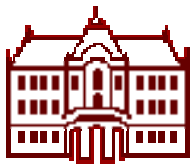




# Results from B Factories II

**Peter Križan**

*University of Ljubljana and J. Stefan Institute*



# Contents

**CKM:  $V_{ub}$  measurements**

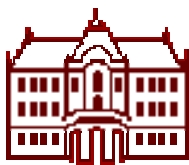
**$D^0$  mixing**

**Hadron spectroscopy**

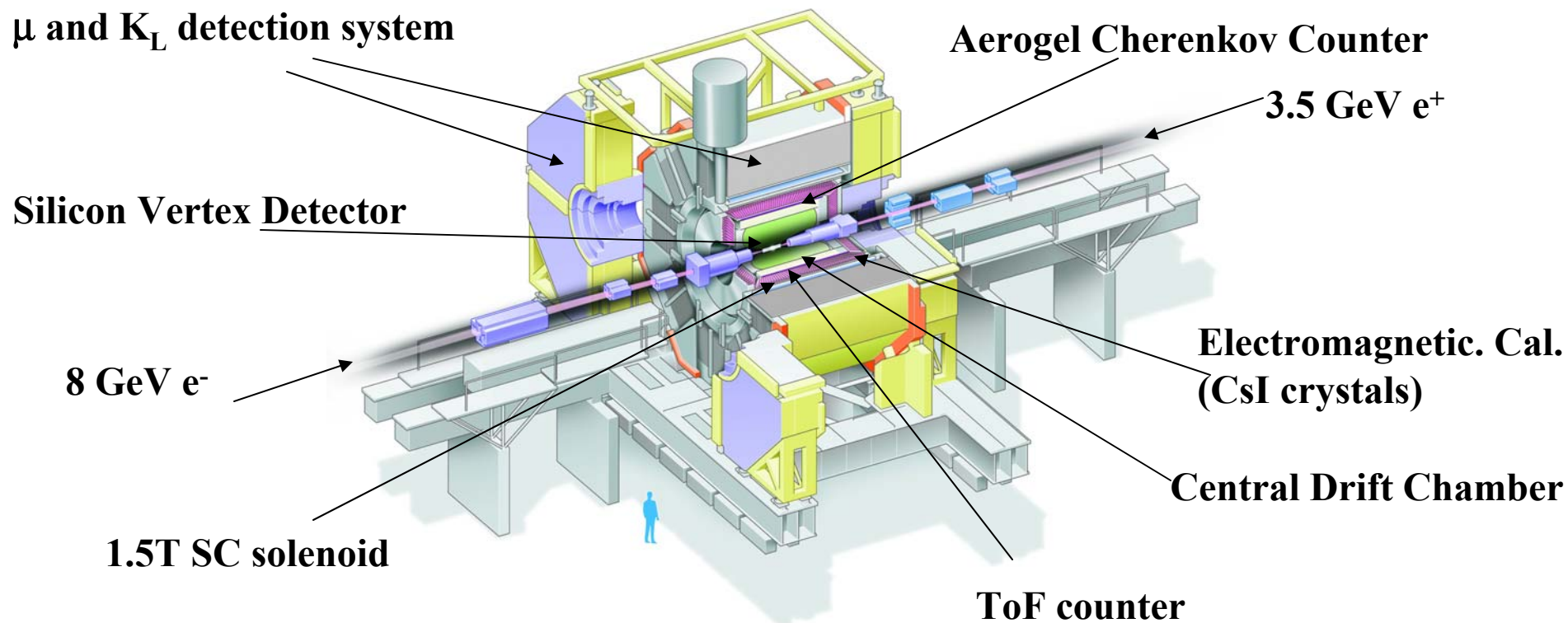
**FCNC B decays**

**Summary**

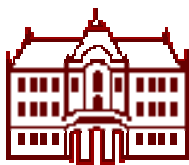
**(Only a very modest part of the harvest at B factories.)**



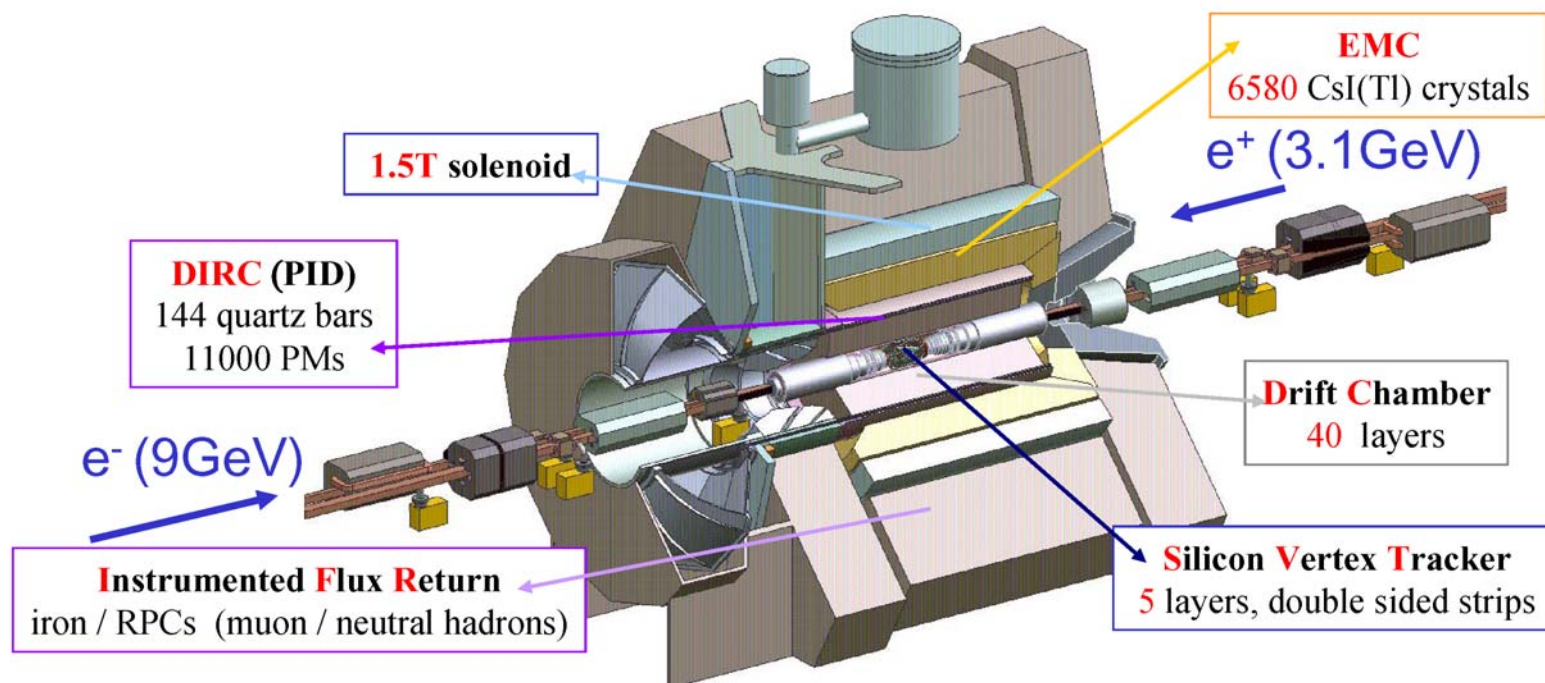
# Belle spectrometer at KEK-B



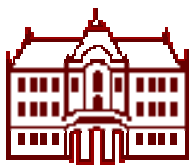
Accumulated luminosity: **258 fb<sup>-1</sup>**.



# BaBar spectrometer at PEP-II



Accumulated luminosity: **221 fb<sup>-1</sup>**.



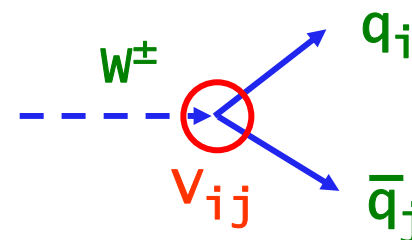
# CKM matrix measurements

**BaBar & Belle main task:** CP violation in the system of B mesons

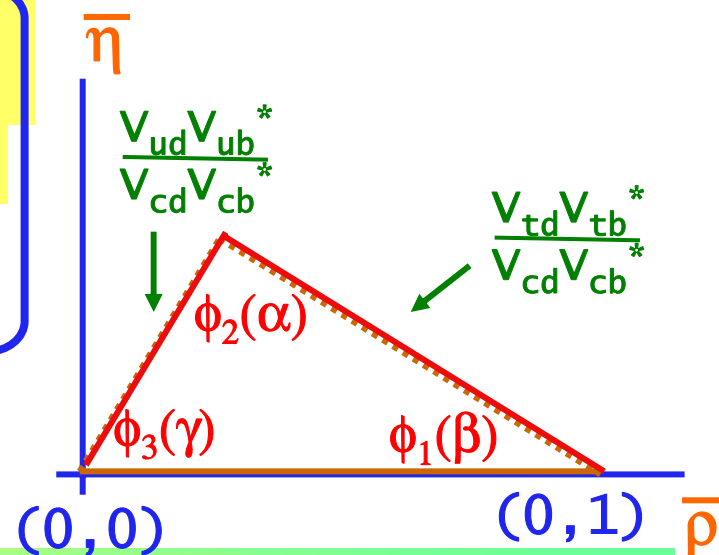
specifically: various measurements of complex elements of Cabbibo-Kobayashi-Maskawa matrix

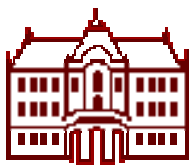
CKM matrix is unitary

deviations could signal processes not included in SM

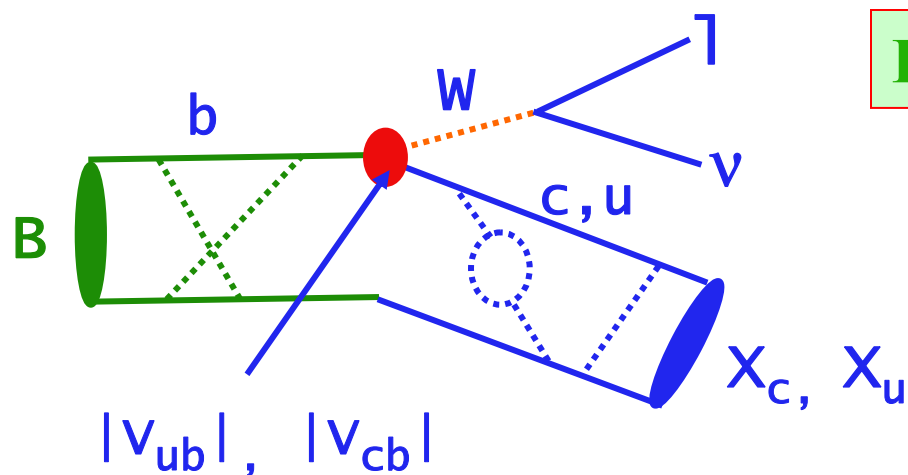


$$\begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} = \begin{pmatrix} 1-\lambda^2/2 & \lambda & A\lambda^3(\bar{\rho}-i\bar{\eta}) \\ -\lambda & 1-\lambda^2/2 & A\lambda^2 \\ A\lambda^3(1-\bar{\rho}-i\bar{\eta}) & -A\lambda^2 & 1 \end{pmatrix}$$

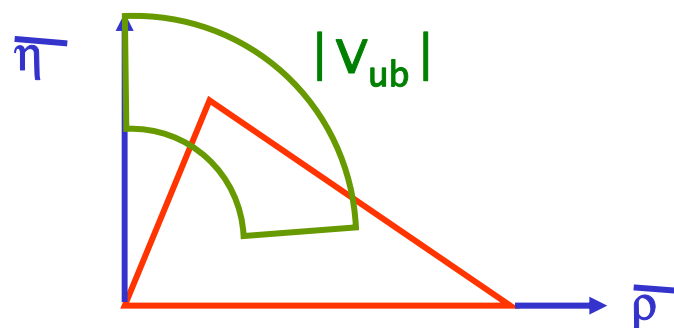




# $|V_{ub}|$ measurements



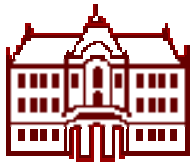
From semileptonic B decays



$|V_{cb}|$  known to  $\sim 1.4\%$ , becoming as precise as  $|V_{us}|=1$  ( $\sim 1\%$ )

need to pin-down  $|V_{ub}|$ , present world average  $\sim 10\%$

$b \rightarrow cl\nu$  background typically order of magnitude larger.

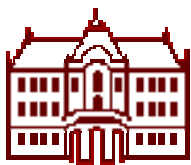


# Inclusive $|V_{ub}|$ measurement

**Traditional inclusive method: use semileptonic decays, fight the background from  $b \rightarrow cl\nu$  decays by using only events with electron momentum above the  $b \rightarrow cl\nu$  kinematic limit. Problem: extrapolation to the full phase space  $\rightarrow$  large theoretical uncertainty.**

**New: fully reconstruct one of the B mesons, check the properties of the other (semileptonic decay, low mass of the hadronic system)**

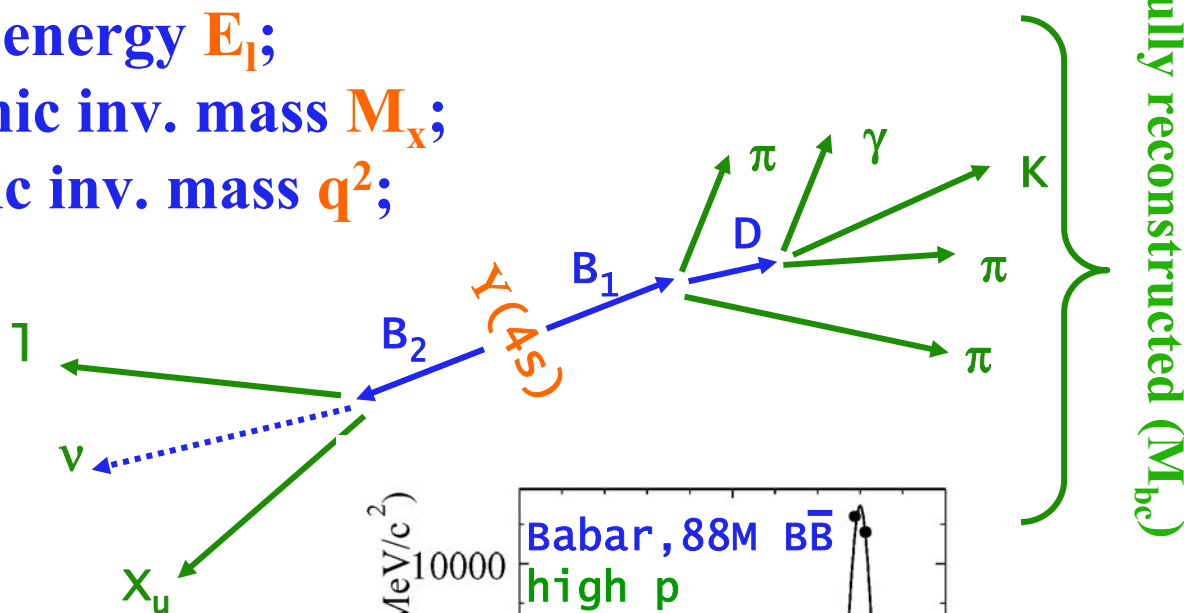
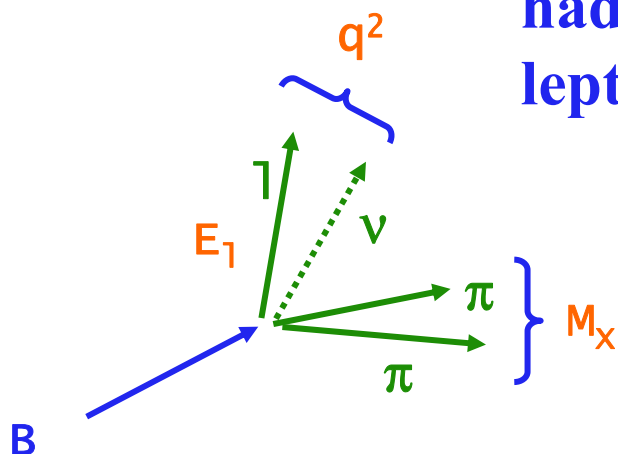
- **Very good signal to noise**
- **Low yield (full reco efficiency is 0.3-0.4%)**



# $|V_{ub}|$ measurement

Variables separating  $b \rightarrow ul\nu$  from  $b \rightarrow cl\nu$ :

- lepton energy  $E_l$ ;
- hadronic inv. mass  $M_x$ ;
- leptonic inv. mass  $q^2$ ;



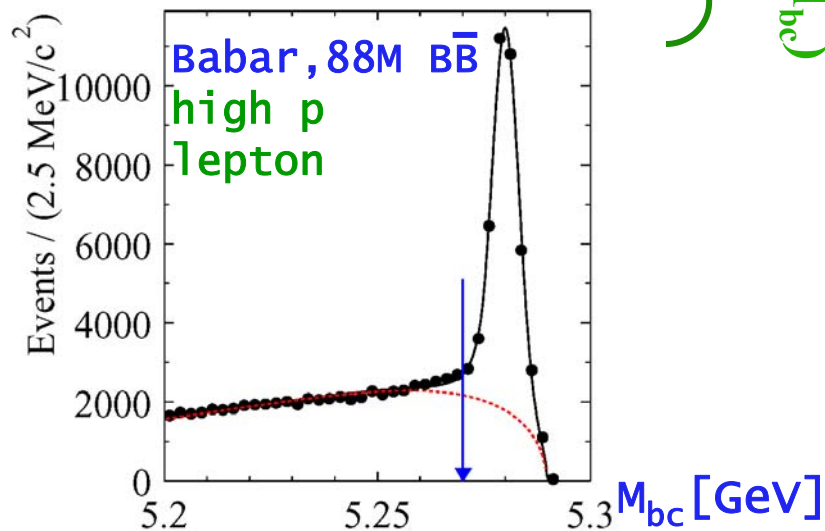
## Full reconstruction

Belle:  $B \rightarrow D^{(*)-} \pi^+ / \rho^+ / a_1^+ / D_s^{(*)+}$

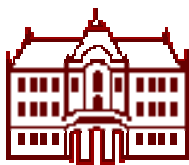
$\epsilon \sim 0.25\%$

BaBar:  $B \rightarrow D^{(*)-} n_1 \pi \quad n_2 K \dots$

$\epsilon \sim 0.4\%$

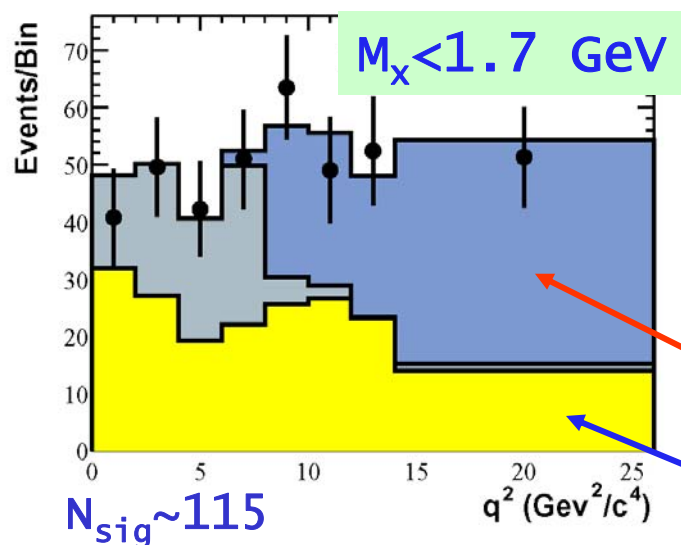






# Inclusive $|V_{ub}|$ measurement

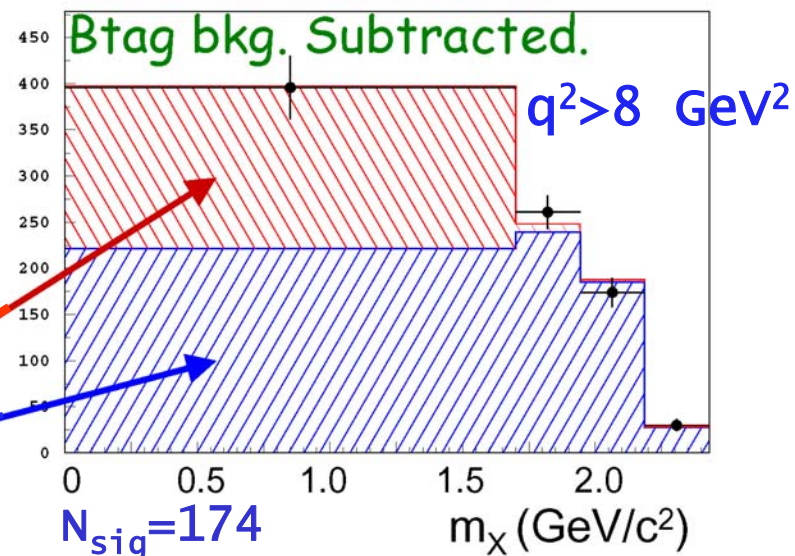
Extract signal in high  $q^2$  low  $M_X$  region (reduce theo. error):



signal

$b \rightarrow c l \nu$

$m_X$  distribution with  
Btag bkg. Subtracted.



Babar

$$|V_{ub}| = (4.98 \pm 0.40 \pm 0.39 \pm 0.47) \times 10^{-3}$$

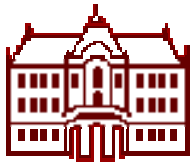
(stat.)

(syst.)

(th.)

Belle

$$|V_{ub}| = (5.54 \pm 0.42 \pm 0.50 \pm 0.55) \times 10^{-3}$$



# $D^0$ mixing in $D^0 \rightarrow K\pi$ and $Klv$ decays

The method: search for D mixing in the decay sequence:  
 $D^{*+} \rightarrow D^0\pi^+$ ,  $D^0 \rightarrow$ flavour specific final state.

## Semileptonic decay:

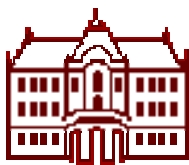
- $K^- e^+ \nu$  : no mixing (RS, Right Sign)
- $K^+ e^- \nu$  : mixing (WS, Wrong Sign)

→ measure WS rate

## Hadronic decay:

- $K^- \pi^+$  : no mixing
- $K^+ \pi^-$  : mixing or doubly Cabibbo suppressed (DCSD)

→ measure WS time evolution



# $D^0$ mixing in $D^0 \rightarrow K\pi$ decays

## $D^0 \rightarrow K\pi$ time evolution

$$dN/dt \propto \{ \underbrace{R_D}_{\text{interference}} + \underbrace{R_D^{1/2} y'}_{\text{mixing}} t + (x'^2 + y'^2) t^2/4 \} e^{-t}$$

interference

mixing

$$x' = x \cos \delta + y \sin \delta$$

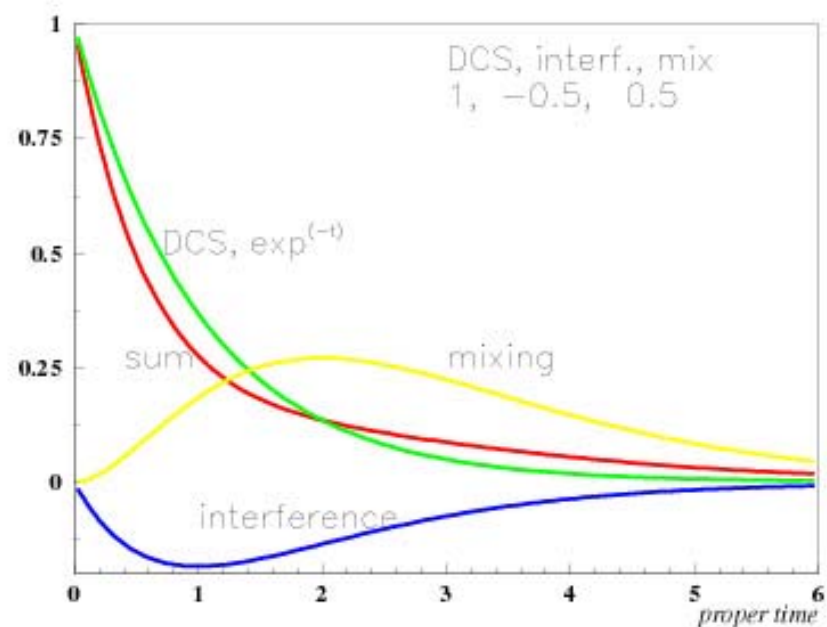
$$y' = y \cos \delta - x \sin \delta$$

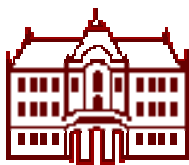
$$x = \Delta M/\Gamma \quad y = \Delta\Gamma/2\Gamma$$

$\delta$  = strong phase difference

SM:  $x < 10^{-3}$ ,  $y < 10^{-3}$  (long dist. effects);

new physics:  $x \gg y$ , CPV





# D<sup>0</sup> mixing in D<sup>0</sup>→Kπ decays

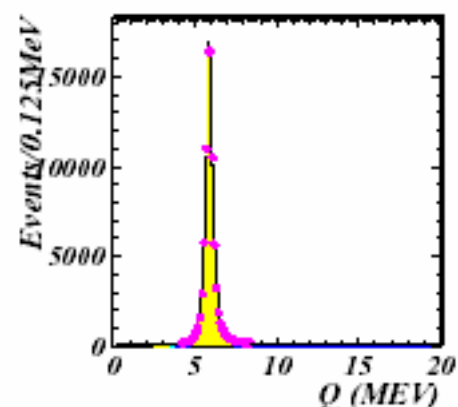
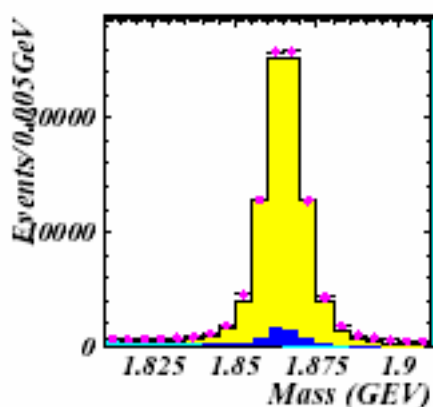


## Signal extraction

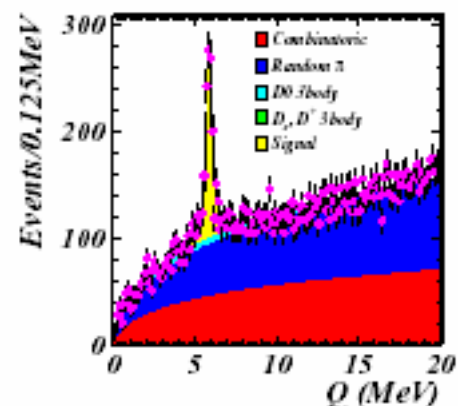
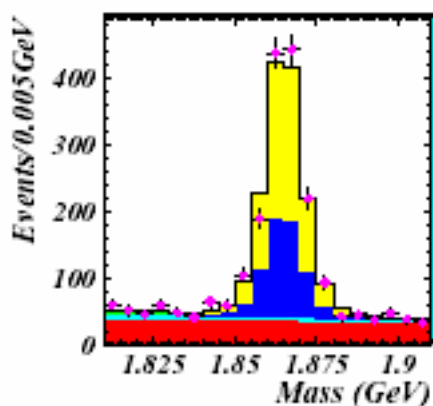
$$M = M(K, \pi)$$

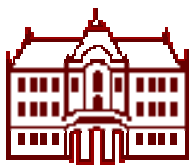
$$Q = M(K^+, \pi^-, \pi_{\text{slow}}) - M(K^+, \pi^-) - M_{\pi}$$

Right-Sign



Wrong-Sign





# $D^0$ mixing in $D^0 \rightarrow K\pi$ decays



Free fit

$$R_D = (0.287 \pm 0.037)\%$$

$$y' = (2.54^{+1.11}_{-1.02})\%$$

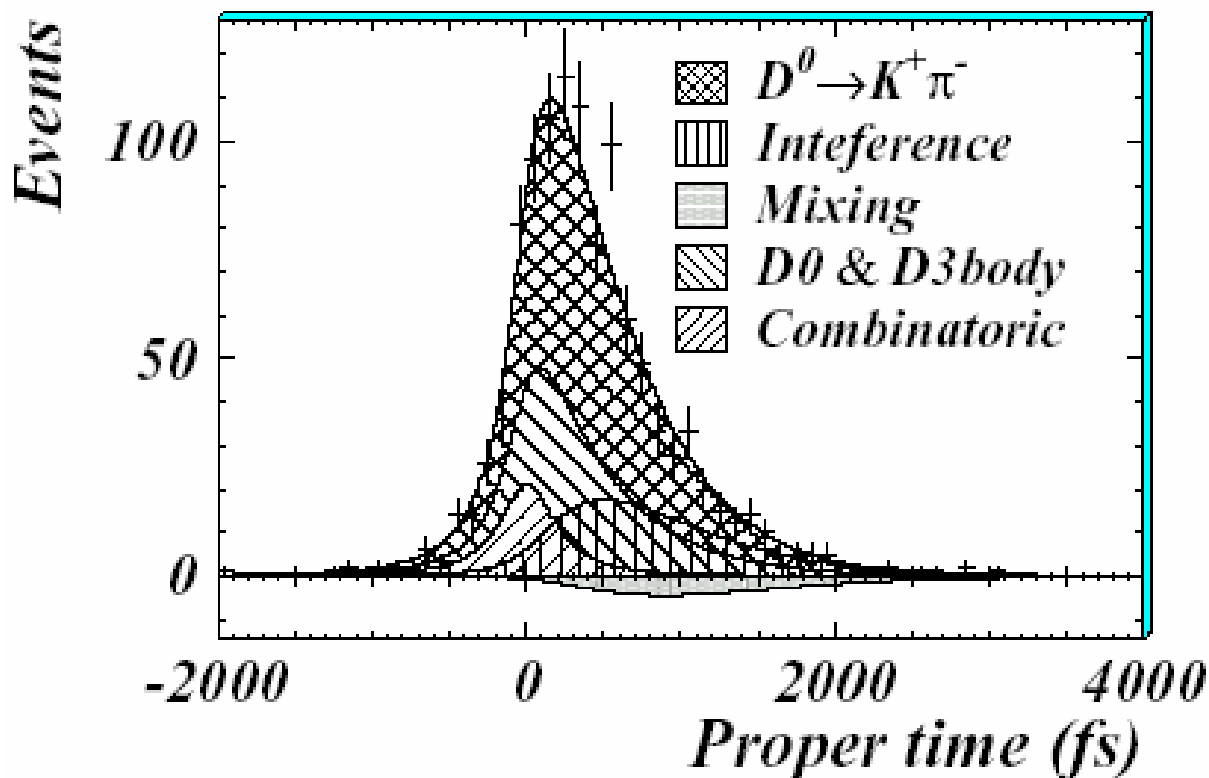
$$x'^2 = -(0.153^{+0.08}_{-0.10})\%$$

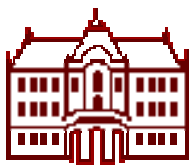
Physical region

$$R = (0.343^{+0.027}_{-0.026})\%$$

$$y' = (0.60 \pm 0.33)\%$$

$$x'^2 = 0\%$$

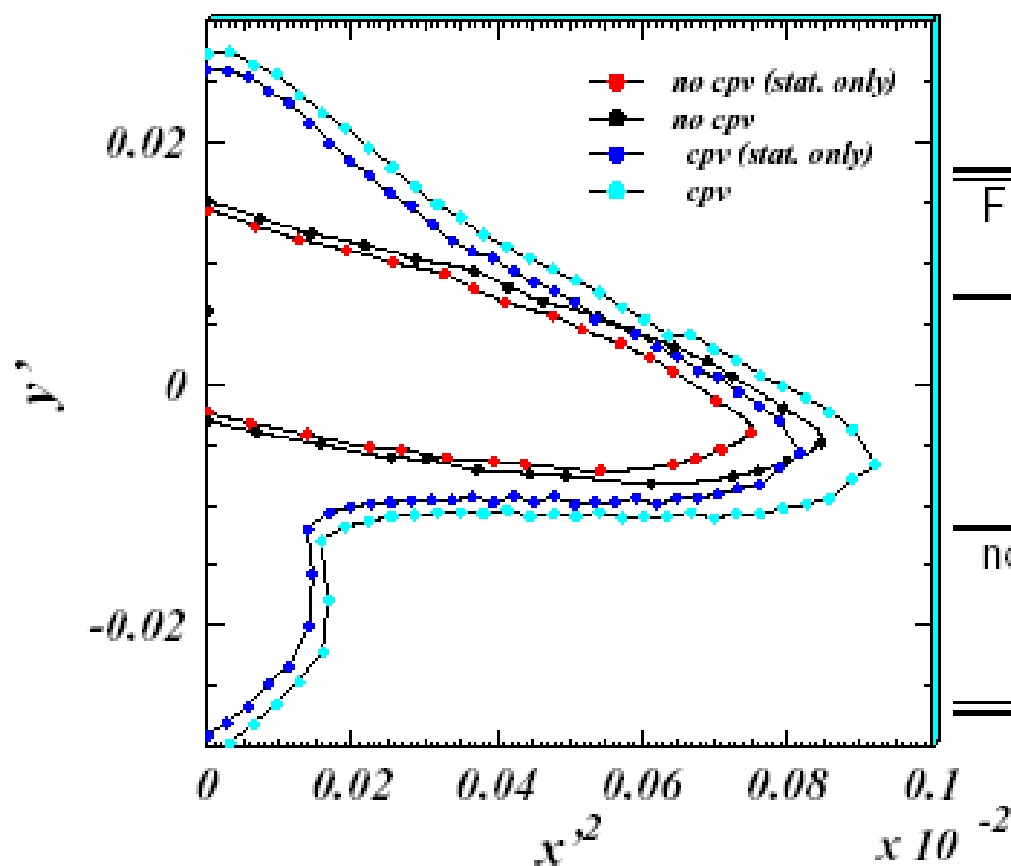




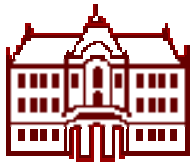
# $D^0$ mixing in $D^0 \rightarrow K\pi$ decays



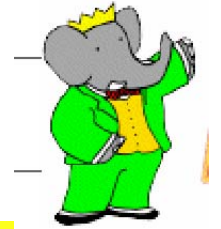
Results: 95% contour in  $x'^2$  and  $y'$  plane (with  $90 \text{ fb}^{-1}$ )



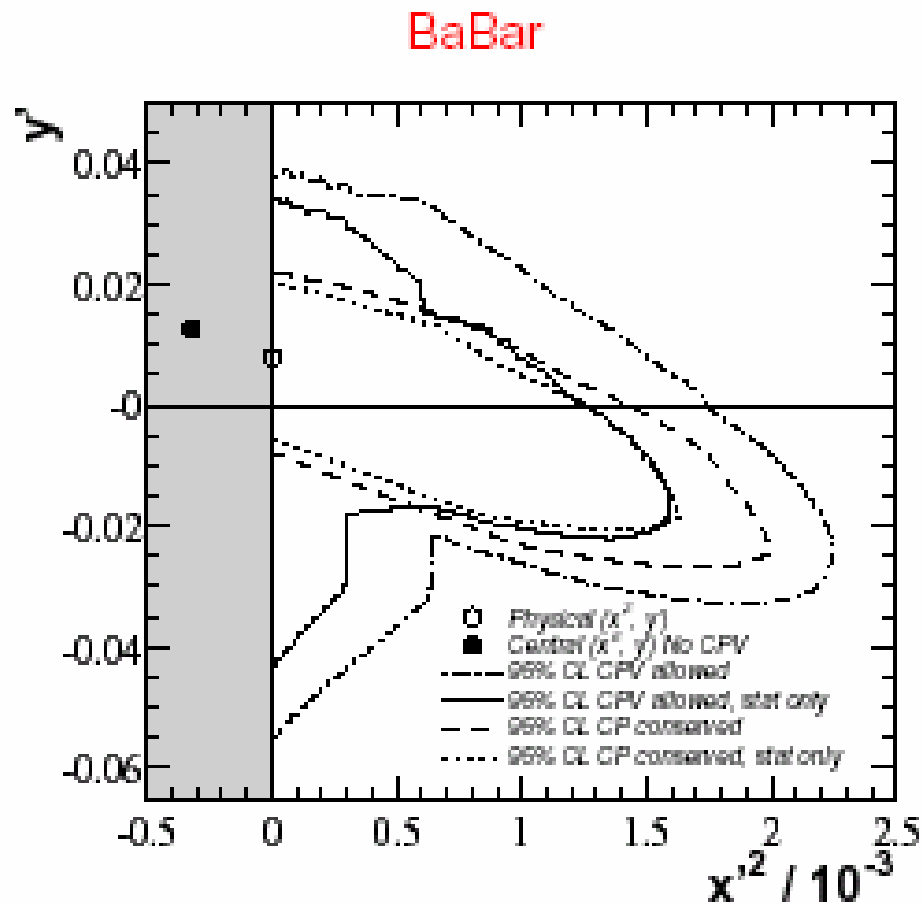
Fit case	Parameter	95% C.L. interval ( $\times 10^{-3}$ )
CPV	$A_D$	$-250 < A_D < 110$
	$A_M$	$-991 < A_M < 1000$
	$x'^2$	$x'^2 < 0.89$
	$y'$	$-30 < y' < 27$
no CPV	$x'^2$	$x'^2 < 0.81$
	$y'$	$-8.2 < y' < 16$
	$R_D$	$2.7 < R_D < 4.0$

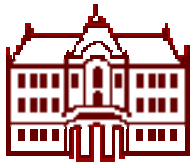


# $D^0$ mixing in $D^0 \rightarrow K\pi$ decays



Results: 95% contour in  $x'^2$  and  $y'$  plane (with  $57.1 \text{ fb}^{-1}$ )





# $D^0$ mixing in $D^0 \rightarrow K\ell\nu$ decays



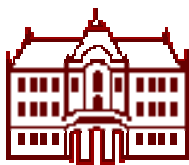
## Selection criteria:

- c.m.s. momentum of the  $K\ell$  system  $> 2$  GeV (bb, comb. backgr.)
- Invariant mass of  $e^-e^+$  ( $e^+ \rightarrow \pi^+$ )  $> 0.15$  GeV ( $\gamma$  conversions)
- Cut on decay time (backgrounds  $\delta(t) + e^{-t}$ , signal  $t^2 e^{-t}$ )

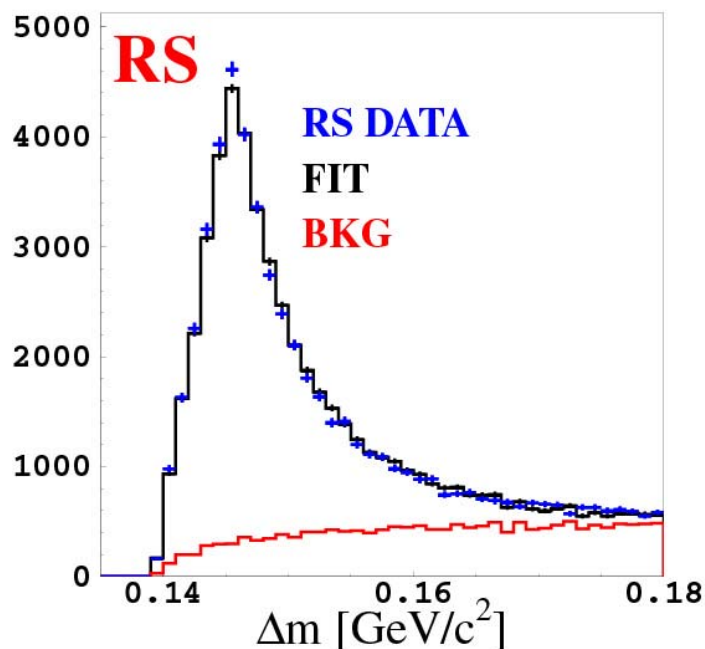
**Neutrino reconstruction: hermiticity of the spectrometer, kinematic constraints.**

**Main observable:  $\Delta m = m(\pi_s K\ell\nu) - m(K\ell\nu)$**



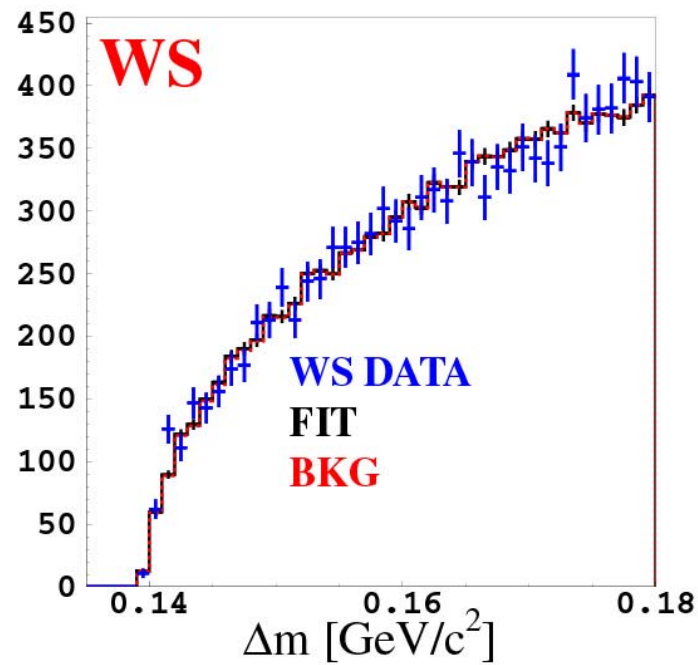


# $D^0$ mixing in $D^0 \rightarrow K\pi$ decays



$$N_{RS} = 40198 \pm 329$$

$\pm$

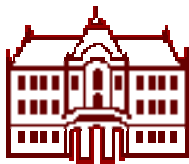


$$N_{WS} = 19 \pm 67$$

$$r_D = (N_{WS} / N_{RS}) (\epsilon_{RS} / \epsilon_{WS}) = (0.20 \pm 0.70) 10^{-3}$$

$$r_D < 1.4 10^{-3} \quad (90\% \text{ conf. level})$$

$$r_D = (x^2 + y^2)/2$$



# $D^0$ mixing in $D^0 \rightarrow K\pi$ decays



**BaBar:** employs neural net techniques to reconstruct the  $D^0$  momentum vector (including again the neutrino), and to reject background events.

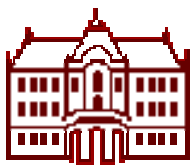
**Yield:** fit to  $\Delta m$ ,  $t$  distributions.

$$N_{RS} = 49620 \pm 265$$

$$N_{WS} = 114 \pm 61$$

$$r_D = (2.3 \pm 1.2(\text{stat})) 10^{-3}$$

$$r_D < 4.2 10^{-3} \text{ (90\% conf. level)}$$



# Hadron spectroscopy – X(3872)

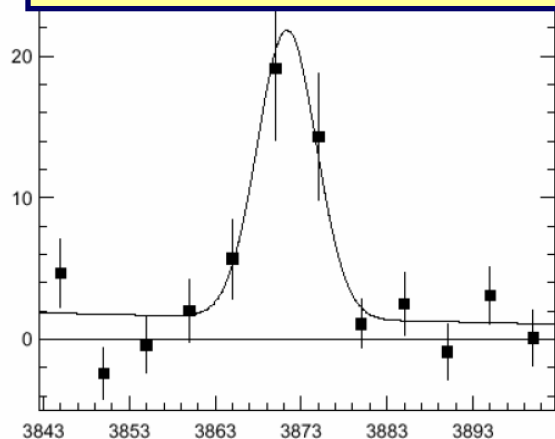


Belle observed a new state  
decaying into  $J/\psi \pi^+\pi^-$

$B^+ \rightarrow K^+ X(3872)$

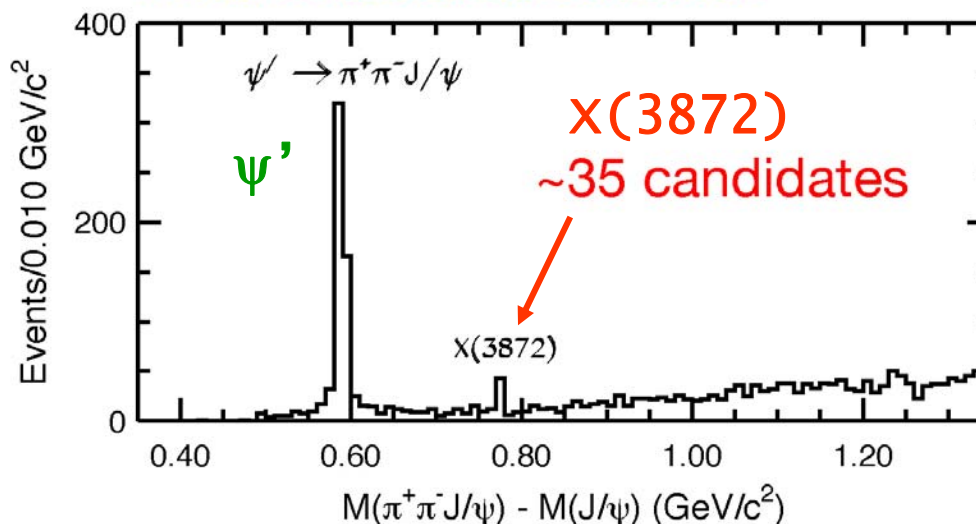
**35±7 events**  
**M=3872.0±0.8 MeV**  
**Γ<2.3MeV (90%)**

$J/\psi \pi^+\pi^-$   
 $I^+I^-$



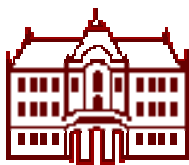
Belle, PRL 91 (2003) 262001

Mass  $3872.0 \pm 0.6 \pm 0.5$  MeV

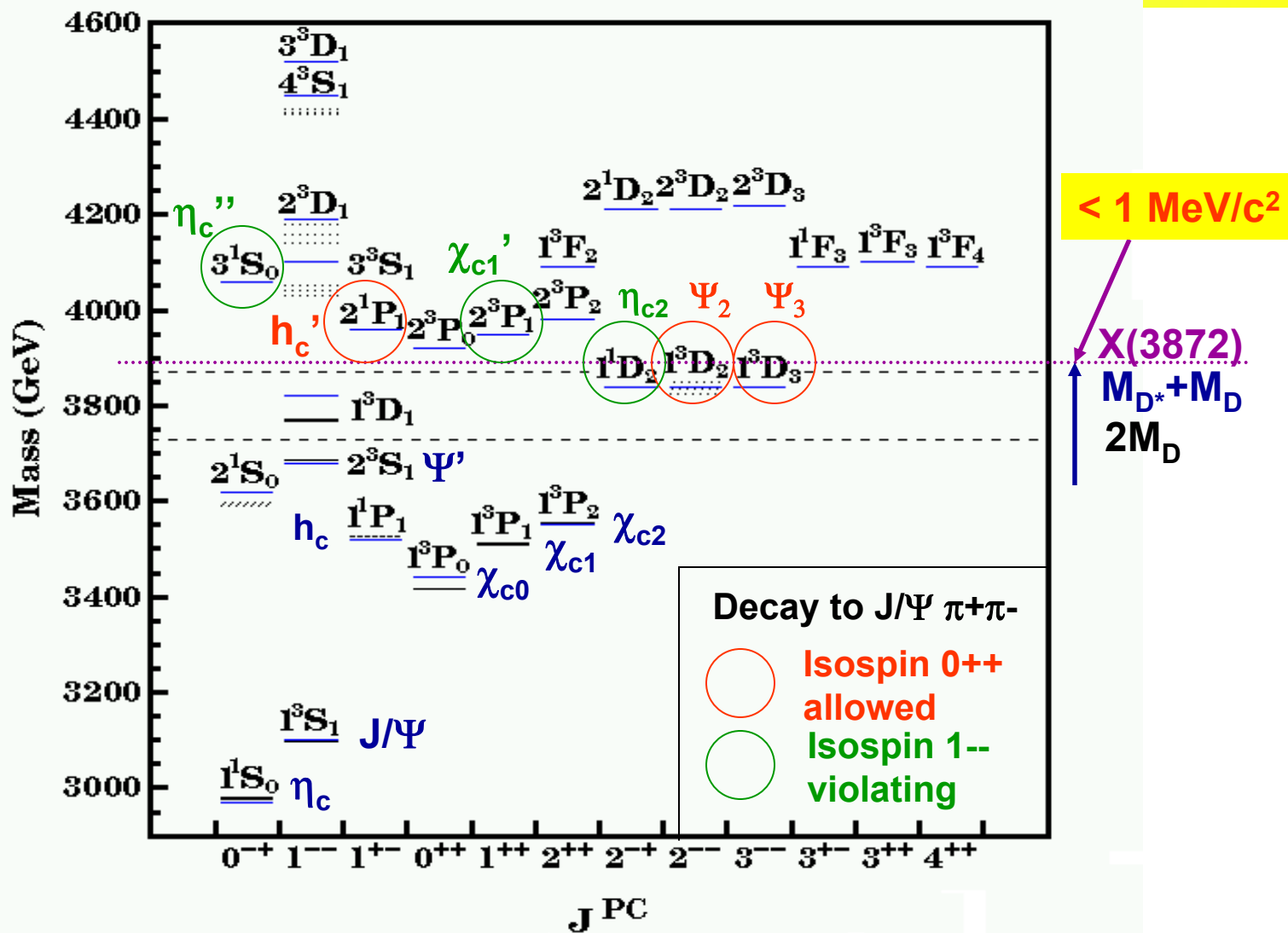


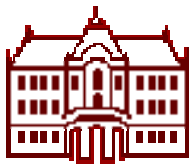
$M(J/\psi \pi^+\pi^-) - M(J/\psi)$  [GeV]

confirmed by  
CDF,D0,BaBar



# Hadron spectroscopy – X(3872)





## Hadron spectroscopy – X(3872)

Search for other decay modes of X(3872):

90% C.L. upper limits (most from Belle):

$$\Gamma(X \rightarrow \gamma\chi_{c1}) / \Gamma(X \rightarrow \pi\pi J / \psi) < 0.89$$

$$\Gamma(X \rightarrow \gamma\chi_{c2}) / \Gamma(X \rightarrow \pi\pi J / \psi) < 1.1$$

$$\Gamma(X \rightarrow \gamma J / \psi) / \Gamma(X \rightarrow \pi\pi J / \psi) < 0.40$$

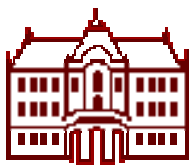
$$\Gamma(X \rightarrow \eta J / \psi) / \Gamma(X \rightarrow \pi\pi J / \psi) < 0.6$$

$$\Gamma(X \rightarrow D\bar{D}) / \Gamma(X \rightarrow \pi\pi J / \psi) < 7$$

$$\Gamma(X \rightarrow D^0\bar{D}^0\pi^0) / \Gamma(X \rightarrow \pi\pi J / \psi) < 6$$

BaBar

**Non-observation of DD modes:  $J^P=0^+, 1^-, 2^+, \dots$ , is ruled out.**

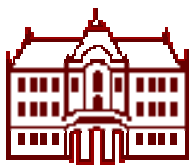


## What kind of state is X(3872)?

### No good cc candidates for X(3872):

- $\eta_c''$  ←  $M$  too low and  $\Gamma$  too small
- ~~$h_c'$~~  ← angular distribution rules out  $1^+$
- ~~$\chi_{c1}'$~~  ←  $\Gamma(\gamma J/\psi)$  too small
- ~~$\psi_2$~~  ←  $\Gamma(\gamma \chi_{c1})$  too small; (PRL 93, 2003)
- $\eta_{c2}$  ←  $\pi\pi \eta_c$  should dominate over  $\pi\pi J/\psi$
- ~~$\psi_3$~~  ←  $\Gamma(\gamma \chi_{c2} \& D\bar{D})$  too small

$\bigcirc$  - Isospin violating decays to  $J/\psi \pi^+\pi^-$

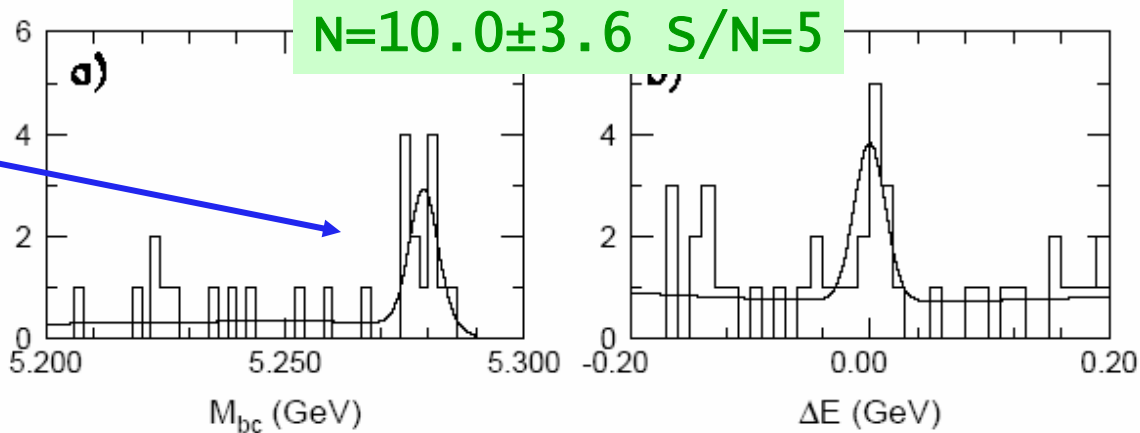
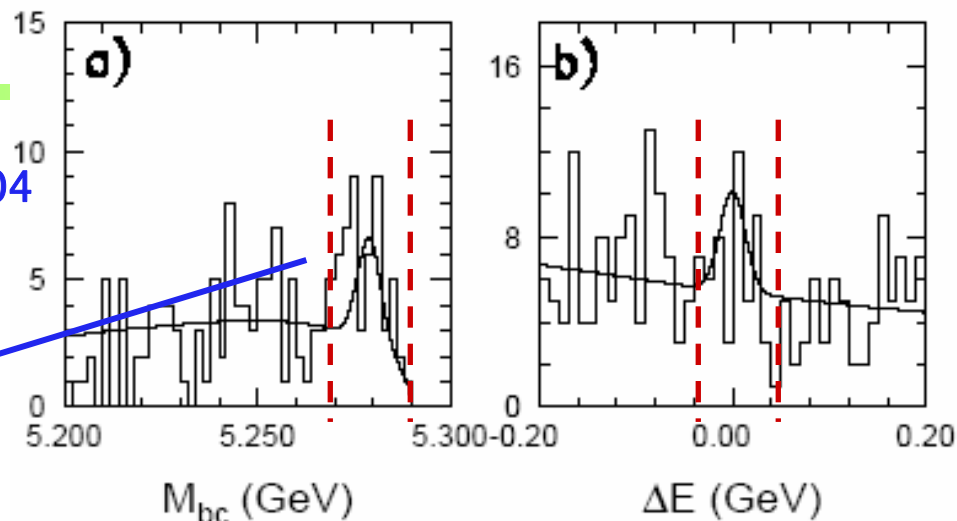
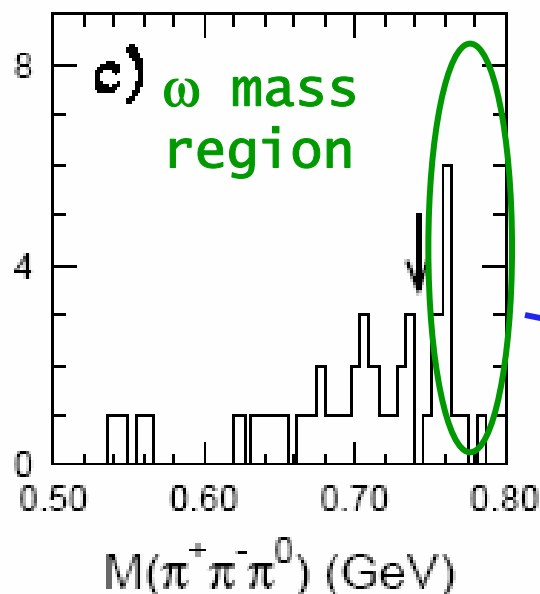


# Hadron spectroscopy – X(3872)

Search for  
 $B^+ \rightarrow K^+ X(3872)$

Belle, 274M  $B\bar{B}$   
 F. Fang, ICHEP'04

$\hookrightarrow J/\psi \pi^+ \pi^- \pi^0$

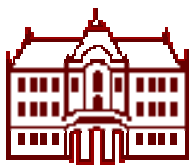


$M(\omega) + M(J/\psi) = 3879 \text{ MeV}$   
 $X(3872) \rightarrow \omega J/\psi$  can  
 occur via virtual  $\omega$

$$\Gamma(\omega J/\psi) / \Gamma(J/\psi \pi^+ \pi^-) = 0.8 \pm 0.3 \pm 0.1$$

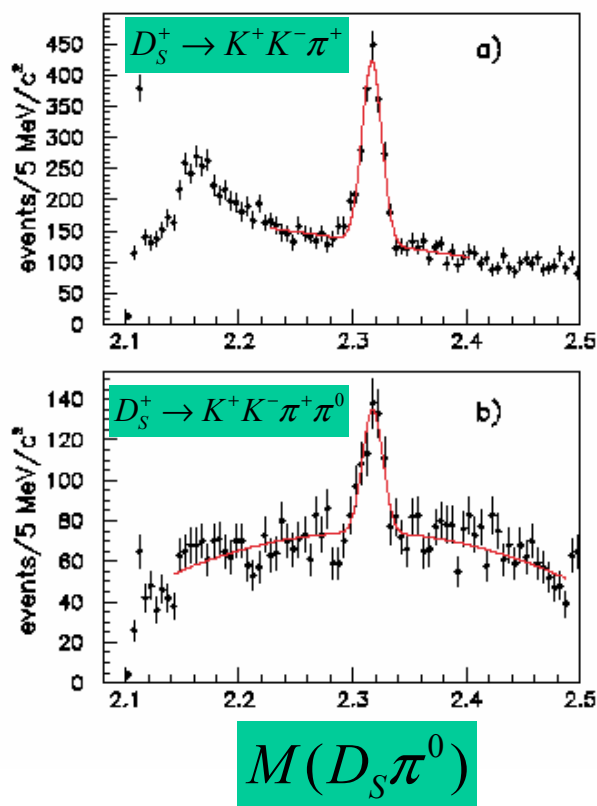
in accordance with  $DD^*$  molecule model

Swanson, PLB 588, 189 (2004)

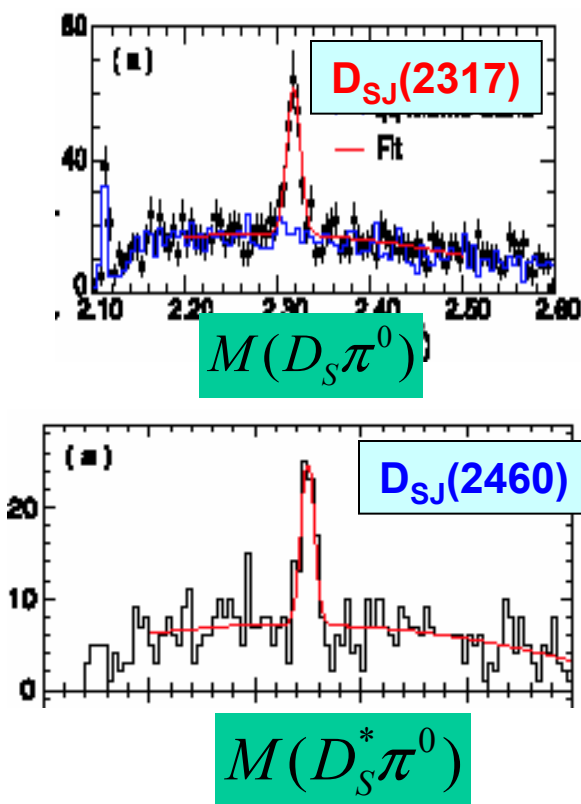


# Hadron spectroscopy – $D_{sJ}(2317)$ and $D_{sJ}(2460)$ mesons

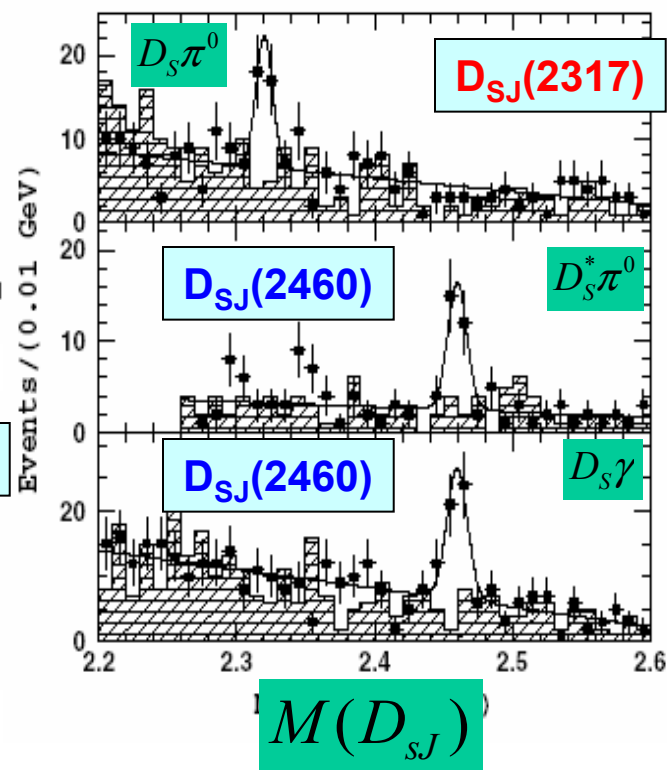
BaBar -  $D_{sJ}(2317)$



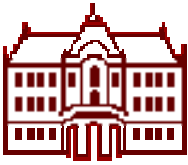
CLEO



Belle

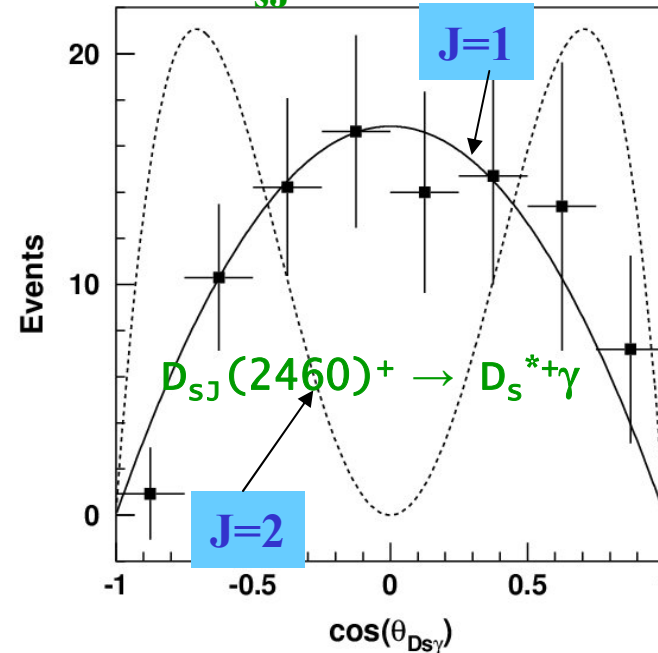
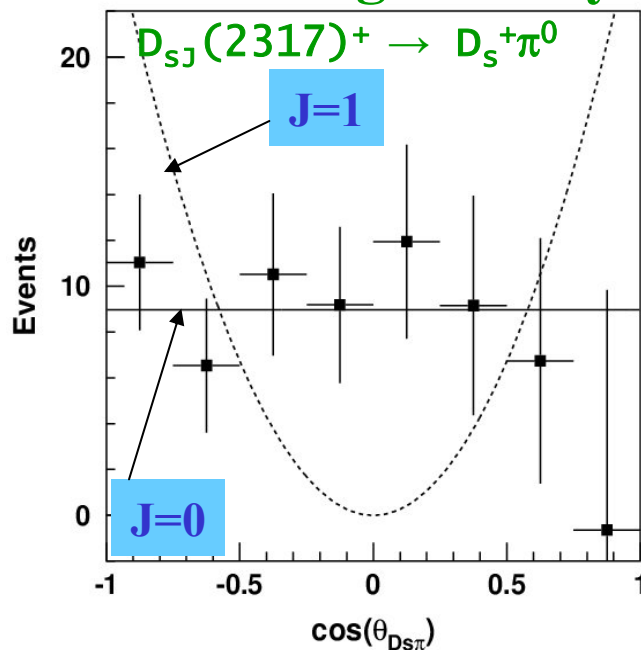
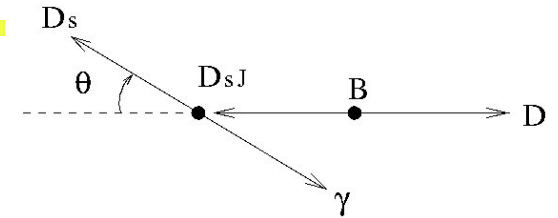






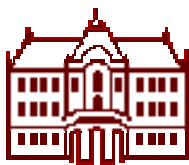
# Hadron spectroscopy – $D_{sJ}$ mesons

Properties studied  
e.g. helicity in  $B \rightarrow DD_{sJ}$



Belle, 280M  $B\bar{B}$ , M. Danilov, ICHEP'04

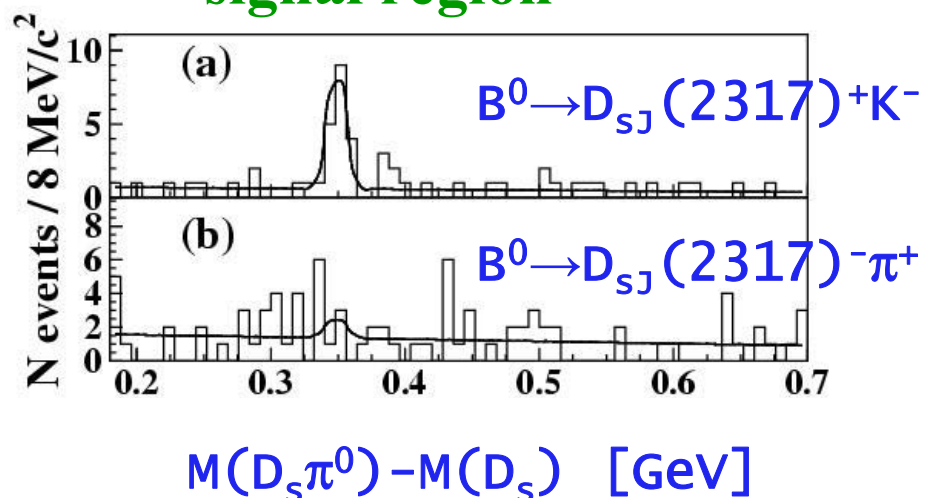
Apart from low masses, all properties in accordance with  
lowest level P states  $J^P=0^+, 1^+$



# Hadron spectroscopy – $D_{sJ}$ mesons

## First observation of $B^0 \rightarrow D_{sJ}(2317)^+ K^-$

Events in  $M_{bc}$ ,  $\Delta E$   
signal region



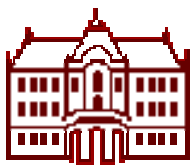
Measured branching fractions  
for comparison

$$\text{Br}(B^0 \rightarrow D_s K^-) = (2.93 \pm 0.55 \pm 0.79) \times 10^{-5}$$

$$\text{Br}(B^0 \rightarrow D_s \pi^+) = (1.94 \pm 0.47 \pm 0.52) \times 10^{-5}$$

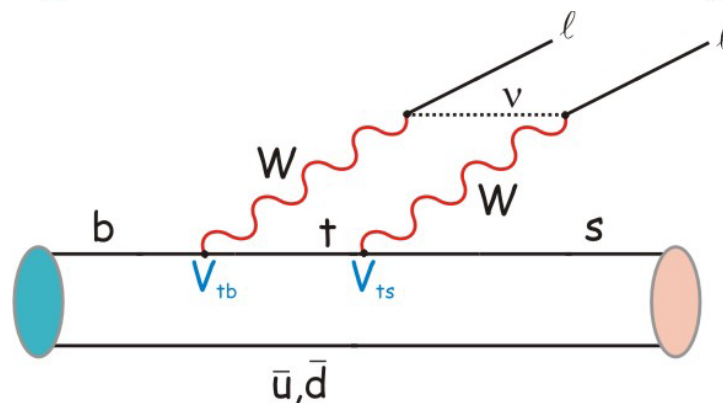
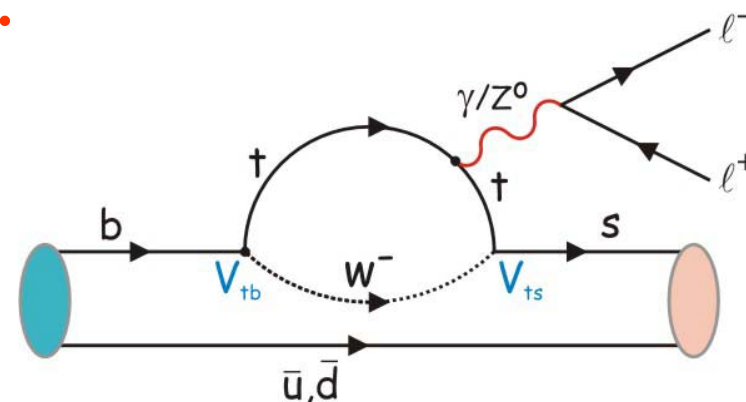
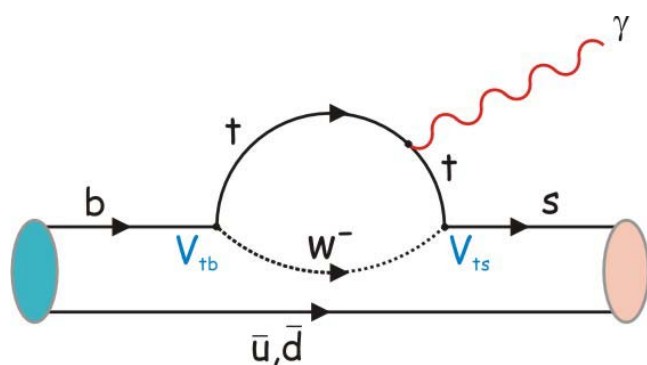
Belle, 152M  $B\bar{B}$ , A. Drutskoy, ICHEP'04

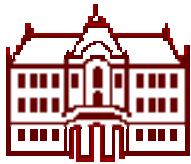
$$\text{Br}(B^0 \rightarrow D_{sJ}(2317)^+ K^-) \times \text{Br}(D_{sJ}(2317)^+ \rightarrow D_s^+ \pi^0) = (5.3 \pm 1.4 \pm 0.5 \pm 1.4) \times 10^{-5}$$



# FCNC B decays

Flavour changing neutral current (FCNC) processes (like  $b \rightarrow s$ ,  $b \rightarrow d$ ) are forbidden at the tree level in the Standard Model. Proceed only at low rate via higher-order loop diagrams. Ideal place to search for new physics.





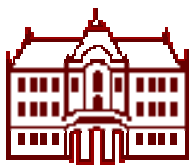
## $b \rightarrow s\gamma$ inclusive

$b \rightarrow s\gamma$  rate: **sensitive to deviations** from the SM, world average in good agreement with SM predictions.

**Photon energy  $E_\gamma$  distribution:** depends on  $m_b$  and Fermi motion parameter in the B system (parameters of HQE); also important for the determination of  $V_{ub}$  in semileptonic B decays.

Previous measurement by CLEO:  $E_\gamma > 2.0$  GeV.

**Belle:** extend the energy range to  $E_\gamma > 1.8$  GeV to cover **>95%** of the rate.



# $b \rightarrow s\gamma$ inclusive



## Results

Branching ratio:

$$\text{BR}(b \rightarrow s\gamma) = (3.55 \pm 0.32^{+0.30+0.11}_{-0.31-0.07}) \cdot 10^{-4}$$

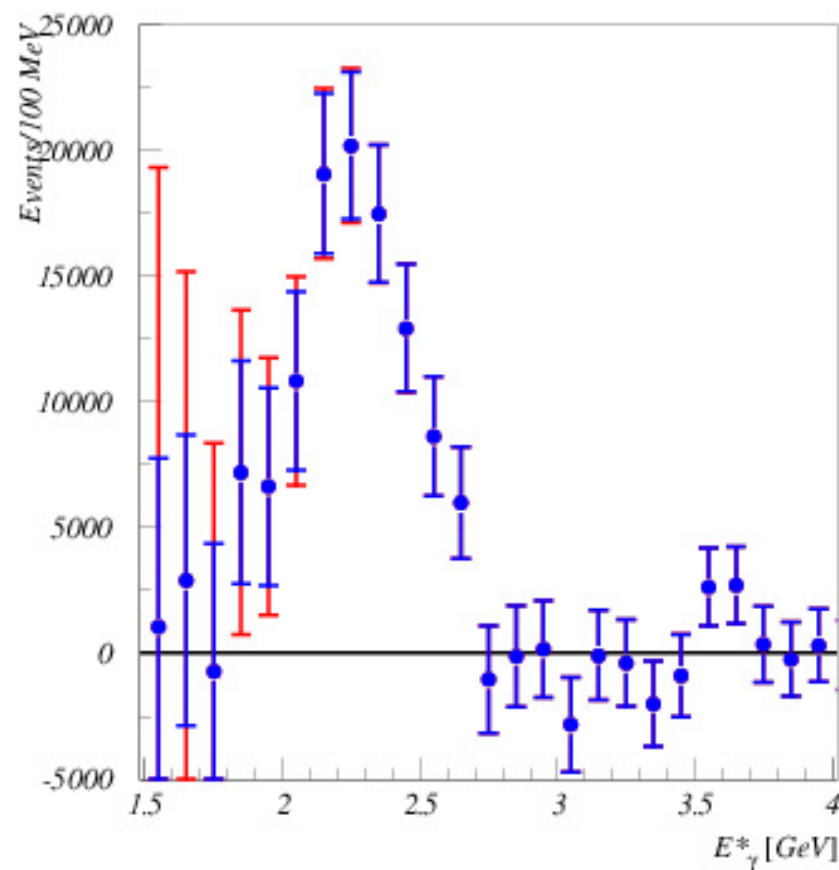
Photon energy  $E_\gamma$  distribution:

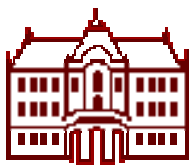
first moment:

$$\langle E_\gamma \rangle = (2.292 \pm 0.026 \pm 0.034) \text{ GeV}$$

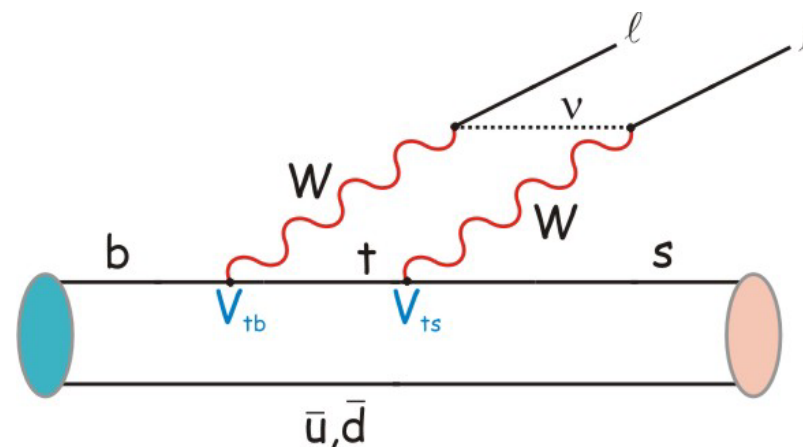
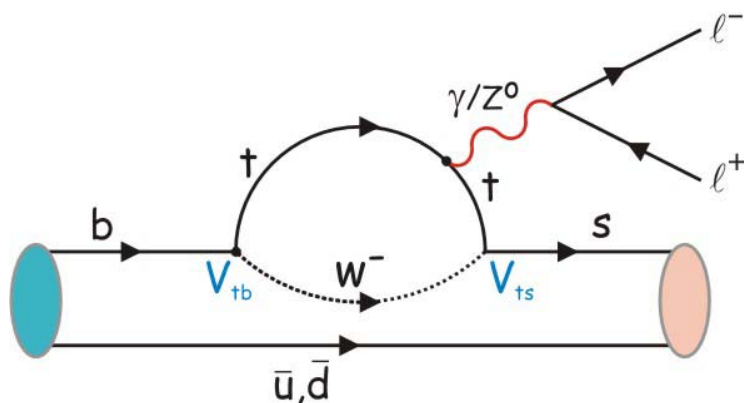
second moment:  $\langle E_\gamma^2 \rangle - \langle E_\gamma \rangle^2 =$

$$(0.0305 \pm 0.0074 \pm 0.0063) (\text{GeV})^2$$





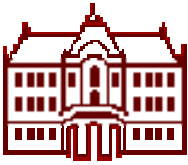
# $B \rightarrow K^* l^+ l^-$



$b \rightarrow s l^+ l^-$  was first measured in  $B \rightarrow K l^+ l^-$  by Belle.

With 140/fb of data, search for  $K^* l^+ l^-$  and update  $K l^+ l^-$ .

Important for further searches for the physics beyond SM:  
backward-forward asymmetry  $A_{FB}$  in  $K^* l^+ l^-$

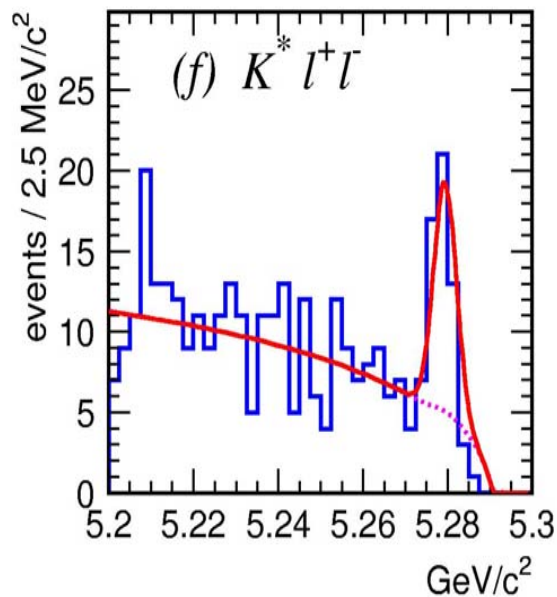


# $B \rightarrow K^* l^+ l^-$

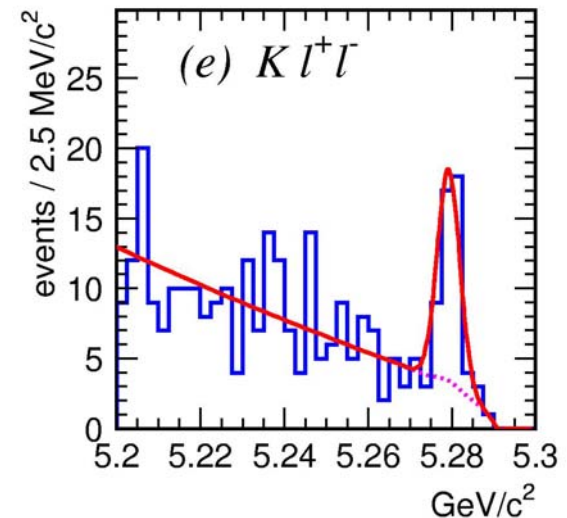


- $K^*$ :  $K^+ \pi^-$ ,  $K_s^0 \pi^+$ ,  $K^+ \pi^0$  with  $|M(K\pi) - M(K^*)| < 75 \text{ MeV}/c^2$
- $K$ : charged or neutral
- Lepton pair:  $e$  or  $\mu$ ,  $p(e) > 0.4 \text{ GeV}/c$ ,  $p(\mu) > 0.7 \text{ GeV}/c$

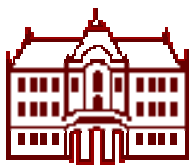
veto on  $J/\Psi$ ,  $\Psi(2S)$



**first  
observation**



$$M_{bc} = \sqrt{(E_{\text{beam}}^*)^2 - |\mathbf{p}_B^*|^2}$$

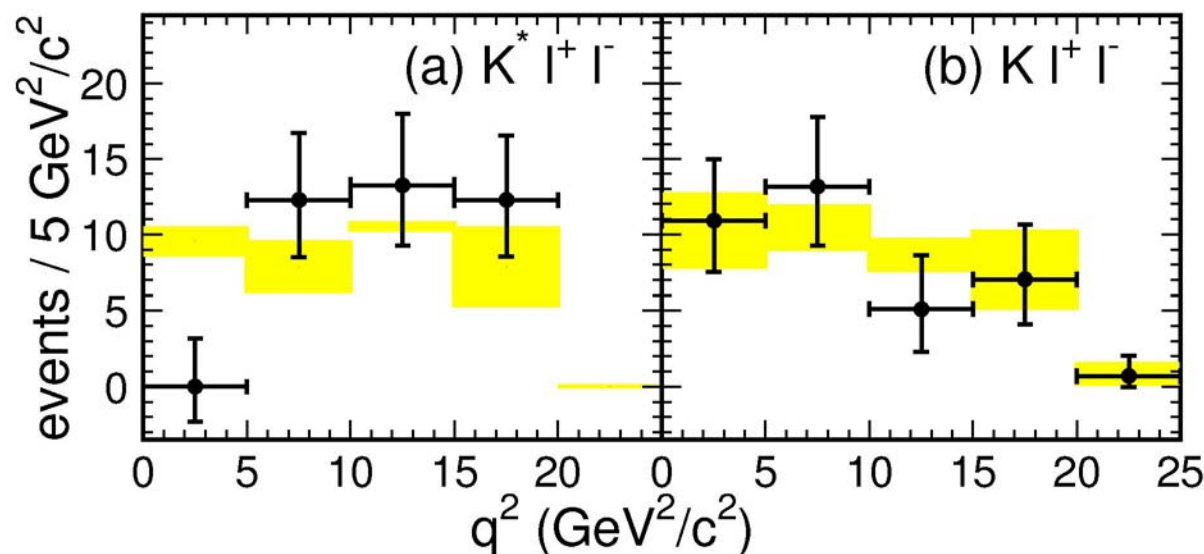


# $B \rightarrow K^* l^+ l^-$



Results based on  $140 \text{ fb}^{-1}$

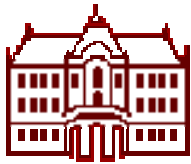
- $\text{BR}(B \rightarrow K^* l^+ l^-) = (11.5_{-2.4}^{+2.6} \pm 0.8 \pm 0.2) 10^{-7}$  observation
- $\text{BR}(B \rightarrow K l^+ l^-) = (4.8_{-0.9}^{+1.0} \pm 0.3 \pm 0.1) 10^{-7}$  update with more data



$$q^2 = M_{ll}^2 c^2$$

yellow: SM expect.





$$B \rightarrow K^* l^+ l^-, K l^+ l^-$$

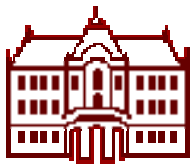


Results based on  $123 \text{ fb}^{-1}$

- $\text{BR}(B \rightarrow K^* l^+ l^-) = (8.8^{+3.3}_{-2.9} \pm 1.0) 10^{-7}$
- $\text{BR}(B \rightarrow K l^+ l^-) = (6.5^{+1.4}_{-1.3} \pm 0.4) 10^{-7}$

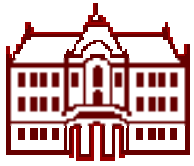
**Belle+BaBar: All in good agreement with SM.**

**With more statistics: measure backward-forward asymmetry  $A_{\text{FB}}$  in  $K^* l^+ l^- \rightarrow$  determine sign of  $C_7$**



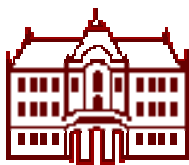
# Summary

- **CKM measurements: new measurements with the fully reco. sample,  $V_{ub}$  with less theoretical uncertainty.**
  - **New upper limits for  $D^0$  mixing in  $D^0 \rightarrow K\pi$  and  $Kl\nu$  decays.**
  - **BR and asymmetries in  $b \rightarrow s\gamma$  and  $b \rightarrow sl^+l^-$  transitions are in good agreement with SM, but some interesting results (e.g.  $A_{FB}$ ) are statistically limited. We are entering an exciting phase of precision measurements.**
  - **New, exciting results from hadron spectroscopy**
- .... and much more, but could not be covered in this talk!**



# More slides – if time left

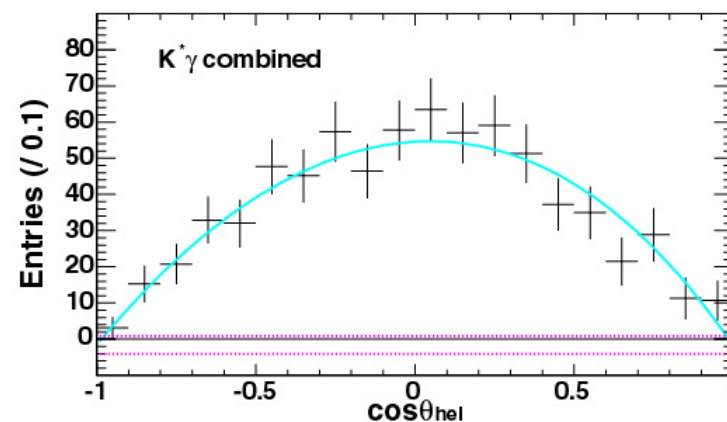
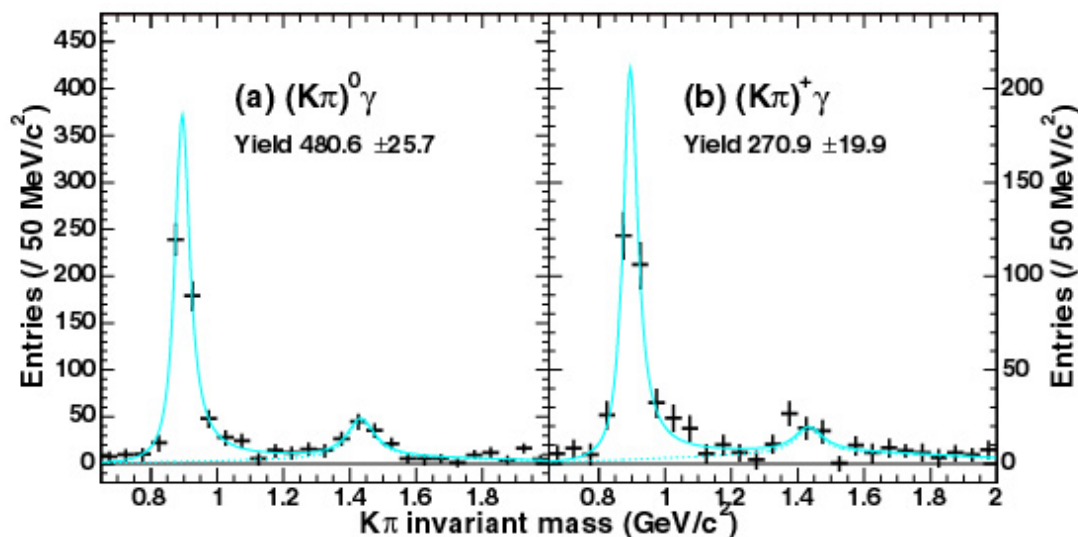
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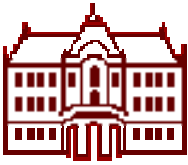
# $B \rightarrow K^* \gamma$



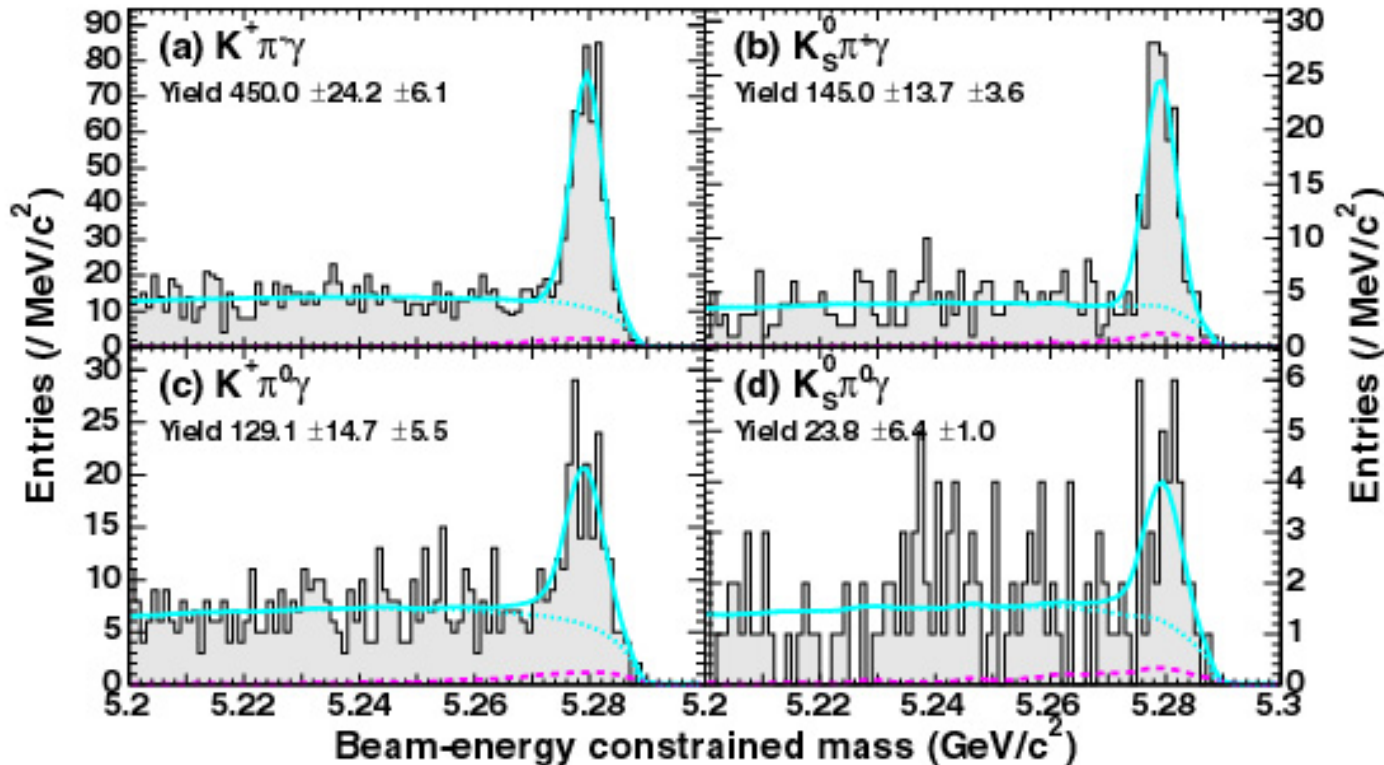
- Photon candidates with  $\pi^0/\eta$  veto
- $K^*(892)$  reconstructed in 4 final states:  
 $K^+\pi^-, K_s^0\pi^0, K^+\pi^0, K_s^0\pi^+$  with  $|M(K\pi) - M(K^*)_r| < 75 \text{ MeV}/c^2$
- BKG suppression against  $e^+e^- \rightarrow qq(\gamma)$  by event shape var.



data sample 78/fb

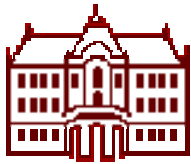


# $B \rightarrow K^* \gamma$ branching fractions



$$M_{bc} = \sqrt{(E_{\text{beam}}^*{}^2 - |\mathbf{p}_B^*|^2)}$$

$$\begin{aligned} \text{BR}(B^0 \rightarrow K^{*0} \gamma) &= (4.01 \pm 0.21 \pm 0.17) \cdot 10^{-5} & \text{SM} &\approx (6.9 \pm 2.1) \cdot 10^{-5} \\ \text{BR}(B^+ \rightarrow K^{*+} \gamma) &= (4.25 \pm 0.31 \pm 0.24) \cdot 10^{-5} & \text{SM} &\approx (7.4 \pm 2.3) \cdot 10^{-5} \end{aligned}$$



# B → K\*γ asymmetries



## Isospin asymmetry $\Delta_{0+} =$

$$\frac{(\tau_{B^+} / \tau_{B^0}) \text{BR}(B^0 \rightarrow K^{*0}\gamma) - \text{BR}(B^+ \rightarrow K^{*+}\gamma)}{(\tau_{B^+} / \tau_{B^0}) \text{BR}(B^0 \rightarrow K^{*0}\gamma) + \text{BR}(B^+ \rightarrow K^{*+}\gamma)}$$

$$\Delta_{0+} = +0.012 \pm 0.044(\text{stat}) \pm 0.026(\text{syst}) \quad \text{Belle}$$

SM: 5-10%

$$\Delta_{0+} = +0.051 \pm 0.044(\text{stat}) \pm 0.023(\text{syst}) \quad \text{BaBar}$$

## CP asymmetry

SM << 0.01

$$A_{\text{CP}} = (\Gamma(\bar{B} \rightarrow \bar{K}^*\gamma) - \Gamma(B \rightarrow K^*\gamma)) / (\Gamma(\bar{B} \rightarrow \bar{K}^*\gamma) + \Gamma(B \rightarrow K^*\gamma)) =$$

$$\frac{1}{(1-2w)} \frac{N(\bar{B} \rightarrow \bar{K}^*\gamma) - N(B \rightarrow K^*\gamma)}{N(\bar{B} \rightarrow \bar{K}^*\gamma) + N(B \rightarrow K^*\gamma)}$$

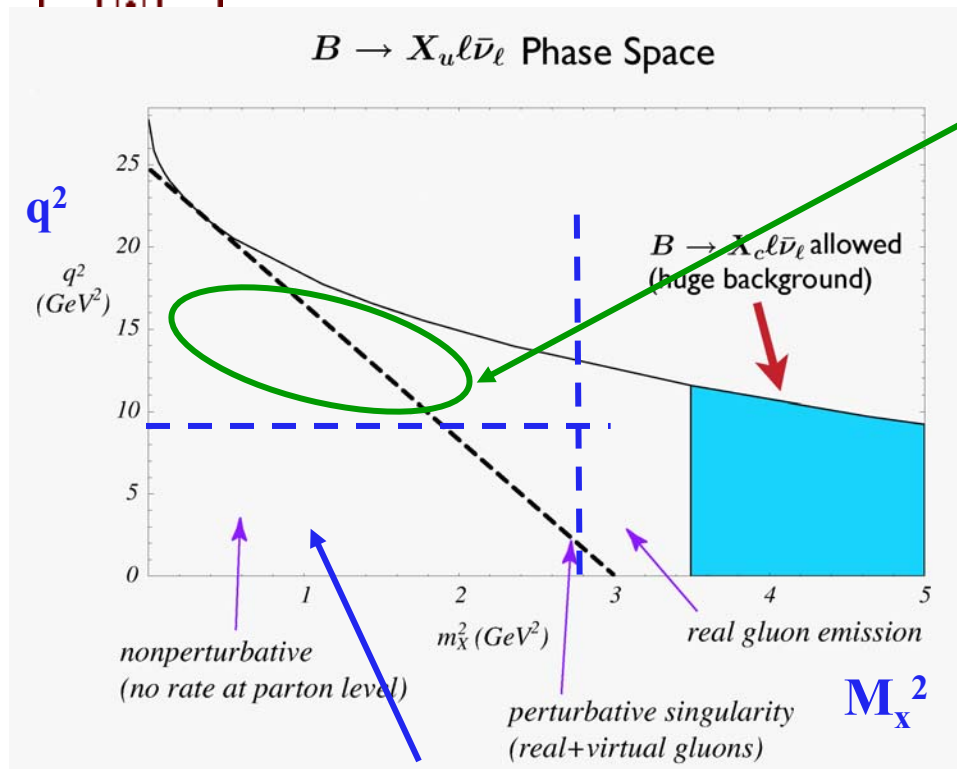
(w = dilution due to imperfect tagging)

$$A_{\text{CP}} = -0.015 \pm 0.044(\text{stat}) \pm 0.012(\text{syst}) \quad \text{Belle}$$

$$A_{\text{CP}} = -0.015 \pm 0.036(\text{stat}) \pm 0.010(\text{syst}) \quad \text{BaBar}$$



# $|V_{ub}|$ inclusive



used in the measurement

$(q^2_{\text{cut}}, M_{X\text{cut}})$  8 GeV<sup>2</sup>, 1.7 GeV

$\Delta V_{ub}$  6%-9%

only  $q^2_{\text{cut}}$  11.6 GeV<sup>2</sup>

$\Delta V_{ub}$  12%-15%

C.W.Bauer et al., hep-ph/0111387

large non-perturbative corr.  
(large th. uncertainty)

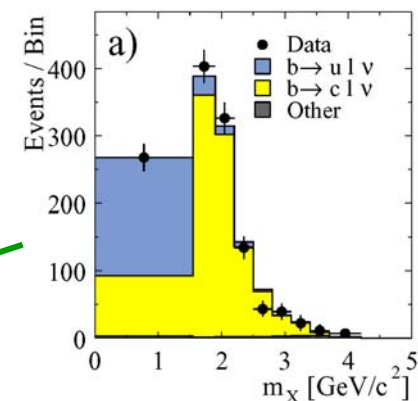
Babar-CONF-04/11, ICHEP'04

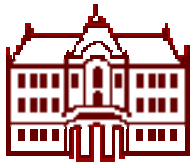
$$|V_{ub}| = (4.77 \pm 0.28 \pm 0.28 \pm {}^{0.69}_{0.39}) \times 10^{-3}$$

$M_X$ - $q^2$

$$|V_{ub}| = (4.92 \pm 0.39 \pm 0.36 \pm 0.46) \times 10^{-3}$$

$M_X$  only





## $|V_{ub}|$ inclusive

$M_x - q^2$

$$|V_{ub}| = (4.92 \pm 0.39 \pm 0.36 \pm 0.46) \times 10^{-3}$$

**BaBar**

(stat.) (syst.) (th.)

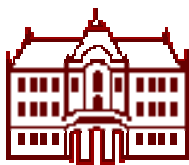
$$|V_{ub}| = (5.54 \pm 0.42 \pm 0.50 \pm 0.55) \times 10^{-3}$$

**Belle**

**BaBar syst.:** largest from detector (tracking, ID) and  
 $b \rightarrow cl\nu$  modeling

**Belle syst.:** MC statistics





# $A_{FB}$ for $B \rightarrow K^{(*)}l^+l^-$



- Raw  $A_{FB}$  in each  $q^2$  region is extracted from  $M_{bc}$  fit.
- Dotted lines indicate charmonium veto windows.
- $Kll$  has no asymmetry, hence a good control sample.
- Curves (**not fitted lines!**) show theory including exp'tal efficiency.
- Both are in agreement with data.

