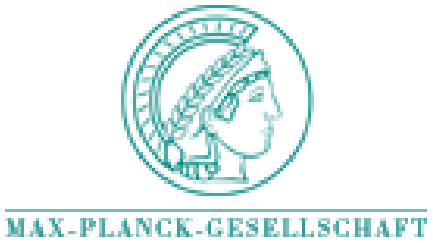


Vertexing studies

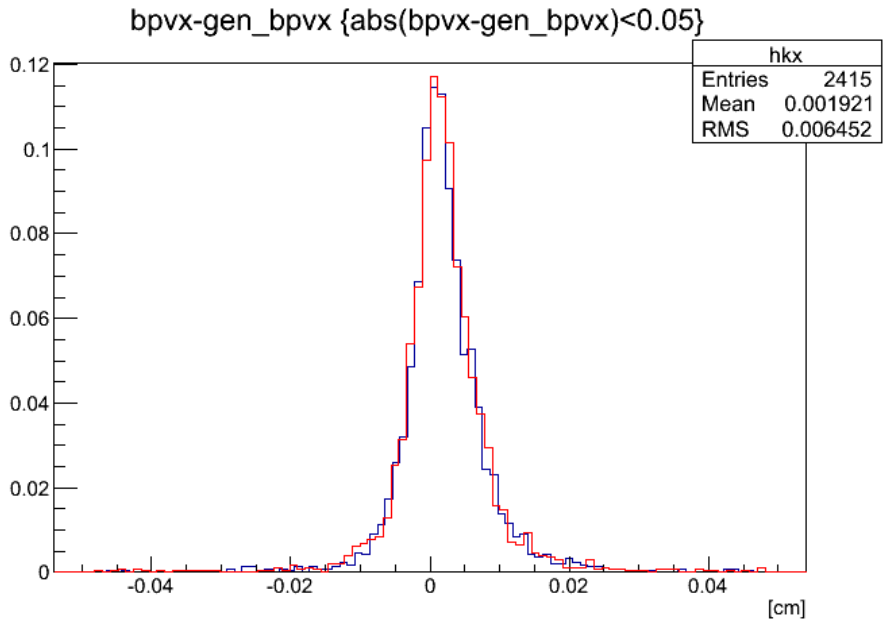
Luigi Li Gioi

Max-Planck-Institut für Physik, München

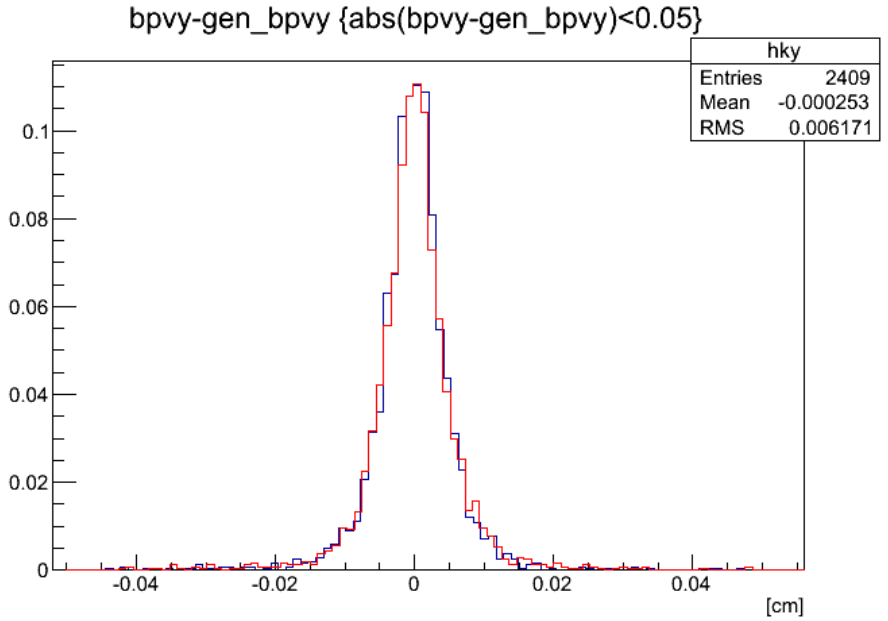
Tracking meeting – 22nd August 2014

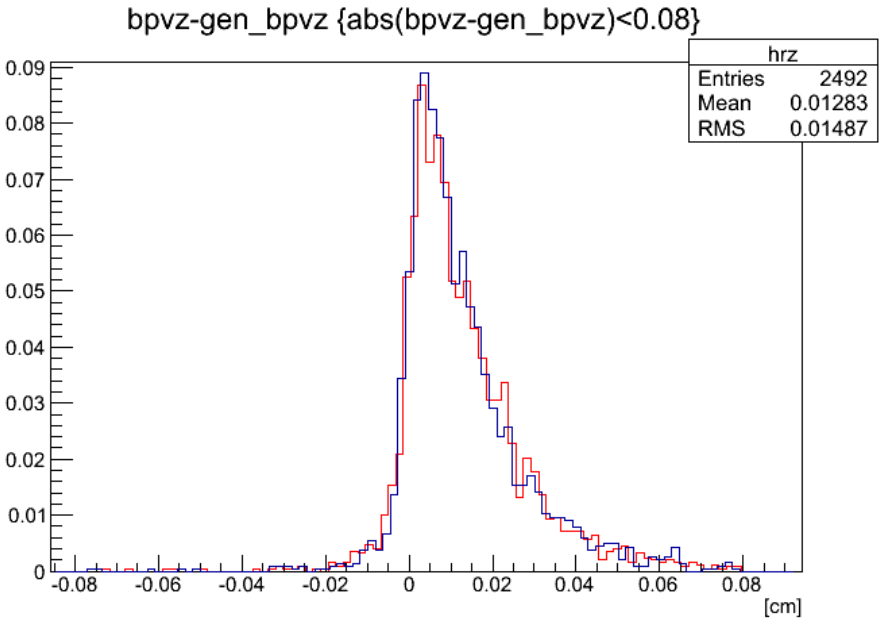
$B^0 \rightarrow \pi\,\pi$

Vertex space resolution: X(fit) - X(MC)



RAVE
kFIT



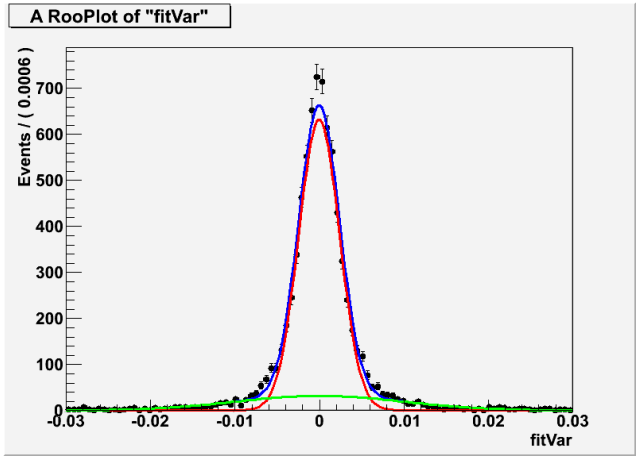


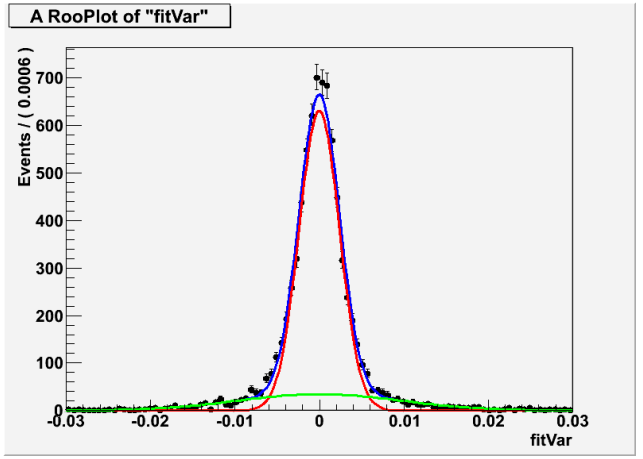
Same performance in this simple case

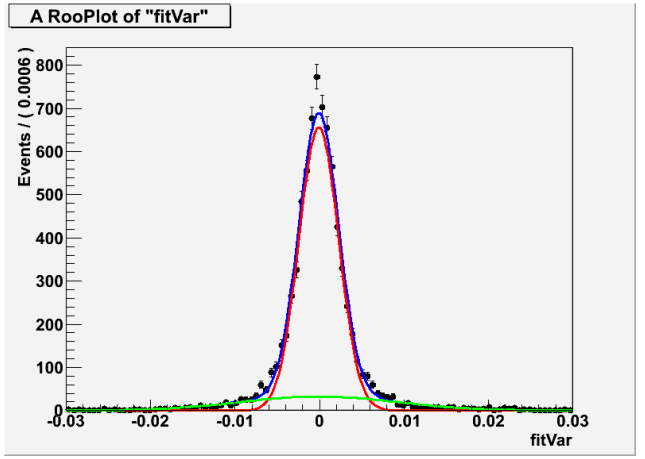
$B^0 \rightarrow j/\psi Ks$

j/ψ Vertex space resolution: X(fit) - X(MC)

j/ψ: x, y, z







f12	8.2668e-01	+/- 7.18e-03
mean1	-3.7685e-05	+/- 3.49e-05
mean2	1.6822e-05	+/- 2.86e-04
sigma1	2.4123e-03	+/- 3.33e-05
sigma2	1.0000e-02	+/- 1.18e-04

Mean Value = -8.98165e-05
Sqrt(RMS-90%) = 0.00257387

f12	8.1868e-01	+/- 9.11e-03
mean1	-2.2049e-05	+/- 3.49e-05
mean2	1.1541e-05	+/- 2.70e-04
sigma1	2.3854e-03	+/- 3.62e-05
sigma2	9.6079e-03	+/- 2.50e-04

Mean Value = -7.38515e-05
Sqrt(RMS-90%) = 0.00247054

f12	8.3675e-01	+/- 9.25e-03
mean1	-7.9579e-05	+/- 3.38e-05
mean2	-1.1997e-04	+/- 2.75e-04
sigma1	2.3519e-03	+/- 3.65e-05
sigma2	9.2623e-03	+/- 2.61e-04

Mean Value = -0.000116555
Sqrt(RMS-90%) = 0.00241202

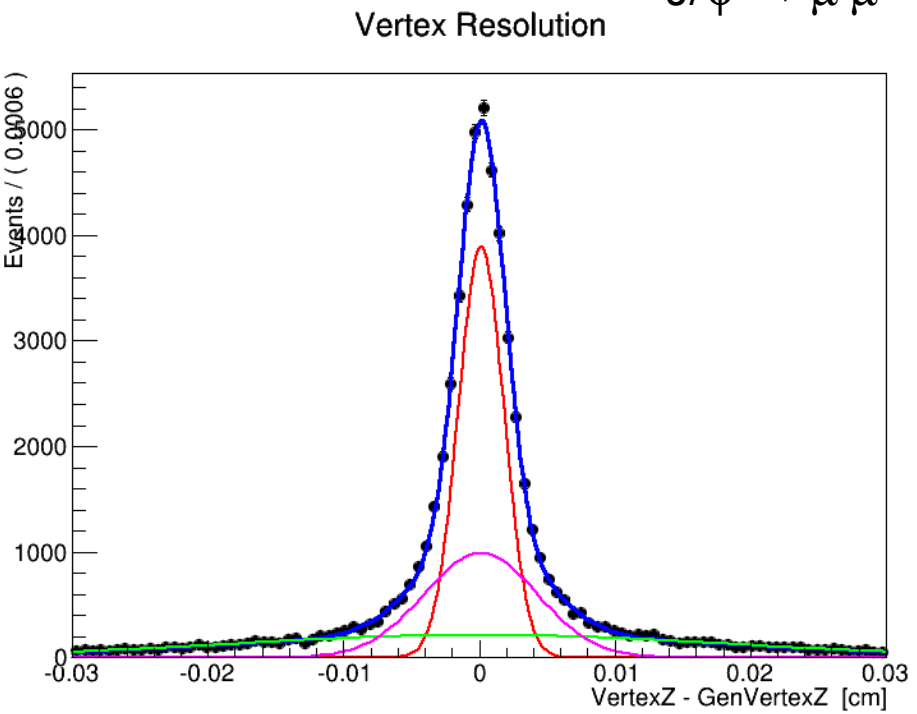
26 – 05 – 2014

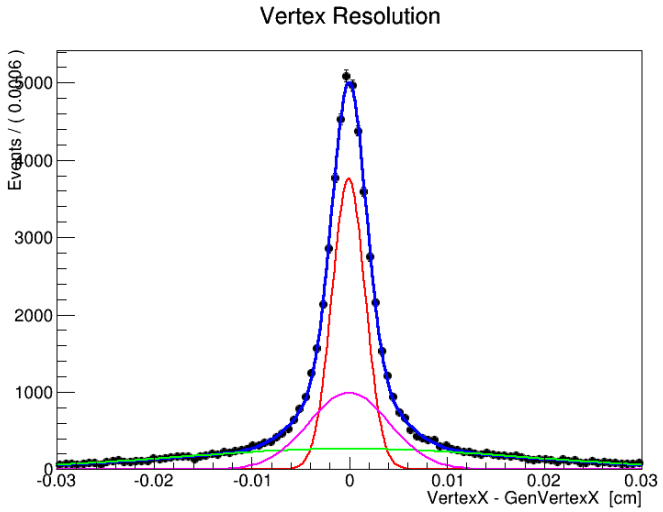
Two vertex fitters used for kinematic vertex fit

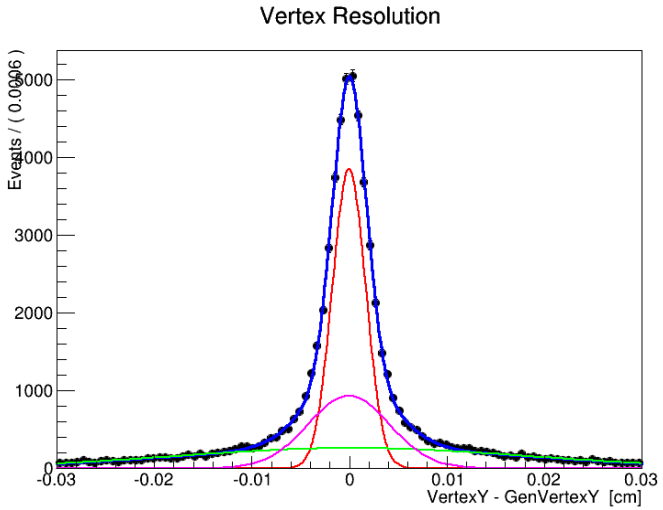
- Kfit : used in Belle
- RAVE: a CMS tool, see https://rave.hepforge.org/)

Quasi identical results

$J/\psi \rightarrow \mu\,\mu$







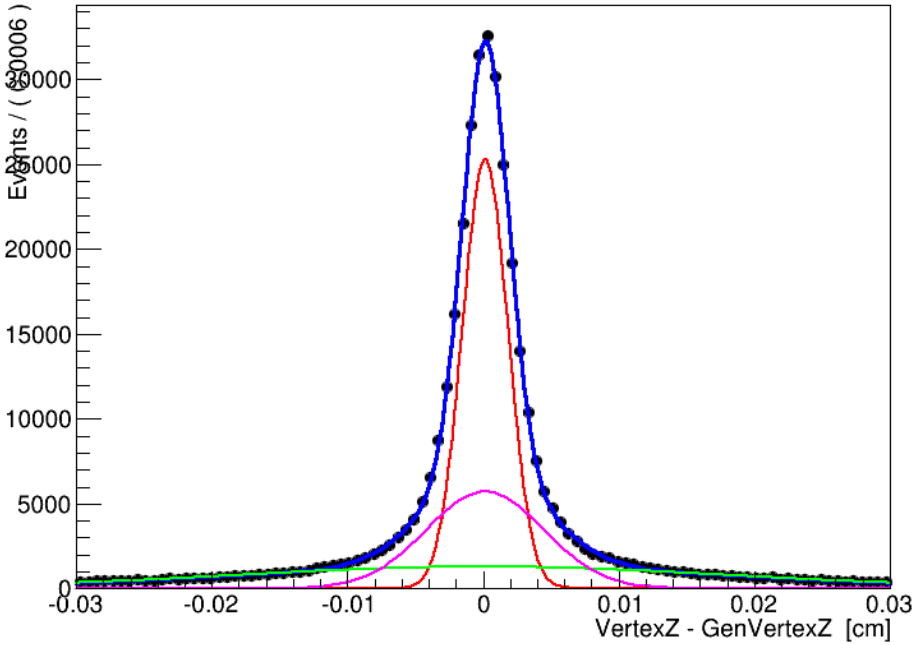
Floating Parameter	FinalValue +/- Error
Mu1	1.6707e-04 +/- 1.61e-05
Mu2	6.9441e-05 +/- 2.01e-04
Mu3	1.3686e-04 +/- 5.31e-05
Sigma1	1.6787e-03 +/- 2.76e-05
Sigma2	1.8251e-02 +/- 4.15e-04
Sigma3	4.1844e-03 +/- 1.30e-04
frac1	4.6151e-01 +/- 1.34e-02
frac2	2.4712e-01 +/- 4.97e-03

Shift (micron) = 1.34141
Resolution (micron) = 65.0417

Official MC production

$J/\psi \rightarrow \mu\,\mu$

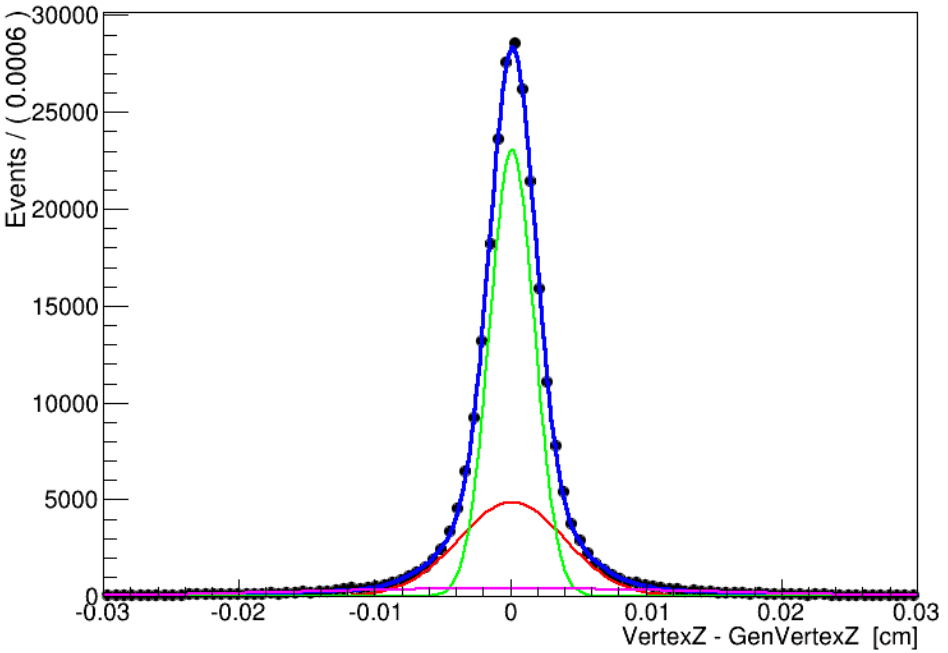
No cut on POCA



Floating Parameter	FinalValue +/-	Error
Mu1	1.6839e-04 +/-	6.14e-06
Mu2	-1.5387e-05 +/-	8.29e-05
Mu3	1.7173e-04 +/-	2.24e-05
Sigma1	1.6831e-03 +/-	1.04e-05
Sigma2	1.8421e-02 +/-	1.79e-04
Sigma3	4.3267e-03 +/-	5.60e-05
frac1	4.8030e-01 +/-	5.03e-03
frac2	2.4092e-01 +/-	2.09e-03

Shift (micron) = 1.25047
Resolution (micron) = 64.5248

Cut on Z POCA : efficiency = 94 %



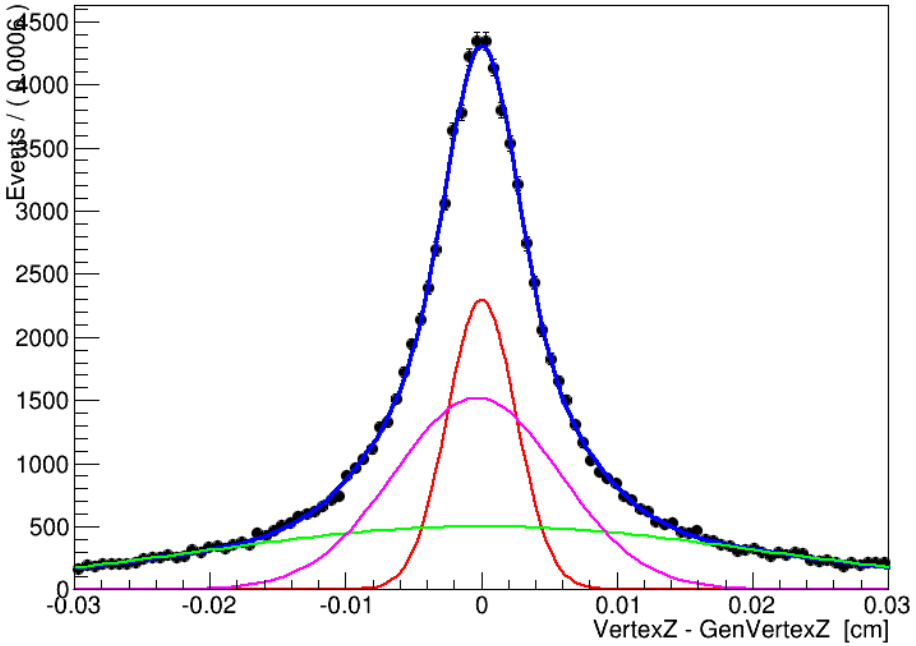
Floating Parameter	FinalValue +/-	Error
Mu1	1.5510e-04 +/-	2.03e-05
Mu2	1.6270e-04 +/-	6.06e-06
Mu3	-1.0663e-04 +/-	1.14e-04
Sigma1	3.9217e-03 +/-	7.62e-05
Sigma2	1.6422e-03 +/-	1.66e-05
Sigma3	1.4930e-02 +/-	2.19e-04
frac1	3.0278e-01 +/-	1.00e-02
frac2	6.0160e-01 +/-	1.14e-02

Shift (micron) = 1.34643
Resolution (micron) = 36.0296

build-2014-08-01

$J/\psi \rightarrow \mu\,\mu$

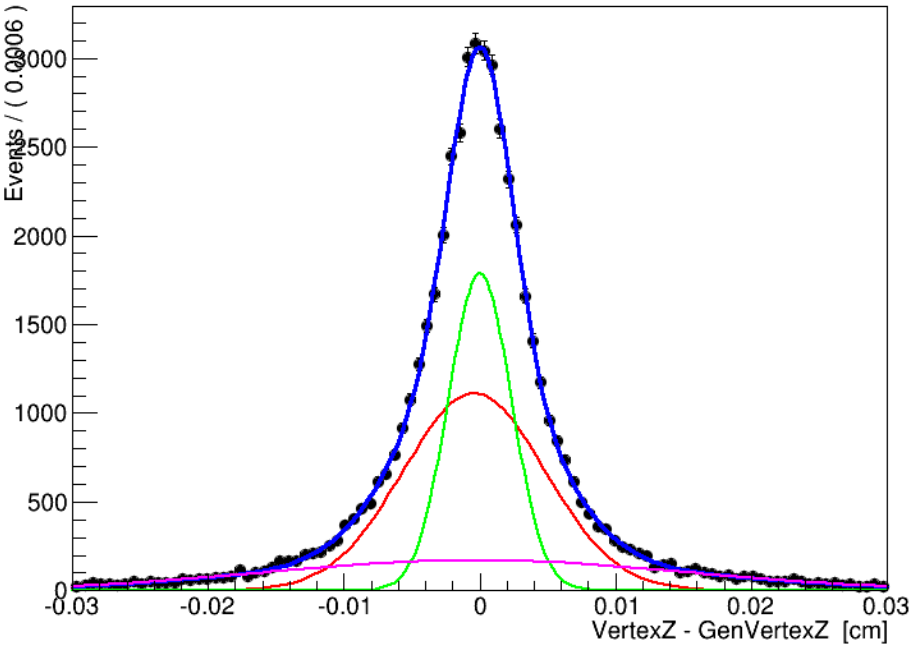
No cut on POCA



Floating Parameter	FinalValue +/- Error
Mu1	6.5241e-05 +/- 3.58e-05
Mu2	1.6565e-04 +/- 1.71e-04
Mu3	-2.8330e-04 +/- 5.97e-05
Sigma1	2.5217e-03 +/- 7.06e-05
Sigma2	2.0649e-02 +/- 5.91e-04
Sigma3	6.1041e-03 +/- 1.80e-04
frac1	2.4264e-01 +/- 1.40e-02
frac2	3.6942e-01 +/- 9.76e-03

Shift (micron) = -0.32877
Resolution (micron) = 106.081

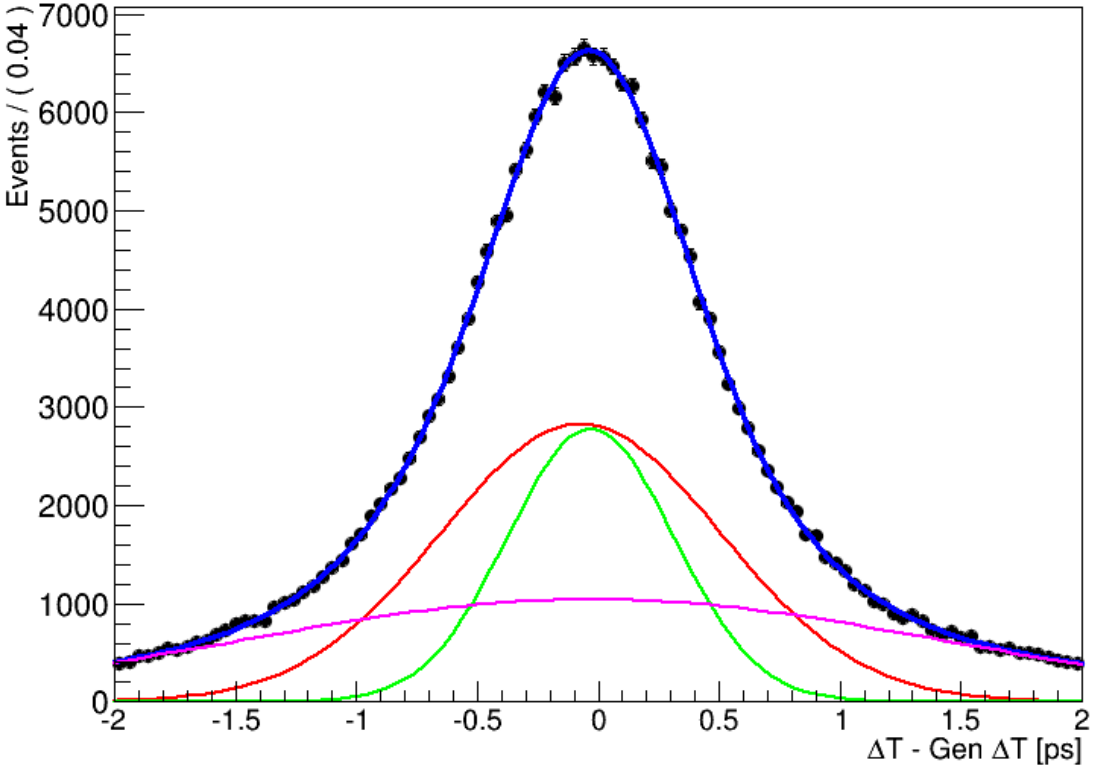
Cut on Z POCA : efficiency = 52 %

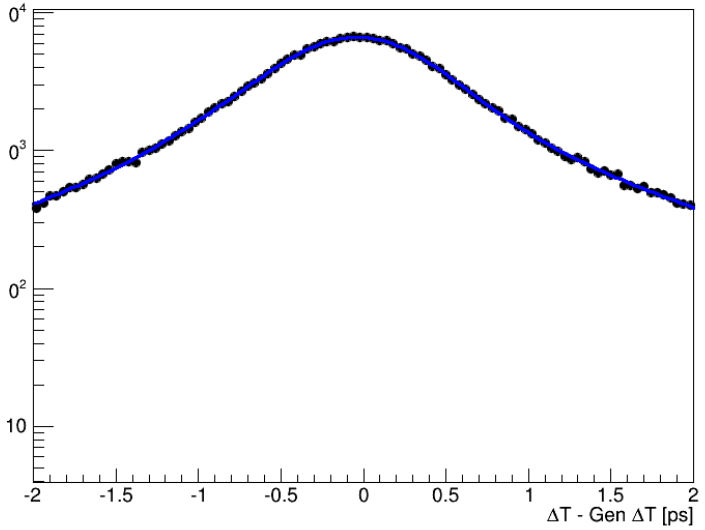


Floating Parameter	FinalValue +/- Error
Mu1	-3.7589e-04 +/- 5.88e-05
Mu2	4.5380e-05 +/- 3.63e-05
Mu3	-2.2770e-04 +/- 1.97e-04
Sigma1	5.2257e-03 +/- 1.59e-04
Sigma2	2.3130e-03 +/- 7.33e-05
Sigma3	1.5199e-02 +/- 4.59e-04
frac1	4.6748e-01 +/- 1.79e-02
frac2	3.3285e-01 +/- 2.24e-02

Shift (micron) = -2.06082
Resolution (micron) = 62.4773

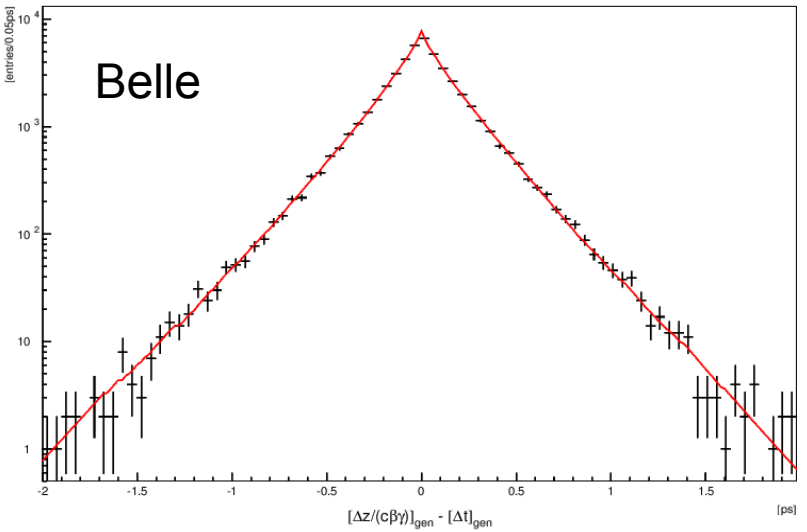
Δt resolution



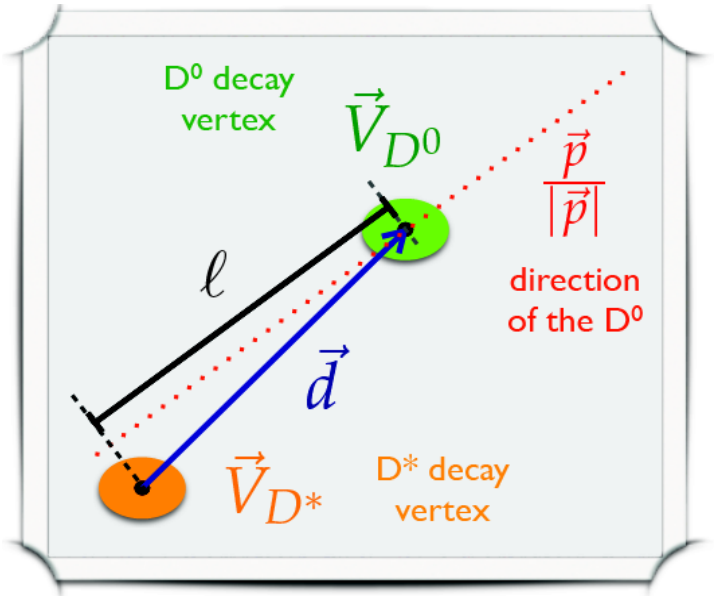


Floating Parameter	FinalValue +/-	Error
Mu1	-7.0499e-02 +/-	8.21e-03
Mu2	-2.7849e-02 +/-	7.19e-03
Mu3	-2.3723e-02 +/-	1.83e-02
Sigma1	5.7861e-01 +/-	5.62e-02
Sigma2	3.4308e-01 +/-	2.27e-02
Sigma3	1.4234e+00 +/-	1.31e-01
frac1	4.2673e-01 +/-	4.10e-02
frac2	2.4825e-01 +/-	7.34e-02

Shift (ps) = -0.0447081
Resolution (ps) = 0.79471



Giulia's talk @ the 31st physics meeting



- KEKCC = central production of the signal (no bkg included), build-13-07-11
  https://belle2.cc.kek.jp/~twiki/bin/view/Physics/MCProduction (PID Performance)
- giulia = release 11949, many many changes in software wrt build-13-07-11

- The Flight Time is the main ingredient for time-dependent analysis. The flight distance is needed to compute the flight time.
- Consider the following decay chain:

$$D^{*+} \to D^0 \pi^+ \ , \quad D^0 \to K^- \pi^+$$

- The D⁰ flight length ℓ is defined as:

$$\ell = \frac{\vec{d}\cdot\vec{p}}{|\vec{p}|} \ , \quad \vec{d} = \vec{V}_{D^0} - \vec{V}_{D^*}$$

D⁰ momentum after the fit

from a mass constrained fit

from a beam-spot constrained fit

the kFitter was used to fit vertices

- The D⁰ flight distance error is $\sigma_\ell^2 = S^T C\, S$

9x9 cov matrix

vector of the derivatives

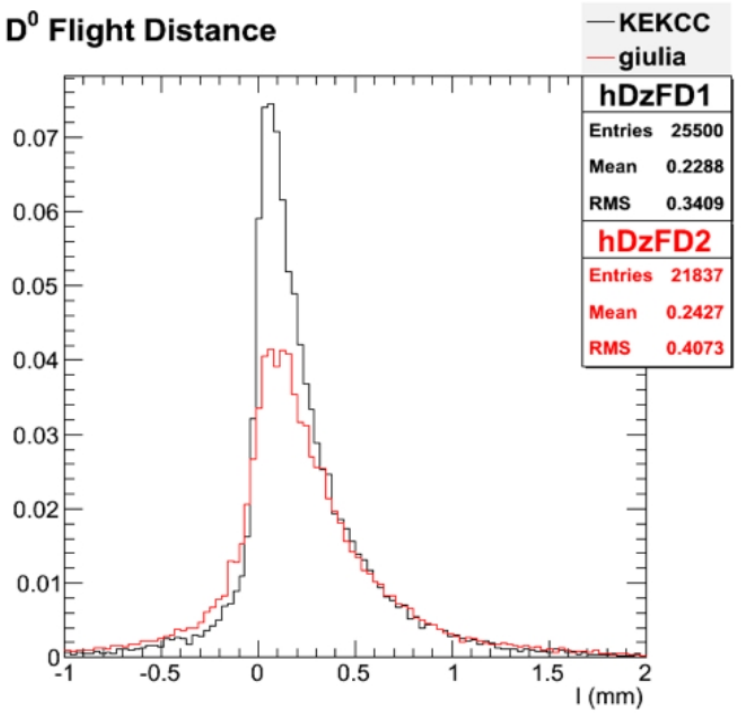
$$\ell = \frac{\vec{d}\cdot\vec{p}}{\hat{n}\cdot\vec{p}}$$

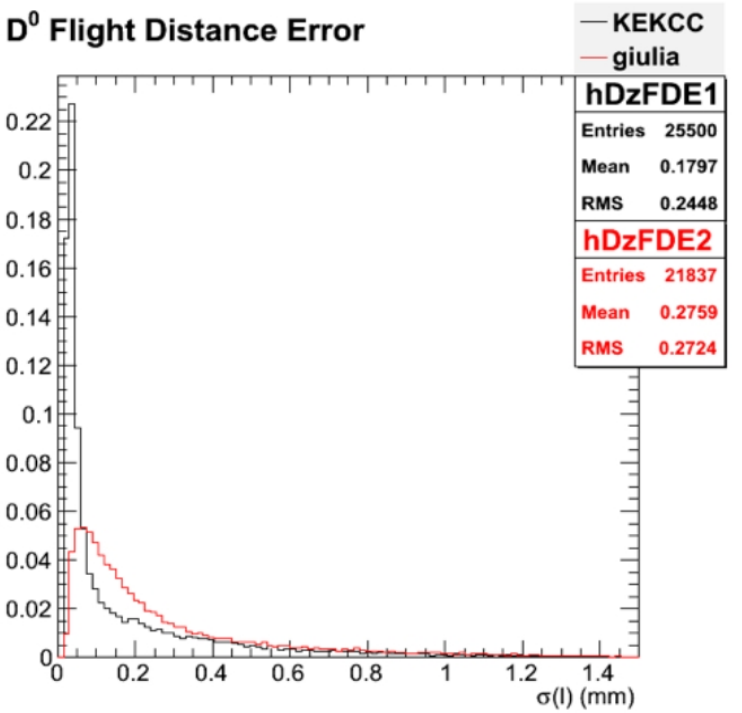
fixed

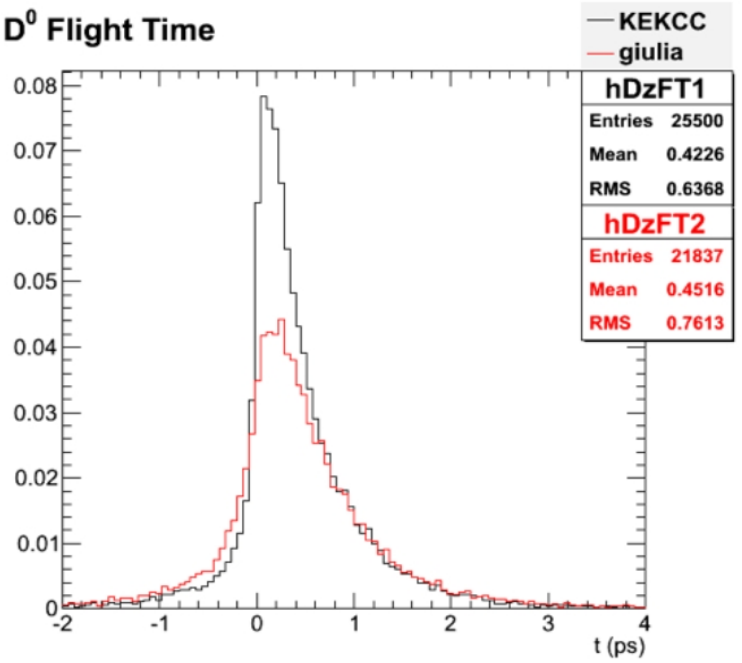
the computation of the derivatives is now straightforward

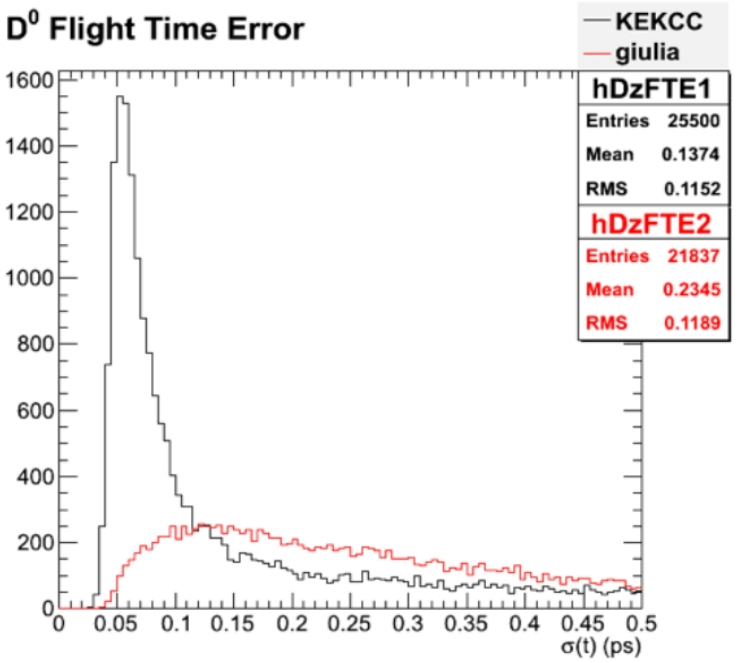
derive with respect to each component of $\vec{p}$, $\vec{V}_{D^0}$, $\vec{V}_{D^*}$

- The assumptions for error estimations:
  1) infinitely precise direction of the D⁰, $\hat{n} = \vec{p}/|\vec{p}|$
  2) Gaussian-distributed errors on $\vec{V}_D$ and $\vec{p}$
  3) D* vertex and D⁰ vertex+momentum are not correlated
     - this is not true in general, but at present we can fit a vertex at a time


D0 Flight Distance
KEKCC
giulia
hDzFD1
Entries 25500
Mean 0.2288
RMS 0.3409
hDzFD2
Entries 21837
Mean 0.2427
RMS 0.4073
l (mm)


D0 Flight Distance Error
KEKCC
giulia
hDzFDE1
Entries 25500
Mean 0.1797
RMS 0.2448
hDzFDE2
Entries 21837
Mean 0.2759
RMS 0.2724
σ(l) (mm)


D0 Flight Time
KEKCC
giulia
hDzFT1
Entries 25500
Mean 0.4226
RMS 0.6368
hDzFT2
Entries 21837
Mean 0.4516
RMS 0.7613
t (ps)


D0 Flight Time Error
KEKCC
giulia
hDzFTE1
Entries 25500
Mean 0.1374
RMS 0.1152
hDzFTE2
Entries 21837
Mean 0.2345
RMS 0.1189
σ(t) (ps)