ICPV

Yosuke Yusa
Niigata University

Analysis strategy

Control sample reconstruction

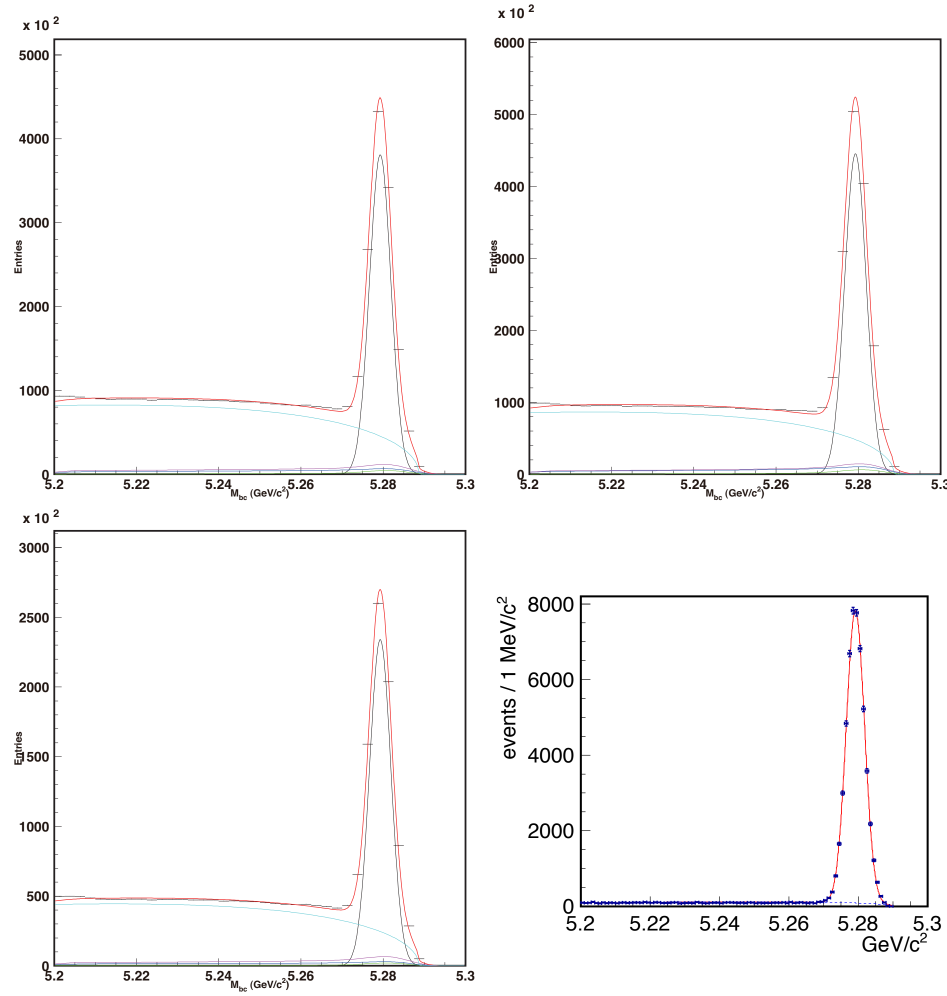
↓

Resolution function (flavor tagging)

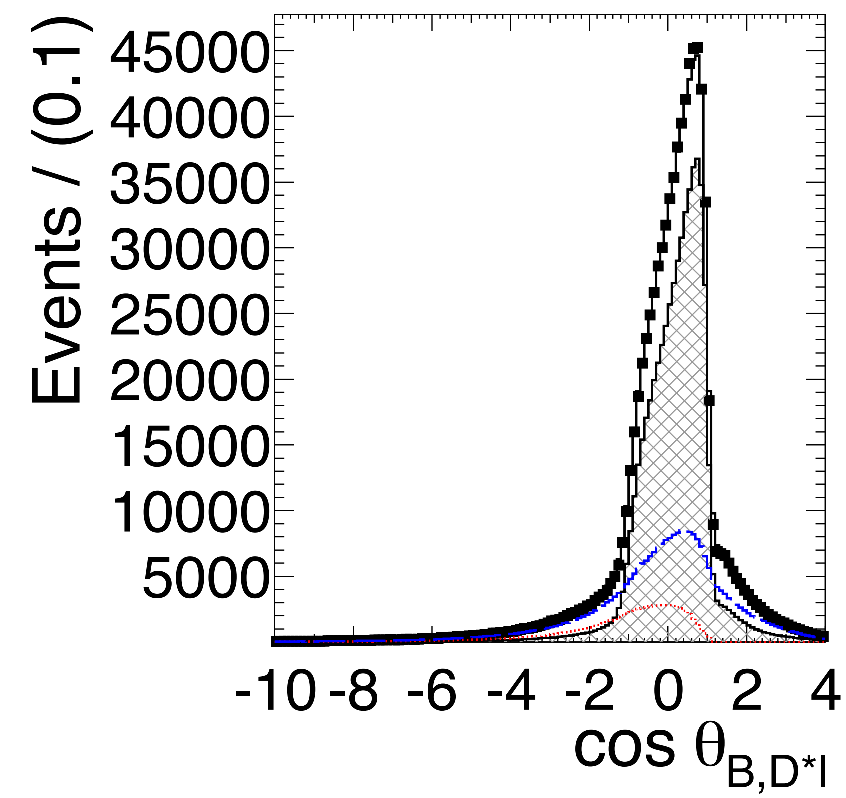
↓

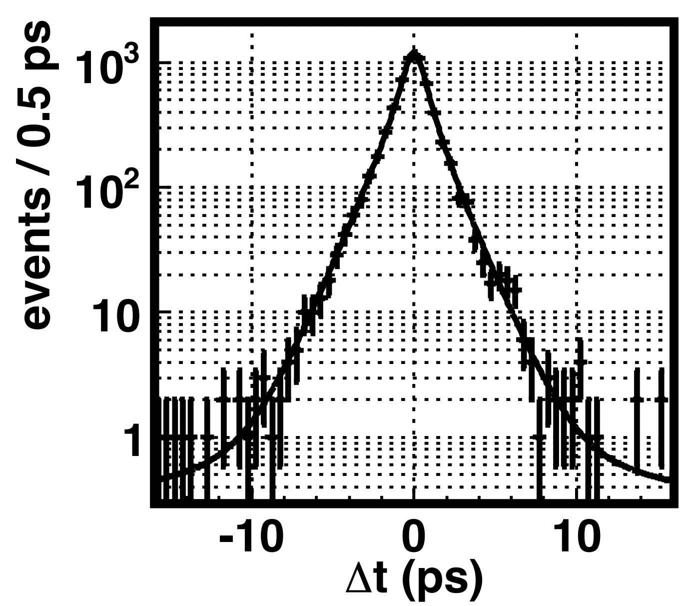
CP fit

Hadronic



semi-leptonic





$J/\psi\ K^0_S$ sideband

We plan to develop CP fit tools using common control samples.

Analysis strategy

Control sample reconstruction

↓

Scale error evaluation

↓

Resolution function (flavor tagging)

↓

CP fit

- **Scale error = Correction of helix parameter errors**
- **Why scale error? = avoid incorrect weight assignment to events**
  - In the time-dependent analysis, each event is assigned to an event-by-event weight, which is derived from the measured Δ*t*-uncertainty.
  - The Δ*t*-uncertainty is obtained as a vertex fit output, and is originated from the uncertainty of the helix parameters.
- **Theory of correction**
  - Scale up/down the helix parameter errors so that the pull distribution becomes the standard normal Gaussian.

$$\mathrm{pull} \equiv \frac{x_{\mathrm{rec.}} - x_{\mathrm{ref.}}}{\sqrt{\left(\varepsilon_X^{\mathrm{rec.}}\right)^2 + \left(\varepsilon_X^{\mathrm{ref.}}\right)^2}}$$

$\left(\varepsilon_X^{\mathrm{rec.}}\right)^2 + \left(\varepsilon_X^{\mathrm{ref.}}\right)^2$	Gaussian width (σ)
smaller than ideal	**broader than 1**
appropriate	**1**
larger than ideal	**narrower than 1**

- **Pull of helix parameters of hadronic MC sample**

$$\mathrm{pull} \equiv \frac{x_{\mathrm{rec.}} - x_{\mathrm{ref.}}}{\sqrt{\left(\varepsilon_X^{\mathrm{rec.}}\right)^2 + \left(\varepsilon_X^{\mathrm{ref.}}\right)^2}}$$

$x_{\mathrm{rec.}}$: GEANT reconstructed

$x_{\mathrm{ref.}}$: MC input

$\varepsilon^{\mathrm{rec.}}$: GEANT reconstructed

$\varepsilon_{\mathrm{ref.}}$: zero by defintion

- **Pull of helix parameters of cosmic sample**
  - Single cosmic ray track (penetrating the IP) is reconstructed as two tracks.

$$\mathrm{pull} \equiv \frac{x_{\mathrm{rec.}} - x_{\mathrm{ref.}}}{\sqrt{\left(\varepsilon_X^{\mathrm{rec.}}\right)^2 + \left(\varepsilon_X^{\mathrm{ref.}}\right)^2}}$$

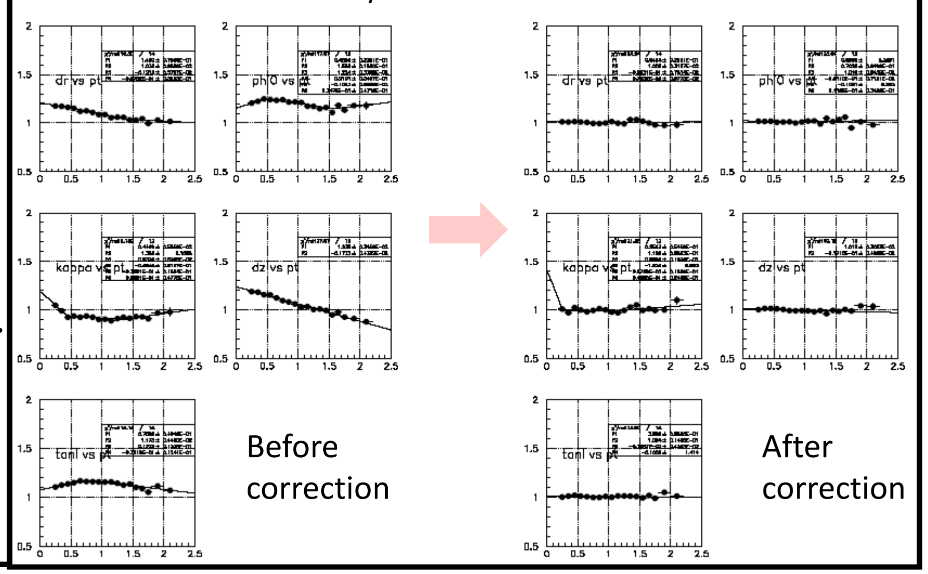
$x_{\mathrm{rec.}}$: The first track reconstructed

$x_{\mathrm{ref.}}$: The second track reconstructed

$\varepsilon^{\mathrm{rec.}}$: Helix error for the first track

$\varepsilon_{\mathrm{ref.}}$: Helix error for the second track

p_t dependencies of 5 helix parameter errors (hadronic MC) before/after the correction



Tracking scale error should be evaluated before resolution function study.

Issues in discussion

- CP fit using GRID is possible?
  According to Hayasaka-san, multi-core job on GRID is possible technically.
  Need to discuss with software and computing group by showing specific example of what we want to do.
  → Advanced common CPfitter for complex fit (Dalitz, ϕ_2, global fit for b→sqq penguin (b→ccs tree) modes)

- Flavor tagging using MDLH needs study of correlation among parameters. Neural-net based one is easy to be implement.

Items for tool development

- Control sample mode reconstruction
  Hadronic ($B^0 \to D^- \pi^+$, $D^{*-} \pi^+$, $D^{*-} \rho^+$, $B^+ \to \bar{D}^0 \pi^+$, $J/\psi K^+$)
  Semi-leptonic ($B \to D^* l \nu$)
- Scale error evaluation
  Cosmic penetrating IP (data/MC fraction)
  Hadronic MC
- Resolution function
  Δt distribution analysis (materials to discuss model, shape study)
- (Flavor tagging)
  Neurobayes
  Multi-dimensional Likelihood (if Kakuno-san can help)
- CP fitter
  Common fitter
  Fitter with multi-core on GRID

Free analysis

Many channels are free for analysts to take, here I list some (somewhat in order of importance):

Channel	CKM angle	Motivations
$B \rightarrow \pi^+ \pi^-, \pi^+ \pi^0$	ϕ_2	Inputs for the $B \rightarrow \pi\pi$ and $B \rightarrow \rho\rho$ isospin analysis. The modes with π^0's in the final states are important, given that LHCb will have limited sensitivity.
$B \rightarrow \rho\ \rho$	ϕ_2	
$B \rightarrow \rho\ \pi$	ϕ_2	Dalitz plot analysis to extract ϕ_2 with no ambiguities.
$B^0 \rightarrow K_S K_S K_S$	ϕ_1	Penguin dominated modes, with different levels of "tree pollution". It will be important to measure as many channels as possible to detect any pattern in a global fit.
$B^0 \rightarrow \omega K^0$	ϕ_1	
$B^0 \rightarrow \eta K^0$	ϕ_1	
$B^0 \rightarrow \rho\ \gamma$	-	Significant CPV would hint for New Physics.

Plus, you are welcome to propose your analysis ideas!

Mailing list: physics-tdcpv@belle2.org
If interested, please contact Alessandro and Luigi