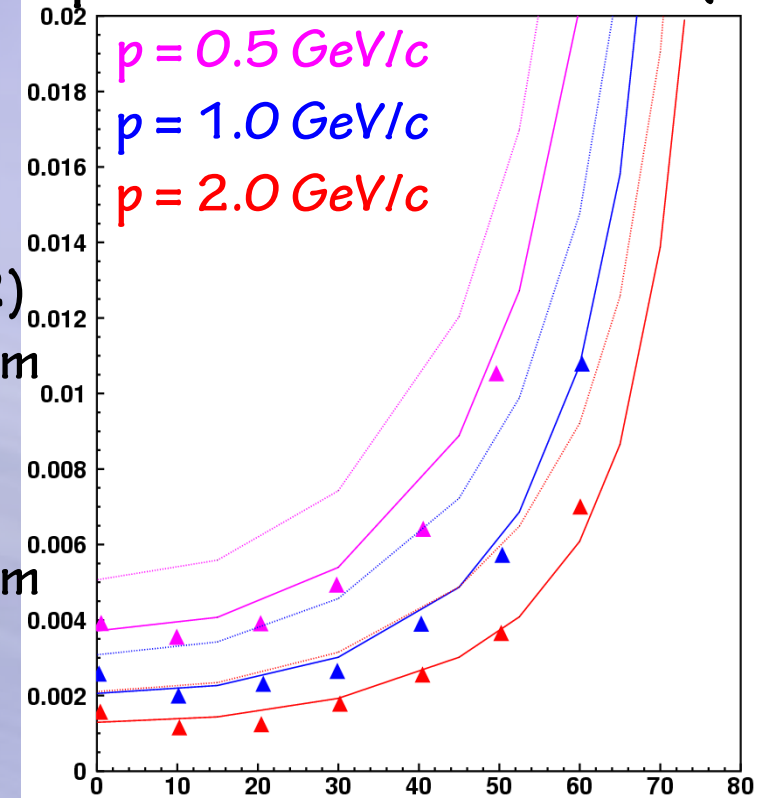
(K.Trabelsi : KEK)

reported in the 1st proto-Collaboration meeting

Impact Param. Resol in $r-\phi$ (cm)



Impact Param. Resol in z (cm)



lines : TRACKERR

dotted : Belle (SVD2)

$R_{\text{beampipe}} = 1.5\text{cm}$

$R_{1\text{st lyr}} = 2.0\text{cm}$

solid : sBelle

$R_{\text{beampipe}} = 1.0\text{cm}$

$R_{1\text{st lyr}} = 1.3\text{cm}$

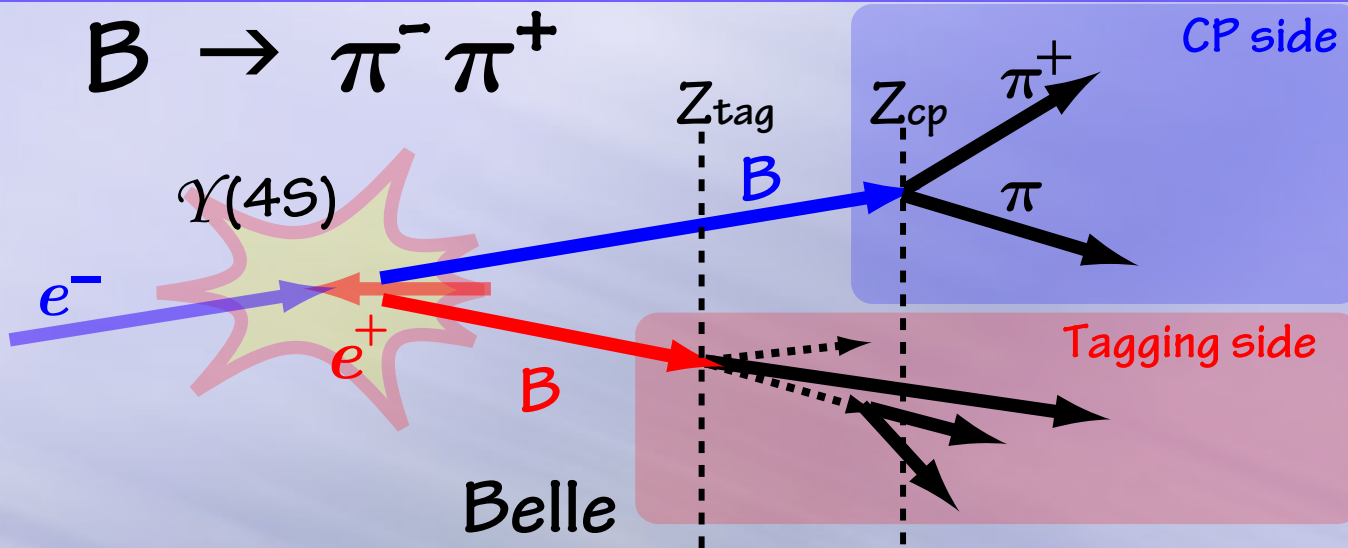
triangles : G4

CDC+SVD Tracking is working !

(except for the 5th/6th slanted parts)

Vertex Resolution

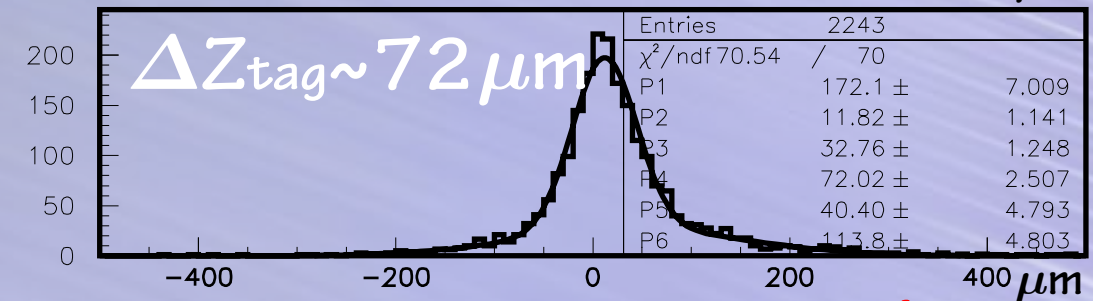
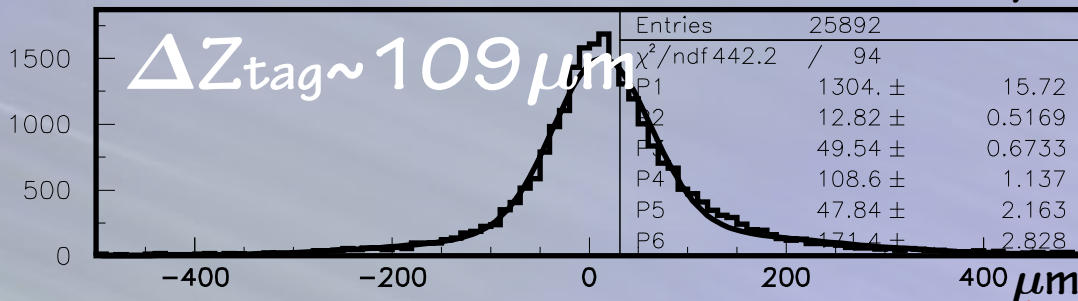
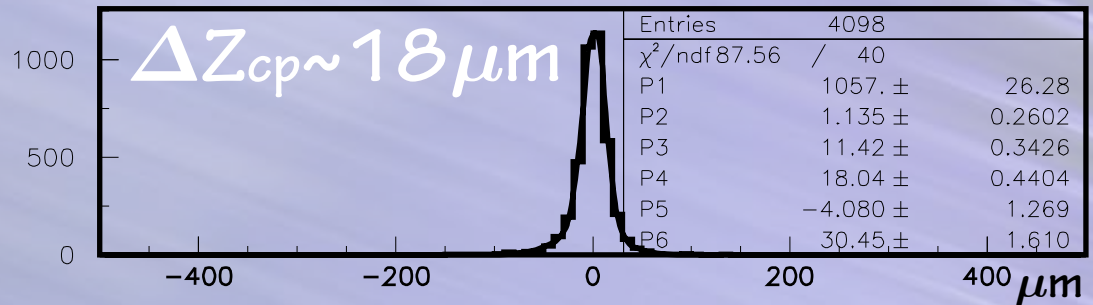
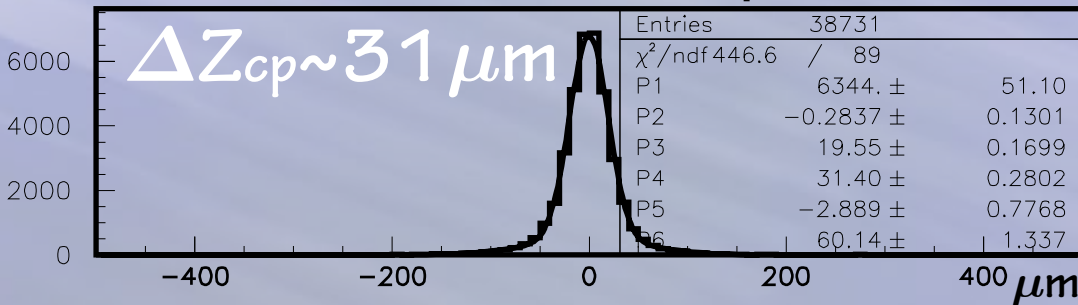
(T.Hara : Osaka U.)



$$f = \frac{h_n \sigma_n}{h_n \sigma_n + h_w \sigma_w}$$

$$rms = \sqrt{\sigma_n^2 f + \sigma_w^2 (1-f)}$$

definition of vtx reso.

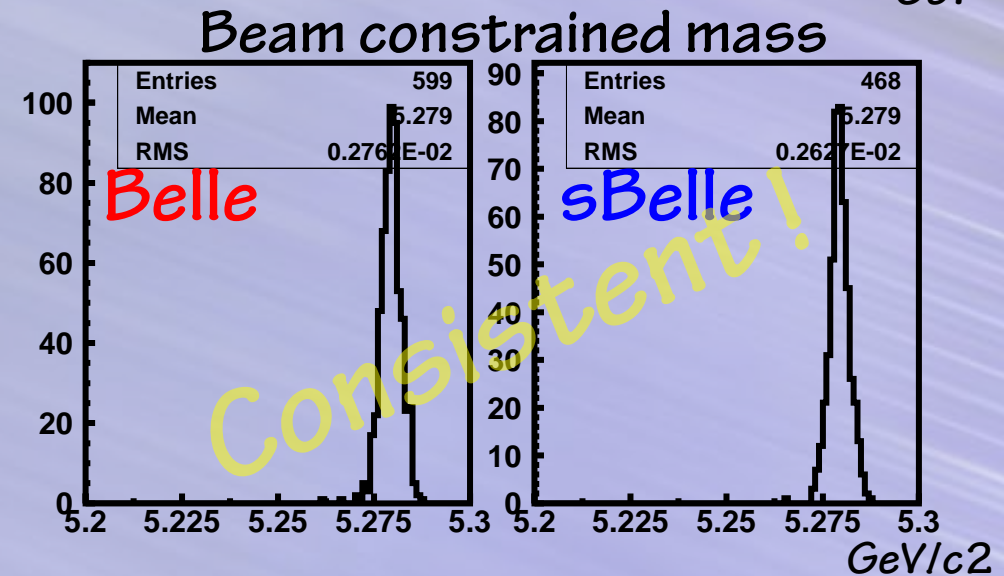
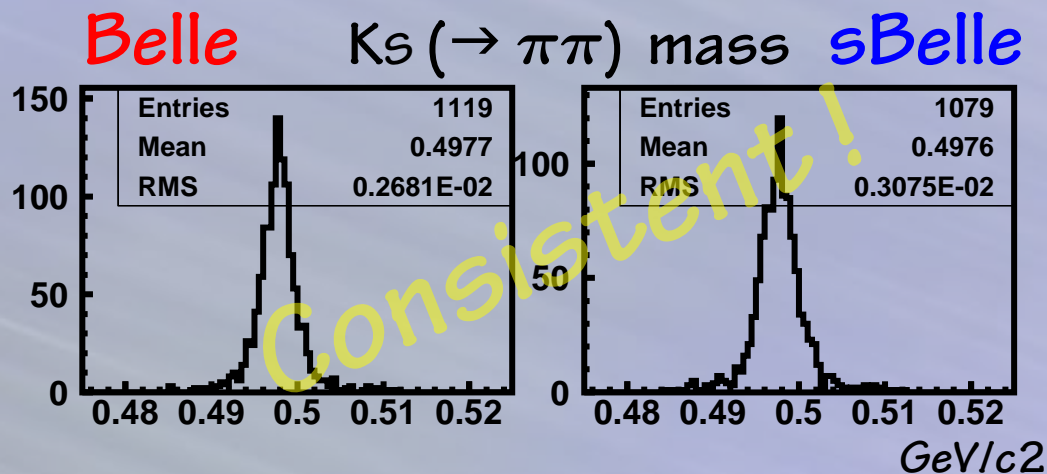
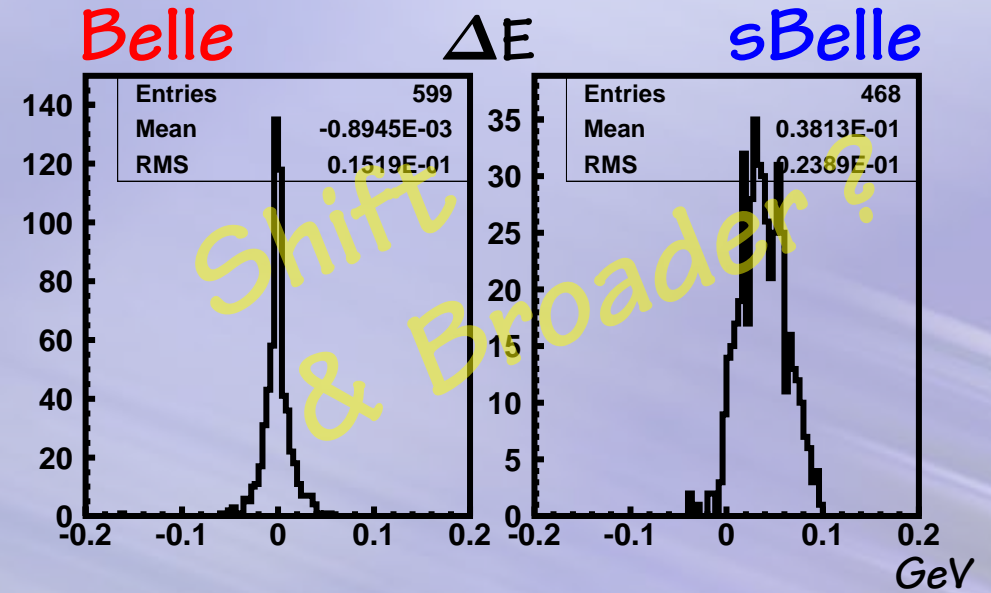
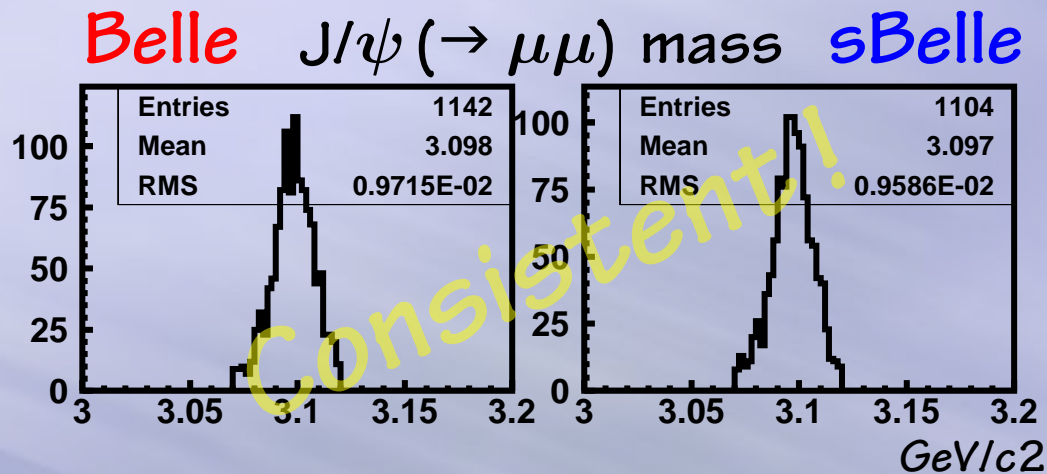


Kinematics Fitter / Tag-side vertexing are working !

Physics Analysis

reconstructed B

$B \rightarrow J/\psi K_S$ (w/o PID)



KS Reconstruction tool is working

Software

- . Data format
- . Calibration Nothing to be done now
- . Monitor
- . Simulation
 - IR (P.Chen), SVD (H.Kim), PXD (H.Hoedlmoser)
- . Reconstruction SOI, CMOS, DEPFET ???
 - Clustering
 - SVD+PXD self-tracking (**D^*D^* , Full-reconstruction**)
 - CDC-based tracking
 - Continuum Suppression
 - Tag-side vertexing **CP analyses**
 - PID ?
- . Alignment
 - main source of the systematic error in CP analyses ?**

Installation of hardware is not the goal, Goal is Physics !