Recent results on $B \rightarrow X(s)\gamma$ and $B \rightarrow X(s)l^+l^-$ Measurements with Belle

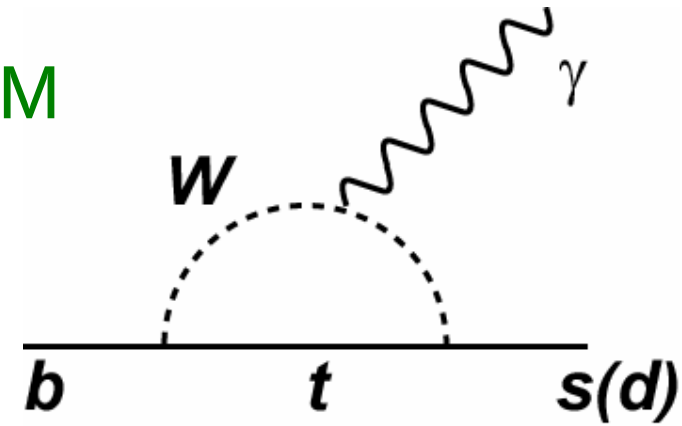
M. Iwasaki
University of Tokyo
For the Belle Collaboration

特定領域「質量起源と超対称性物理の研究」

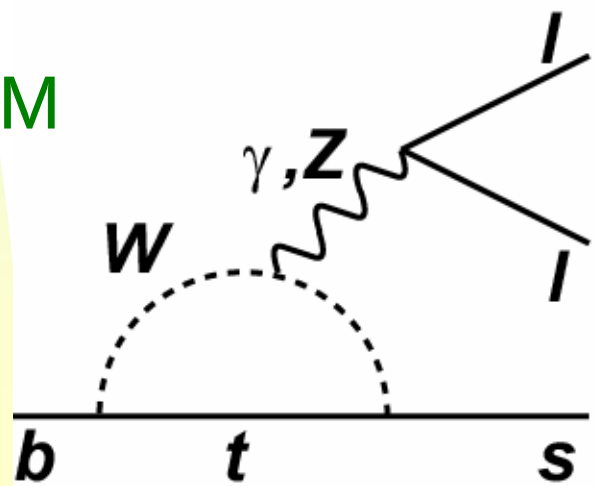
Introduction (I)

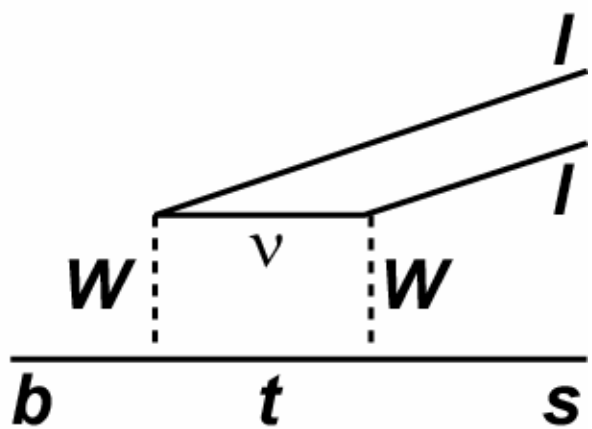
- b→sγ, b→sll : FCNC processes
  In SM, FCNC are forbidden at tree level
- Lowest order diagram : One-loop Penguin or Box

b→sγ in the SM



b→sll in the SM





Introduction (II)

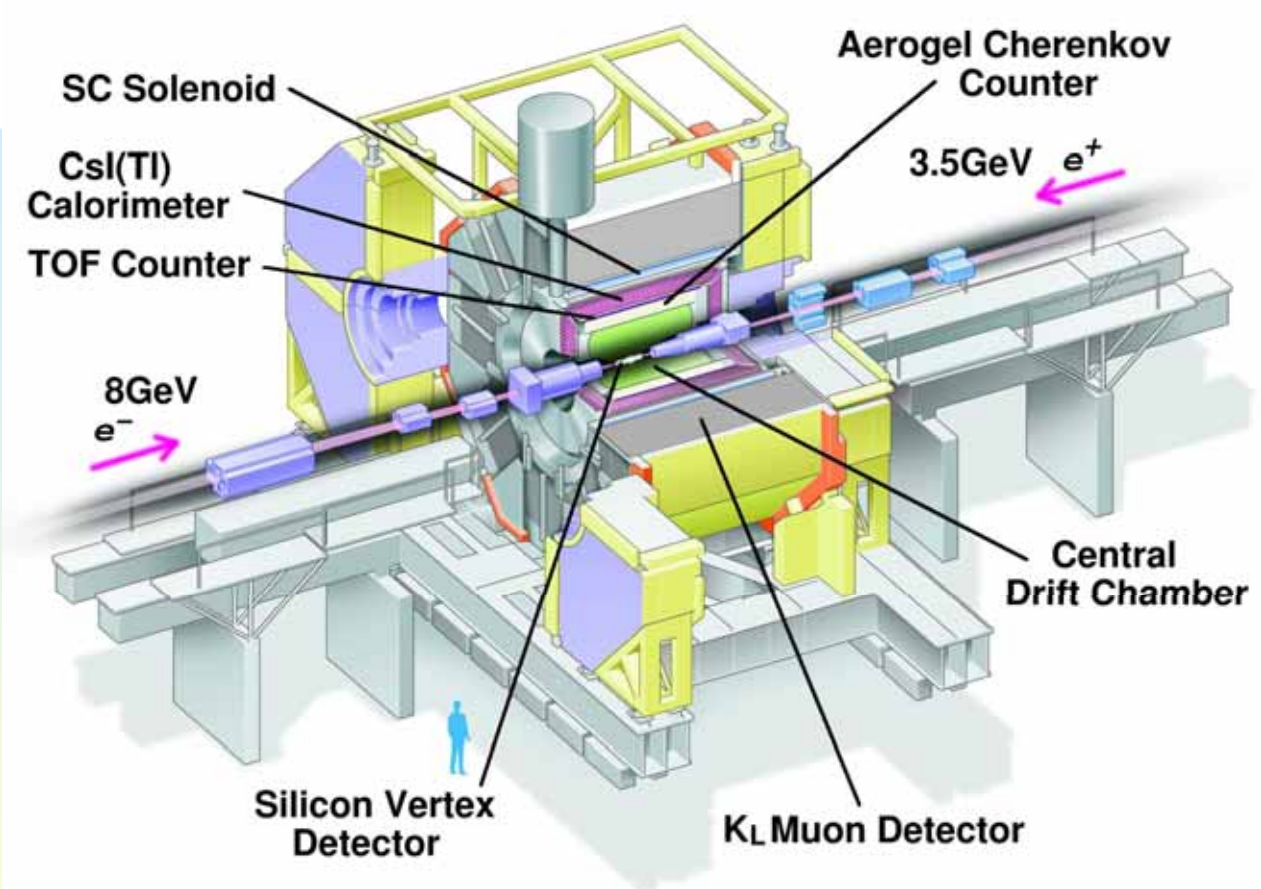
- Sensitive to New Physics
  - → Branching fraction, A_{cp},
    Kinematical distributions q^2, A_{FB}

- -

In this talk, we'll show

1) **Exclusive B→K*(892)γ** (Br, Δ_{0+} , A_{cp})
2) **Inclusive B→Xsγ** (Br, E_γ spectrum)
3) **Exclusive B→$K^{(*)}l^+l^-$** (Br, q^2 spectrum)
4) **Semi-inclusive B→Xsl^+l^-** (Br, M_{ll} and M_{xs} spectrum)

Belle Detector

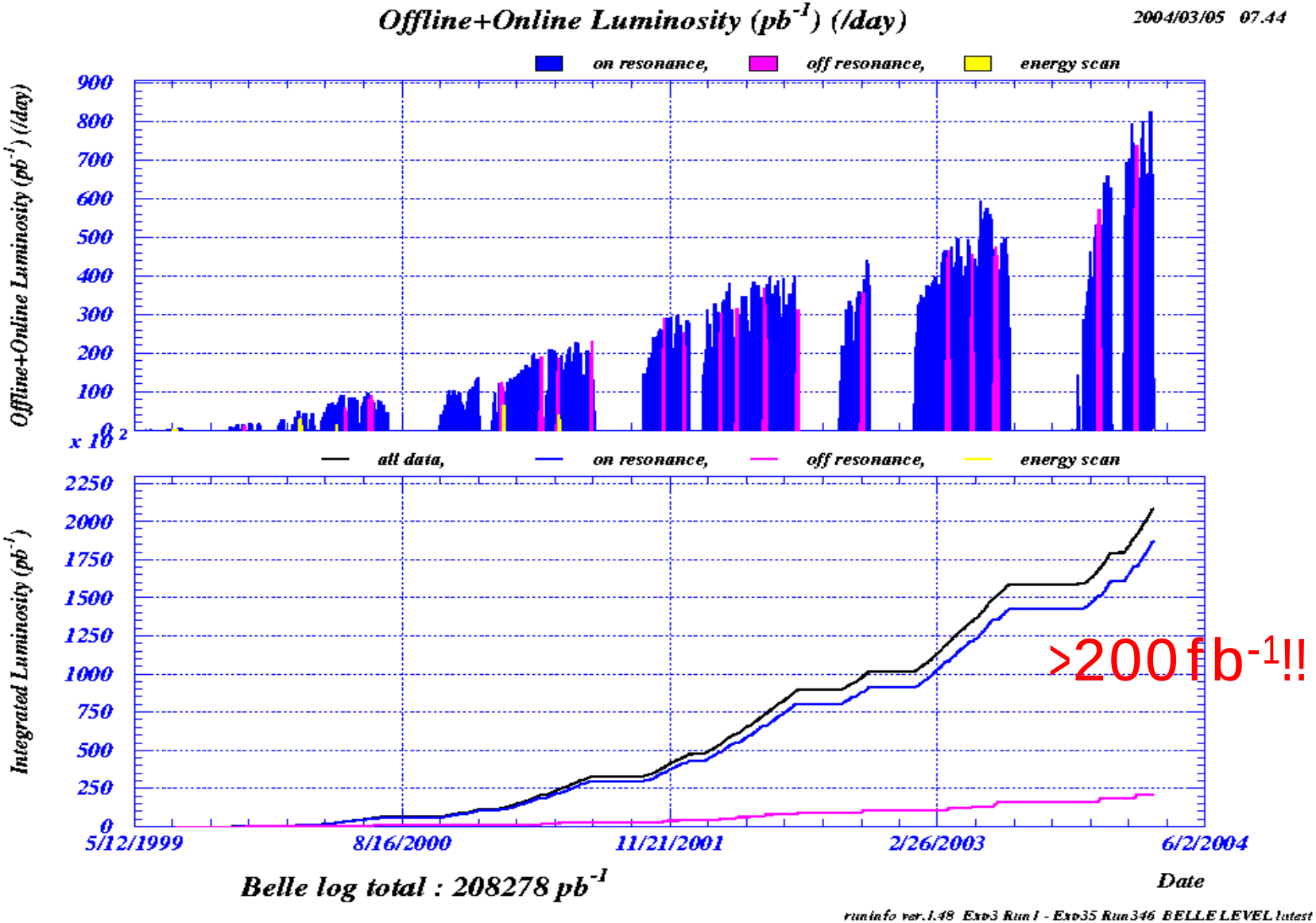


γ energy resolution σ_E/E = 1.5% (at E=2.5GeV)

Electron ID P>500MeV, ε=91%, fake rate = 0.2%

Muon ID P>1.0GeV, ε=83%, fake rate = 1.5%

Belle Luminosity



>200fb^{-1}!!

Record : 818.8pb^{-1}/day peak 1.20x10^{34}/cm^2/sec

Exclusive B→K*(892)γ

Analysis of B→ K*γ

- Reconstruct K* from $K^+\pi^0$,$Ks^0\pi^+$,$K^+\pi^-$,$Ks^0\pi^0$
- Main Background … continuum
- Used data sample

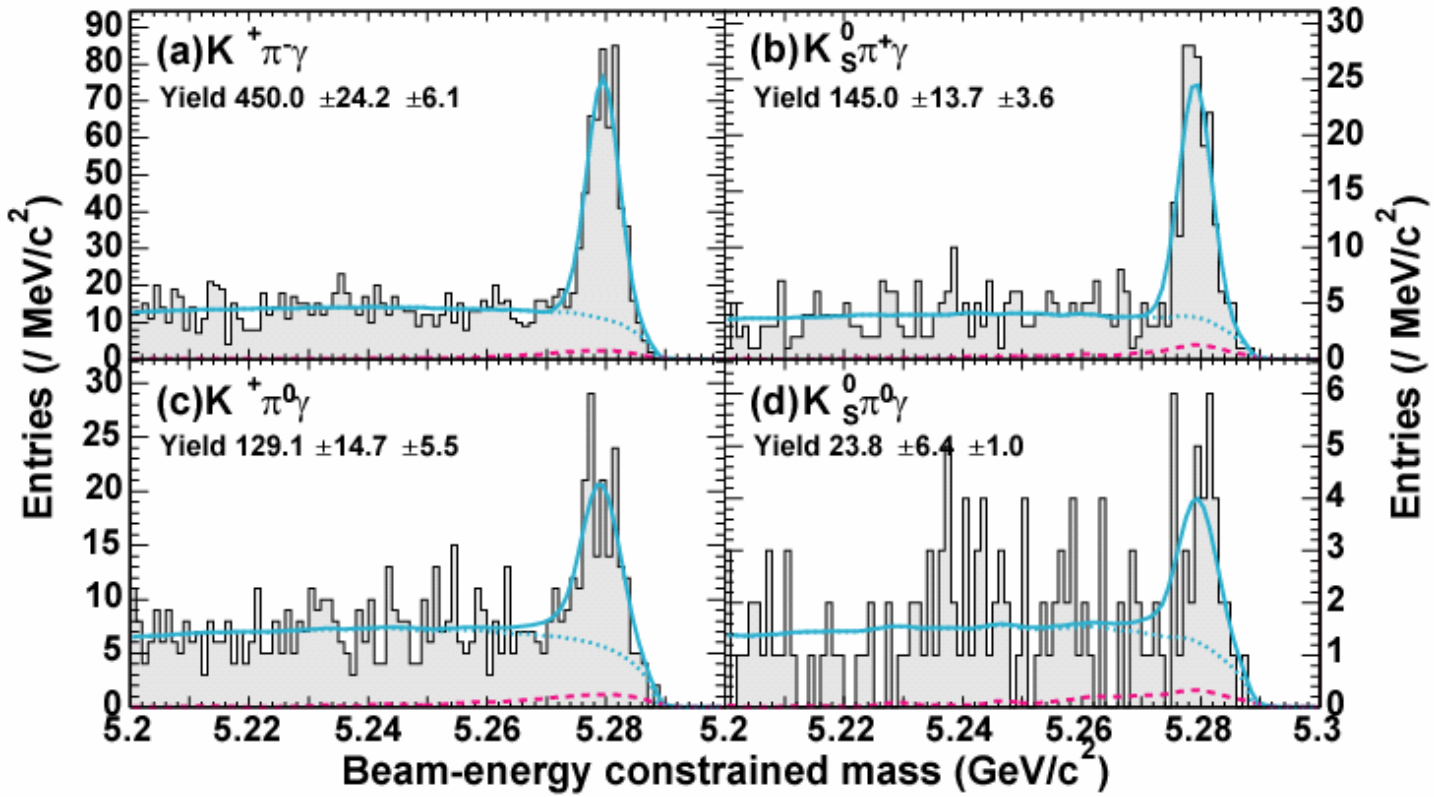
  → 78 fb^{-1} (submitted to PRD)
- Theoretical prediction by

  S.W.Bosch and G.Buchalla (2002)

$$Br(B \to K^*\gamma) = [70.9^{+24.7}_{-22.7}] \times 10^{-6}$$

B→K*(892)γ results (I)

Belle 78 fb^{-1}



$Br(B^0 \to K^{*0}\gamma) = (40.1 \pm 2.1 \pm 1.7) \times 10^{-6}$

$Br(B^+ \to K^{*+}\gamma) = (42.5 \pm 3.1 \pm 2.4) \times 10^{-6}$

Isospin asymmetry

$$\Delta_{0+} = [(\tau_{B^+}/\tau_{B^0})Br(B^0) - Br(B^+)] \,/\, [(\tau_{B^+}/\tau_{B^0})Br(B^0) + Br(B^+)]$$
$$= +0.012 \pm 0.044 \pm 0.026$$

Belle 78 fb^{-1}

B→K*(892)γ results (II)

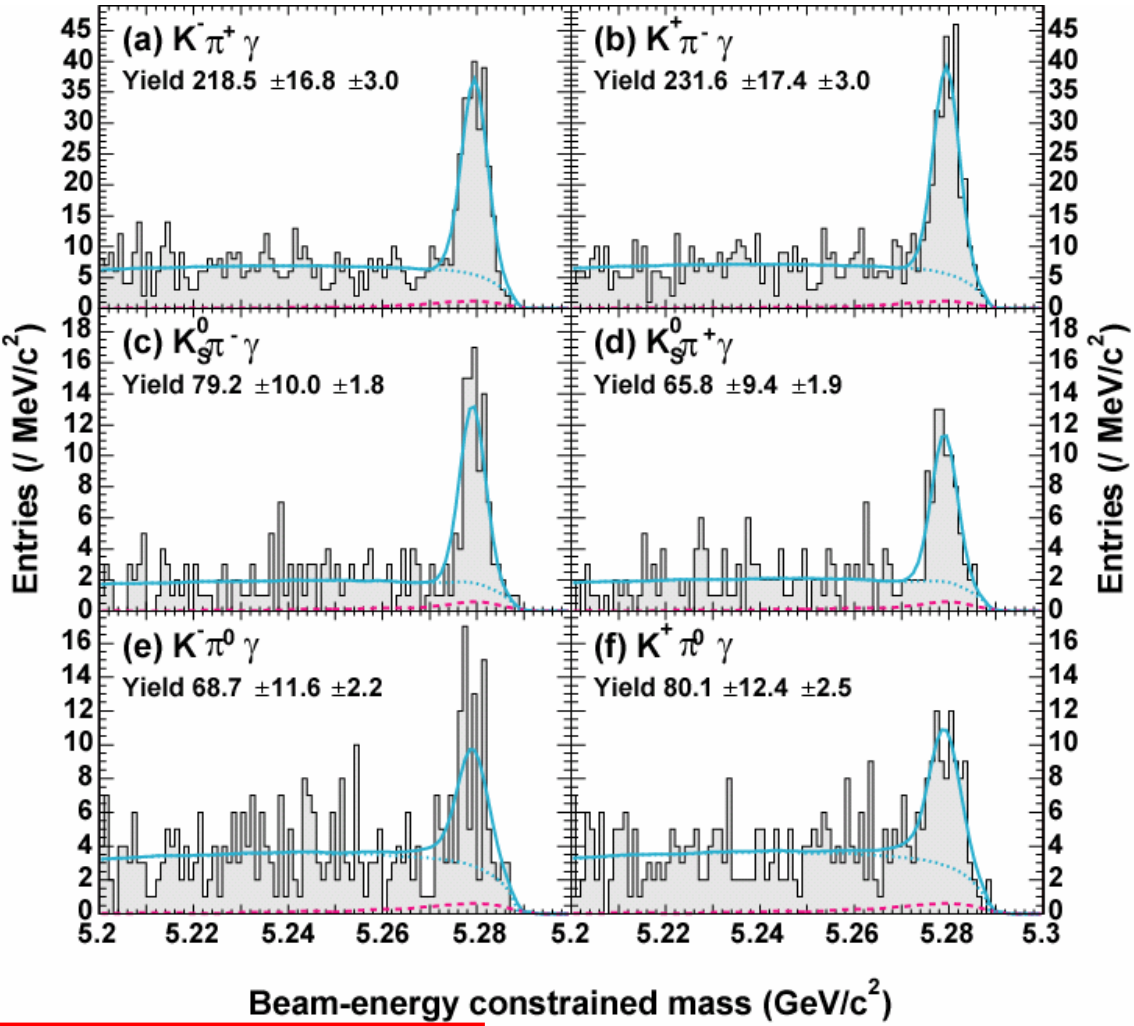
Partial rate asymmetry

$A_{cp} = 1/(1-2\omega) \times [N(B)-N(\bar{B})]/[N(B)+N(\bar{B})]$

ω: wrong-tag fraction

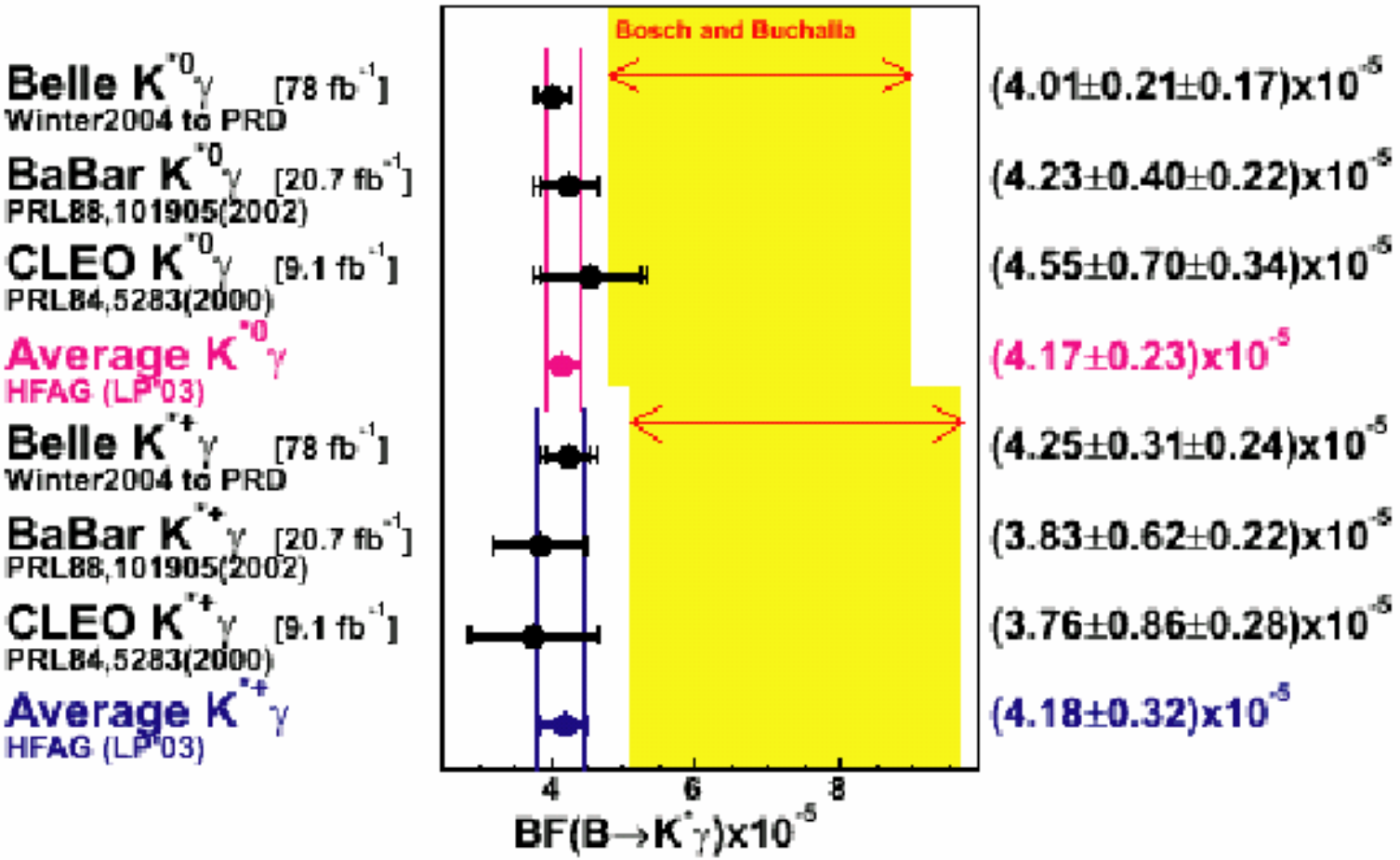
0.9% for the neutral mode

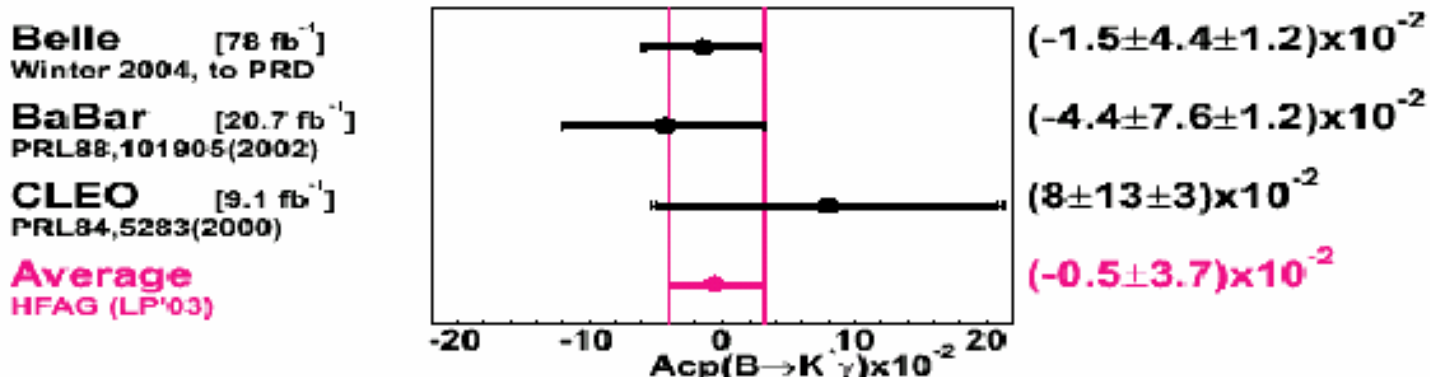
negligible for the charged



A_{cp} (B→K*γ) = -0.015 ± 0.044 ± 0.012

B→K*(892)γ results (III)





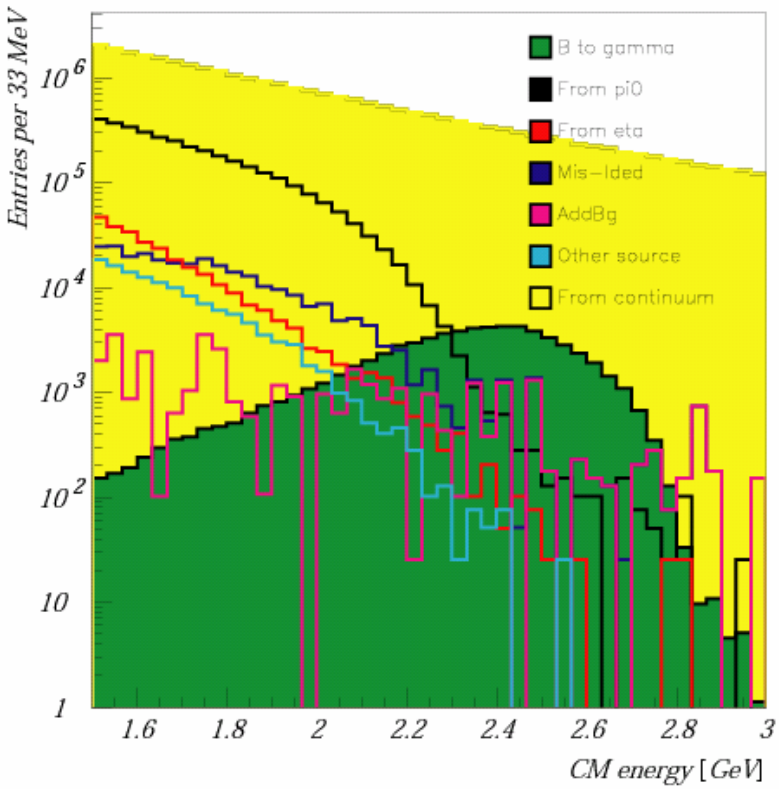
Inclusive $B \rightarrow X_s\gamma$

Analysis of $B \rightarrow K^*\gamma$

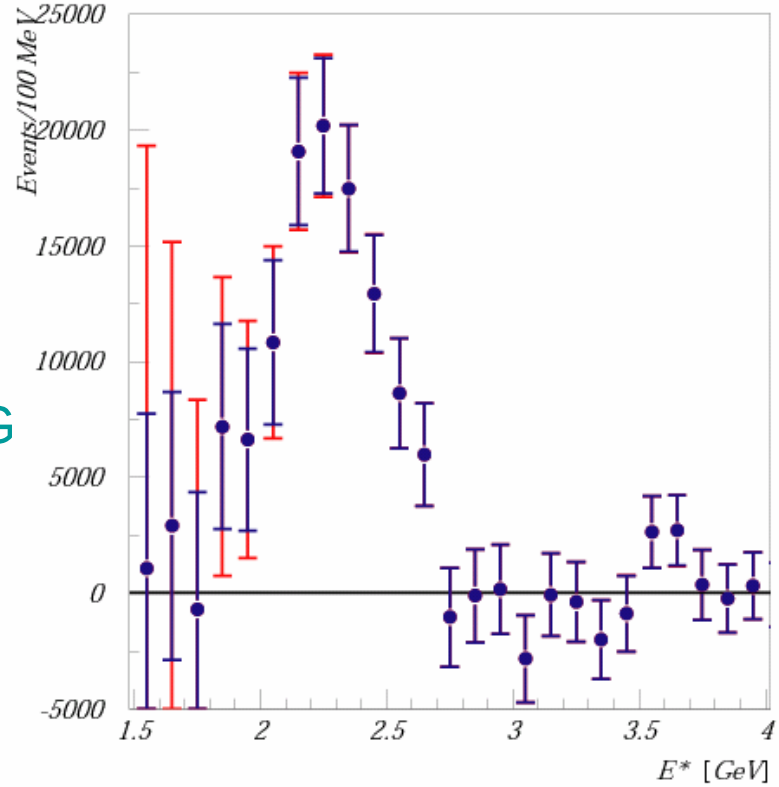
- Fully inclusive reconstruction: see only the γ spectrum
  1) Measure E_γ spectrum (single high-energy photon)
  2) Continuum suppression based on the event shape
  3) π^0/η veto
- Huge BG … Subtract BG E_γ spectrum
  γ from Continuum estimated by off-resonance data
  γ from π^0/η in BB estimate the E_γ spectrum by on- and off-resonance data
- $E_\gamma >$ 1.8 GeV (CLEO… 2.0GeV BaBar … 2.1GeV)
  → reduce theoretical model error
- Used data sample → 140 fb^{-1} (submitted to PRL)

B→Xsγ results (I)

Belle 140 fb^{-1}



Subtract BG
ε correction

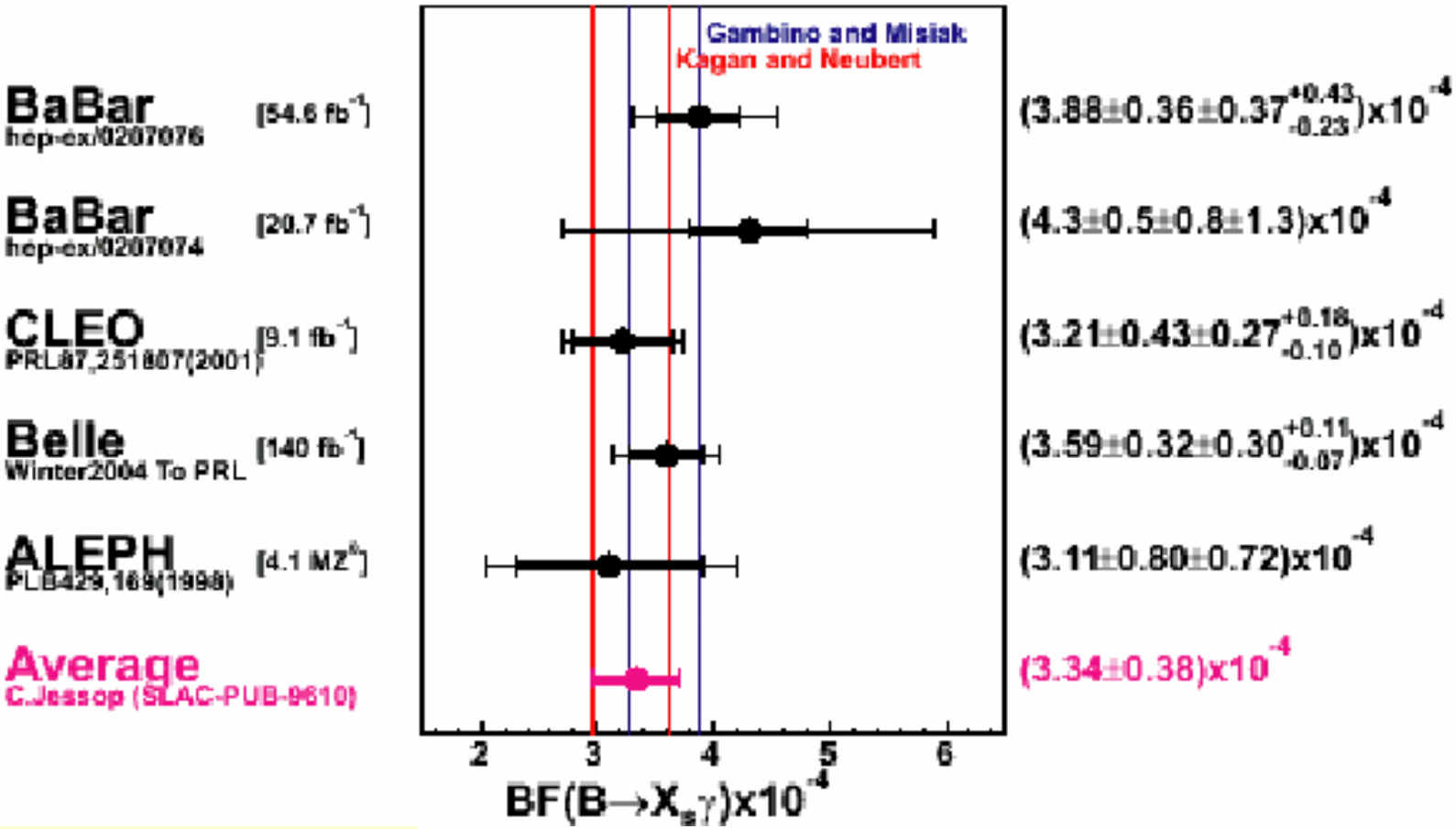


$$Br(b \to s\gamma) = (3.59 \pm 0.32^{+0.30\,+0.11}_{-0.31\,-0.07}) \times 10^{-4}$$

$$\langle E\gamma \rangle = 2.289 \pm 0.026 \pm 0.034 (GeV)$$

$$\langle E\gamma^2 \rangle - \langle E\gamma \rangle^2 = 0.0311 \pm 0.073 \pm 0.063 (GeV^2)$$

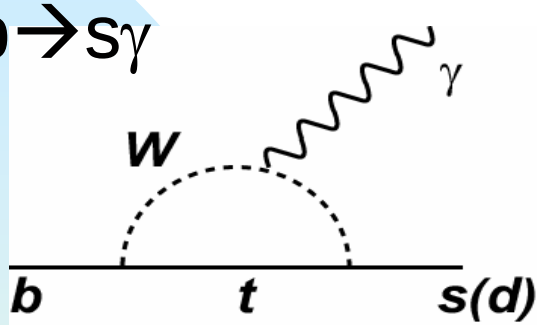
$B \to X_s\gamma$ results (II)



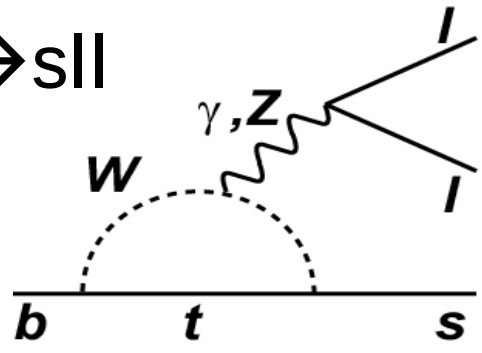
b→sll measurements

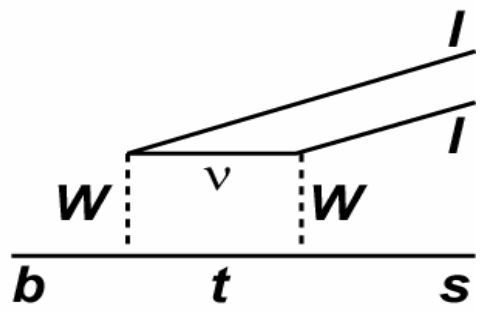
- b->sγ vs b->sll

b→sγ



b→sll





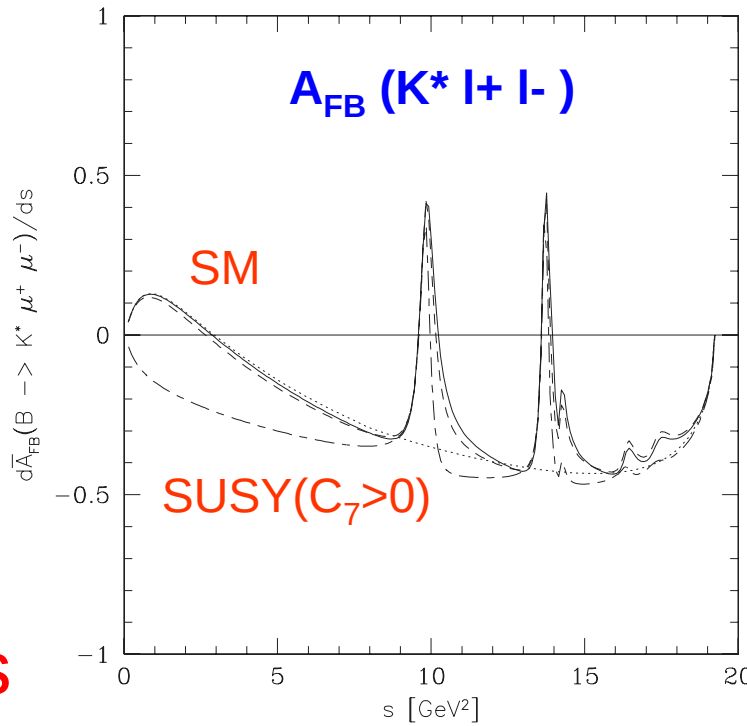
Br is low (b→sγ: 10^{-4} b→sll: 10^{-6})

Exists the contribution from Z^0

Have Additional operator with $q^2(=m_{ll}^2)$ dependence

→ q^2 distribution, $A_{FB}(q^2)$

.. Sensitive to the New Physics



Ali et al. PRD61 (2000) 074024

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

Analysis of $B \rightarrow K^{(*)} l^+ l^-$ ($l = e, \mu$)

- Reconstructed hadron system

  ... K^+, K_s^0, $K^{*+}(K^+\pi^0, K_s^0\pi^+)$, K^{*0} $(K^+\pi^-)$

- Backgrounds

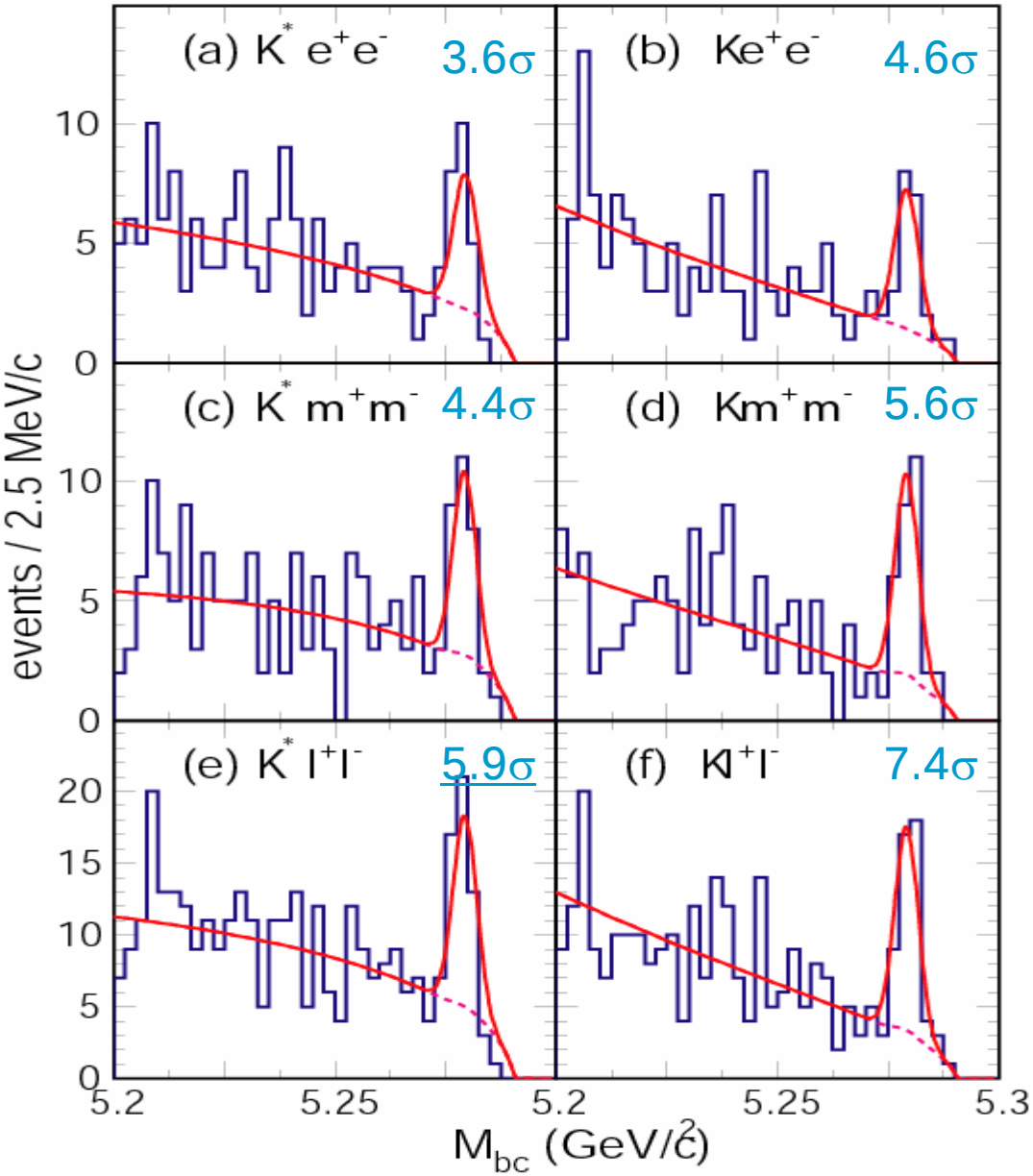
J/ψ	eliminated by J/ψ veto
$l^+\nu X$, $l^-\nu X$	dominant source
Single lepton misID	small
Double lepton misID	small but peaked BG source studied with Kh^+h^- data

- Used data sample ... 140 fb^{-1} (PRL91(2004)012002)

$B \to K^{(*)} ll$ Results (1) PRL90(2003)021801

Belle (140 fb^{-1})

Fits to M_{bc} after ΔE cut



B→K(*)ll Results (2)

Combining Modes (Average Branching Fractions)

Isospin symmetry for K^+ vs. K^0

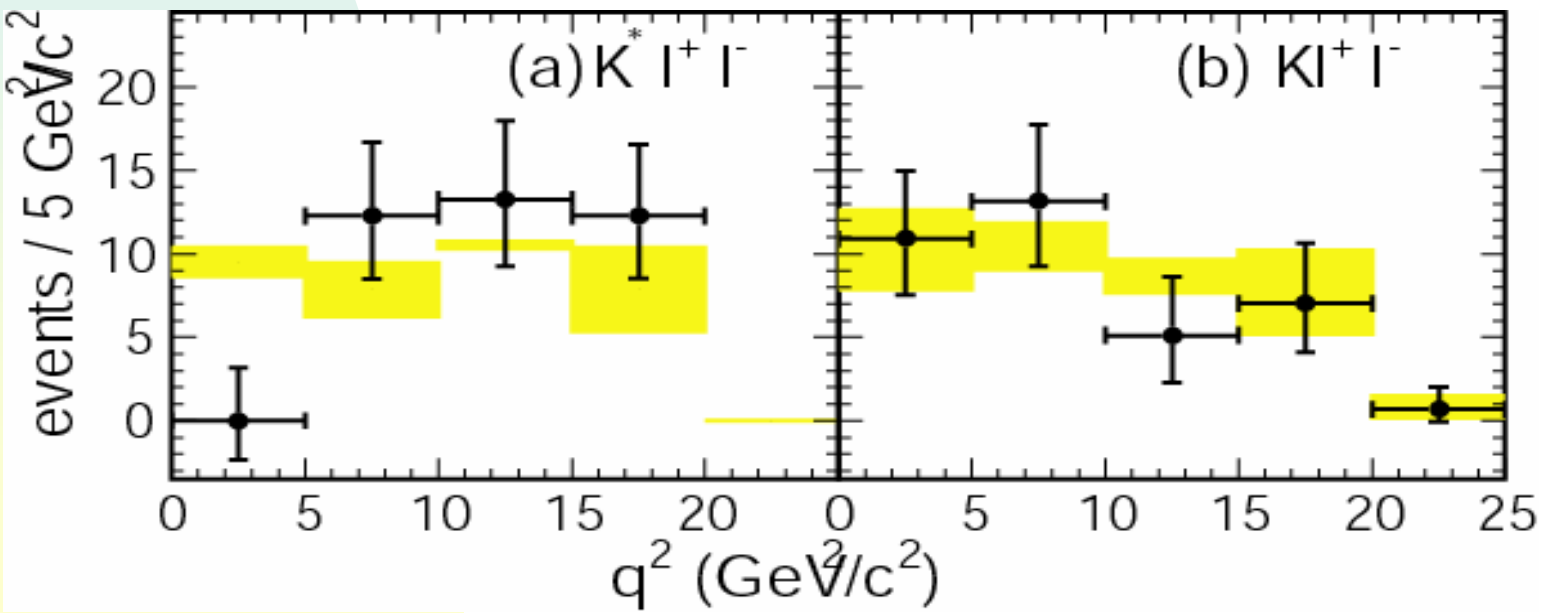
Lepton universality is assumed for Kll

$\mathcal{B}(B \to K^* ee) / \mathcal{B}(B \to K^* \mu\mu) = 1.33$ (Ali et al. 2002) (due to the photon pole)

$$Br(B \to Kll) = 4.8^{+1.0}_{-0.9} \pm 0.3 \pm 0.1 \times 10^{-7}$$

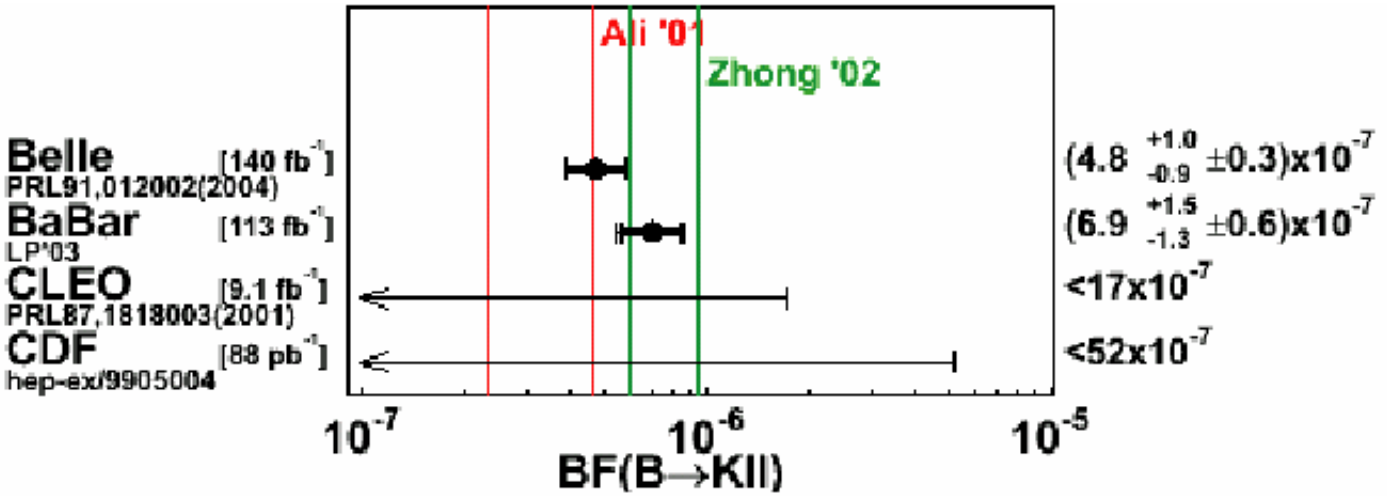
$$Br(B \to K^* ll) = 11.5^{+2.6}_{-2.4} \pm 0.7 \pm 0.4 \times 10^{-7}$$

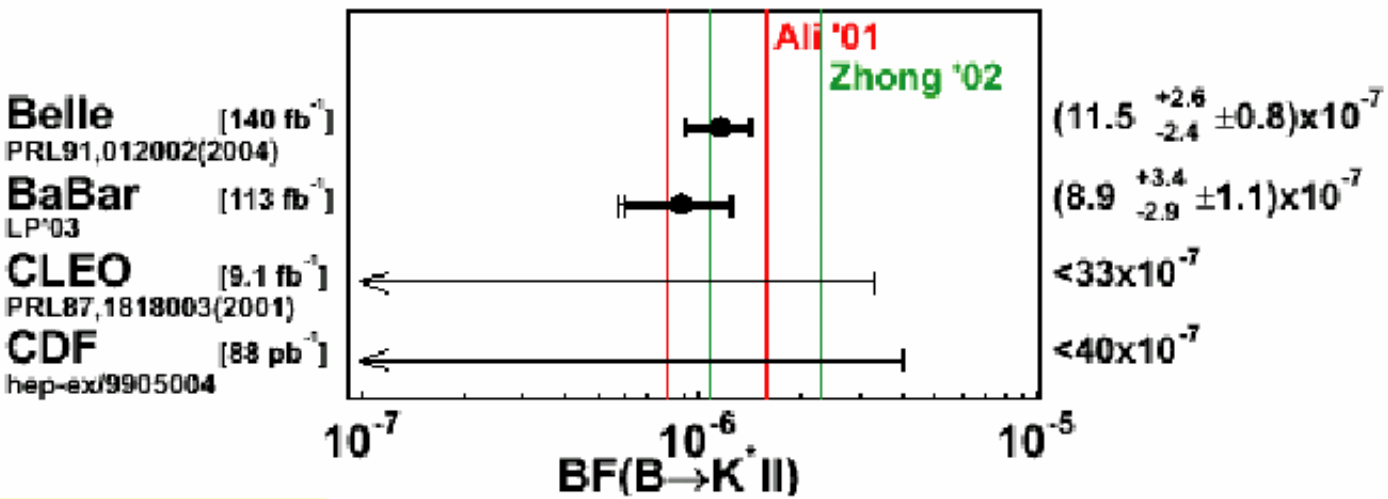
First measurement!



$q^2 (= m_{ll}^2)$ distributions : consistent with SM

Results $B \to K^{(*)}ll$





Consistent with the predictions.

Kll : Error is already comparable to the theoretical error.

K*ll : First measurement!!

Semi-inclusive $B \rightarrow X_s l^+ l^-$

Analysis of $B \rightarrow X_s l^+ l^-$ ($l = e, \mu$)

- Reconstructed Xs system

  …1 (K^+ or K_s^0) + 0-4π (at most $1\pi^0$)

- Backgrounds

  Dominant sources … 1) continuum 2) $B\bar{B} \rightarrow l^+ \nu X + l^- \nu X$

- Best candidate selection: LR(ΔE, $\cos\theta_B$)

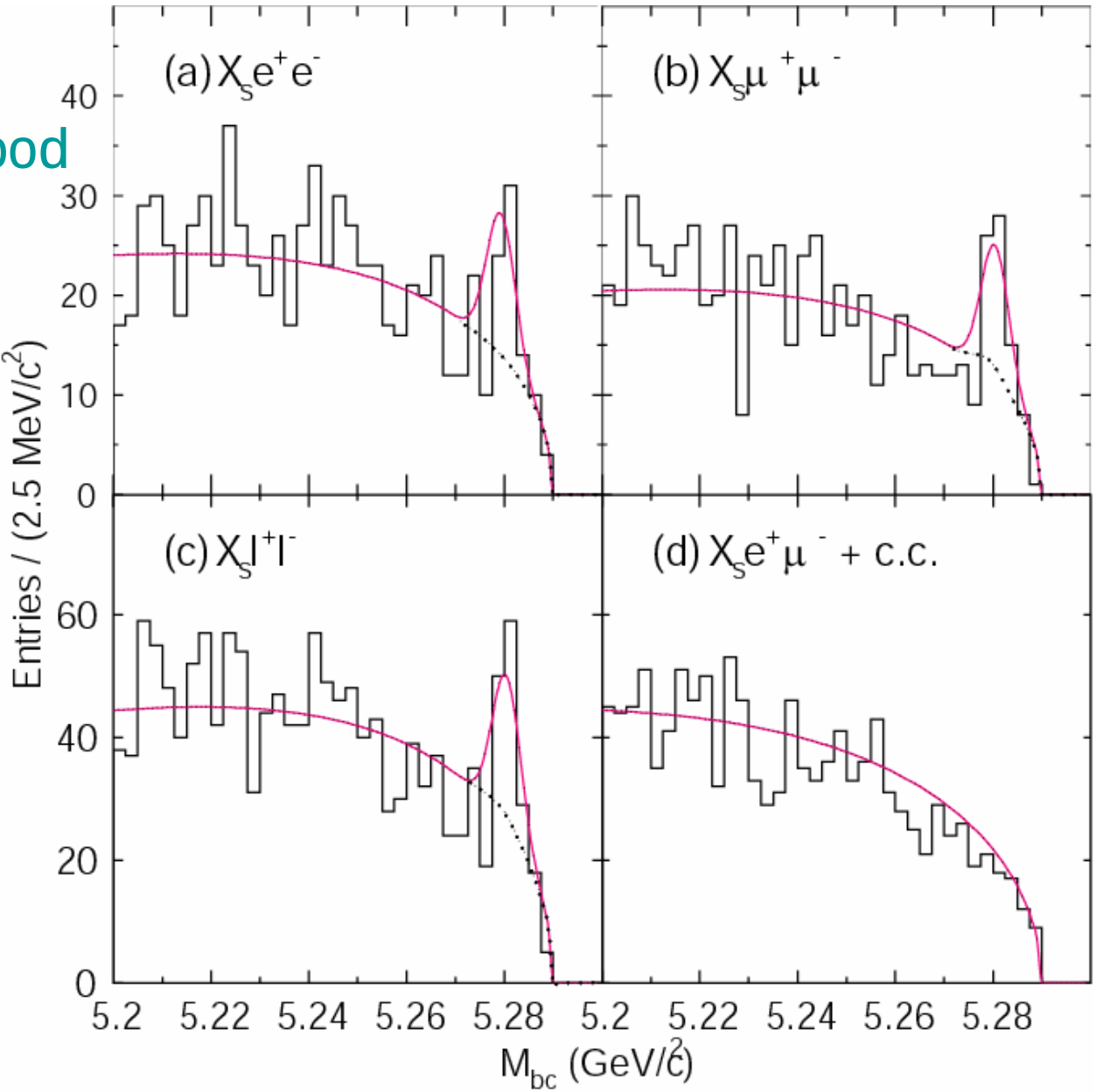
- Used data sample … 60.1 fb^{-1} (PRL90(2003)021801)

- Ali et al. SM prediction ($M_{ll} > 0.2$GeV)

  $Br(B \rightarrow X_s ll) = (4.2 \pm 0.7) \times 10^{-6}$

Belle (60.1 fb^{-1})

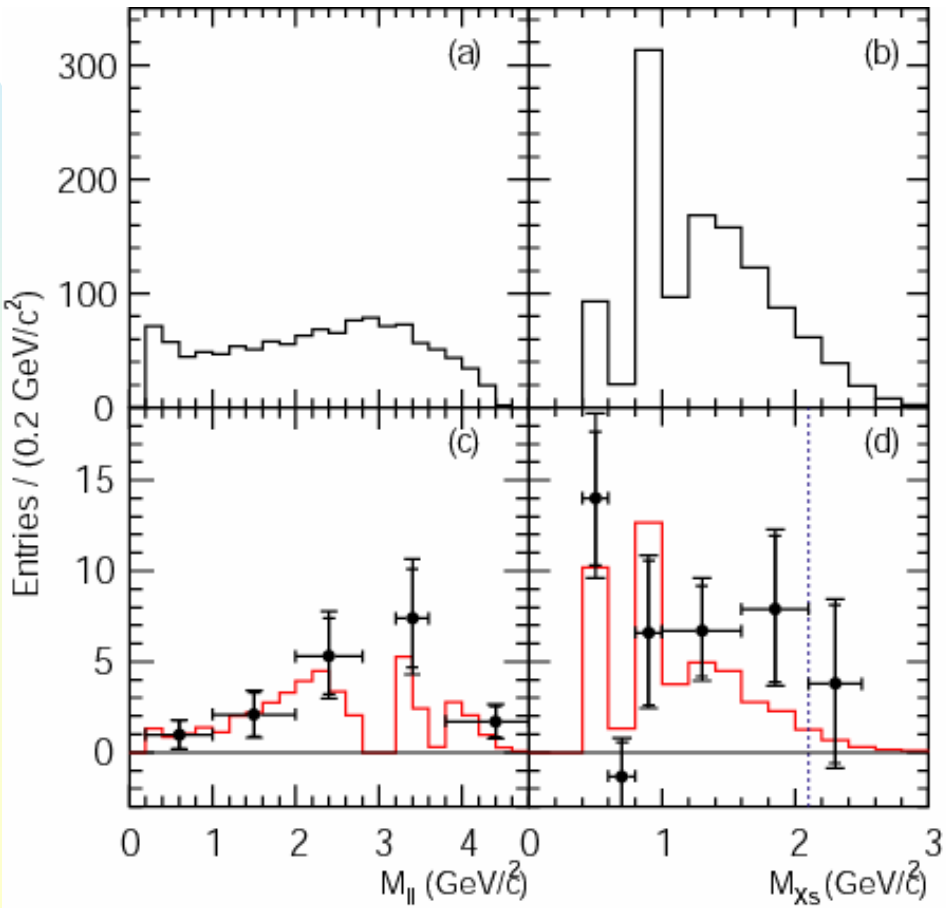
M_{bc} unbinned likelihood fits, after all cuts



B→Xsll results (PRL90 (2003)021801)

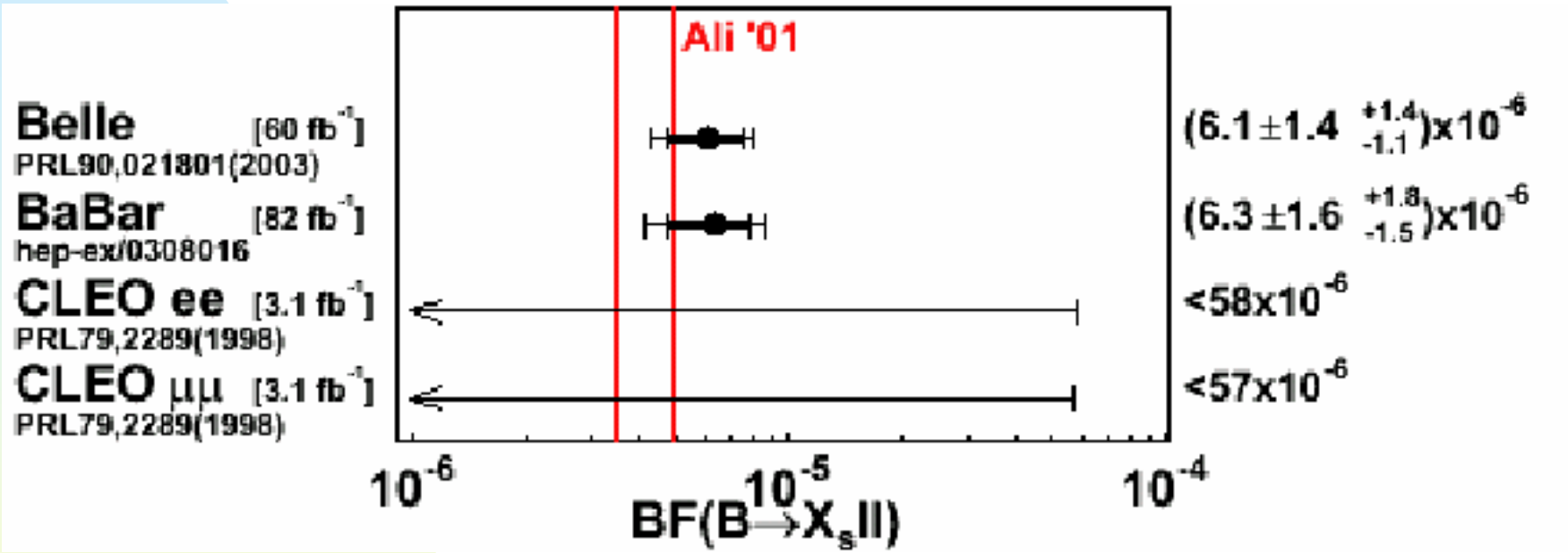
60.1 net signal, significance 5.4σ, Ave. of e^+e^-, $\mu^+\mu^-$

$$Br(B \to Xsll) = [6.1 \pm 1.4^{+1.4}_{-1.1}] \times 10^{-6}$$



The result is in agreement with SM

B→Xsll results (II)



Both Belle and BaBar results are consistent with SM

Summary

With the world highest luminosity provided by KEKB, Belle is continually updating the results.

Exclusive B→ K*γ (78pb^{-1})

Measure partial-rate asymmetry A_{CP} and isospin asymmetry Δ_{0+} — submitted to PRD

Inclusive B→Xsγ (140pb^{-1})

Fully inclusive method $E\gamma$>1.8GeV — submitted to PRL

Exclusive B→K$^{(*)}$ll (140pb^{-1})

First observation of K*ll — published in PRL

Semi-inclusive B→Xsll (60fb^{-1})

First observation of inclusive B→ Xsll — published in PRL & updat with 140fb^{-1} soon