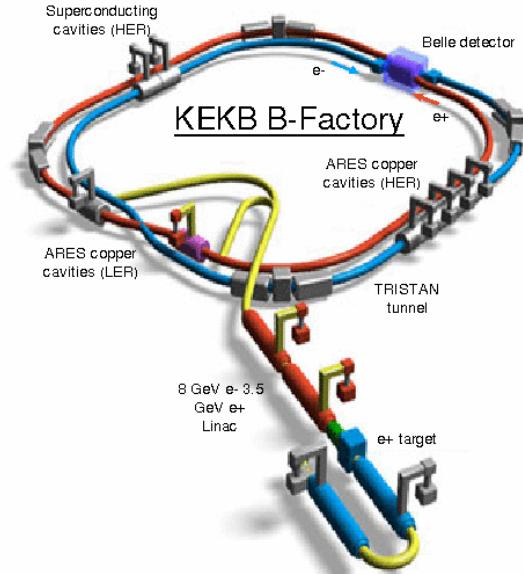
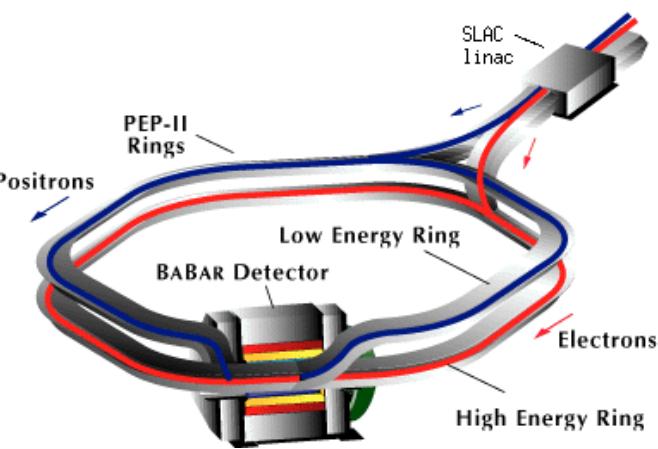
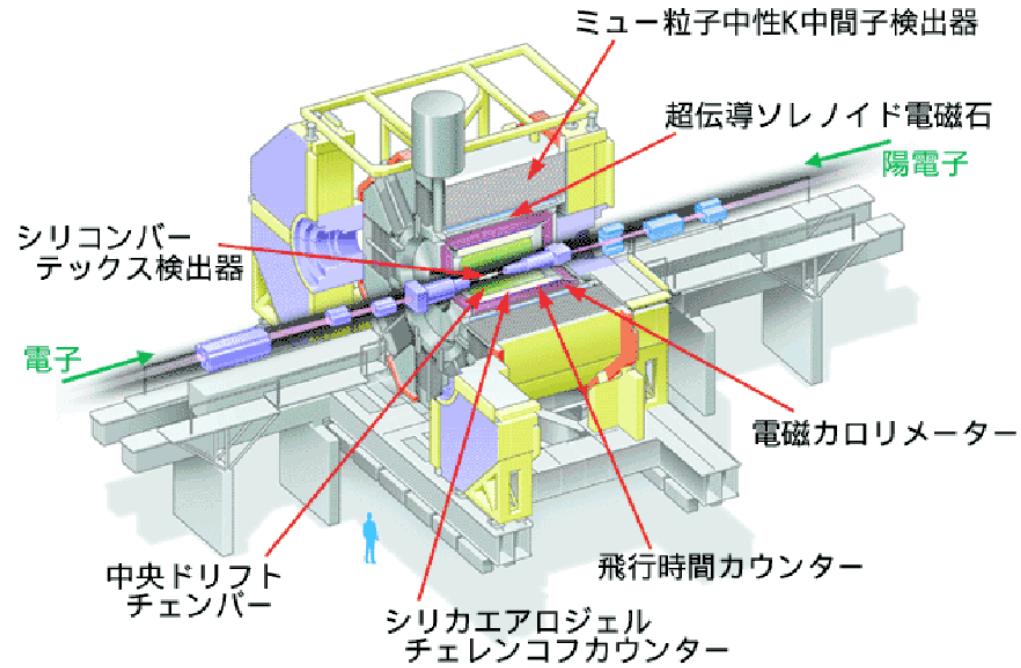
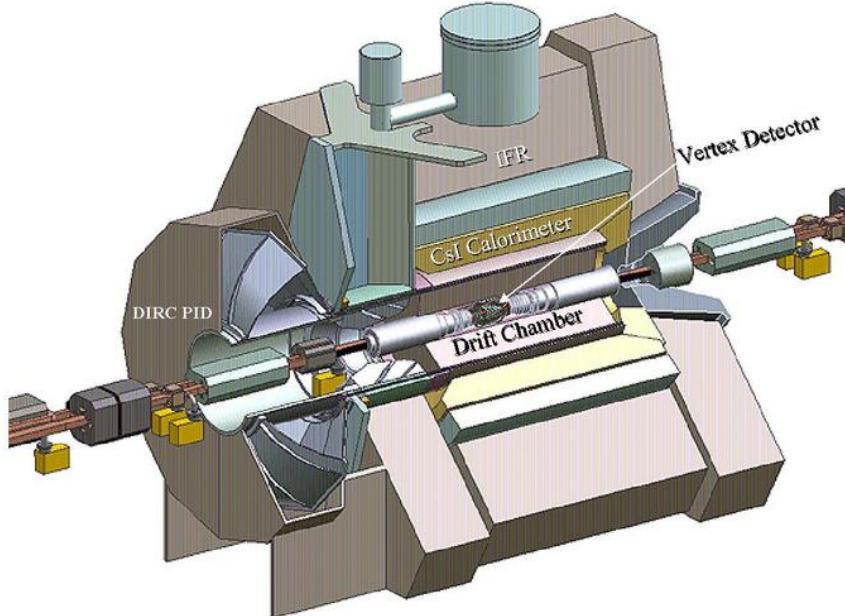


# CHARM PHYSICS AT B FACTORIES



Galina Pakhlova  
representing the Belle and BaBar collaborations



# $D^0 - \bar{D}^0$ mixing

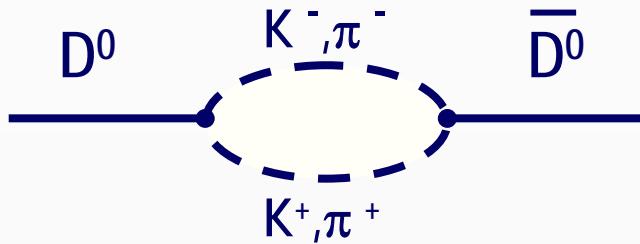
# $D^0$ - $\bar{D}^0$ mixing in the SM

The mass eigenstates  $|D_1\rangle$  and  $|D_2\rangle$  have different masses and lifetimes

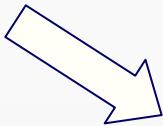
$$|D_{1,2}\rangle = p |D^0\rangle \pm q |\bar{D}^0\rangle, \quad |p|^2 + |q|^2 = 1$$

$$\begin{aligned} x &= \Delta M / \Gamma & y &= \Delta \Gamma / 2\Gamma \\ \Delta M &= M_2 - M_1 & \Gamma &= 1/2(\Gamma_1 + \Gamma_2) & \Delta \Gamma &= \Gamma_2 - \Gamma_1 \end{aligned}$$

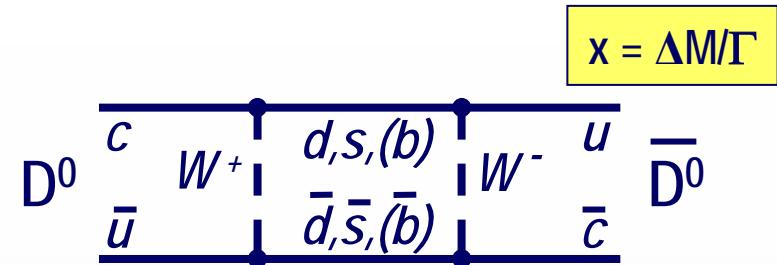
$$y = \Delta \Gamma / 2\Gamma \sim \sin^2 \theta_C \times [\text{SU}(3) \text{ breaking}]^2 \sim 0.1\text{-}1\%$$



Long distance effects contribute to  $x$  as well!

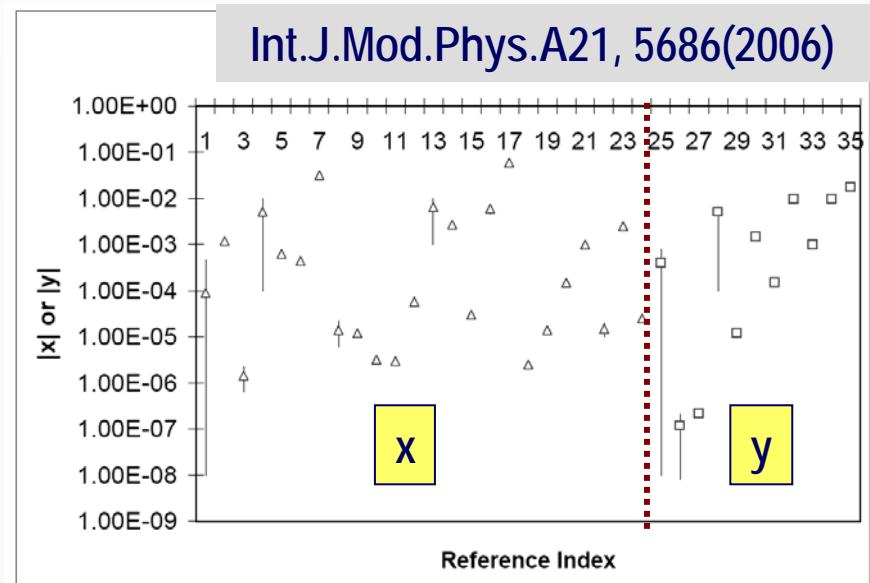


Wide range of SM predictions  
 $x, y \sim 10^{-6} - 10^{-2}$



SM: box diagram is negligibly small

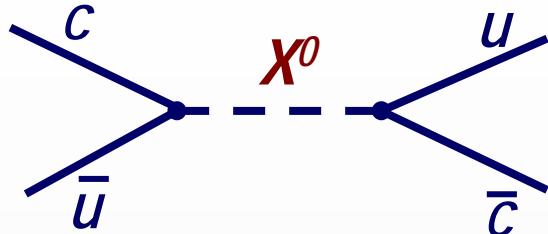
- CKM suppression
- GIM suppression



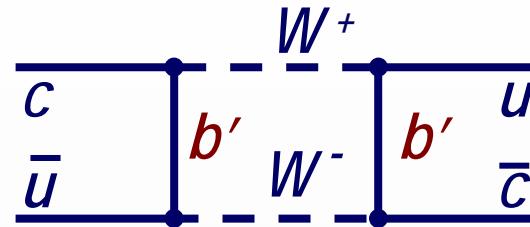
# $D^0$ - $\bar{D}^0$ mixing and New Physics

"box" mixing can be enhanced by:

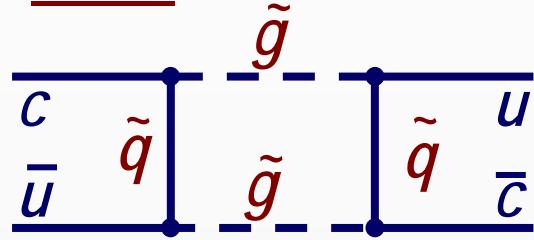
FCNC



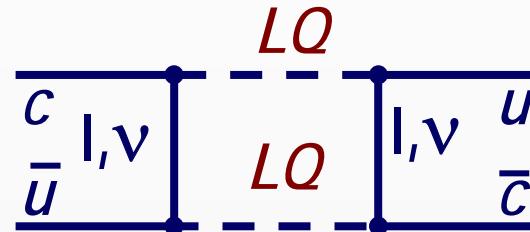
4th generation quark



SUSY



leptoquarks



and increase  $x$  (but not  $y$ )

- If  $x \gg y$ , it might be a hint of New Physics
- If CPV in mixing is found, it is an indication of New Physics

# $D^0$ - $\bar{D}^0$ mixing: experimental methods

- Wrong sign (WS) hadronic decays

e.g.  $K^+ \pi^-$  ( $K^+ \pi^- \pi^0$ ,  $K^+ \pi^- \pi^- \pi^+$ )

t-dependent analysis required to disentangle mixing and DCS contributions

$$\Gamma_{WS}(t) \propto e^{-\Gamma t} \left( R_D + y' \sqrt{R_D} \Gamma t + \frac{x'^2 + y'^2}{4} (\Gamma t)^2 \right)$$

$$x' = x \cos \delta_{K\pi} + y \sin \delta_{K\pi} \quad y' = y \cos \delta_{K\pi} - x \sin \delta_{K\pi}$$

Strong phase difference between CF and DCS

$R_D$  ratio of DCS/CF decay rates

- Lifetime difference

e.g.  $D^0 \rightarrow K^+ K^- (\tau^+)$  vs  $D^0 \rightarrow K^- \pi^+ (\tau^0)$

$$\tau^0 / \tau^+ = 1 + y_{CP}$$

$$y_{CP} = y \text{ if no CP violation}$$

- Wrong sign (WS) semileptonic decays

$D^0 \rightarrow K^+ l^- \nu$

t-dependent analysis is NOT required  
but t-cut useful to reduce background

$$\Gamma_{WS}(t) \propto e^{-\Gamma t} (R_M (\Gamma t)^2) \quad R_M = 1/2(x^2 + y^2)$$

- New: Dalitz plot analysis

$D^0 \rightarrow K_S \pi^- \pi^+$

t-dependent analysis:

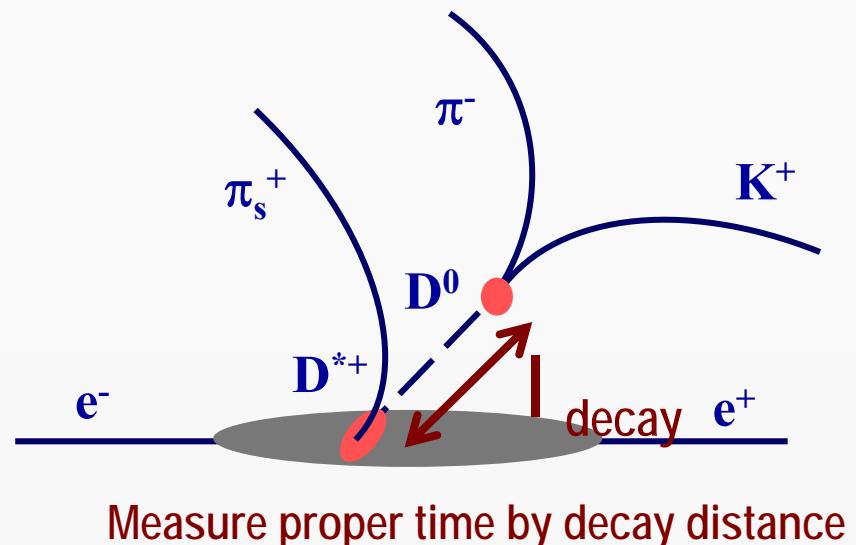
interference of DCS and mixing

e.g.  $D^0 \rightarrow K^+ \pi^-$

CP final states e.g.  $D^0 \rightarrow K_S \rho^0 (\tau^+)$

All methods use  $D^{*+}$  tag:

- tag flavour
- suppress backgrounds



# $D^0$ - $\bar{D}^0$ mixing: status in 2006

Wrong sign (WS) hadronic decays:

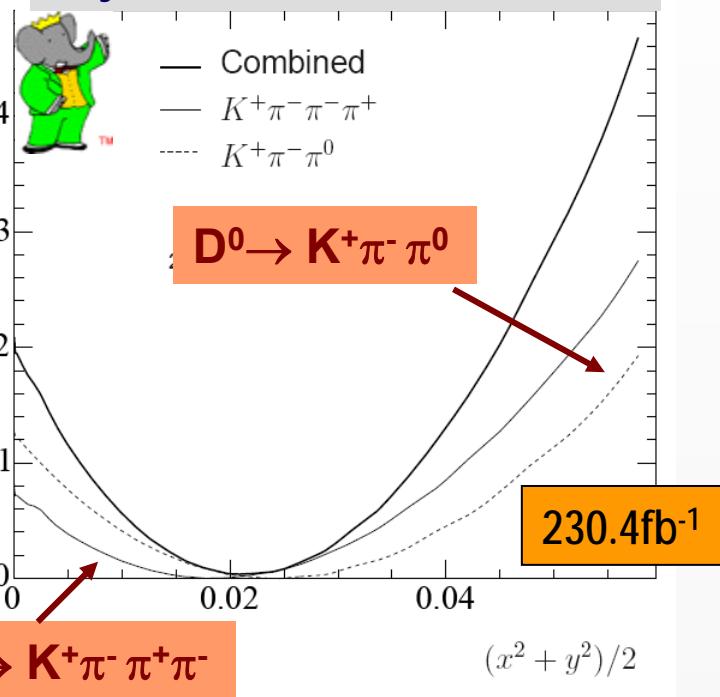
$K^+\pi^-$ ,  $K^+\pi^-\pi^0$ ,  $K^+\pi^-\pi^+\pi^+$

t-dependent analysis

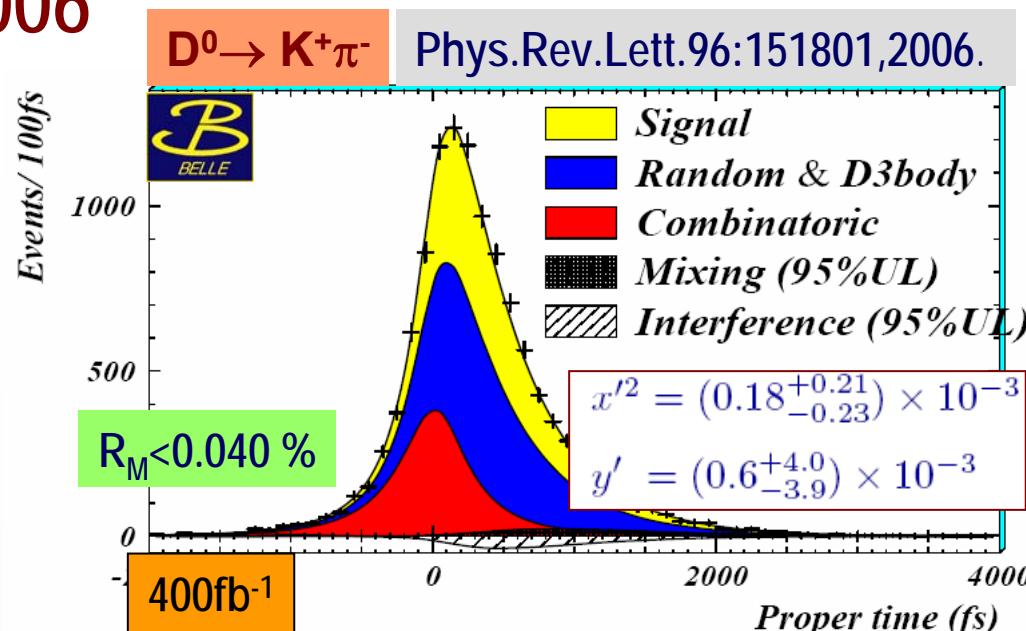
to disentangle mixing and DCS

$\Delta \log \mathcal{L}$

Phys.Rev.Lett.97: 221803,2006.

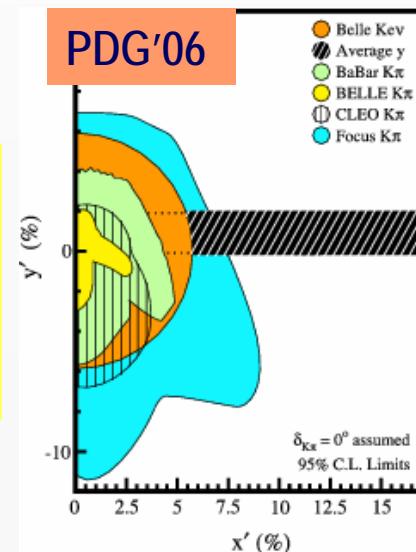


No mixing:  $\sim 2.3\sigma$  (x,y) away (0,0)



No mixing:  $\sim 2.1\sigma$  (x,y) away (0,0)

Many hints of  $D^0$ - $\bar{D}^0$  mixing:  
 $\sim 2.1\sigma$  Belle  $D^0 \rightarrow K\pi$   
 $\sim 2.3\sigma$  BaBar  $D^0 \rightarrow K2\pi/K3\pi$   
 $\sim 2.2\sigma$  Average  $y_{CP}$  (PDG'06)





# New $D^0 \rightarrow K^+ \pi^-$ study at BaBar

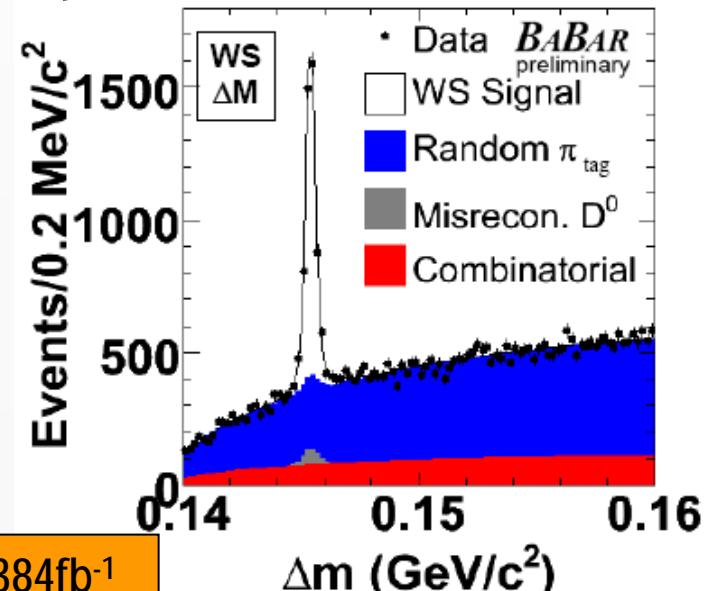
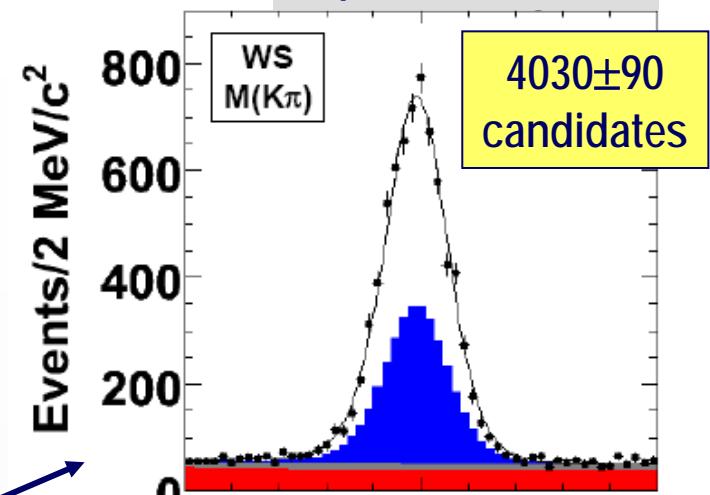
Blind analysis of  $D^{*+} \rightarrow D^0 (\rightarrow K^+ \pi^-) \pi^+_{tag}$

## Strategy to determine mixing parameters $x'^2, y', R_D$

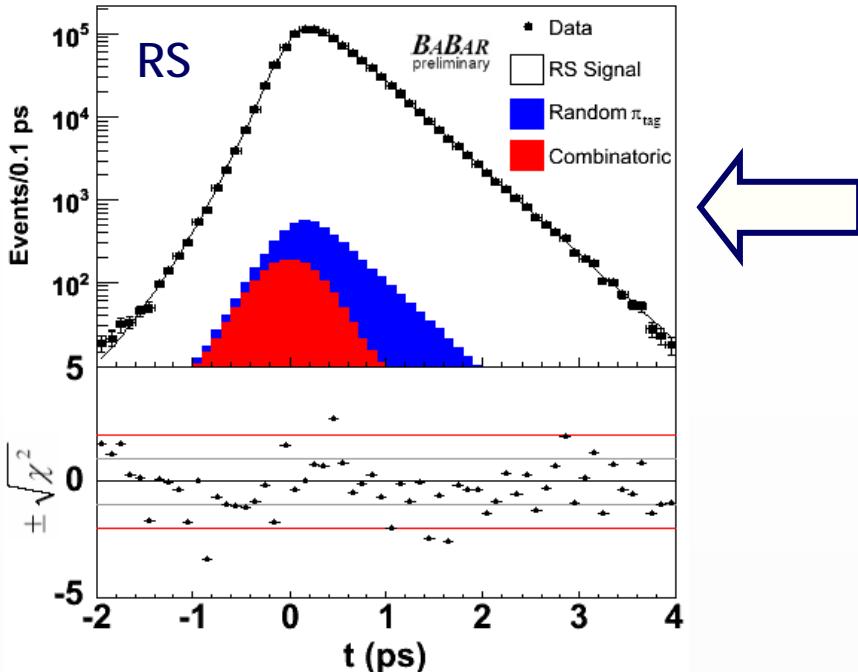
unbinned maximum-likelihood fit to RS and WS data over  $m(K\pi)$ ,  $\Delta m = m(K\pi \pi_{tag}) - m(K\pi)$ ,  $t$  and  $\delta t$

- RS and WS signal and bckg shape parameters
  - fit to  $m(K\pi)$  and  $\Delta m$  distributions
- $D^0$  proper time resolution function and life time ( $t$ )
  - fit to RS data using  $m(K\pi)$  and  $\Delta m$  to separate signal and background
- Fit to WS data with three different models
  - CP conservation and absence of mixing
  - CP conservation and mixing
  - CP violation and mixing

hep-ex/0703020v1



# Decay time analysis

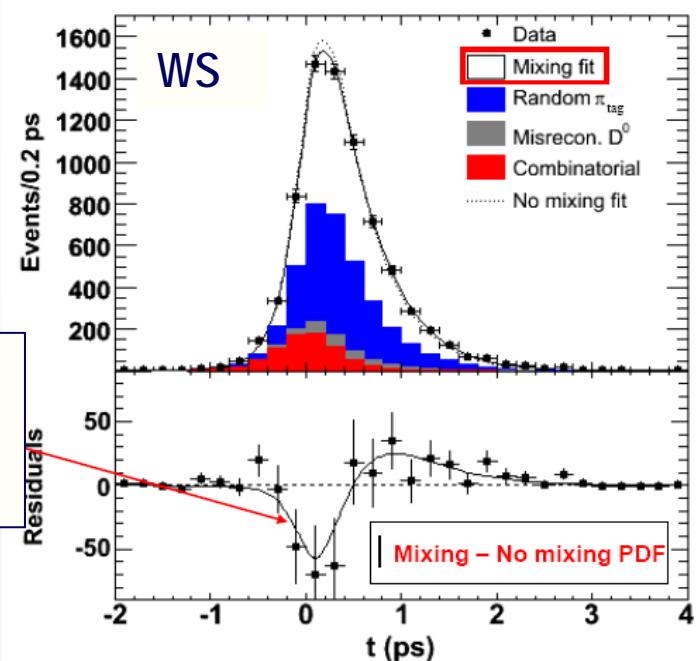


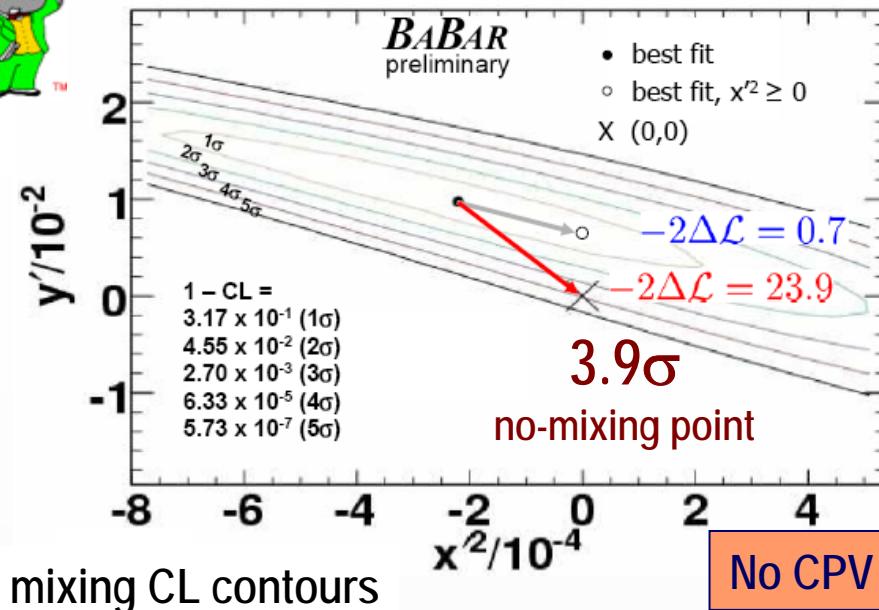
Fit to RS proper time distribution:  
exp convoluted with resolution function  
(sum of three Gaussian with width  $\sim \delta t$ )

$D^0$  lifetime:  $(410.3 \pm 0.3)$  fs  
PDG2006:  $(410.1 \pm 1.5)$  fs

Fit to WS proper time distribution:  
resolution function from RS proper time fit

points: data – no-mixing fit  
curve : "mixing fit" – "no mixing fit"  
Fit with mixing is better match to data!





# Mixing contours

## $x'^2$ and $y'^2$ CL contours

- calculated from the change in log likelihood
- include systematic errors

Fit type	$R_D \times 10^{-3}$	$x'^2 \times 10^{-3}$	$y'^2 \times 10^{-3}$	$A_D \times 10^{-3}$
No CPV , no mix	$3.53 \pm 0.08 \pm 0.04$			
No CPV	$3.03 \pm 0.16 \pm 0.10$	$-0.22 \pm 0.30 \pm 0.21$	$9.7 \pm 4.4 \pm 3.1$	
CPV (+)		$-0.24 \pm 0.43 \pm 0.30$	$9.8 \pm 6.4 \pm 4.5$	
CPV (-)	$3.03 \pm 0.16 \pm 0.10$	$-0.20 \pm 0.41 \pm 0.29$	$9.6 \pm 6.1 \pm 4.3$	$-21 \pm 52 \pm 15$
No evidence for CPV				

# New Dalitz analysis $D^0 \rightarrow K_S^0 \pi^+ \pi^-$

Study self-conjugate decay  $D^0 \rightarrow K_S^0 \pi^+ \pi^-$

t-dependence of Dalitz plot distribution provide direct access to x and y!!!

3-body final state  $K_S^0 \pi^+ \pi^-$  consists:

- CF-modes + DCS-modes  $\nwarrow$  mixing e.g.  $D^0 \rightarrow K^* \pi^+$
- DCS-modes + CF-modes  $\nwarrow$  mixing e.g.  $D^0 \rightarrow K^* \pi^-$
- CP-final states (color suppressed) e.g.  $D^0 \rightarrow K_S^0 \rho^0$

Interference of all these

Decay amplitude assuming  $M = \bar{M}$  (no CPV):

$$M(m_-^2, m_+^2, t) = A(m_-^2, m_+^2) \frac{e_1(t) + e_2(t)}{2} + A(m_+^2, m_-^2) \frac{e_1(t) - e_2(t)}{2}$$

for  $D^0$   $m_{\pm}^2 = m^2(K_S \pi^{\pm})$ , for  $\bar{D}^0$   $m_{\pm}^2 = m^2(K_S \pi^{\circ})$

t - dependence is contained in

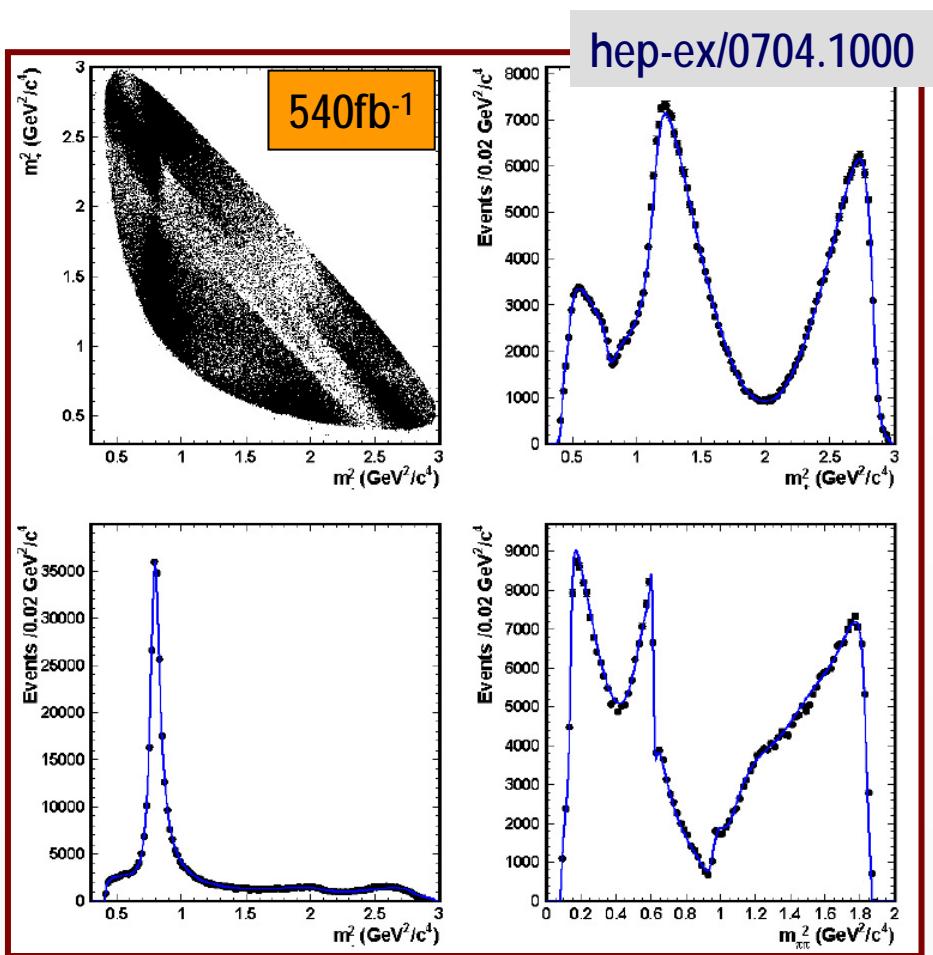
$$e_{1,2}(t) = e^{-i(m_{1,2} - i\Gamma_{1,2}/2)t}$$

tag is required to know what is  $m_+$  and  $m_-$

$D^0$  decay vertex from  $\pi^+ \pi^-$

Strong phase difference between CF and DCS amplitudes fixed by Dalitz fit!

# Dalitz fit



Resonance	Amplitude	Phase (deg)	Fit fraction
$K^*(892)^-$	$1.629 \pm 0.005$	$134.3 \pm 0.3$	0.6227
$K_0^*(1430)^-$	$2.12 \pm 0.02$	$-0.9 \pm 0.5$	0.0724
$K_2^*(1430)^-$	$0.87 \pm 0.01$	$-47.3 \pm 0.7$	0.0133
$K^*(1410)^-$	$0.65 \pm 0.02$	$111 \pm 2$	0.0048
$K^*(1680)^-$	$0.60 \pm 0.05$	$147 \pm 5$	0.0002
$K^*(892)^+$	$0.152 \pm 0.003$	$-37.5 \pm 1.1$	0.0054
$K_0^*(1430)^+$	$0.541 \pm 0.013$	$91.8 \pm 1.5$	0.0047
$K_2^*(1430)^+$	$0.276 \pm 0.010$	$-106 \pm 3$	0.0013
$K^*(1410)^+$	$0.333 \pm 0.016$	$-102 \pm 2$	0.0013
$K^*(1680)^+$	$0.73 \pm 0.10$	$103 \pm 6$	0.0004
$\rho(770)$	1 (fixed)	0 (fixed)	0.2111
$\omega(782)$	$0.0380 \pm 0.0006$	$115.1 \pm 0.9$	0.0063
$f_0(980)$	$0.380 \pm 0.002$	$-147.1 \pm 0.9$	0.0452
$f_0(1370)$	$1.46 \pm 0.04$	$98.6 \pm 1.4$	0.0162
$f_2(1270)$	$1.43 \pm 0.02$	$-13.6 \pm 1.1$	0.0180
$\rho(1450)$	$0.72 \pm 0.02$	$40.9 \pm 1.9$	0.0024
$\sigma_1$	$1.387 \pm 0.018$	$-147 \pm 1$	0.0914
$\sigma_2$	$0.267 \pm 0.009$	$-157 \pm 3$	0.0088
NR	$2.36 \pm 0.05$	$155 \pm 2$	0.0615

- Dalitz model: 18 resonances + non-resonant
- Results with this model consistent with  $\phi_3$  measurements by Belle : *PRD73 112009 (2006)*

# Result of Dalitz plot analysis $D^0 \rightarrow K_S^0 \pi^- \pi^+$



$$x = (0.80 \pm 0.29 \pm 0.17) \%$$

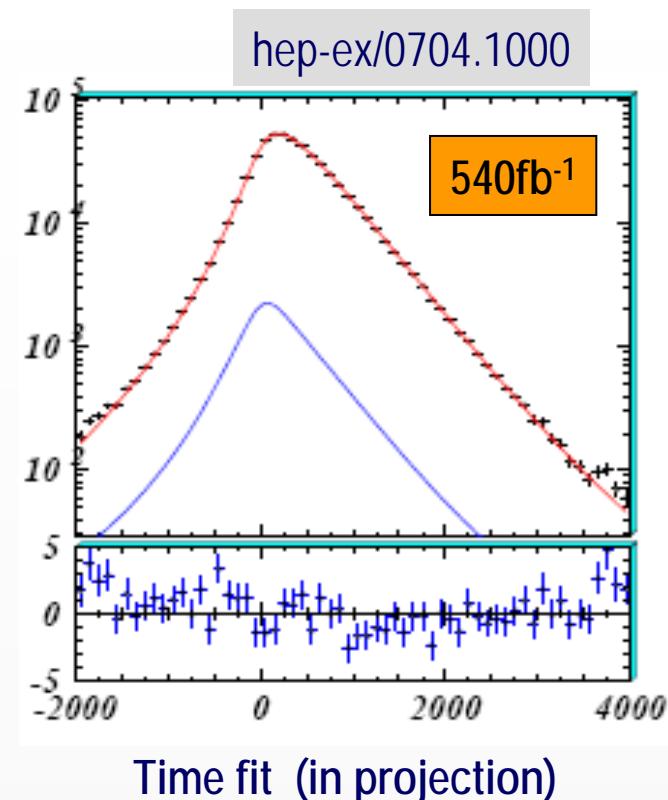
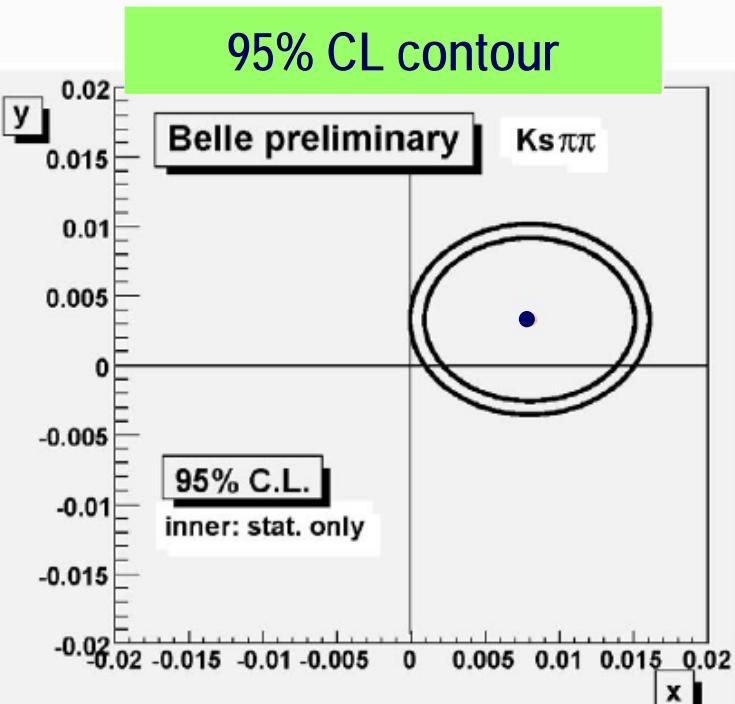
$$y = (0.33 \pm 0.24 \pm 0.15) \%$$

$$\tau = (410.3 \pm 0.3) \text{ fs}$$

Most sensitive measurements of x  
 Cleo PRD72, 012001(2005)

$$x = (1.80 \pm 3.4 \pm 0.6) \%$$

$$y = (-1.4 \pm 2.5 \pm 0.9) \%$$



disfavor no-mixing  $x=y=0$  point  
 with significance  $2.7 \sigma$

# New $y_{CP}$ study at Belle

World average'06:  
 $y_{CP} = (1.09 \pm 0.46)\%$

Measure relative lifetime difference:  $D^0 \rightarrow K^- \pi^+$  and  $D^0 \rightarrow K^+ K^- (\pi^+ \pi^-)$

mixing parameter

$$y_{CP} = \frac{\tau(K^- \pi^+)}{\tau(K^+ K^-)} - 1$$

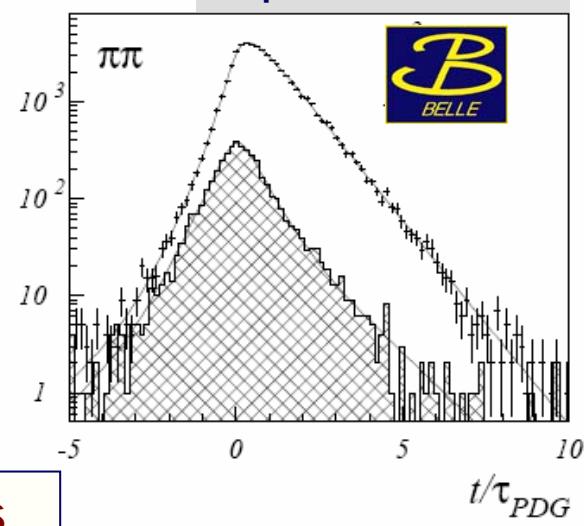
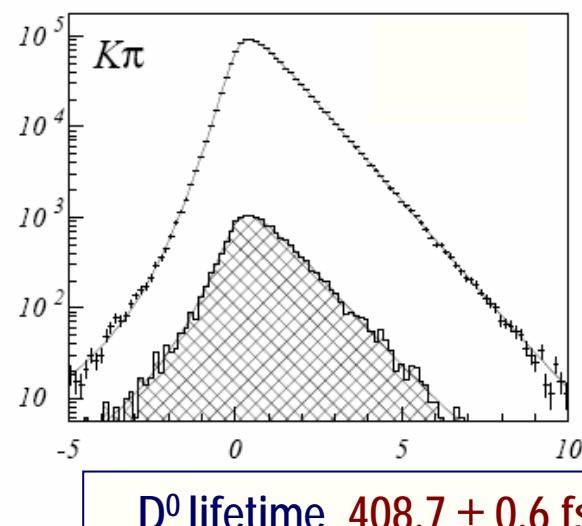
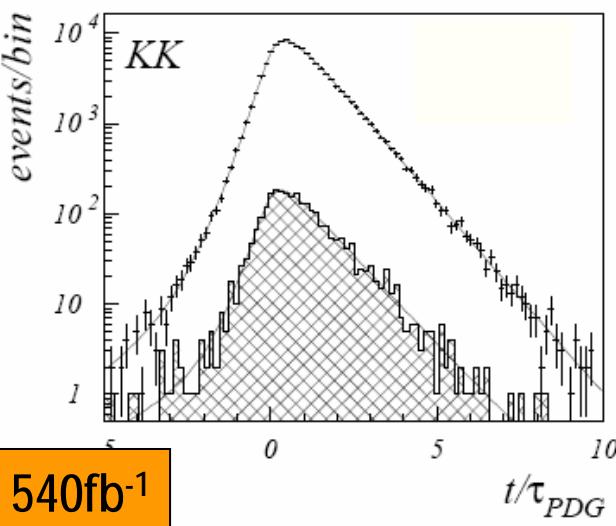
$$y_{CP} = y \cdot \cos\phi - 1/2 A_M x \cdot \sin\phi$$

$$\text{CP conservation: } A_M = \sin\phi = 0 ; y_{CP} = y = \Delta\Gamma / \Gamma$$

Search for CPV by measuring

$$A_\Gamma = 1/2 A_M y \cdot \cos\phi - x \cdot \sin\phi$$

$$A_\Gamma = \frac{\tau(\overline{D}^0 \rightarrow K^- K^+) - \tau(D^0 \rightarrow K^+ K^-)}{\tau(\overline{D}^0 \rightarrow K^- K^+) + \tau(D^0 \rightarrow K^+ K^-)}$$

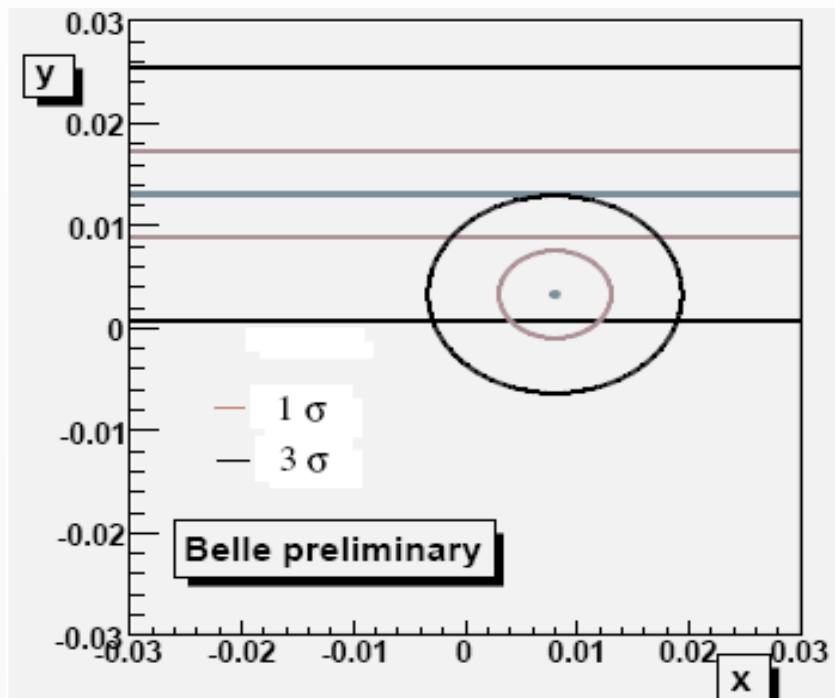


hep-ex/0703036v2

$D^0$  lifetime  $408.7 \pm 0.6$  fs

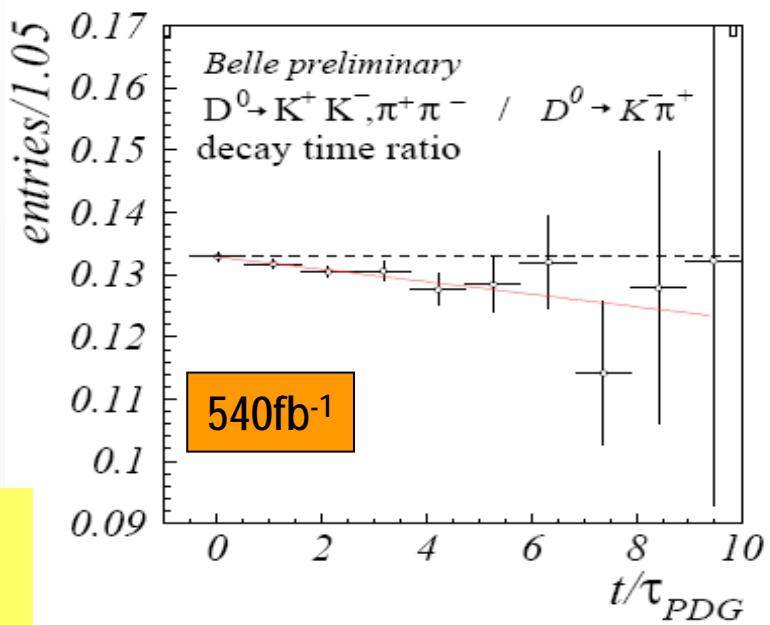
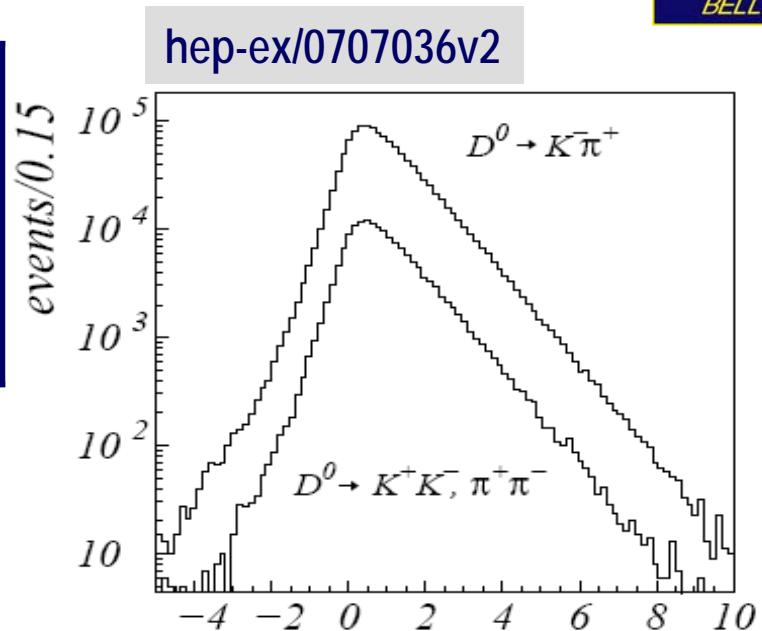
# Mixing results

	$y_{CP}$ (%)	$A_\Gamma$ (%)
KK	$1.25 \pm 0.39 \pm 0.28$	$0.15 \pm 0.34 \pm 0.16$
$\pi\pi$	$1.44 \pm 0.57 \pm 0.42$	$-0.28 \pm 0.52 \pm 0.30$
KK + $\pi\pi$	$1.31 \pm 0.32 \pm 0.25$	$0.01 \pm 0.30 \pm 0.15$



$3.2\sigma$  above zero  
Evidence of  $D^0$  -  $\bar{D}^0$  mixing !!!

No evidence  
for CP violation

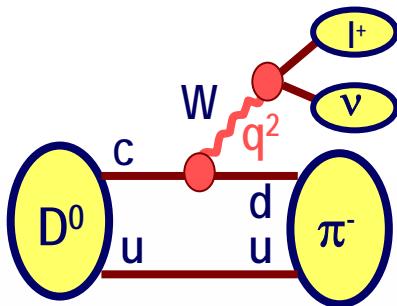


# $D^0$ - $\bar{D}^0$ mixing summary

- This year results :
  - New  $D^0 \rightarrow K^+ \pi^-$  study at BaBar:  $3.9\sigma$  of  $(x', y') \neq (0, 0)$
  - New Dalitz analysis  $D^0 \rightarrow K^0_S \pi^- \pi^+$  at Belle:  $2.7\sigma$  of  $(x, y) \neq (0, 0)$
  - New  $y_{CP}$  measurement at Belle:  $3.2\sigma$  of  $y \neq 0$
- Past years (independent) results:
  - $D^0 \rightarrow K^+ \pi^-$  study at Belle:  $2.1\sigma$  of  $(x', y') \neq (0, 0)$
  - $D^0 \rightarrow K^+ 2\pi / K^+ 3\pi$  study at Babar:  $2.3\sigma$  of  $(x', y') \neq (0, 0)$
  - $y_{CP}$  measurement at BaBar:  $1.9\sigma$  of  $y \neq 0$
- Still  $x$  and  $y$  and not well constrained.
- New measurements/updates coming soon.

# Semileptonic D decays

# Form Factors in semileptonic D decays



$$\frac{d\Gamma^{K(\pi)}}{dq^2} = \frac{G_F^2 |V_{cs(d)}|^2}{24\pi^3} |f_+^{K(\pi)}(q^2)|^2 p_{K(\pi)}^3$$

$$q^2 = (P_l + P_{\bar{\nu}})^2 = (P_D - P_{K,\pi})^2$$

- Single form factor  $F_D(q^2)$
- Calculated in LQCD
  - checking from data
- Can be applied in B physics
  - extraction of CKM parameters

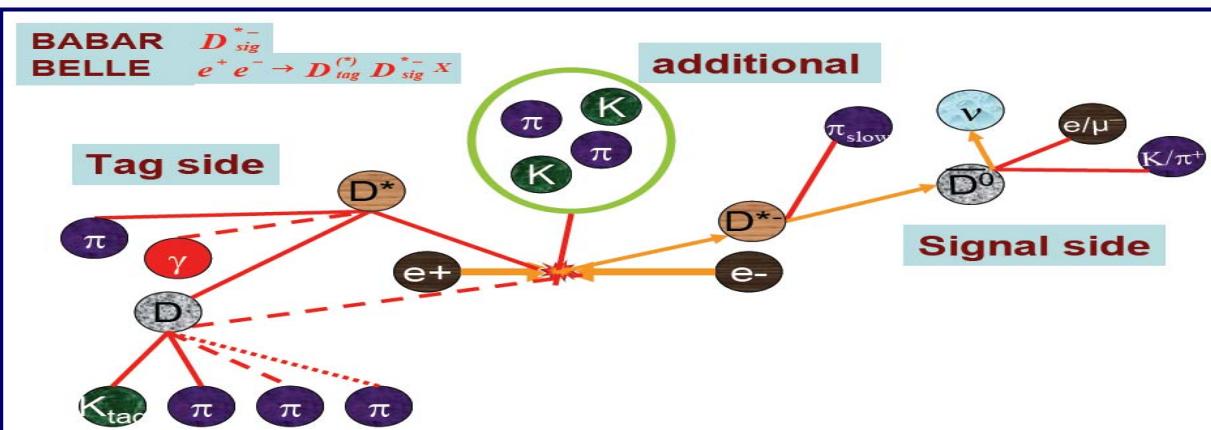
Modified pole model

$$f_+(q^2) = \frac{f_+(0)}{(1 - q^2/m_{\text{pole}}^2)(1 - \alpha_p q^2/m_{\text{pole}}^2)}$$

Simple pole model  $\alpha_p = 0$

ISGW2

$$f_+(q^2) = \frac{f_+(0)(1 + \alpha_I q_{max}^2)^2}{(1 - \alpha_I(q^2 - q_{max}^2))^2}$$



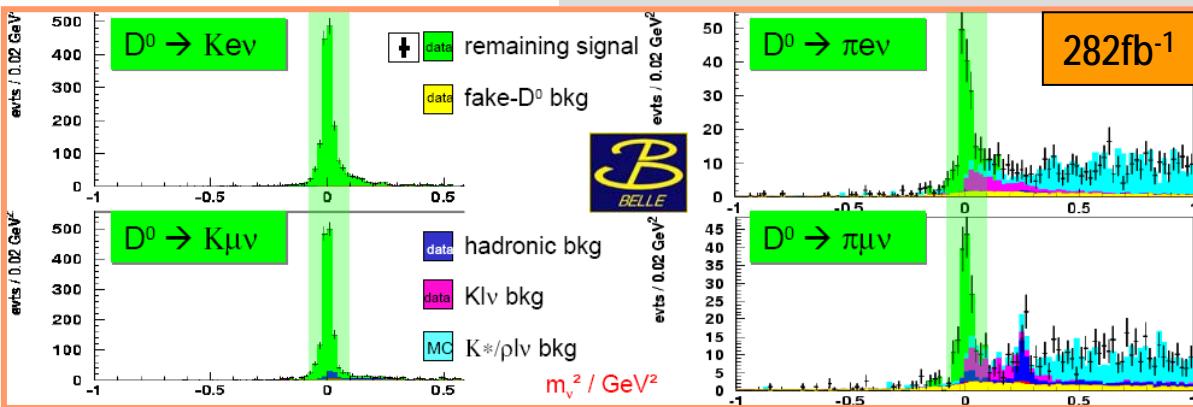
Event topology  
and reconstruction methods

# BR of the semileptonic D decays

## Rest event full reconstruction tag:

- Low statistics/clean tag
- Good  $q^2$  resolution
- $D \rightarrow \pi l \nu / D \rightarrow K l \nu$  separation using kinematics

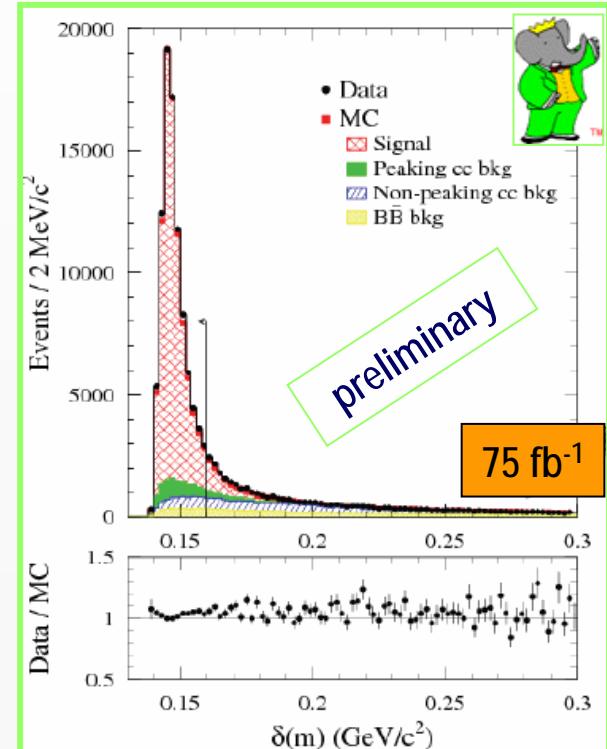
Phys. Rev. Lett. 97, 061804 (2006)



BRs(%)		PDG 2006
BaBar	K e nu	$3.554 \pm 0.027 \pm 0.045 \pm 0.065$
Belle	K e nu	$3.45 \pm 0.10 \pm 0.19$
Belle	K mu nu	$3.45 \pm 0.10 \pm 0.21$
Belle	pi e nu	$0.279 \pm 0.027 \pm 0.016$
Belle	pi mu nu	$0.231 \pm 0.027 \pm 0.019$

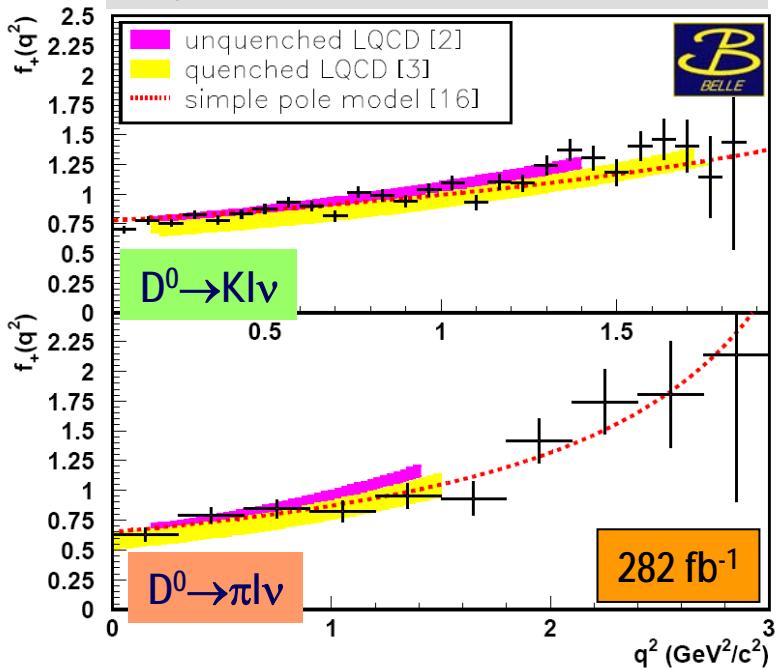
## D^{\*+} tag:

- Huge statistics
- Poor  $q^2$  resolution
- Poor  $D \rightarrow \pi l \nu / D \rightarrow K l \nu$



# $D^0 \rightarrow K(\pi)l\nu$ Form Factor

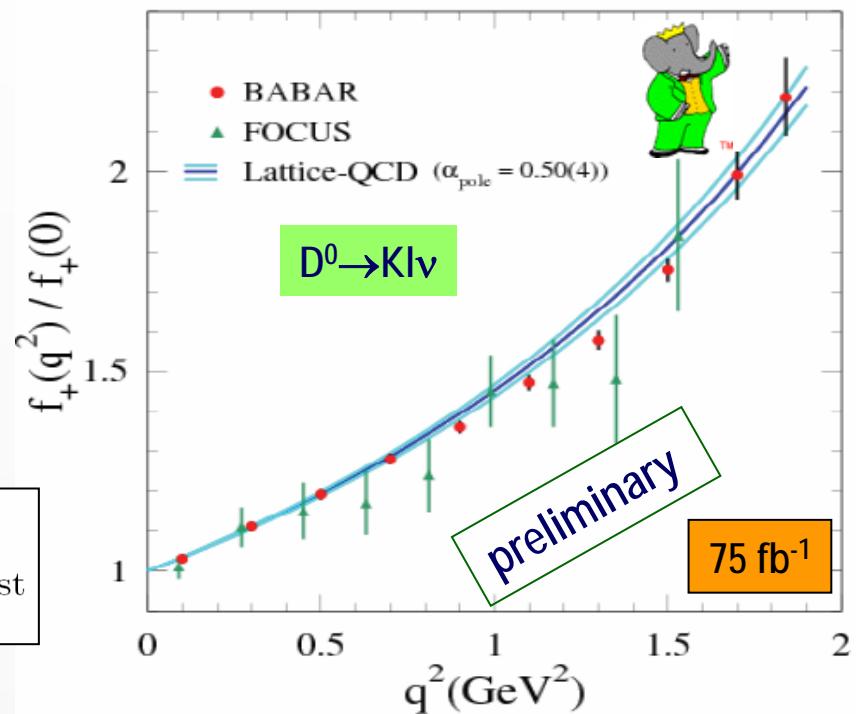
Phys. Rev. Lett. 97, 061804 (2006)



LQCD shape agrees with the data

$$\frac{f_+^\pi(0)^2 |V_{cd}|^2}{f_+^K(0)^2 |V_{cs}|^2} = 0.042 \pm 0.003_{\text{stat}} \pm 0.003_{\text{syst}}$$

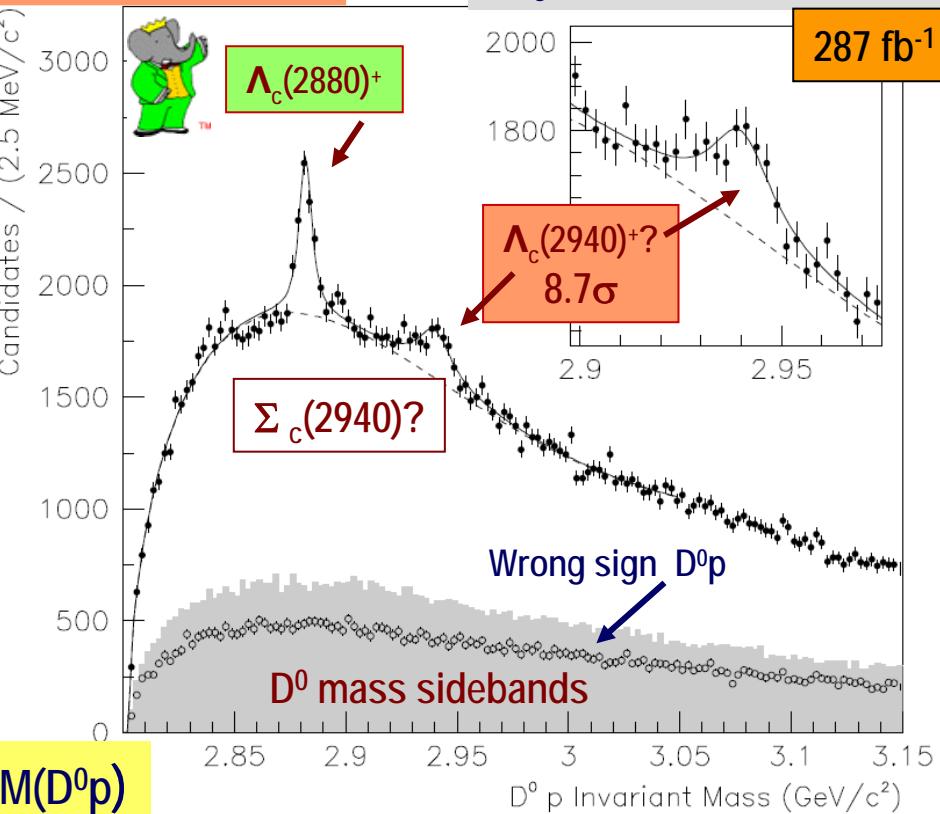
	$m_{\text{pole}}(\text{GeV}/\text{c}^2)$	$\alpha_{\text{pole}}$
BaBar $K l \bar{\nu}$	$1.884 \pm 0.012 \pm 0.015$	$0.377 \pm 0.023 \pm 0.029$
Belle $K l \bar{\nu}$	$1.82 \pm 0.04 \pm 0.03$	$0.52 \pm 0.08 \pm 0.06$
Belle $\pi l \bar{\nu}$	$1.97 \pm 0.08 \pm 0.04$	$0.10 \pm 0.21 \pm 0.10$
Lattice		$0.50 \pm 0.04$



$$f_+(0) = 0.730 \pm 0.007 \pm 0.005 \pm 0.007$$

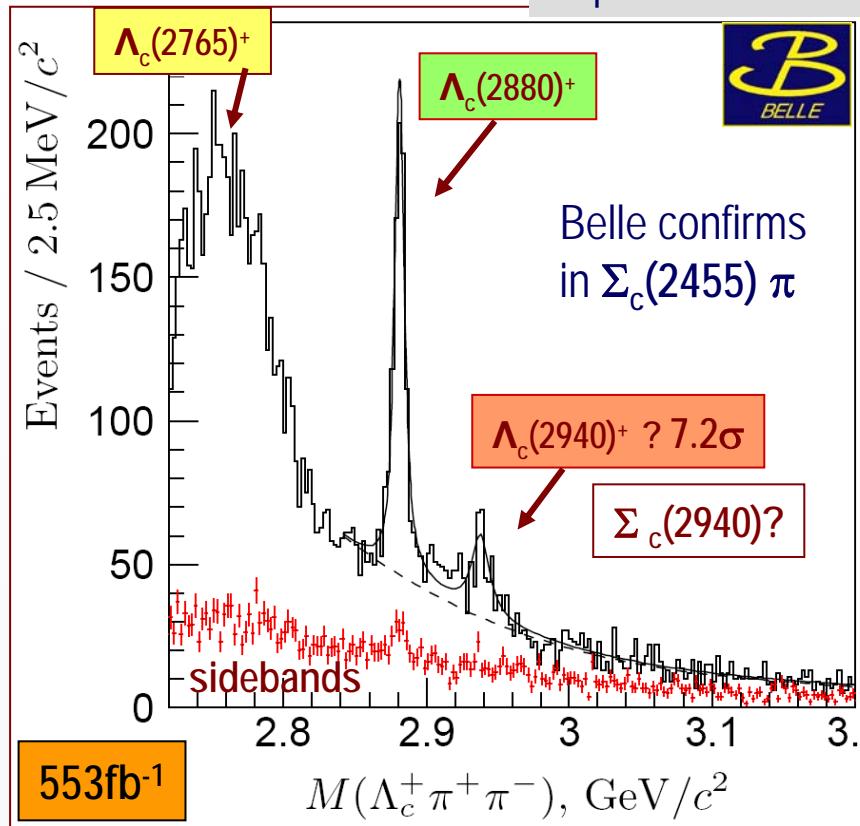
# Charmed Baryon Spectroscopy

## New baryon in $D^0 p$



## $\Lambda_c(2940)^+$ new charm baryon $\Lambda_c(2880)^+$ new decay mode

hep-ex/0608043v2

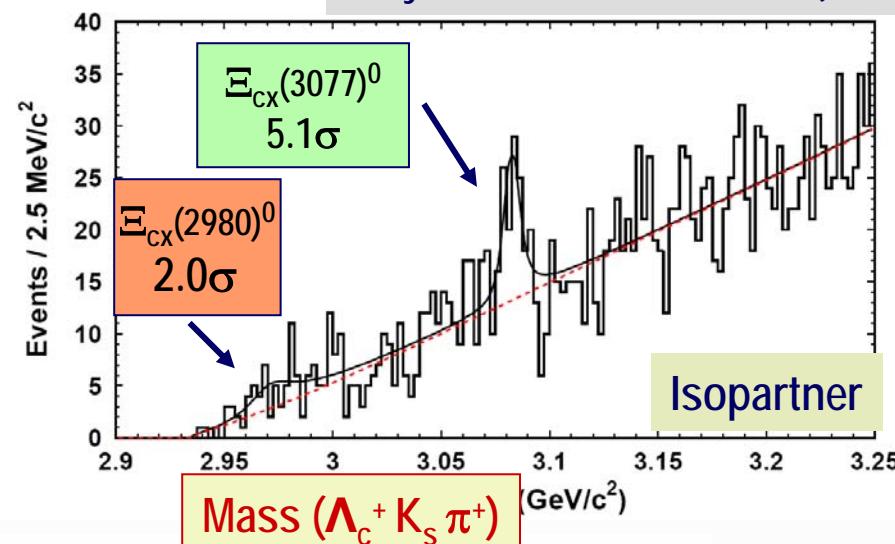
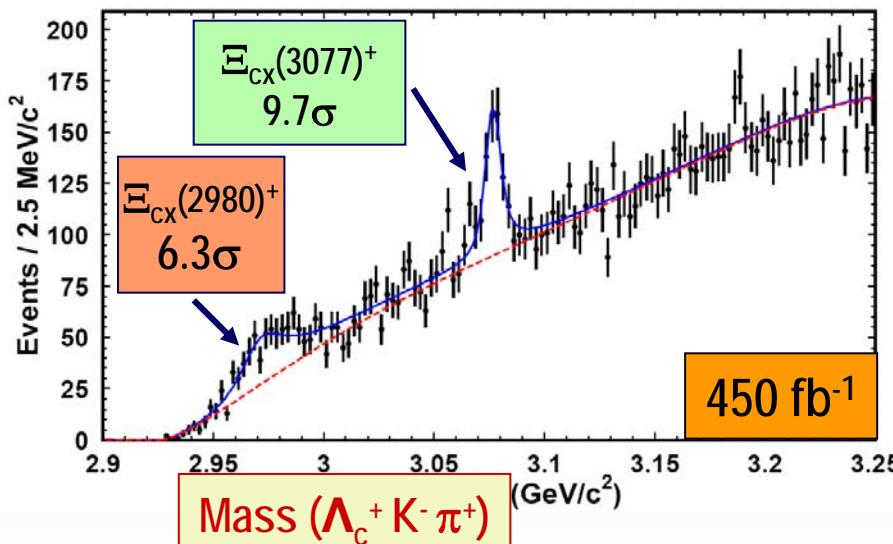


State	Yield	$M, \text{ MeV}/c^2$	$\Gamma, \text{ MeV}$
$\Lambda_c(2880)^+$	$690 \pm 50$	$2881.2 \pm 0.2 \pm 0.4$	$5.8 \pm 0.7 \pm 1.1$
$\Lambda_c(2940)^+$	$220^{+80}_{-60}$	$2938.0 \pm 1.3^{+2.0}_{-4.0}$	$13^{+8+27}_{-5-7}$

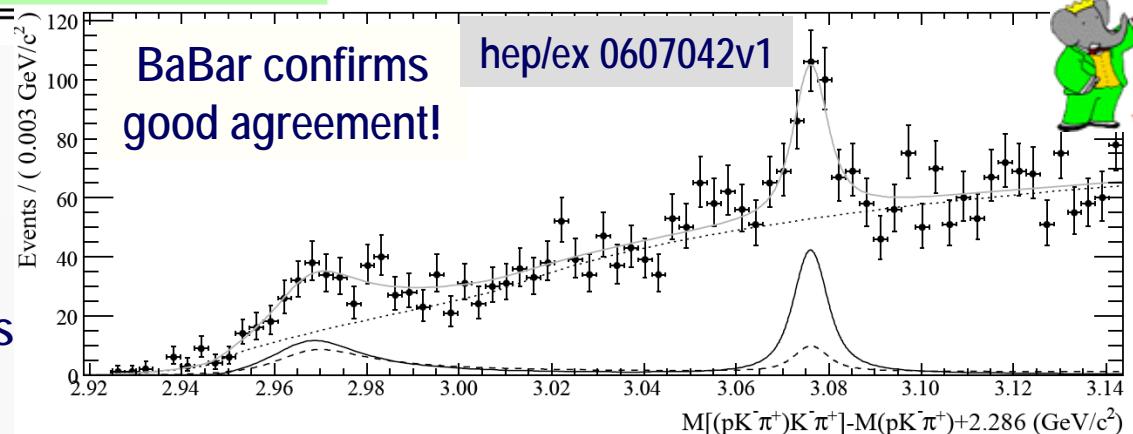
$\text{BR}(\rightarrow D^0 p)/\text{BR}(\rightarrow \Sigma_c \pi) = ?$   
to be obtained in the same experiment

# New charm strange baryons

Phys. Rev. Lett. 97, 162001 (2006)



	Mass (MeV/c <sup>2</sup> )	Width (MeV)	Yield (Events)	Significance
BABAR $\Xi_c(2980)^+$	$2967.1 \pm 1.9 \pm 1.0$	$23.6 \pm 2.8 \pm 1.3$	$284 \pm 45 \pm 46$	7.0 $\sigma$
Belle $\Xi_c(2980)^+$	$2978.5 \pm 2.1 \pm 2.0$	$43.5 \pm 7.5 \pm 7.0$	$405 \pm 51$	6.3 $\sigma$
BABAR $\Xi_c(3077)^+$	$3076.4 \pm 0.7 \pm 0.3$	$6.2 \pm 1.6 \pm 0.5$	$204 \pm 35 \pm 12$	8.6 $\sigma$
Belle $\Xi_c(3077)^+$	$3076.7 \pm 0.9 \pm 0.5$	$6.2 \pm 1.2 \pm 0.8$	$326 + 40$	9.7 $\sigma$



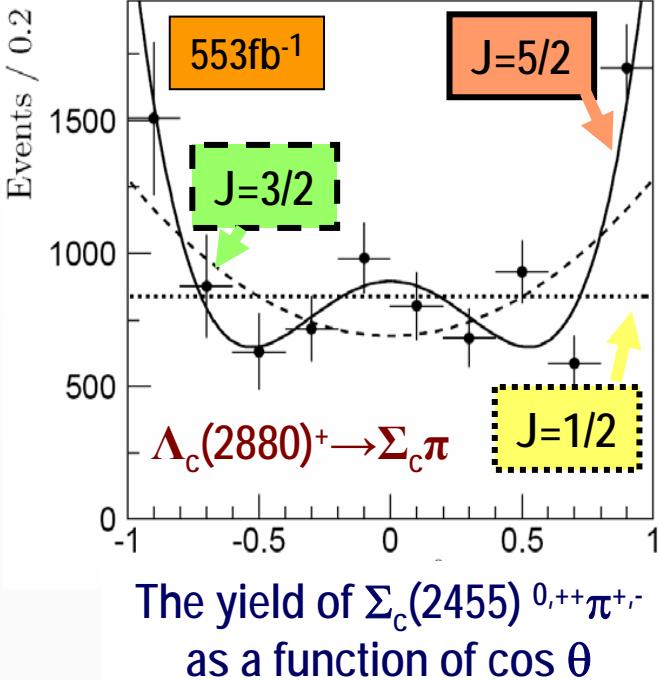
Interpretation as excited charmed strange baryons,  $\Xi_c$

New baryons decay into separate charmed ( $\Lambda_c^+$ ) and strange (K) hadrons

# $\Lambda_c(2880)^+$ angular analysis



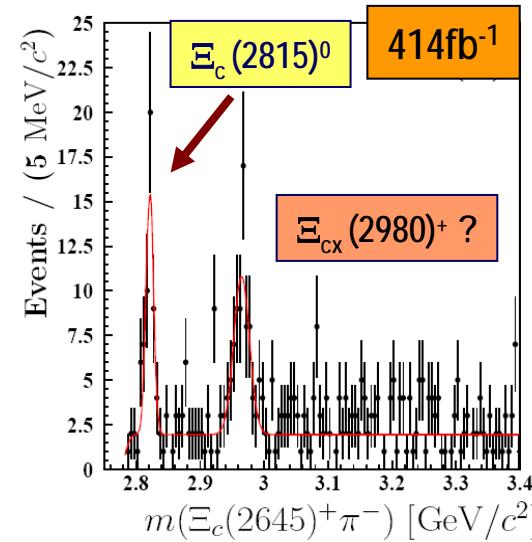
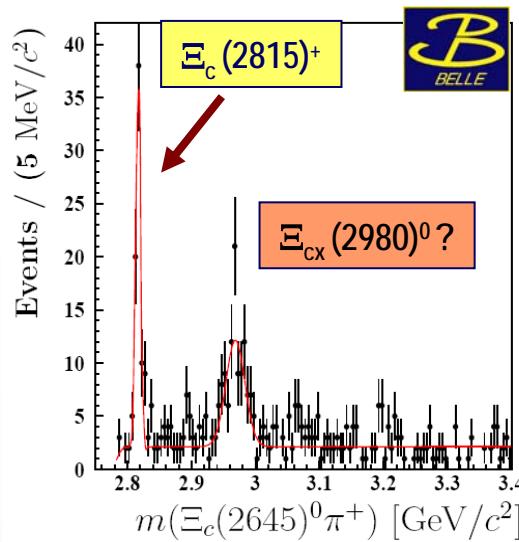
hep-ex/0608043v2



5/2 is strongly favored over 1/2 and 3/2

# Mass of $\Xi_c(2815)$

hep-ex/0608012



First observation of  $\Xi_c(2815) \rightarrow \Xi_c(2645)\pi$

$M(\Xi_c(2815)^+)$ (MeV/c <sup>2</sup> )	$2816.7 \pm 0.6 \pm 0.8$
$M(\Xi_c(2815)^0)$ (MeV/c <sup>2</sup> )	$2819.7 \pm 0.8 \pm 0.9$
$M(\Xi_c(2815)^+) - M(\Xi_c(2815)^0)$	$-3.0 \pm 1.0 \pm 0.8$

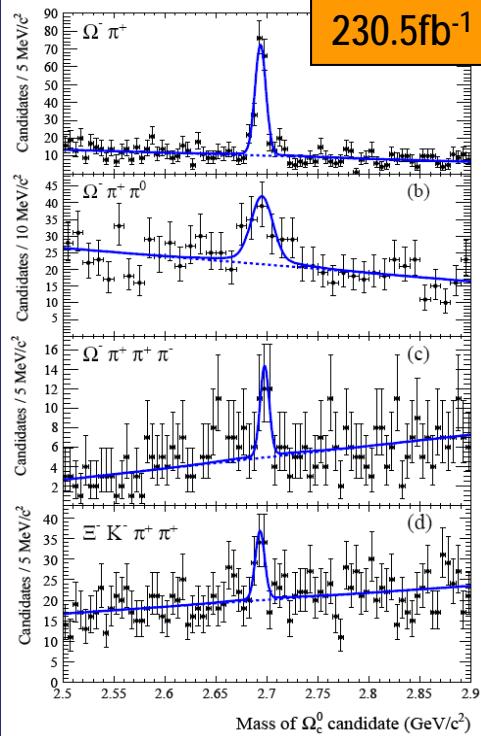
Better precision than world average

# Production and decays $\Omega_c^0$

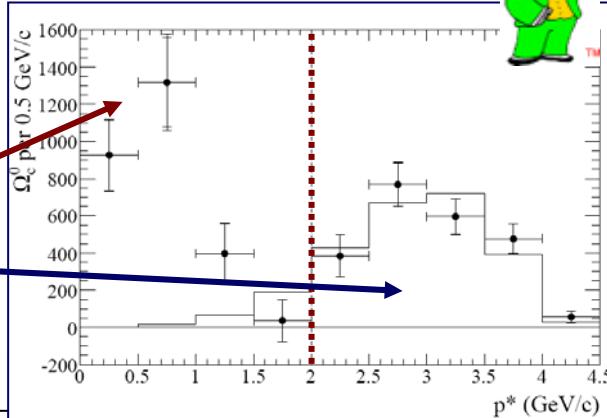
hep-ex/0703030v1



230.5 fb<sup>-1</sup>



yield from **B decays** ( $p^* < 2 \text{ GeV}/c^2$ )  
yield from **continuum** ( $p^* > 2 \text{ GeV}/c^2$ )  
are comparable



$$\begin{aligned} \frac{\mathcal{B}(\Omega_c^0 \rightarrow \Omega^- \pi^+ \pi^0)}{\mathcal{B}(\Omega_c^0 \rightarrow \Omega^- \pi^+)} &= 1.27 \pm 0.31(\text{stat}) \pm 0.11(\text{syst}) \\ \frac{\mathcal{B}(\Omega_c^0 \rightarrow \Omega^- \pi^+ \pi^+ \pi^-)}{\mathcal{B}(\Omega_c^0 \rightarrow \Omega^- \pi^+)} &= 0.28 \pm 0.09(\text{stat}) \pm 0.01(\text{syst}) \\ \frac{\mathcal{B}(\Omega_c^0 \rightarrow \Xi^- K^- \pi^+ \pi^+)}{\mathcal{B}(\Omega_c^0 \rightarrow \Omega^- \pi^+)} &= 0.46 \pm 0.13(\text{stat}) \pm 0.03(\text{syst}) \end{aligned}$$

Substantially improvement  
of previous measurements

First observation of  $\Omega_c^*$  (css),  $J^P = 3/2^+$

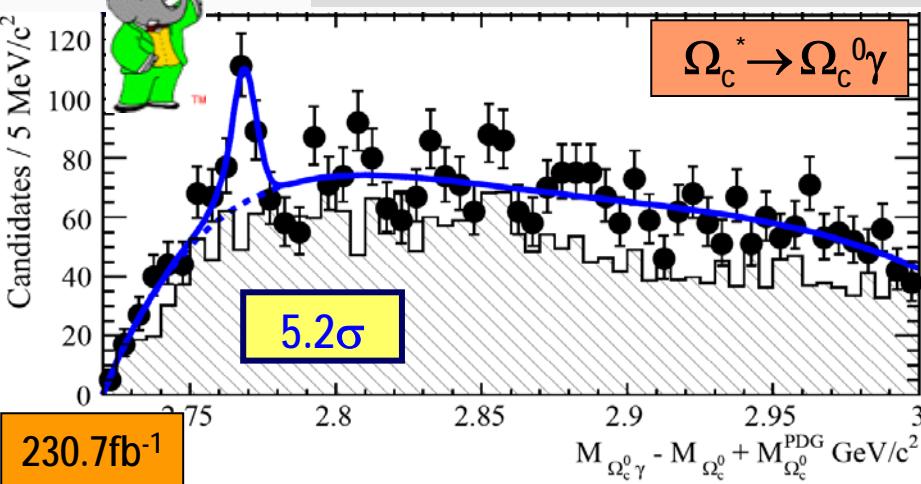
$$M(\Omega_c^*) - M(\Omega_c^0) = (70.8 \pm 1.0 \pm 1.1) \text{ MeV}/c^2$$

In agreement with expectations 50-100 MeV/c<sup>2</sup>

$$R = \frac{\sigma(e^+ e^- \rightarrow \Omega_c^* X, x_p(\Omega_c^*) > 0.5)}{\sigma(e^+ e^- \rightarrow \Omega_c^0 X, x_p(\Omega_c^0) > 0.5)}$$

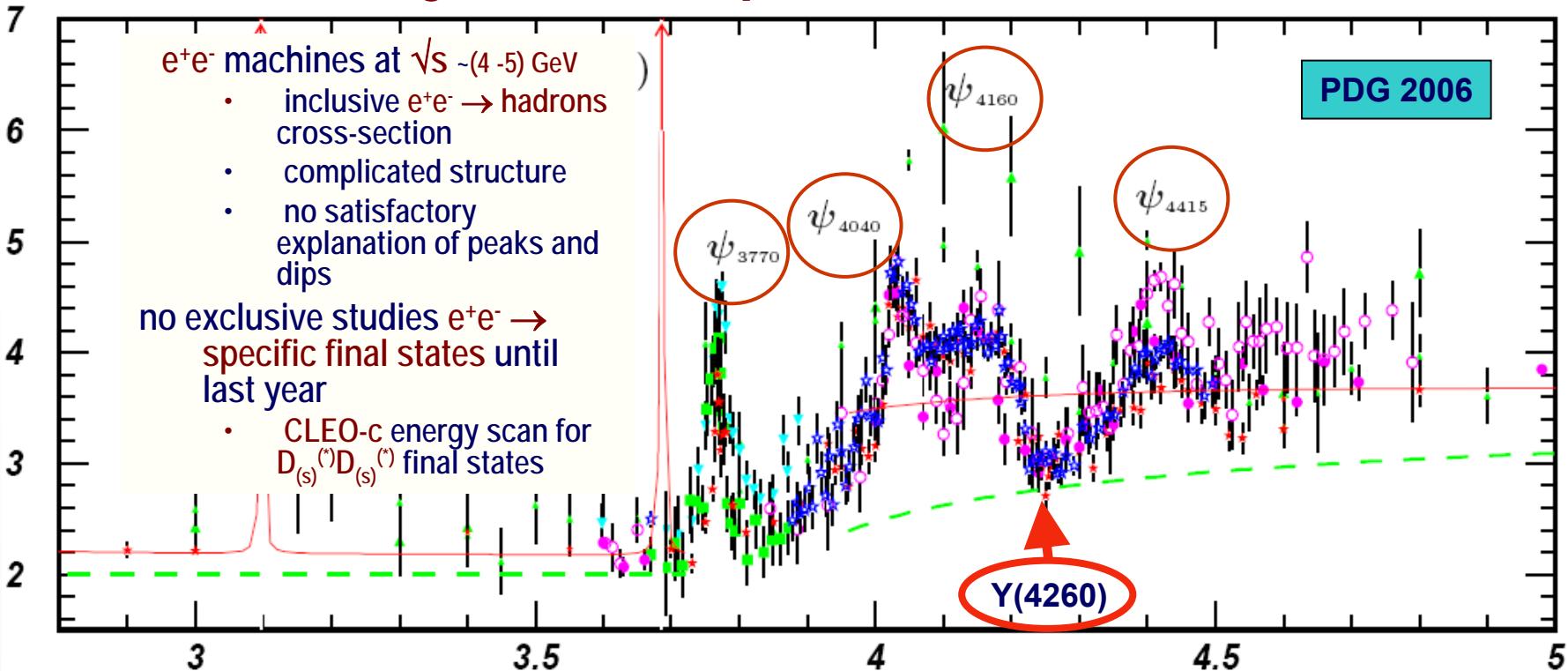
$$R = 1.01 \pm 0.23 \text{ (stat)} \pm 0.11 \text{ (syst)}$$

Phys.Rev.Lett.97:232001,2006.



# ISR Study

# R-study around open charm threshold

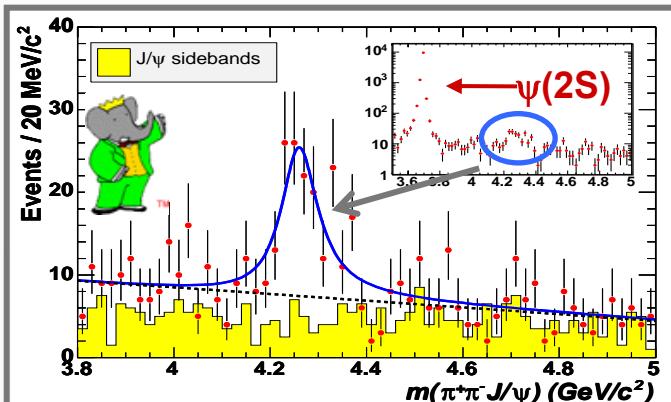


Last years new interest both in experiment and theory  
Mostly initiated by observation of  $Y(4260)$  by BaBar

Confirmed by

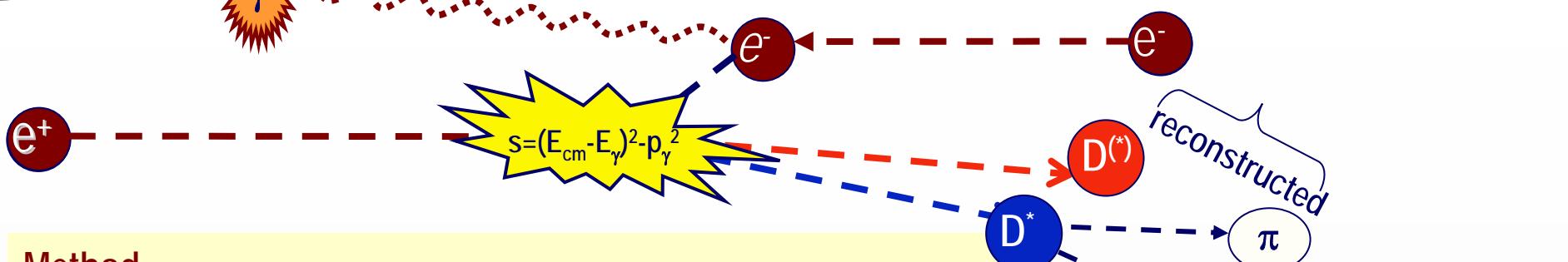
- CLEOc Phys.Rev.Lett. 96, 162003 (2006)
- Cleo hep-ex/0611021
- Belle hep-ex/0601206

Phys.Rev.Lett. 95, 142001 (2005)





# Exclusive $e^+e^- \rightarrow D^{(*)}D^{(*)}$ cross-sections with ISR



## Method

ISR at B-factories comparable with energy scan (CLEOc, BES)

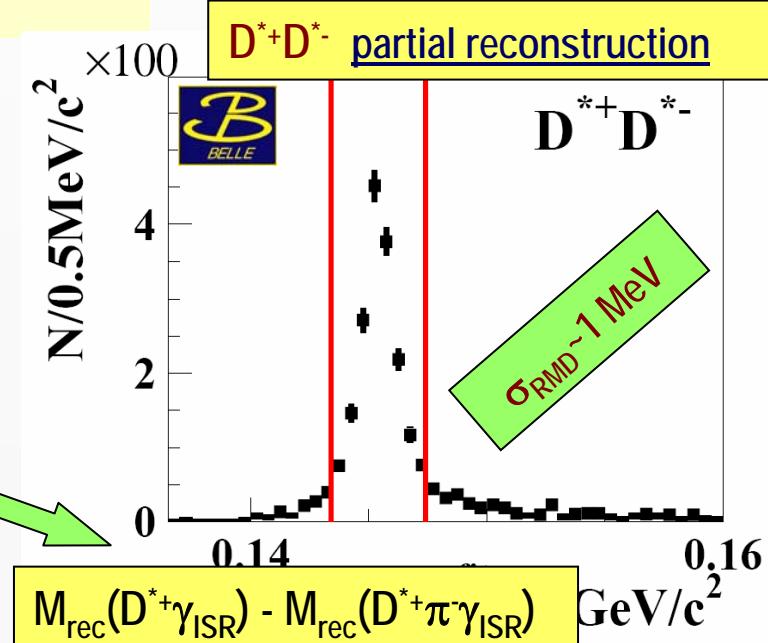
- Hard ISR photon takes away significant fraction of energy
- Continuous ISR spectrum: access to whole  $\sqrt{s}$  interval
- $\alpha_{em}$  suppression, but  $\sim 500/fb$  ( $\sim 60/pb$  CLEO-c)

BaBar:  $D^+D^-$ ,  $D^0D^0$  with full reconstruction

- small background

Belle:  $D^{*+}D^{*-}$ ,  $D^+D^{*-}$  with partial reconstruction

- small background, increase eff  $\sim 10$  times
- narrow peak in recoil mass difference!
  - mass resolution

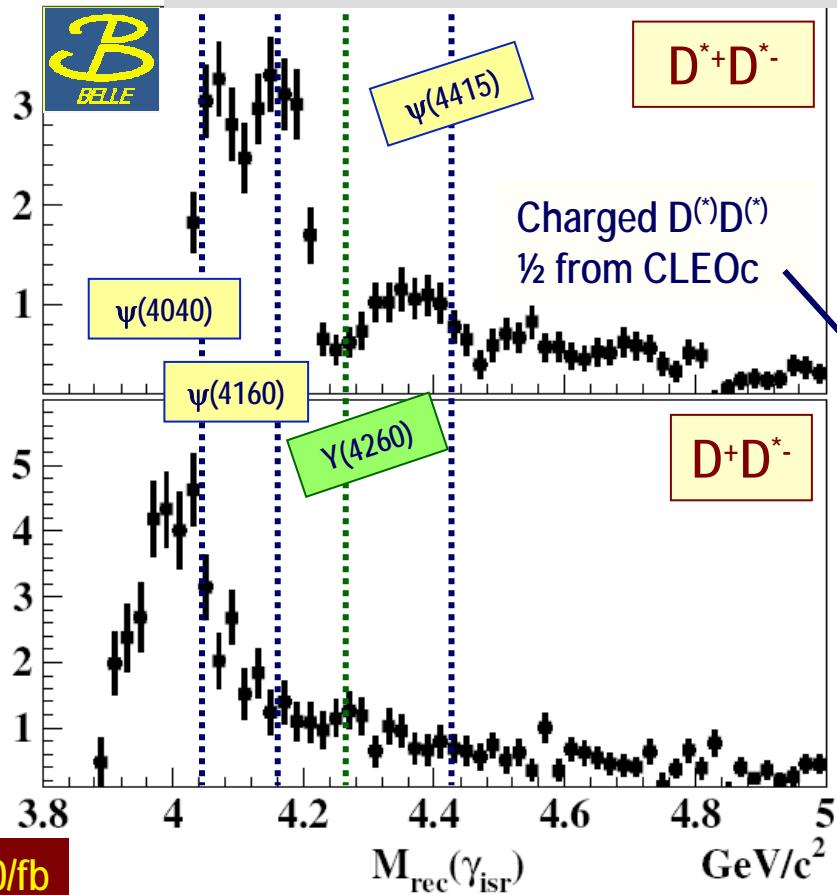


# Exclusive $e^+e^- \rightarrow D^{(*)}D^{(*)}$ cross-sections using ISR

hep-ex/0607083v1

$\sigma(\text{nb})$

Phys. Rev. Lett. 98, 092001 (2007)

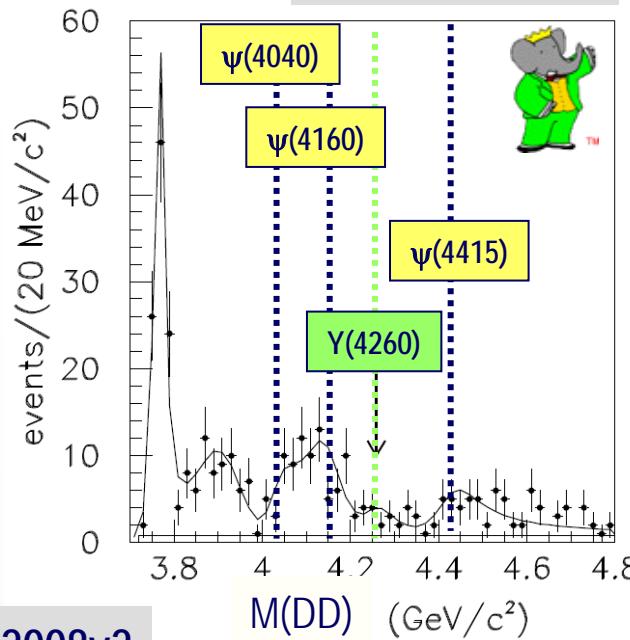


$\psi(4260)$  signal

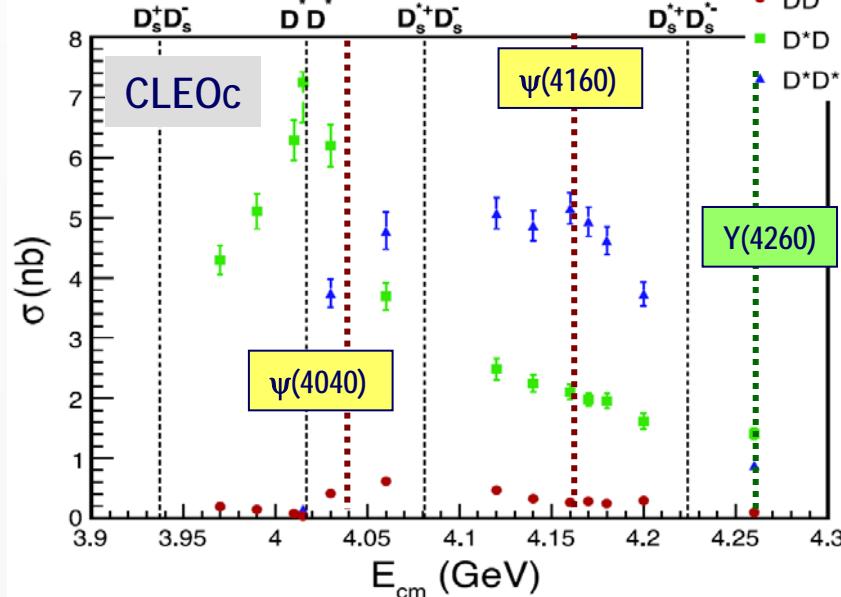
$D^*D$  : hint

$D^*D^*$  : clear dip (similar to incl. R)

$DD$  : no signal



hep-ex/0702008v2



# Conclusion

- Evidence for **DD-mixing** is observed
- **D (semileptonic) decays:** huge luminosities make the B-factories competitive with CLEO-c in purity, statistics and precision
- Many **new charmed hadrons** observed in the last 5 years
  - 8 charmonium(like) states, 6 charmed mesons
- New era for **charmed baryon** spectroscopy has arrived
- **ISR studies** at B-factories provide access to near-threshold **exclusive open charm cross-sections**
  - key to unraveling the complicated **inclusive structures**
  - hopefully help our understanding of the **Y(4260)/Y(4325)**