Bファクトリーの成果とSuper-B

Jan.19, 2005　＠京都大学

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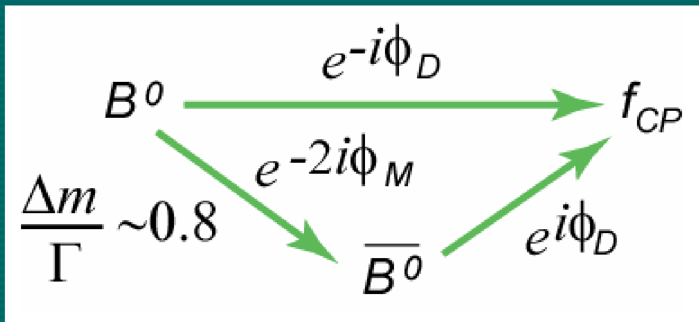
KEK

CP violation in $B^0\overline{B^0}$ system



$$A_{CP}(t) \equiv \frac{\Gamma(\overline{B^0} \to f_{CP};t) - \Gamma(B^0 \to f_{CP};t)}{\Gamma(\overline{B^0} \to f_{CP};t) + \Gamma(B^0 \to f_{CP};t)}$$
$$= A_f \cos(\Delta m t) - \xi_{CP} S_f \sin(\Delta m t)$$

$$A_f = \frac{|\lambda_f|^2 - 1}{|\lambda_f|^2 + 1}$$

$$S_f = -\xi_f \frac{2Im(\lambda_f)}{|\lambda_f|^2 + 1}$$

$$\lambda_f \equiv e^{-2i\phi_M} \frac{A(\overline{B} \to \overline{f})}{A(B \to f)}$$

Standard model predictions

	$b \to c\bar{c}s$	$b \to c\bar{c}d$	$b \to s\bar{s}s$	$b \to u\bar{u}d$
example	$J/\psi Ks$	$J/\psi \pi^0$	ϕKs	$\pi^+\pi^-$
A_f	0	0	small	$\neq 0$
S_f	$\sin 2\phi_1$	$\sin 2\phi_1$	$\sin 2\phi_1$	"$\sin 2\phi_2$"

Note: $A_f \neq 0$ ⇨ $\Gamma(B \to f) \neq \Gamma(\overline{B} \to \overline{f})$ ⇨ direct CP violation.

The ϕ_i's and CKM matrix

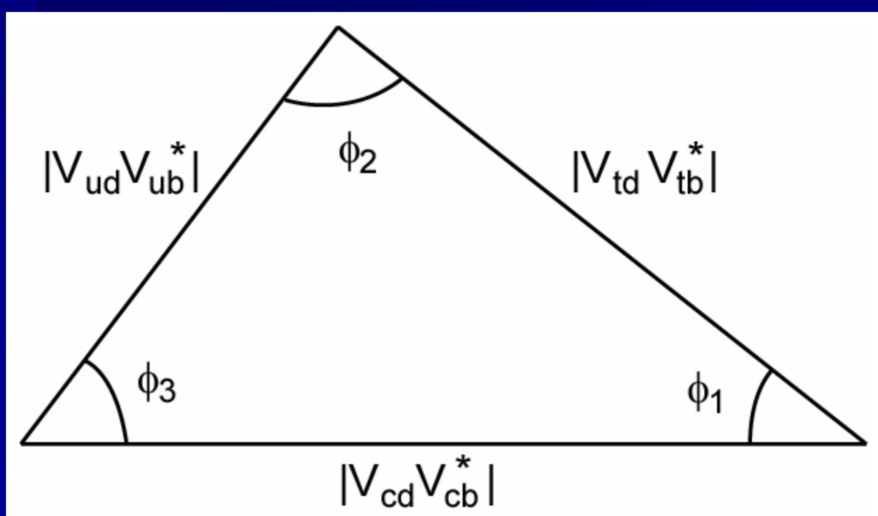
CKM quark mixing matrix

$$\begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix}$$

Unitarity

$$V_{ud}V_{ub}^{*} + V_{cd}V_{cb}^{*} + V_{td}V_{tb}^{*} = 0$$

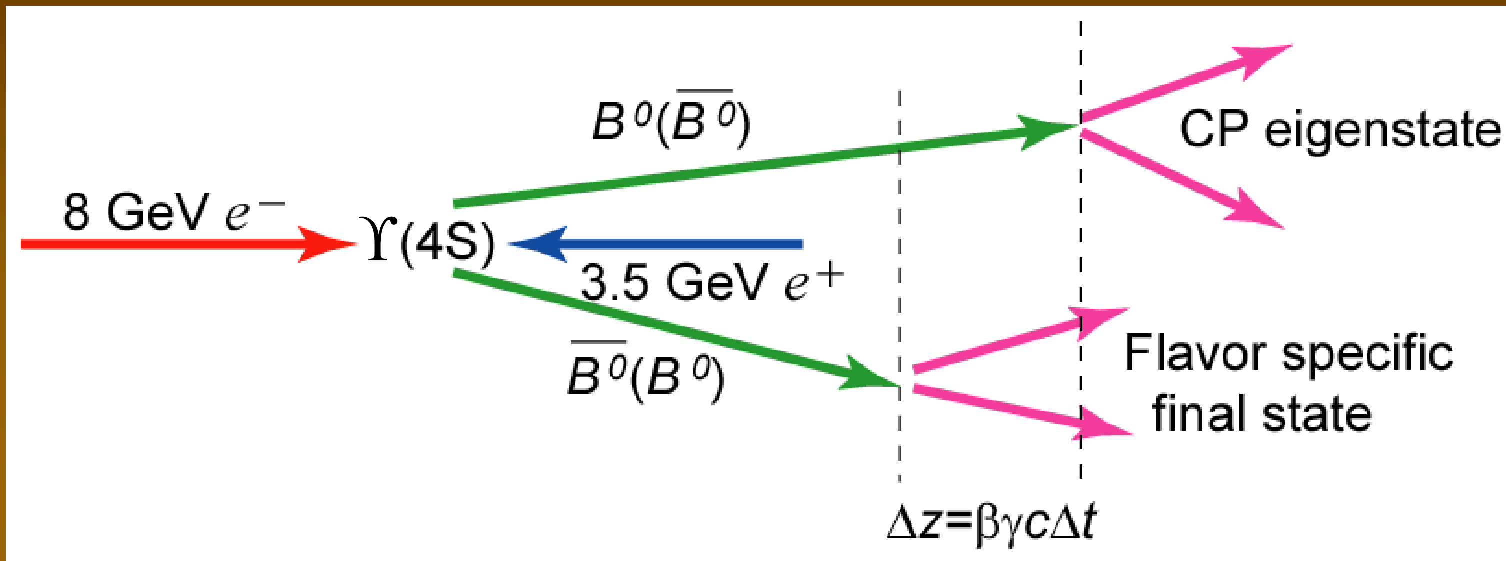
Unitarity triangle



$$\phi_1 \equiv \pi - \arg\left(\frac{-V_{tb}^{*}V_{td}}{-V_{cb}^{*}V_{cd}}\right)$$

$$\phi_2 \equiv \arg\left(\frac{V_{tb}^{*}V_{td}}{-V_{ub}^{*}V_{ud}}\right)$$

Principle of the measurement



$\Gamma(B\to f_{CP};t)$ can be measured.

Large data sample

→ Reconstruct *B* decays into CP eigenstates

→ Tag flavor of the other *B*

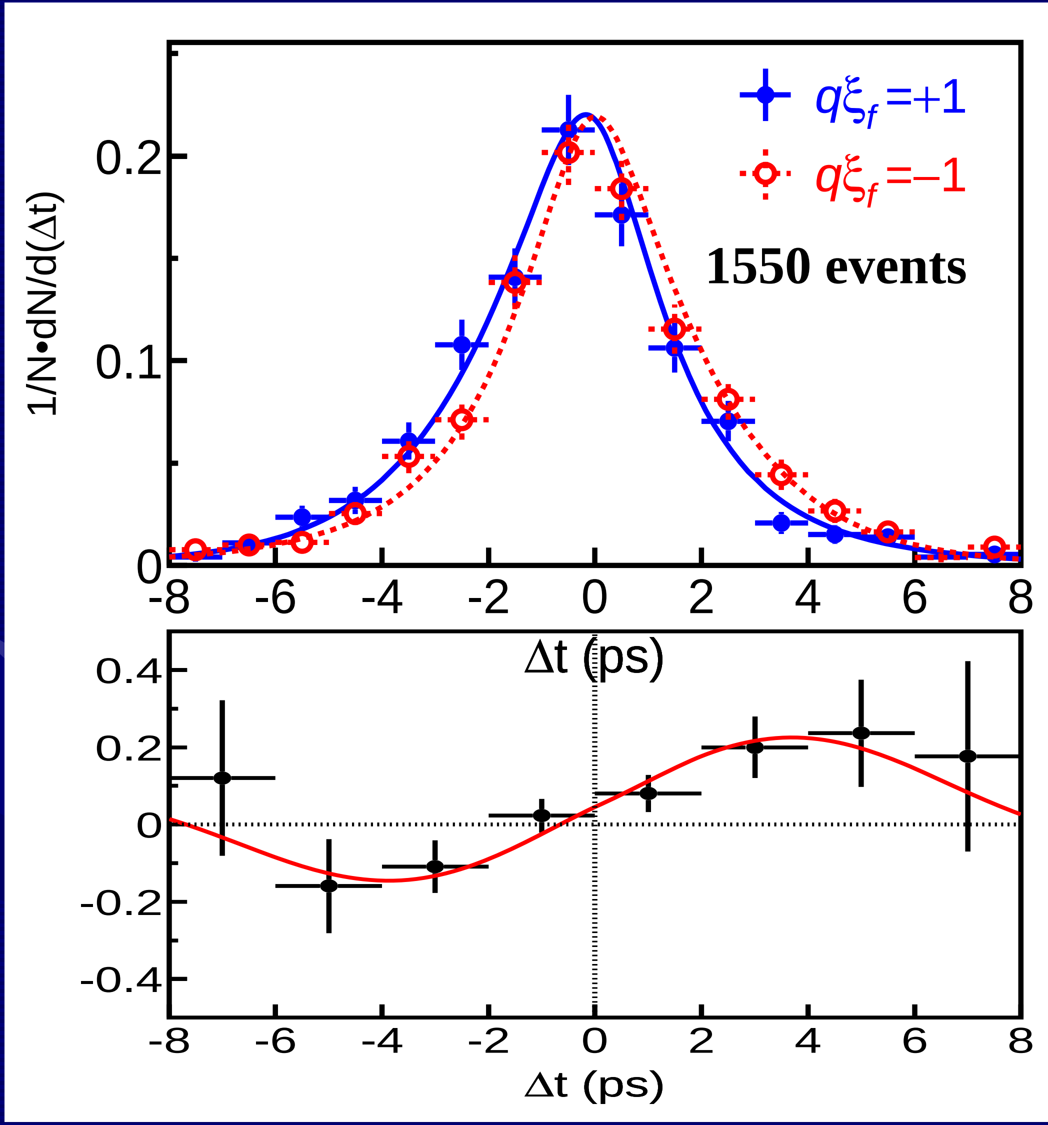
→ Measure distance between the two vertices

→ Fit Δt distr. with expected shape

→ A_f and S_f

Old result of $\sin 2\phi_1$

(Belle, Feb. 2002, hep-ex/0205020)

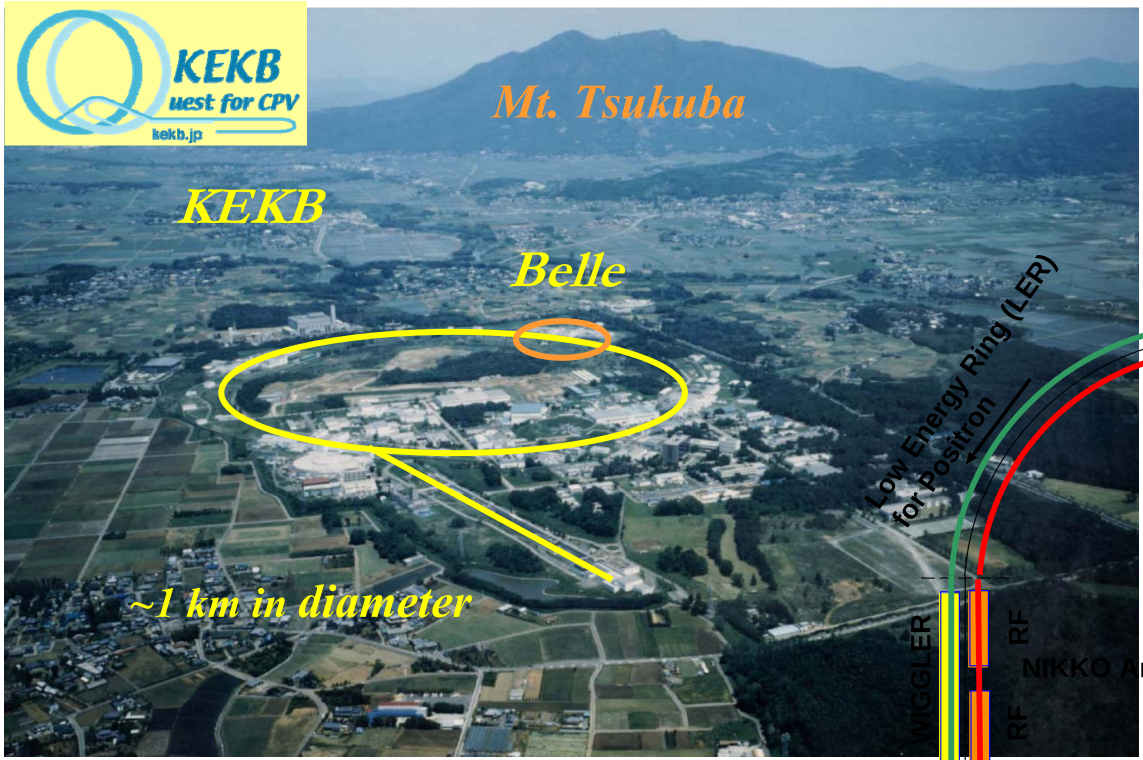


- 41.8 fb^{-1}
- 6 $b \to c\bar{c}s$ decay modes ($B \to J/\psi K_S$, $J/\psi K_L$ etc.)
- $S_{ccs} = \sin 2\phi_1$

  $= \underline{0.82 \pm 0.12 \pm 0.05}$
- $|\lambda_{ccs}| = 1.01\ ^{+0.08}_{-0.07}$ (stat.)

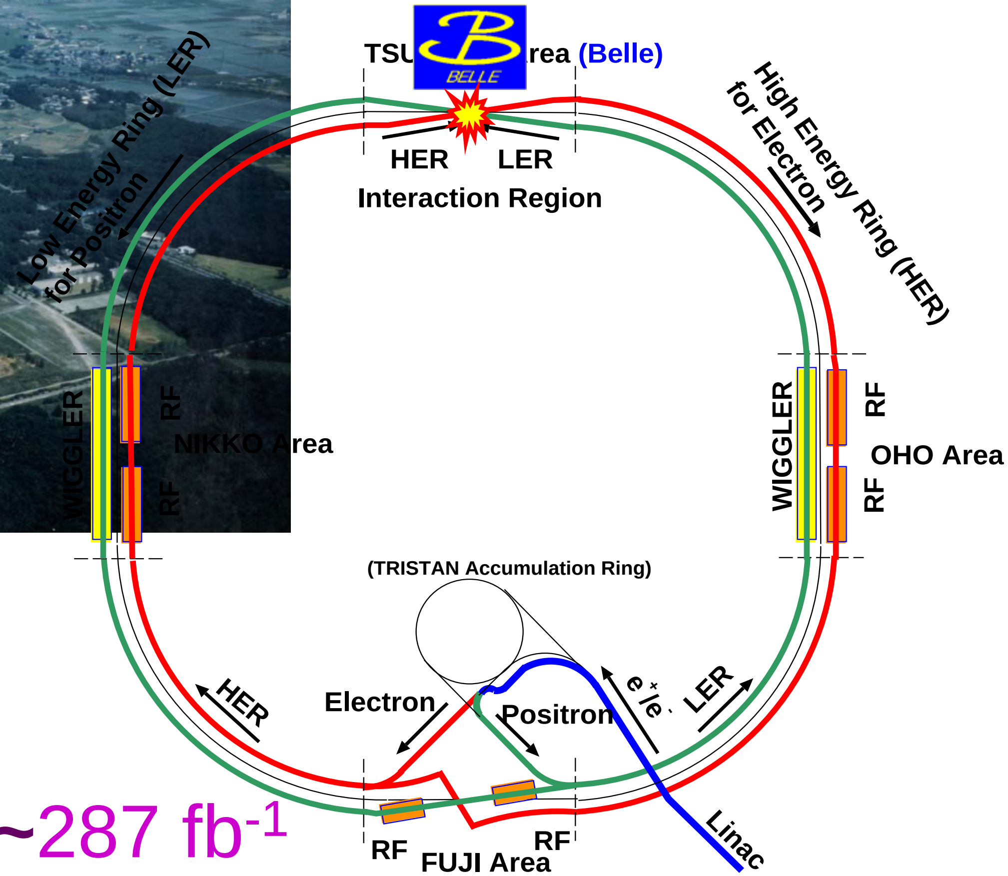
  i.e., A_{ccs} is consistent with 0.

KEKB Collider



8 GeV e⁻ x 3.5 GeV e⁺

±11mrad crossing



$L_{peak} = 1.39 \times 10^{34}\ sec^{-1}cm^{-2}$

@ 1.2A x 1.6A

$253\ fb^{-1}$ on Υ(4S) 275M $B\bar{B}$

$28\ fb^{-1}$ below Υ(4S)

$\sim 287\ fb^{-1}$

Continuous Injection

No need to stop run

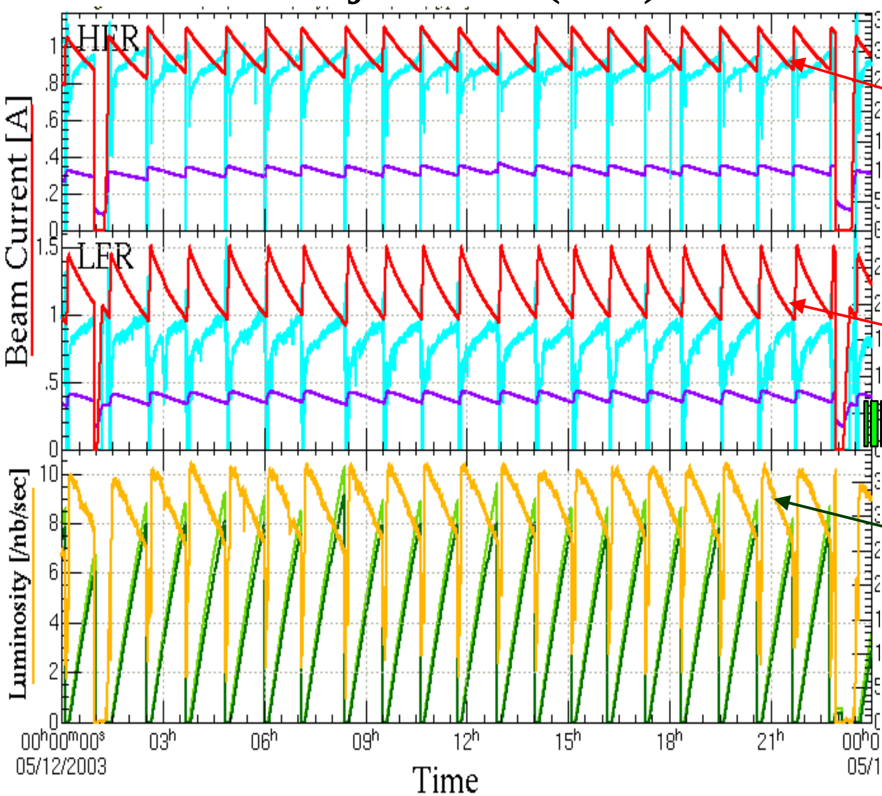
Always at ~max. currents, luminosity

⇒ **~30% more $\int L\, dt$**

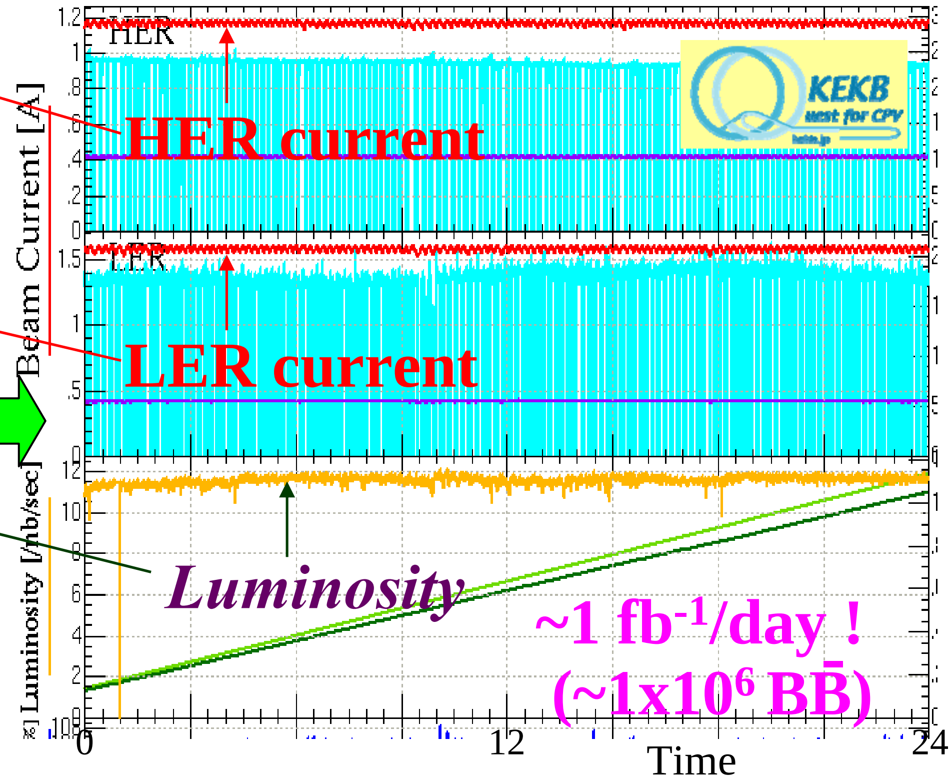
[CERN courier Jan/Feb 2004]

both KEKB & PEP-II

normal injection (old)



continuous injection (new)



Belle Collaboration

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Chuo U.
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Frankfurt U.
Gyeongsang Nat'l U.
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U. of Melbourne
Nagoya U.
Nara Women's U.
National Central U.
Nat'l Kaoshiung Normal U.
Nat'l Lien-Ho Inst. of Tech.
Nat'l Taiwan U.
Nihon Dental College
Niigata U.
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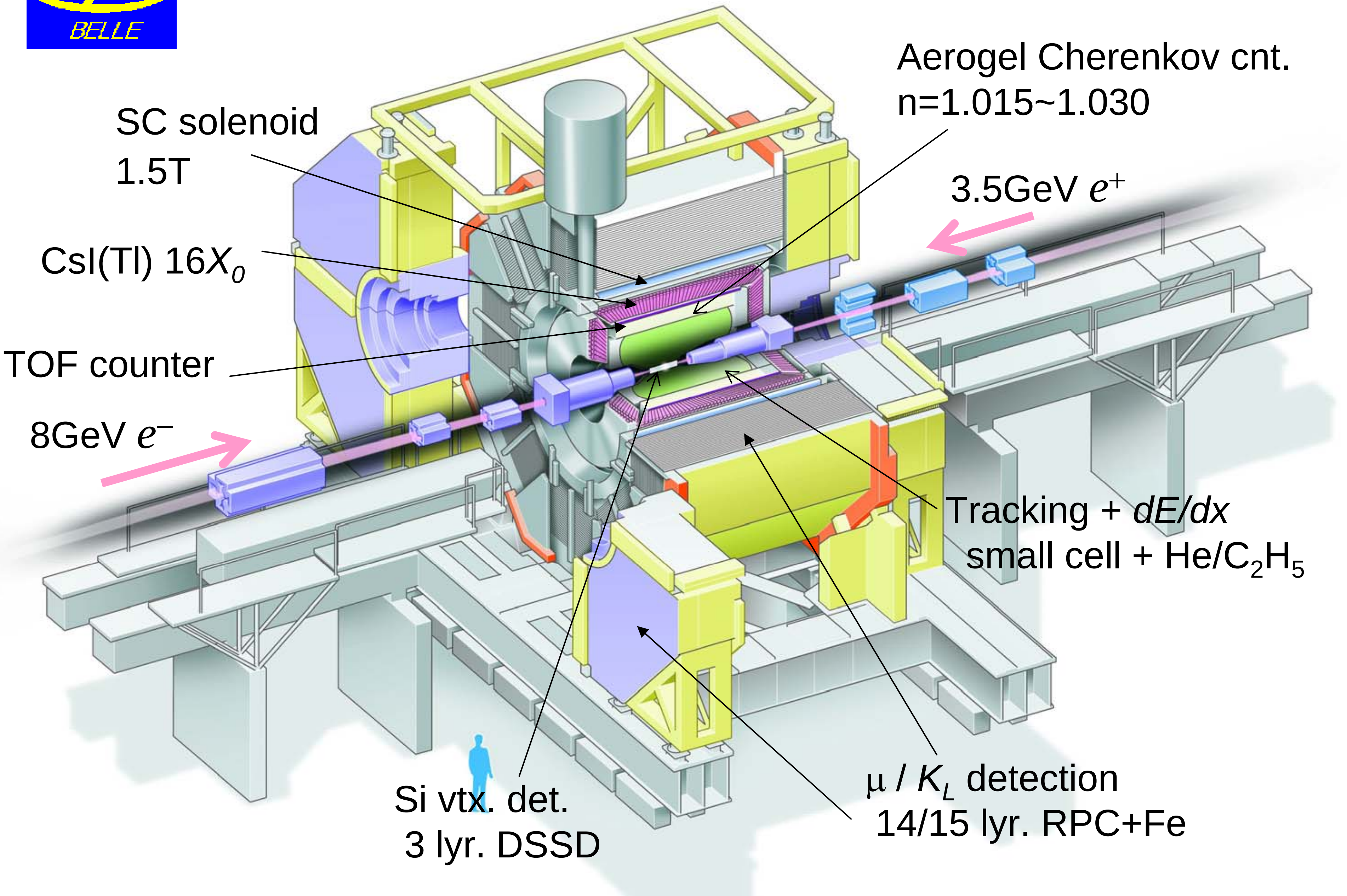
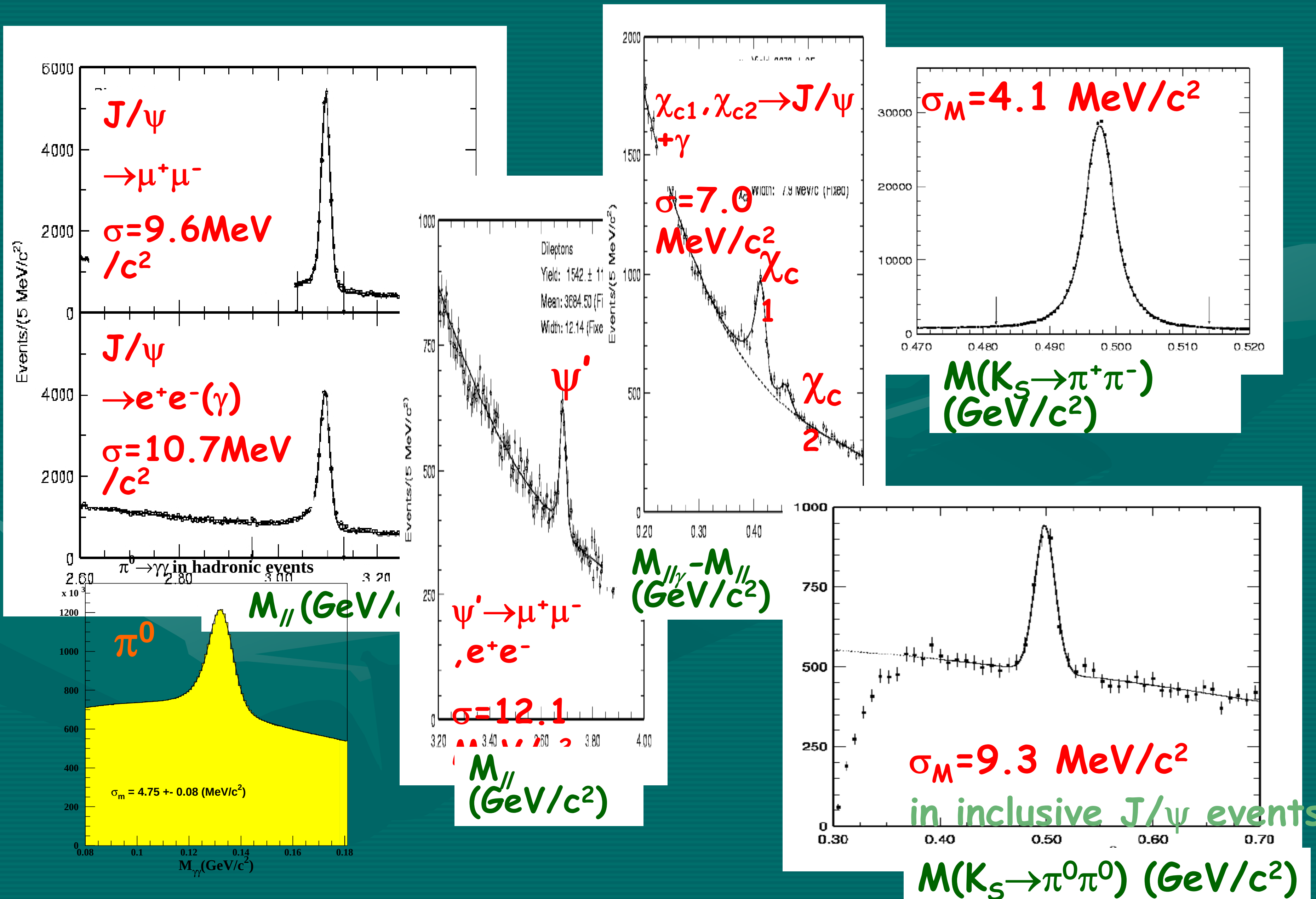
Osaka City U.
Panjab U.
Peking U.
Princeton U.
Riken
Saga U.
USTC

Seoul National U.
Sungkyunkwan U.
U. of Sydney
Tata Institute
Toho U.
Tohoku U.
Tohuku Gakuin U.
U. of Tokyo
Tokyo Inst. of Tech.
Tokyo Metropolitan U.
Tokyo U. of A and T.
Toyama Nat'l College
U. of Tsukuba
Utkal U.
IHEP, Vienna
VPI
Yokkaichi U.
Yonsei U.

Belle Detector

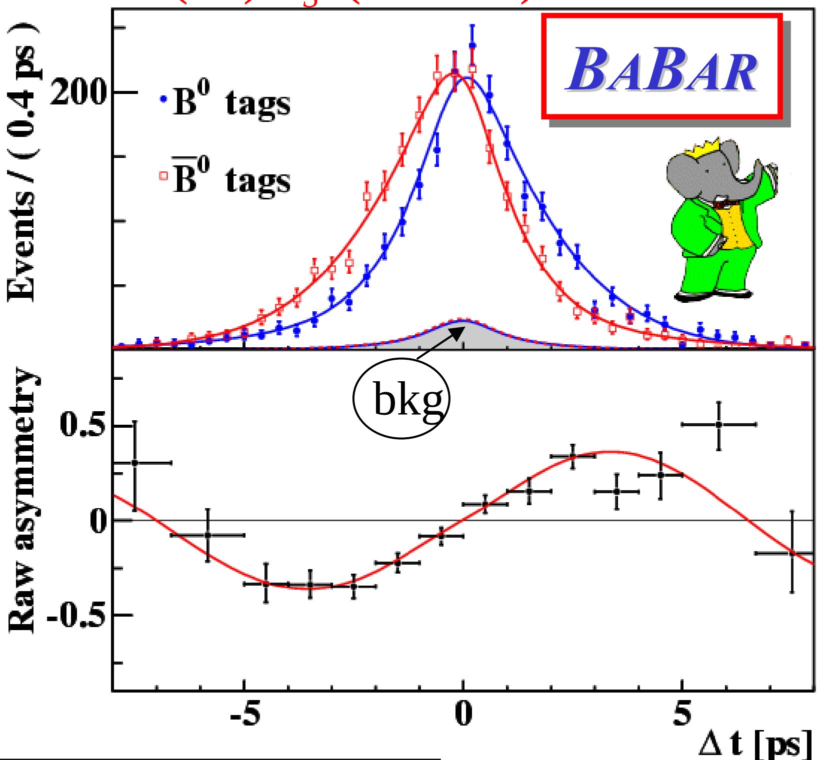


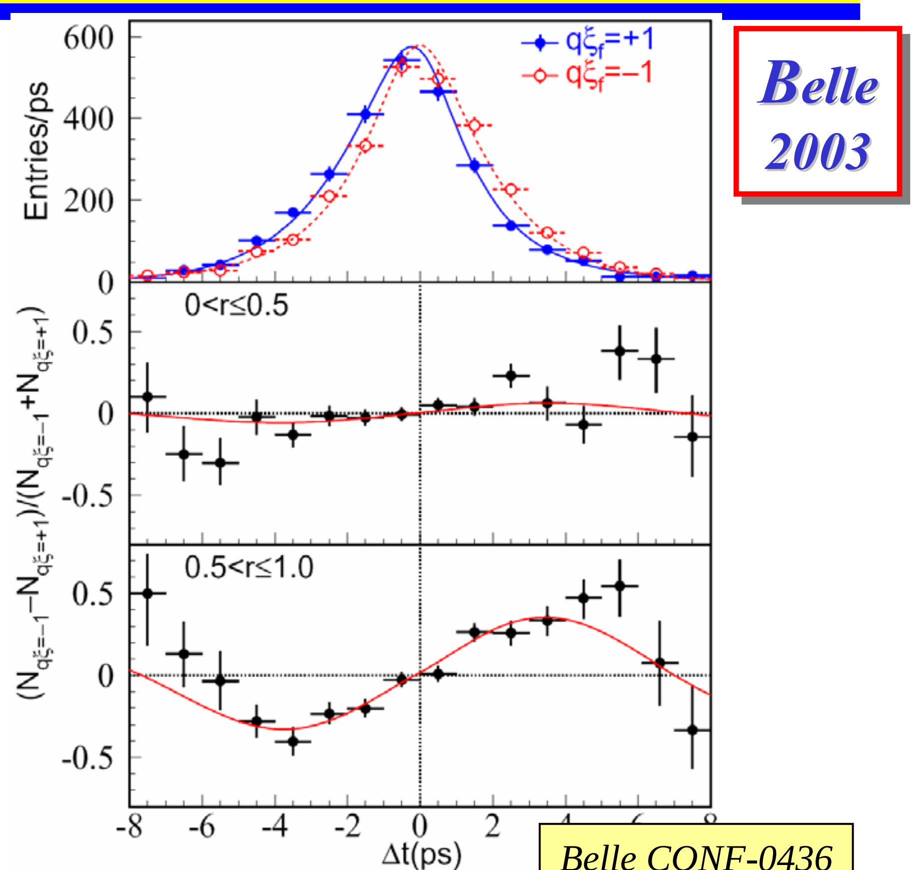
Sub decay modes



$\sin 2\phi_1$: charmonium K^0

$(c\bar{c})K_S^0$ (CP odd) modes





Update for ICHEP04

BABAR PUB-04/038

Belle CONF-0436

$$\sin 2\beta = +0.722 \pm 0.040 \pm 0.023$$
$$|\lambda| = |\bar{A}/A| = 0.950 \pm 0.031 \pm 0.013$$

$(c\bar{c})K_S^0 +$
$(c\bar{c})K_L^0$

$$\sin 2\beta = +0.728 \pm 0.056 \pm 0.023$$
$$|\lambda| = |\bar{A}/A| = 1.007 \pm 0.041 \pm 0.033$$

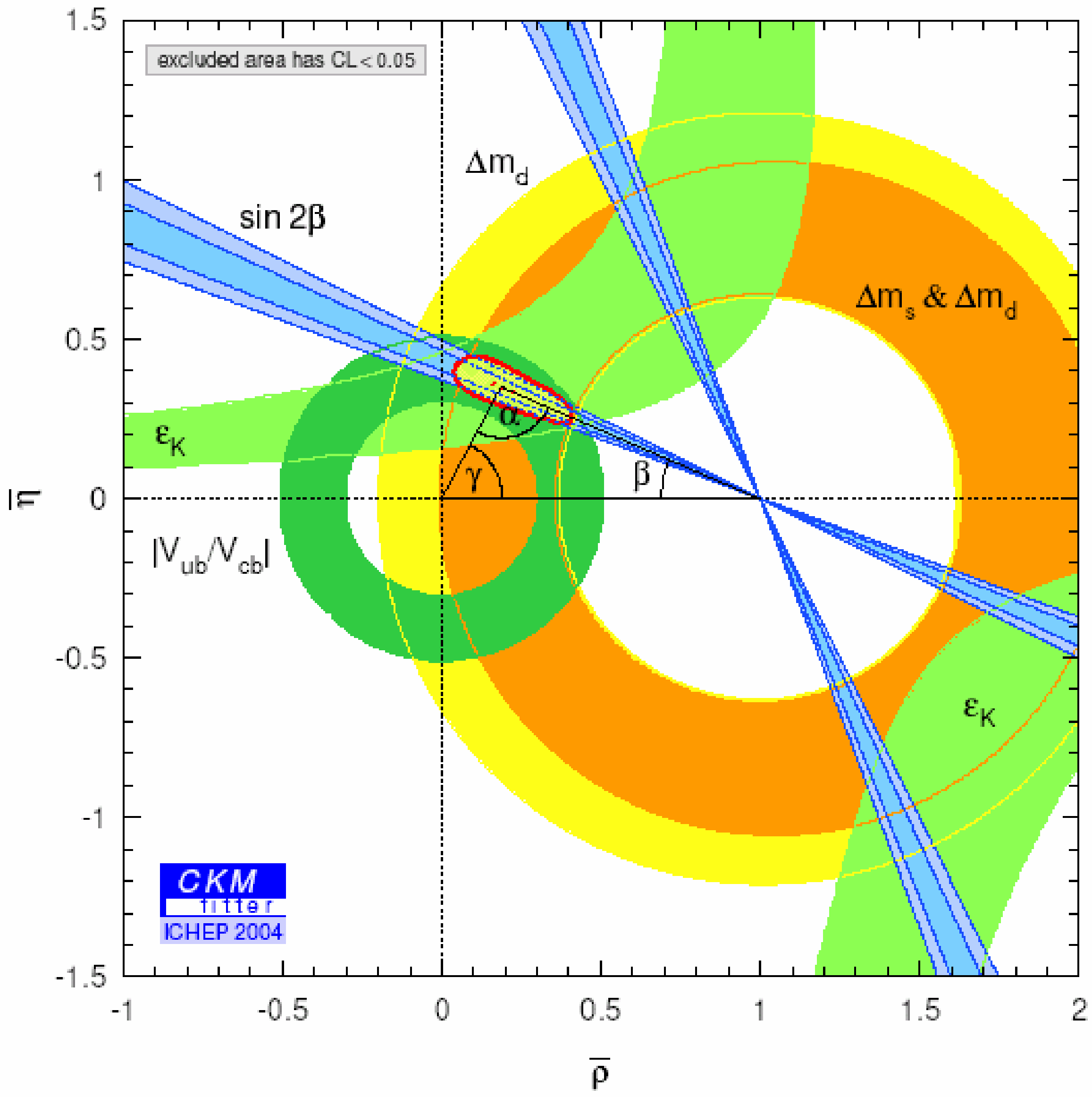
205 fb^{-1} on peak or 227M $B\bar{B}$ pairs

7730 CP events (tagged signal)

140 fb^{-1} on peak or 152M $B\bar{B}$ pairs

4347 CP events (tagged signal)

Current Results for $\sin 2\phi_1$



$\sin 2\phi_1$ (2004 World Av.)

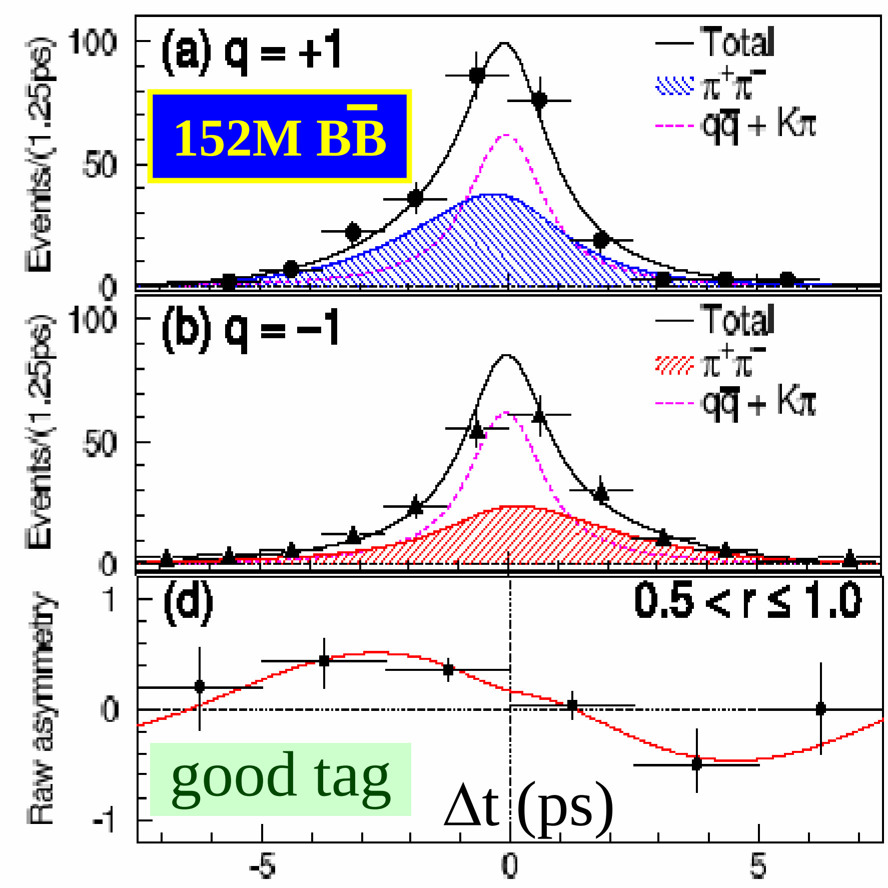
= **0.726±0.037**

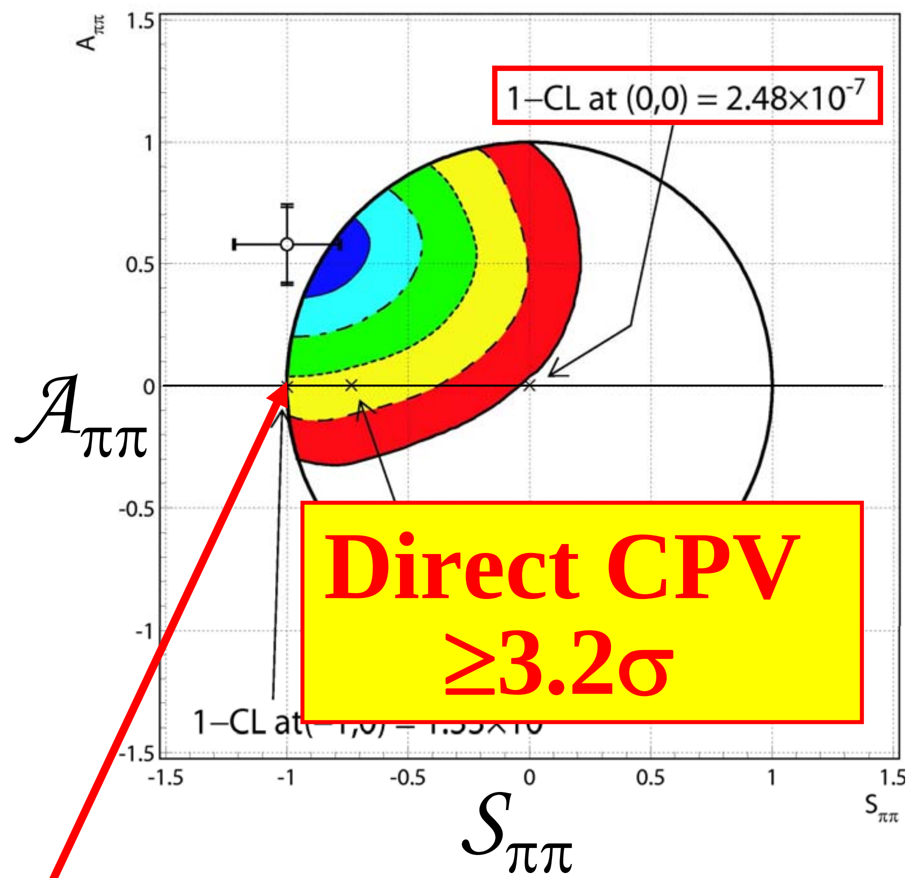
[LP2003: 0.736 ±0.049]

precision measurement (~5%)

Good SM reference

$B^0 \to \pi^+\pi^-$ CPV Result





$\mathcal{A}_{\pi\pi}$ = +0.58 ±0.15(stat) ±0.07(syst)

$\mathcal{S}_{\pi\pi}$ = −1.00 ±0.21(stat) ±0.07(syst)

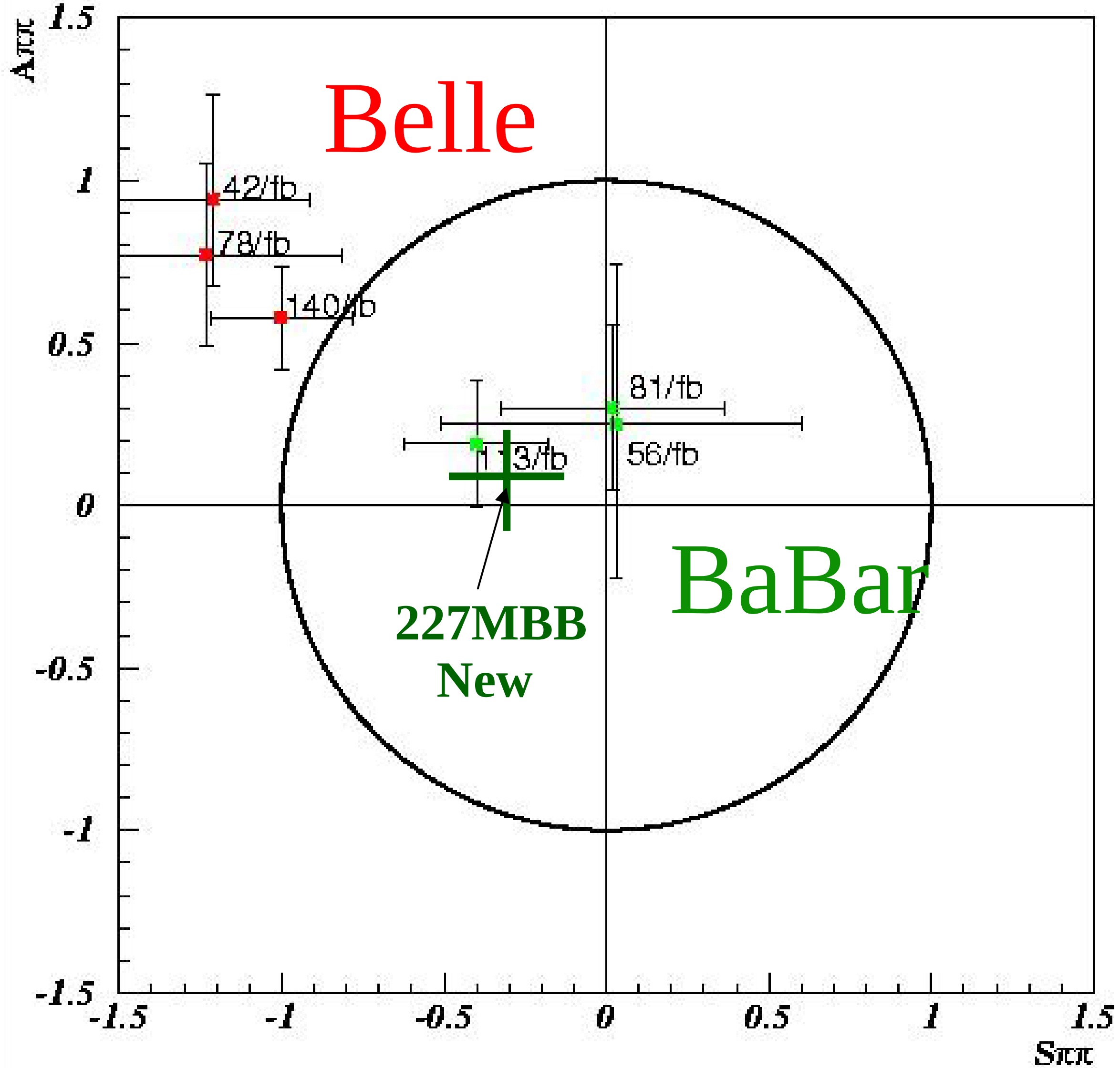
[PRL93,021801 (2004)]

History of $\mathcal{A}_{\pi\pi}$ and $\mathcal{S}_{\pi\pi}$

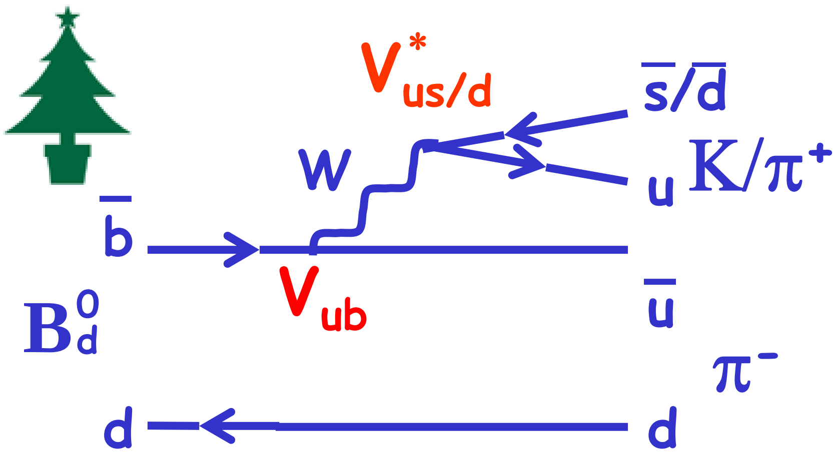
$B^0 \to \pi^+\pi^-$

TCPV

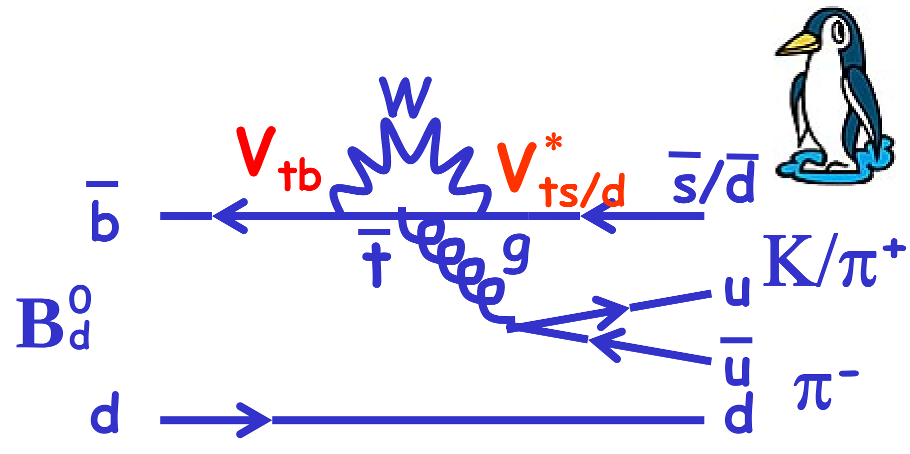
Difference at ~3.1σ level (was ~2.2σ)



Direct CPV: $B \to K\pi$



Tree



Penguin

- Simplest charmless rare decay modes
- Tree - Penguin interference → **Direct CP Violation**

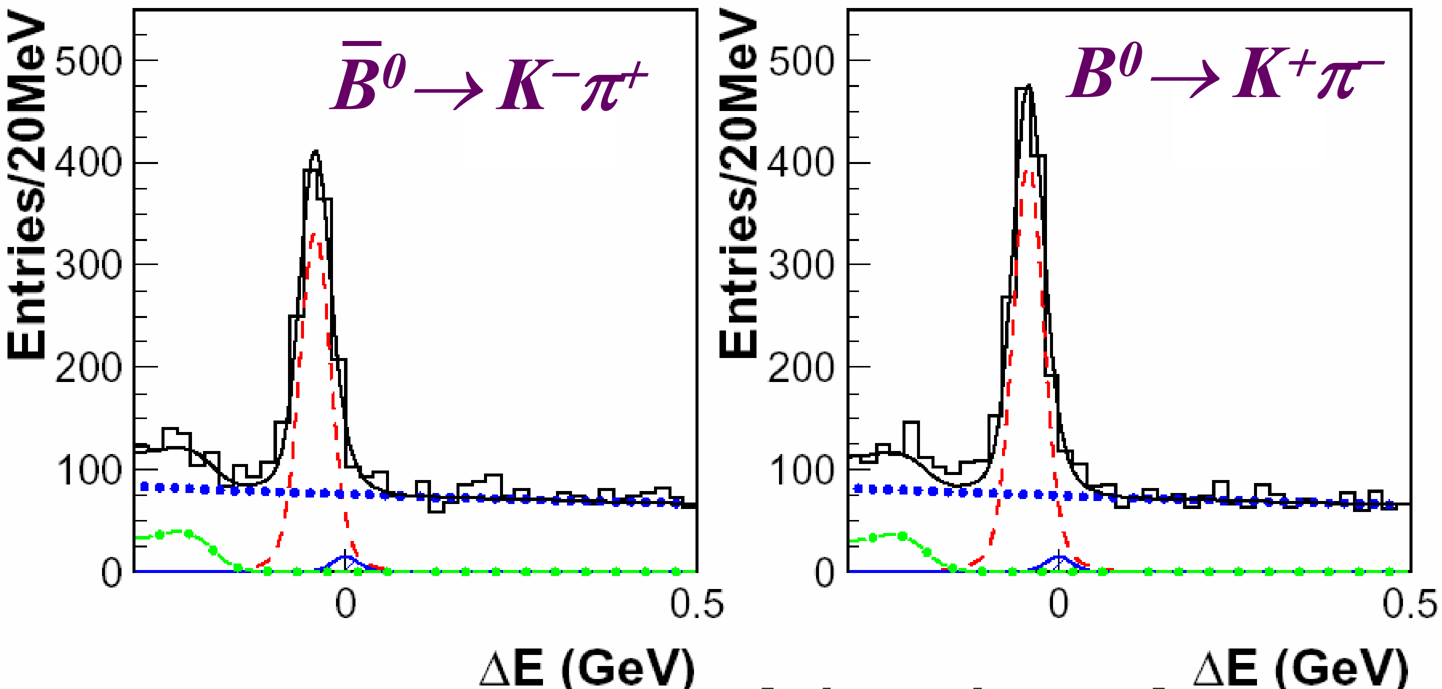
Key prediction of
Kobayashi-Maskawa model

$$A_{CP} = \frac{\Gamma(\bar{B}\to\bar{f}) - \Gamma(B\to f)}{\Gamma(\bar{B}\to\bar{f}) + \Gamma(B\to f)}$$

Observation in B ⇨ Strong support of KM

$A_{CP}(B^0 \to K^+\pi^-)$

274M $B\bar{B}$ New



Signal:
2139 ±53

[submitted to PRL]

A_{CP} **= -0.101 ± 0.025 ± 0.005**

3.9σ significance

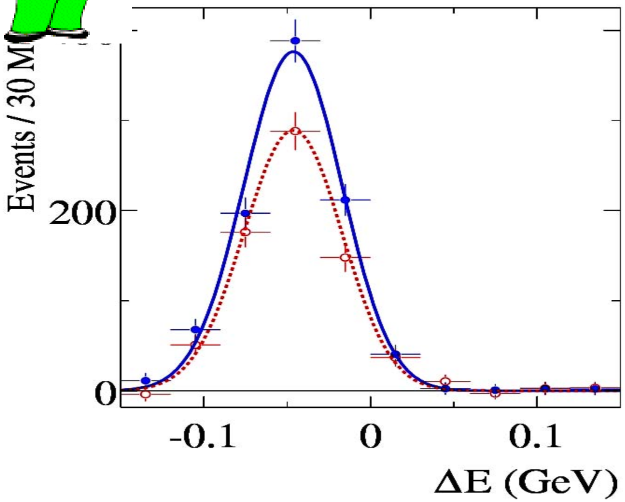
[PID efficiency bias correction: δA = -0.01 ± 0.004]

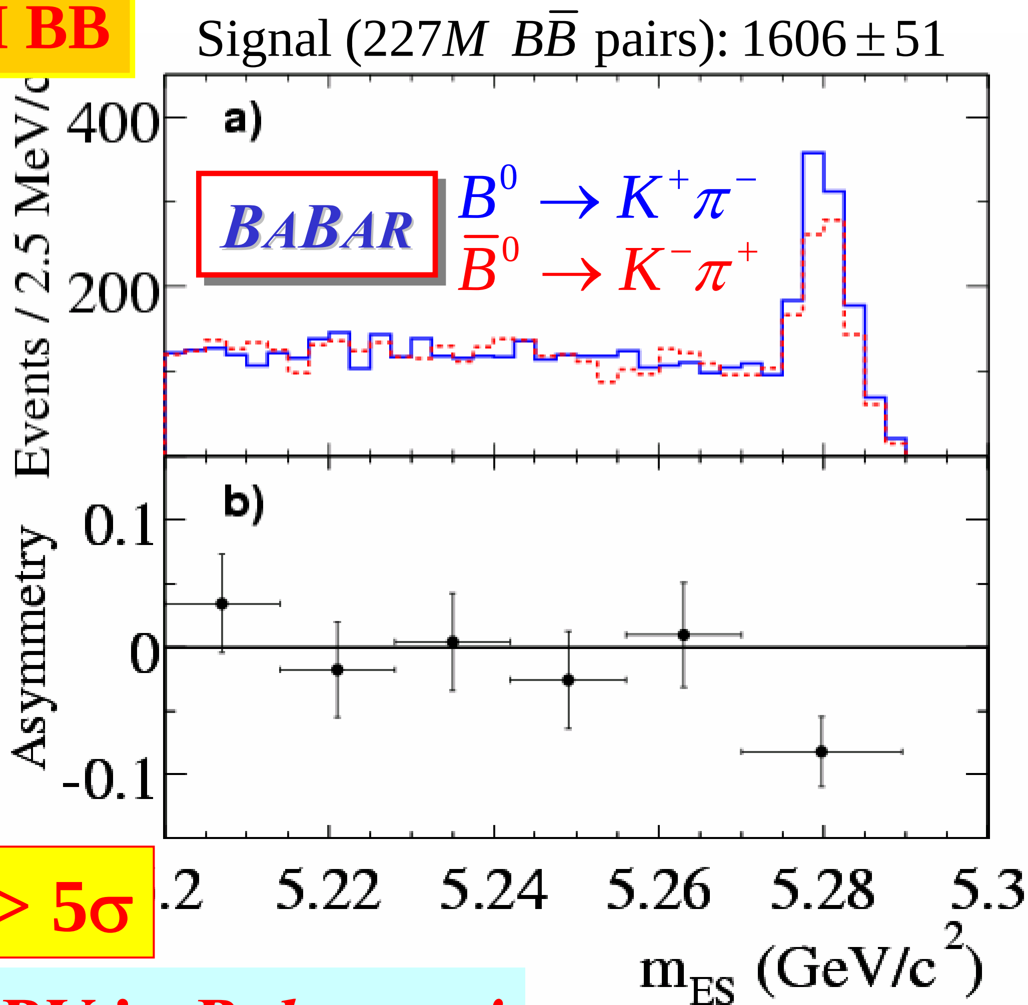
2nd Evidence for DCPV at Belle ! [$\mathcal{A}(\pi^+\pi^-)$ 3.2σ]

$A_{CP}(B^0 \to K^+\pi^-)$

hep-ex/0408057, submitted to PRL

227M $B\bar{B}$





4.2σ

$$A_{CP} = -0.133 \pm 0.030 \pm 0.009$$

Average of Belle and BaBar

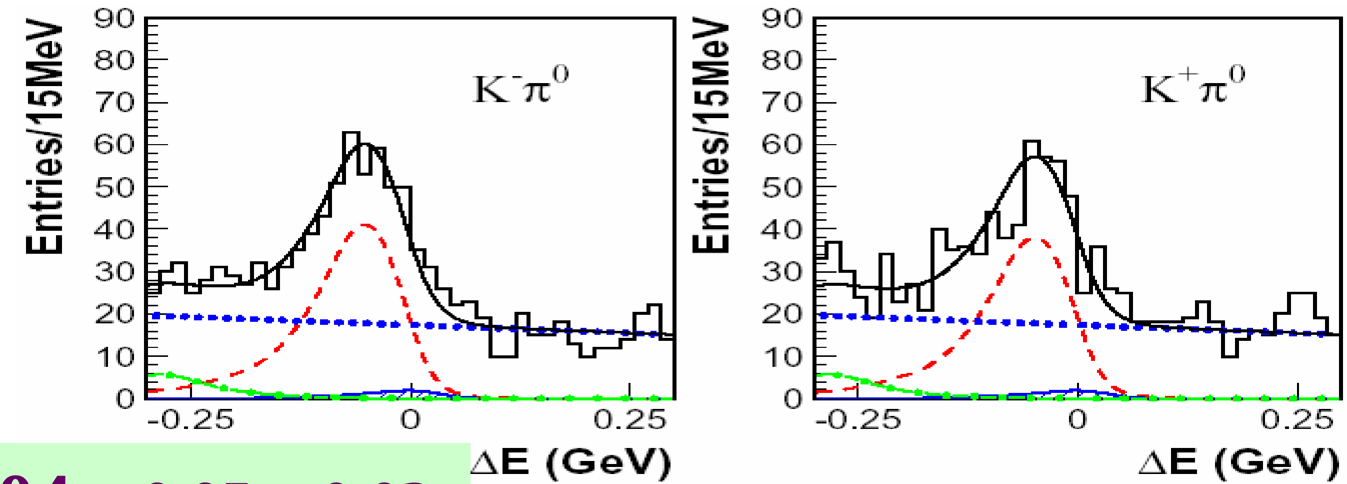
$$A_{CP} = -0.114 \pm 0.020$$ **> 5σ**

First established Direct CPV in B decays !

$A_{CP}(B \to K^+\pi^0)$

274M $B\bar{B}$
New

$K^{\pm}\pi^0$: 728 ±53



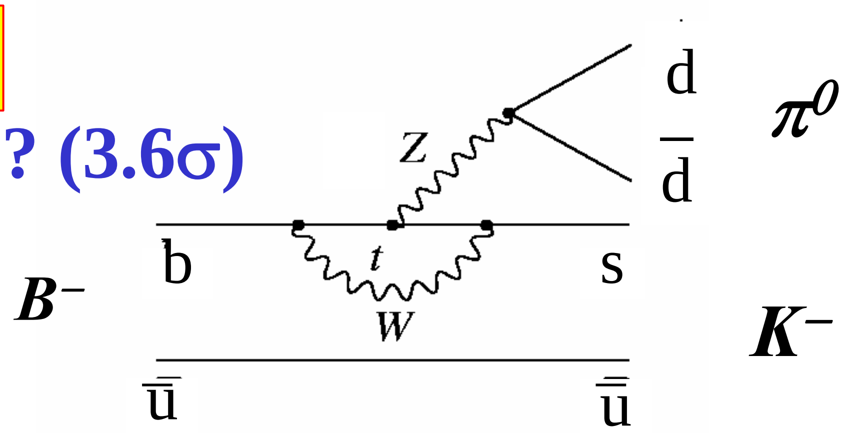
$A_{CP}(K^{\pm}\pi^0)$ **= 0.04 ± 0.05 ± 0.02**

0.06 ± 0.06 ± 0.06 (BaBar, 227M)

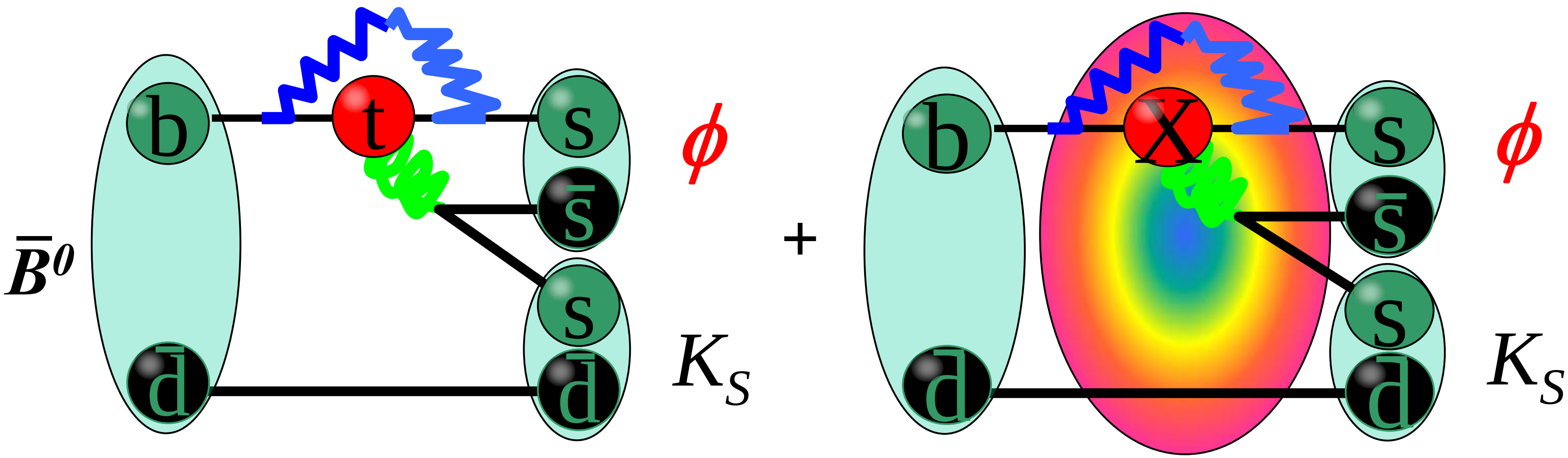
Average $A_{CP} = +0.049 \pm 0.040$

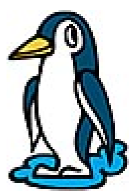
hint that $A_{CP}(K^+\pi^-) \neq A_{CP}(K^{\pm}\pi^0)$? (3.6σ)

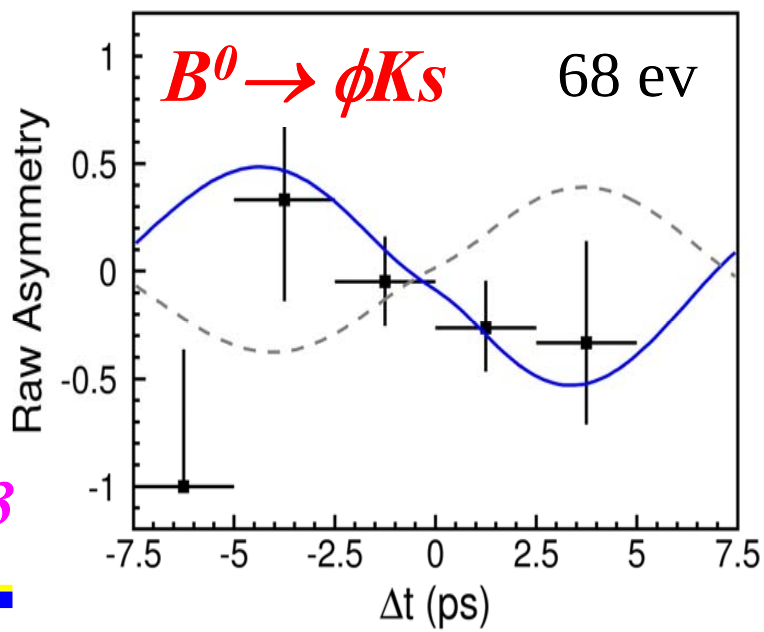
Large EW penguin (Z^0) ?
New Physics ?



New physics Search : $b \to s\bar{q}q$







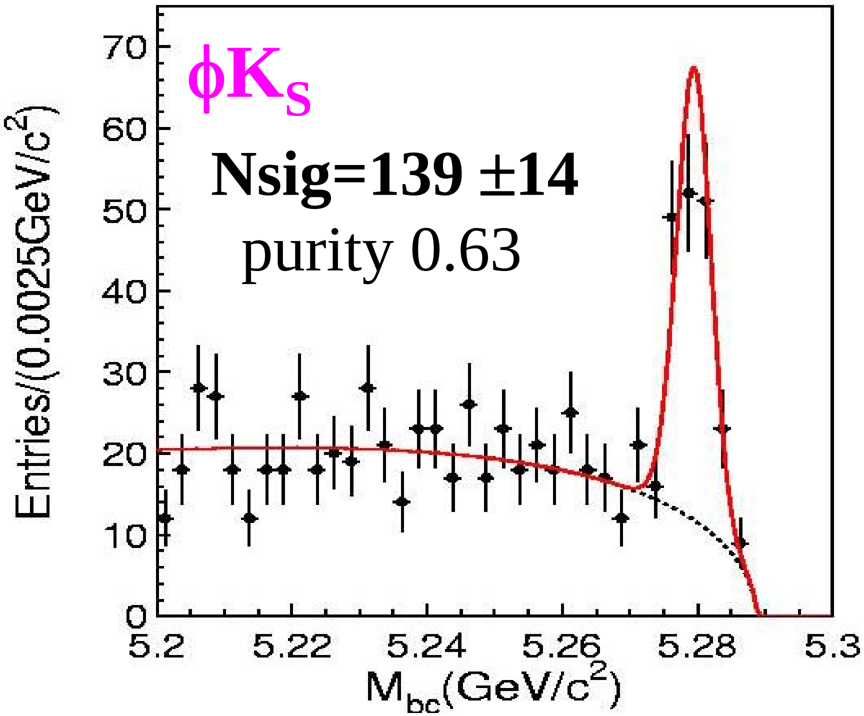
"sin2ϕ_1"= −0.96 ± 0.51

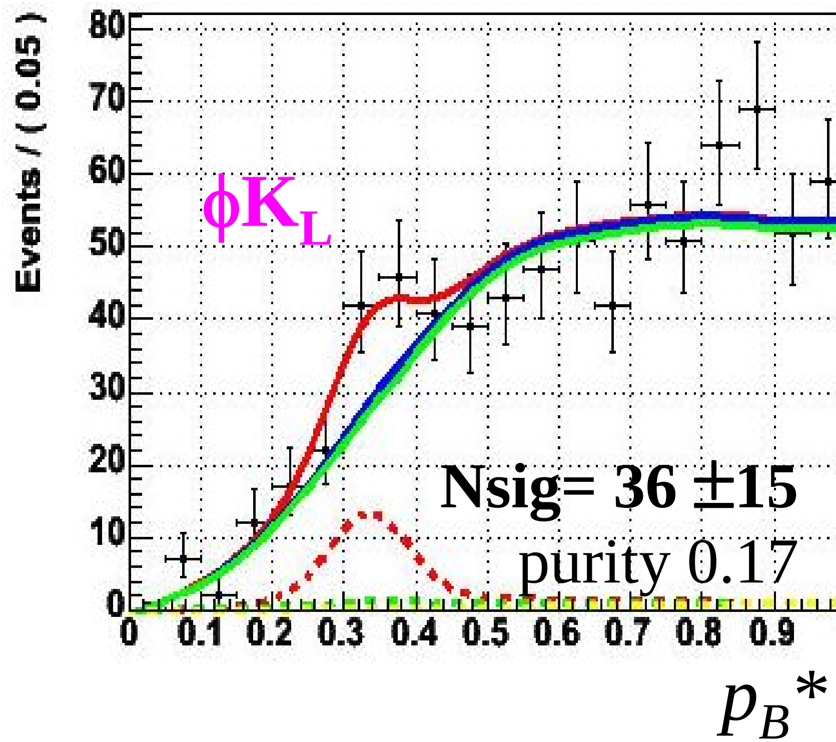
3.5σ deviation from the SM !

Belle @LP03

$B^0 \to \phi K^0$

274M $B\bar{B}$

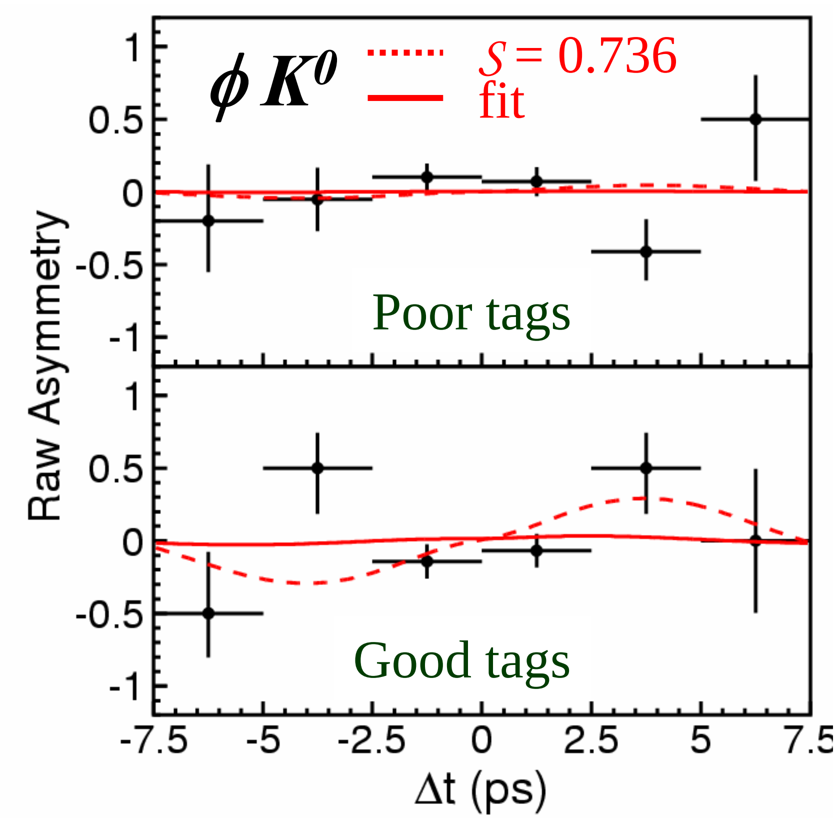


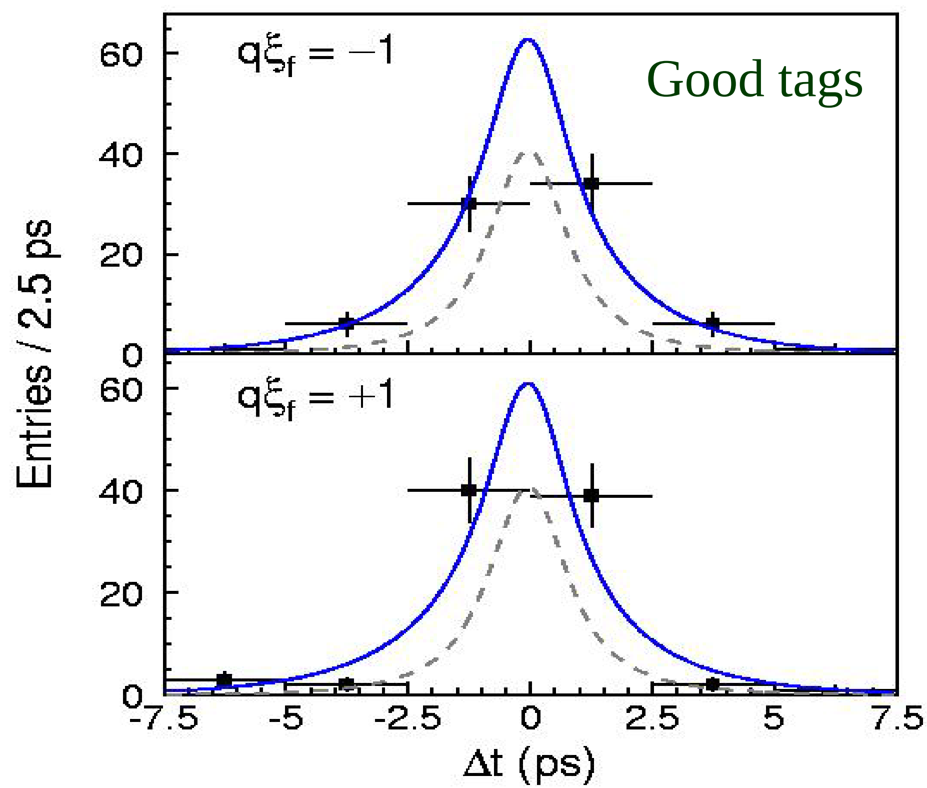


includes Ks $\to \pi^0\pi^0$
(Nsig=13 ±5)

Similar to $J/\psi K_L$ recon.
+ sophisticated continuum suppression

$B^0 \to \phi K^0$: CPV Result





274M $B\bar{B}$

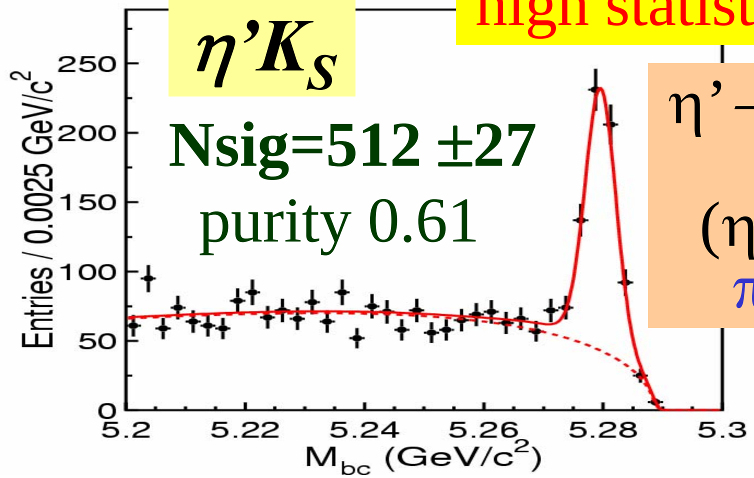
$$\phi K_S + \phi K_L: \ \mathcal{S}(\phi K^0) = +0.06 \pm 0.33 \pm 0.09$$

$$\mathcal{A}(\phi K^0) = +0.08 \pm 0.22 \pm 0.09$$

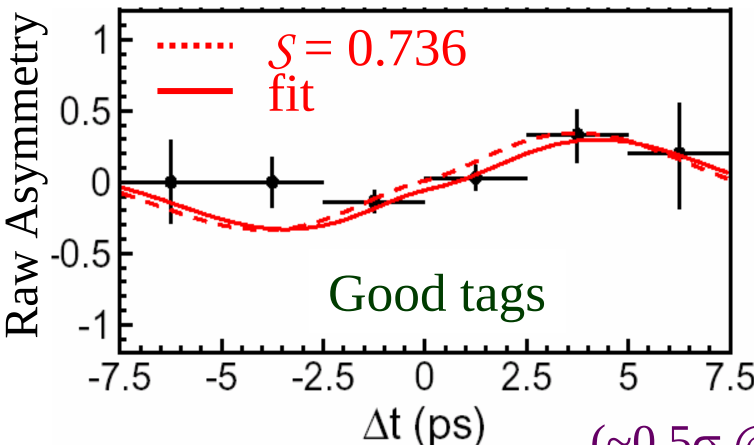
~2.2σ away from SM

$B^0 \to \eta' K_S$

high statistics modes



$\eta' \to \rho\gamma$, $\eta\pi^+\pi^-$
($\eta \to \gamma\gamma$, $\pi^+\pi^-\pi^0$)



(~0.5σ @SM)

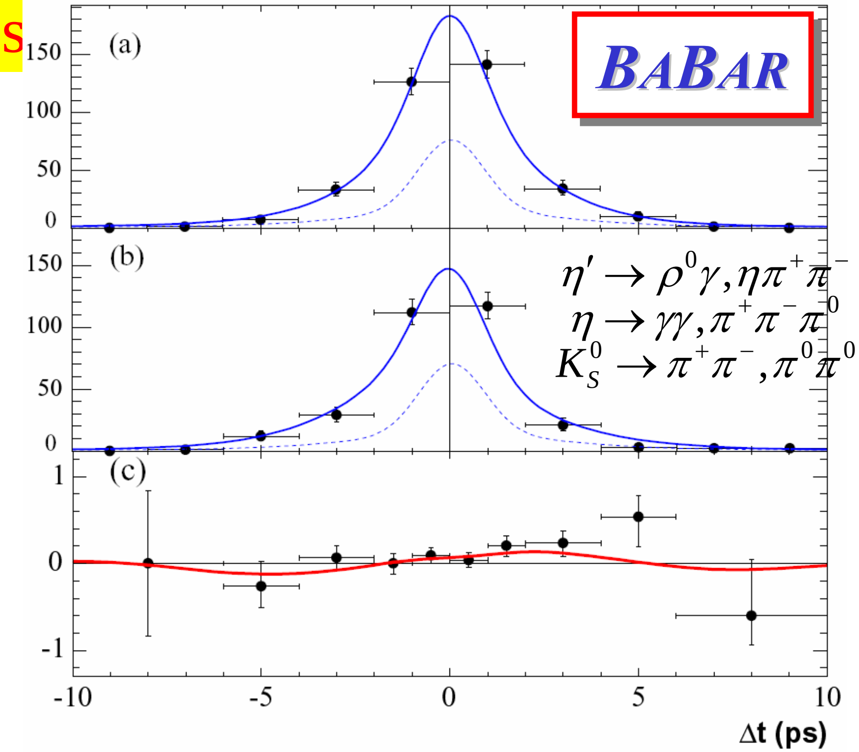
$\mathcal{S} = +0.65 \pm 0.18 \pm 0.04$

$\mathcal{A} = -0.19 \pm 0.11 \pm 0.05$

BELLE

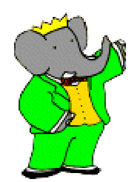
274M $B\bar{B}$

BABAR



$B^0 \to \eta' K_S^0$ Signal: 819 ± 38

$\neq \sin 2\beta[c\bar{c}]@3.0\sigma$

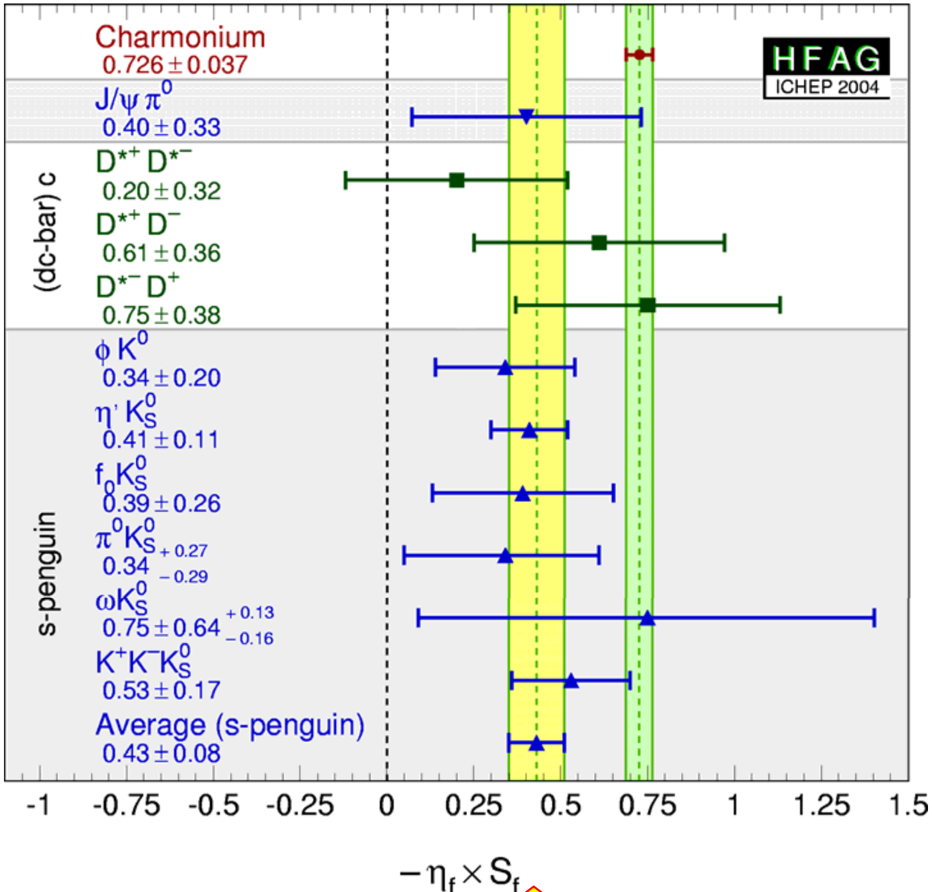


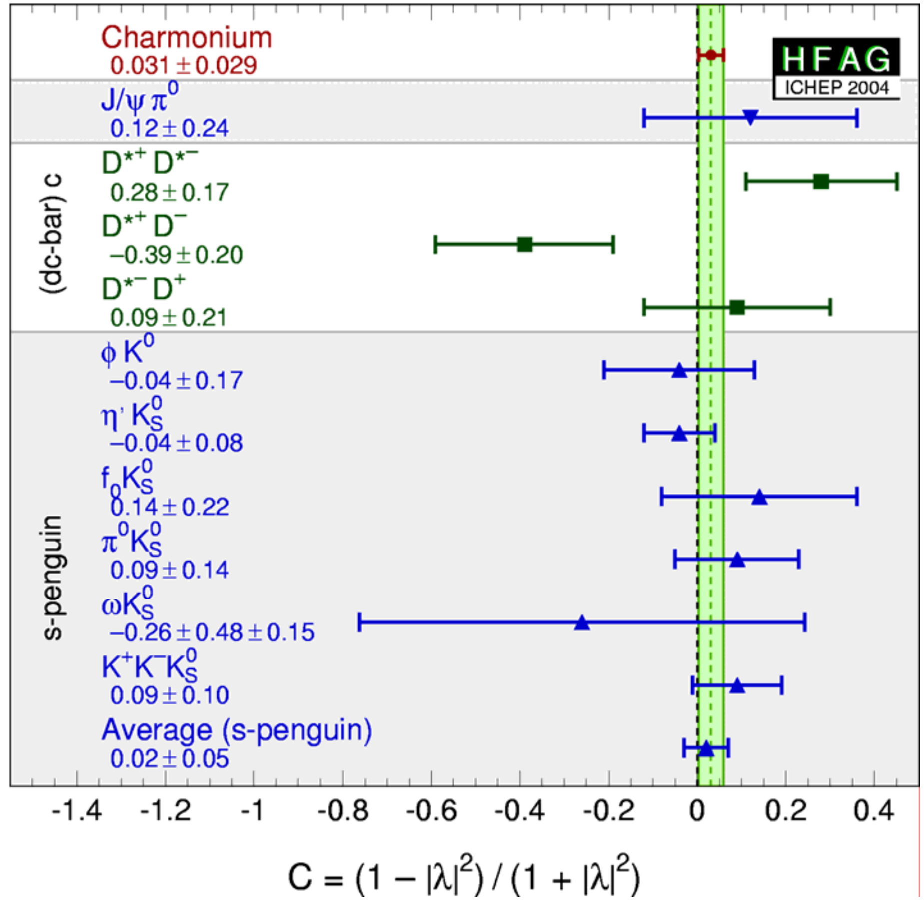
$-\eta_{CP} \cdot S_{\eta' K_S^0} = +0.27 \pm 0.14 \pm 0.03$

$C_{\eta' K_S^0} = -0.21 \pm 0.10 \pm 0.03$

208M $B\bar{B}$ pairs

Averages for sin2β and s-penguin modes



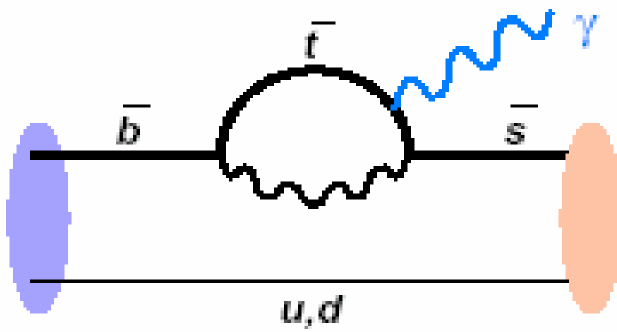


3.6s from s-penguin to sin2b ($c\bar{c}$)

No sign of Direct *CP* in averages

Radiative & EW Penguins

Loops → Sensitive to New Physics



b → sγ penguin

Br, A_{CP} ~SM

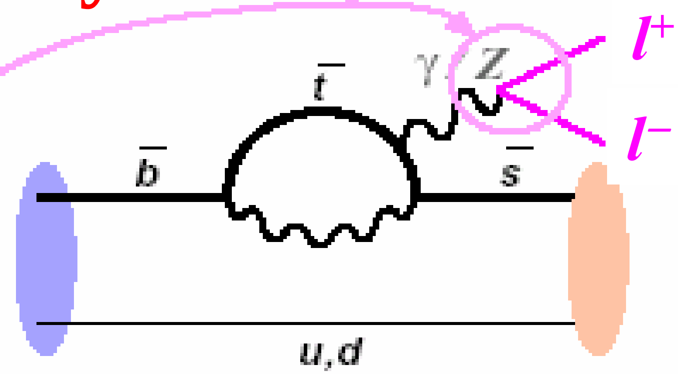
↓

$K^*\gamma$ TCPV

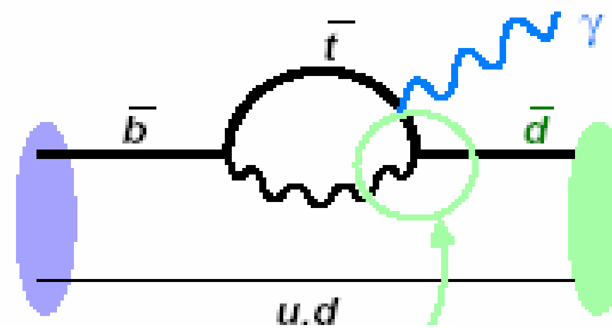
α_{EW}

~1/100

$\left|\frac{V_{td}}{V_{ts}}\right|^2$



b → sl^+l^- penguin



b → dγ penguin

$B \to K^{(*)} l^+ l^-$

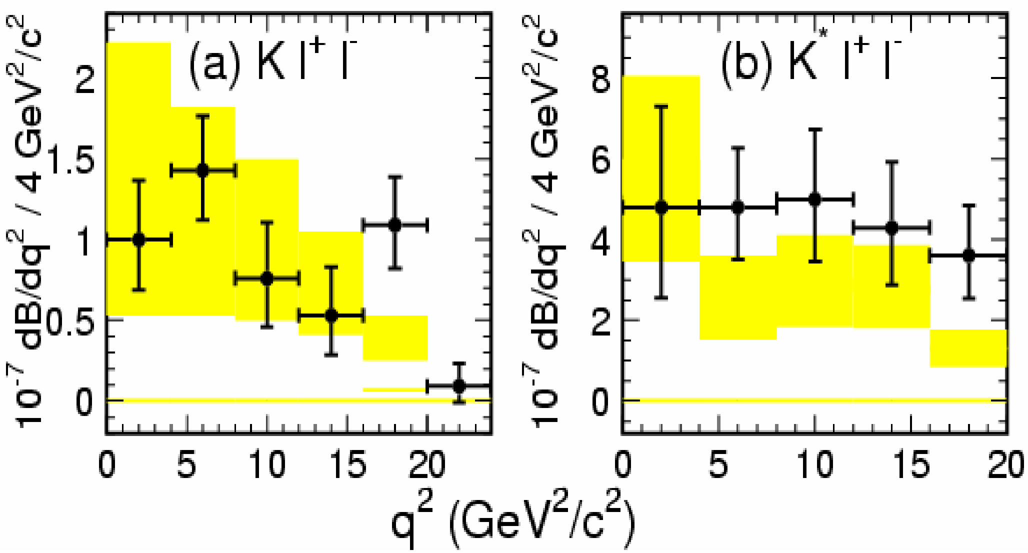
LP03: $B \to X_s ll$, $K^{(*)}ll$: first observed by Belle, confirmed by BaBar
Br, A_{CP} ~SM

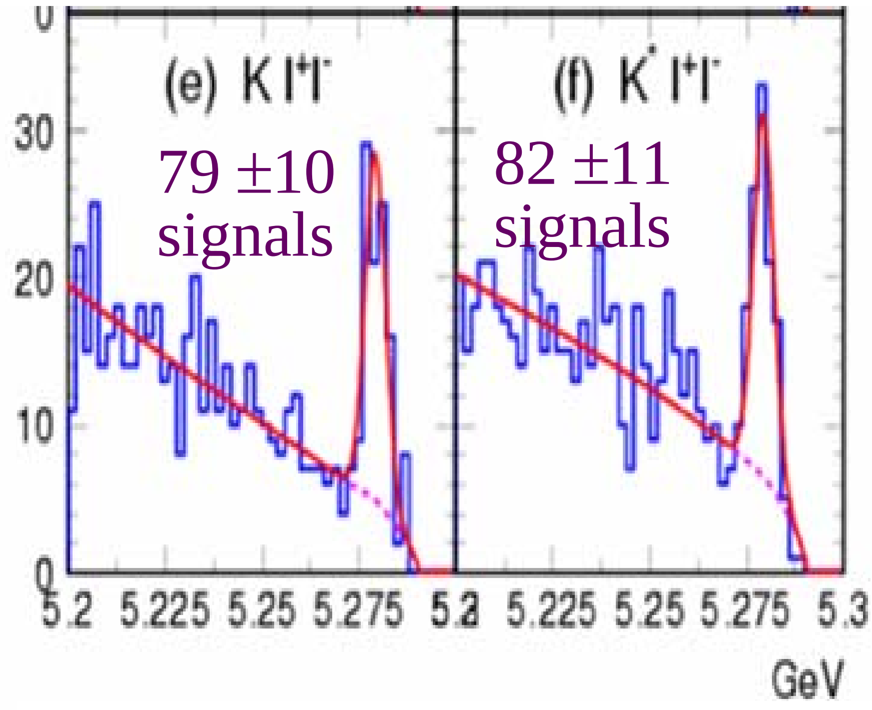
BELLE **274M $B\bar{B}$** update **>10σ signals**

$\mathcal{B}(\mathrm{Kll}) = (5.50 \pm {}^{0.75}_{0.70} \pm 0.27 \pm 0.02)$

$\mathcal{B}(\mathrm{K^*ll}) = (16.5 \pm {}^{2.3}_{2.2} \pm 0.9 \pm 0.4\ )$

x 10^{-7}





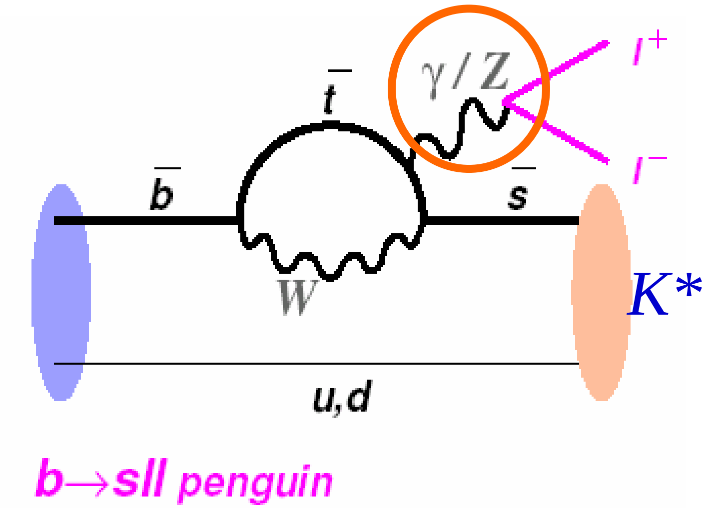
[Belle-conf-0415]

$B \to K^* l^+ l^-$:FB Asymmetry

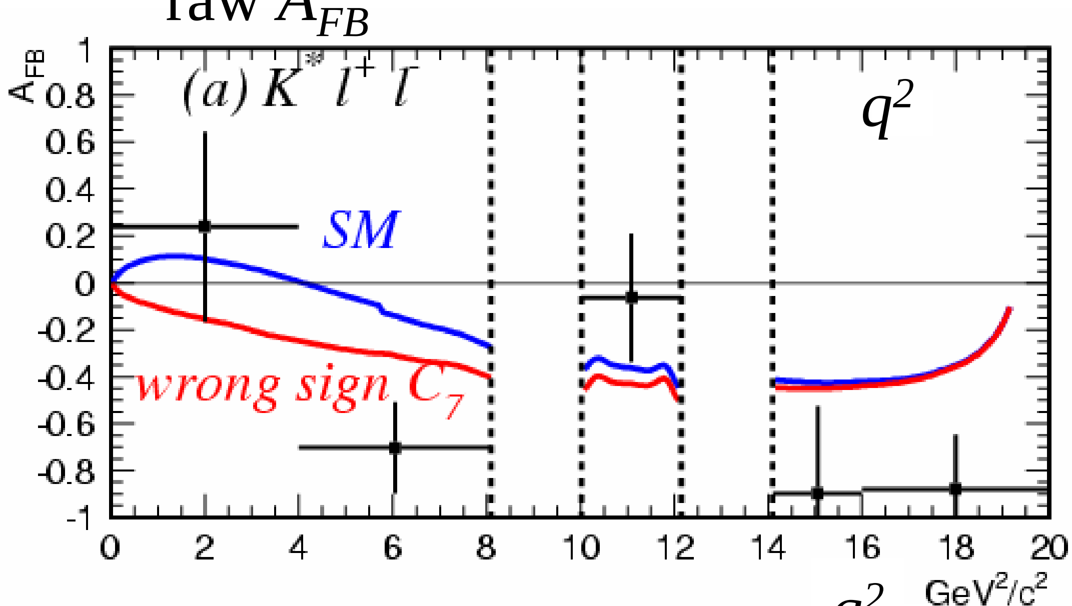
274M $B\bar{B}$

$A_{FB}(K^*ll)$: very sensitive to NP that may not be seen in $\mathcal{B}(b \to s\gamma)$

$$A_{FB} = \frac{\Gamma(\theta_{Bl^+} < \pi/2) - \Gamma(\theta_{Bl^+} > \pi/2)}{\Gamma(\theta_{Bl^+} < \pi/2) + \Gamma(\theta_{Bl^+} > \pi/2)}$$



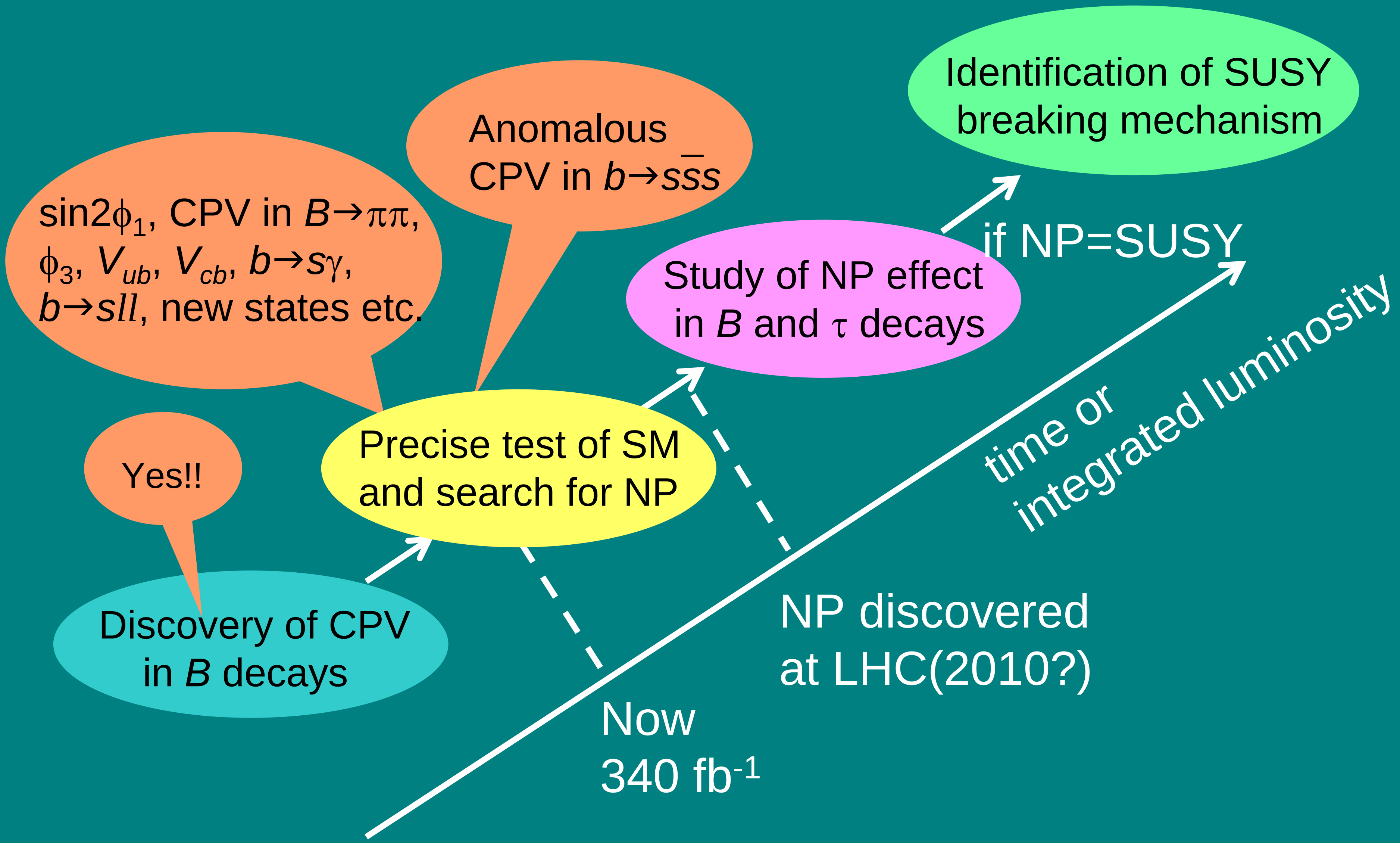
raw A_{FB}



First Look !

[Belle-conf-0415]

Road Map of B Physics



Physics Program at Super-B

New CPV phase

$B \to \phi K^0, \eta' K^0, \ldots$

$B \to K^* \gamma, X_S \gamma$

FCNC decays

$B \to X_S \gamma$

$B \to K^{(*)} \ell\ell, X_S \ell\ell$

Precision CKM

$\sin 2\phi_1 \; (B \to J/\psi K^0)$

$\sin 2\phi_2 \; (B \to \pi\pi, \rho\pi, \rho\rho)$

$\phi_3 \; (B \to DK)$

$|V_{ub(cb)}| \; (B \to X_{u(c)} \ell \nu)$

LFV decays

$\tau \to \ell \gamma$

$\tau \to \ell\ell\ell, \ell \eta$

Higgs Search

$B \to \tau \nu$

$B \to D^{(*)} \tau \nu$

Global Analysis of B Physics

(Study of New Physics Scenario)

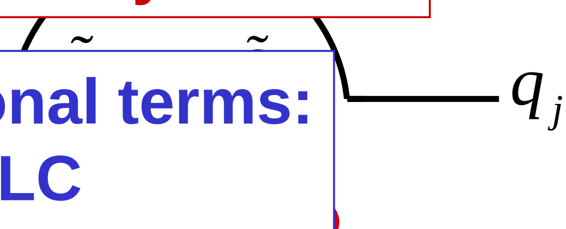
Investigating SUSY in flavor physics

- MSSM parameters > 100 !   Mass+mixing angle+phase
- The squark/slepton mass matrix
  - Sensitive to SUSY breaking mechanism.
  - New sources of flavor mixing ⟹ **Baryon asymmetry ?**

$$\left(m^2_{\tilde{q}}\right)_{ij} = \begin{pmatrix} m^2_{11} & m^2_{12} & m^2_{13} \\ m^2_{21} & m^2_{22} & m^2_{23} \\ m^2_{31} & m^2_{32} & m^2_{33} \end{pmatrix}$$

Off-diagonal terms
Flavor Physics
Luminosity frontier

Diagonal terms:
LHC/ILC
Energy frontier



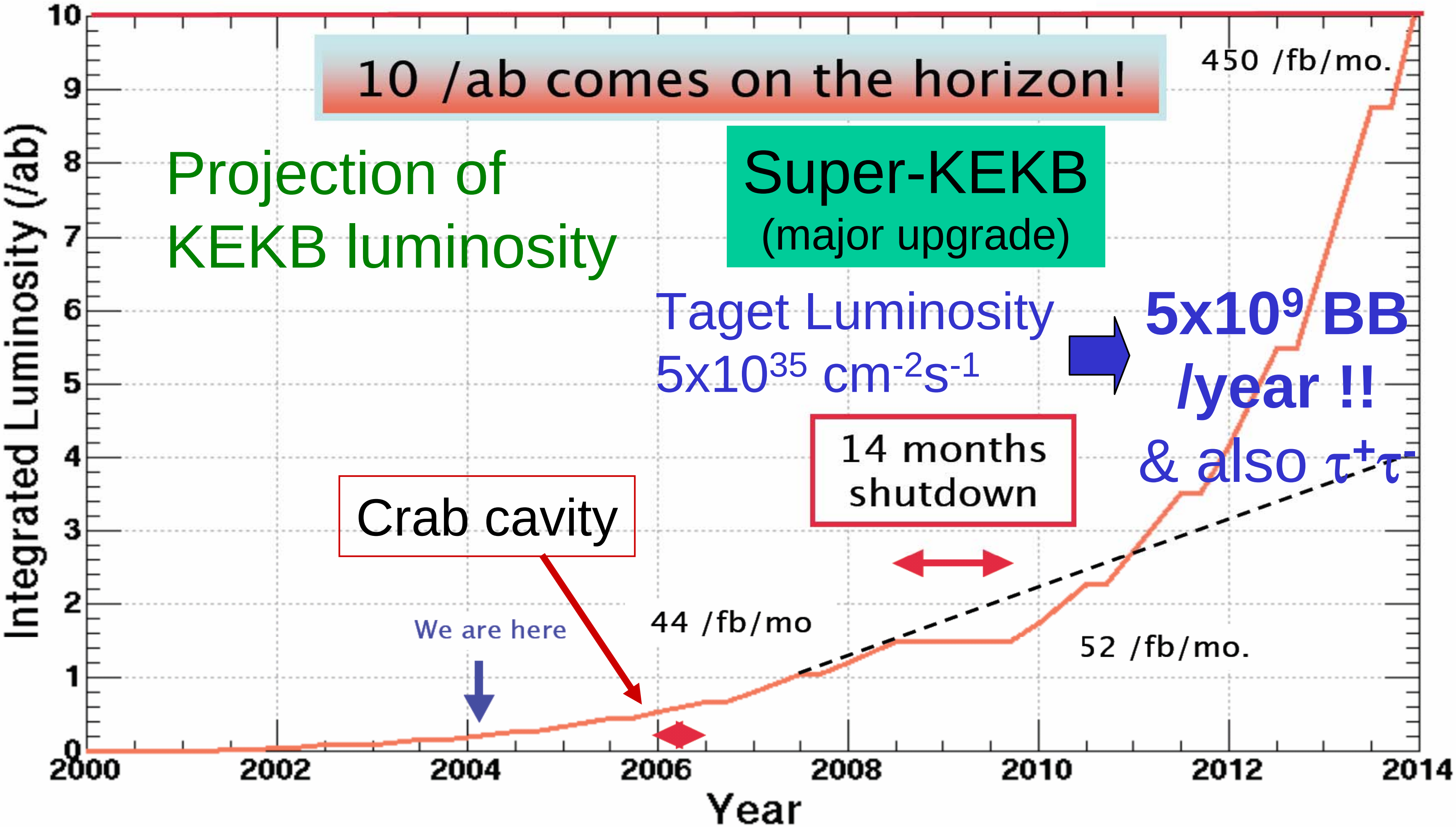
Physics at Super-B = SUSY Flavor Physics

Its importance is independent of LHC results.

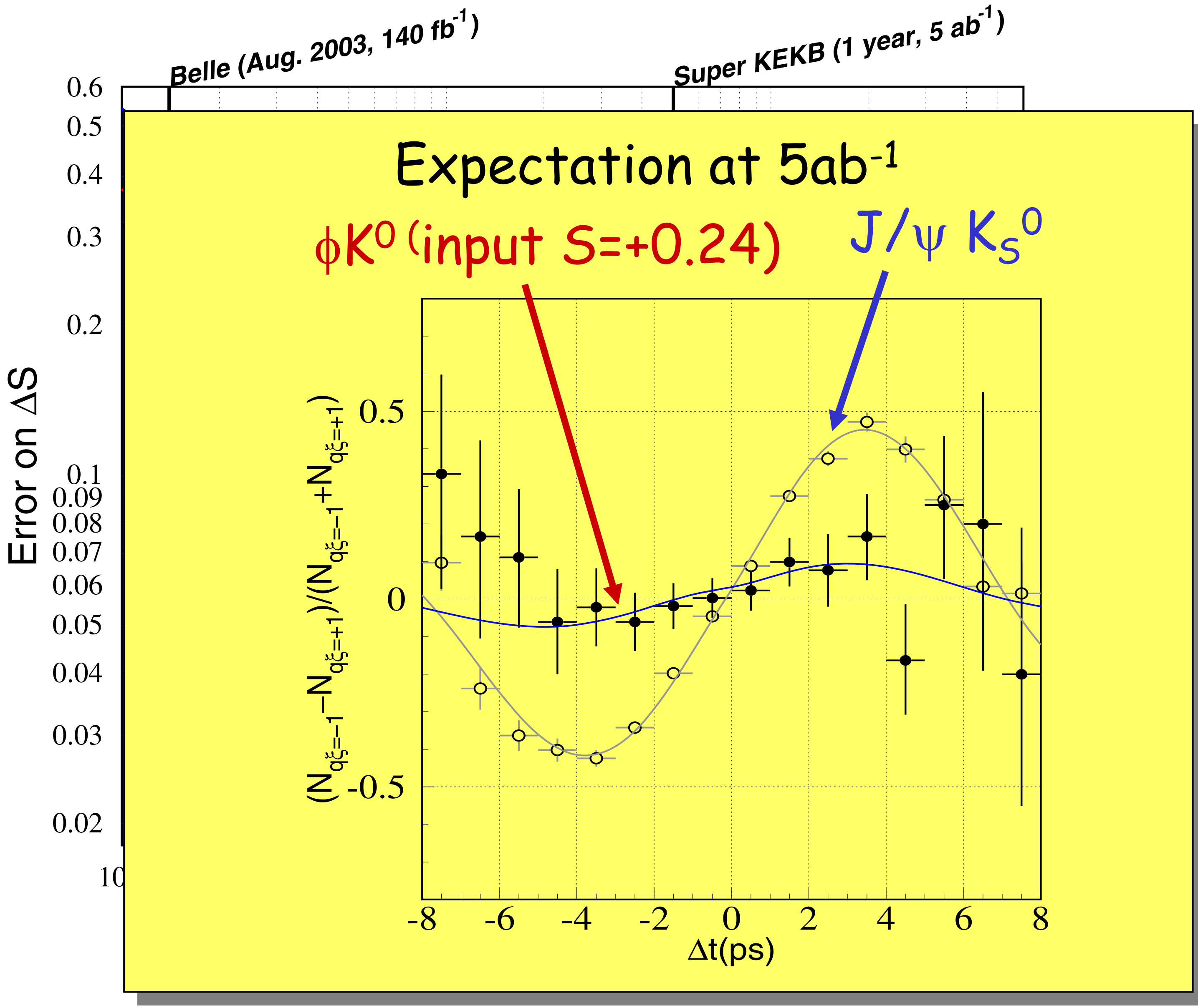
(V_{CKM} could not be pin down only with energy frontier)

Super-KEKB

L_{peak} ($cm^{-2}s^{-1}$)	1.4×10^{34}	5×10^{34}	5×10^{35}
L_{int}	280 fb^{-1}	1 ab^{-1}	10 ab^{-1}



Expected Precision



Statistical significance w/ the present central value

Signif.
4.9
6.4
3.5

error

^{0}: ~0.05

^{0}: ~0.10

Pattern of the deviation from the SM prediction

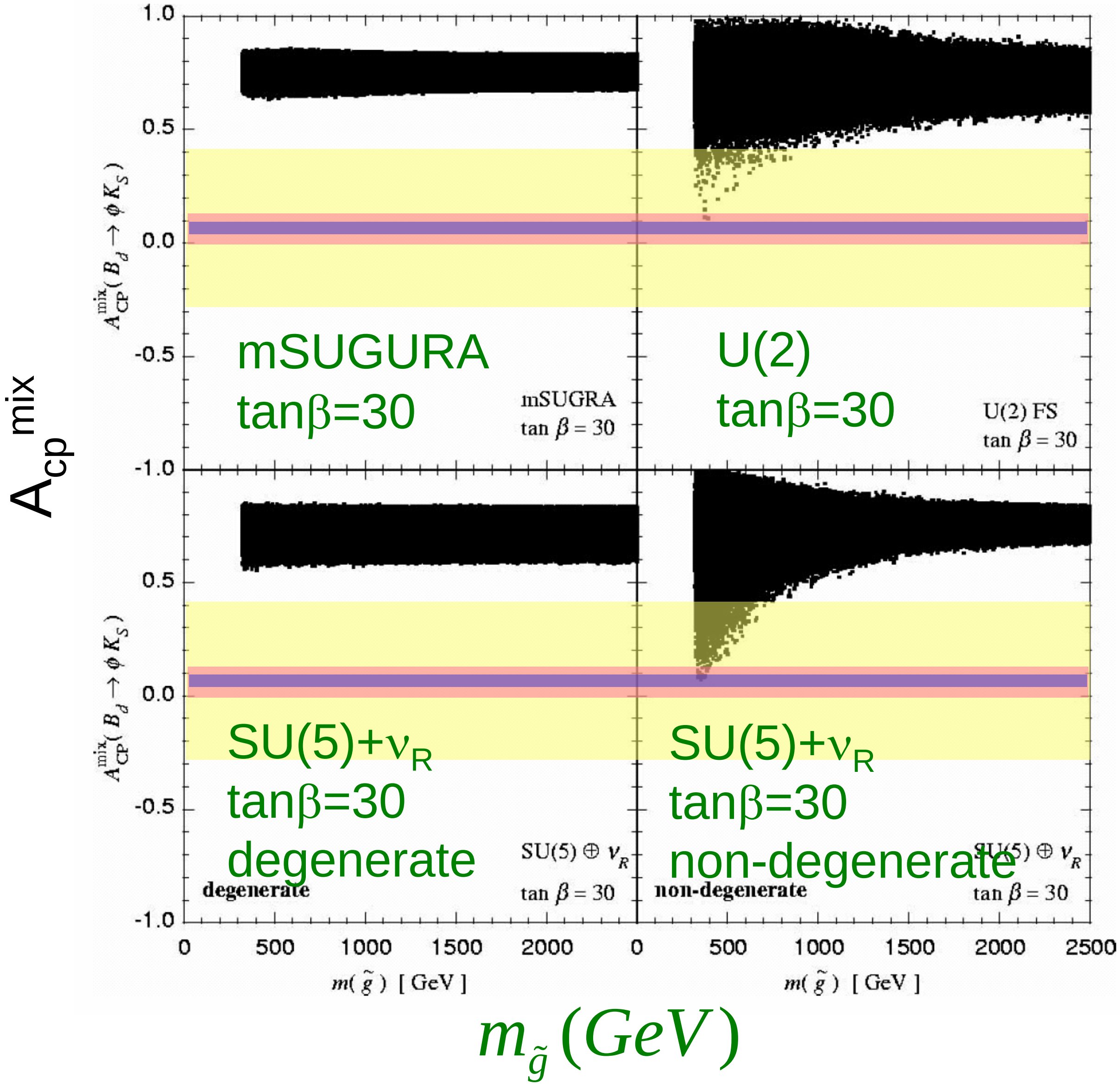
Y.Okada

Unitarity triangle | Rare decay

	Bd-unitarity	ε	Δ m(Bs)	B->ϕKs	B->Msγ indirect CP	b->sγ direct CP
mSUGRA	-	-	-	-	-	+
SU(5)SUSY GUT + νR (degenerate)	-	+	+	-	+	-
SU(5)SUSY GUT + νR (non-degenerate)	-	-	+	++	++	+
U(2) Flavor symmetry	+	+	+	++	++	++

++: Large, +: sizable, -: small

$A_{cp}(B \rightarrow \phi K_s)$ vs SUSY models



$280fb^{-1}$

$5ab^{-1}$

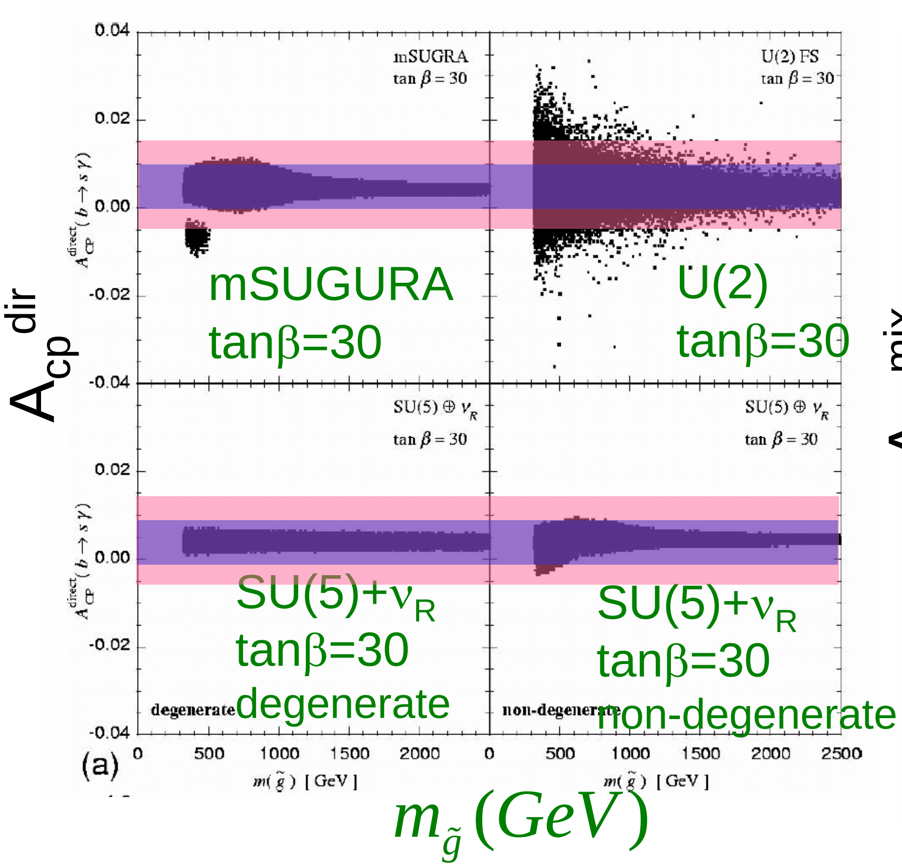
$50ab^{-1}$

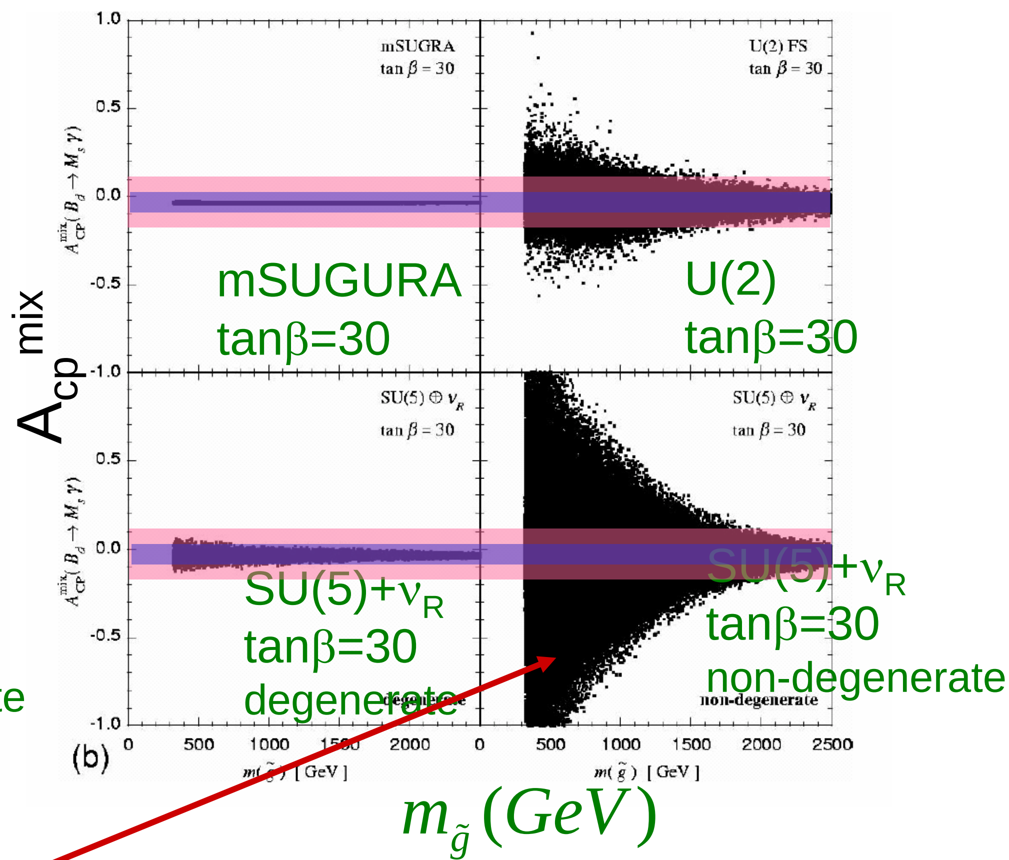
Acpが比較的小さければ早期にズレははっきりする。
その場合、M(gluino)~500GeVを示唆する。

$A_{cp}(B \to X_s\gamma)$ vs SUSY models

5ab-1　　50ab-1

Direct CPV　　Mixing CPV





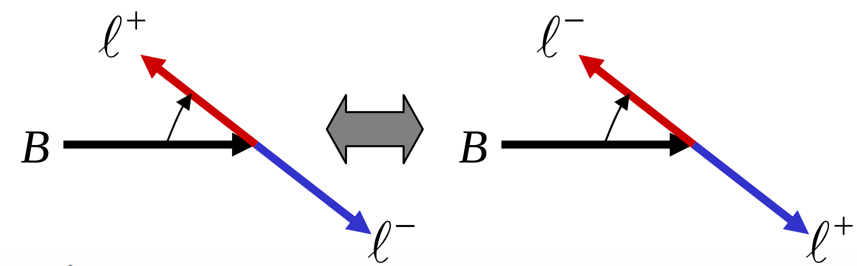
5ab-1 ではM(gluino)=1TeV, 50ab-1では2TeVまで攻める。

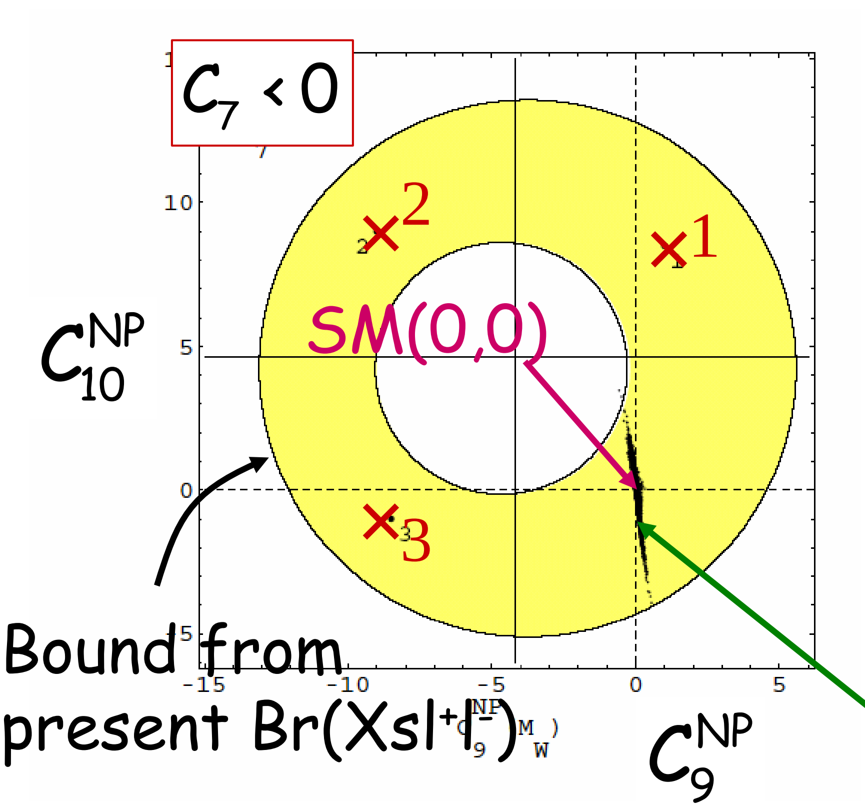
FB asymmetry in b→sl⁺l⁻

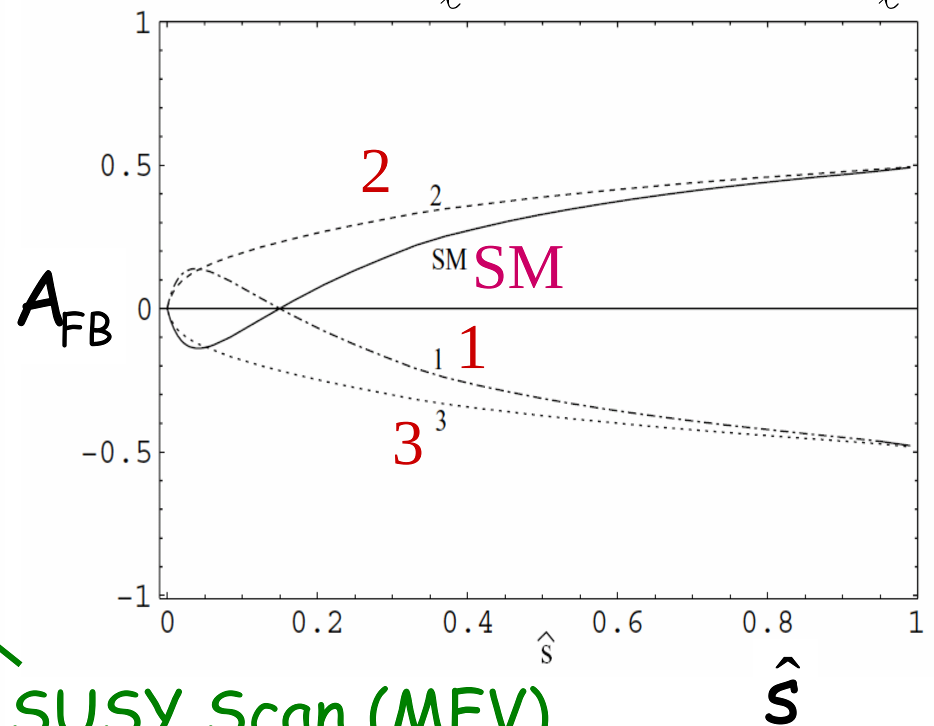
- Sensitive probe for NP (theoretically clean)

Br(B→Xsγ), Δ_{0+}(B→K*γ)

$$A_{FB} \propto \Re\left[C_{10}^{*}(sC_9^{eff}(s)+r(s)C_7)\right]$$

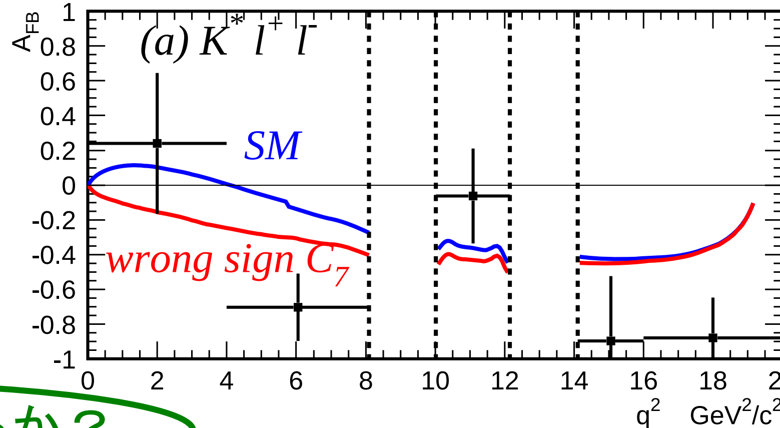






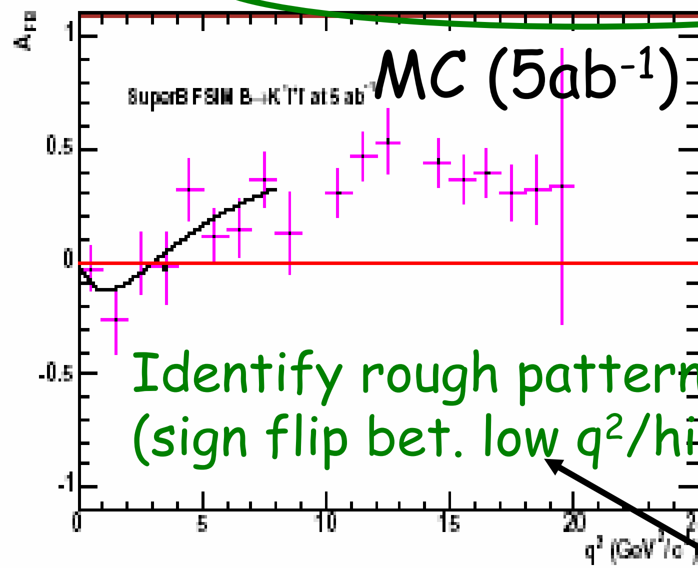
FB asymmetry in b→sl⁺l⁻ (cont'd)

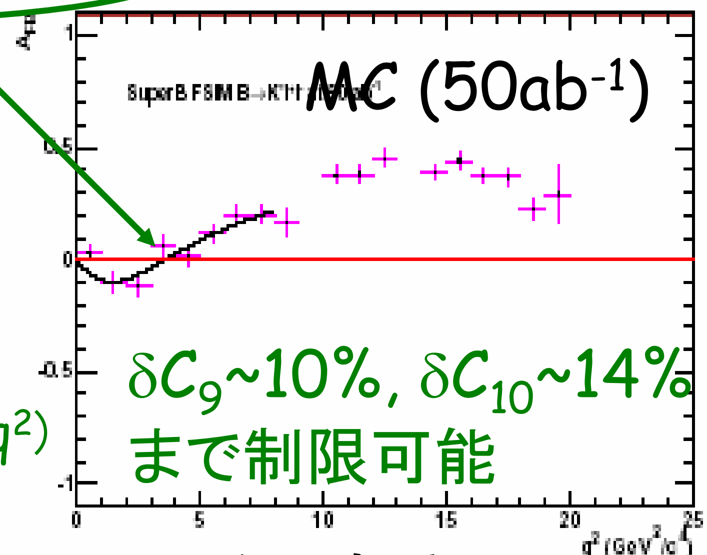
- Present status (250fb⁻¹)



- At Super-B

どこで Zero-cross するか？





Identify rough pattern
(sign flip bet. low q^2/high q^2)

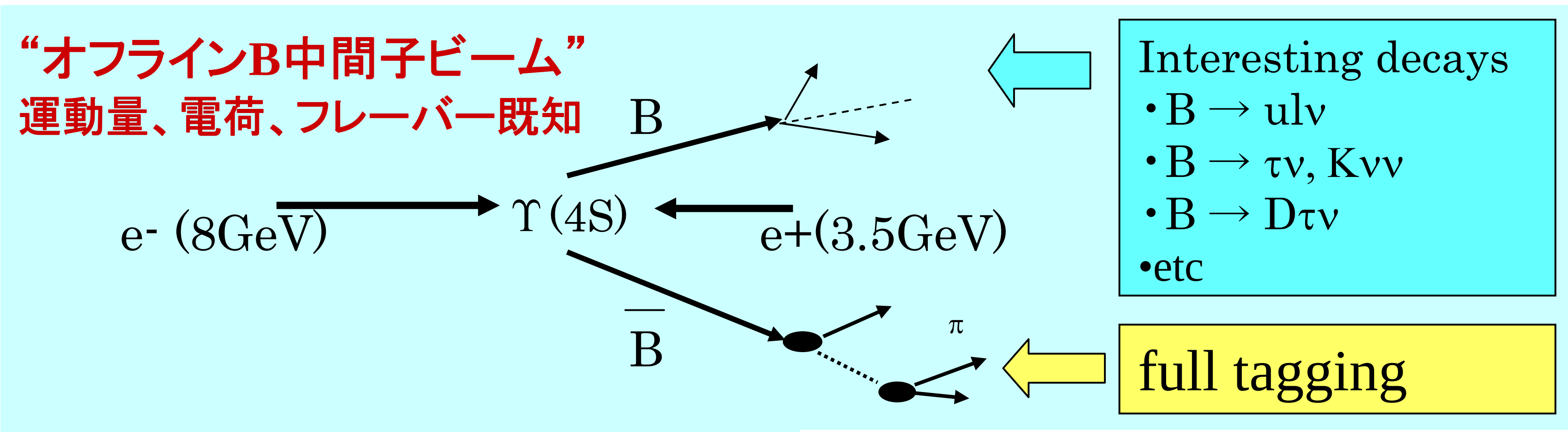
δC_9~10%, δC_{10}~14%
まで制限可能

PID（μ/π）も重要。

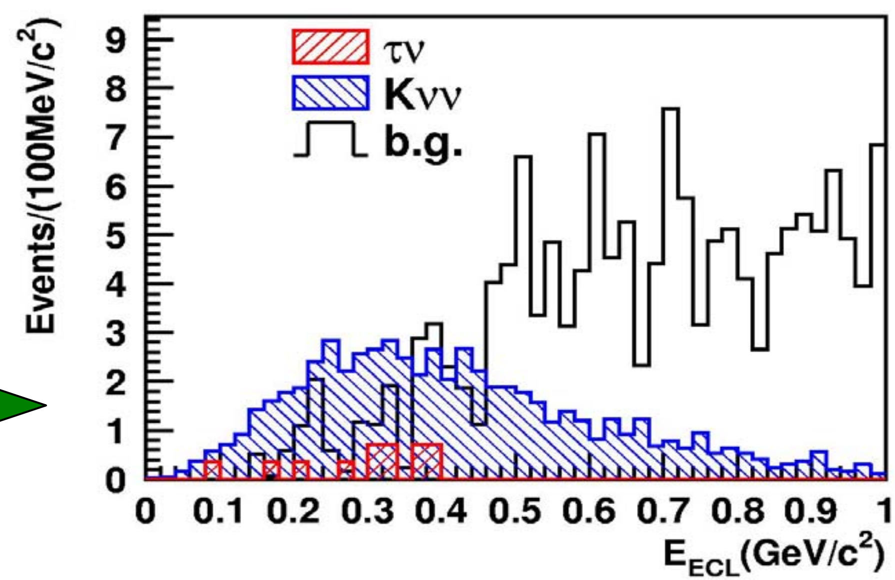
Branching fraction のdilepton mass 分布の測定も有効。

Full reconstruction

- 片側のB中間子を完全再構成して反対側のB崩壊をtagする。
- 特に、ν, τ を含む崩壊の精密測定や探索に威力。e+e- B factory でのみ可能。



- B→ Dτν: 12 σ observation at 5 ab^{-1}.
- B→Kνν: 5 σ observation at 50ab^{-1}.

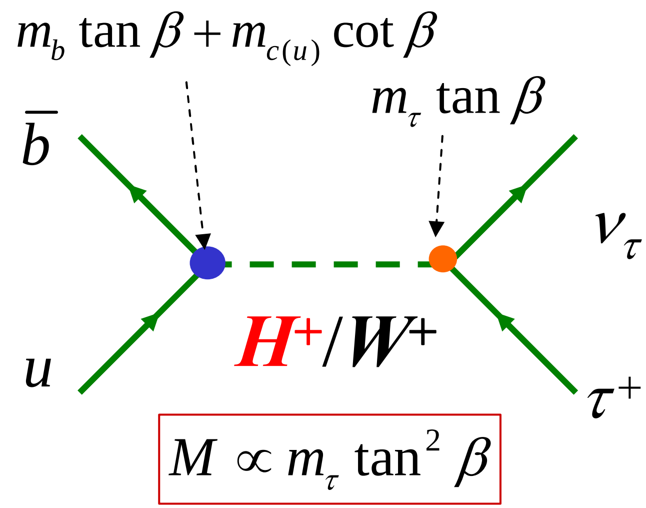


Charged Higgs 探索

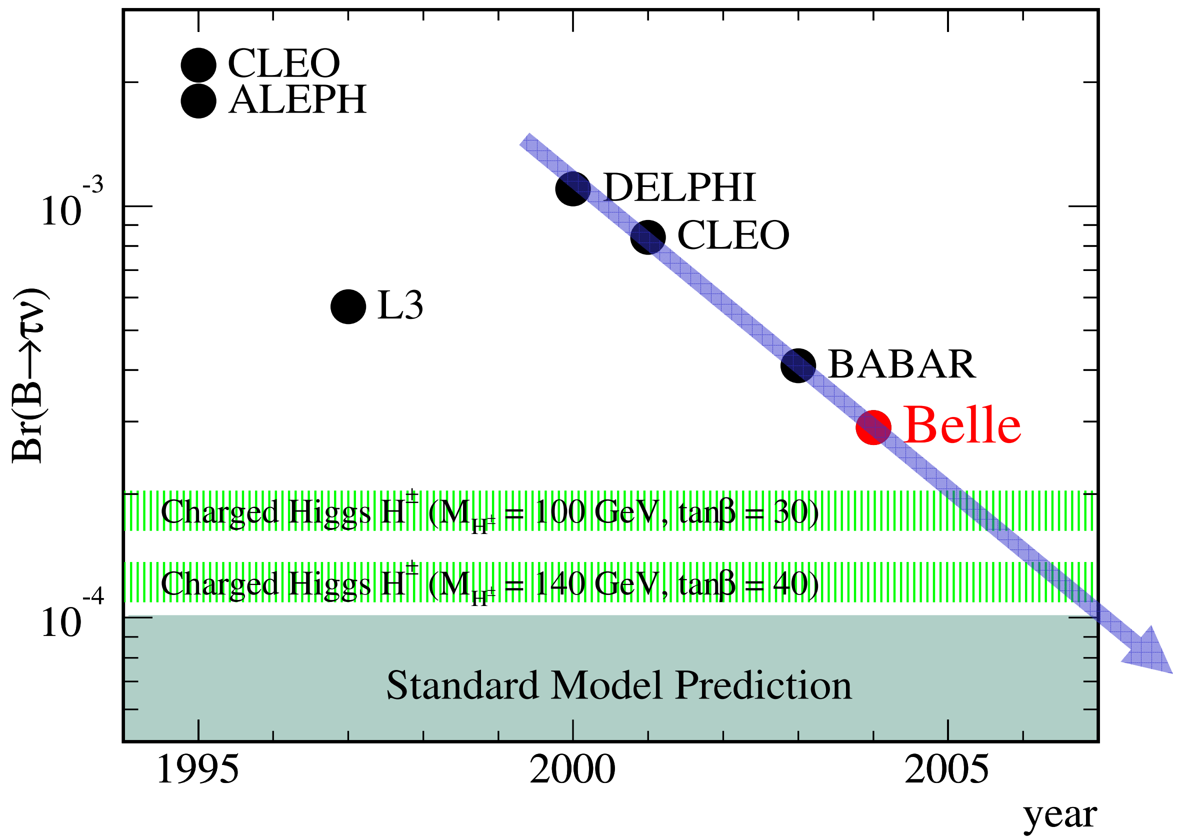
- B→τν (leptonic decay)

$$\Gamma(B \to \ell \nu) = \frac{G_F^2 m_B m_\ell^2 f_B^2}{8\pi} |V_{ub}|^2 \left(1 - \frac{m_\ell^2}{m_B^2}\right) \times r_H$$

$$r_H = 1 - \tan^2\beta \frac{m_B^2}{m_{H^\pm}^2}$$



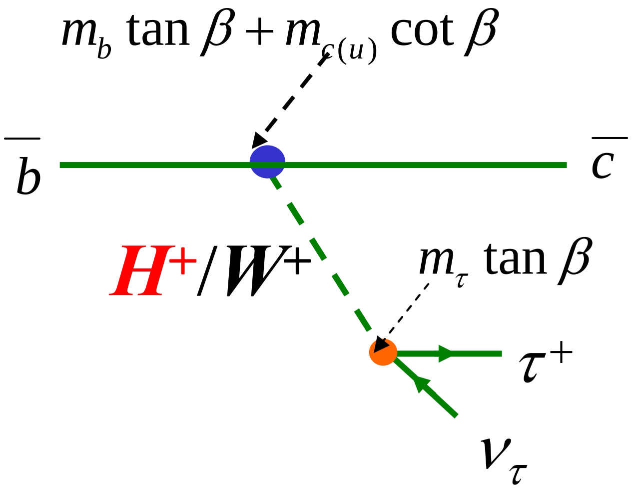
Present status →

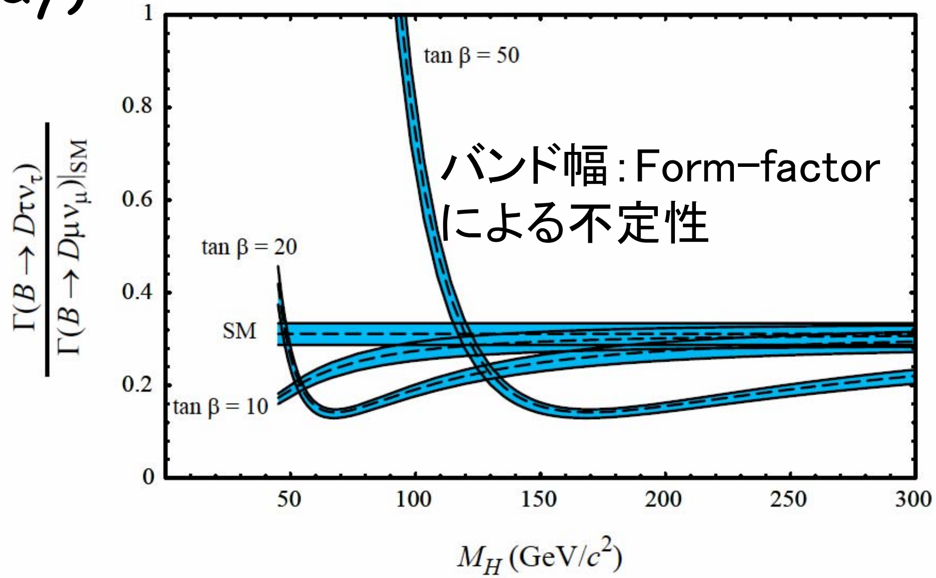


Charged Higgs 探索

$$B = \frac{\Gamma(B \to \bar{D}\tau\nu_\tau)}{\Gamma(B \to \bar{D}\mu\nu_\mu)}$$

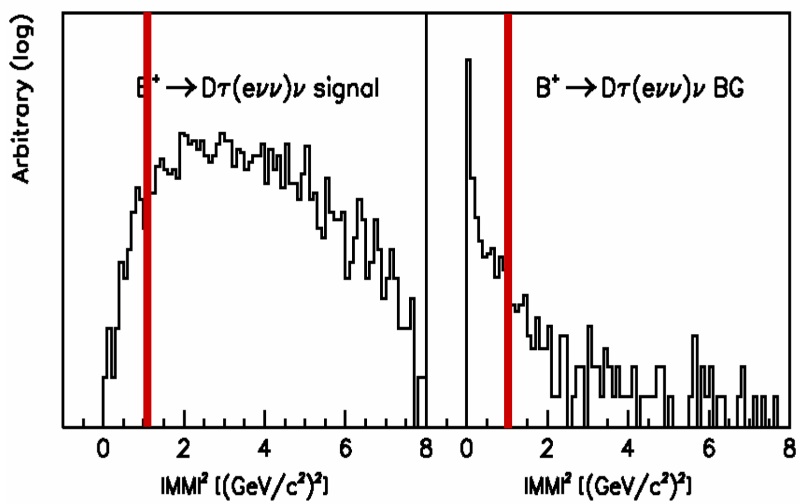
- B→Dτν (semileptonic decay)





- Signal → large missing mass
- Expected at 5ab^{-1}

Mode	Nsig	Nbkg	dB/B
$D^0\tau^+(\ell^+\bar{\nu}_\tau\nu_\ell)\nu_\tau$	280	550	7.9%
$D^0\tau^+(h^+\bar{\nu}_\tau)\nu_\tau$	620	3600	

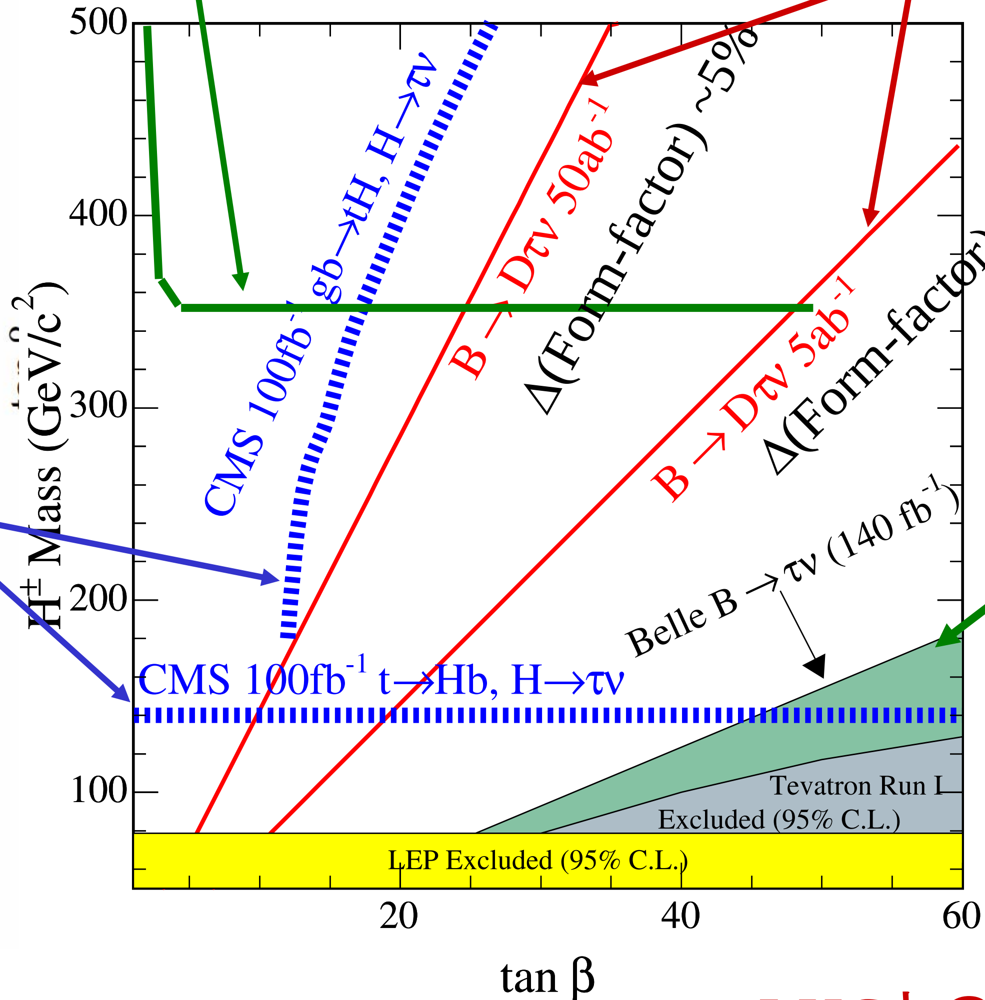


Sensitivity for charged Higgs

B→Xs γ による制限

B→Dτν

LHC 100fb-1



現在のB→τν による制限

Δ(form-factor)は
現在のB→Dμν
データで測定可能

LHCとの先陣争い。

Lepton Flavor Violation

LFV in neutrino sector already seen (at maximal mixing).

⇒LFV in charged leptons ?

Tau lepton

- The heaviest lepton → Enhancement in the rate
  ex.) $Br(\tau \rightarrow \mu\gamma) \sim 10^{4-5} \times Br(\mu \rightarrow e\gamma)$
- 3^{rd} generation → Both $3 \rightarrow 2(\mu)/3 \rightarrow 1(e)$ transition can be explored ⇒slepton flavor structure.

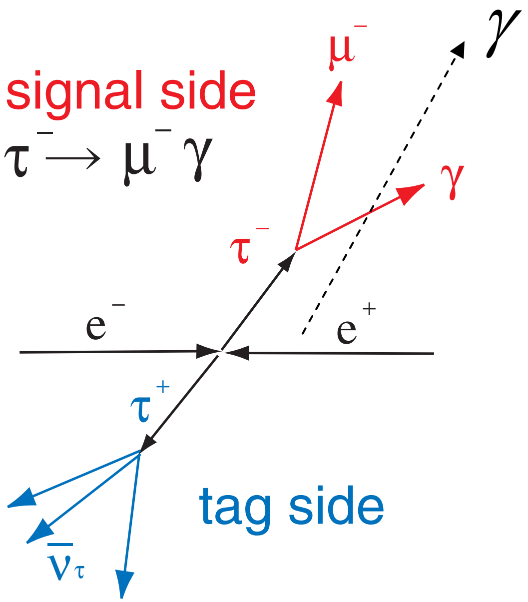
B-factory = "Tau-factory"

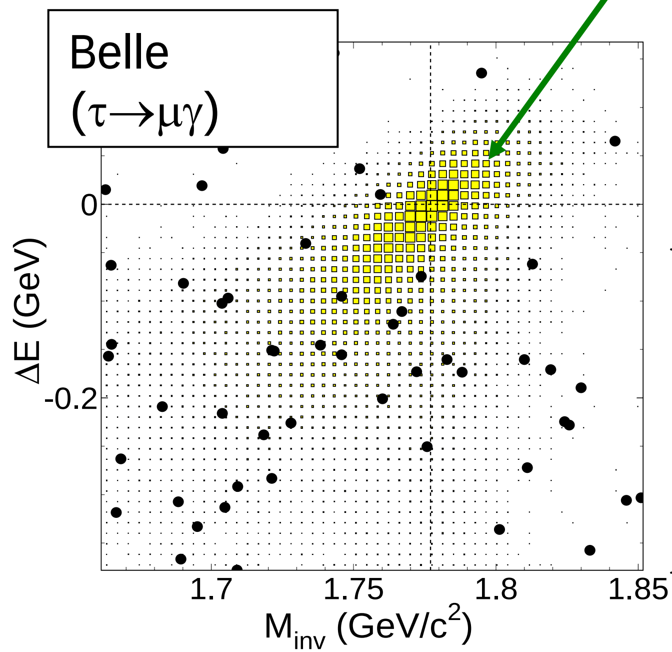
- $\sigma(\tau\tau) \sim \sigma(BB)$
- 5×10^9 τ pairs at $5ab^{-1}$

→ Rare decay sensitivity at $O(10^{-9})$

$\tau \rightarrow \mu\gamma$ measurements

- Present Belle results ($86 fb^{-1}$, 7.9×10^{7} t-pairs)
  - $Br(\tau \rightarrow \mu\gamma) < 3.1 \times 10^{-7}$ (90%CL)
  - $Br(\tau \rightarrow e\gamma) < 3.8 \times 10^{-7}$ (90%CL)





Expected signal distribution

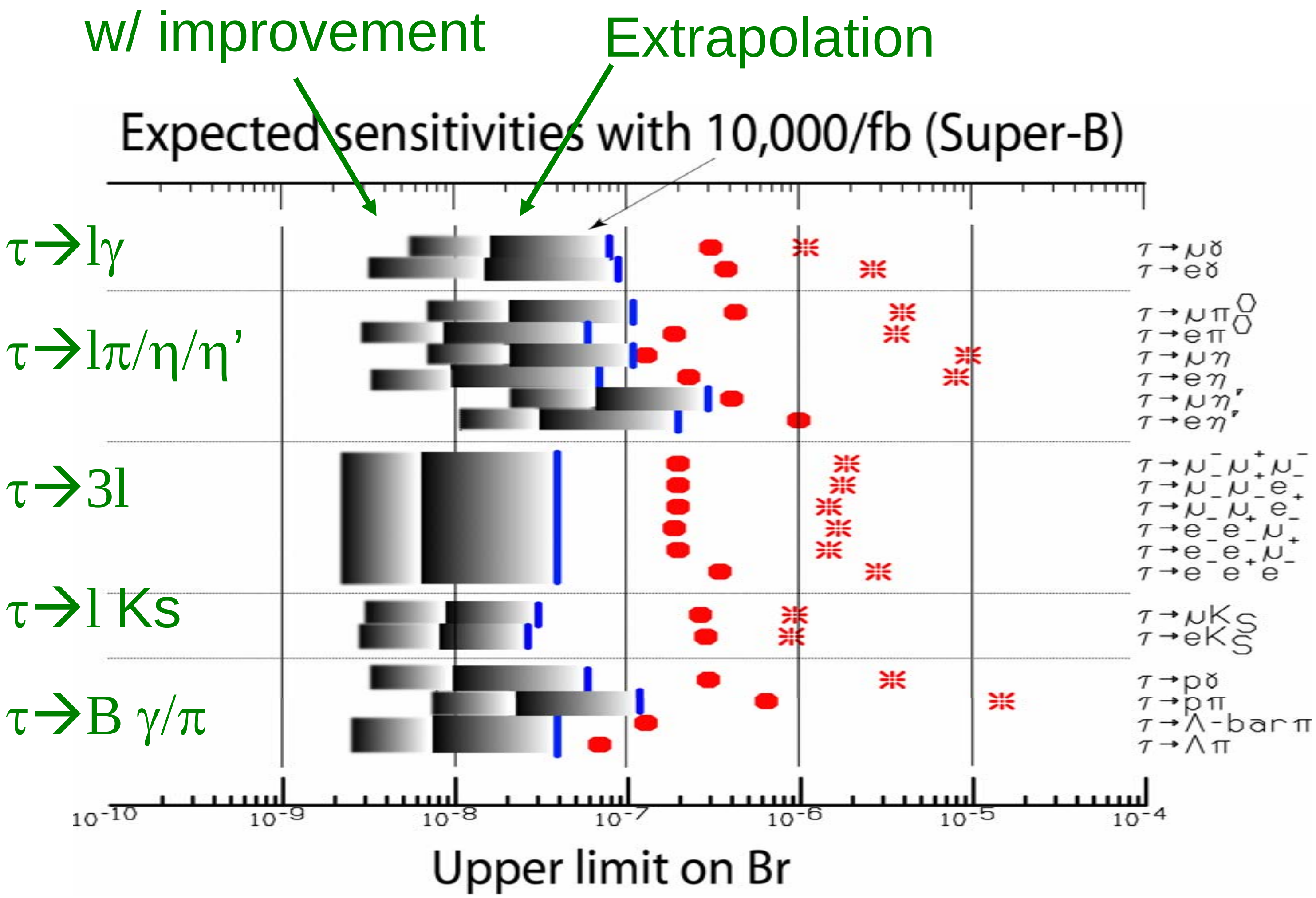
Background

- $\mu\mu\gamma$
- Mis-id ($\mu \rightarrow \pi$)
- $\tau\tau\gamma$ generic
- Escape from missing mass cut

Improvement

- Analysis (selection criteria, cut analysis → likelihood analysis)
- Particle ID (better rejection of $\mu \rightarrow \pi$ fake)
- γ energy resolution

Tau LFV search (past→future)

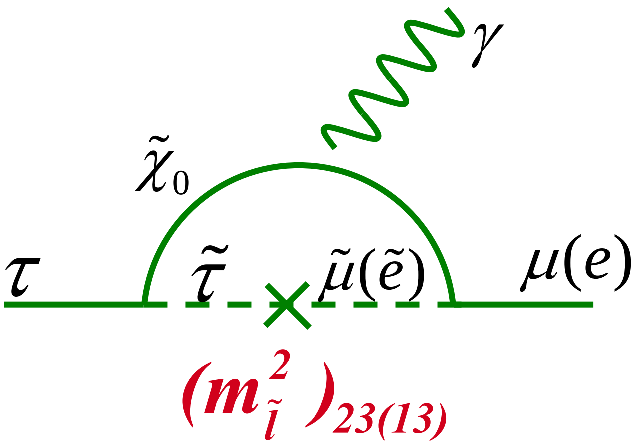


Search region enters into $O(10^{-8} \rightarrow 10^{-9})$

$\tau \to \mu\gamma / e\gamma$

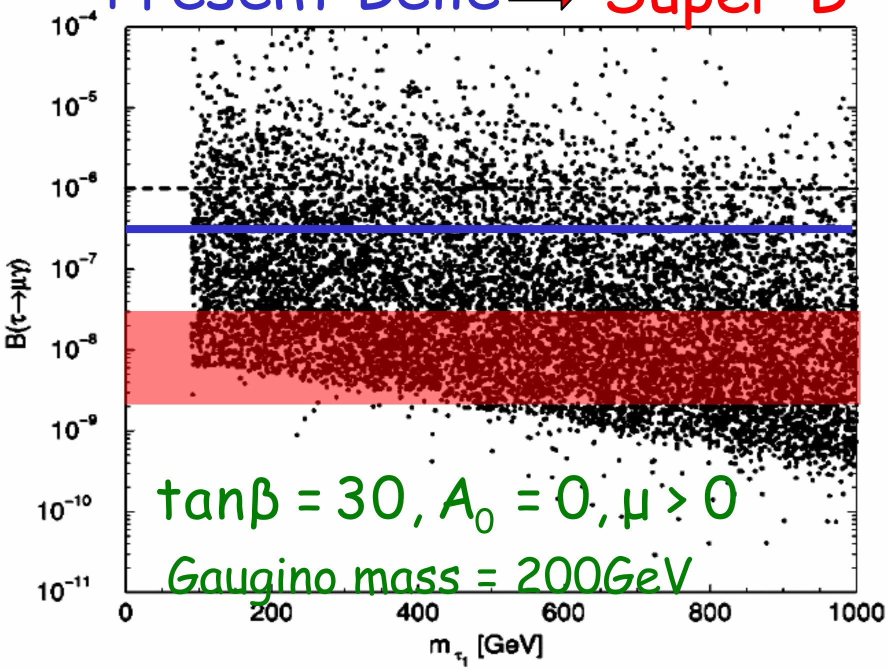
- SUSY + Seasaw
  - Flavor violation by ν-Yukawa coupling.
  - Large LFV $Br(\tau \to \mu\gamma) = O(10^{-7\sim9})$

$$Br(\tau \to \mu\gamma) \simeq 10^{-6} \times \left(\frac{(m^2_{\tilde{L}})_{32}}{\bar{m}^2_{\tilde{L}}} \right) \left(\frac{1\,TeV}{m_{SUSY}} \right)^4 \tan^2\beta$$

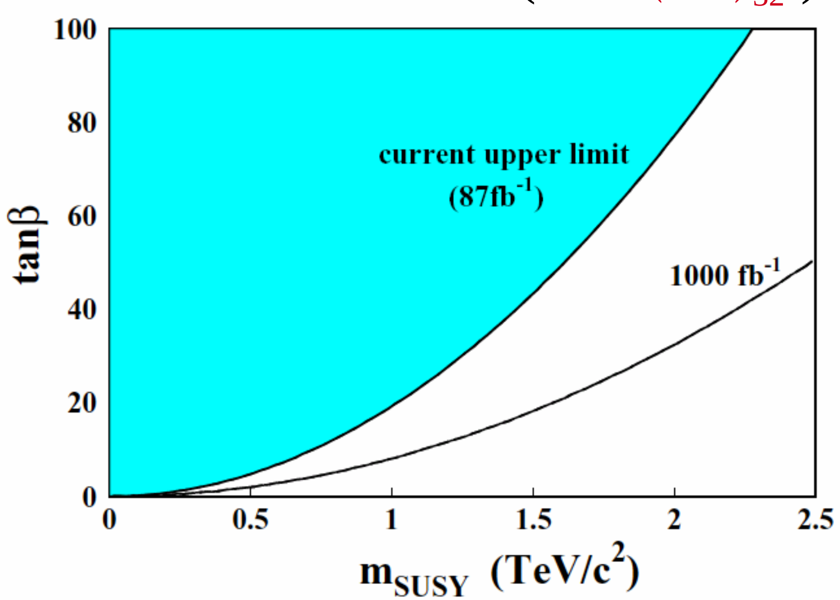


Similar for eγ case

Present Belle ➡ Super-B



探索可能な領域 $(\max.(m^2_{\tilde{L}})_{32})$



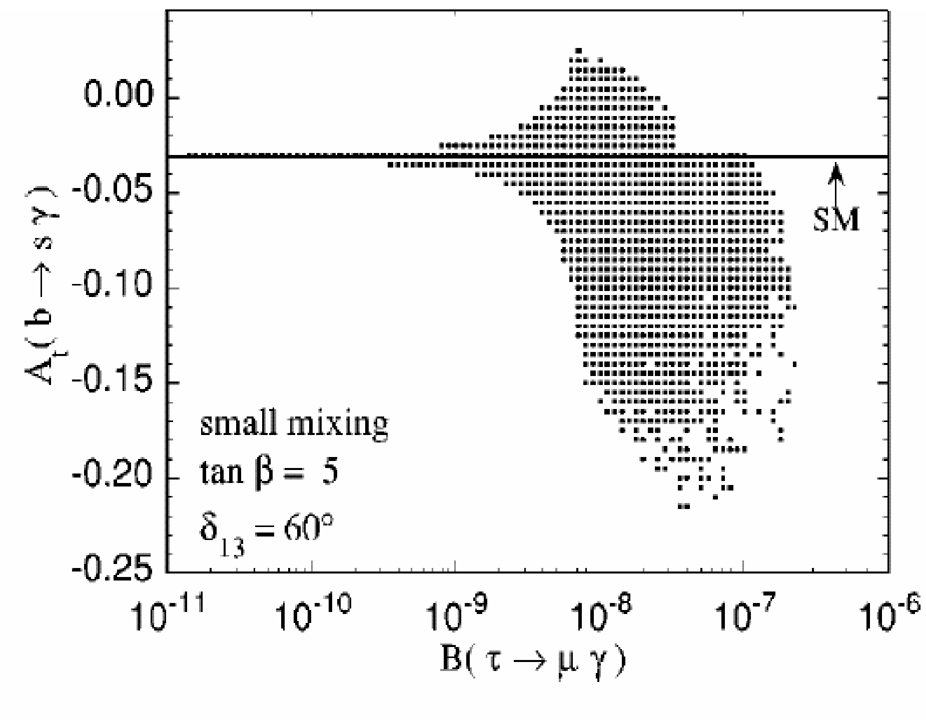
$\tau \to \mu\gamma$ in SUSY GUT

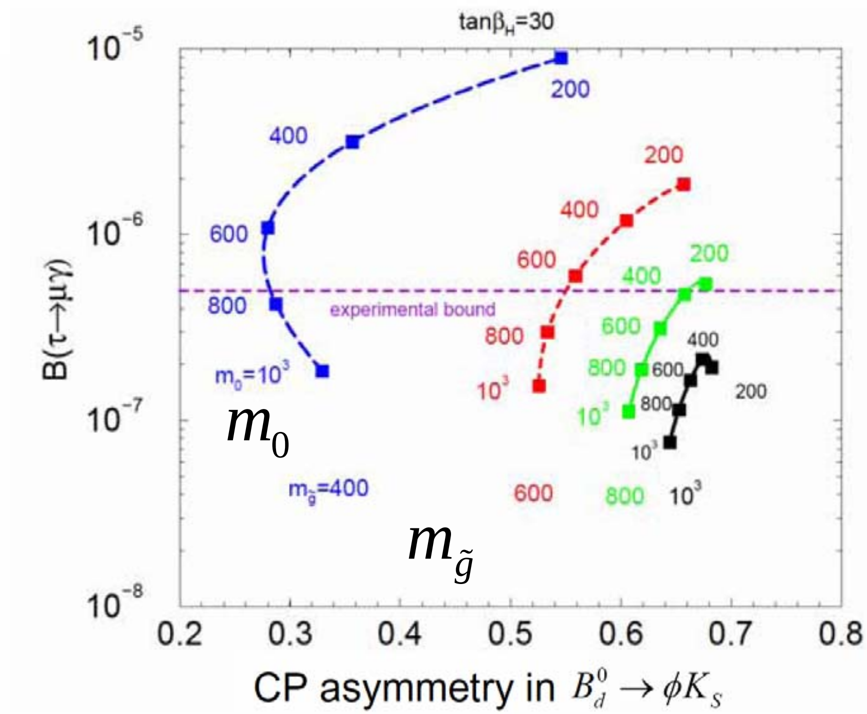
SU(5) GUT+ν_R

Squark/slepton mass matrix relation

$$\left(m^2_{\tilde{d}_R}\right)_{23} \approx \left(m^2_{\tilde{l}_L}\right)_{23} e^{i(\varphi_2 - \varphi_3)}$$

➡ Correlation to $A_{cp}^{mix}(B \to X_s\gamma)$ and $A_{cp}^{mix}(B \to \phi K_s)$

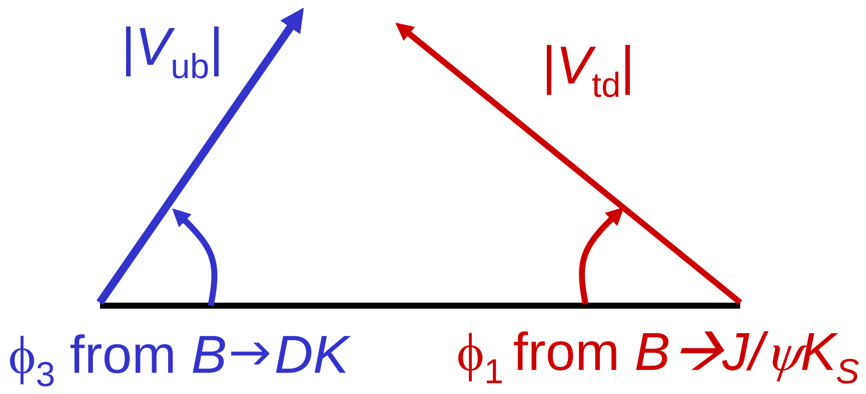




These correlations provides non-trivial test of SUSY GUT

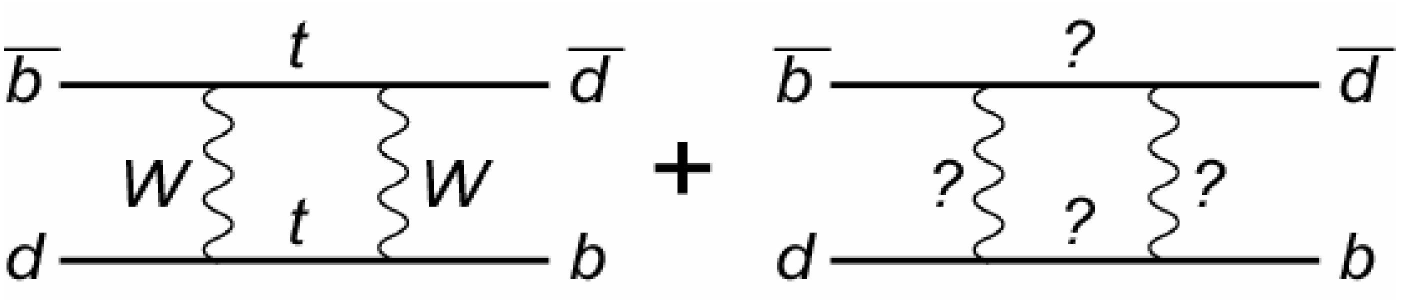
CKM fit

- Determine (ρ,η) only by tree processes (SM dominant).
  - $|V_{ub}|$ from $b \to u l \nu$
  - ϕ_3 from $B \to DK$



- Compare it with (ρ,η) determined through
  - $|V_{td}|$ from BB mixing, i.e. ΔM_d
  - ϕ_1 from $B \to J/\psi K_S$

- This gives $M_{12} = M_{12}^{SM} + M_{12}^{NP}$



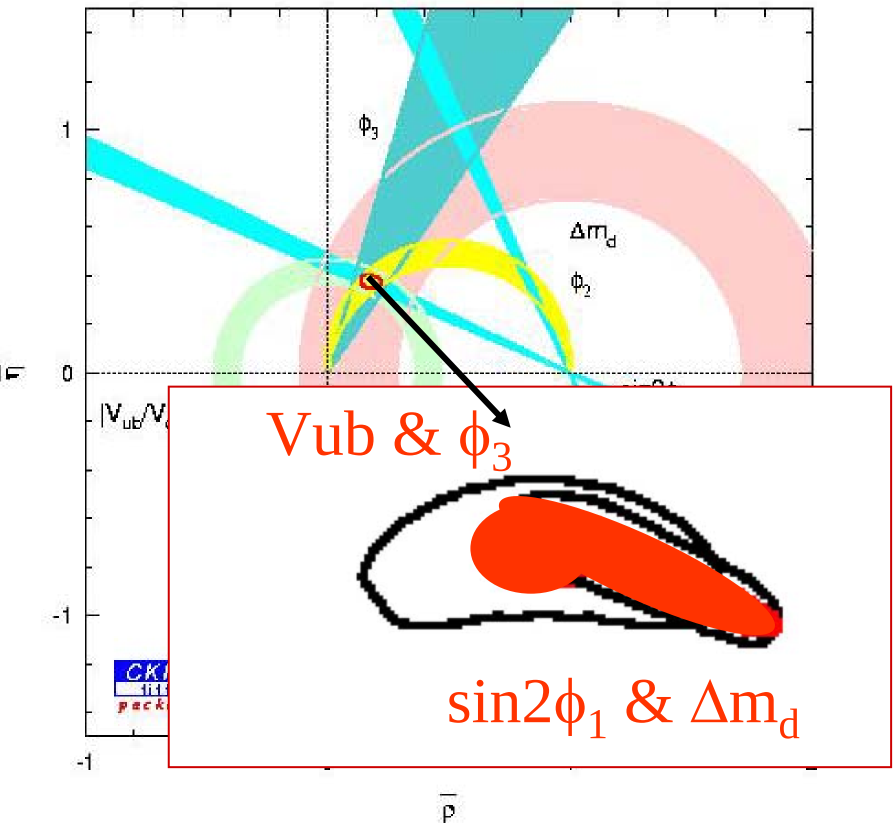
UT at Super-B

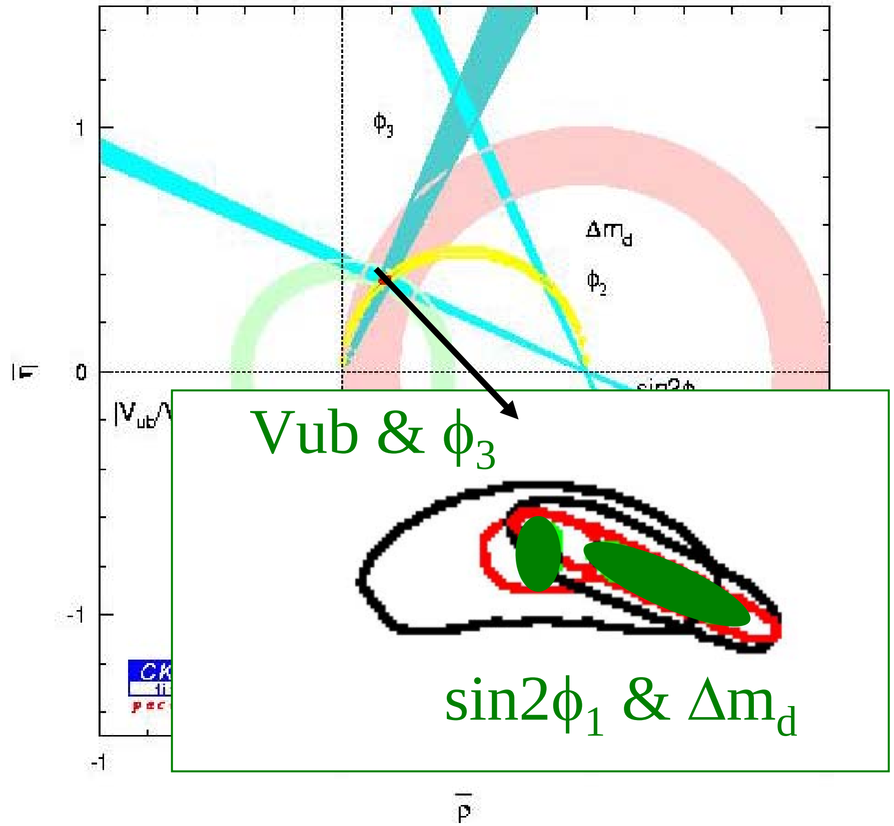
5 ab^{-1}

$$\Delta \sin 2\phi_1 = 0.019$$
$$\Delta(f_B\sqrt{B_d}) = 0.011 \pm 0.026$$
$$\Delta |V_{ub}| = 5.8\%$$
$$\Delta\phi_3 = 4^\circ$$

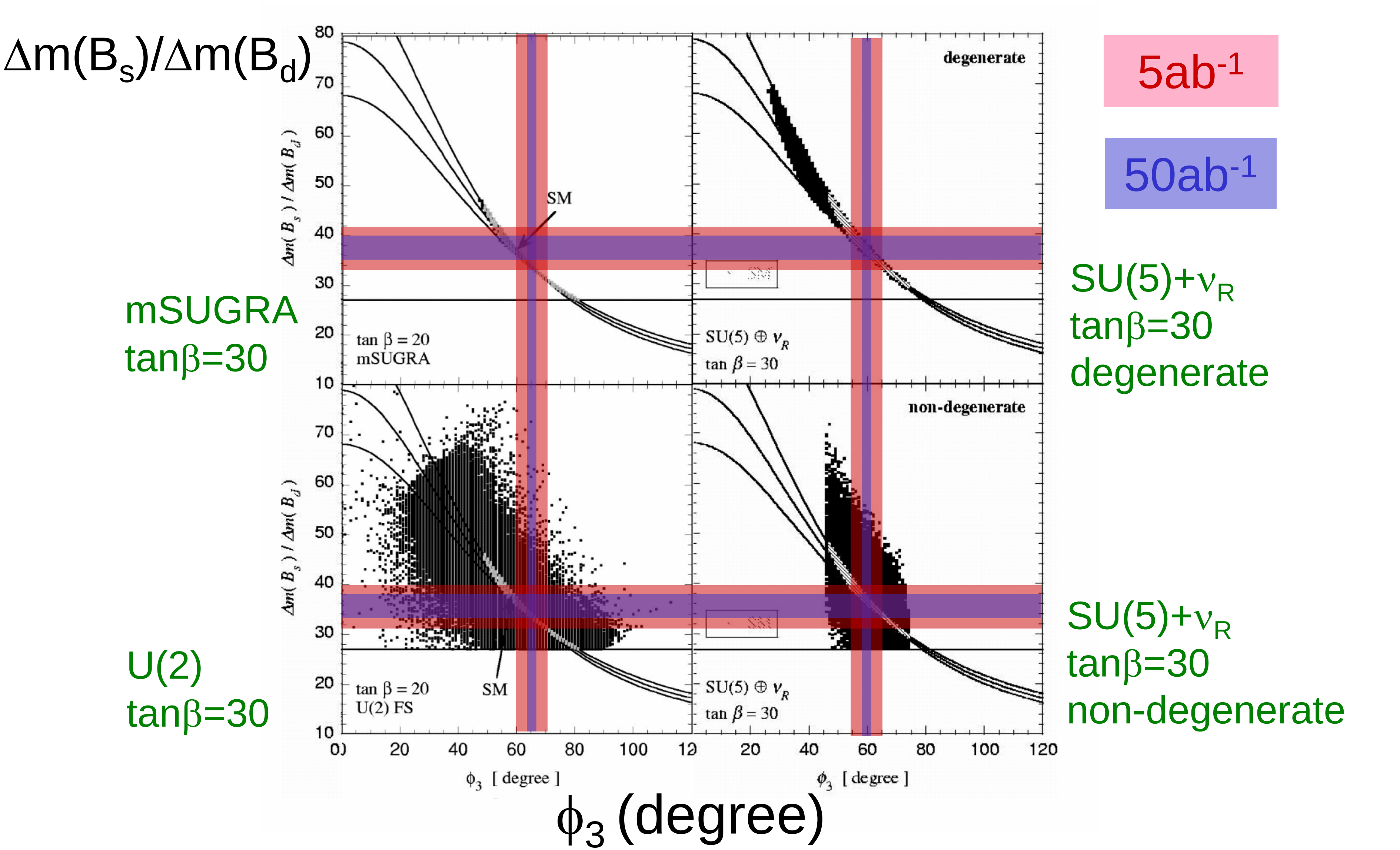
50 ab^{-1}

$$\Delta \sin 2\phi_1 = 0.014$$
$$\Delta(f_B\sqrt{B_d}) = 0.005 \pm 0.015$$
$$\Delta |V_{ub}| = 4.4\%$$
$$\Delta\phi_3 = 1.2^\circ$$





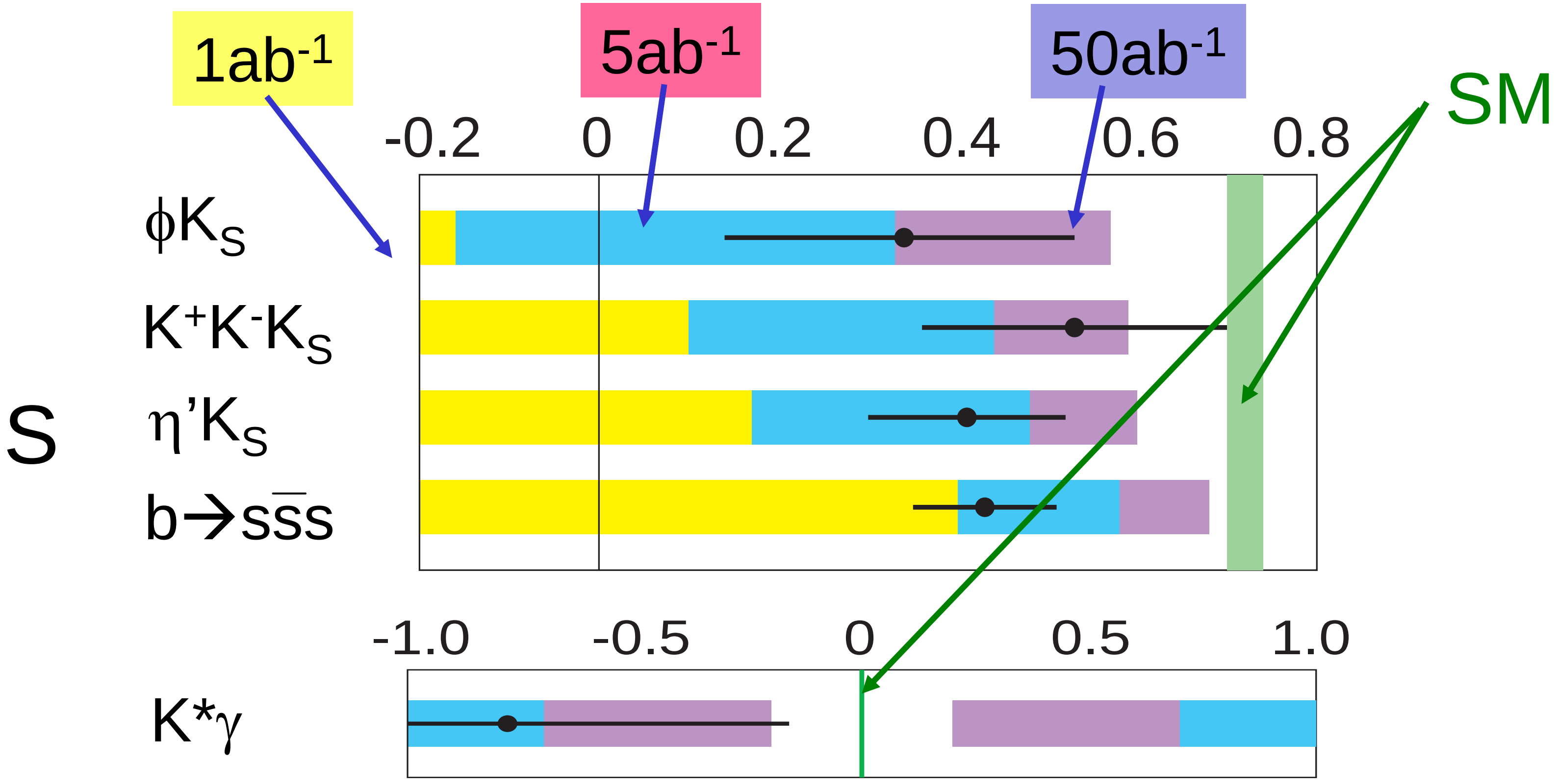
UT vs SUSY models



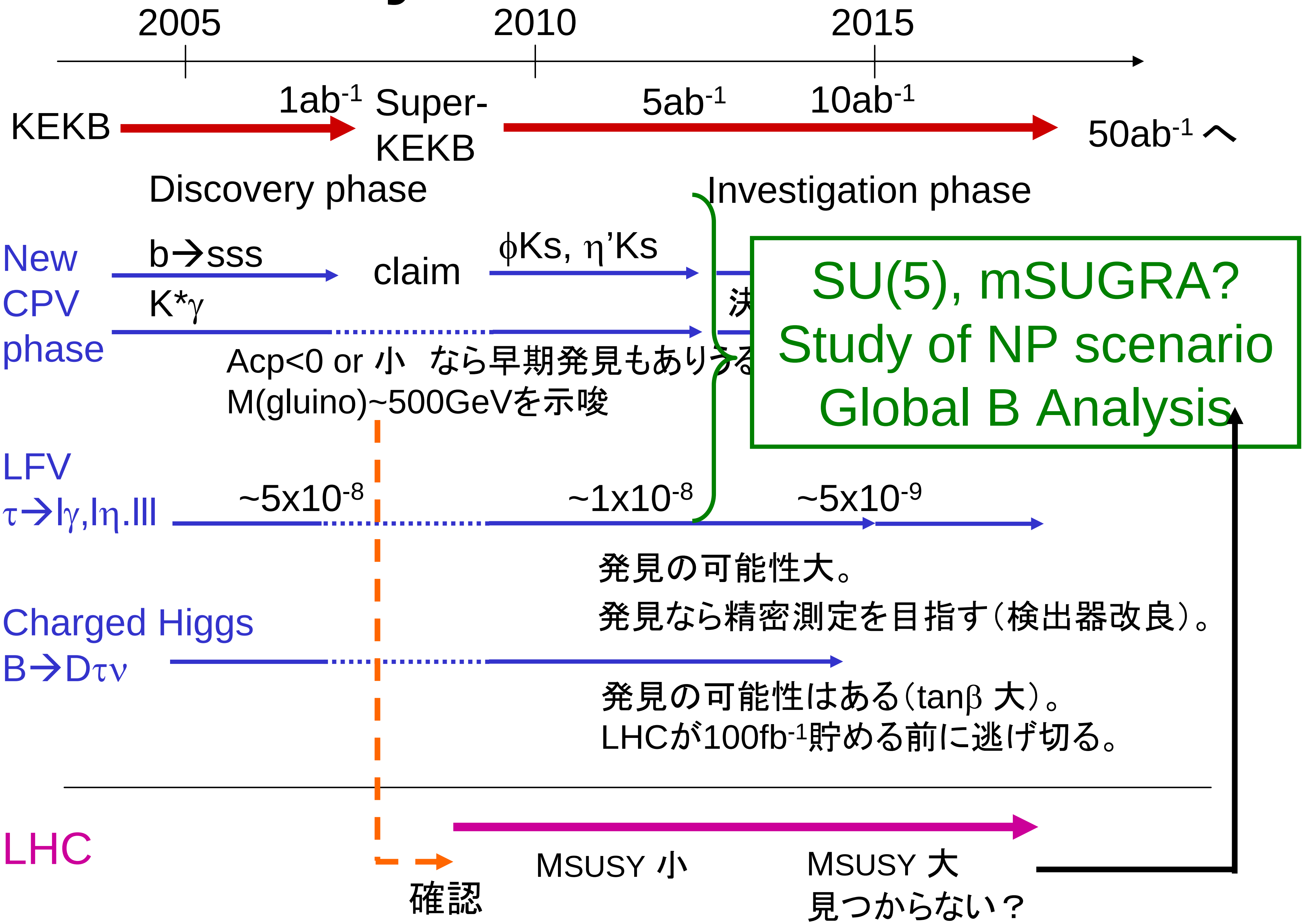
Summary-1

- New CPV phase の発見可能性
  - 中心値による
  - 5ab^{-1} で可能（2012年頃？）
  - B→s$\bar{s}$s 平均については1ab^{-1}でも可（2007年）

"ずれ">5σとなる領域



Summary-2



2005
2010
2015
KEKB
1ab-1
Super-
KEKB
5ab-1
10ab-1
50ab-1へ
Discovery phase
Investigation phase
New
CPV
phase
b→sss
K*γ
claim
φKs, η'Ks
決
Acp<0 or 小　なら早期発見もありう
M(gluino)~500GeVを示唆
SU(5), mSUGRA?
Study of NP scenario
Global B Analysis
LFV
τ→lγ,lη.lll
~5x10-8
~1x10-8
~5x10-9
発見の可能性大。
発見なら精密測定を目指す（検出器改良）。
Charged Higgs
B→Dτν
発見の可能性はある（tanβ 大）。
LHCが100fb-1貯める前に逃げ切る。
LHC
確認
MSUSY 小
MSUSY 大
見つからない？

結論

Discovery:

Super-B は、ループ効果による新粒子探索のフロンティア
New Physics の間接発見をできる可能性は十分にある。

Investigation:

Super-B で、種々のフレーバー遷移過程を測定することによって、New Physics scenario の検証が可能。

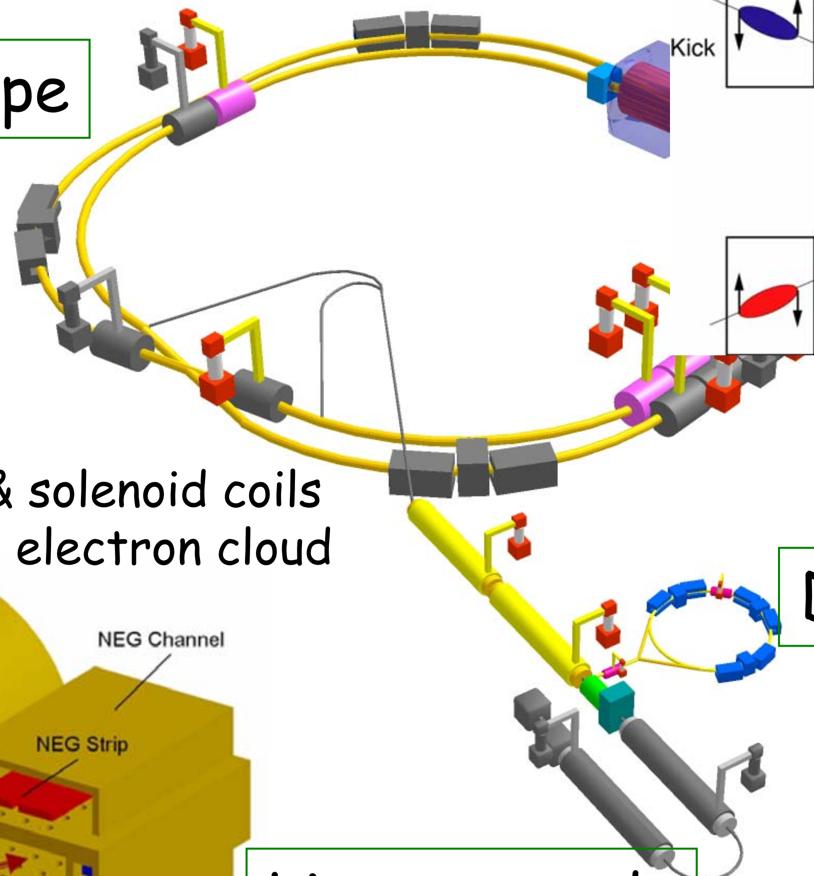
2009年前後に Super-B へのアップグレードを行えば、上記のような研究をLHC実験と同時期にできる。

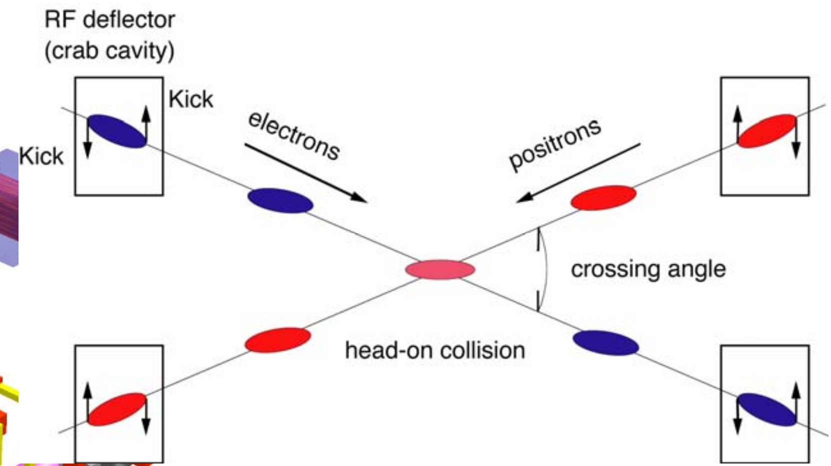
Super-Bの物理の重要性はLHC/ILCと補完的。LHCでSUSYが見つからない（或いは重い）場合、Super-Bの物理はさらに重要。

FCNC＋LFV

Super-KEKB upgrades

New beam pipe

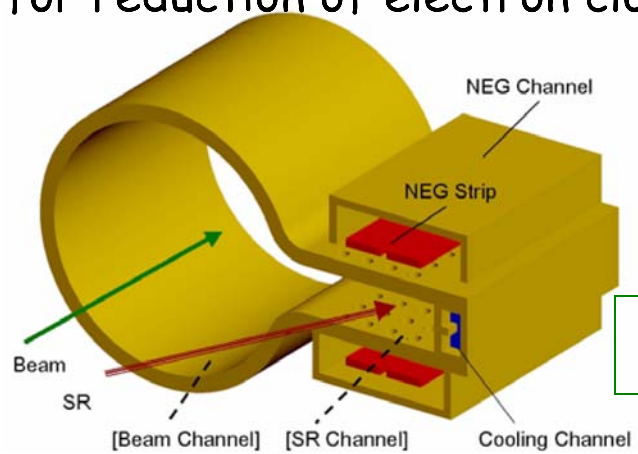




More rf power

Damping ring

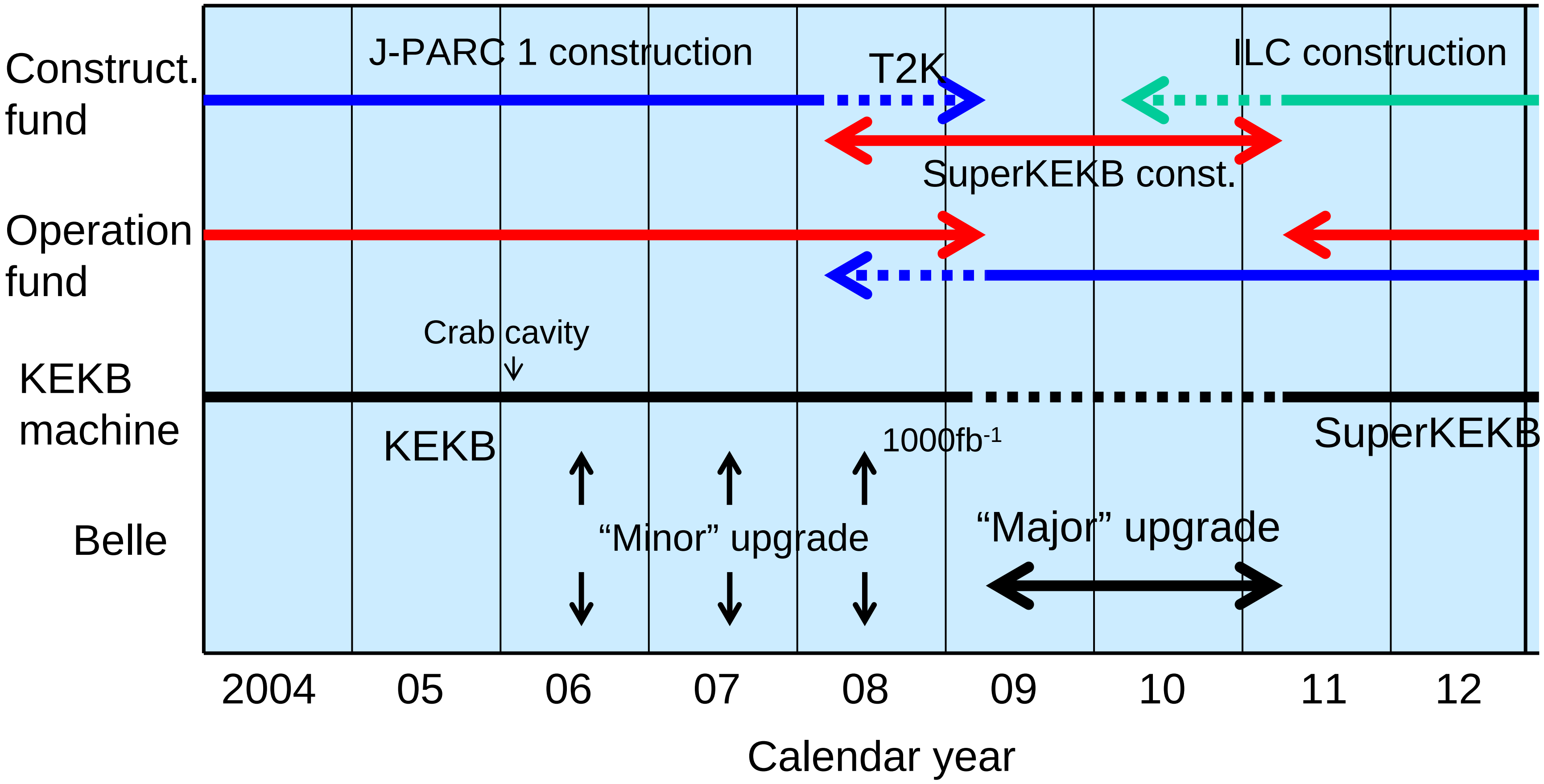
Ante-chamber & solenoid coils
for reduction of electron cloud



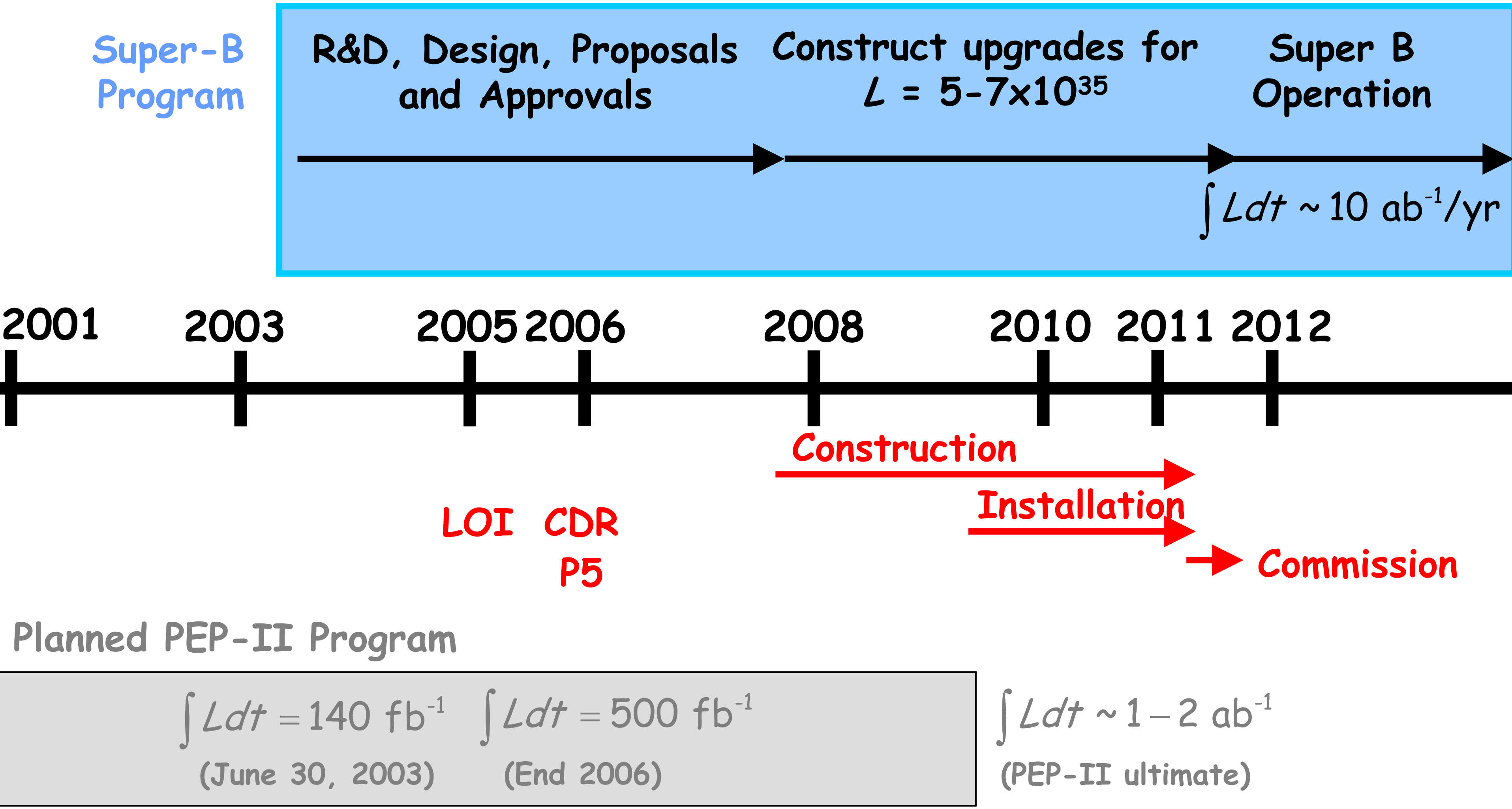
Linac upgrade

LOI (Jan 04) for SuperKEKB
[http://belle.kek.jp/superb/]

HEP Scenario in Japan



Possible Timeline for Super PEP Program



結論とまとめ

- Bファクトリーはこれまで．．．
  - B中間子におけるCPVの発見、精密測定
  - ユニタリティ三角形の決定
  - 直接的CPVの発見
  - b→sペンギンにおける異常CPV：新しい物理？
  - 新しい共鳴の発見、4-quark？
  - Bの稀崩壊の系統的研究
- この延長としてSuper-Bを提案
  - 異常CPVの確立と精密測定
  - b→sl^+l^-などの測定によるループの直接測定
  - CKMの精密な決定
  - LFV、$H^\pm$の探索

．．．などによって、新しいフレーバー混合とCPVを解明

- SLACと協調し、新たな実験グループの創設へ
- ILCと干渉しない国内計画として適正規模