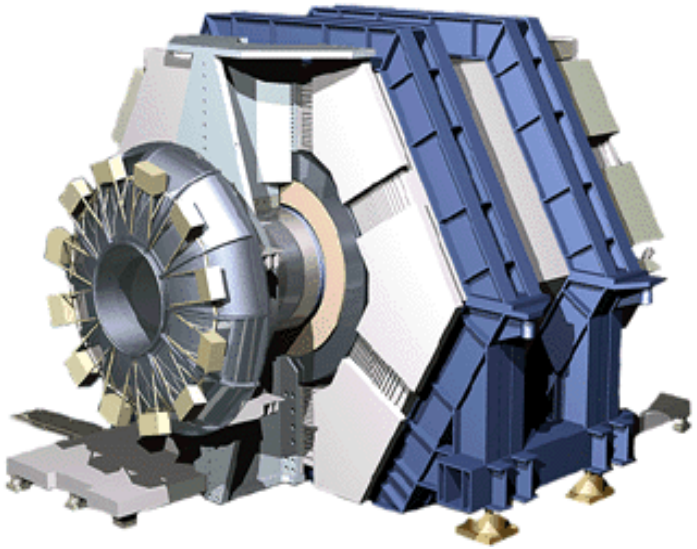
# Charm and Tau results from B Factories

Fabrizio Salvatore

*Royal Holloway, University of London*

(on behalf of the BABAR and Belle collaborations)

- The BABAR and Belle experiments
- D mixing results
- $D^+_s \to \mu^+ \nu_\mu$ decay and measurement of $f_{Ds}$
- LFV in Tau decays
- Rare $\tau$ decays
- Study of $\tau^- \to \pi^- \pi^0 \nu_\tau$ decay
- Measurement of $m_\tau$ and test of CPT

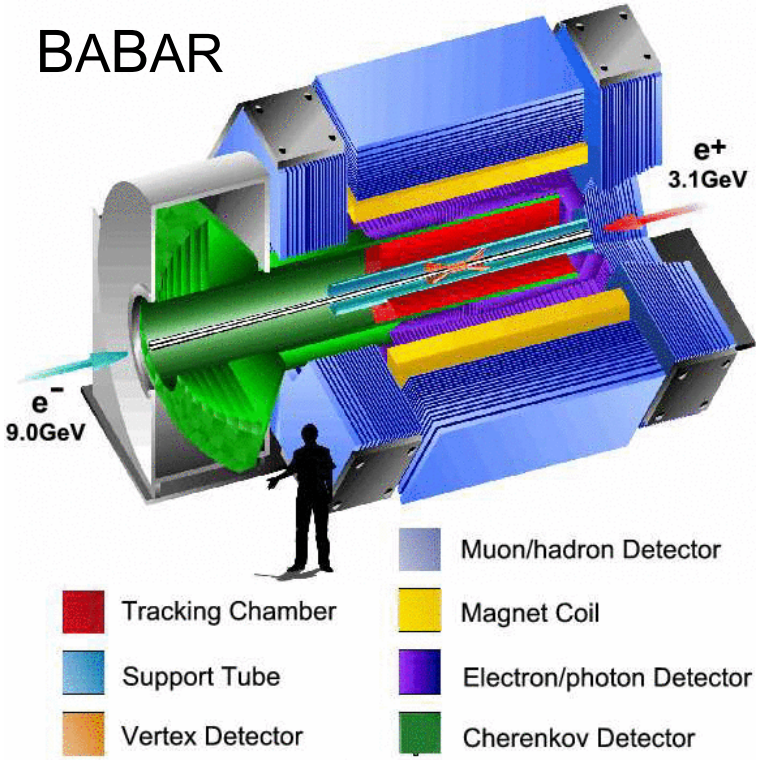


Les Rencontres de Physique de la Vallée d'Aoste

# B-Factories Detectors

Royal Holloway
University of London

BABAR




Asymmetric energy colliders:

$\sqrt{s} = 10.58\,\text{GeV}$ at $\Upsilon(4s)$ peak

$$\sigma(B\bar{B}) \approx 1.1nb \approx \sigma(c\bar{c}) \approx 1.3nb \approx \sigma(\tau^+\tau^-) \approx 0.9nb$$

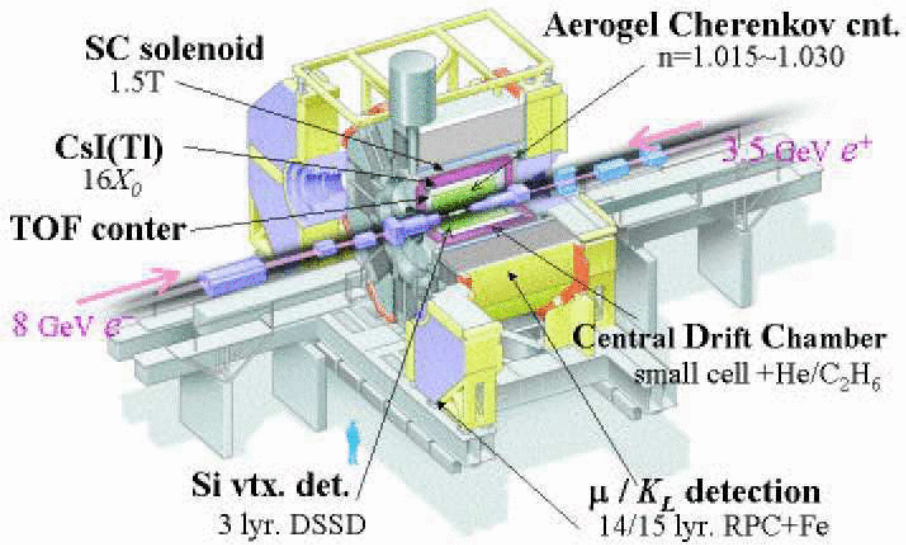
More than just B-Factories !

$\int Ldt \approx 330\ fb^{-1}$ BABAR

$\int Ldt \approx 550\ fb^{-1}$ Belle

Analyses presented use smaller samples

Belle Detector



# Charm results from B Factories

Royal Holloway
University of London

## D mixing analysis

# D mixing

- $D^0$ and $\overline{D^0}$ flavor eigenstates are not mass eigenstates
- Parameters used to characterize mixing:

$$x \equiv \frac{\Delta m}{\overline{\Gamma}},\quad y \equiv \frac{\Delta\Gamma}{\overline{\Gamma}},\quad R_M = \frac{x^2+y^2}{2}$$

mixing rate

- In SM mixing is expected to be small:

$$\text{box diagram}: \; x, y \le 10^{-5}$$

$$\text{long-distance}: x \le y \sim 10^{-3}\text{-}10^{-2}$$

x>>y or CPV in D mixing would signal new physics

- Recent results obtained using $D^0 \to K^+\pi^-(n\pi)$ Wrong Sign events
  - $K\pi$ final state obtained via DCS $D^0 \to K^+\pi^-$ $(n\pi)$ or $D^0$-$\overline{D^0}$ mixing, followed by CF $\overline{D^0} \to K^-\pi^+$ $(n\pi)$ decay
- The two decays can be distinguished by the decay-time distribution

$$\frac{dN}{dt} \propto e^{-t}\left[R_D + \sqrt{R_D}\,y'\,t + \frac{x'^2+y'^2}{4}\,t^2\right]$$

$\frac{DCS}{CF}$ decay rates; interference; CF decay

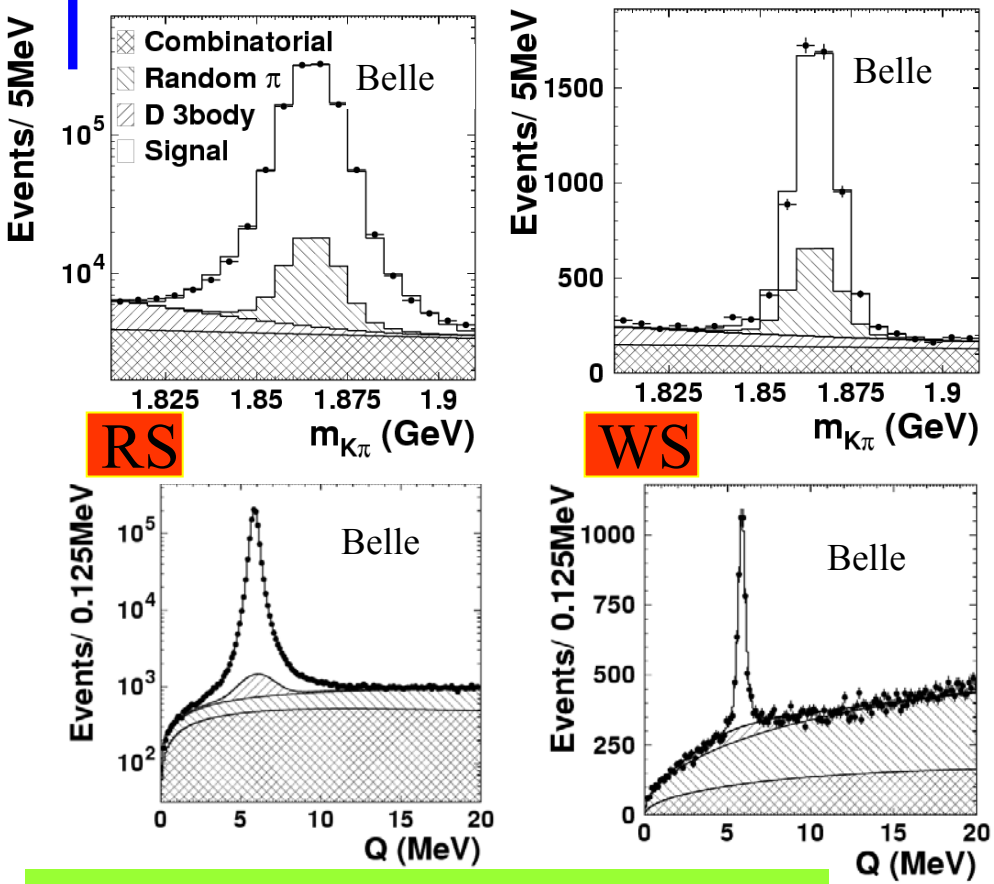
$$x' = x\cos(\delta) + y\sin(\delta)$$

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

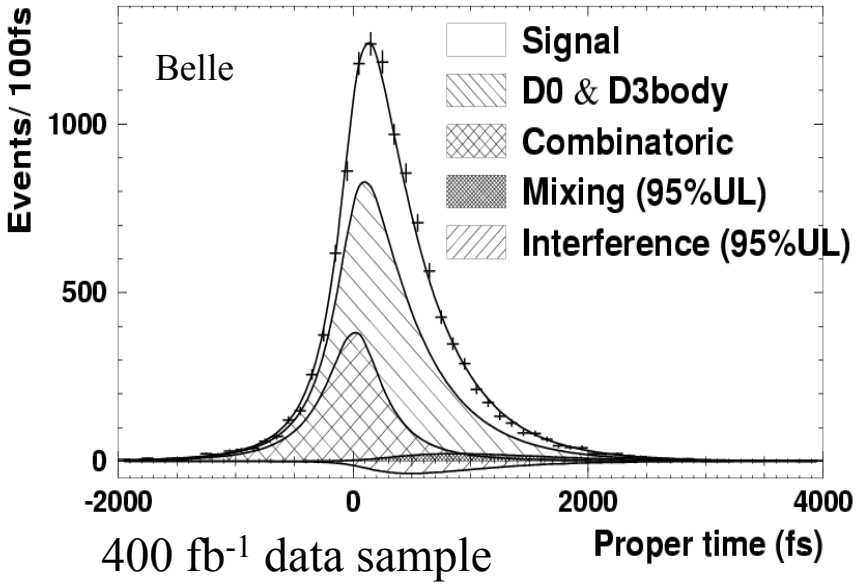
$\delta$ = stong phase difference

# $D^0 \to K^+\pi^-$ results - I

- $D^0$ reconstructed from $D^{*+} \to D^0\pi^+_s$ decay
  - $D^0$ flavour tagged by charge of the pion
- RS and WS yields obtained from 2D fit in M-Q distribution




- WS decay-time fit
  - $R_D$, $x'^2$, $y'$ only free parameters



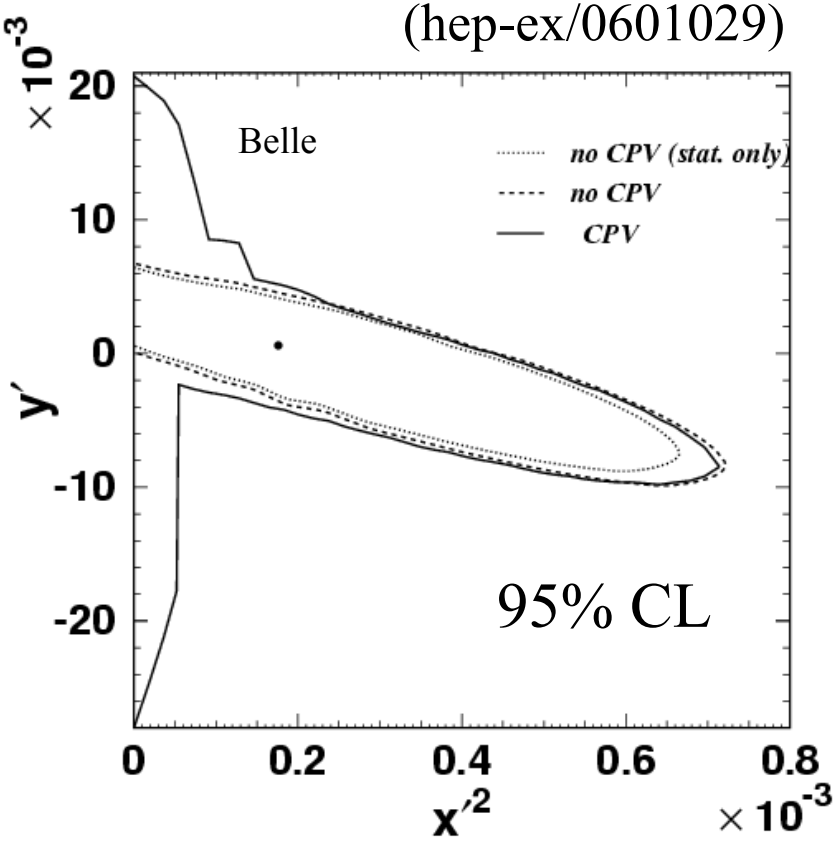

400 fb$^{-1}$ data sample

$$R_{WS} = N_{WS} / N_{RS} = (0.375 \pm 0.008)\%$$

time-integrated rate

# $D^0 \to K^+\pi^-$ results - II

(hep-ex/0601029)




| Fit case | | Result ($10^{-3}$) | 95% CL ($10^{-3}$) |
|---|---|---|---|
| No CPV | $R_D$ | 3.64±0.17 | (3.3, 4.0) |
| | $x'^2$ | $0.18^{+0.21}_{-0.23}$ | < 0.72 |
| | y' | $0.6^{+4.0}_{-3.9}$ | (-9.9, 6.8) |
| CPV | $A_D$ | 23±47 | (-76, 107) |
| | $A_M$ | 670±1200 | (-995, 1000) |
| | $x'^2$ | - | <0.72 |
| | y' | - | (-28, 21) |
| No Mixing | $R_D$ | 3.77 ±0.08 | ±0.05 |

Test CPV fitting separately $D^0$ and $\overline{D}^0$:

$$A_D = \frac{R_D^+ - R_D^-}{R_D^+ + R_D^-}, \quad A_M = \frac{R_M^+ - R_M^-}{R_M^+ + R_M^-}$$

$$R_M^{\pm} = \frac{x'^{\pm} + y'^{\pm}}{2}$$

$x'^2=y'=0$ corresponds to 3.9% CL

# Charm results from B Factories

Royal Holloway
University of London

## D mixing analysis

## $f_{D_s}$ measurement using charm tagged events in $e^+e^-$ collisions

# $f_{Ds}$ measurement using charm tagged $e^+e^-$ events

Royal Holloway University of London

- Leptonic weak decays of charmed pseudo-scalar mesons provide unambiguous determination of form factor $f_M$

$$\Gamma(D_s^+ \to l\upsilon_l) = \frac{G_F^2 |V_{cs}|^2}{8\pi} f_{D_s}^2 m_l^2 m_{D_s^+} \left(1 - \frac{m_l^2}{m_{D_s^+}^2}\right)^2$$

- Lattice QCD calculations predict $f_{Ds}/f_D = 1.24 \pm 0.07$ with $f_{Ds} = (249 \pm 17)$ MeV (PRL 95, 122002 (2005))

- Recent preliminary results improve measurement of $\Gamma(D_s^+ \to \mu\upsilon_\mu)/\Gamma(D_s^+ \to \phi\pi)$ and $f_{Ds}$
  - BABAR data sample: 230.2 $fb^{-1}$

# $D_s^+ \to \mu^+ \nu_\mu$ analysis

Royal Holloway
University of London

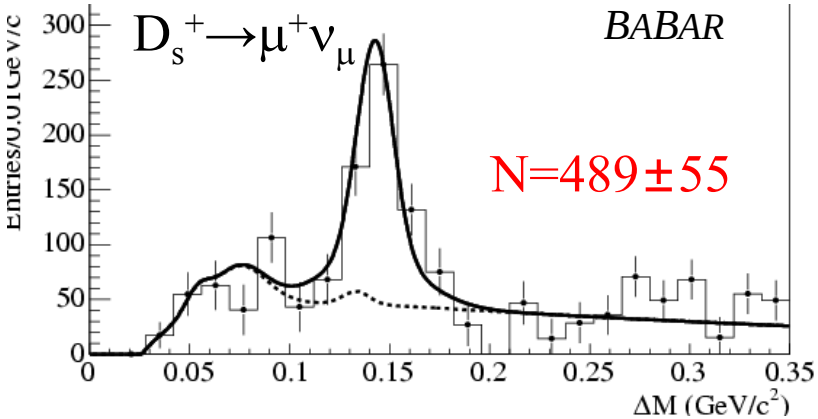
- Signal events: $D_s^{*+} \to \gamma D_s^+ \to \mu^+ \nu_\mu$ from $c\bar{c}$ events
  - $\gamma$, $D_s^+$, $\mu^+$, $\nu_\mu$ lie in the same hemisphere
- Recoil system: fully reconstructed $D^0$, $D^+$, $D_s^+$, $D^{*+}$ ("tag")
  - Charge of signal muon uniquely identified
- Main backgrounds:
  - $e^+e^- \to ff$ ($f=u,d,s,b,\tau$) without a real charm tag
    - $p^*(tag)>2.35$ GeV/c (reject B background);
    - use tag side-bands from data
  - correctly tagged events with $\mu$ from semi-leptonic charm decay or $\tau$ decay
    - repeat analysis substituting e for $\mu$
  - remaining bkgnds estimated from simulation

# $D_s^+ \to \mu^+ \nu_\mu$ preliminary results

Royal Holloway University of London

- Selected events grouped in 4 sets:
  - l=e,μ; tag in signal or side-band region
- Subtract side-band to e and μ events
  - Subtract e events to μ events
- Fit resulting ΔM distribution:

$$(N_{sig} f_{sig} + N_{bg} f_{bg})(\Delta M)$$



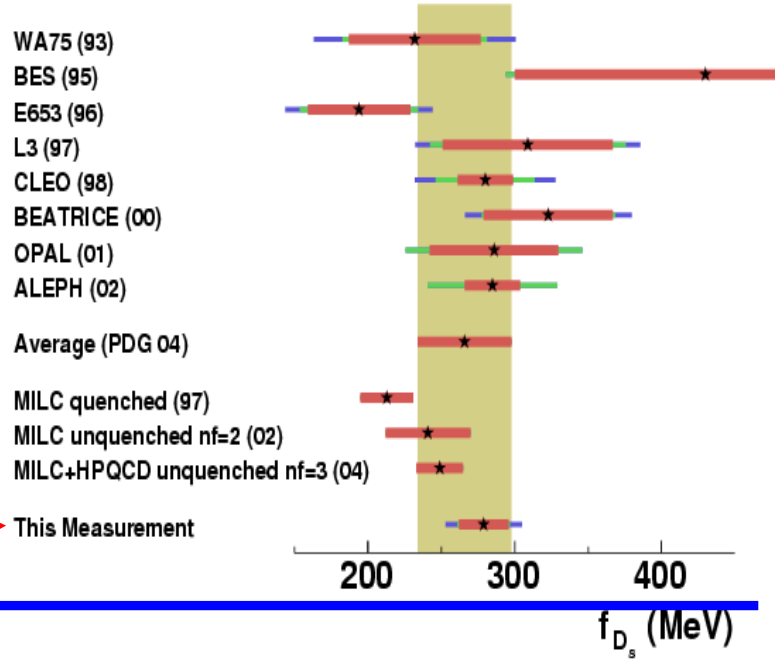

- $B(D_s^+ \to \mu^+ \nu_\mu)$ cannot be measured directly

→ measure $\Gamma(D_s^+ \to \mu\upsilon_\mu)/\Gamma(D_s^+ \to \phi\pi)$

$$\frac{\Gamma(D_s^+ \to \mu\upsilon_\mu)}{\Gamma(D_s^+ \to \phi\pi)} = 0.136 \pm 0.017\,(\text{stat})$$

$$B(D_s^+ \to \mu^+\upsilon_\mu) = (6.5 \pm 0.8 \pm 0.3 \pm 0.9) \times 10^{-3}$$

$$f_{D_s} = (279 \pm 17 \pm 6 \pm 19)\ \text{MeV}$$



# Tau results from B Factories

Royal Holloway
University of London

## Lepton Flavor Violation

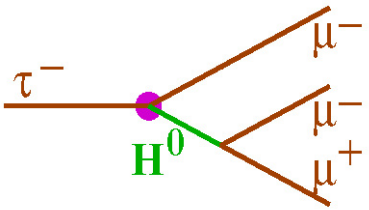
# LFV with τ decays

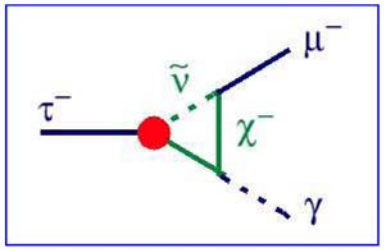
Royal Holloway University of London

- Search for LFV τ decays ideal probe of new physics effects
  - forbidden in SM: BR O($10^{-40}$) in SM with neutrino oscillations
  - much larger BR predicted by several SM extensions

BELLE

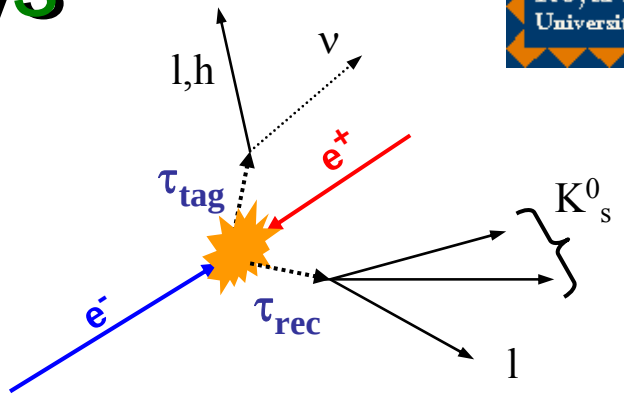
| | |
|---|---|
| $\tau \to \mu\gamma$ | BR < $3.10\times10^{-7}$ (PRL 92 (2004) 171802) |
| $\tau \to e\gamma$ | BR < $3.90\times10^{-7}$ (PLB 613 (2005) 22-28) |
| $\tau \to lll$ | BR < $(1.9\text{-}3.5)\times10^{-7}$ (PLB 598 (2004) 103) |
| $\tau \to lhh'$ | BR < $(1.6\text{-}8.0)\times10^{-7}$ (Preliminary results) |
| $\tau \to l(\pi^0,\eta,\eta')$ | BR < $1.5\text{-}10\times10^{-7}$ (PLB 622 (2005) 218-228) |
| $\tau \to lV^0$ | BR < $(2.0\text{-}7.7)\times10^{-7}$ (Preliminary results) |
| $\tau \to \Lambda\pi,\bar{\Lambda}\pi$ | BR < $(1.4, 0.72)\times10^{-7}$ (hep-ex/0508044) |



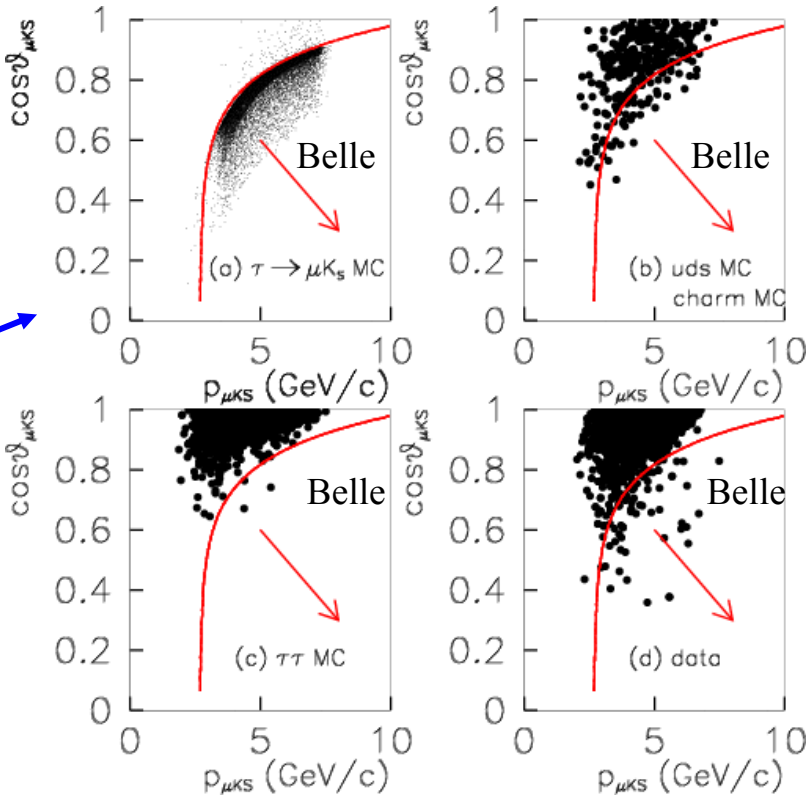

| | |
|---|---|
| $\tau \to \mu\gamma$ | BR < $0.68\times10^{-7}$ (PRL 95 (2005) 041802) |
| $\tau \to e\gamma$ | BR < $1.10\times10^{-7}$ (PRL 96 (2006) 041801) |
| $\tau \to lll$ | BR < $(1.1\text{-}3.3)\times10^{-7}$ (PRL 92 (2004) 121801) |
| $\tau \to lhh'$ | BR < $(0.7\text{-}4.8)\times10^{-7}$ (PRL 95 (2005) 191801) |

# LFV $\tau \to lK^0_s$ decays




- Typical topology for LFV decays
- Analysis requirements:
  - All reconstructed particles within acceptance of detector
  - $0.482 < M(\pi^+\pi^-) < 0.514$ GeV/c$^2$
  - Lepton ID
  - No $P_{miss}$ in signal side
  - $5.29 < E_{vis} < 10.0$ GeV
  - Correlation $p(lK^0_s)$ vs $\cos\theta_{(lK^0_s)}$

Signal candidates extracted from [$M_{inv}$, $E_{cand}$-$E_{beam}$] plot



# $\tau \to l K^0_s$ results

- Select signal in 5σ ellipse in [$M_{inv}$, ΔE] plane

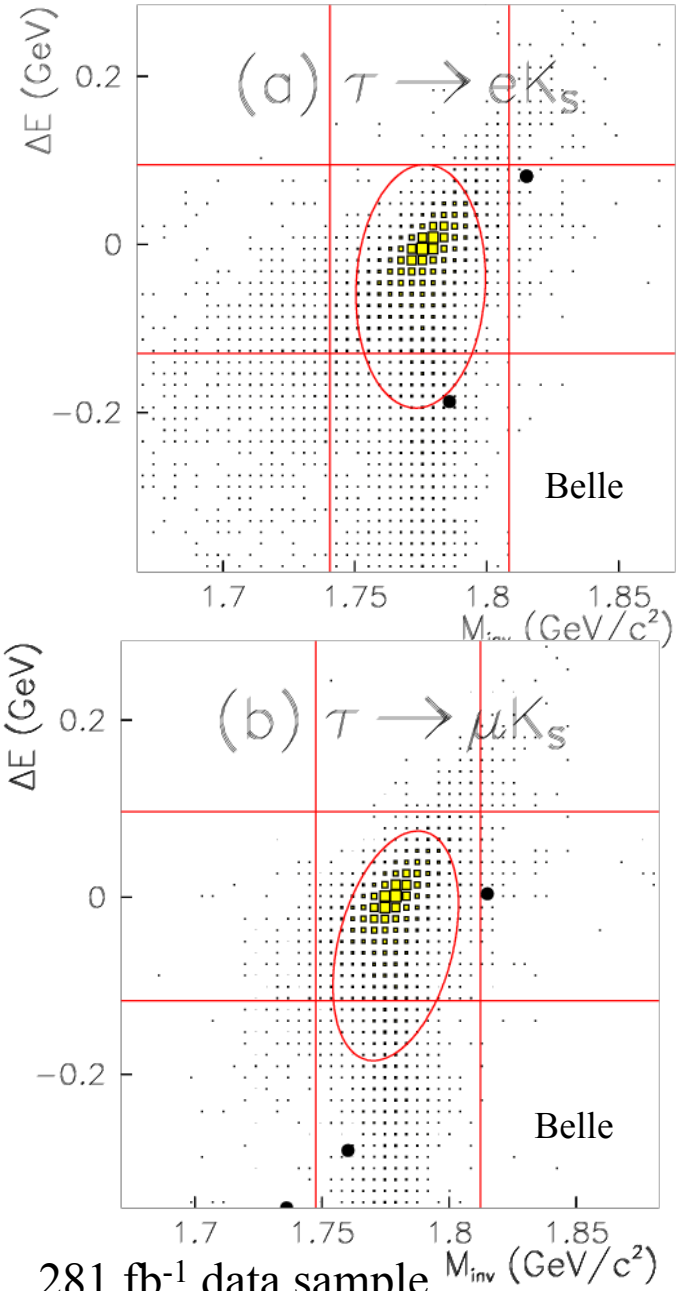
| | l=e | l=μ |
|---|---|---|
| Efficiency: | 11.5% | 13.5% |
| Exp. bkgnd: | 0.2±0.2 | 0.2±0.2 |
| Evts found: | 0 | 0 |

- Background estimated from $M_{inv}$ sideband
  - Extrapolate to signal region assuming flat distribution in $M_{inv}$

$$BR(\tau \to eK^0_s) < 5.6 \times 10^{-8} \quad (@\,90\%\,CL)$$

$$BR(\tau \to \mu K^0_s) < 4.9 \times 10^{-8} \quad (@\,90\%\,CL)$$

hep-ex/0509014




281 fb$^{-1}$ data sample

# LFV $e^+e^- \to l^+\tau^-$

Royal Holloway
University of London

- Strongly suppressed in SM with heavy neutrinos
- Very sensitive to beyond SM contributions
- Experimental limits:

| | $\sqrt{s}$(GeV) | UL (95% CL) | Publication |
|---|---|---|---|
| $\sigma_{\mu\tau}/\sigma_{\mu\mu}$ | 29 | $<6.1\times10^{-3}$ | PRL 66, 1007 (1991) |
| $\sigma_{e\tau}/\sigma_{\mu\mu}$ | 29 | $<1.3\times10^{-3}$ | " |
| $BR(Z^0 \to \mu\tau, e\tau)$ | 92 | $<(0)1\times10^{-5}$ | Phys. Lett. 254, 293 (1991) |
| $\sigma_{\mu\tau}$ | $>92$ | 64 *fb* | Phys. Lett. 519, 23 (2001) |
| $\sigma_{e\tau}$ | $>92$ | 78 *fb* | " |

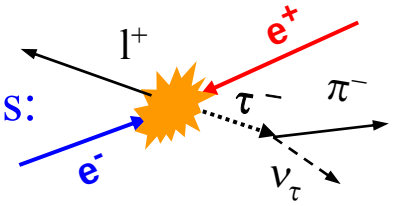
- First result from BABAR at energies accessible by B Factories


- Data sample 210.6 $fb^{-1}$
- Four modes: $e^+e^- \to l^+\tau^-$ , $l^+ = e^+, \mu^+$; $\tau^- \to \pi^- \nu_\tau$, $\pi^-\pi^+\pi^- \nu_\tau$

# LFV $e^+e^- \to l^+\tau^-$ - preliminary results

Royal Holloway University of London

- Signature of signal process:

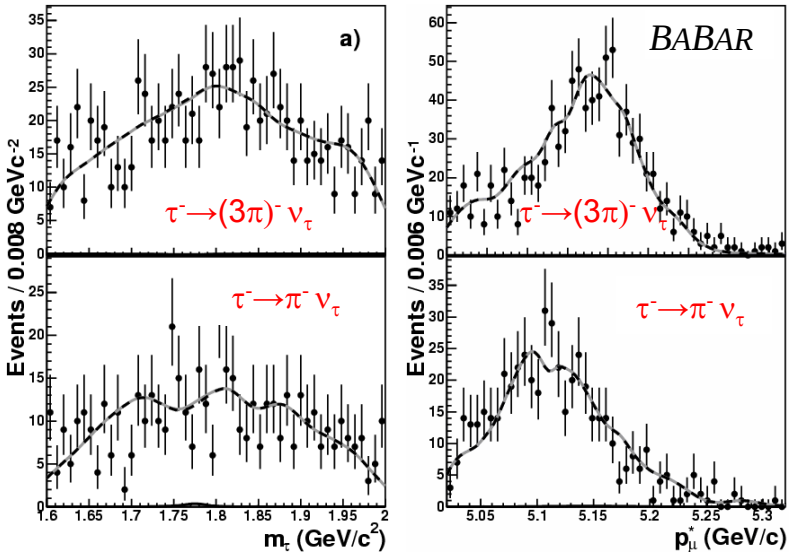



- Select signal events in ($m_\tau$, $p^*(l)$) plane
  - Unbinned ML fit to extract signal and bg

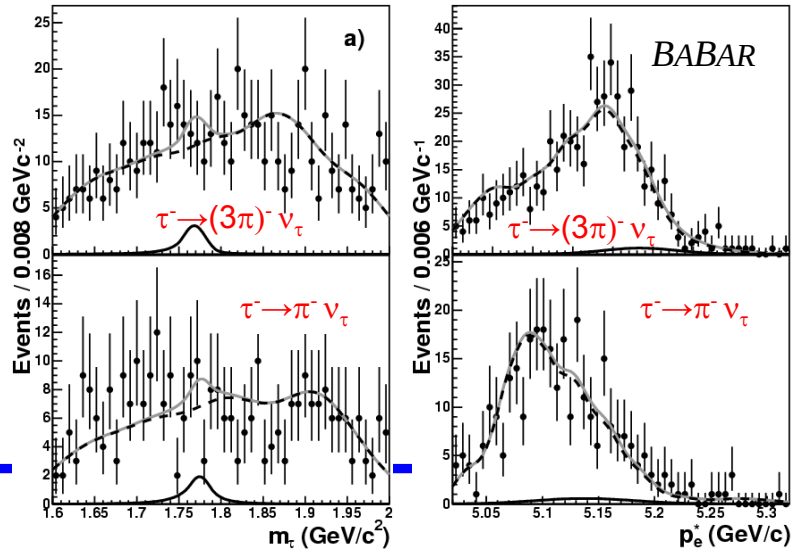
**No evidence for signal**

| *Mode* | σ UL(95%) | $\sigma/\sigma_{\mu\mu}$ UL(95%) |
|---|---|---|
| $e^+e^- \to \mu^-\tau^+(\tau^+ \to \pi^+\pi^-\pi^+\upsilon_\tau)$ | $5.91\,fb$ | $5.2\times10^{-6}$ |
| $e^+e^- \to \mu^-\tau^+(\tau^+ \to \pi^+\upsilon_\tau)$ | $11.4\,fb$ | $10.1\times10^{-6}$ |
| $e^+e^- \to e^-\tau^+(\tau^+ \to \pi^+\pi^-\pi^+\upsilon_\tau)$ | $14.8\,fb$ | $13.1\times10^{-6}$ |
| $e^+e^- \to e^-\tau^+(\tau^+ \to \pi^+\upsilon_\tau)$ | $11.1\,fb$ | $9.8\times10^{-6}$ |
| *Combined* | $\sigma$ | $\sigma/\sigma_{\mu\mu}$ |
| $e^+e^- \to \mu^-\tau^+$ | $4.6\,fb$ | $4.0\times10^{-6}$ |
| $e^+e^- \to e^-\tau^+$ | $10.1\,fb$ | $8.9\times10^{-6}$ |

$e^+e^- \to \mu^+\tau^-$




$e^+e^- \to e^+\tau^-$



# Tau results from B Factories

Royal Holloway
University of London

## Lepton Flavor Violation

## Rare tau decays

# Rare τ decays

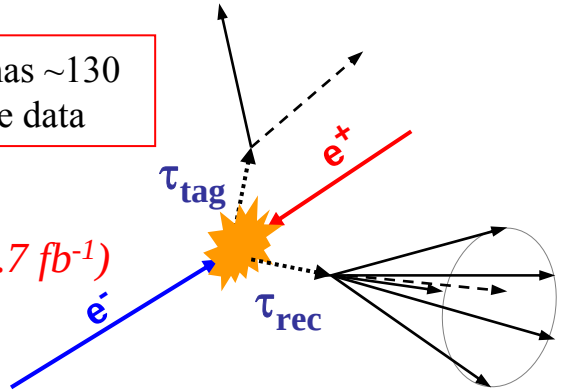
Royal Holloway
University of London

## $\tau^- \to (5\pi)^- 2\pi^0 \nu_\tau$ decay

BABAR has ~130 times more data

Current experimental limit:

- BR( $\tau \to 5h\, 2\pi^0 \nu_\tau$ ) < $1.1\times10^{-4}$ @ 90% CL (*CLEO 1994, 1.7 fb$^{-1}$*)
- Tiny phase space suppresses 8-body τ decays
- No BR prediction
- Decay is likely to go through $\tau \to 2\omega\pi\nu_\tau$ *(R. Sobie, PRD 60, 017301 (1999))*




5-prong τ decay

Select signal using pseudo-mass

- assume neutrino is mass-less
- approximate τ direction by 7 tracks

$$m^*_\tau{}^2 = 2(E_{beam} - E_{7\pi})(E_{7\pi} - P_{7\pi}) + m_{7\pi}^2$$

- signal region: $1.3 < m^*_\tau < 1.8$ GeV/c$^2$

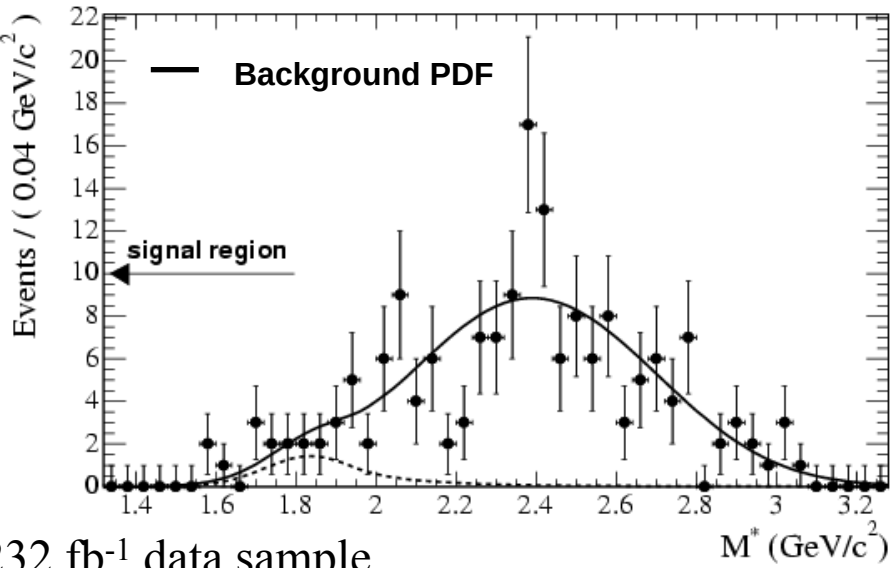
Improves rejection of $q\bar{q}$ background

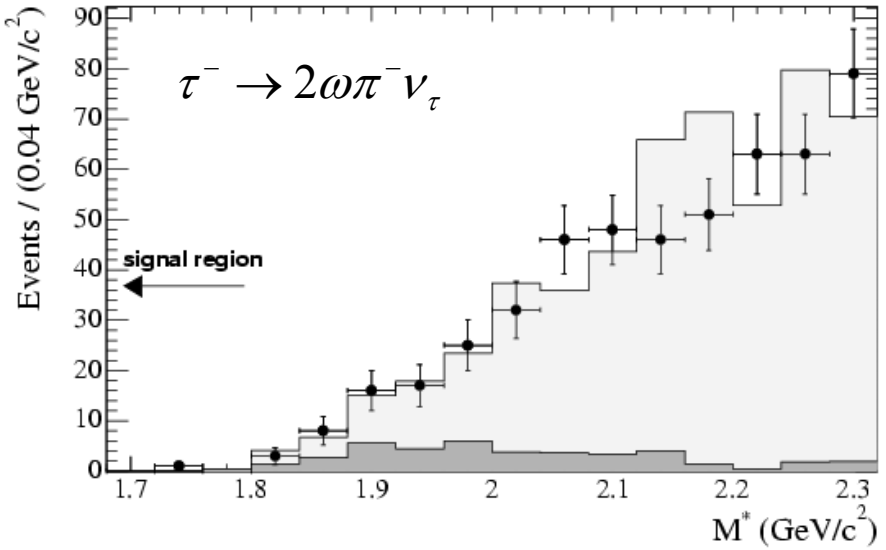
Cuts applied

- 1-prong (tag) hemisphere
  - lepton tag
- 5-prong (signal) hemisphere
  - 5-prong pion ID
  - $\pi^0$ identification
  - conversion veto

# $\tau \to 5\pi 2\pi^0 \nu_\tau$ preliminary results

Royal Holloway University of London




232 fb$^{-1}$ data sample

| | |
|---|---|
| Signal efficiency | 0.66 ± 0.05 % |
| Total expected bkg. | $6.5^{+2.0}_{-1.4}$ |
| Observed events | 10 |

| | |
|---|---|
| Signal efficiency | 1.53 ± 0.13 % |
| Total expected bkg. | $0.4^{+1.0}_{-0.4}$ |
| Observed events | 1 |


| Multi-pion mode | PDG2004 | BABAR |
|---|---|---|
| $\tau \to 5\pi\ 2\pi^0\nu_\tau$ | $< 1.1 \times 10^{-4}$ | $< 3.4 \times 10^{-6}$ (to be submitted to PRD) |
| $\tau \to 2\omega\ \pi\nu_\tau$ | N/A | $< 5.4 \times 10^{-7}$ (to be submitted to PRD) |
| $\tau \to 7\pi\ (\pi^0)\nu_\tau$ | $< 2.4 \times 10^{-6}$ | $< 3.0 \times 10^{-7}$ (PRD72:012003,2005) |

# Tau results from B Factories

Royal Holloway
University of London

## Lepton Flavor Violation

## Rare tau decays

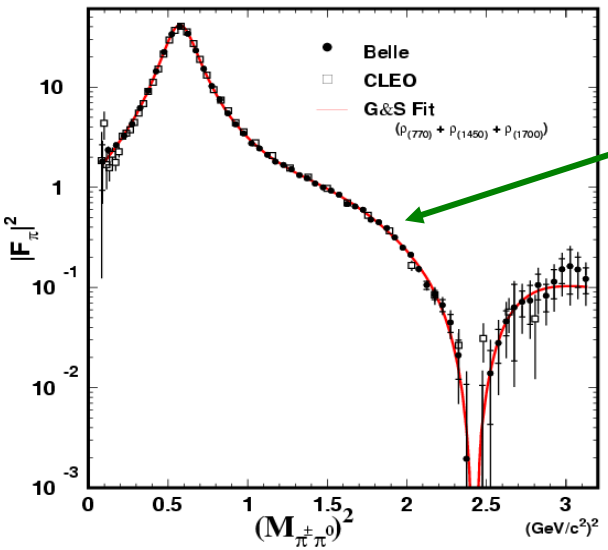
## Study of $\tau^- \to \pi^- \pi^0 \nu_\tau$ decay

# Study of $\tau^- \rightarrow \pi^-\pi^0\nu_\tau$ decay

Royal Holloway University of London

Decay dominated by intermediate resonances: ρ, ρ', ρ''

Under CVC theorem, $\pi\pi^0$ mass spectrum can be used to improve theoretical error on $a_\mu = (g_\mu - 2)/2$




$$F_\pi(s) = \frac{1}{1+\beta+\gamma}\left(BW_\rho + BW_{\rho'} + BW_{\rho''}\right)$$

$$BW_{GS} = \frac{M_i^2 + d\cdot M_i\Gamma_i(s)}{(M_i^2 - s) + f(s) - i\sqrt{s}\,\Gamma_i(s)}$$

$m_\rho = 774.6\pm0.2\pm0.3$ MeV/c$^2$

$\Gamma_\rho = 150.6\pm0.3\pm0.5$ MeV

$m_{\rho'} = 1336\pm12\pm23$ MeV/c$^2$

$\Gamma_{\rho'} = 471\pm29\pm21$ MeV

$m_{\rho''} = 1600\pm13\pm4$ MeV/c$^2$

$\Gamma_{\rho''} = 255\pm19\pm79$ MeV

$$a_\mu^{\pi\pi}[0.50,1.80] = (462.6\pm0.6\pm3.2\pm2.3)\times10^{-10}$$

hep-ex/0512071

$$a_\mu^{\pi\pi}[0.50,1.80] = (464.0\pm3.0\pm2.3)\times10^{-10}$$

τ: ALEPH, CLEO

$$a_\mu^{\pi\pi}[0.50,1.80] = (448.3\pm4.1\pm1.6)\times10^{-10}$$

$e^+e^-$: CMD2, KLOE

Differences between $\pi\pi^0$ mass spectrum and $\pi^+\pi^-$ mass spectrum in $e^+e^-\rightarrow \pi^+\pi^-$ reaction

# Tau results from B Factories

Royal Holloway
University of London

## Lepton Flavor Violation results

## Rare tau decays

## Study of $\tau^- \to \pi^- \pi^0 \nu_\tau$ decay

## Measurement of $\tau^-$ mass

# τ mass measurement

In SM, high precision measurements of mass, lifetime and BF of τ lepton can be used to test lepton universality

- Present limit on $m_\tau$ dominated by BES result (PRD 53 (1996) 20)
  - Same accuracy (~0.3 MeV ) can be obtained with present stat

The Analysis of τ lepton decays allows to measure separately $m_{\tau^+}$ and $m_{\tau^-}$ and test CPT theorem

- Similar test from OPAL: $(m_{\tau^+} - m_{\tau^-})/m_{avg} < 3.0\times10^{-3}$ @90%CL
- High τ statistic of Belle allow significant improvement

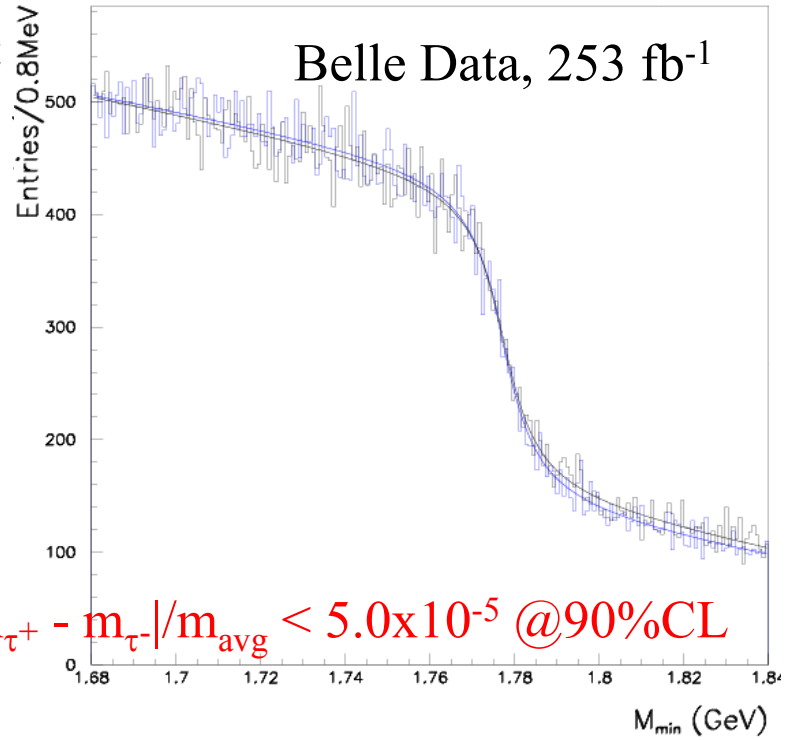
Analysis uses different technique than BES:

- Define estimator of τ mass (pseudo-mass)

$$M_{\min} = \sqrt{M_X^2 + 2(E_{beam} - E_X)(E_X - P_X)}$$

- $M_{min} \le m_{\tau^+}$; in absence of ISR and FSR, $M_{min}$ has an edge at $m_\tau$
- Use $\tau^- \to l^- \nu_l \nu_\tau$; $\tau^+ \to \pi^+\pi^-\pi^+(\pi^0)\nu_\tau$ decays and fit $M_{min}$

$$F(X) = (p_3+p_4X)\,\mathrm{atan}((X-p_1)/p_2) + p_5 + p_6X$$




$|m_{\tau^+} - m_{\tau^-}|/m_{avg} < 5.0\times10^{-5}$ @90%CL

# Conclusion - I

Royal Holloway
University of London

B Factories are also charm and tau factories

- A lot of extremely interesting results obtained by B Factory experiments in Charm and Tau physics
  - World's best sensitivity in the search for D mixing
    - Measurement of mixing parameters in $D^0 \to K^+\pi^-$
    - No CP violation observed
  - Most precise measurement of $\frac{\Gamma(D_s^+ \to \mu\upsilon_\mu)}{\Gamma(D_s^+ \to \phi\pi)}$ and decay constant $f_{Ds}$

# Conclusion - II

Royal Holloway University of London

- New and updated results on LFV and rare tau decays
  - World's best limits on LFV
    - $\tau \to e\gamma$, $\mu\gamma$, lll, lhh' 
    - new result on $\tau \to lK_s^0$ 
    - First limit on $\sigma(e^+e^- \to \mu^+\tau^-, e^+\tau^-)$ at energies accessible to B Factories 
  - World's best limits on $\tau \to 5\pi 2\pi^0 \nu_\tau$ and first limit on $\tau \to 2\omega\pi^-\nu_\tau$ search 
- Study of $\tau^- \to \pi^-\pi^0\nu_\tau$ decay 
  - study of mass spectrum and measurement of $a_\mu = (g_\mu - 2)/2$
- Improved measurement of $m_\tau$ and test of CPT theorem 

Many more results coming soon !

Royal Holloway
University of London

# Backup Slides

# $D^0 \to K^+\pi^-(n\pi)$ results

Royal Holloway University of London

$D^0 \to K\pi\pi^0$, $K3\pi$ (PRL 95, 231801 (2005))

Signal yield obtained using binned ML fit in $M(K\pi(n\pi))$-Q space

$$R_{WS} = \frac{N_{WS}}{N_{RS}} \cdot \frac{\varepsilon_{RS}}{\varepsilon_{WS}} = \left[2.29 \pm 0.15^{+0.13}_{-0.09}\right] \times 10^{-3}$$

$D^0 \to K\pi\pi^0$

$D^0 \to K3\pi$

$\left[3.20 \pm 0.17^{+0.18}_{-0.13}\right] \times 10^{-3}$

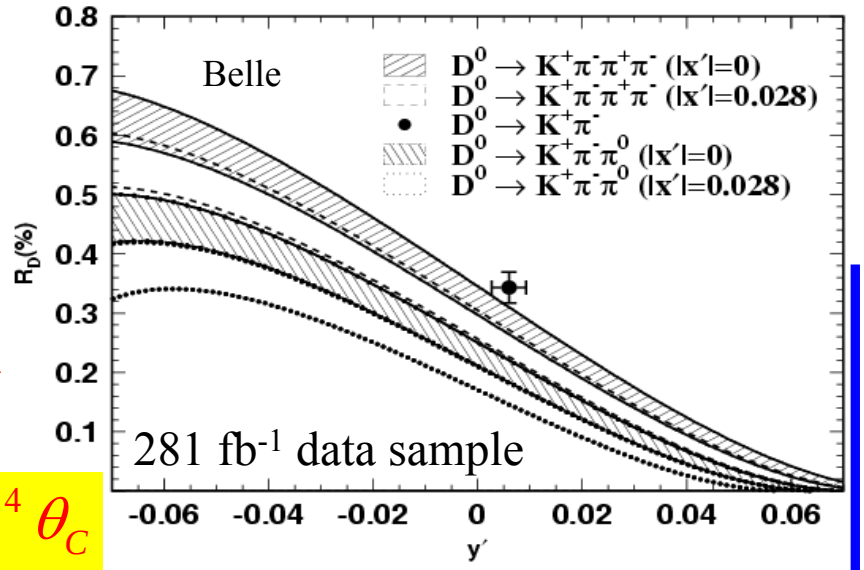
$$A_{CP} = \frac{R_{WS}(D^0) - R_{WS}(\bar{D}^0)}{R_{WS}(D^0) + R_{WS}(\bar{D}^0)} = -0.006 \pm 0.053$$

$-0.018 \pm 0.044$

$$R_{WS} = R_D + \sqrt{R_D}\, y' + (x'^2 + y'^2)/2$$

measure $R_{WS}$, fix x' to limit obtained in $K\pi$

→ measure $R_D$ vs y'




x'=y'=0 →

$$R_D(K\pi\pi^0) = \left(0.85^{+0.08}_{-0.07}\right)\tan^4\theta_C$$

$$R_D(K3\pi) = \left(1.18^{+0.10}_{-0.09}\right)\tan^4\theta_C$$

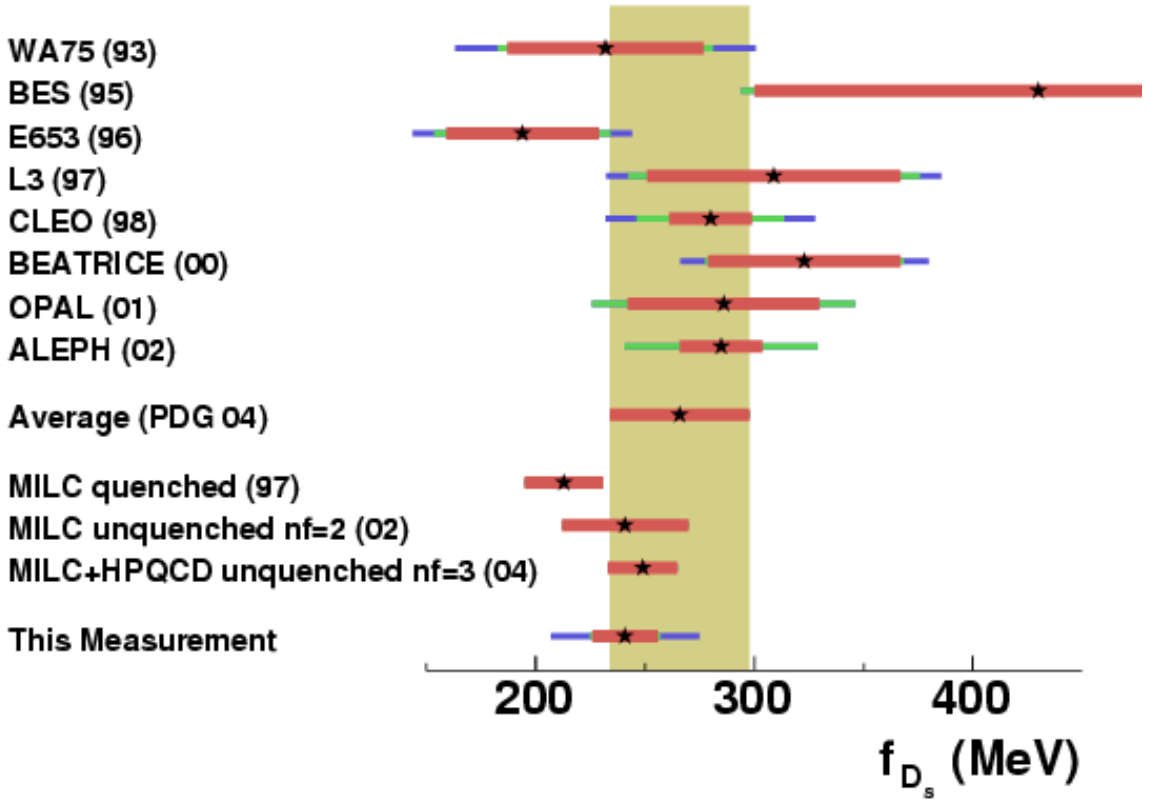
in agreement with expectation

# $D_s^+ \to \mu^+ \nu_\mu$ preliminary results

Royal Holloway University of London

$f_{D_s}$ result obtained normalizing to $D_s^+ \to \phi\pi^+$ BF from PDG

$$f_{D_s} = (241 \pm 16 \pm 6 \pm 30)\ \text{MeV}$$



# $\tau^- \to \pi^-\pi^0\nu_\tau$ branching fraction

Royal Holloway University of London

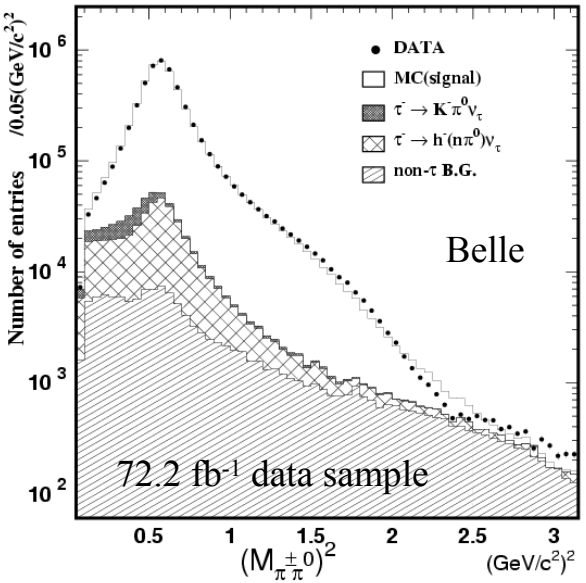
$e^+e^- \to \tau^+\tau^-(\gamma)$ selection:

- 2 or 4 charged trks with $p_T > 0.1$ GeV/c
- Sum $E_{cm}$ 2 highest p trks < 9.0 GeV/c
  - Removes Bhabha and $\mu^+\mu^-$ evts
- Reconstructed vtx close to IP
  - Removes beam-related bkgnd
- Highest p trk in the fiducial volume
- Cut in ($M_{miss}$, $\theta_{miss}$) plane
  - Removes remaining Bhabha, $2\gamma$ and $\mu\mu\gamma$ evts

$\tau^- \to \pi^-\pi^0\nu_\tau$ selection:

- Evt divided in 2 hemispheres
  - 1 trk and 1 $\pi^0$ in one hemisphere
  - $\pi^0$ selection: $-6.0 < \frac{m_{\gamma\gamma} - m_{\pi^0}}{\sigma_{\gamma\gamma}} < 5.0$
  - $\pi^0$ bg from sideband
- $\pi^0$ momentum > 0.25 GeV/c

$$B_{h\pi^0} = (25.60 \pm 0.04 \pm 0.31)\%$$
$$B_{\pi\pi^0} = (25.15 \pm 0.04 \pm 0.31)\%$$




- Good agreement with previous measurements
- Improvement in statistical error