

# Geant4 Activity

(T.Hara : Osaka U.)

— Outline — (belle lib. 20080525 version + something extra)

- . Status of sub-detectors

  - IR, SVD, PXD, CDC, TOP, ECL, RICH, KLM

- . G4EXT (track extrapolation tool)

- . Tracking

- . MDST (mini-DST for physics analysis)

- . Physics Analyses

  - Vertex resolution for  $B \rightarrow \pi^- \pi^+$

  - $\Delta E$  and reconstructed mass for  $B \rightarrow J/\psi K_s$

- . Known troubles

- . Summaries

# 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 ?

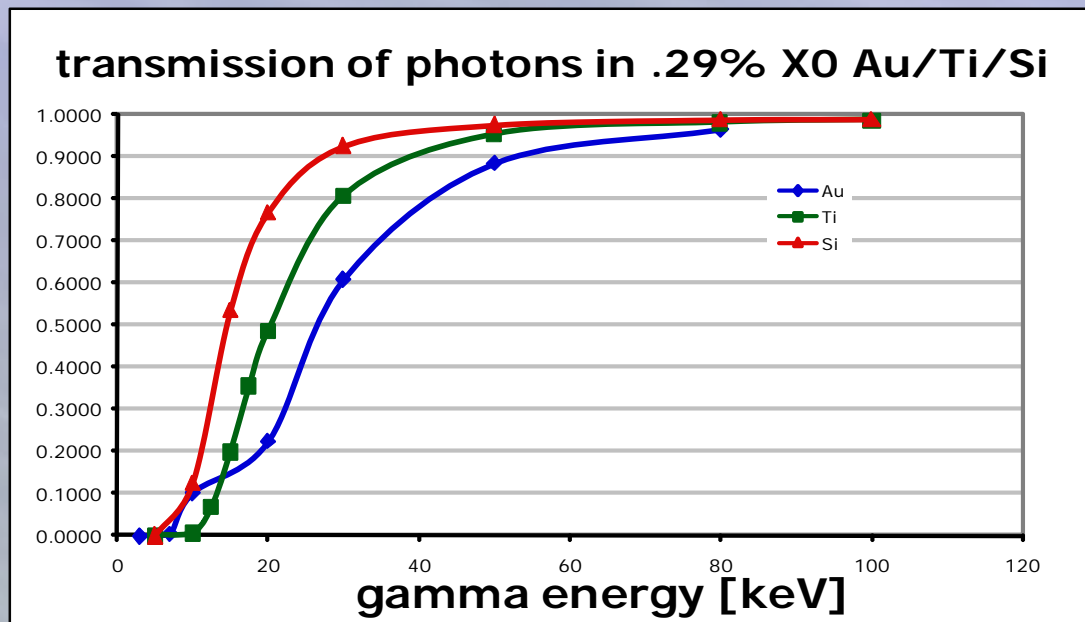
*not yet*

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)

bullet-shape SVD

## Status

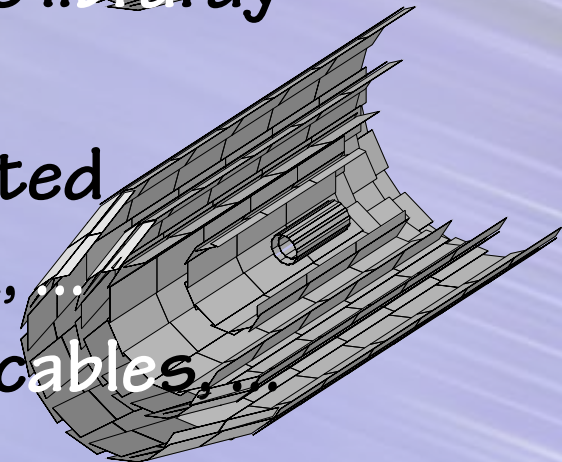
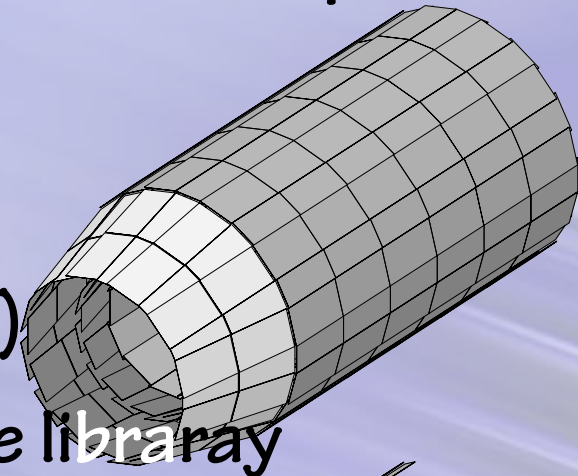
*done* To fix geometrical overlaps

*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, ...



# PXD

(H.Hoedlmoser : Hawaii)

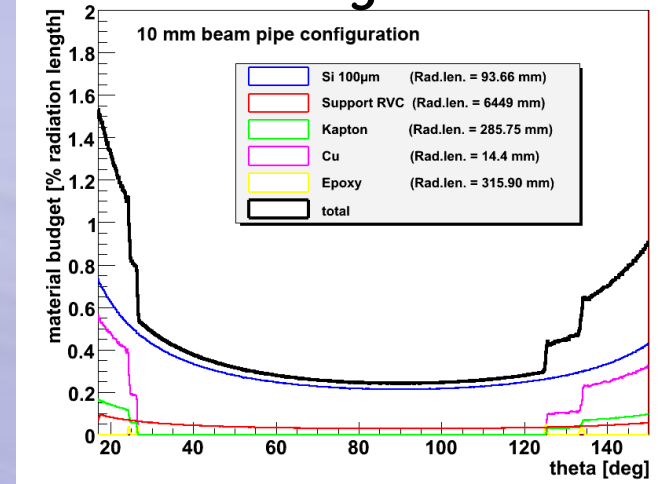
## Status

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

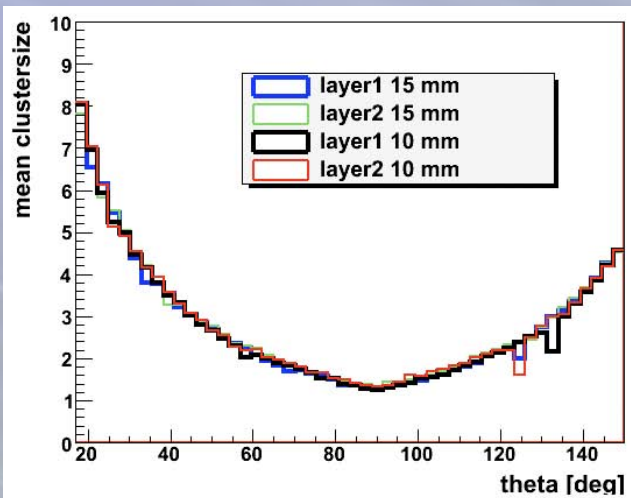
## Standalone version

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

## Material Budget vs. theta



## Cluster size vs. theta



## SR background study

See sBelle note#0006

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

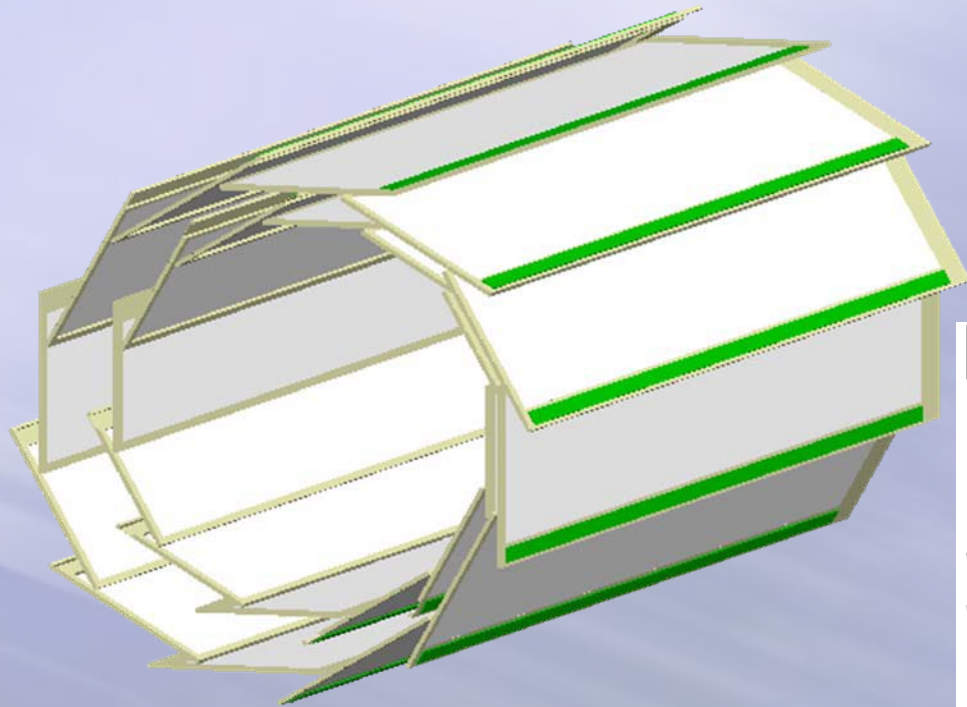
*in progress*

*not yet*

To incorporate these in Belle library  
To update tracking code

# PXD

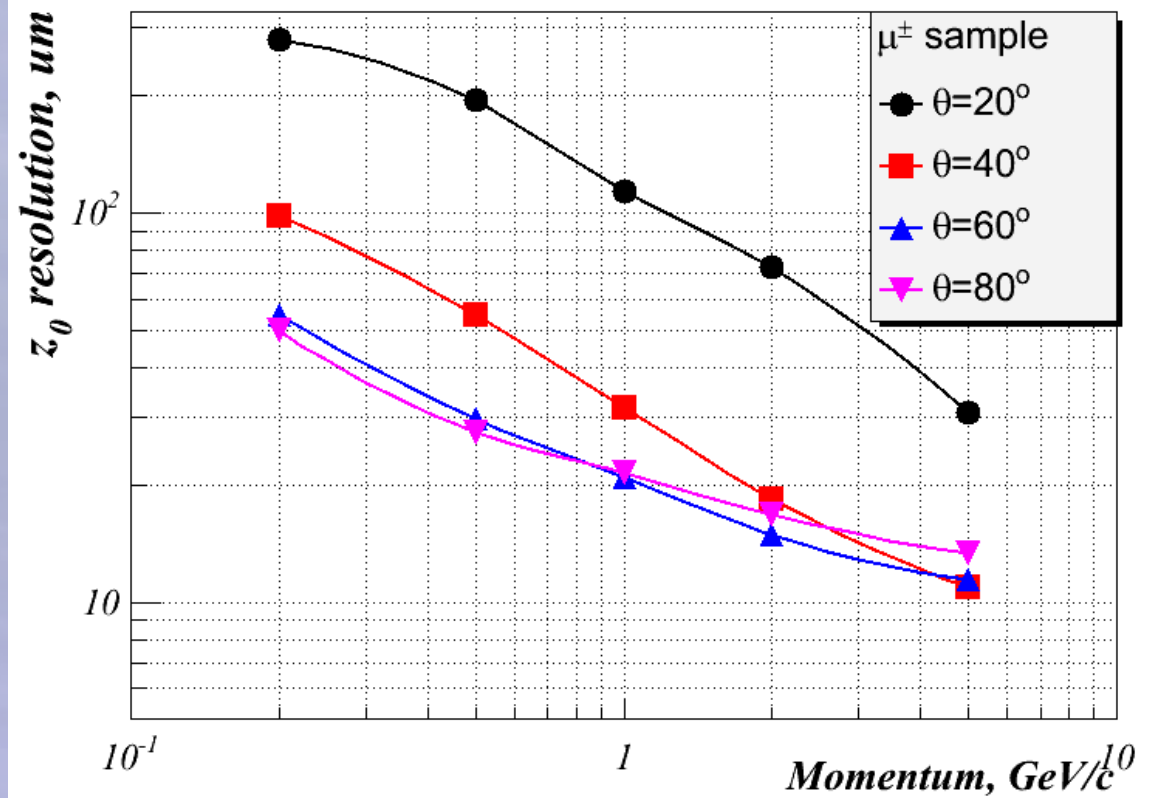
(A.Frey : MPI)



done by *Alexei Raspereza*

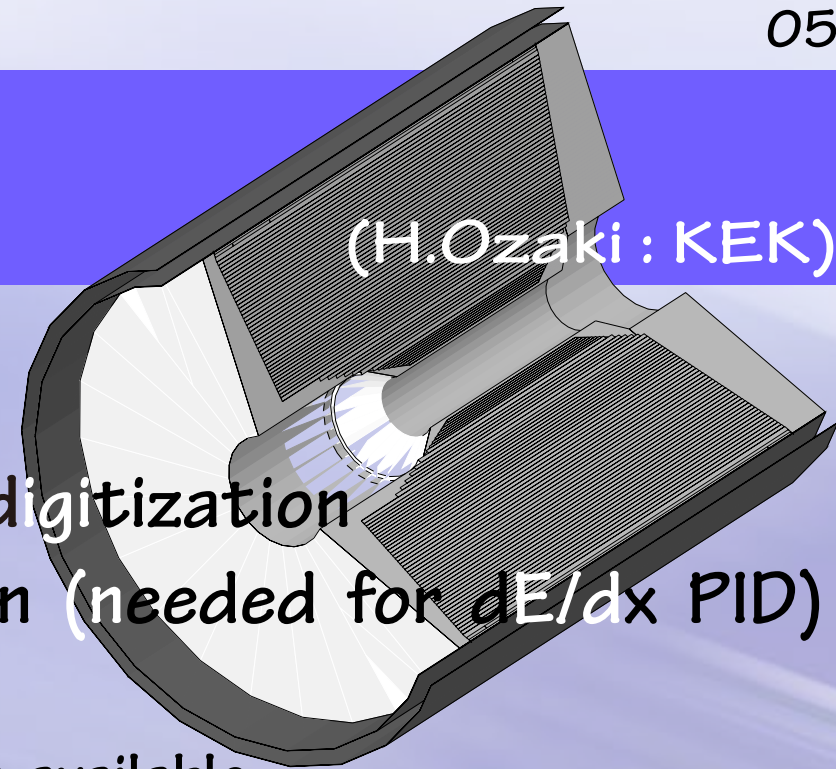
## Impact Parameter Resolution

$z_0$  resolution



# CDC

(H.Ozaki : KEK)



## Status

*done* To implement geometry/hits/digitization

*done* To store p.h.(ADC) information (needed for  $dE/dx$  PID)

RecCDC\_wirhit and

DatCDC\_MCwirhit are now available

*done* To make a link between a reconstructed track  
and a generator information

e.x. we can specify particle species using generator info.

*in progress* To prepare a  $dE/dx$  PID tool

A module for Reconstruction is prepared (not yet released)

Parametarization of  $\langle dE/dx \rangle$  and  $\sigma_{dE/dx}$

as a function of particle  $p$ , species, angle, #samplings ...

# TOP

(K.Inami : Nagoya U)

## Status

*done* To implement geometry/hits/digitization

*done* To reconstruct the ring image

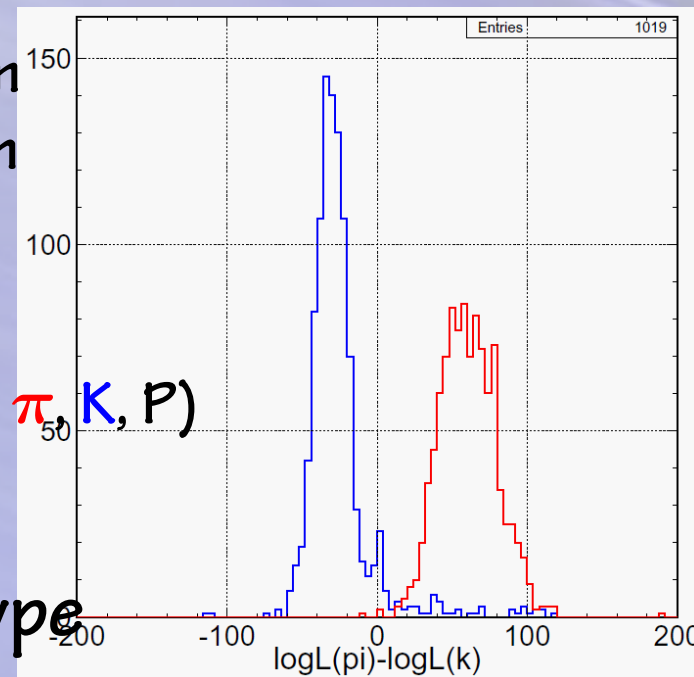
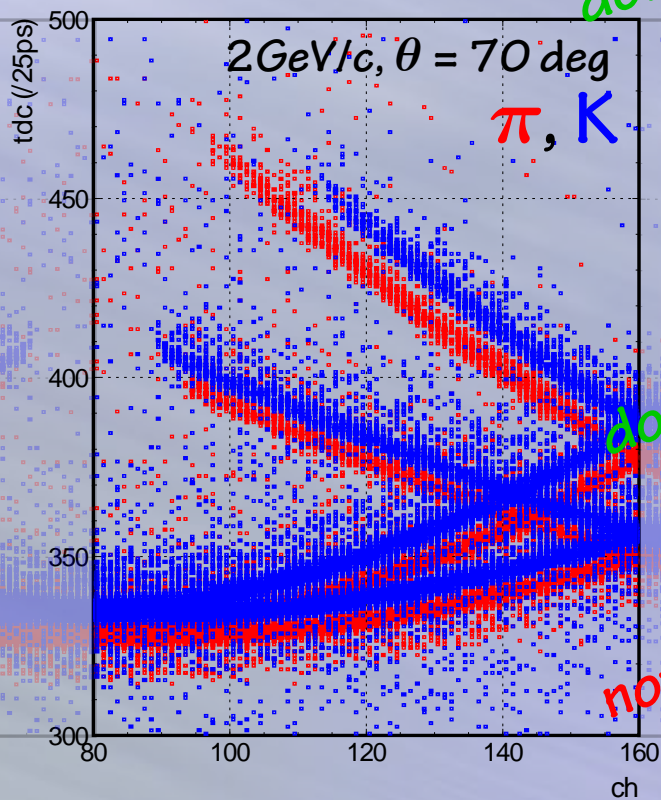
*done* To prepare P.D.F for PID

depending on

- . track momentum
- . entering position
- . incident angle

*done* To make output Likelihood (e,  $\mu$ ,  $\pi$ , K, P)

*not yet* To implement the focusing type



# ECL



## Status

*done* To implement geometry/hits/digitization

*done* To make clusters

*done* To reconstruct  $\gamma / \pi^0$

*not yet* To make links between reconstructed clusters  
and generator information



# RICH

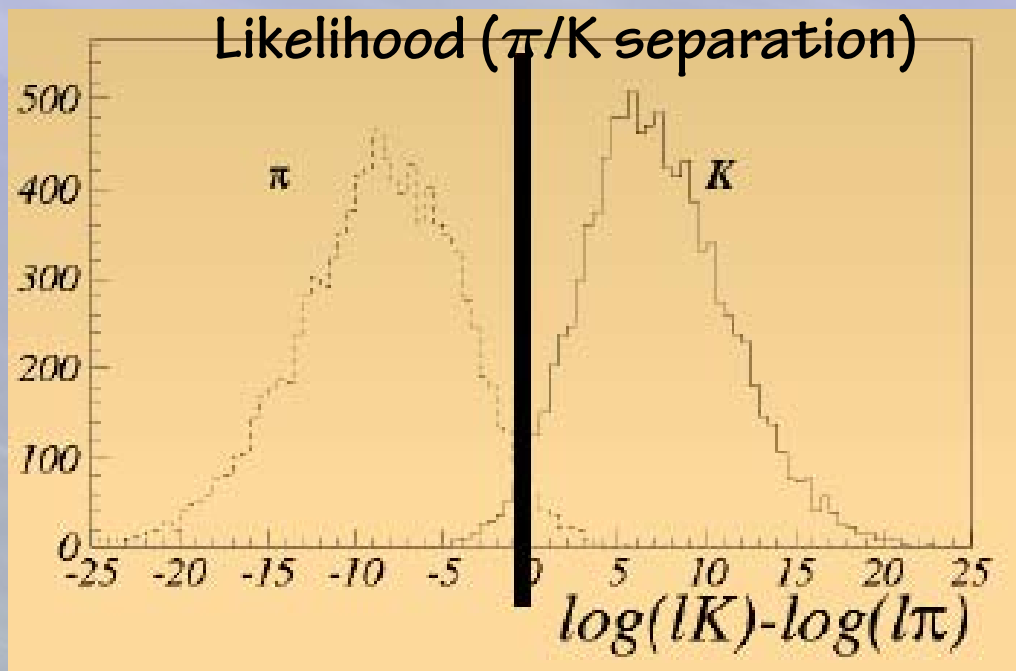
(R. Pestotnik : Ljubliana)

## Status

*done* To implement geometry/hits/digitization

To prepare PID tools

*in progress* Standalone g4 version works well  
. not integrated into Belle library

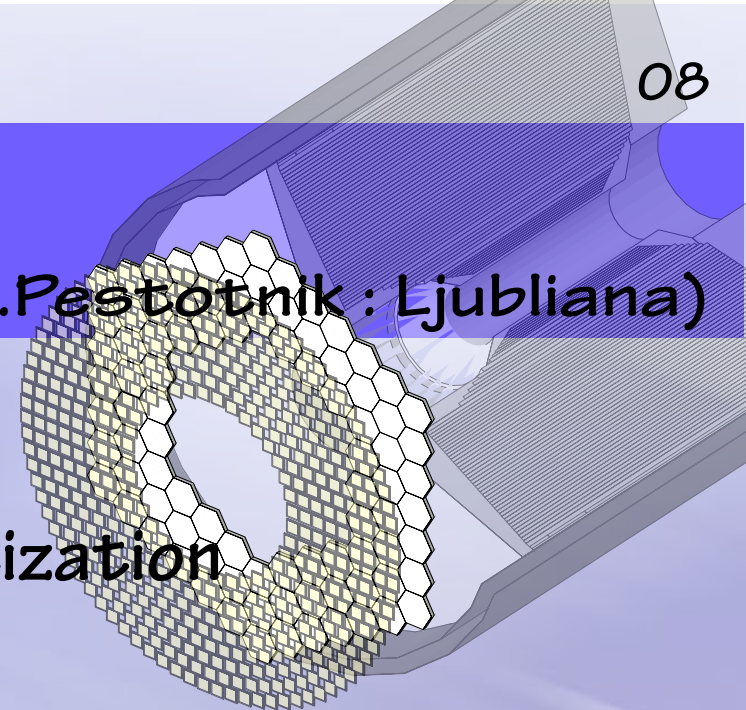


RICH-based PID does not  
work with Belle lib.

waited for track extrapolation tool

Now "g4ext" is ready!

Much progress is expected.



# KLM

(L.Piilone : Virginia)  
(T.Uglov : ITEP)  
(G.Pakhlova : ITEP)

## Status

To implement geometry/hits/digitization

. Resistive Plate Counter (RPC) option  
in barrel & endcap

done

a bug in geometry setting was fixed

done

hit strip / reconstructed KL information is ready

. Scintillator KLM option in endcap

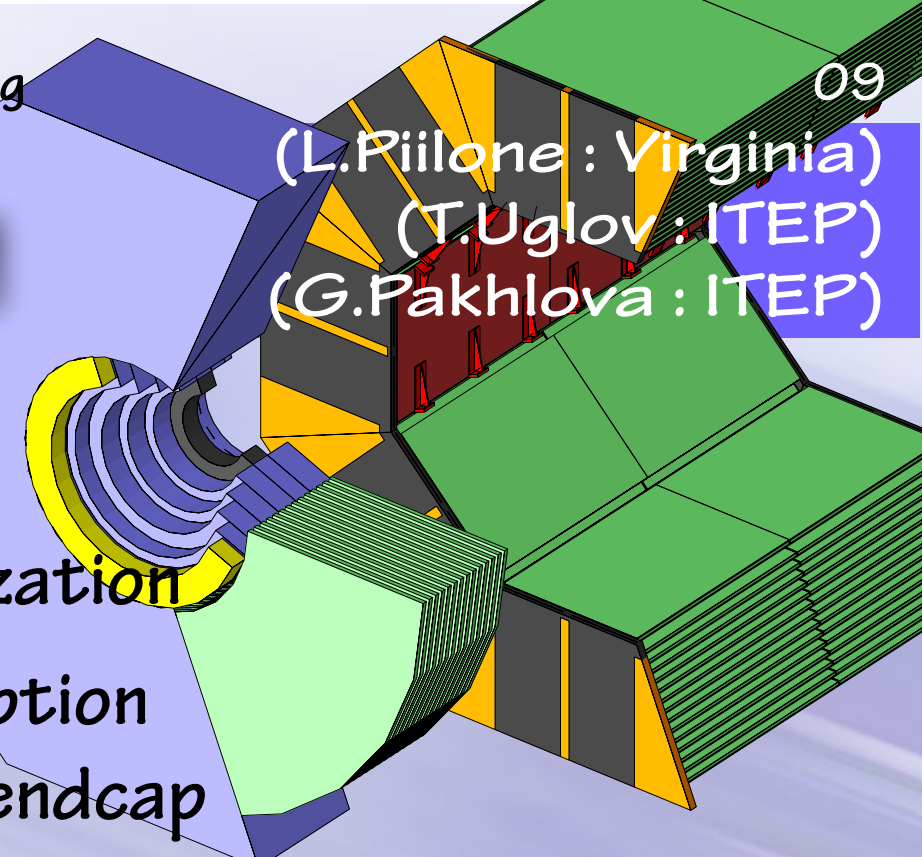
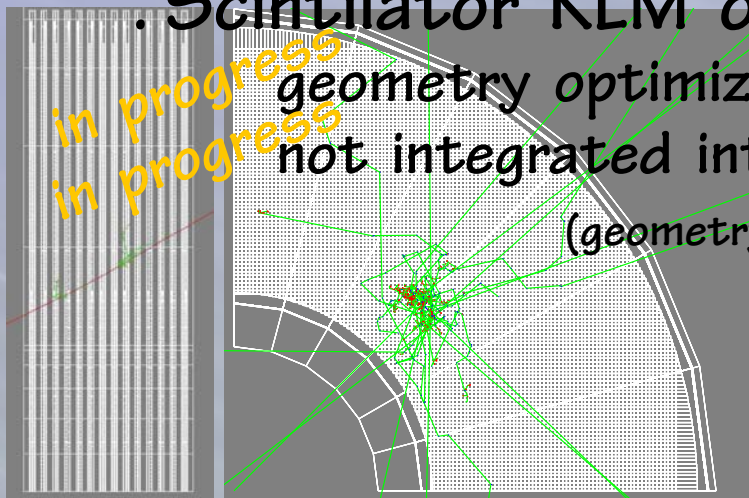
geometry optimization / recon. algorithm tuning are in progress

not integrated into Belle library

(geometry has been installed by L.Piilonen and will be available in next lib.)

in progress

To prepare Muid



# G4EXT

(L.Piilonen : Virginia)

G4EXT: extrapolating track parameters & covariance matrix  
to the outer detectors

## Status

*done* To make it coexist with g4superb

*done* To incorporate an interface for muid module "muid\_dec"

*done* To implement useful user commands  
to control which volume entry/exit points are saved.

still needs debugging ..., but

g4ext will be ready and

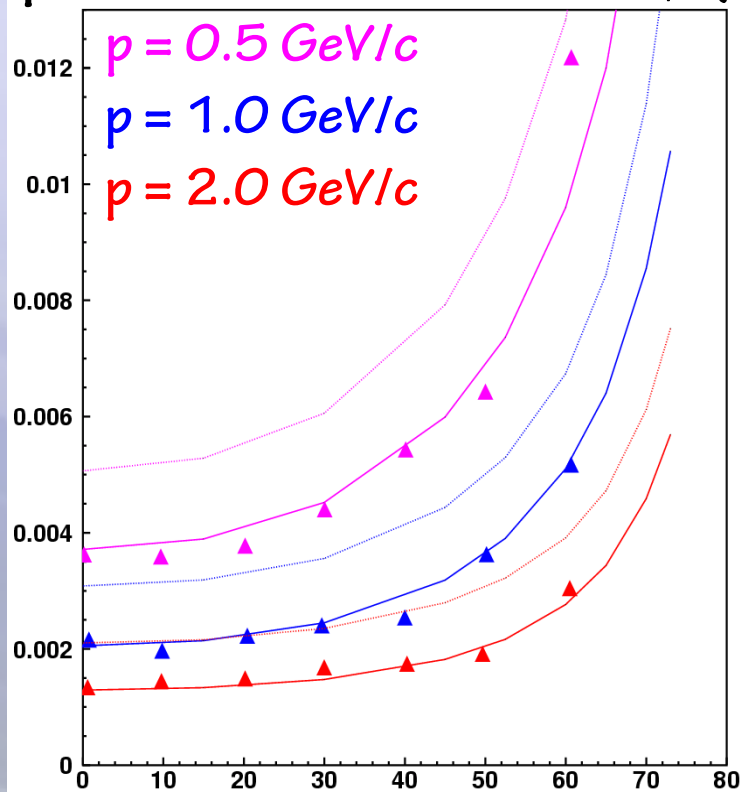
Outer detector groups can use track information

**PID in RICH / KLM is expected to proceed !**

# Tracking

(K.Trabelsi : KEK)

reported in the 1st proto-Collaboration meeting

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

lines : TRACKERR

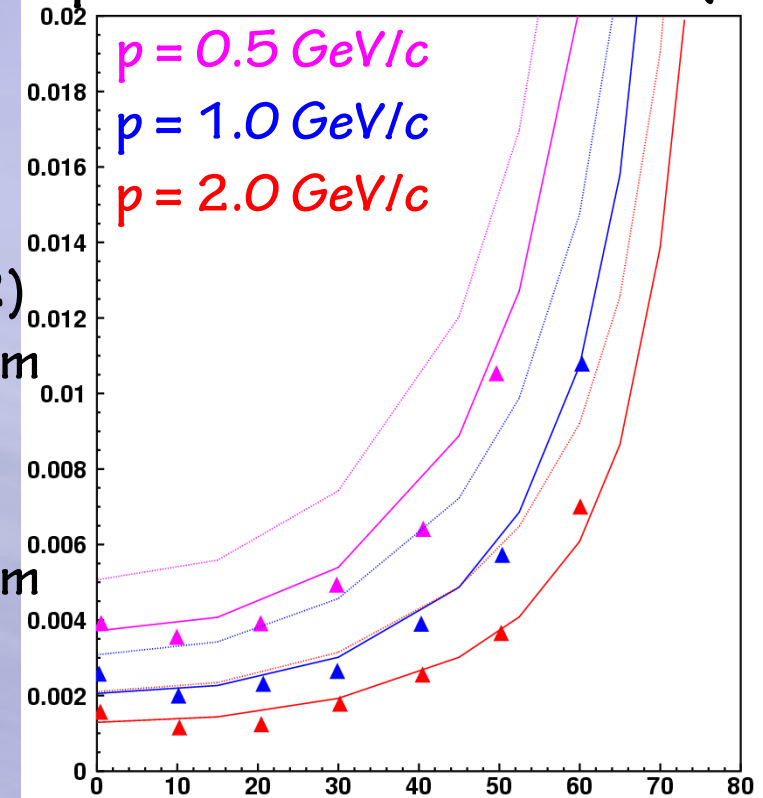
dotted : Belle (SVD2)

 $R_{\text{beampipe}} = 1.5\text{cm}$  $R_{1\text{st lyr}} = 2.0\text{cm}$ 

solid : sBelle

 $R_{\text{beampipe}} = 1.0\text{cm}$  $R_{1\text{st lyr}} = 1.3\text{cm}$ 

triangles : G4

Impact Param. Resol in  $z$  (cm)

**CDC+SVD Tracking is working !**

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

# Readiness of MDST

## charged track

MDST\_Charged  
MDST\_TRK  
MDST\_TRK\_Add  
MDST\_TRK\_Extra  
MDST\_TRK\_Fit

## Ks/ $\Lambda$ vertex

MDST\_Vee2  
MDST\_Vee2\_Extra  
MDST\_Vee\_Daughter  
MDST\_Vee\_Daughter\_Add

## $\gamma/\pi^0$

MDST\_Gamma  
MDST\_Pi0

## $\mu/K_L$

MDST\_Klong  
(only for RPC)  
MDST\_Muid

## Sub-detector information

MDST_SVD_Hit	MDST_KLM_Cluster
MDST_SVD_Hit_Extra	MDST_KLM_Cluster_Hit (only for RPC)
MDST_CDC_Fit	MDST_KLM_Mu
MDST_ECL	MDST_KLM_Mu_EX
MDST_ECL_Aux	MDST_TOP
MDST_ECL_CR	(only for $\pi/K$ )
MDST_ECL_TRK	MDST_RICH

## link to generator

MDST\_Sim\_Trk  
MDST\_Sim\_Trk\_Extra  
MDST\_Sim\_ECL

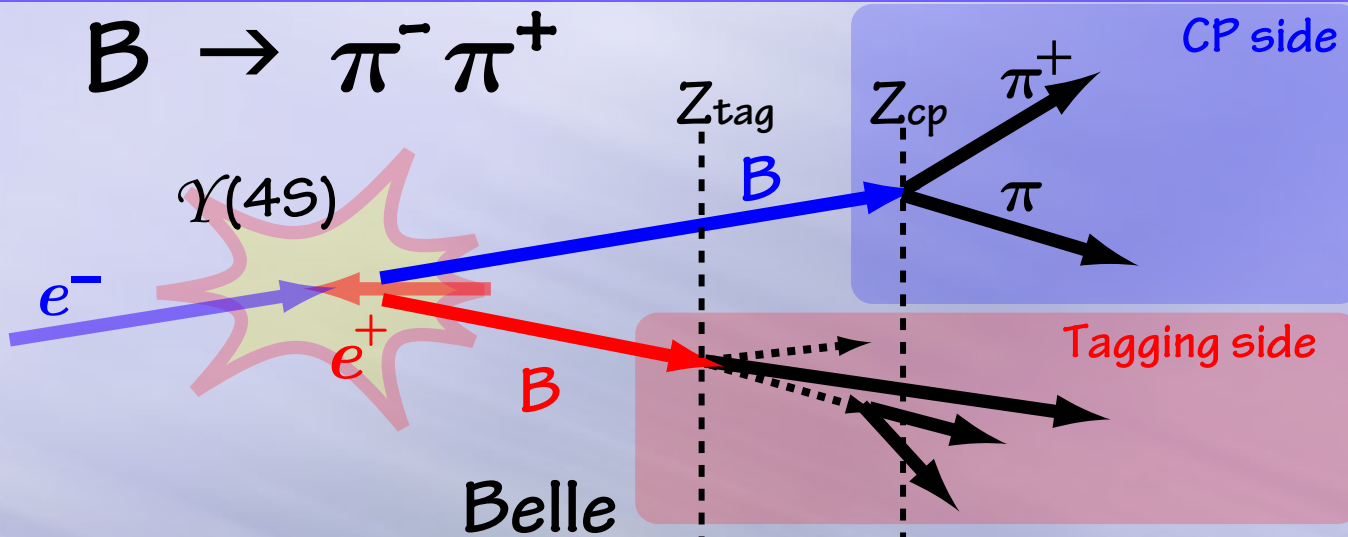
red : not available  
blue : (almost) ready

Plus,

PID tools do not work ...

# Vertex Resolution

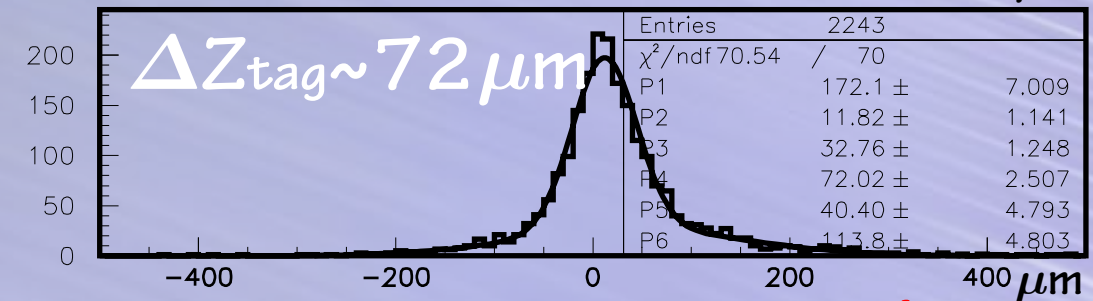
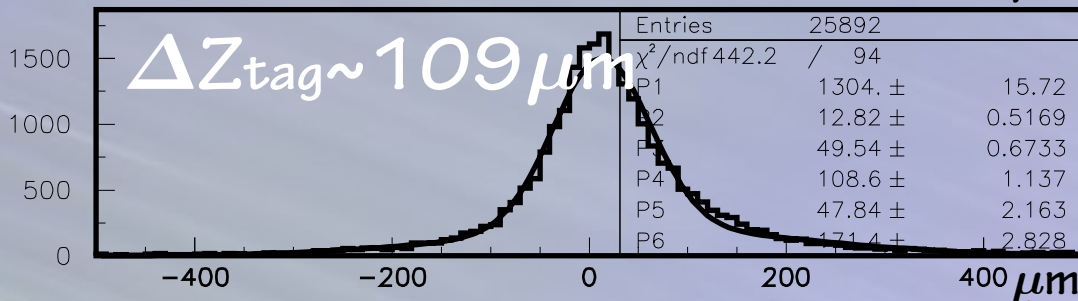
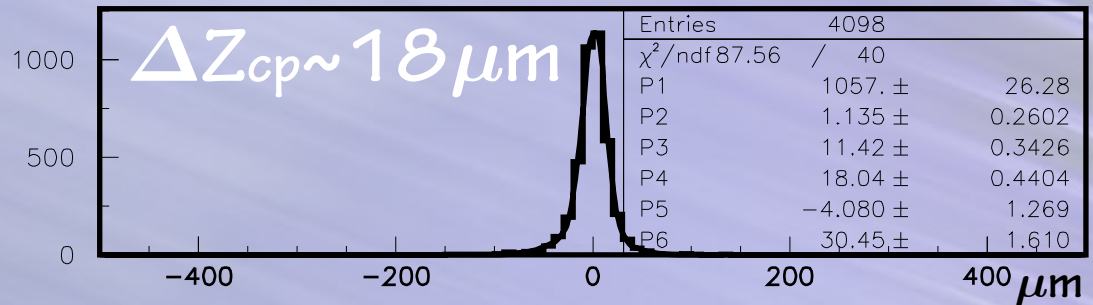
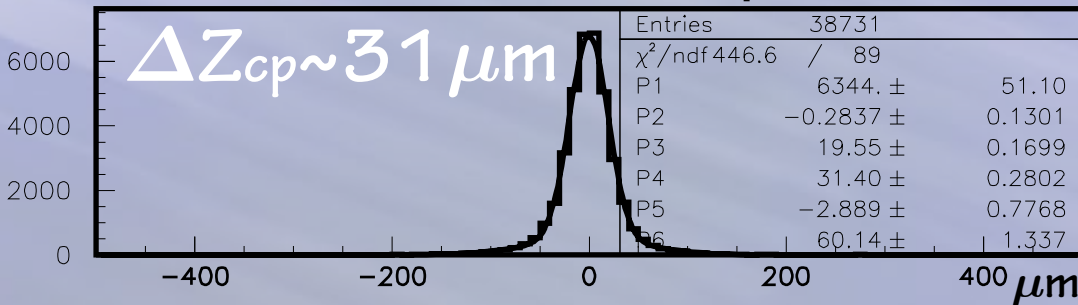
(T.Hara : Osaka U.)



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

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

definition of vtx reso.

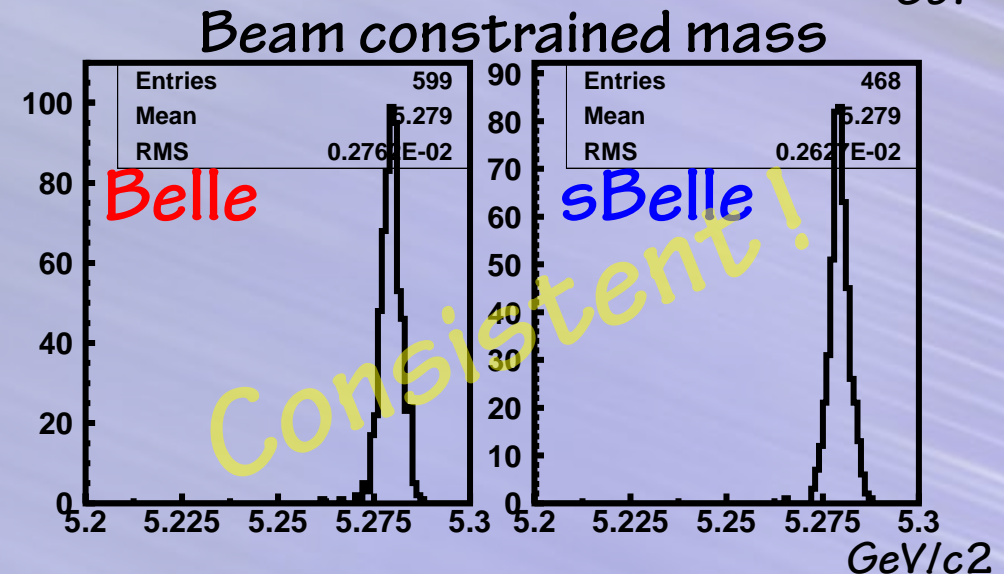
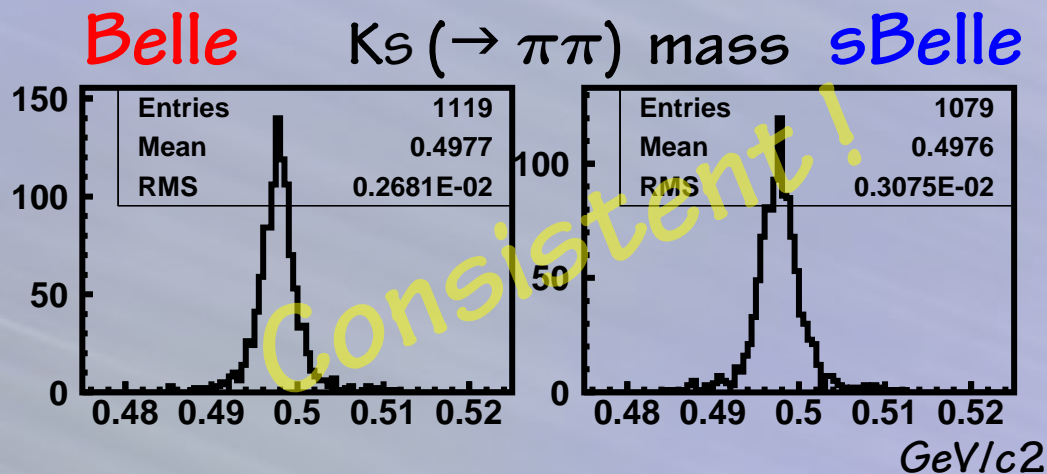
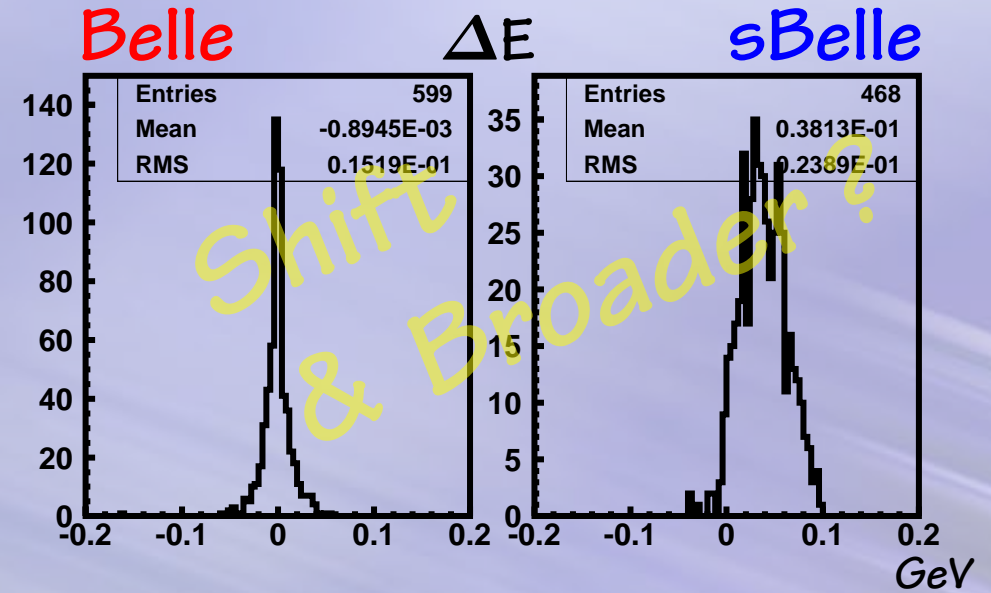
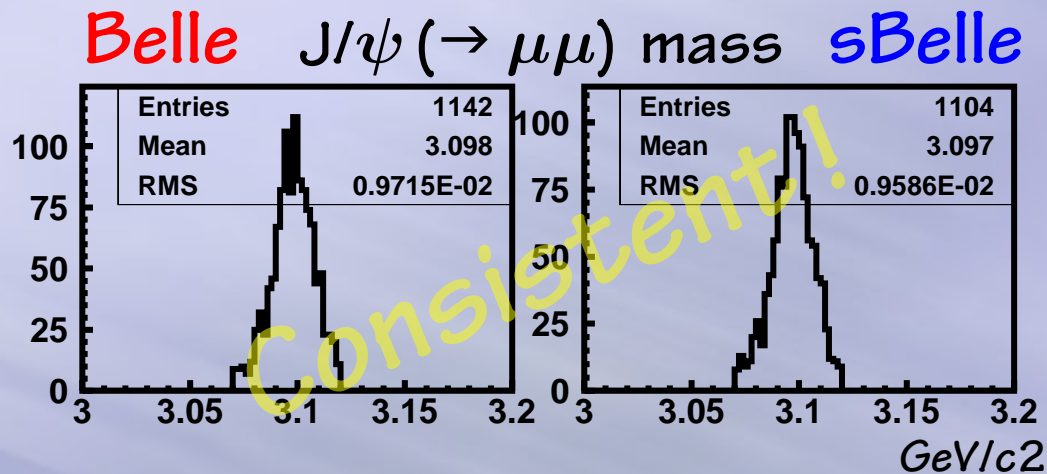


Kinematics Fitter / Tag-side vertexing are working !

# Physics Analysis

reconstructed B

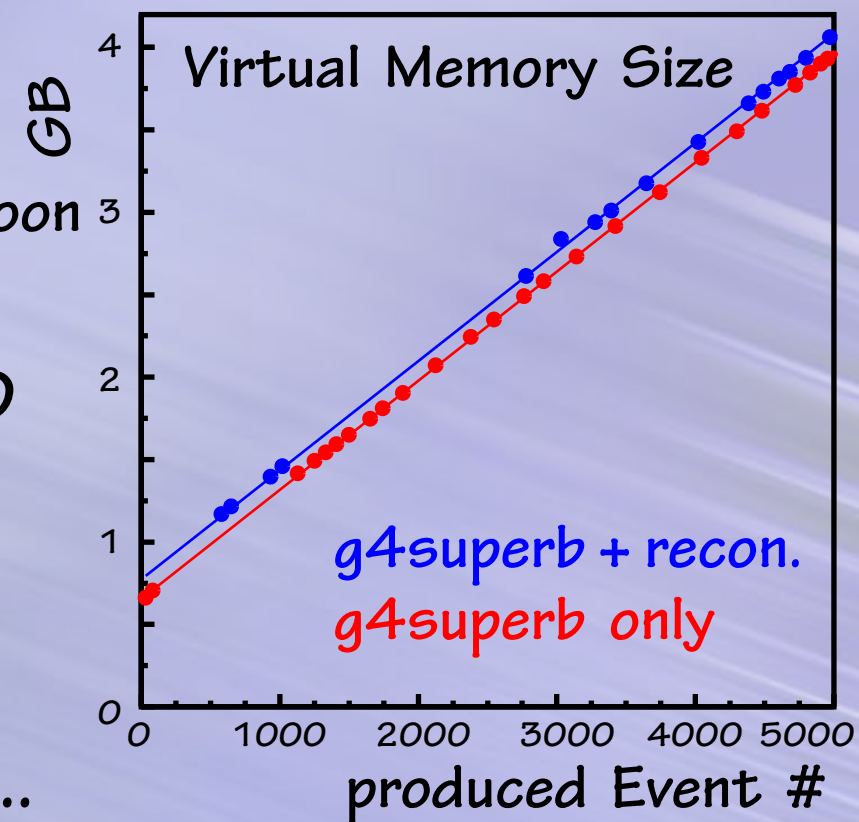
$B \rightarrow J/\psi K_S$  (w/o PID)



KS Reconstruction tool is working

# Troubles

- . There seems to be a memory leak in *g4superb*
- . “muid” and “eid” do not work
- . *dE/dx* PID in CDC is not ready  
reconstruction module will be released soon
- . RICH-based PID does not work
- . combined likelihood function for PID  
is not prepared (e.x. “atc\_pid”)
- . SVD slanted parts are  
not included in tracking
- . still debugging / tuning many tools ...  
trasan, trak, *g4ext*, *vOfinder*, tag-side vertexing, flavour tagging ...





# Geant4 / Status

*newly joined since this April*

Kernel/addbg	: N.Katayama (KEK)	
IR	: <b>P.Chen (NTU)</b>	: checking codes
SVD	: <b>H.Kim (KNU)</b>	: debugging / implementing readout part
PXD	: H.Hoedlmoser (Hawaii U)	: integrating his codes into Belle lib.
CDC	: H.Ozaki (KEK)	: tuning sim/rec. / working on dE/dx PID
TOP	: K.Inami (Nagoya U)	: almost done, but should do PID part
ECL	: P.Krokovny (KEK)	: almost done ?, but sould update "eid"
RICH	: R.Pestotnik (Ljubliana)	: working on PID
Scinti. KLM	: <b>T.Uglov, G.Pakhlova (ITEP)</b>	: proto-type sim. is done,
KLM/EXT	: L.Piilonen (Virginia)	: EXT is almost OK / working on "muid"
Special Adviser:	<b>K.Trabelsi (KEK)</b>	: checking a physics analysis flow

- 1) a reconstructed charged track is now traceable to HEPvt. (by H.Ozaki)
- 2) charged track can be extrapolated to the outer detectors. (by L.Piilonen)  
(this allows outer detector groups to start PID works.)
- 3) physics analysis is useful to see the readiness of analysis tools. (by K.Trabelsi)

# To-do List

## feedback to Hardware

- . beam background effect on SVD / PXD / CDC
- . design of beam pipe
- . optimization of each sub-detector  
(geometry, hits, digitization)
- . Hermeticity
- ⋮



Detector  
design



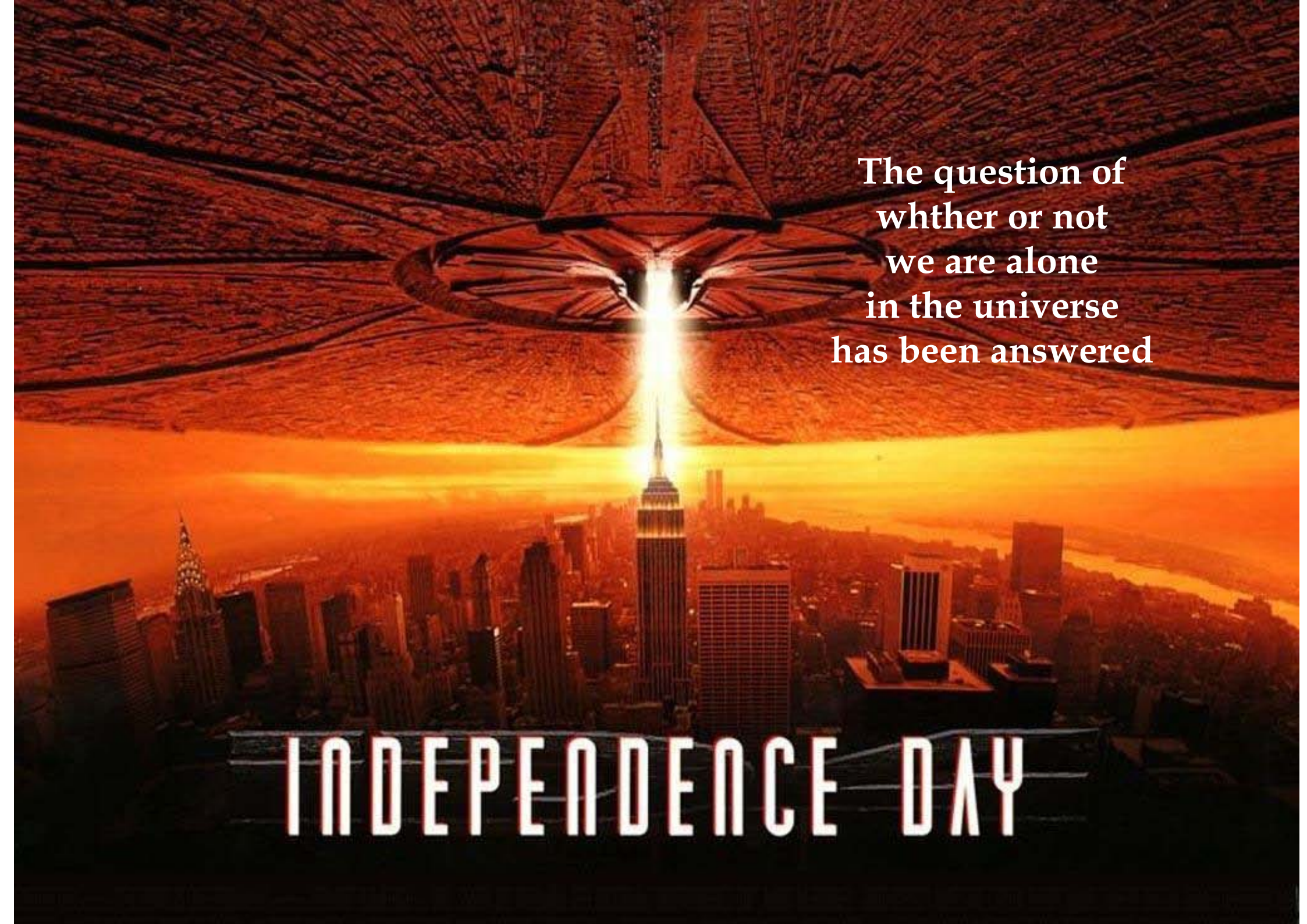
development  
of Software

- . SVD / PXD self-tracking
- . Physcis simulation/analyses

- . tag-side z resolution improvement
- . continuum suppression
- . PID tools (CDC, TOP, RICH, likelihood...)
- . improvement of  
⋮ Full-reconstruction tag

Target  
Physics





The question of  
whether or not  
we are alone  
in the universe  
has been answered

# INDEPENDENCE DAY

**sBelle is approved**

The question of  
whether or not  
~~we are alone~~  
in the ~~universe~~ **future**  
has been answered  
**NOT**

**INDEPENDENCE DAY**