ICEPP Symposium in Hakuba 2004/02/15

Study of CP Violation in $B^0 \to K_S \pi^0$ at Belle

Niigata-University T.Shibata

KEK T.Higuchi

Taiwan-University K.F.Chen

Belle Collaboration

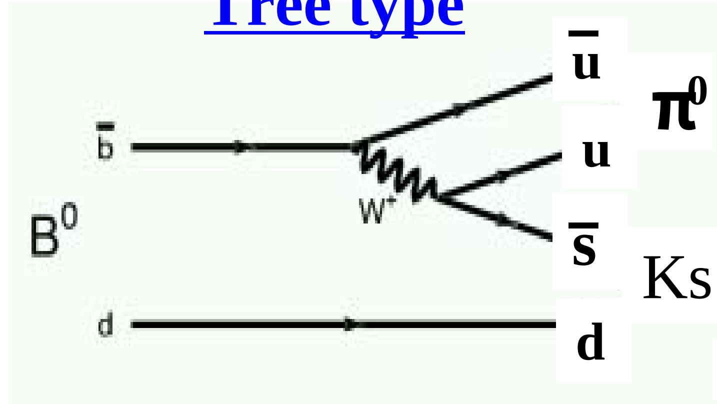

Introduction
to
Ks π^0 Mode
BELLE

Ks π^0 Mixing Indirect CP-Violation Mode likely JψKs

$$Acp(\Delta t) = \frac{\Gamma\left(\overline{\mathrm{B}}^0 \to Ks\pi^0\right) - \Gamma\left(\mathrm{B}^0 \to Ks\pi^0\right)}{\Gamma\left(\overline{\mathrm{B}}^0 \to Ks\pi^0\right) + \Gamma\left(\mathrm{B}^0 \to Ks\pi^0\right)}$$

$$= A_{Ks\pi^0} \cdot \cos\left(\Delta m \Delta t\right) + S_{Ks\pi^0} \cdot \sin\left(\Delta m \Delta t\right)$$

Tree type



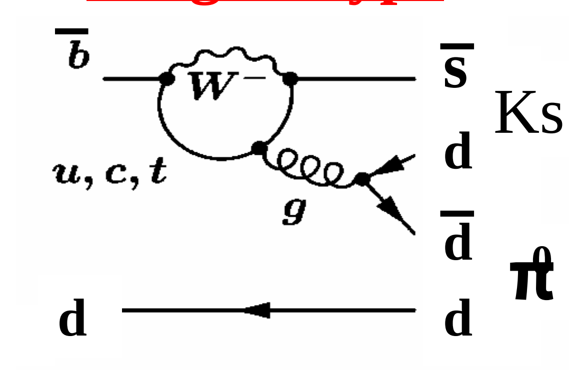
$$\Gamma \propto \mathrm{A}\lambda^4 e^{-i\phi_3}$$

$$\lambda = 0.22$$

→ Very Small Effect

$\ll$

Penguin type



$$\Gamma \propto \mathrm{A}\lambda^2$$

(no phase)

→ Dominant!

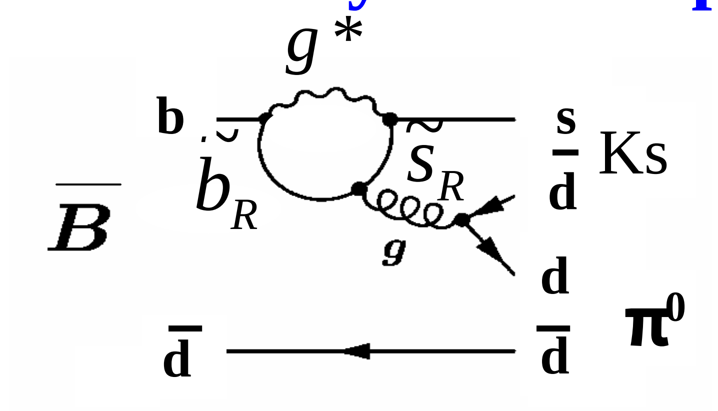
In Standard Model

$$A_{Ks\pi^0} = 0$$

$$S_{Ks\pi^0} = \sin 2\phi_1$$

Physical Motivation

If New Physics in loop …



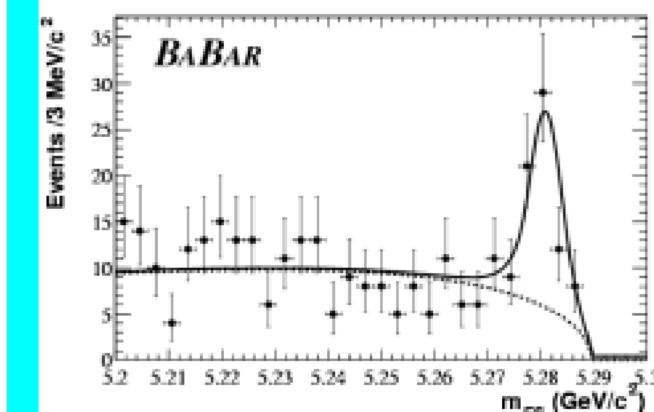
$$\propto e^{i\phi_{new}}$$

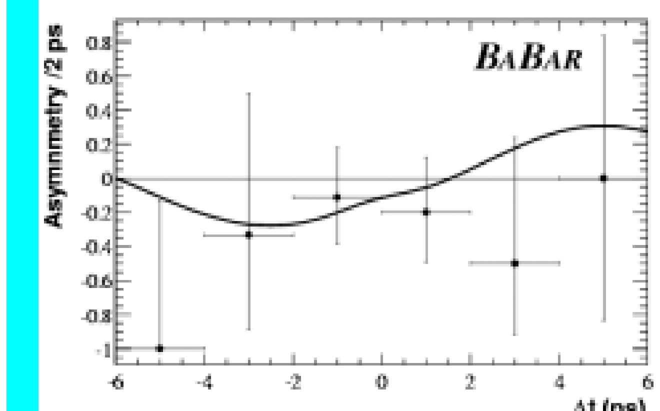
$$S_{Ks\pi^0} \propto \sin 2\phi_?$$

$$\phi_1 \rightarrow \phi_1 + \phi_{new-physics}$$

Ks π0 is sensitivity for new physics in loop diagram.

BaBar Result of LP03





Events=122±1
6

$$A_{Ks\pi^0} = 0.40 {}^{+0.27}_{-0.28} \pm 0.10$$

$$S_{Ks\pi^0} = 0.48 {}^{+0.38}_{-0.47} \pm 0.11$$

Today's Topics
Event Selection & Signal Yield

Analysis process

B^0 reconstruction

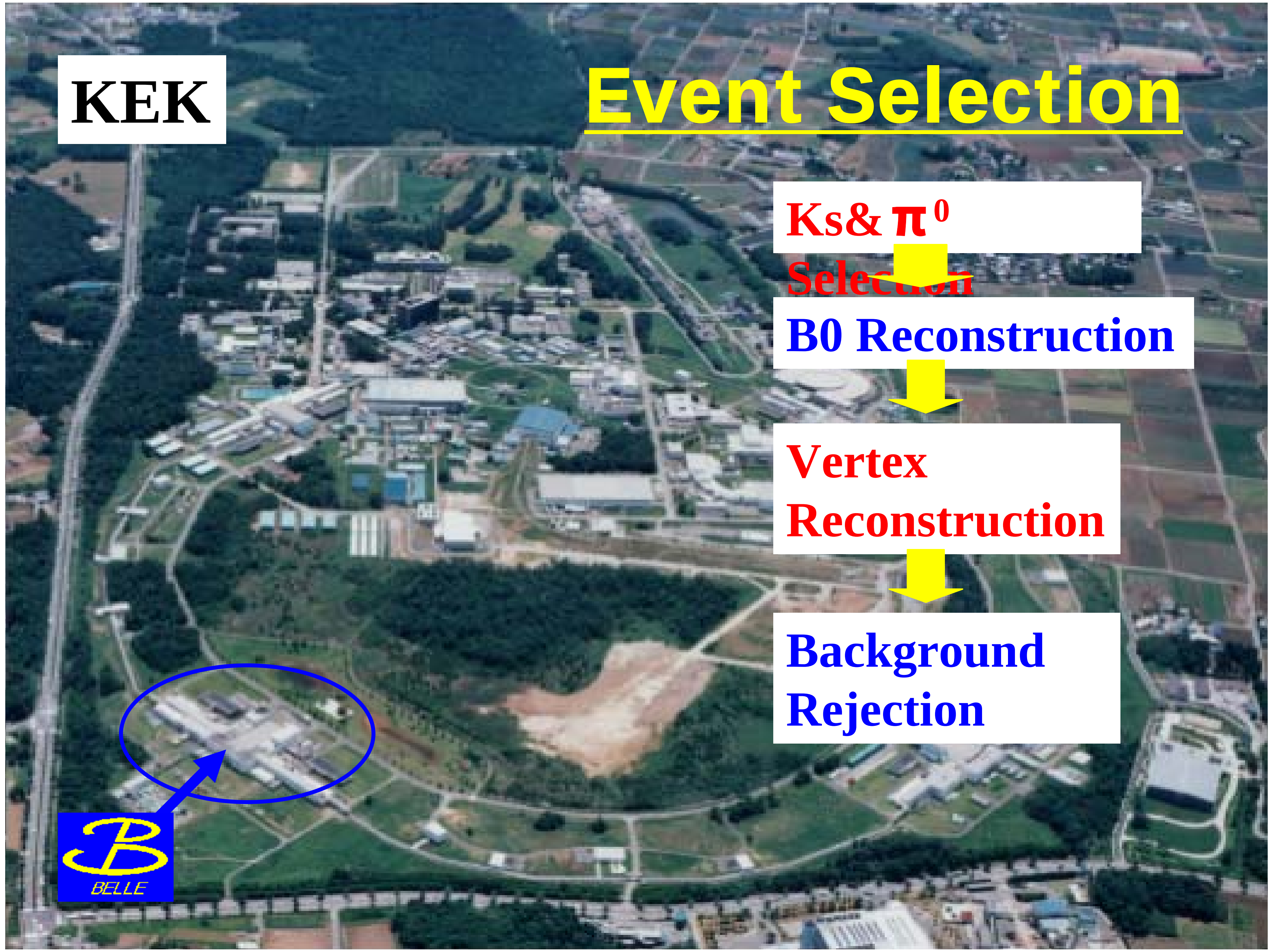
(1) Event Selection

(2) Signal & Background Yield Extraction

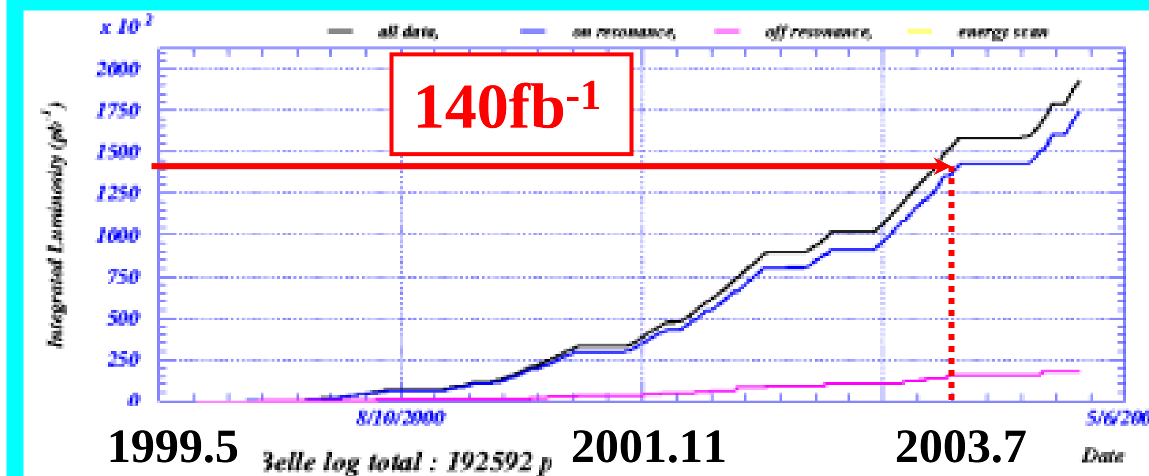
CP-Fit Analysis

(1) Define the Resolution of Δt for $K_s\pi^0$ mode

(2) Δt & CP-Asymmetry Fitting


KEK
Event Selection
Ks& π^0 Selection
B0 Reconstruction
Vertex Reconstruction
Background Rejection
BELLE

Data Sample for Analysis



$\int$ (Luminosity)dt = 140fb^{-1}

#$B\overline{B}$ = 150 × 10^6

Estimate Events

Br($B^0 \rightarrow K_s \pi^0$) ～4 × 10^{-6}

(Physics Letters B407(1997))

Br($\pi^0 \rightarrow \gamma\ \gamma$) ～98.8%

Br($K_s \rightarrow \pi^+ \pi^-$) ～68.6%

→ **～400events**

Efficiency=100%

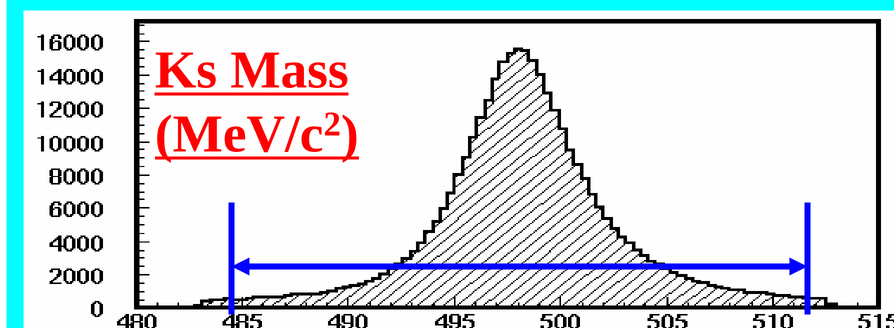
Ks & π0 Selection → **B0 Reconstruction** →

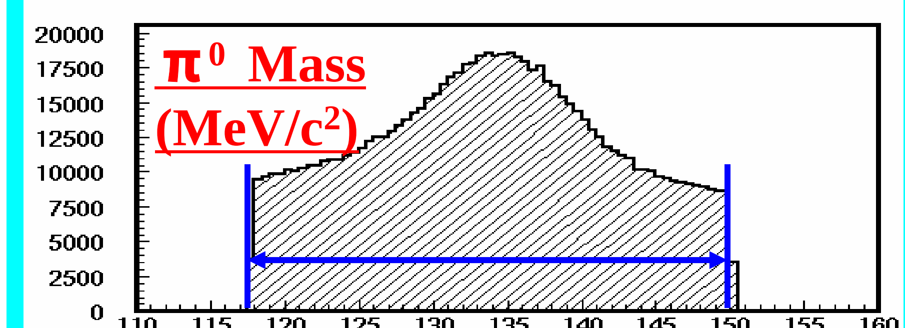
Ks → $\pi^+\pi^-$

$|M_{\pi\pi} - 497.672| < 15 MeV/c^2$

$\pi^0 \rightarrow \gamma\gamma$

$118 < M_{\gamma\gamma} < 150$ MeV/c^2





Beam Constrained Mass

$$M_{bc} \equiv \sqrt{\left(E^{cms}_{Beam}\right)^2 - \left(P^{cms}_{B}\right)^2}$$

$$5.20 < M_{bc} < 5.29 (GeV/c^2)$$

Energy Difference

$$\Delta E \equiv E^{cms}_{B} - E^{cms}_{Beam}$$

$$|\Delta E| < 0.5 (GeV)$$

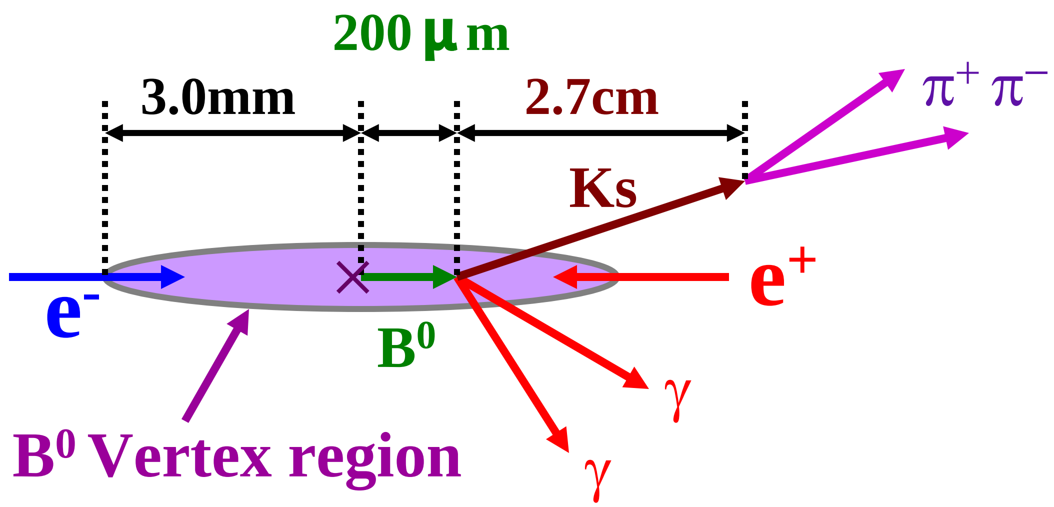
$E^{cms}_{Beam} = 5.29 (GeV)$ **: Beam Energy**

E^{cms}_{B} **: Energy of B**

P^{cms}_{B} **: Momentum of B**

All of them are CMS

Vertex Reconstruction

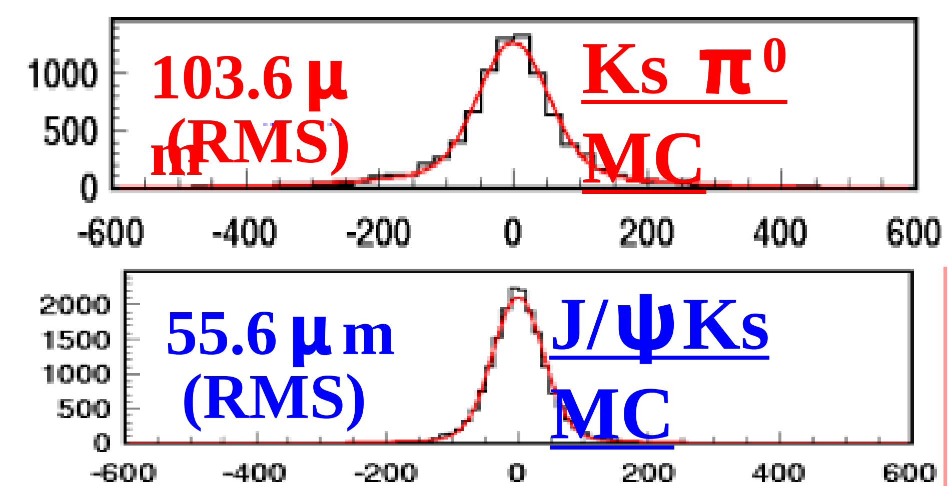


Vertexing process

Calculate Ks Momentum

↓

Vertex Fit used Ks with B^0 Vertex region constrained



True – Reconstructed (μm)

Vertexing efficiency

$B^0 \rightarrow K_s \pi^0$:

$\varepsilon = 25.9\%$

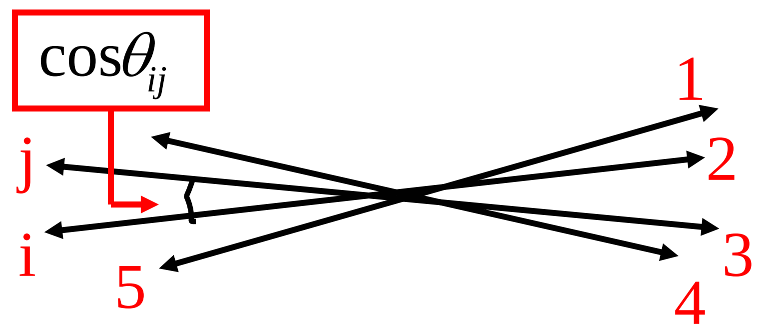
$B^0 \rightarrow J/\psi K_s$: (Not official value)

$\varepsilon = 95.8\%$

Background Rejection

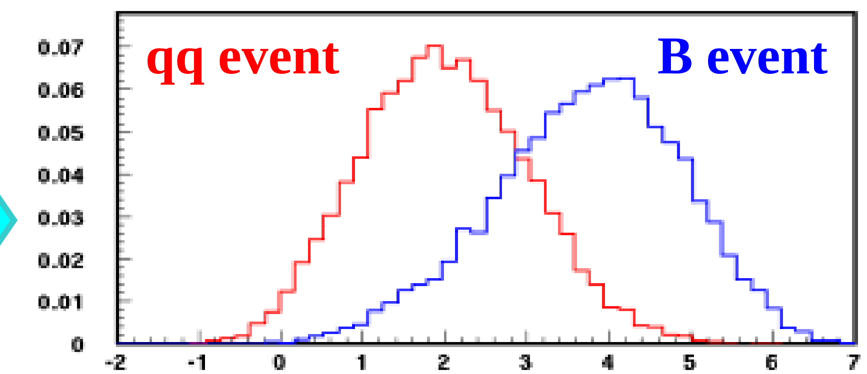
Main Background is Jet events ($e^+e^- \rightarrow q\bar{q}$)

→ Rejected used difference of Topology of events



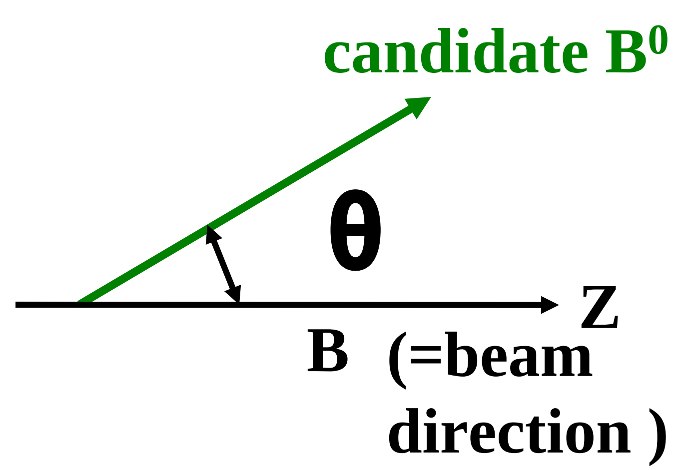
$\cos\theta_{ij} \approx \pm 1$ **: Jet event**

cos θ ij

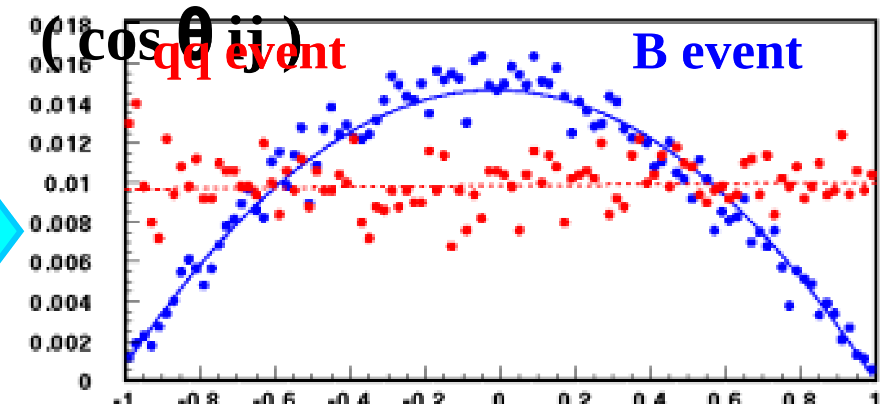


Super Fox-Wolfram(SFW)

(cos θ ij)



cos θ B



Background Rejection

Likelihood Ratio Cut

Likelihood

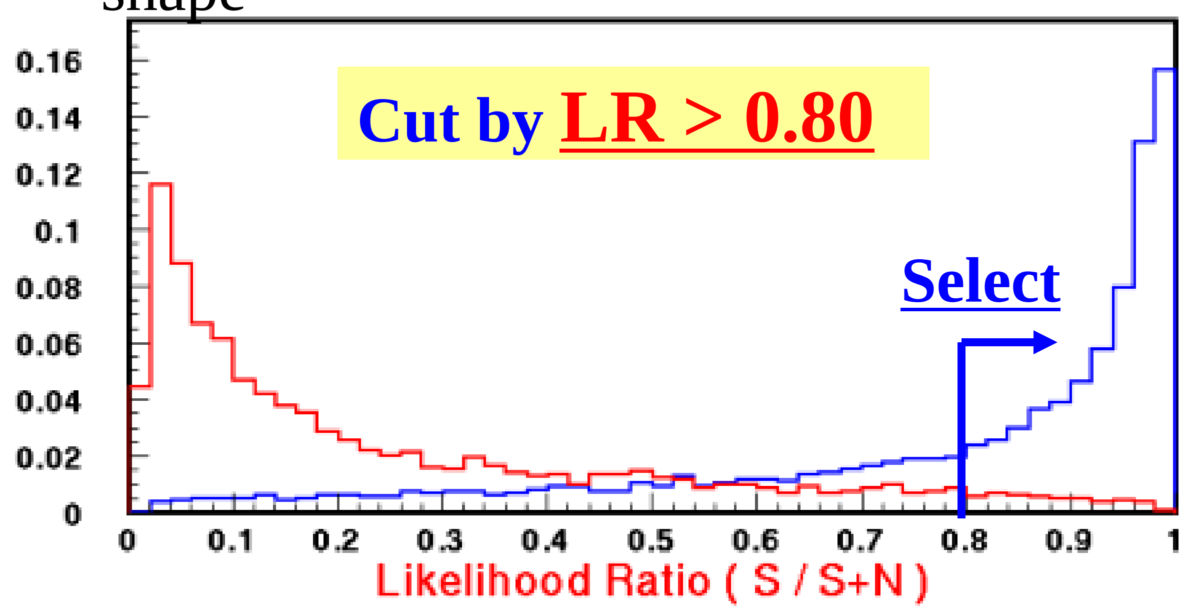
$$L_{BB,qq} = L(SFW) \times L(\cos\theta_B)$$

L(SFW)=SFW shape

L(cos θ B)= cos θ B shape

Likelihood Ratio

$$LR = \frac{L_{BB}}{L_{BB} + L_{qq}}$$



LR>0.8 was defined as

$$\frac{N_{sig}}{\sqrt{N_{sig} + N_{qq}}}$$

became Maximum

$N_{sig,qq}$…#of signal,qq

Signal Yield Extraction

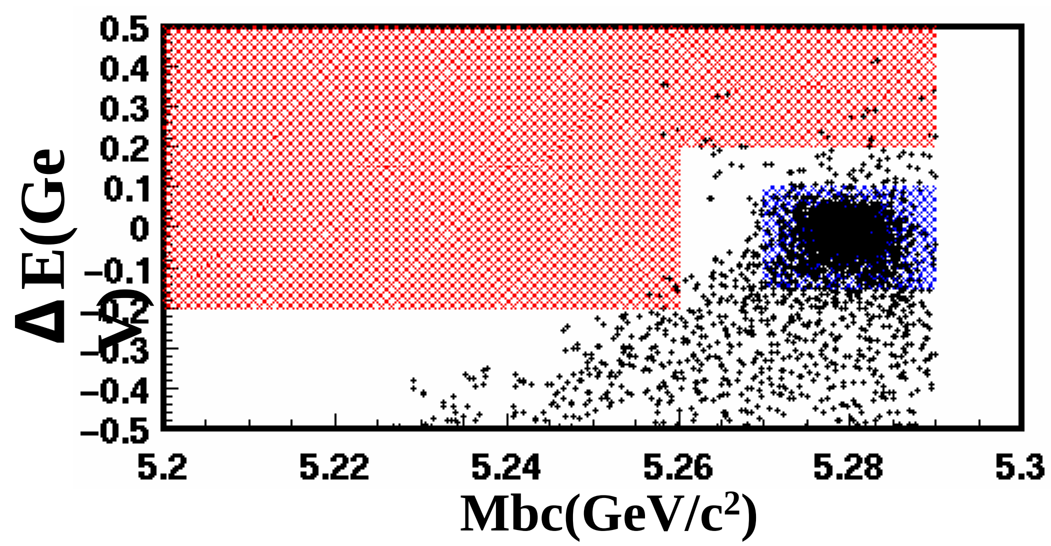
Tukuba hall in KEK

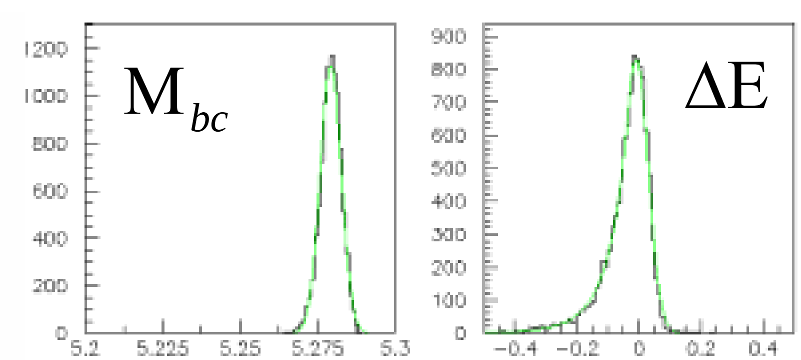
Signal Yield is calculated by

Unbinned Maximum Likelihood Fit to Mbc& ΔE

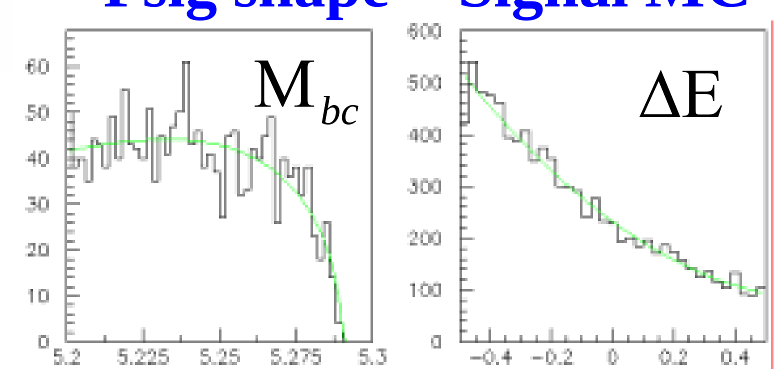
$$Likelihood = \prod_{i=1}^{N} L_i(\mathrm{M}bc, \Delta\mathrm{E})$$

$$L_i(\mathrm{M}bc, \Delta\mathrm{E}) = f_{sig} \cdot P_{sig}(\mathrm{M}bc, \Delta\mathrm{E}) + (1 - f_{dig}) \cdot P_{bkg}(\mathrm{M}bc, \Delta\mathrm{E})$$





Psig shape = Signal MC



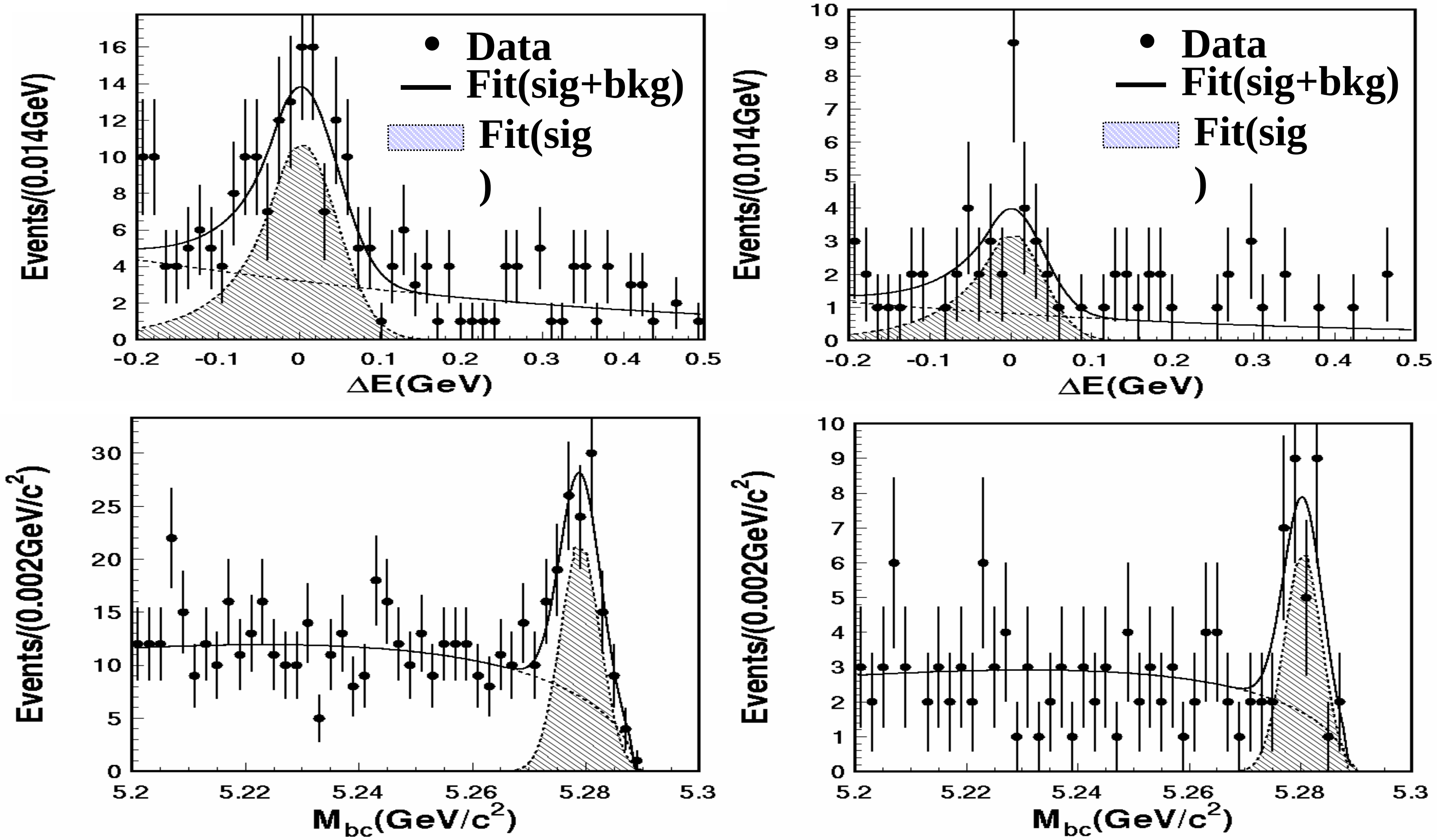
Pbkg shape = Sideband data

Signal Region

5.27<Mbc<5.29(GeV/c²)

-0.15< ΔE < 0.10 (GeV)

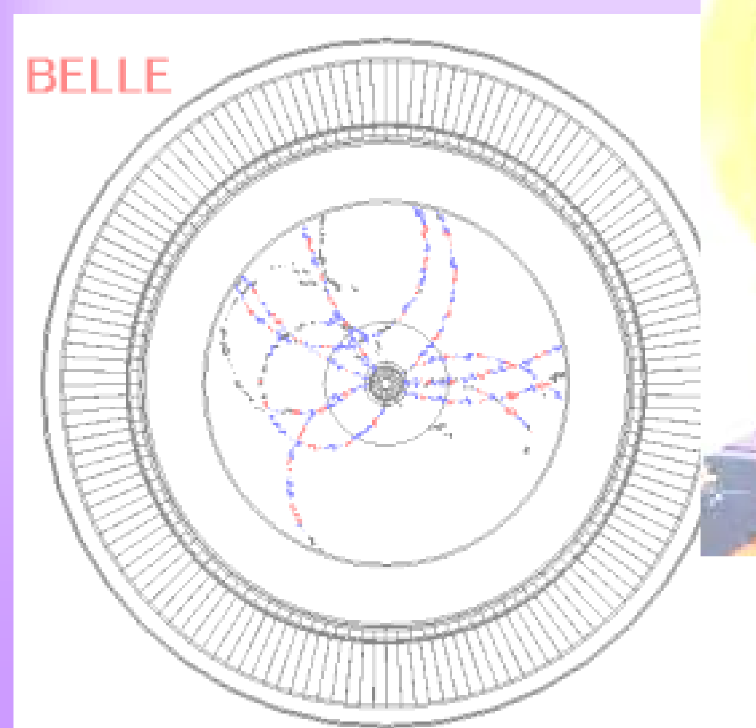
Fitting Result without(L) & with(R) Vertexing

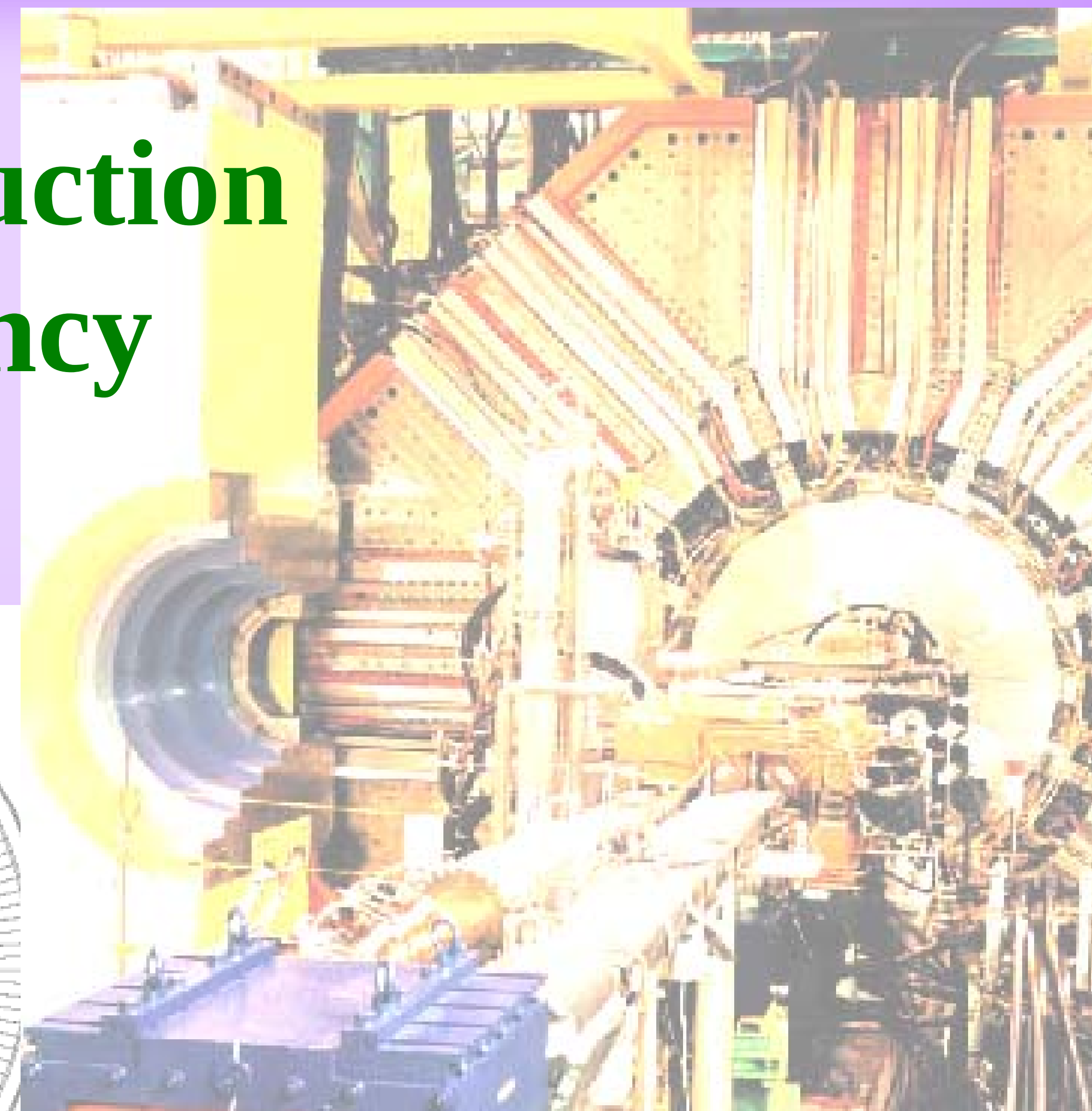


LR>0.80
Signal Yield =92.8±11.3

LR>0.80
Signal Yield =26.2±5.6

Reconstruction Efficiency

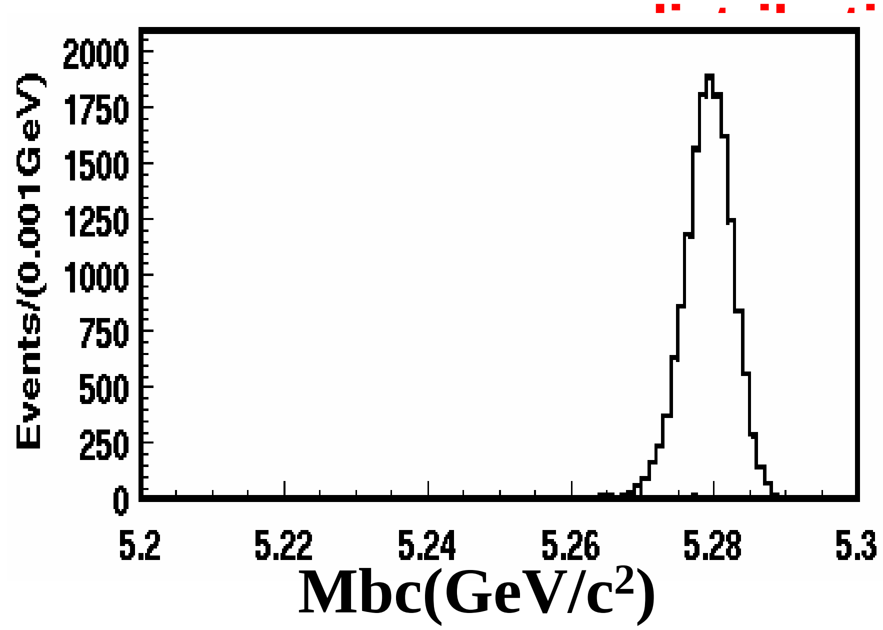


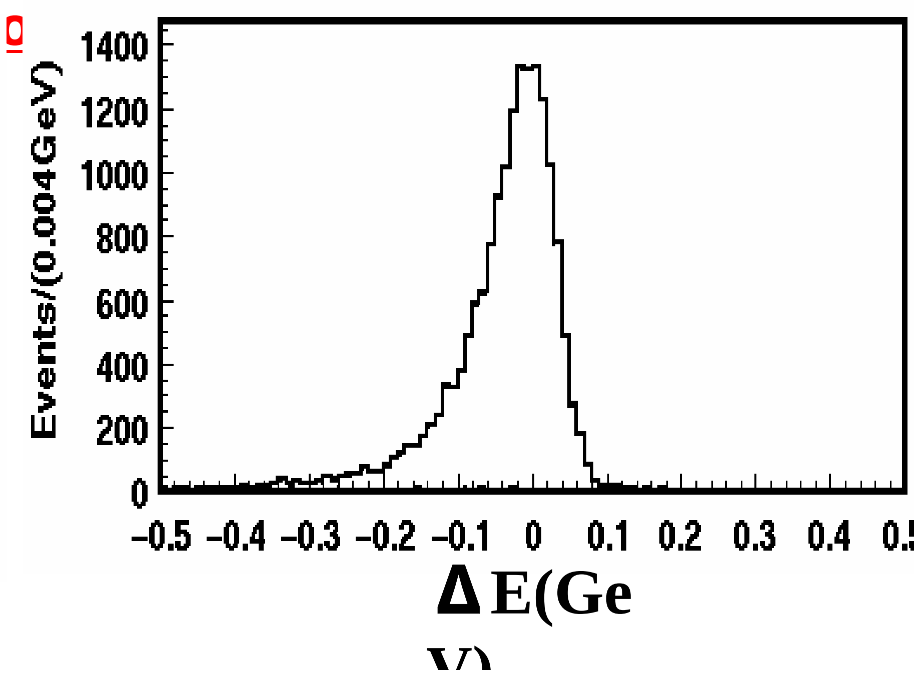


Reconstruction Efficiency was Calculated by Monte Carlo

	W/o Vertex Cut	W/ Vertex Cut
Not LR Cut	30.6 %	7.6 %
LR>0.80 Cut	18.8 %	4.7 %

Mbc & ΔE





Summary

Used data sample140fb^{-1}

w/o Vertexing	Signal Yield	Reconstruction Efficiency
LR > 0.8 Cut	92.8 ± 11.3	18.8 (%)

w/ Vertexing	Signal Yield	Reconstruction Efficiency
LR > 0.8 Cut	26.2 ± 5.6	4.7(%)

Vertex Efficiency	25.9 (%)

We could estimate the $K_s\pi^0$ events without vertexing (93), but vertex efficiency is very small(25%). The #events for CP-fit is 26.

Future Plan

Background Study by MC

→ **Estimate peaking background**

Measurement CP-Asymmetry

→ **Define the special ‘Δt’ Resolution, because this resolution is different from J/Ψ mode(Golden mode)**

→ **This is very difficult problem**

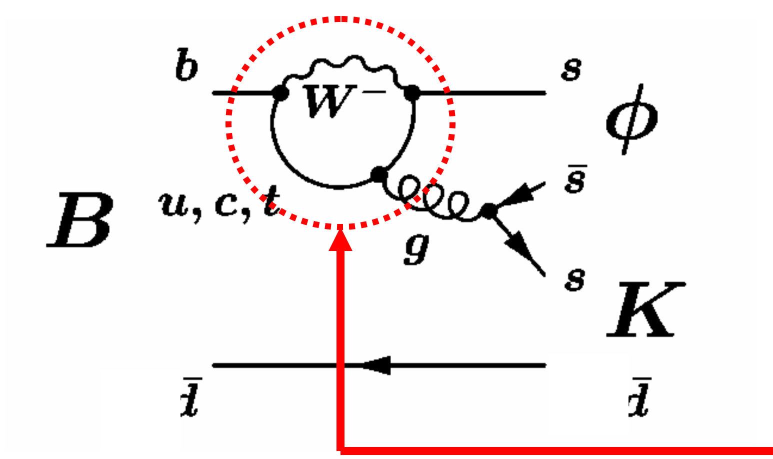
⇒ **Finish until JPS(2004 Spring) ???**

Appendix

Physics Motivation

LP03 Conference

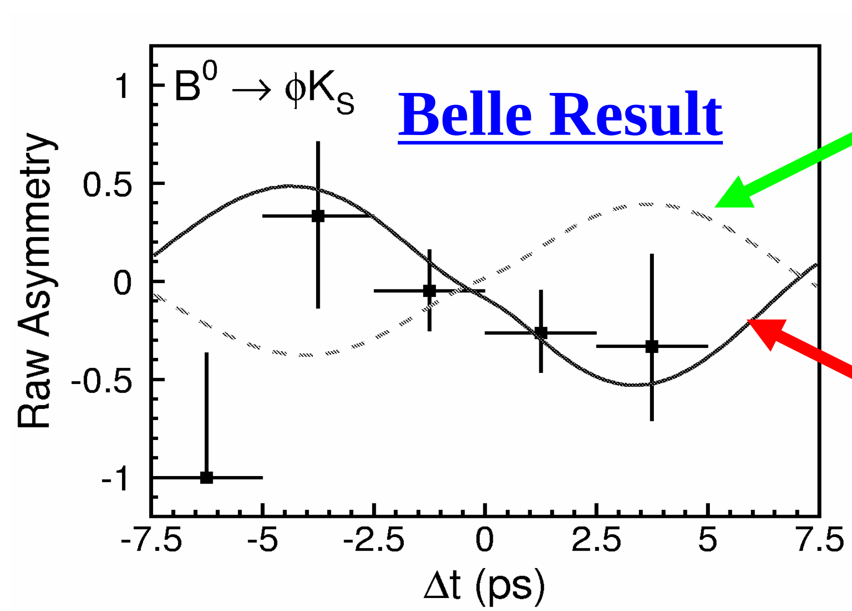
$B_d^0 \rightarrow \phi + Ks$ **Measurement** ϕ_1 **by B0 Mixing**



Theoretical uncertain is

Small in Standard Model

Clean Mode for New Physics



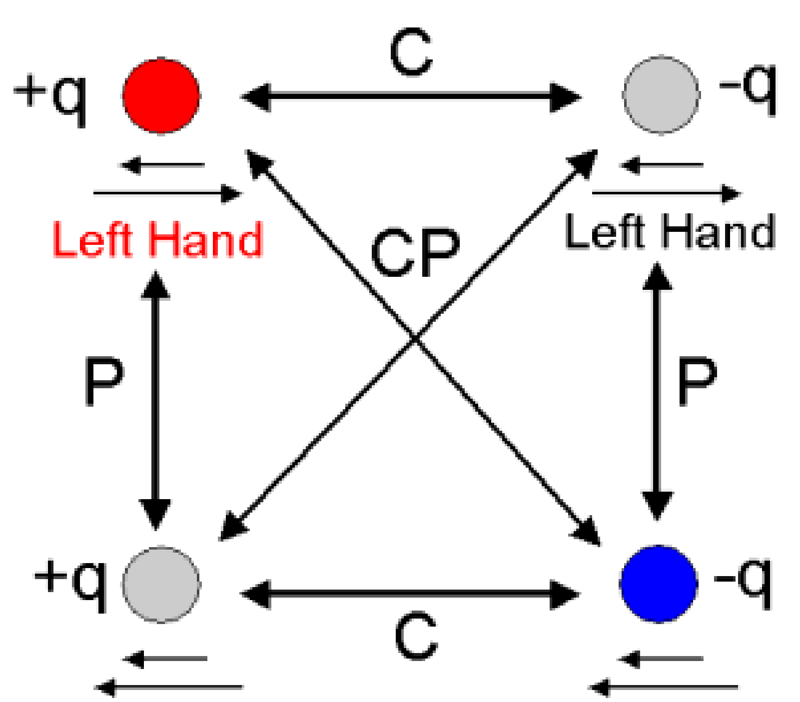
$\sin 2\phi_1$ (Belle 2003,140 fb^{-1})
$=0.733 \pm 0.057 \pm 0.028$

$\sin 2\phi_{1eff} = -0.96 \pm 0.50^{+0.09}_{-0.11}$

Introduction to CP-Violation(1)

Dynamics of Physics = Lagrangian

$$L_{physics} = L + L_{h \cdot c}$$



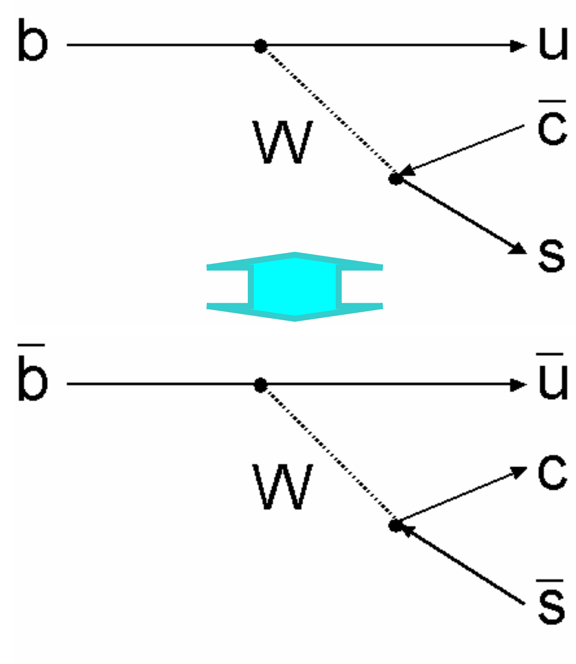
In Weak Interaction

Particle ↔ Anti-Patrticle

||

CP transformation

Introduction to CP-Violation(2)



$$L = -\frac{g_w}{\sqrt{2}} U^*_{ub} \overline{\psi}_u \gamma^\mu (1-\gamma^5) \psi_b W^-_\mu$$

Hermite $$L_{H.C} = -\frac{g_w}{\sqrt{2}} U_{ub} \overline{\psi}_b \gamma^\mu (1-\gamma^5) \psi_u W^+_\mu$$

CP $$L_{CP} = -\frac{g_w}{\sqrt{2}} U^*_{ub} \overline{\psi}_b \gamma^\mu (1-\gamma^5) \psi_u W^+_\mu$$

CP Conservation & CP Violation

(i) $U^*_{ub} = U_{ub}$ → $L_{H.C} = L_{cp} = L$

→ **Particle = Antiparticle** → **CP Conservation**

(ii) $U^*_{ub} \neq U_{ub}$ → $L_{H.C} \neq L_{cp} \neq L$

→ **Particle ≠ Antiparticle** → **CP Violation**

Introduction to CP-Violation(3)

Requirement for CP-Violation Observation

1) **More than Two Decay Process**
2) **Current has complex phase (CKM matrix)**

B^0 decay to CP eigenstate

$$B^0 \rightarrow f_{cp}$$

Mixing $B^0 \rightarrow \overline{B}^0 \rightarrow f_{cp}$

$$CP: f_{cp} = \bar{f}_{cp}$$

$$\Gamma\left(B^0 \rightarrow f_{cp}\right) \propto \left|M\left(B^0 \rightarrow f_{cp}\right) + M\left(\overline{B}^0 \rightarrow B^0 \rightarrow f_{cp}\right)\right|^2$$

Interference !!

If complex phase is included in Amplitude, it will appear in interference term.

Introduction to CP-Violation(4)

Time Dependent CP Violation in B-B Mixing

Time dependent

B Wave function

$$\left|B^0(t)\right\rangle = e^{-i(M+\Gamma/2)t}\left\{\cos\left(\frac{\Delta m t}{2}\right)\left|B^0\right\rangle + i\frac{q}{p}\sin\left(\frac{\Delta m t}{2}\right)\left|\overline{B}^0\right\rangle\right\}$$

$$\left|\overline{B}^0(t)\right\rangle = e^{-i(M+\Gamma/2)t}\left\{\cos\left(\frac{\Delta m t}{2}\right)\left|\overline{B}^0\right\rangle + i\frac{p}{q}\sin\left(\frac{\Delta m t}{2}\right)\left|B^0\right\rangle\right\}$$

Time Dependence & CP-Asymmetry

$$\Gamma\left(B^0 \to f_{cp}\right) \propto e^{-\Gamma t}\left[1+|\lambda|^2 \mp \left(|\lambda|^2-1\right)\cos(\Delta m t) + 2\,\mathrm{Im}(\lambda)\sin(\Delta m t)\right]$$

$$A cp = \frac{\Gamma\left(B^0 \to f_{cp}\right) - \Gamma\left(\overline{B}^0 \to f_{cp}\right)}{\Gamma\left(B^0 \to f_{cp}\right) + \Gamma\left(\overline{B}^0 \to f_{cp}\right)} = -\frac{|\lambda|^2-1}{|\lambda|^2+1}\cdot\cos(\Delta m t) - \frac{2\,\mathrm{Im}(\lambda)}{|\lambda|^2+1}\sin(\Delta m t)$$

$$\lambda = \frac{q}{p}\cdot\frac{\overline{A}(\overline{B}^0 \to f_{cp})}{A(B^0 \to f_{cp})} \qquad \left\langle f_{cp}\left|T\right|B^0\right\rangle \equiv A$$

Introduction to CP-Violation(5)

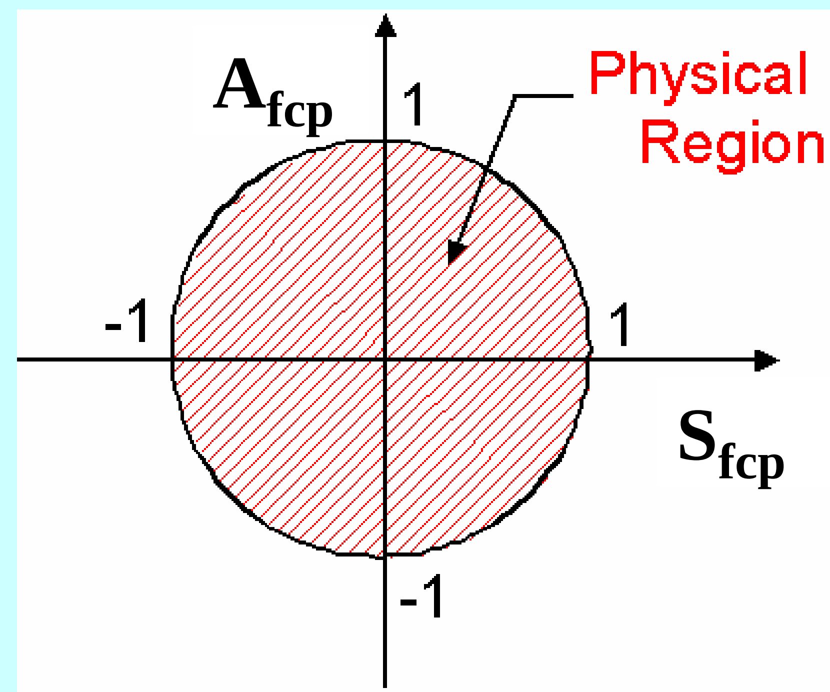
Physical Region

$$A_{CP} = -A_{f_{cp}} \cos(\Delta m t) - S_{f_{cp}} \sin(\Delta m t)$$

$$\frac{|\lambda|^2 - 1}{|\lambda|^2 + 1} = A_{f_{cp}} \qquad \frac{2\,\mathrm{Im}(\lambda)}{|\lambda|^2 + 1} = S_{f_{cp}}$$

$$A_{f_{cp}}^2 + S_{f_{cp}}^2 + \left(\frac{2\,\mathrm{Re}(\lambda)}{|\lambda|^2 + 1}\right)^2 = 1$$

$$\Leftrightarrow A_{f_{cp}}^2 + S_{f_{cp}}^2 \le 1$$



Event Selection

Ks, π^0 Selection Criteria

π^0 $E_\gamma > 50MeV$ (No match with Charged track)

$0.118 < M_{\gamma\gamma} < 0.150 (GeV/c^2)$

Ks $| M_{\pi\pi} - 497.672 (MeV/c^2) | < 15 MeV/c^2$

Fang-san's Cut

Other Cut

- IF Both π tracks have SVD_zhit > 0 → dz<2.0cm
- IF One of π track has SVD_zhit(1)>0 → dr>0.1mm
- IF Both π track have no SVD_zhit → dΦ<2.0cm

↓

B^0 Reconstruction

Background Rejection by Super Fox-Wolfram

Super Fox-Wolfram (moment)

$$H_l^{so} = \sum_{i,j} |p_i||p_j| P_l(\cos\theta_{ij})$$

$$H_l^{oo} = \sum_{j,k} |p_j||p_k| P_l(\cos\theta_{jk})$$

P_i : B-Candidate Particle

P_j P_k : Other Particle (charge&neutral

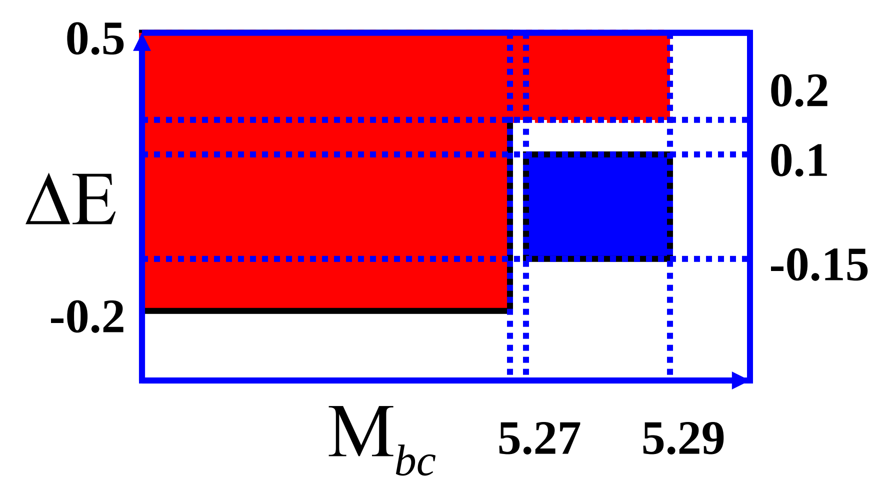
$P_l^{m=0}(\cos\theta_{ij})$:)Legendre Function

Fisher discriminant

$$F = \sum_{l=2,4} \alpha_i \cdot \frac{H_l^{so}}{H_o^{so}} + \sum_{l=1-4} \beta_i \cdot \frac{H_l^{oo}}{H_o^{oo}}$$

α, β are optimized with

Signal MC & Sideband Data



Background Rejection by New Super Fox-Wolfram

I used N-SFW in this Analysis

$$NSFW = \sum_{l=0,4} R_l^{so} + \sum_{l=0,4} R_l^{oo} + \gamma \sum_{n=1} \left| (P_t)_n \right|$$

$$R_l^{so} = \frac{(\alpha_c)\cdot(H'_{charged})_l^{so} + (\alpha_n)_l \cdot (H'_{neutral})_l^{so} + (\alpha_m)_l \cdot (H'_{missing})_l^{so}}{E_{beam} - \Delta E}$$

Missing Mass $$mm^2 = \left(E_{\Upsilon(4s)} - \sum_{n=1} E_n \right)^2 - \left(\left| \sum_{n=1} P_n \right| \right)^2$$

$(H'_X)_{l=1,3}^{so}$

$$(H'_{charged})_l^{so} = \sum_i \sum_{j_X} \beta_l^{so} Q_i Q_{j_X} \left| p_{j_X} \right| P_l(\cos\theta_{ij_X})$$

$$(H'_{neutral})_l^{so} = (H'_{missing})_l^{so} = 0$$

$(H'_X)_{l=0,2,4}^{so}$

$$(H'_X)_l^{so} = \sum_i \sum_{j_X} \beta_l^{so} \left| p_{j_X} \right| P_l(\cos\theta_{ij_X})$$

$$NSFW = \sum_{l=0,4} R_l^{so} + \sum_{l=0,4} R_l^{oo} + \gamma \sum_{n=1} \left| (P_t)_n \right|$$

N-SFW(2)

$R^{oo}_{l=1,3}$

$$R_l^{oo} = \frac{\sum_j \sum_k \beta_l^{oo} Q_j Q_k |p_j| |p_k| P_l(\cos\theta_{jk})}{(E_{beam} - \Delta E)^2}$$

$R^{oo}_{l=0,2,4}$

$$R_l^{oo} = \frac{\sum_j \sum_k \beta_l^{oo} |p_j| |p_k| P_l(\cos\theta_{jk})}{(E_{beam} - \Delta E)^2}$$

$\sum_{n=1} \left| (P_t)_n \right|$ **: Scalar sum of the transverse momentum**

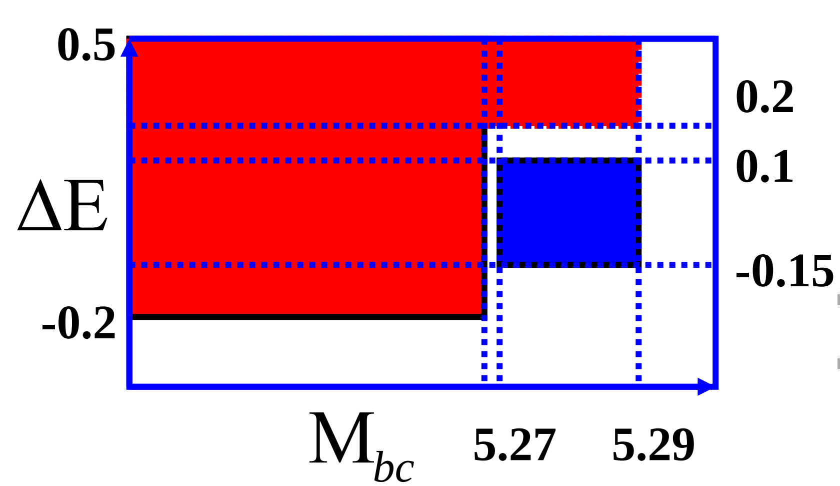
Divide mm^2 region into 7 region for correlation between SFW and mm^2 → **Total Parameter = (11+5+1) × 7**

N-SFW(3)

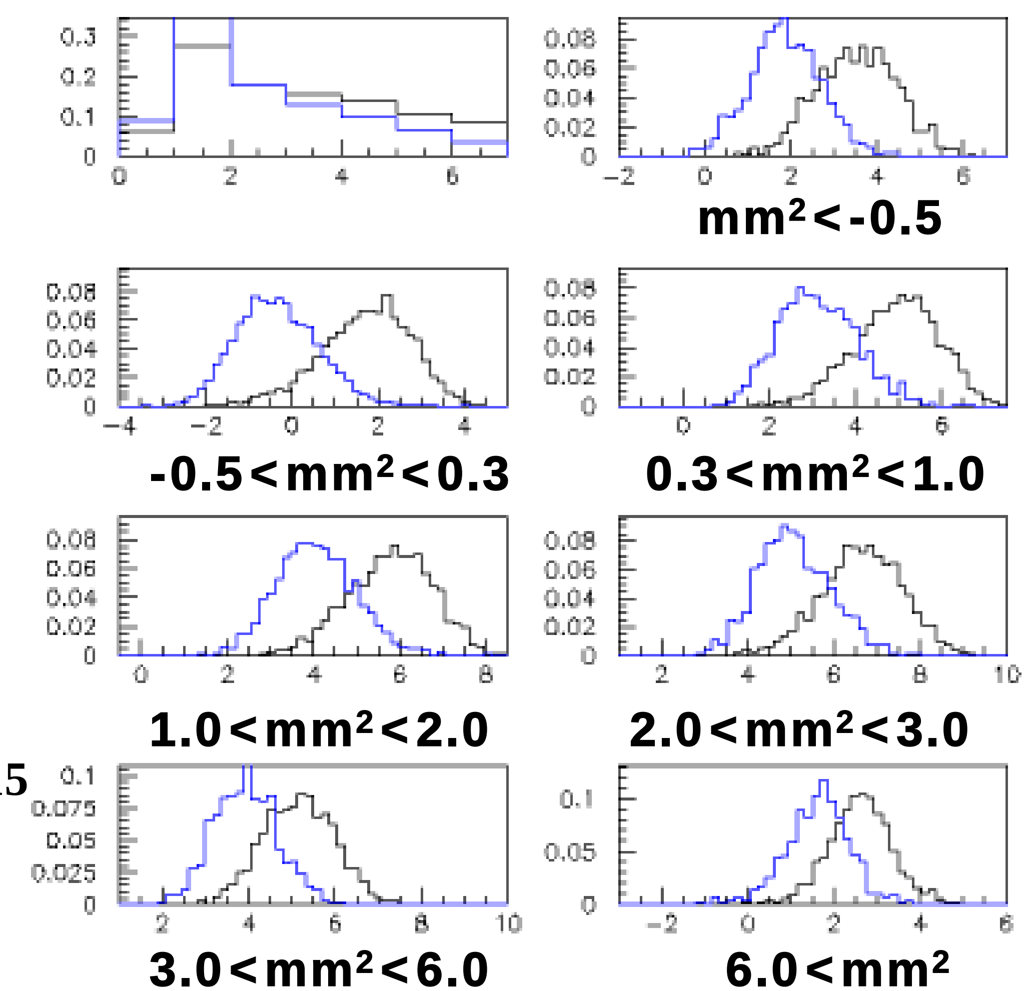
Optimized N-SFW

7 Missing Mass Regions

Parameters are optimized with Signal MC & Sideband Data



K-SFW (7 Missing Mass region) Unit = GeV/c^2



Black …Signal Blue…Background

Background Rejection

Likelihood Ratio Cut

Likelihood

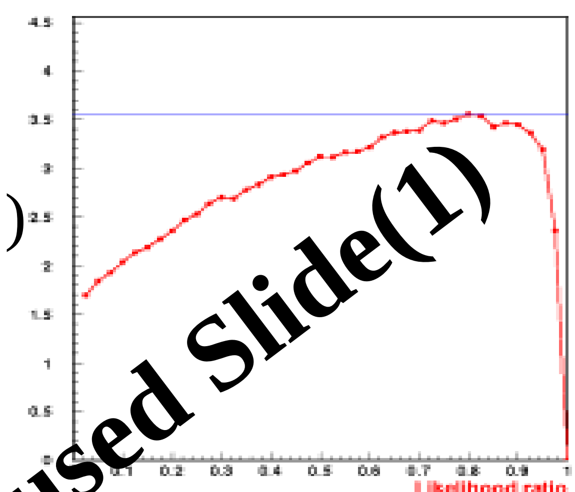
$$L_{BB,qq} = L(SFW) \times L(\cos\theta_B)$$

Likelihood Ratio

$$LR = \frac{L_{BB}}{L_{BB} + L_{qq}}$$

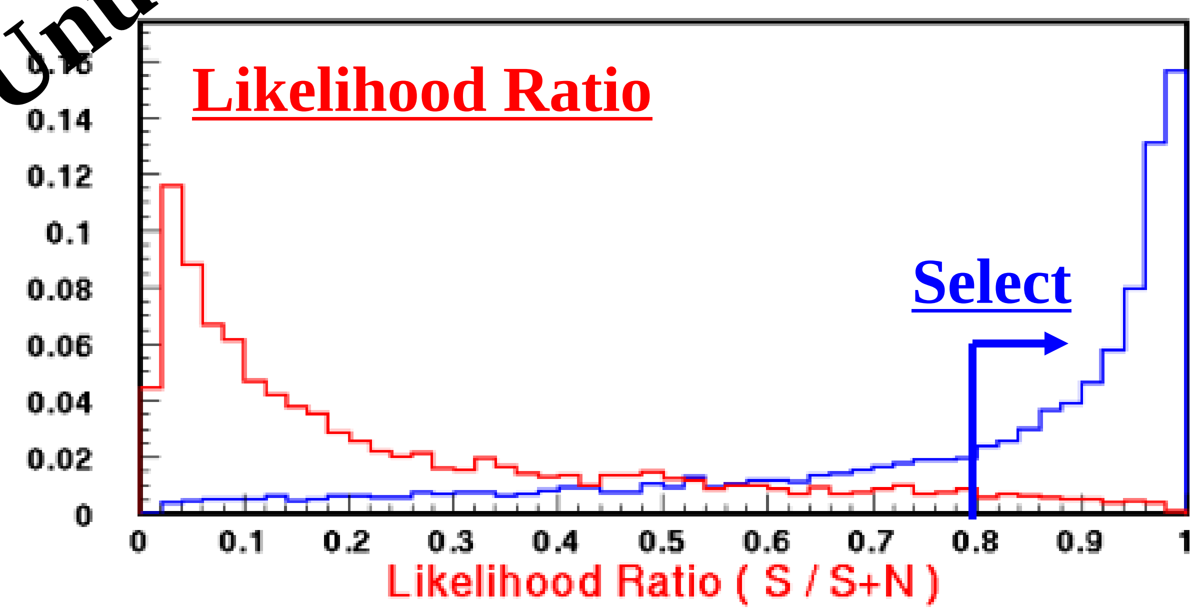
Cut by
LR > 0.80

Threshold was defined by **Figure of Merits**



$$F.o.M = \frac{N_{sig}}{\sqrt{N_{sig} + N_{qq}}}$$

LR at Max of F.o.M



Background Rejection

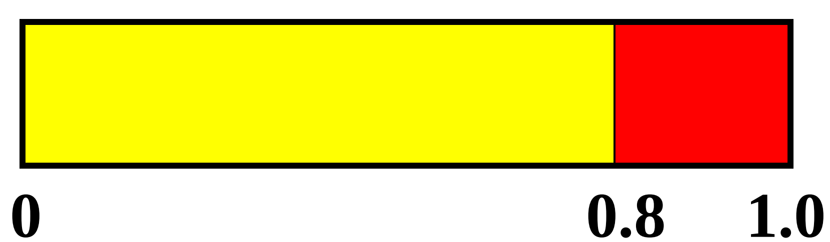
Second Likelihood Ratio Cut

We want to use more events

Even if LR<0.80

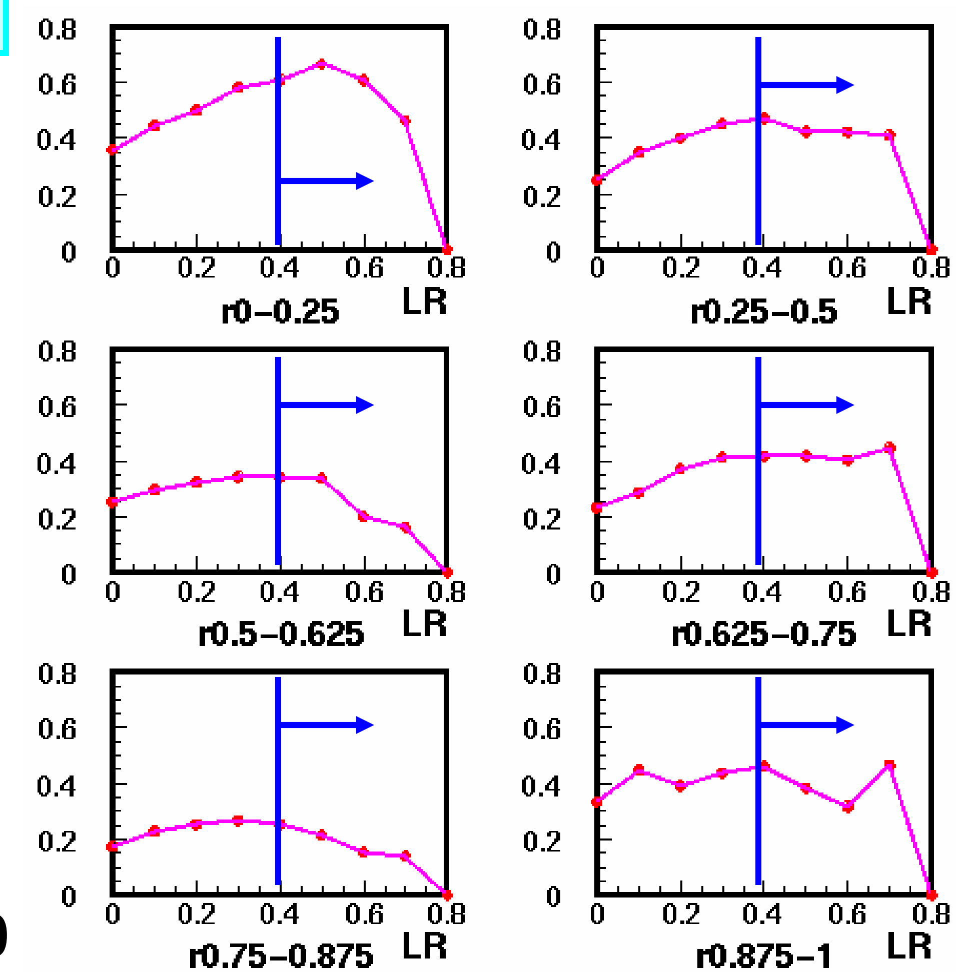
Likelihood Ratio Cut in

0< LR<0.80



Likelihood Ratio region

6 r-regions (r = Wrong tag fraction)



Loose Cut : $0.4 < LR \leq 0.8$

Fitting Function(Signal Shape)

Signal Shape is obtained from Signal MC

Signal Mbc : Single Gaussian

$$P(\mathrm{M}_{bc}) = N_{norm} \cdot \frac{1}{\sqrt{2\pi}\sigma_{Mbc}} \exp\left(- \frac{\left(\langle \mu_{Mbc} \rangle - \mathrm{M}_{bc} \right)^2}{2\sigma_{Mbc}^2} \right)$$

μ_{Mbc}	**5.2792(GeV/c^2)**
σ_{Mbc}	**34.1(MeV/c^2)**

Signal ΔE : Single Gaussian

$$P(\Delta \mathrm{E}) = \begin{cases} \Delta \mathrm{E} - \mu_{\Delta \mathrm{E}} \le -a\sigma_{\Delta \mathrm{E}} : N_{norm} \cdot \exp\left(-\frac{1}{2a} \right) \cdot \left[1 - \frac{a}{n} \left(\frac{\Delta \mathrm{E} - \mu_{\Delta \mathrm{E}}}{\sigma_{\Delta \mathrm{E}}} - a \right) \right] \\ \Delta \mathrm{E} - \mu_{\Delta \mathrm{E}} \le -a\sigma_{\Delta \mathrm{E}} : N_{norm} \cdot \exp\left(- \frac{\Delta \mathrm{E} - \mu_{\Delta \mathrm{E}}}{2\sigma_{\Delta \mathrm{E}}^2} \right) \end{cases}$$

$\mu_{\Delta \mathrm{E}}$	**-9.3(MeV/c^2)**
$\sigma_{\Delta \mathrm{E}}$	**39.0(MeV/c^2)**

a	**0.6518**
n	**11.934**

Fitting Function(Background Shape)

Background Shape is obtained from Sideband data

Background Mbc : ARGUS function

$$P(\mathrm{M}_{bc}) = \mathrm{M}_{bc} \cdot \exp\left(\alpha - \alpha\left(\frac{\mathrm{M}_{bc}}{\mathrm{E}_{beam}}\right)^2\right) \cdot \sqrt{1 - \left(\frac{\mathrm{M}_{bc}}{\mathrm{E}_{beam}}\right)^2}$$

α	**-22.63**

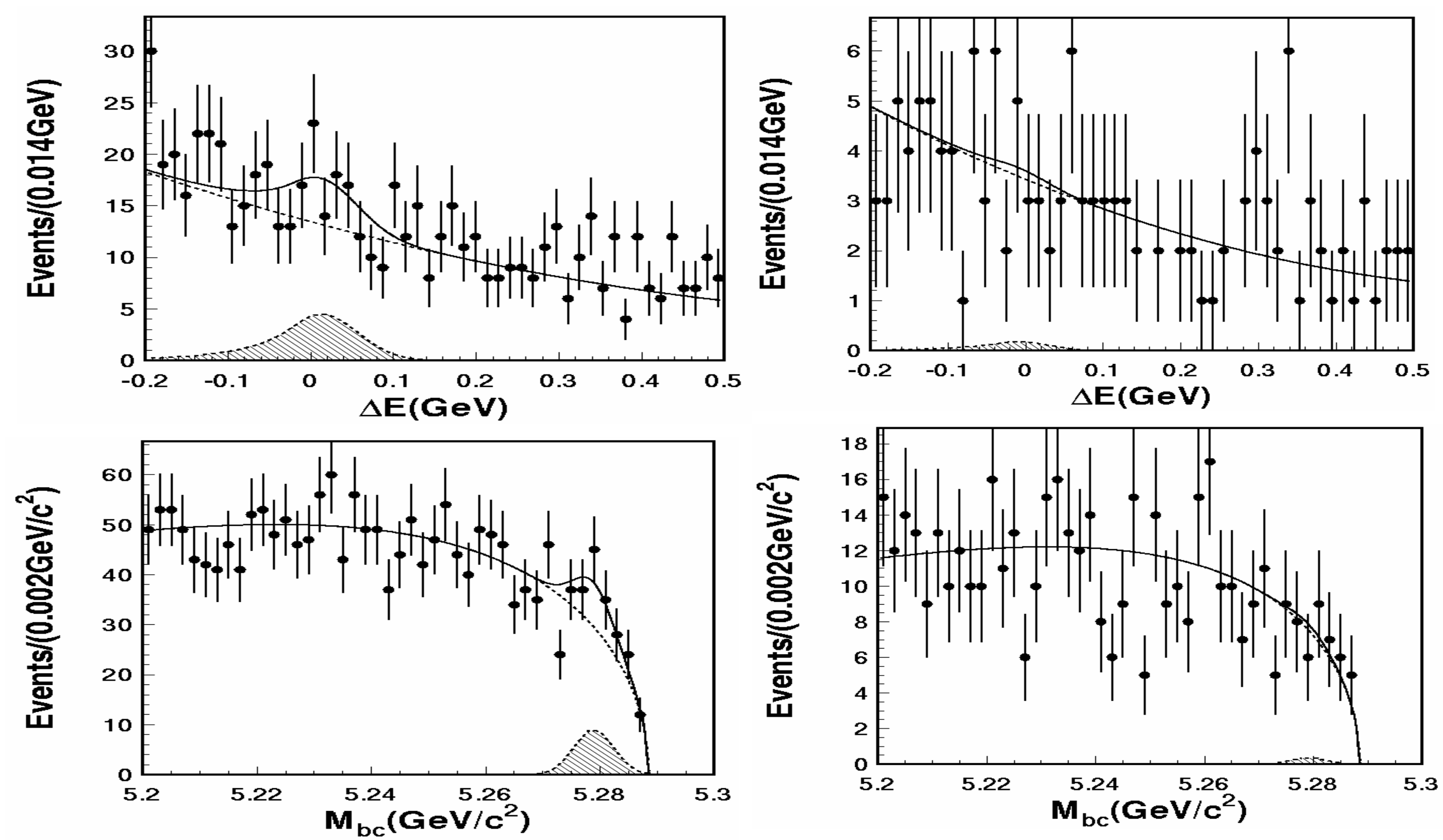
Background ΔE : Chebyshev Function

$$P(\Delta\mathrm{E}) = N_{norm} \cdot \left(1 + a_1 \cdot C + a_2 \cdot \left(2 \cdot C^2 - 1\right)\right)$$

$$C = \frac{2.0 \cdot \Delta\mathrm{E} - \Delta\mathrm{E}_{\min} - \Delta\mathrm{E}_{\max}}{\Delta\mathrm{E}_{\max} - \Delta\mathrm{E}_{\min}}$$

Emax	**0.5 (GeV/c^2)**
Emin	**-0.2 (GeV/c^2)**
a_1	**-0.7961**
a_2	**0.1421**

Fitting Result before(L) & after(R) Vertexing



0.4<LR≤0.80
Signal Yield =38.9±13.0

0.4<LR≤0.80
Signal Yield =1.4±5.5

Reconstruction Efficinecy by MC

Used Signal MC(200,000events)

Genhep Infomarion

Ks efficiency	125510	62.77(%)
π^0 efficiency	97749	48.89(%)
B0 efficiency	74719	37.37(%)

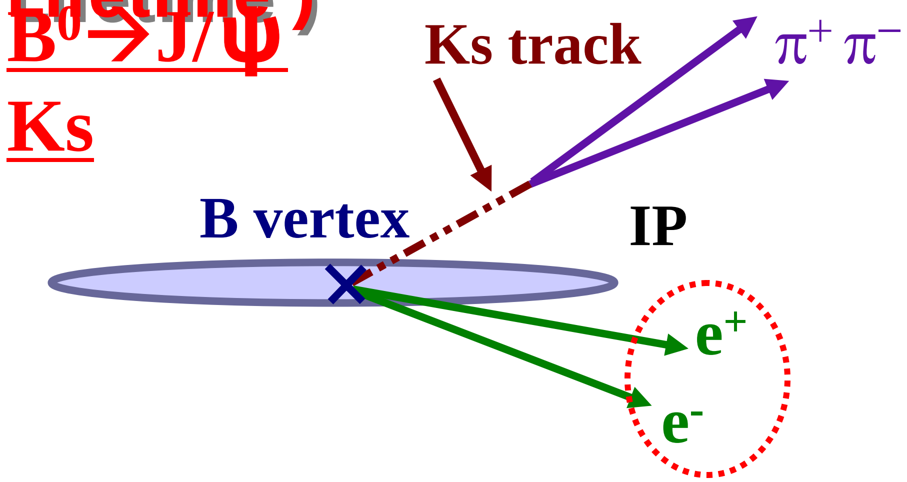
Reconstruction efficiency (Before & after Vertexing)

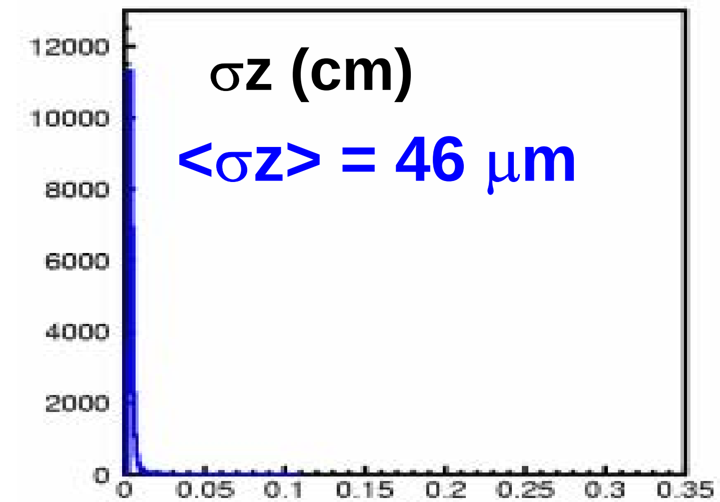
	Before Vertexing	After Vertexing
Reconstructed B^0 all Mbc& ΔE region	71184 True : 70276 = 35.14(%)	
Reconstructed B^0 before LR cut	61795 True : 61187= 30.60(%)	15346 True : 15226 = 7.61(%)
Reconstructed B^0 after LR cut	37922 True : 37611= 18.81(%)	9528 True : 9470 = 4.74(%)

B⁰-Vertexing by Ks

B^0-J/ψ Vertexing process (J/ψ→e+e- Short Lifetime)

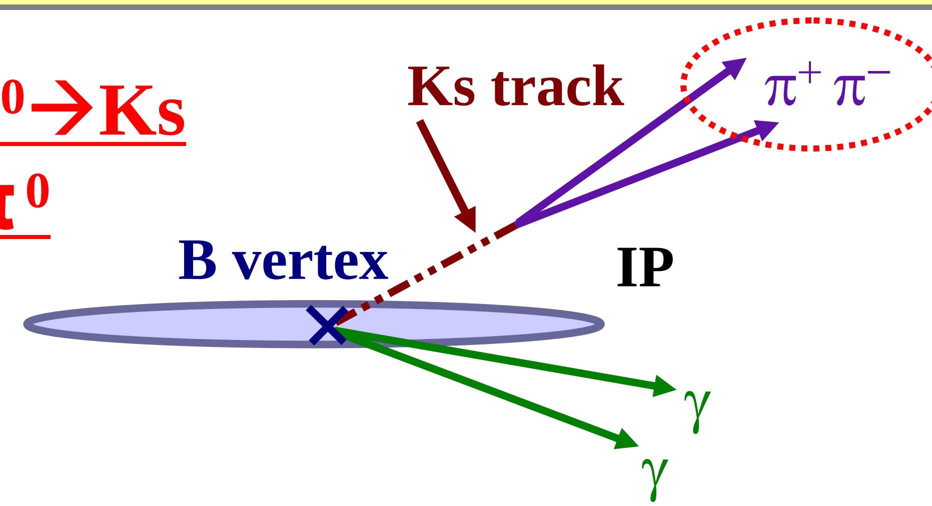
B^0→J/ψ Ks

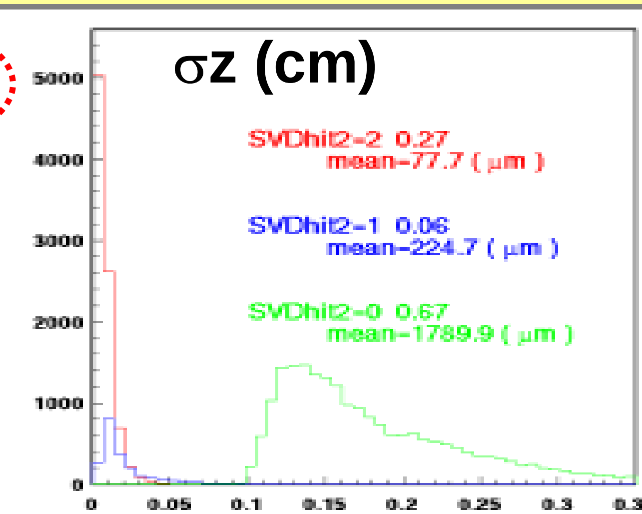




B^0-Ks Vertexing process (Ks → $\pi^+\pi^-$ Long Lifetime)

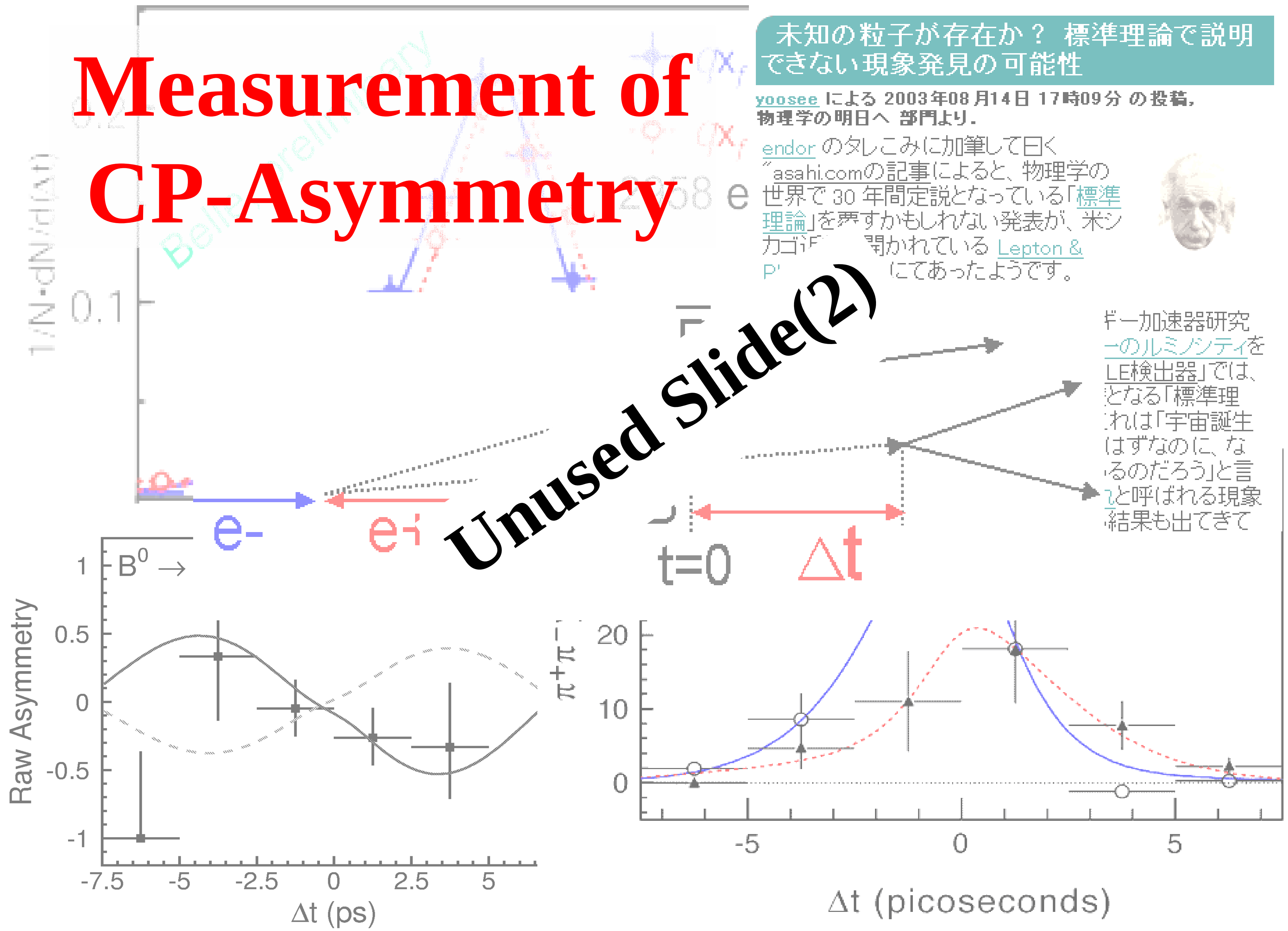
B^0→Ks π^0





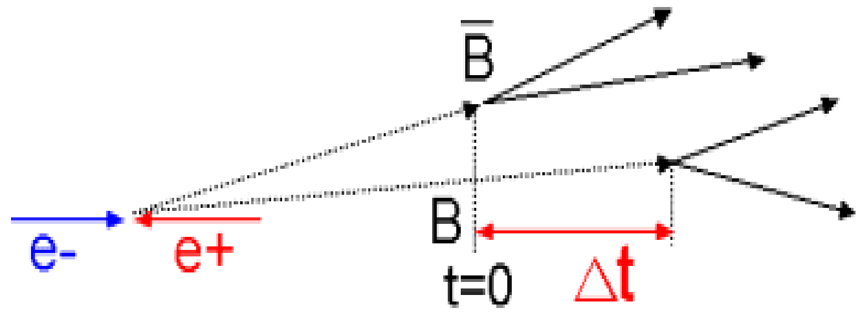
Measurement of CP-Asymmetry

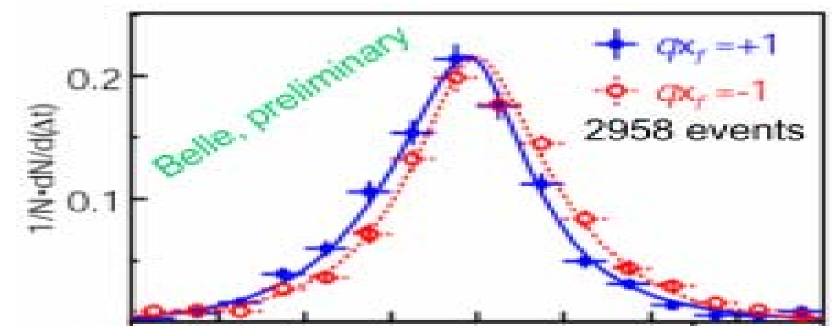
Unused Slide(2)



CP-Fit

Fitting 'Δt' distribution & Asymmetry which free parameter are A_{fcp} & S_{fcp}





J/Ψ mode presented at ICHEP2002

$$P_{q(=\pm1)}(\Delta t) = \frac{1}{4\tau_{B^0}} e^{-\frac{|\Delta t|}{\tau_{B^0}}} \left\{1 + q\cdot\left(A_{f_{cp}} \cos(\Delta m \Delta t) + S_{f_{cp}} \sin(\Delta m \Delta t)\right)\right\}$$

$$\mathrm{A}cp(\Delta t) = \frac{P_{q=-1}(\Delta t) - P_{q=1}(\Delta t)}{P_{q=-1}(\Delta t) + P_{q=1}(\Delta t)}$$

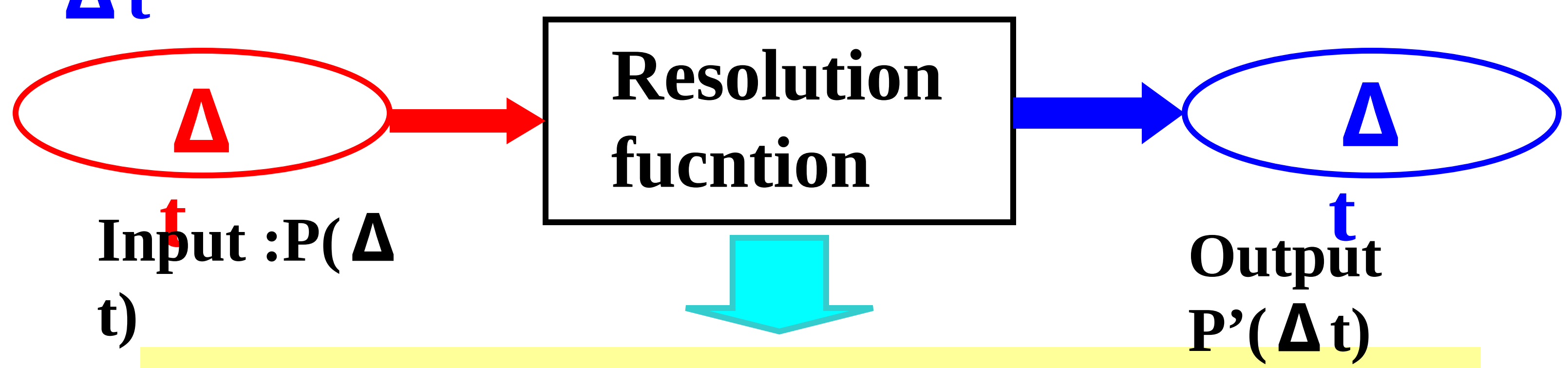
$$\mathrm{A}_{CP}(\Delta t) = -A_{f_{cp}} \cos(\Delta m \Delta t) - S_{f_{cp}} \sin(\Delta m \Delta t)$$

Free Parameters

CP-fit : Resolution Function(1)

Most important work is define a Resolution Function of ‘Δt’

Resolution Function = Response Function of Δt



$$P'(\Delta t) = \int_{-\infty}^{\infty} P(\Delta t') R(\Delta t - \Delta t') d\Delta t'$$

$R(\Delta t - \Delta t')$ **Resolution Function**

CP-fit : Resolution Function(2)

P(Δt) include Resolution Function

Signal Probability Density Function

$$P_{sig}^{q(=\pm1)}(\Delta t) = \frac{1}{4\tau_{B^0}} e^{-\frac{|\Delta t|}{\tau_{B^0}}} \left\{1 + q \cdot (1-2w) \cdot \left(A_{f_{cp}} \cos(\Delta m \Delta t) + S_{f_{cp}} \sin(\Delta m \Delta t)\right)\right\}$$

Background (qq) Probability Density Function

$$P_{q\bar{q}}(\Delta t) = \frac{1 + q\delta_{bg}}{2} \left\{ \frac{f_\tau}{2\tau_{bg}} e^{-\frac{|\Delta t|}{\tau_{bg}}} + (1 - f_\tau)\delta(\Delta t) \right\}$$

Proper time difference include resolution function

$$P(\Delta t) = (1 - f_{ol}) \int_{-\infty}^{+\infty} \left\{ f_{sig} P_{sig}(\Delta t') R_{sig}(\Delta t - \Delta t') + f_{q\bar{q}} P_{q\bar{q}}(\Delta t') R_{q\bar{q}}(\Delta t - \Delta t') \right\} d\Delta t' + f_{ol} P_{ol}(\Delta t)$$

CP-fit : Resolution Function(3)

Component of Resolution Function

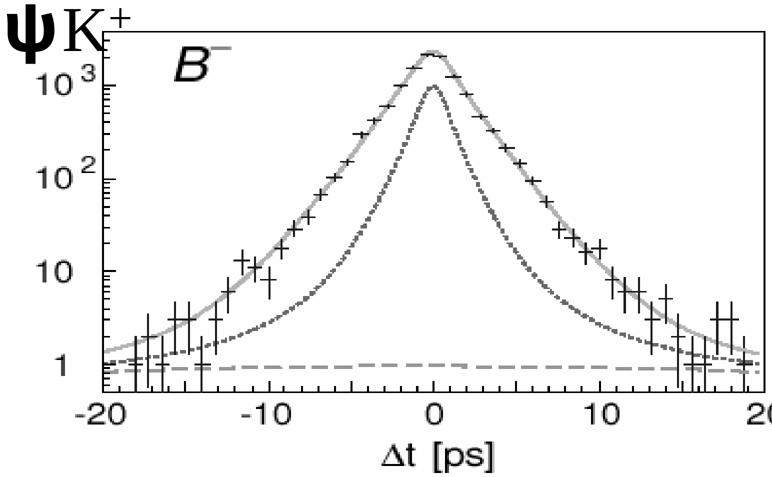
(1) Detector Resolution

(2) Secondary Particle effect

(3) Kinematic Approximation

In Belle, Resolution Function Parameters are defined by B^0 Lifetime Fitting by Unbinned Maximum likelihood fit used Control Sample.

D π , D* π, D* ρ ,D^0 π,J/ψKs, J/$\psi$$K^+$



$$\tau_{B^0} = ????\pm ????\pm ????$$