Review of BaBar results

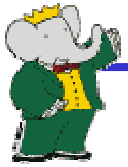
L.Lista

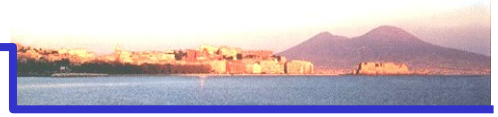
INFN - Napoli

Outline

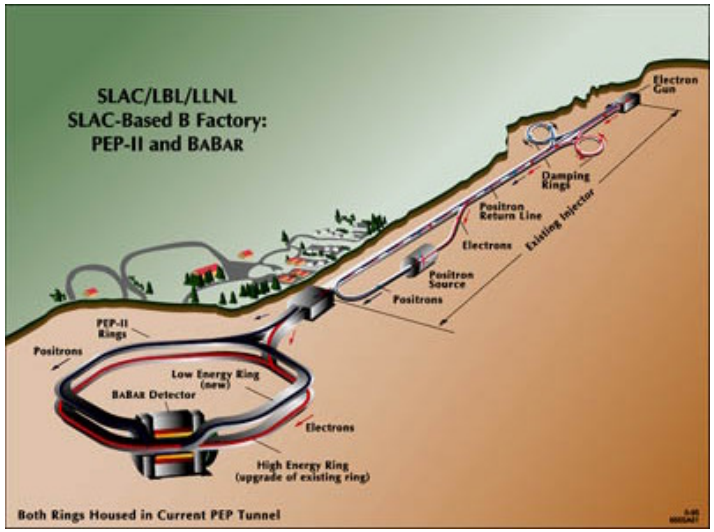
- PEP-II and BaBar experiment
- CP Violation:
  - Direct CP violation
  - Measurements of sin2β, α and γ
- Measurements of |Vub| and |Vcb|
- Searches beyond the Standard Model
- Conclusions

- Many results skipped due to limited time…



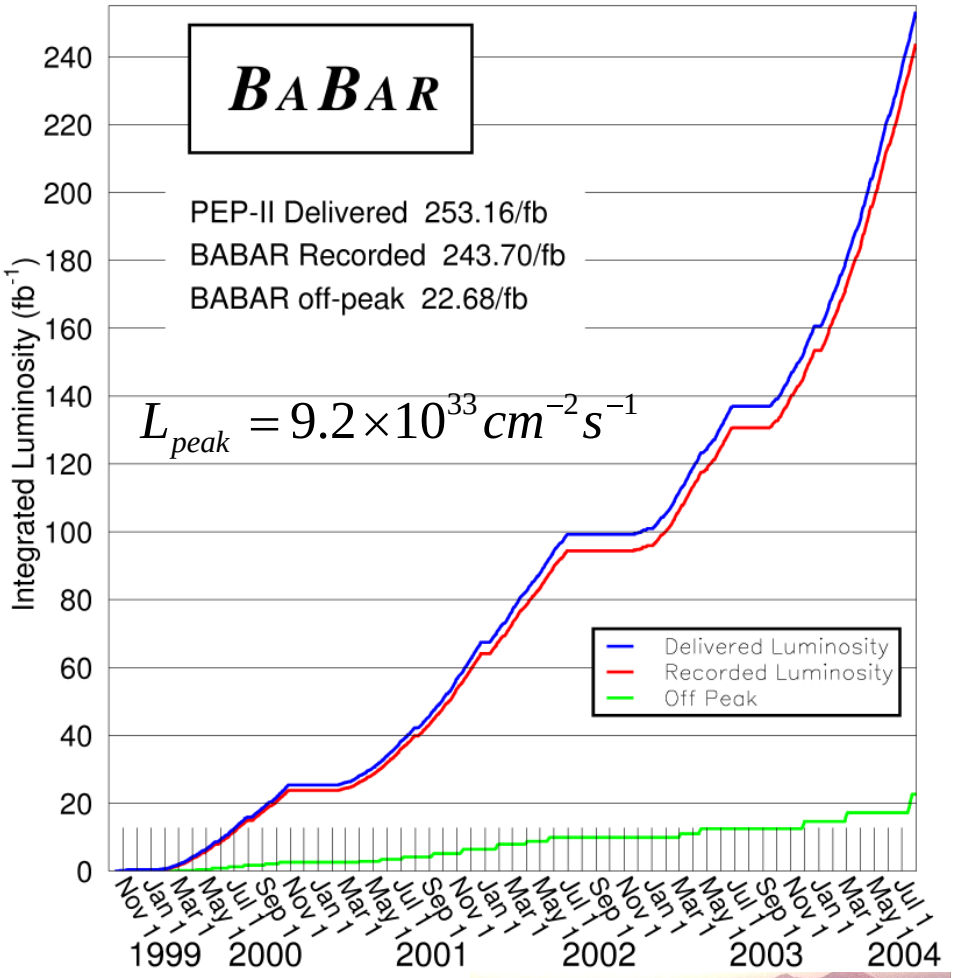


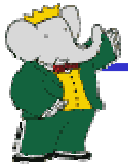
PEP-II: Luminosity and Data Sample



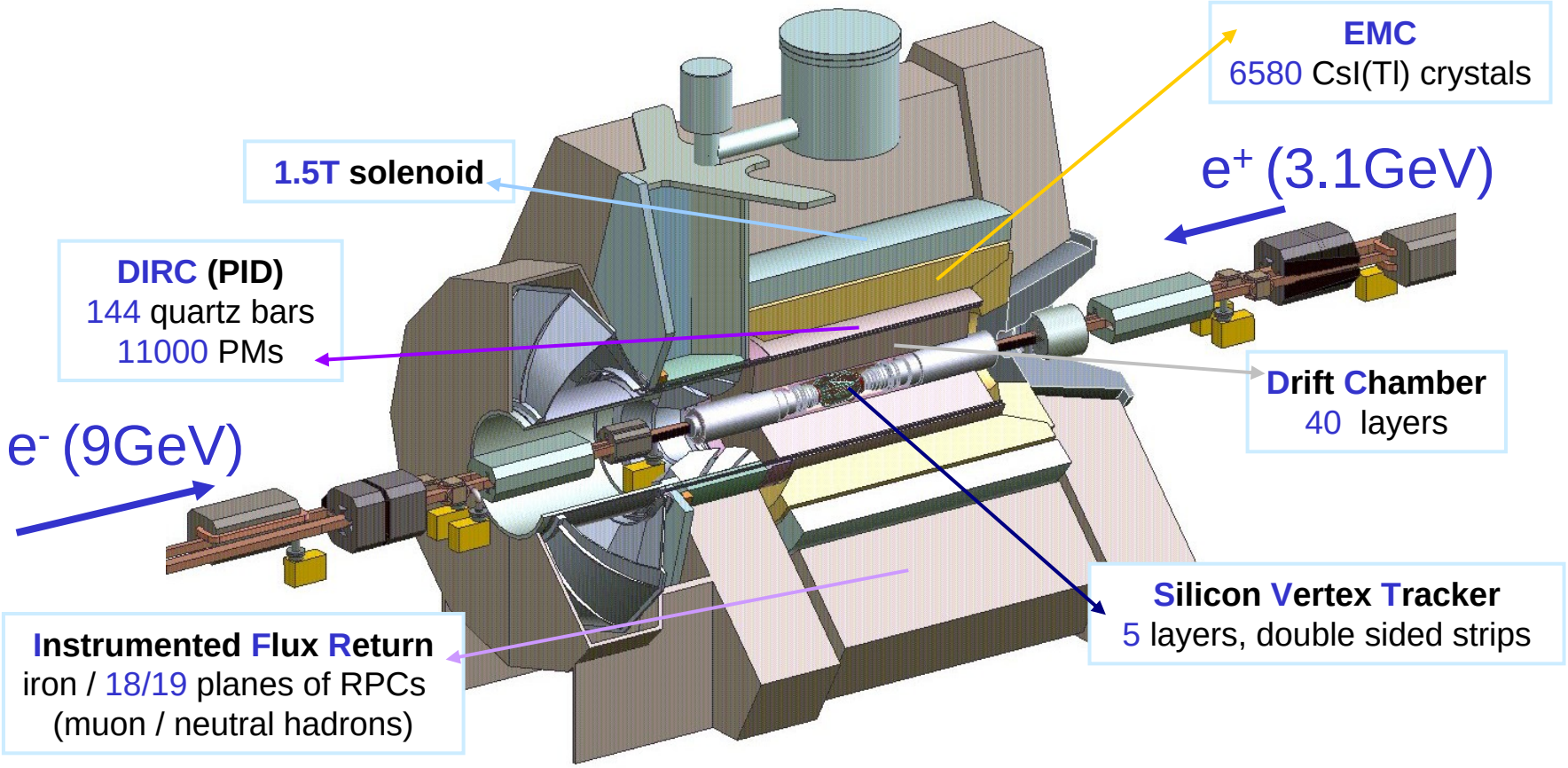
- PEP-II is SLAC e^+e^- B factory running at the Y(4S) c.m. energy
- Y(4S) resonance decays to charged and neutral B-anti-B pairs

Total: 244 fb^{-1} (Jul 31st 04)



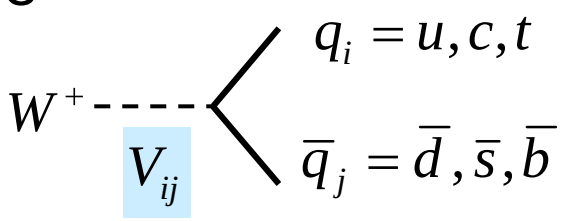


BaBar Detector

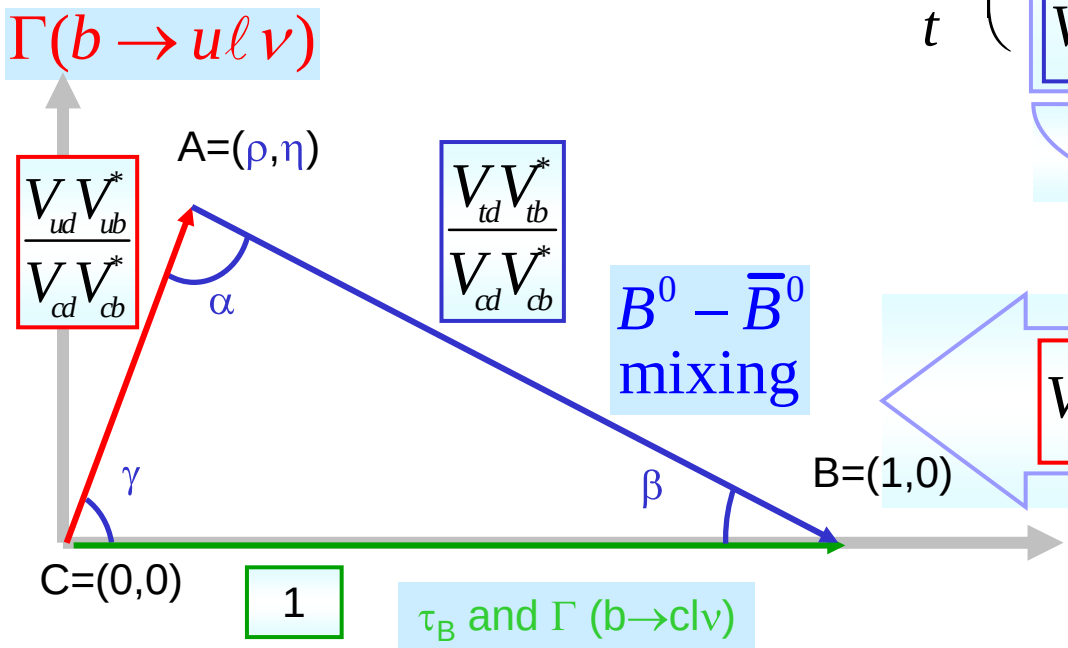


The Unitarity triangle

- CKM matrix measures Quarks mixing in weak interactions
- Unitarity relations lead to unitarity triangles in the complex plane



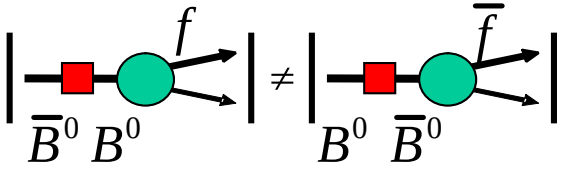
$$\begin{array}{c} \\ u \\ c \\ t \end{array} \begin{array}{c} \begin{array}{ccc} d & s & b \end{array} \\ \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \end{array}$$



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

CP Violation (I, II)

CP violation in mixing



CP first observed in kaon decays

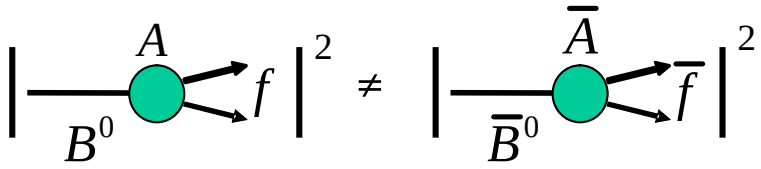
q and *p* are the mass eigenstates coefficients in the flavor eigenstate basis; M - i½ Γ is the 2×2 effective Hamiltonian

$$\left|\frac{q}{p}\right| = \sqrt{\frac{(M_{12}^* - i\frac{\Gamma_{12}^*}{2})}{(M_{12} - i\frac{\Gamma_{12}}{2})}} \neq 1$$

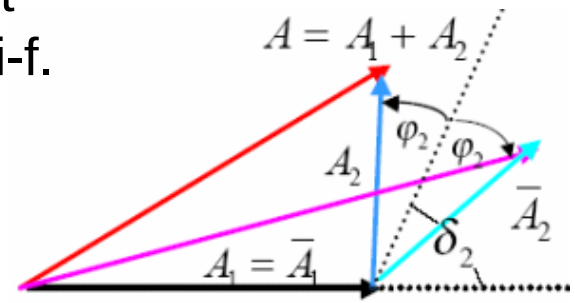
SM prediction for B mesons is very small:

$$\left|\frac{q}{p}\right| - 1 \approx 4\pi \frac{m_c^2}{m_t^2} \sin\beta \approx 5\times 10^{-4}$$

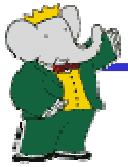
Direct CP violation in the decay

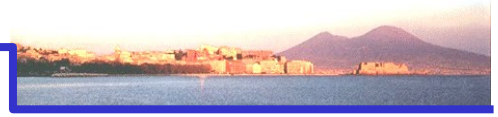


If B decay amplitude to f is different from anti-B decay amplitude to anti-f. Requires a relative CP violating phase ϕ_2 and a CP conserving phase δ_2



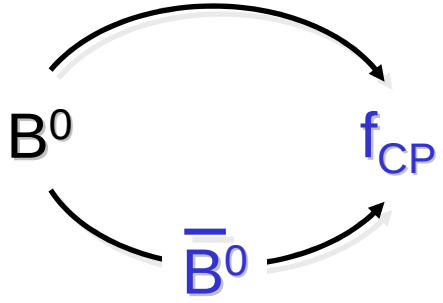
$$\left|\bar{A}/A\right| \neq 1$$

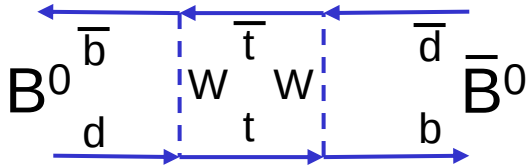




CP Violation (III)

Time dependent CP violation





$$\Gamma\left(B^0_{phys}(t)\to f_{CP}\right) \neq \Gamma\left(\overline{B}^0_{phys}(t)\to f_{CP}\right)$$

Time dependent CP Asymmetry:

$$A_{f_{CP}}(t)=\frac{\Gamma\left(\overline{B}^0_{phys}(t)\to f_{CP}\right)-\Gamma\left(B^0_{phys}(t)\to f_{CP}\right)}{\Gamma\left(B^0_{phys}(t)\to f_{CP}\right)+\Gamma\left(\overline{B}^0_{phys}(t)\to f_{CP}\right)}$$

$$A_{f_{CP}} = -C_{f_{CP}}\cos(\Delta m t)+S_{f_{CP}}\sin(\Delta m t)$$

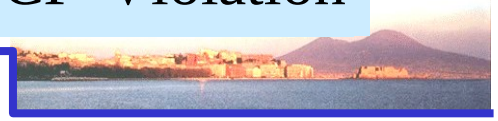
For a single amplitude

$$\lambda_{f_{CP}}=\frac{q}{p}\cdot\frac{\overline{A}_{f_{CP}}}{A_{f_{CP}}} \approx e^{-2i\beta}$$

$$C_{f_{CP}}=\frac{1-|\lambda_{f_{CP}}|^2}{1+|\lambda_{f_{CP}}|^2} = 0$$

$$S_{f_{CP}}=\frac{-2\,\mathrm{Im}\,\lambda_{f_{CP}}}{1+|\lambda_{f_{CP}}|^2} = -\,\mathrm{Im}\,\lambda_{f_{CP}}$$

$C_{f_{CP}} \neq 0$ implies Direct CP Violation

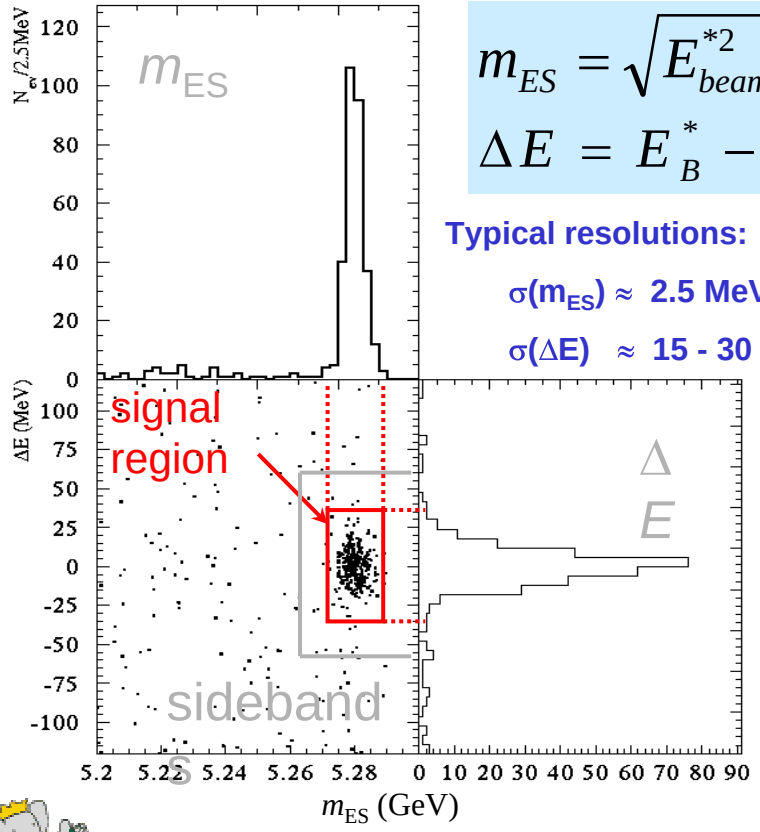


B decay reconstruction and tagging

B kinematics

$$e^+e^- \to \Upsilon(4S) \to B\overline{B}$$

$$\sigma_{b\bar{b}} \cong 1.1\text{nb}; \quad \frac{\sigma_{b\bar{b}}}{\sigma_{had}} \cong 0.28$$



$$m_{ES} = \sqrt{E^{*2}_{beam} - p^{*2}_{B}}$$

$$\Delta E = E^{*}_{B} - E^{*}_{beam}$$

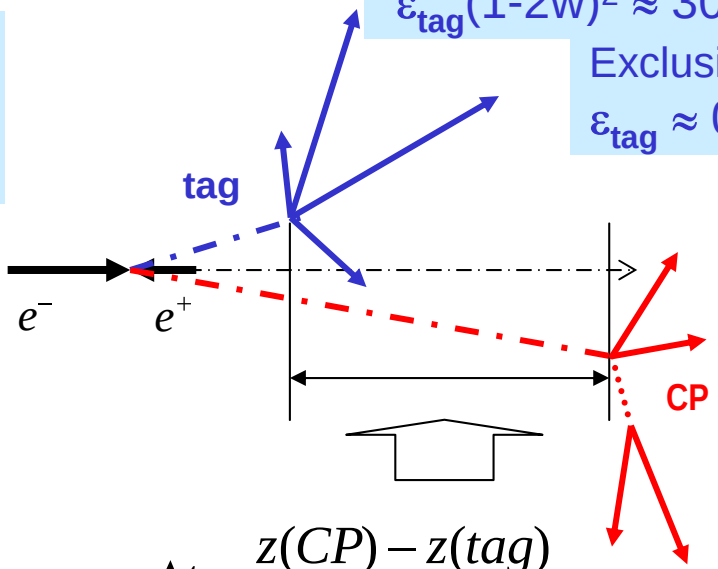
Typical resolutions:

$\sigma(m_{ES}) \approx$ 2.5 MeV

$\sigma(\Delta E) \approx$ 15 - 30 MeV

Inclusive tag (lepton, K, …):
$\varepsilon_{tag}(1\text{-}2w)^2 \approx 30\%$

Exclusive tag:
$\varepsilon_{tag} \approx 0.1 \div 0.2\%$

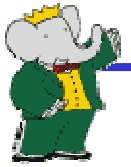


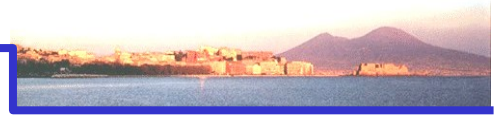
$$\Delta t = \frac{z(CP) - z(tag)}{c\gamma\beta}$$

$\varepsilon_{rec} \approx 15 \div 40\%$

$< \Delta z > \approx 260\ \mu m$

$\sigma_{\Delta z}$ (RMS) $\approx 150\ \mu m$





Direct CP Violation

hep-ex/0408057, submitted to PRL on

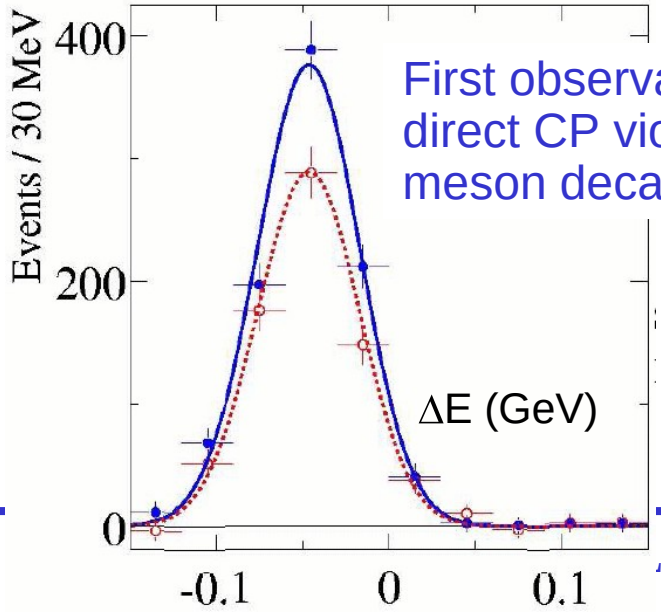
$B^0 \to K^+\pi^-$

B flavor is tagged by the kaon charge

$$\mathcal{A}_{K\pi} \equiv \frac{n_{K^-\pi^+} - n_{K^+\pi^-}}{n_{K^-\pi^+} + n_{K^+\pi^-}}$$

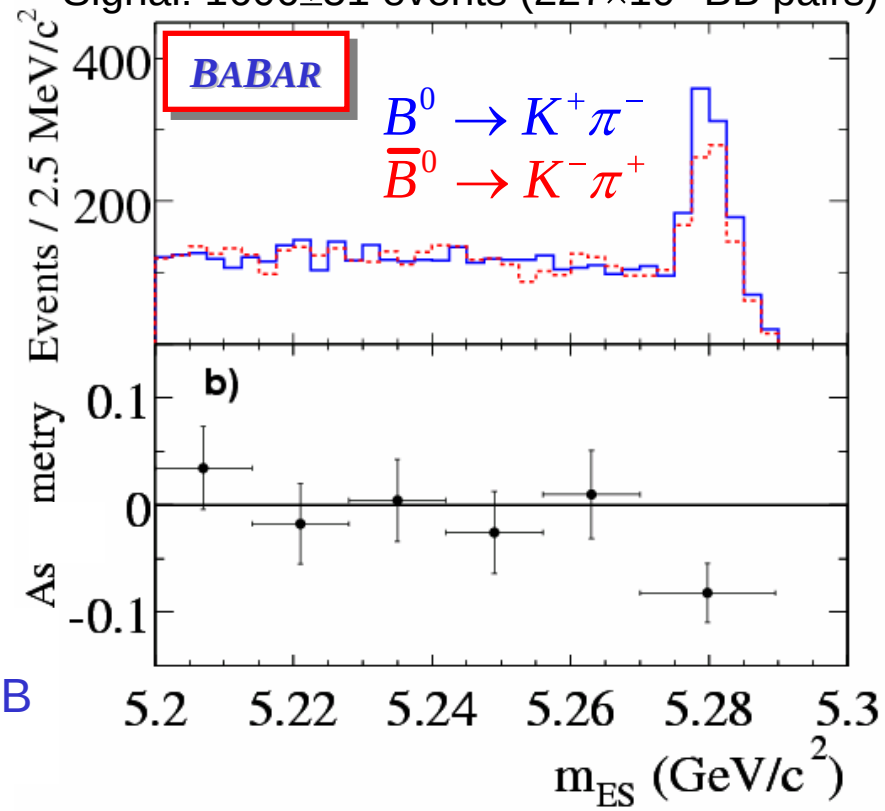
$A_{K\pi}$ = -0.133±0.030±0.009 (4.2σ)

Tree + Penguin contributions



First observation of direct CP violation in B meson decays!

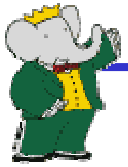
Signal: 1606±51 events (227×10^6 BB pairs)

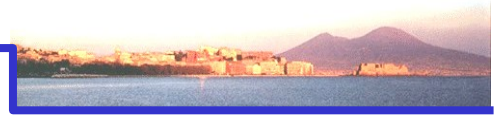


$B^+ \to K^+\pi^0$

Pure Penguin

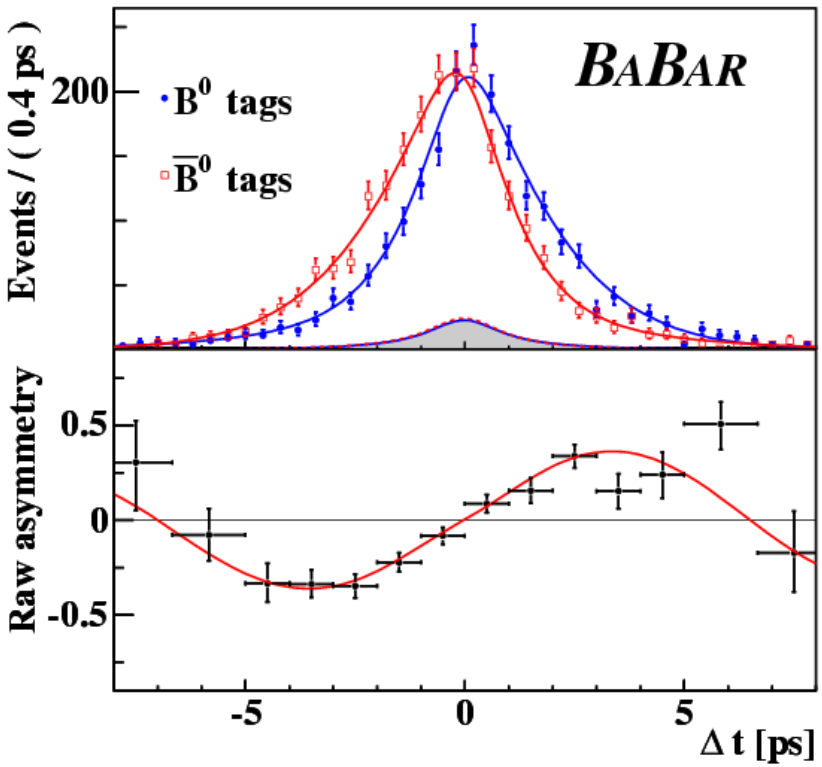
$A_{K\pi}$ = 0.06±0.06±0.01



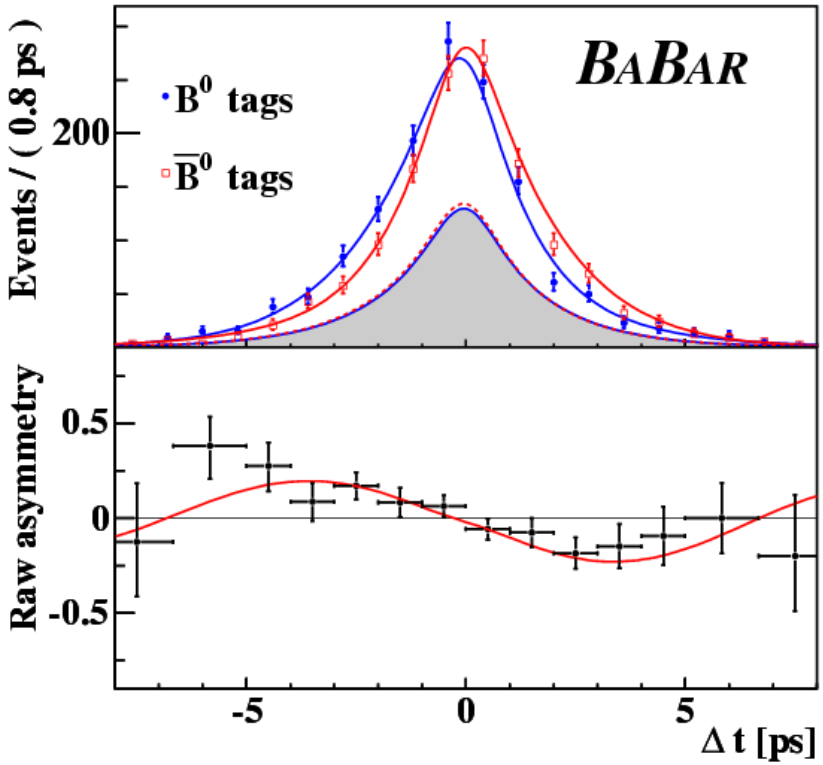


CP Violation in Mixing-Decay interference

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



J/ψ K_L (CP even) mode

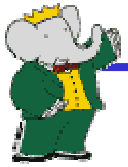


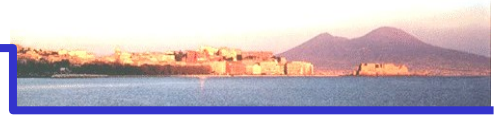
$S = \sin 2\beta = 0.722 \pm 0.040 \pm 0.023$

$C = |\lambda| = |\bar{A}/A| = 0.950 \pm 0.031 \pm 0.013$

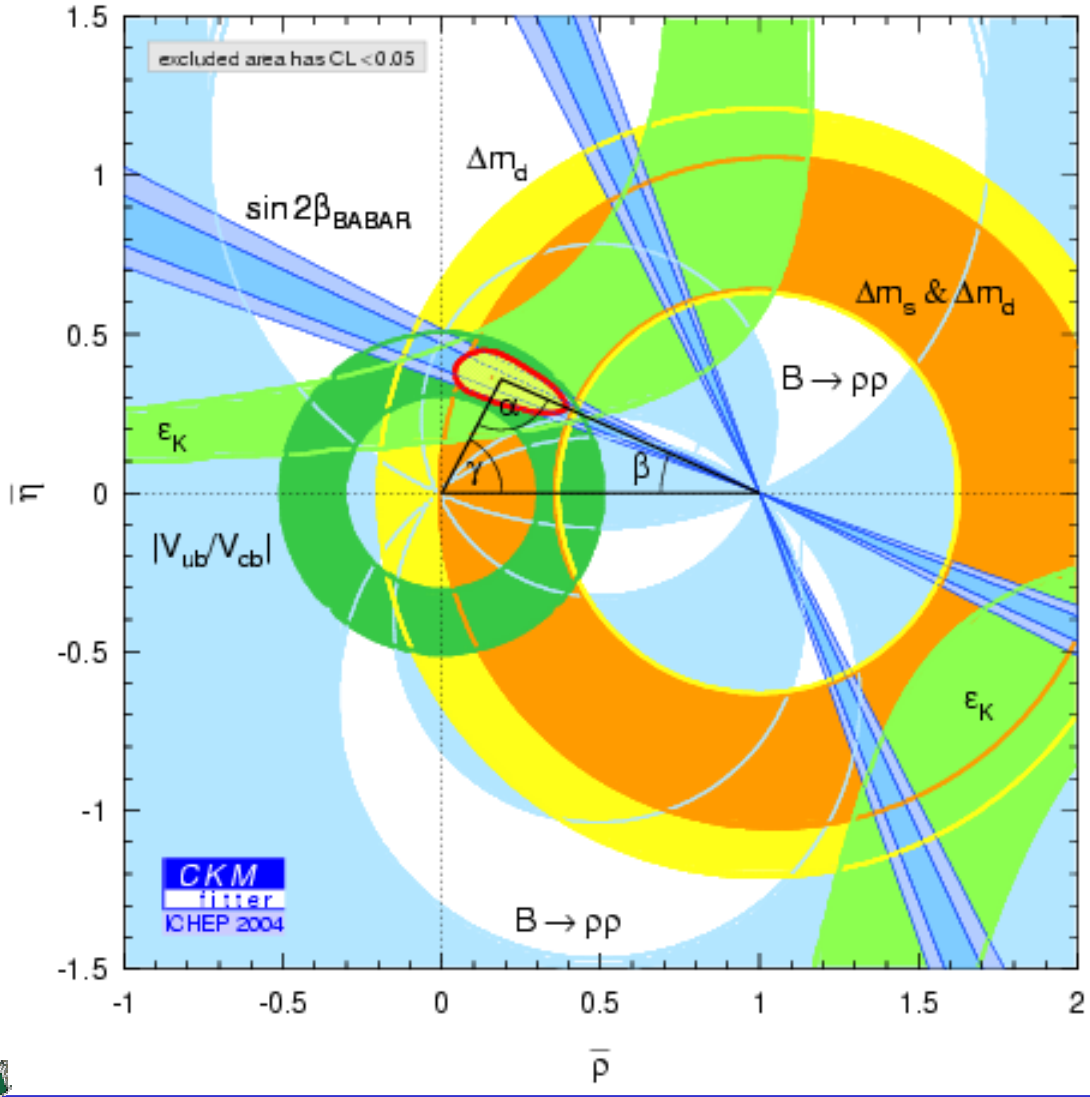
Direct CP violation if $\neq 1$

7730 tagged CP events
on 227×10^6 BB pairs =205fb^{-1} on peak
Measured on a variety of cc decay modes



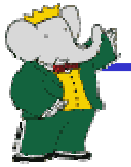


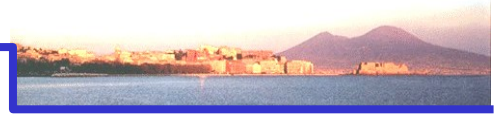
sin2β in the Unitarity Triangle plane



$\cos 2\beta > 0$ at 87% C.L.

Using an s- and p-wave interference in angular analysis of $B \to J/\psi K^{*0}$ ($K_S \pi^0$)





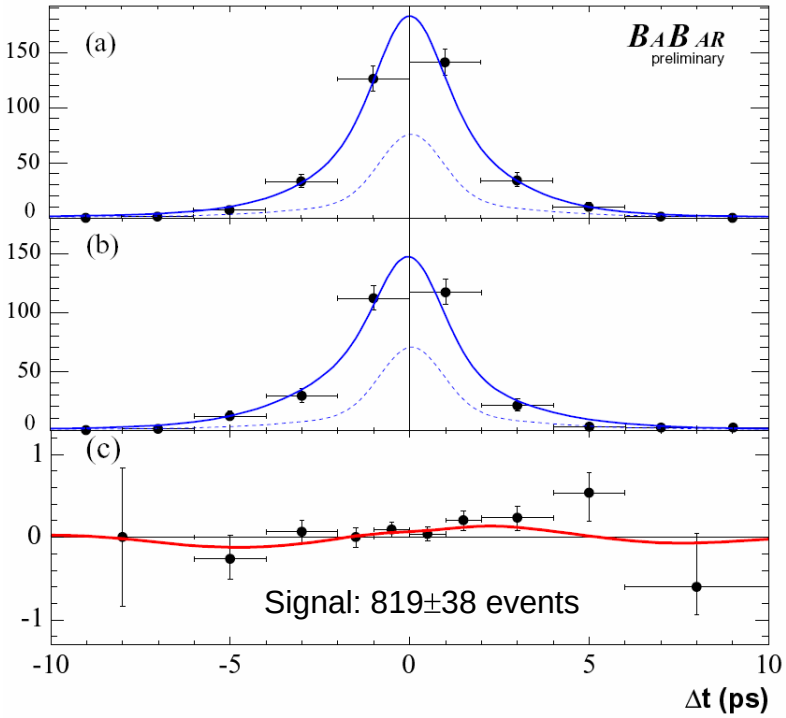
"sin2β" channels probing new Physics

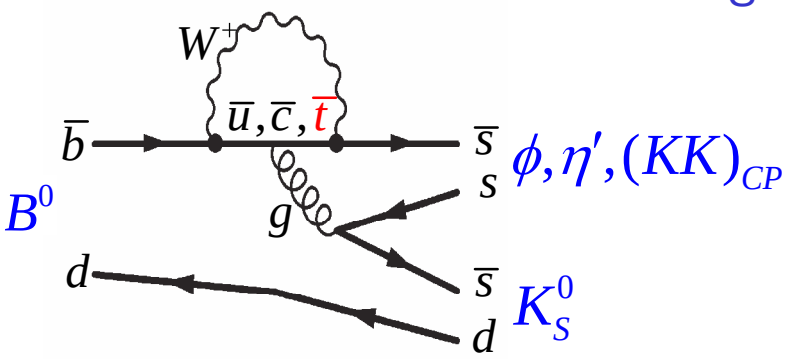
- Decays dominated by loop diagrams can exhibit contributions from new physics

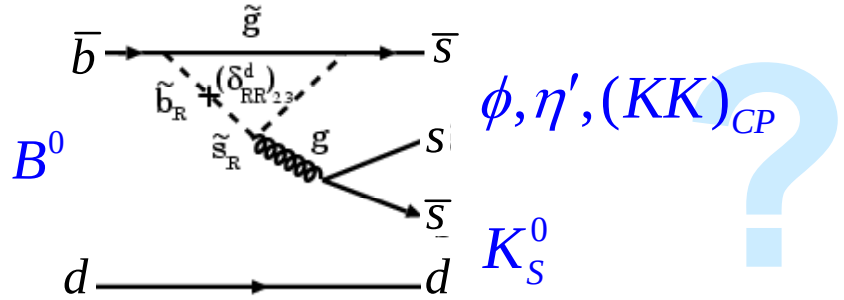
$B^0 \to \eta' K^0_S$

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

$B^0 \to K^0_S \pi^0$



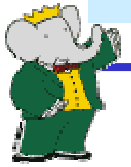


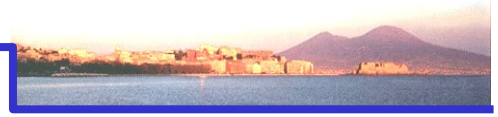


$$-\eta_{CP} \cdot S_{\eta' K^0_S} = +0.27 \pm 0.14 \pm 0.03$$

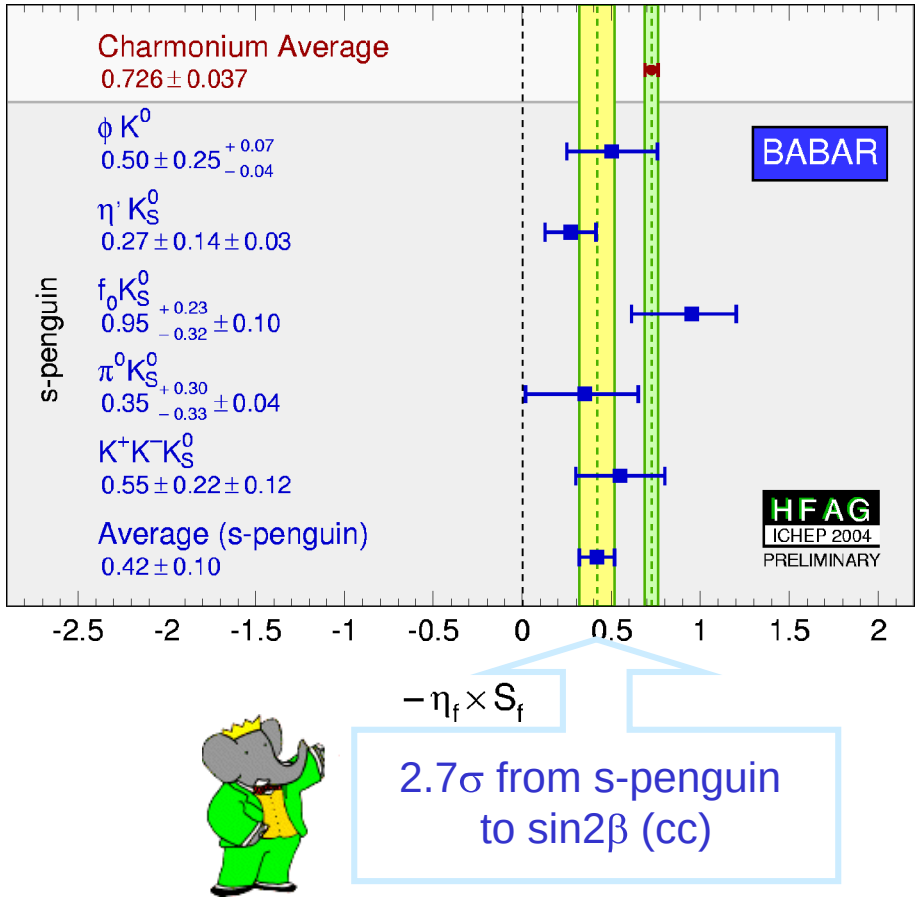
$$C_{\eta' K^0_S} = -0.21 \pm 0.10 \pm 0.03$$

3σ deviation from charmonium sin2β

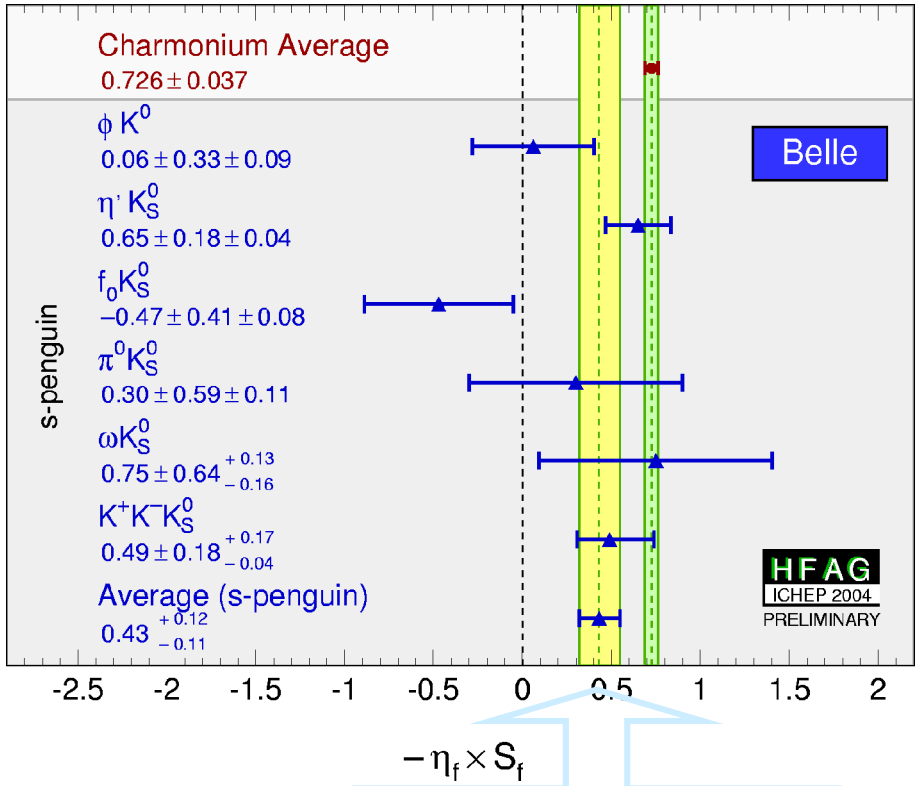




Comparison of sin2β modes

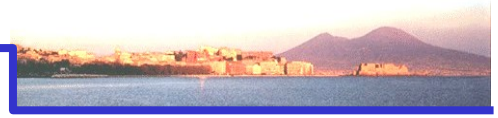


2.7σ from s-penguin to sin2β (cc)



BELLE

2.4σ from s-penguin to sin2β (cc)

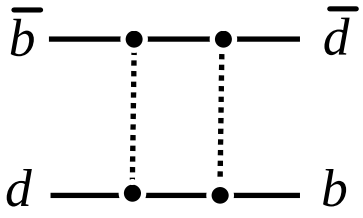


Measurement of sin2α

Interference of suppressed
$b \to u$ "tree" decay with mixing

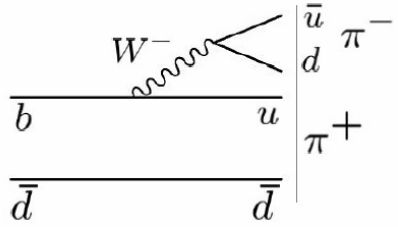
Penguin diagrams
may be of the same magnitude.

B^0 mixing



$\oplus$

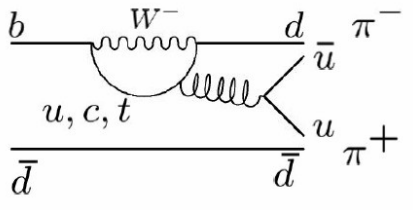
B^0 decay: tree



$q/p \propto V_{tb}^* V_{td} / V_{tb} V_{td}^*$ $\quad A \propto V_{ub}^* V_{ud}$ $\quad \propto \lambda^3$

$\oplus$

B^0 decay: penguin



$A \propto V_{td}^* V_{tb}$ $\quad \propto \lambda^3$

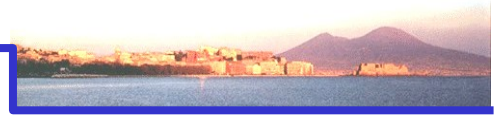
$$\lambda_{\pi\pi} = \frac{q}{p}\frac{\bar{A}_{\pi\pi}}{A_{\pi\pi}} = e^{-i2\beta} e^{-i2\gamma} = e^{i2\alpha}$$

$$\lambda_{\pi\pi} = e^{i2\alpha} \frac{T + Pe^{+i\gamma} e^{i\delta}}{T + Pe^{-i\gamma} e^{i\delta}}$$

$$S_{\pi\pi} = \sin 2\alpha$$
$$C_{\pi\pi} = 0$$

$$S_{\pi\pi} = \sqrt{1 - C_{\pi\pi}^2} \sin 2\alpha_{eff}$$
$$C_{\pi\pi} \propto \sin\delta$$

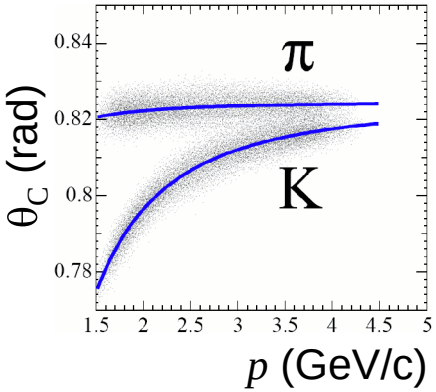
Isospin analysis could measure the amount of correction to α



sin2α with B→ππ

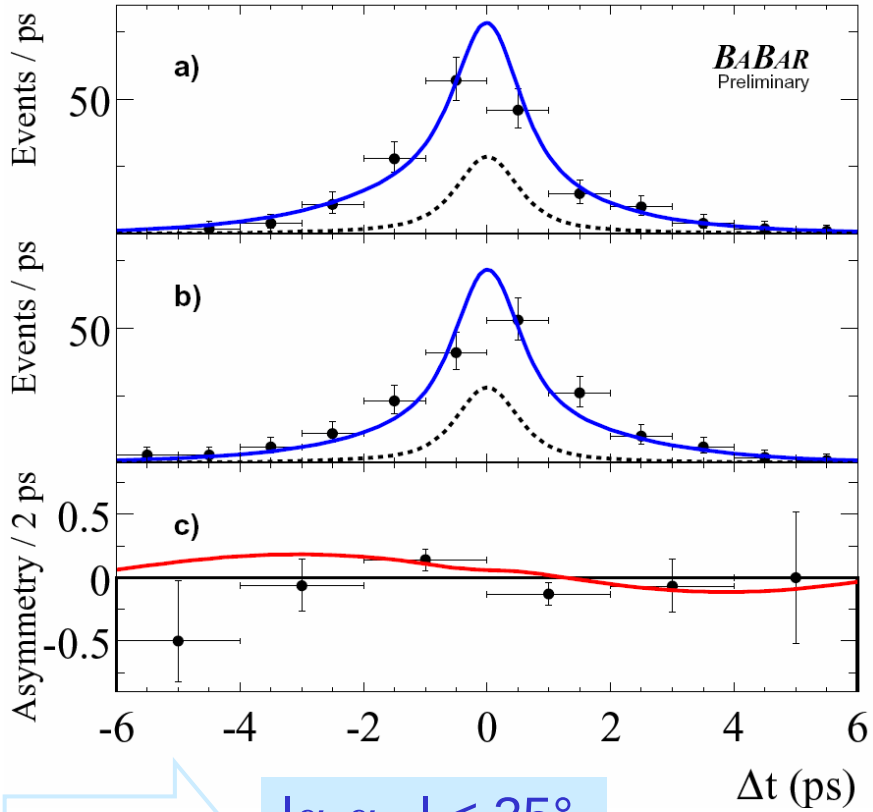
$B^0 \to \pi^+\pi^-$

$S_{\pi\pi} = -0.30 \pm 0.17 \pm 0.03$
$C_{\pi\pi} = -0.09 \pm 0.15 \pm 0.04$



Particle identification is fundamental

227×10^6 BB pairs



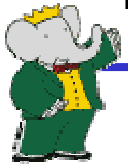
$B(B^\pm \to \pi^\pm\pi^0) = (5.80 \pm 0.06 \pm 0.40)\times10^{-6}$
$A_{\pi^\pm\pi^0} = -0.01 \pm 0.10 \pm 0.02$

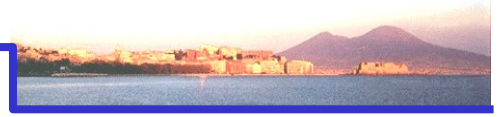
$B(B^0 \to \pi^0\pi^0) = (1.17 \pm 0.32 \pm 0.10)\times10^{-6}$
$C_{\pi^0\pi^0} = -0.12 \pm 0.56 \pm 0.06$

$|\alpha-\alpha_{eff}| < 35°$
90% C.L.

(Gronau, London)

Belle observes $C_{\pi^0\pi^0} = -0.58 \pm 0.15 \pm 0.07$ …





sin2α with B→ρρ

- Similar to ππ, but smaller penguin pollution
- Not a CP eigenstate in principle, but observed to be almost pure CP = +1

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

Signal: 314 ± 34 events

$f_{long} = 1.00 \pm 0.02$

$S_{long} = -0.19 \pm 0.33 \pm 0.11$

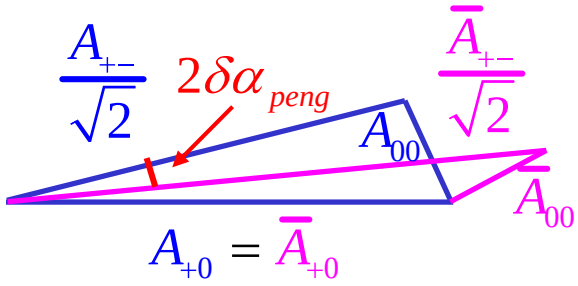
$C_{long} = -0.23 \pm 0.24 \pm 0.14$

89×10⁶ BB

$B(B^\pm \to \rho^\pm\rho^0) = (22.5\ ^{+5.7}_{-5.4} \pm 5.8)\times 10^{-6}$

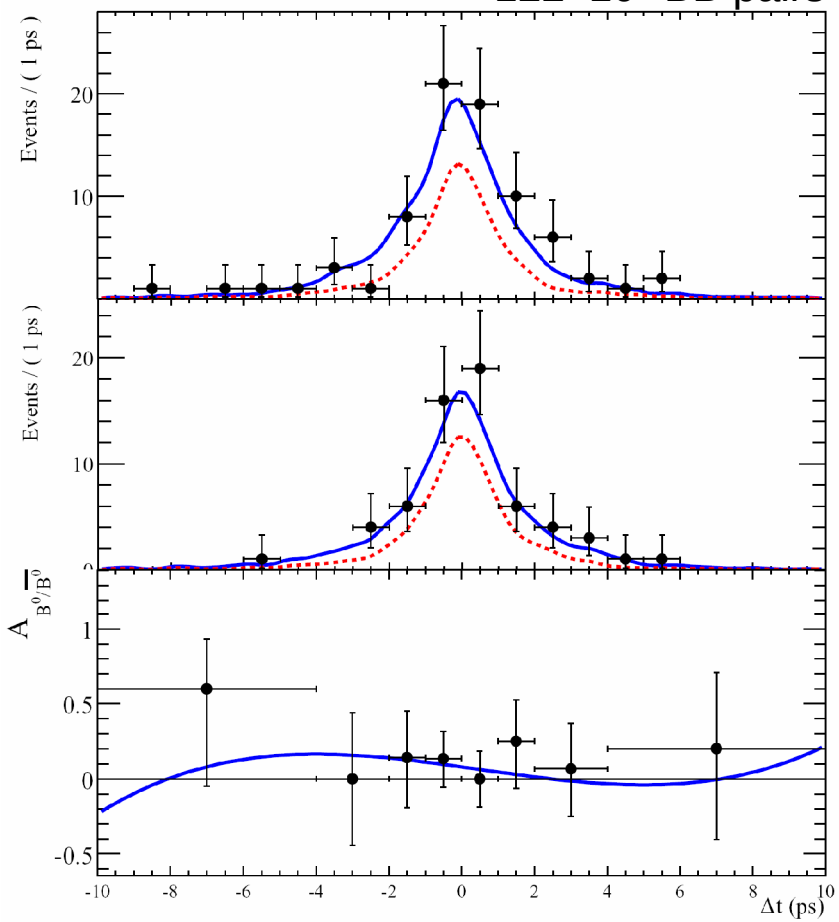
$B(B^0 \to \rho^0\rho^0) < 1.1\times 10^{-6}$ (90% C.L.)

277×10⁶ BB



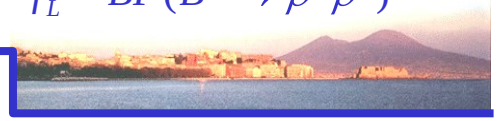
$\alpha = (96 \pm 10_{(stat)} \pm 4_{(sys)} \pm 11_{(peng)})^\circ$

122×10⁶ BB pairs



$\sin^2(\delta\alpha_{peng}) \le \frac{f_L^{00} \cdot BF(B^0 \to \rho^0\rho^0)}{f_L^{+0} \cdot BF(B^+ \to \rho^+\rho^0)}$

(Grossman, Quinn)



Combined B→ππ, ρρ, πρ (Dalitz)

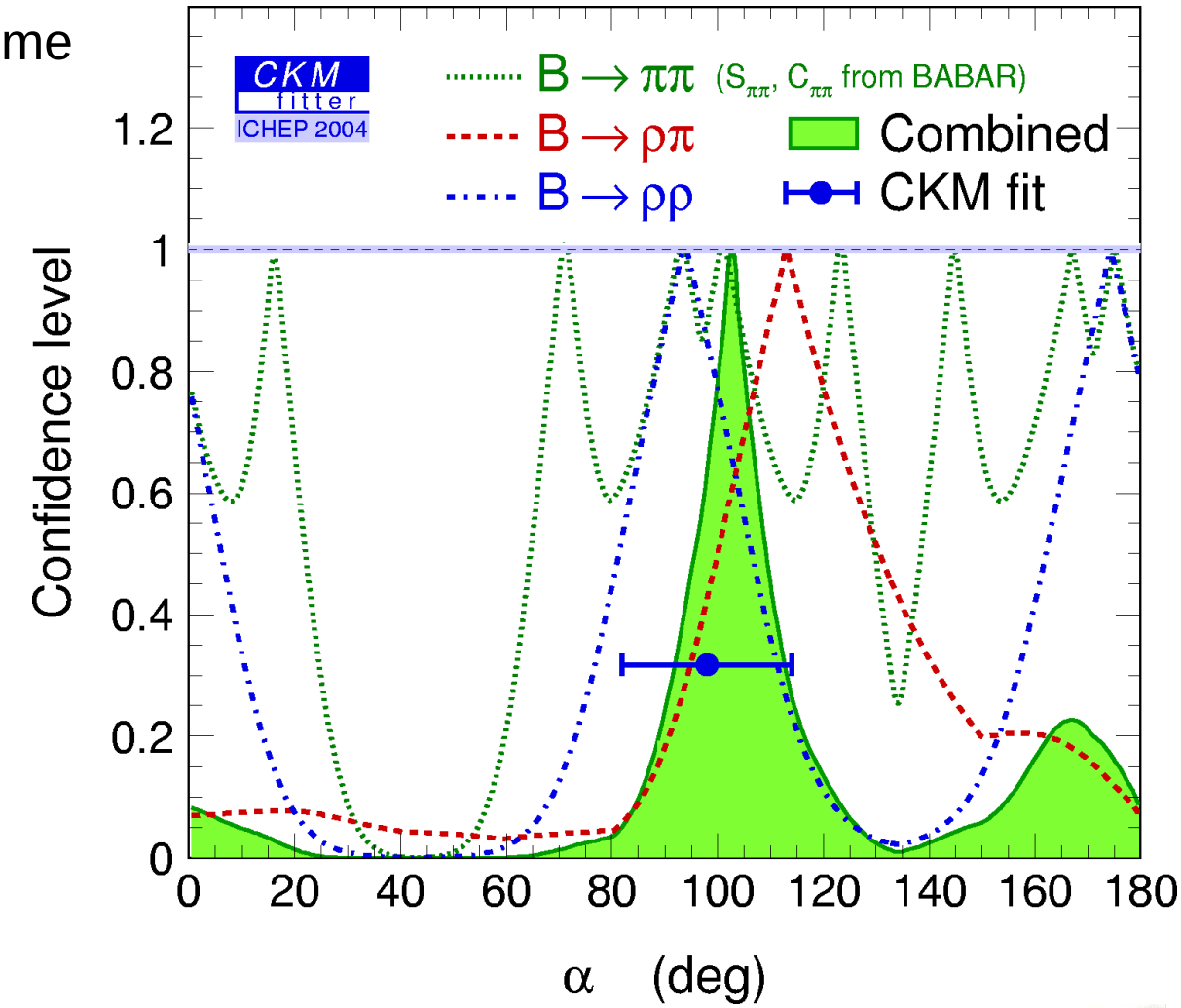
"mirror" solutions become disfavored

From CKM matrix fit (with no α meas.):

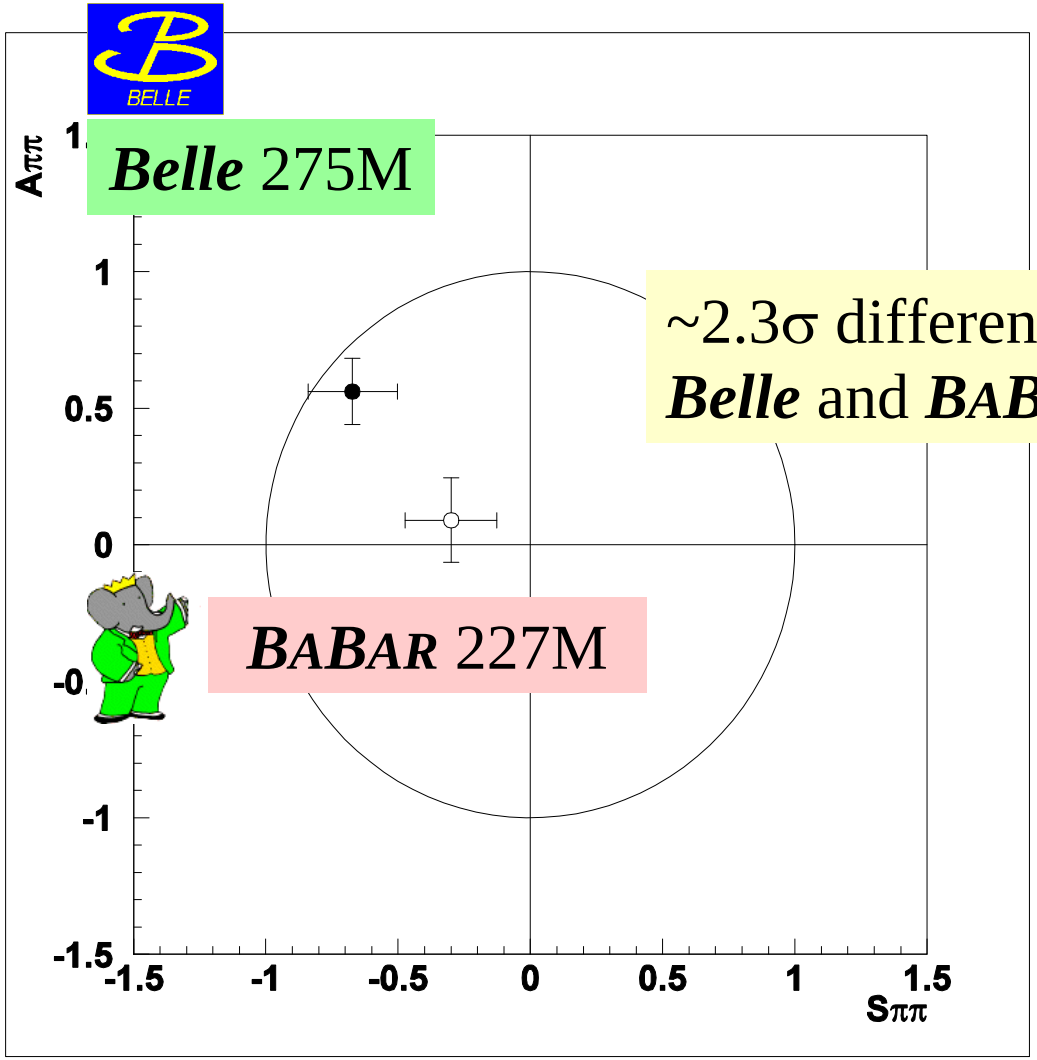
$\alpha = (98 \pm 16)^\circ$

Fit + ππ, ρρ, πρ:

$\alpha = (103\ ^{+10}_{-11})^\circ$



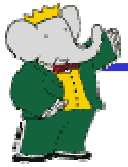
Belle….

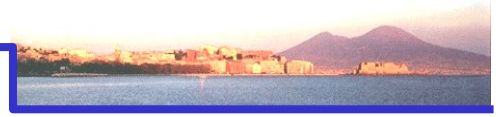


Belle 275M

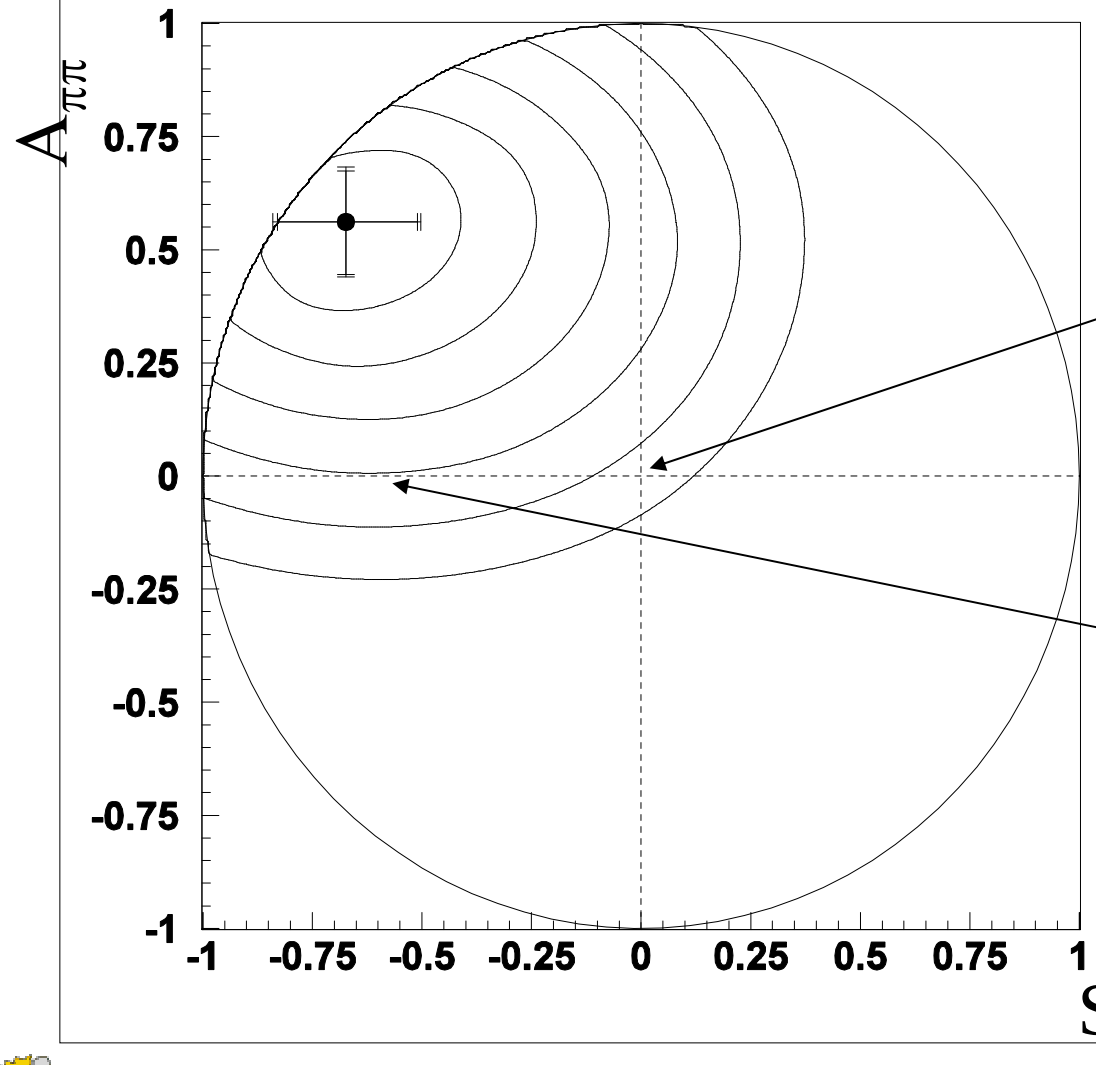
BABAR 227M

~2.3σ difference between ***Belle*** and ***BABAR***





Belle: evidence of CP violation



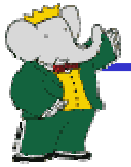
Large CP Violation,

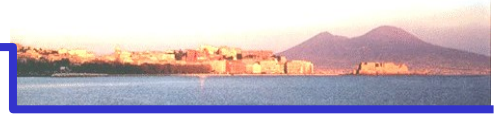
(A,S)=(0,0)
1-C.L.=5.62×10^{-8}, 5.4σ

(A,S)=(0,−0.62)
1-C.L.=5.13×10^{-5}, 4.0σ

Large Direct CP violation, confirmation of the previous Belle results

C.L. = Confidence Level





Belle: $\pi^0\pi^0$

Belle measurement with 275M $B\bar{B}$ pairs

$$Br(\pi^0\pi^0) = (2.3^{+0.4+0.2}_{-0.5-0.3}) \times 10^{-6}$$

$$A_{CP}(\pi^0\pi^0) = +0.44^{+0.53}_{-0.52} \pm 0.17$$

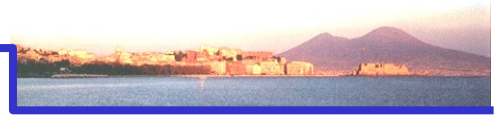
hep-ex/0408101
submitted to PRL

BABAR measurement with 227M $B\bar{B}$ pairs

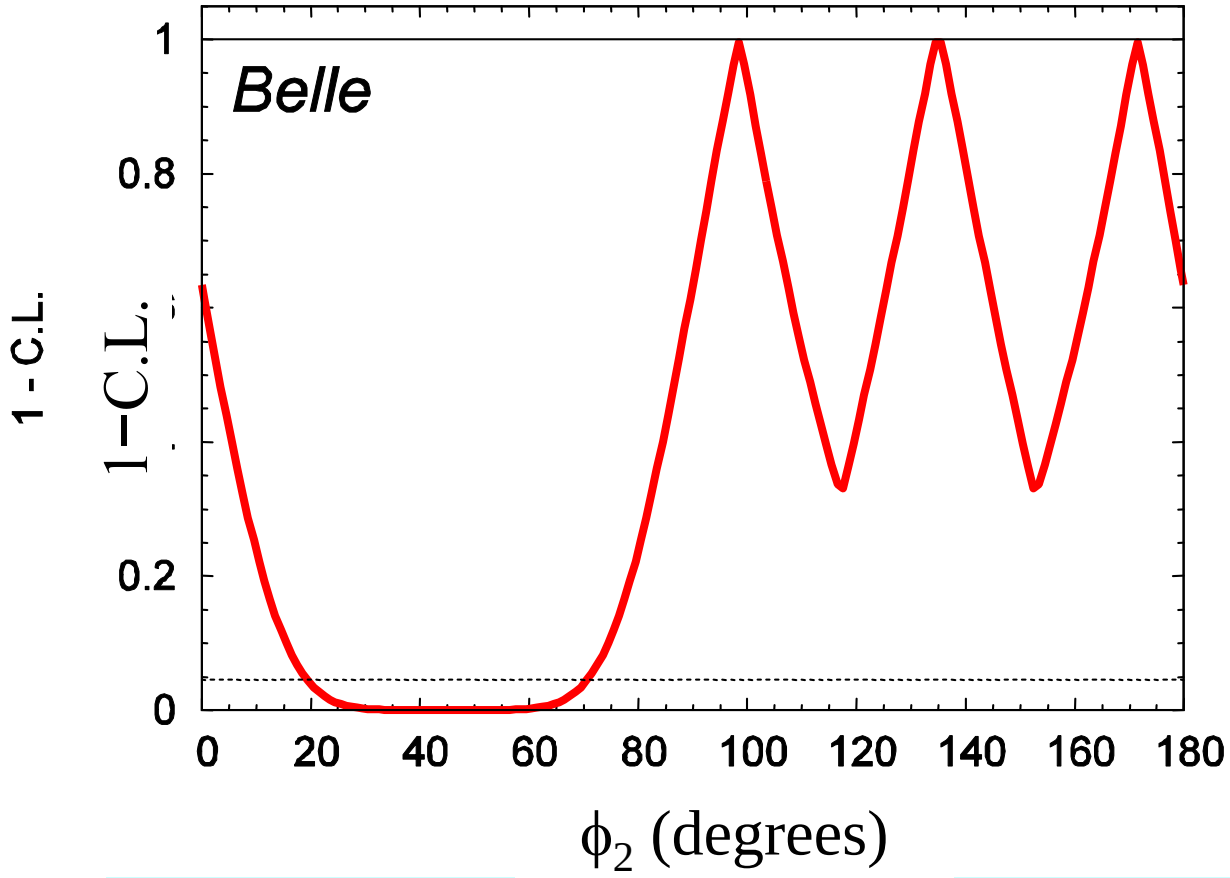
$$Br(\pi^0\pi^0) = (1.17 \pm 0.32 \pm 0.10) \times 10^{-6}$$

$$A_{CP}(\pi^0\pi^0) = +0.12 \pm 0.56 \pm 0.06$$

hep-ex/0412037
submitted to PRL



Belle: constraints on ϕ_2 (α)

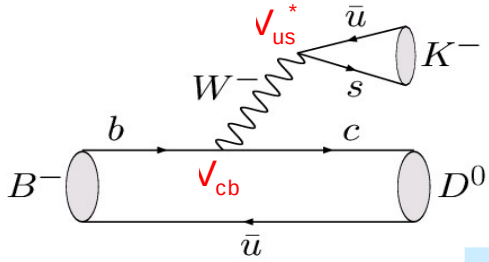


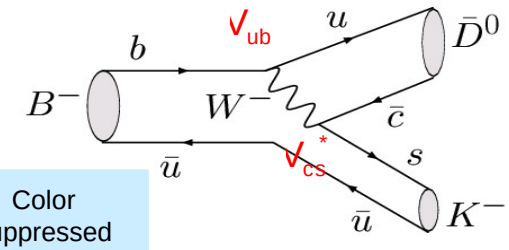
95.4% confidence interval

$$0^\circ < \phi_2 < 19^\circ \quad \text{and} \quad 71^\circ < \phi_2 < 180^\circ$$

Different methods to measure γ GLW

- The phase between b→c and b→u transitions is γ





Color suppressed

$$A \propto V_{cb}V_{us}^* \propto \lambda^3$$

$$A \propto V_{ub}V_{cs}^* \propto \lambda^3\sqrt{\rho^2+\eta^2}e^{i\gamma}$$

Size of CP asymmetry depends on:

$$r_B^{(*)} = \frac{\left|A(B^- \to \overline{D}^{(*)0}K^-)\right|}{\left|A(B^- \to D^{(*)0}K^-)\right|} \approx 0.1-0.3$$

- Gronau, London, Wyler, 1991: use $B^- \to D^0_{CP\pm}$ (small D^0 B.r., 8-fold ambiguity)
- Atwood, Dunietz, Soni, 2001: interference in D and anti-D dec. to same final state

$$B^- \to D^0 K^- \quad (\text{favored}) \qquad D^0 \to K^+\pi^- \quad (\text{suppressed})$$
$$B^- \to \overline{D}^0 K^- \quad (\text{suppressed}) \qquad \overline{D}^0 \to K^+\pi^- \quad (\text{favored})$$

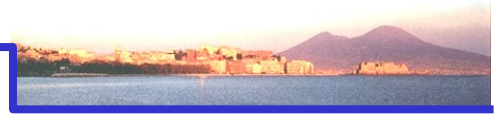
δ_B between the B^- decays, δ_D between the D^0 decays, $\to [K^+\pi^-]_D K^-$

input:

$$r_D = \frac{|A(D^0 \to K^+\pi^-)|}{|A(D^0 \to K^-\pi^+)|} = 0.060 \pm 0.003$$

BABAR measurement, Phys.Rev.Lett.91:171801,2003

- Giri, Grossman, Soffer, Zupan, 2003: $B^- \to D^{(*)0}K^-$, $D^0 \to K_S\pi^+\pi^-$ Dalitz analysis

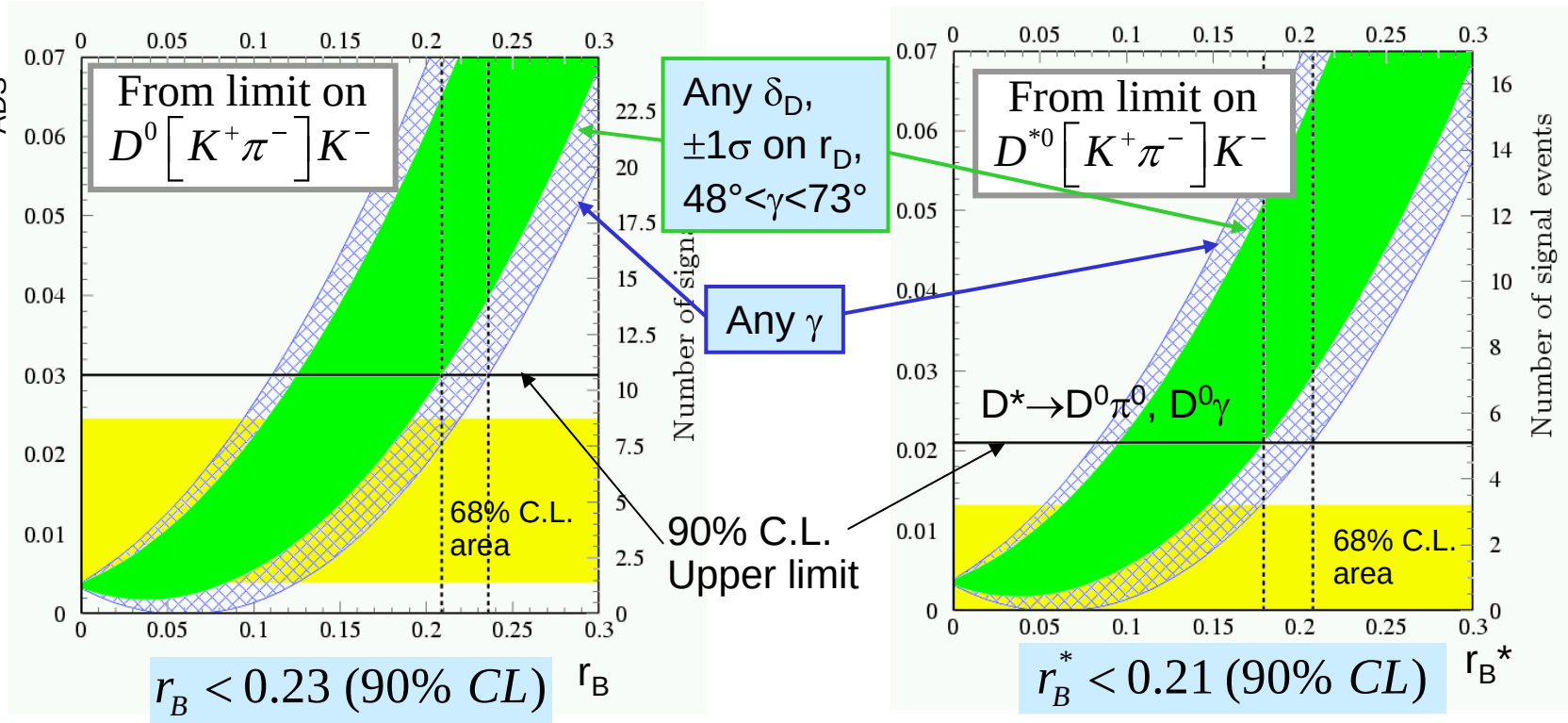


$B^- \to D^{(*)0} K^-$, $D^0 \to K^+\pi^-$ ADS method

$$R_{ADS} = \frac{Br([K^+\pi^-]K^-) + Br([K^-\pi^+]K^+)}{Br([K^-\pi^+]K^-) + Br([K^+\pi^-]K^+)} = r_D^2 + r_B^2 + 2r_B r_D \cos(\delta_D + \delta_B)\cos\gamma$$

$$A_{ADS} = \frac{Br([K^+\pi^-]K^-) - Br([K^-\pi^+]K^+)}{Br([K^+\pi^-]K^-) + Br([K^-\pi^+]K^+)} = 2r_B r_D \sin(\delta_D + \delta_B)\sin\gamma / R_{ADS}$$

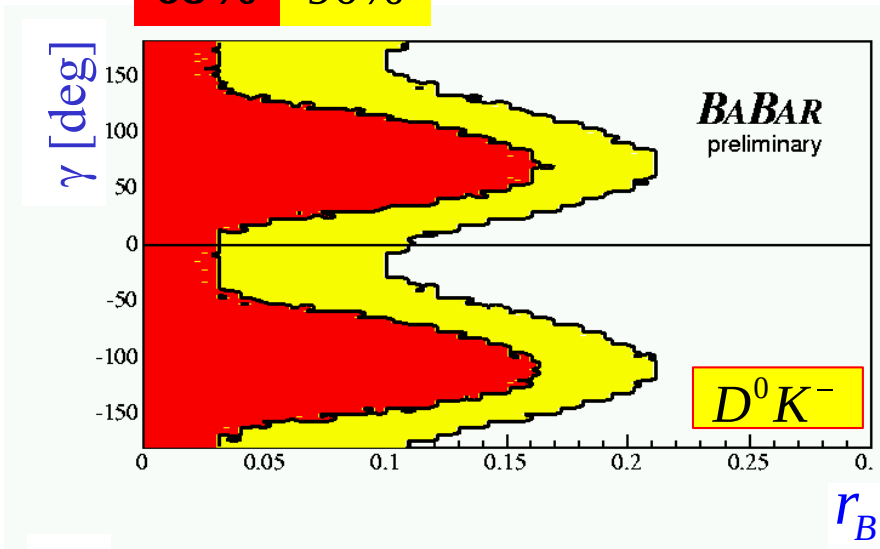
No signal observed in 227×10^6 BB pairs $\Rightarrow$ A_{ADS} not measured, limits on R_{ADS}

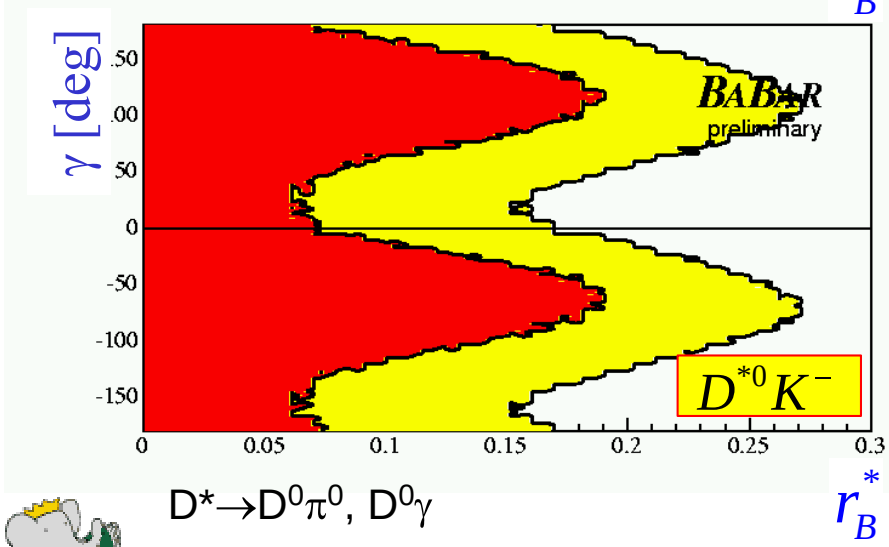


Small r_B values make measuring γ hard

$B^- \to D^{(*)0}K^-$, $D^0 \to K_S\pi^+\pi^-$ Dalitz analysis

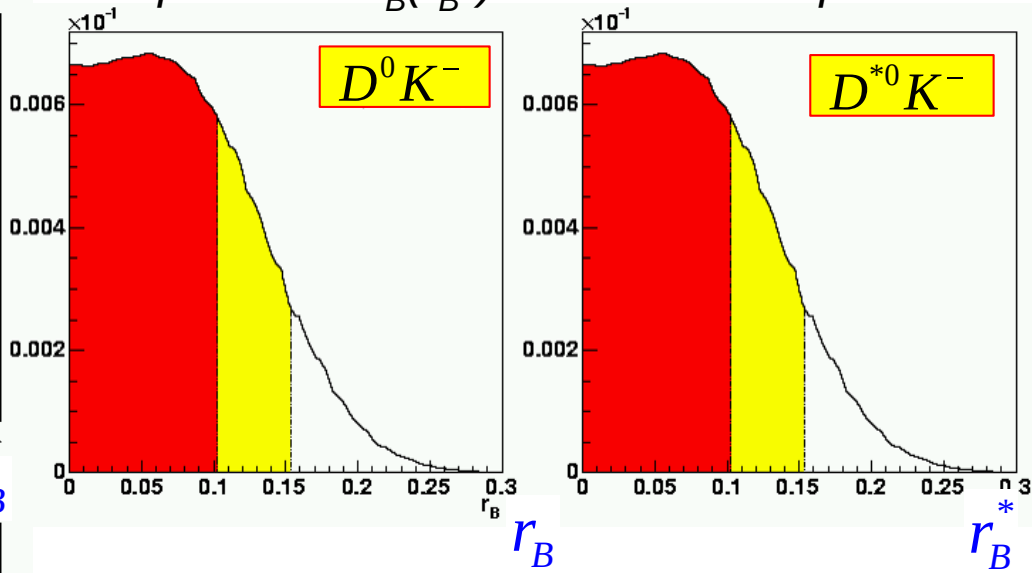
68% 90%





D*→D$^0\pi^0$, D$^0\gamma$

A posteriori $r_B(r_B^*)$ with uniform a priori

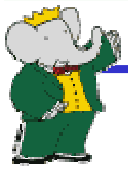


$r_B < 0.18$ (90% CL) $\quad r_B^* < 0.24$ (90% CL)

$$\delta_B = (130 \pm 45 \pm 8 \pm 10_{(model)})^o$$
$$\delta_B^* = (311 \pm 52 \pm 23 \pm 10_{(model)})^o$$
$$\gamma = (88 \pm 41 \pm 19 \pm 10_{(model)})^o$$

Dalitz model syst.

Sensitivity depends on $r_B^{(*)}$

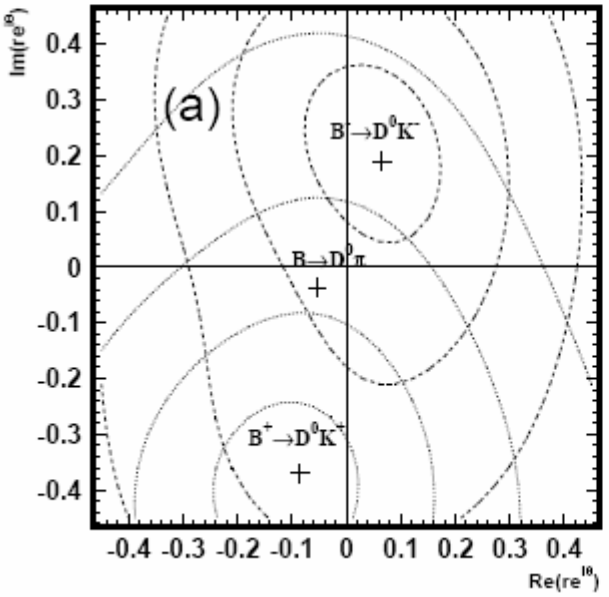


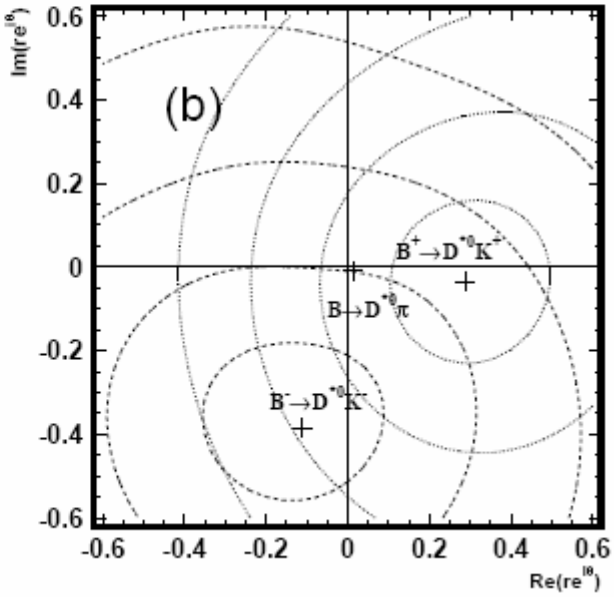
Belle: γ

A. Poluektov *et al.* (Belle Collaboration), hep-ex/0406067, to appear in PRD

Using $B^{\pm} \to DK^{\pm}$ and $B^{\pm} \to D^{*}K^{\pm}$ $(D^{*} \to D\pi^{0})$

$$\phi_3 = 77^\circ \, {}^{+17^\circ}_{-19^\circ}(\text{stat}) \pm 13^\circ(\text{syst}) \pm 11^\circ(\text{model})$$



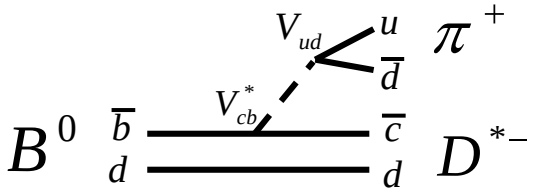


Updated with 275M BB events:

$$\phi_3 = 68^\circ \, {}^{+14^\circ}_{-15^\circ}(\text{stat}) \pm 13^\circ(\text{syst}) \pm 11^\circ(\text{model})$$

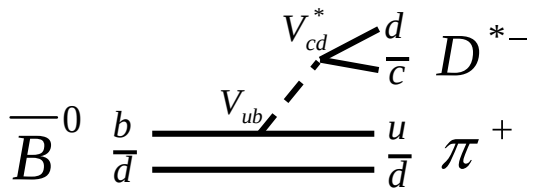
sin(2β+ γ) using $B^0 \to D^{(*)-}\pi^+/\rho^+$

- Time-dependent CP violation in the mixing/decay interference



favored b→c amplitude $\sim\lambda^2$

$|A_1||V_{cb}^* V_{ud}|$

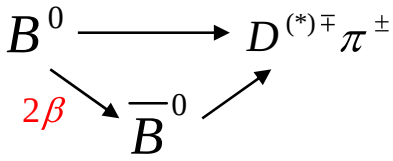


suppressed b→u amplitude $\sim\lambda^4$

$|A_2||V_{ub}V_{cd}^*|e^{i\delta}e^{-i\gamma}$

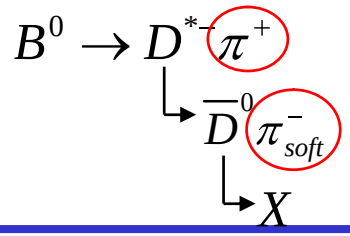
Time-dependent asymmetry can be expressed in term of the parameters:

a = 2rsin(2β+γ)cosδ
c = 2rcos(2β+γ)sinδ

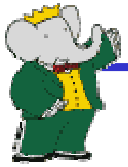


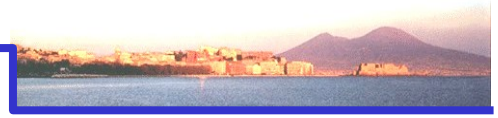
Exclusive reconstruction of $D^-\pi^+$, $D^{*-}\pi^+$, $D^-\rho^+$

Partial reconstruction of $D^{*-}\pi^+$



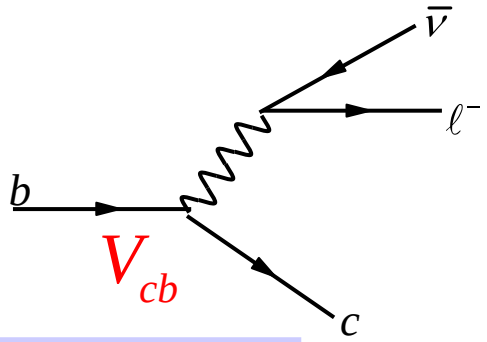
No CP asymmetry observed yet…





Vcb inclusive measurement

- Inclusive B → Xc l ν decays: measure hadron mass moments and lepton energy moments



$$\Gamma(b \to c\ell\bar{\nu}) \propto |V_{cb}|^2 m_b^2 (m_b - m_c)^3$$

$$M_0^\ell = \frac{\int_{E_{\rm cut}}^{\infty} d\Gamma}{\Gamma_B}$$

$$M_1^\ell = \frac{\int_{E_{\rm cut}}^{\infty} E_\ell d\Gamma}{\int_{E_{\rm cut}}^{\infty} d\Gamma}$$

$$M_n^\ell = \frac{\int_{E_{\rm cut}}^{\infty} (E_\ell - M_1^\ell)^n d\Gamma}{\int_{E_{\rm cut}}^{\infty} d\Gamma}, (n = 2, 3)$$

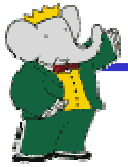
Partial B.F.

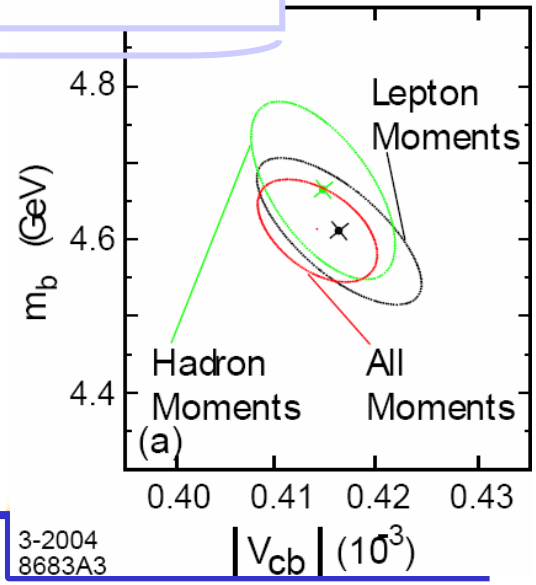
Lepton energy momenta

HQE predicts the moments up to 8 parameters to be fitted (including $|V_{cb}|$, m_b and m_c)

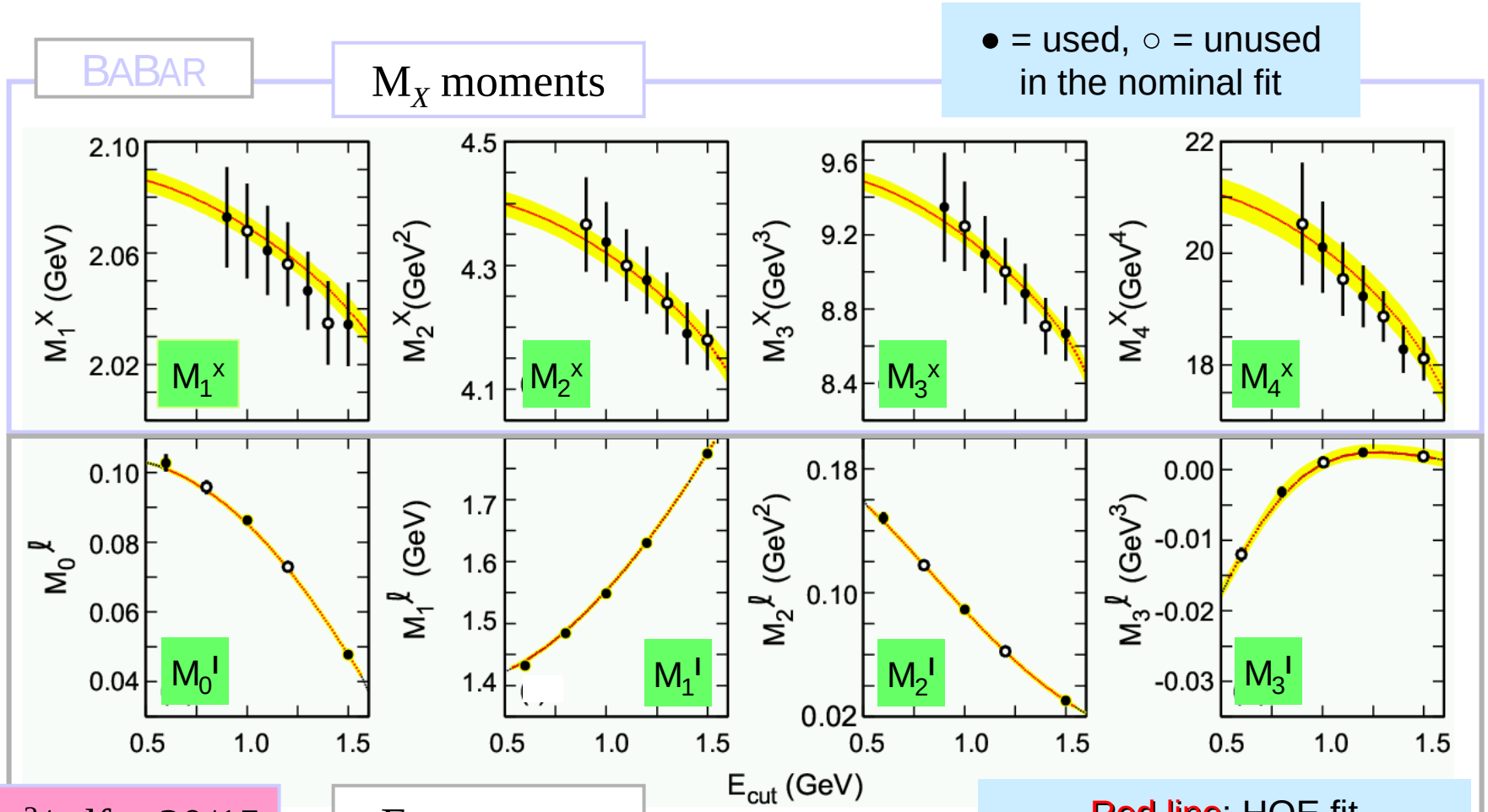
B (b→ clν)=(10.61 ± 0.16$_{exp}$ ± 0.06$_{th,HQE,}$)%

$$|V_{cb}| = (41.4 \pm 0.4_{ex} \pm 0.4_{HQE} \pm 0.6_{th}) \times 10^{-3}$$





Vcb: HQE Fits to M_X / E_l moments

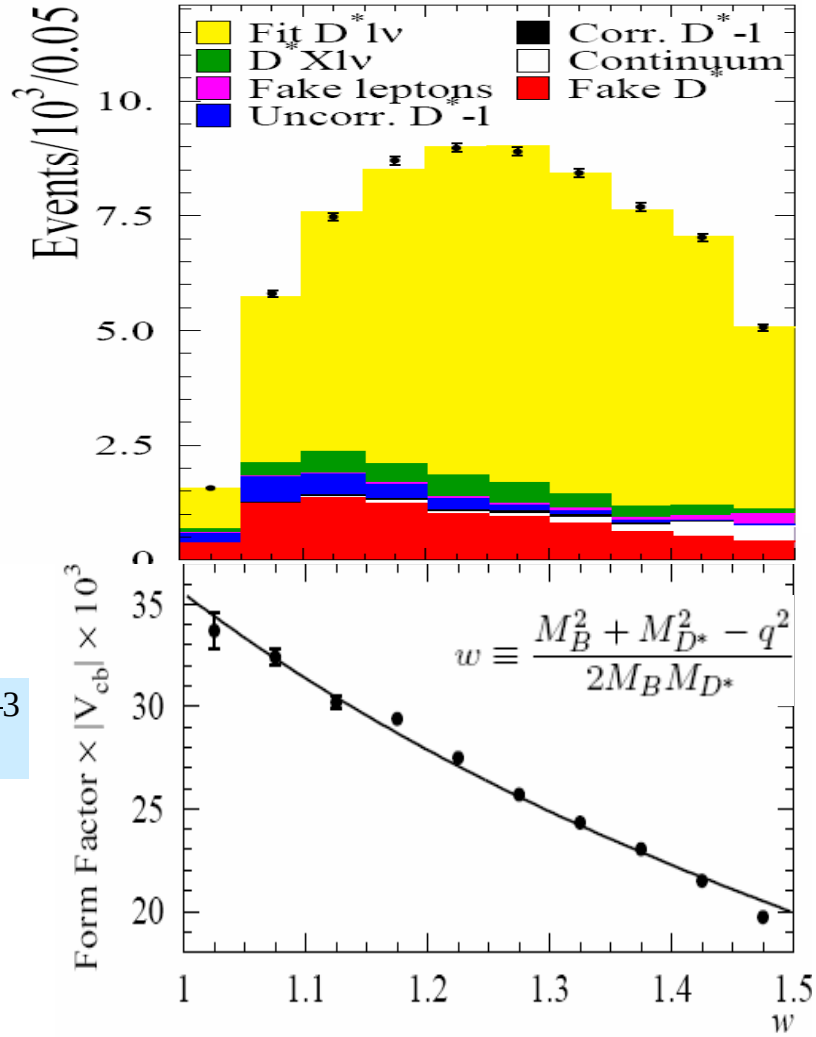


Vcb exclusive measurements

- Exclusive B → D*+ l ν Decays

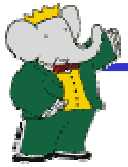
$$\frac{d\Gamma}{dw} \propto \mathcal{G}(w)\mathcal{F}(w)^2|V_{cb}|^2,$$

w = prod. B, D* 4-velocities



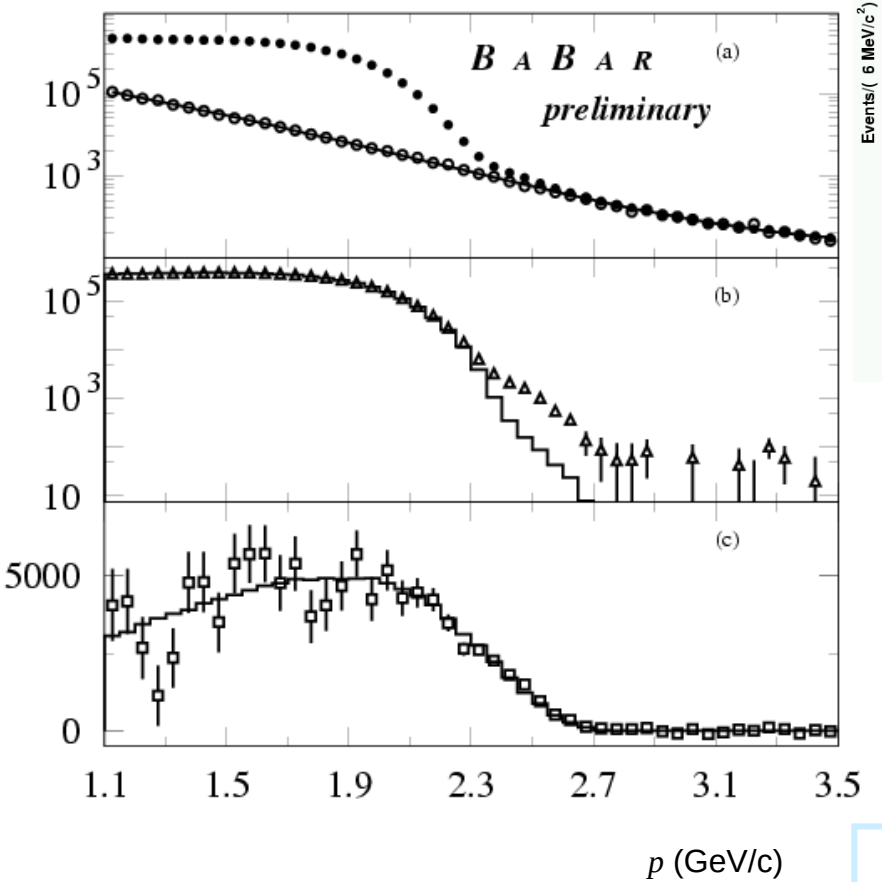
B (B0→ D*- l+ ν)=(4.90 ± 0.07$_{stat}$ ± 0.36$_{syst}$)%

$$|V_{cb}| = (38.7 \pm 0.3_{stat} \pm 1.7_{syst} \pm^{1.5}_{1.3th,lattice}) \times 10^{-3}$$



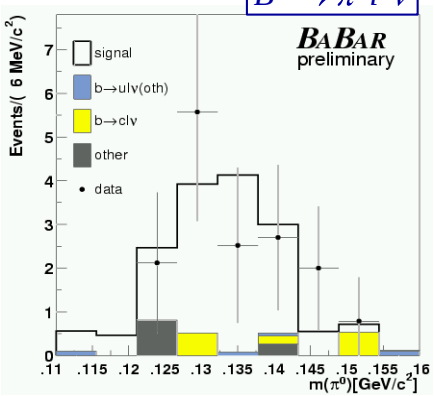
Vub measurements

- Inclusive: measure total Br(b→ulν)

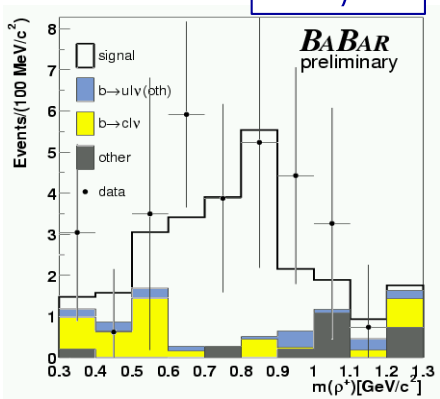


- Exclusive: measure selected decays (B →πlν, ρlν, …)
- Innovative technique: fully reconstruct one of the B

$B^+ \to \pi^0 l^+ \nu$



$B^0 \to \rho^- l^+ \nu$



$B(B^0 \to \pi^- l^+ \nu) = (1.08 \pm 0.28 \pm 0.16) \times 10^{-4}$

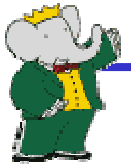
$B(B^+ \to \pi^0 l^+ \nu) = (0.91 \pm 0.28 \pm 0.14) \times 10^{-4}$

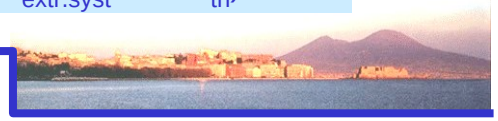
$B(B^0 \to \rho^- l^+ \nu) = (2.57 \pm 0.52 \pm 0.59) \times 10^{-4}$

Electron endpoint spectrum extrapolation using b→sγ photon spectrum (CLEO) using HQET

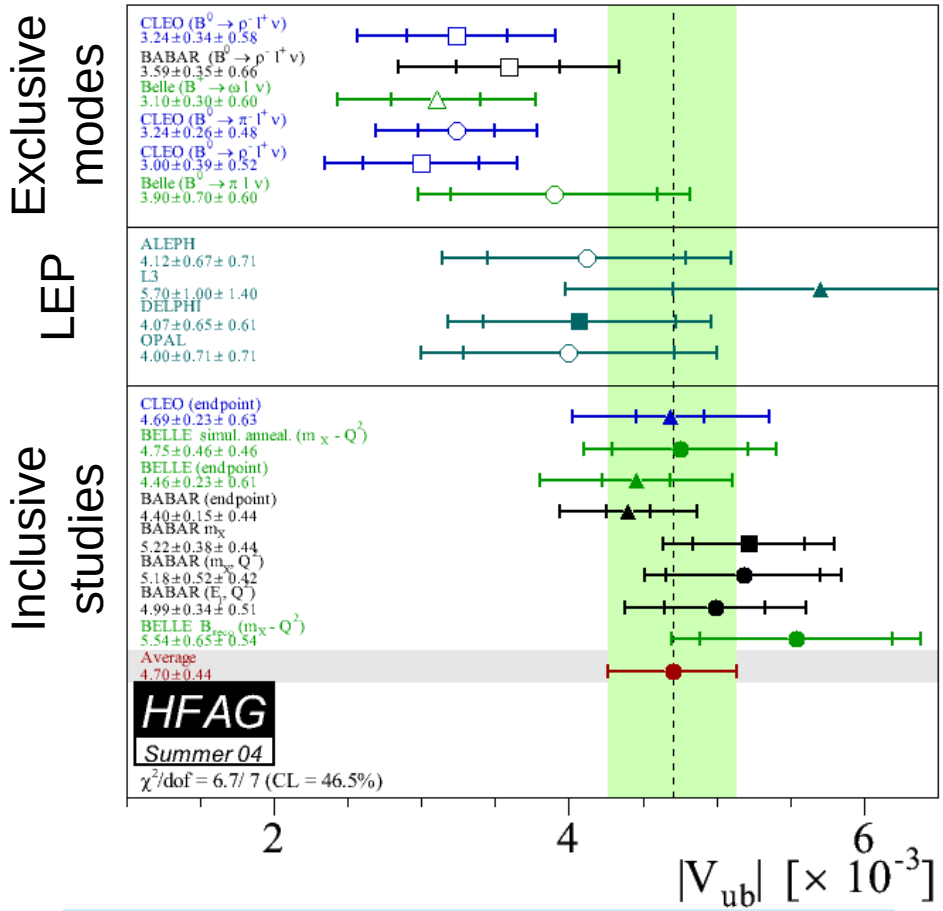
$B(B \to X_u e \nu) = (1.73 \pm 0.22_{exp} \pm 0.33_{extr.syst}) \times 10^{-3}$

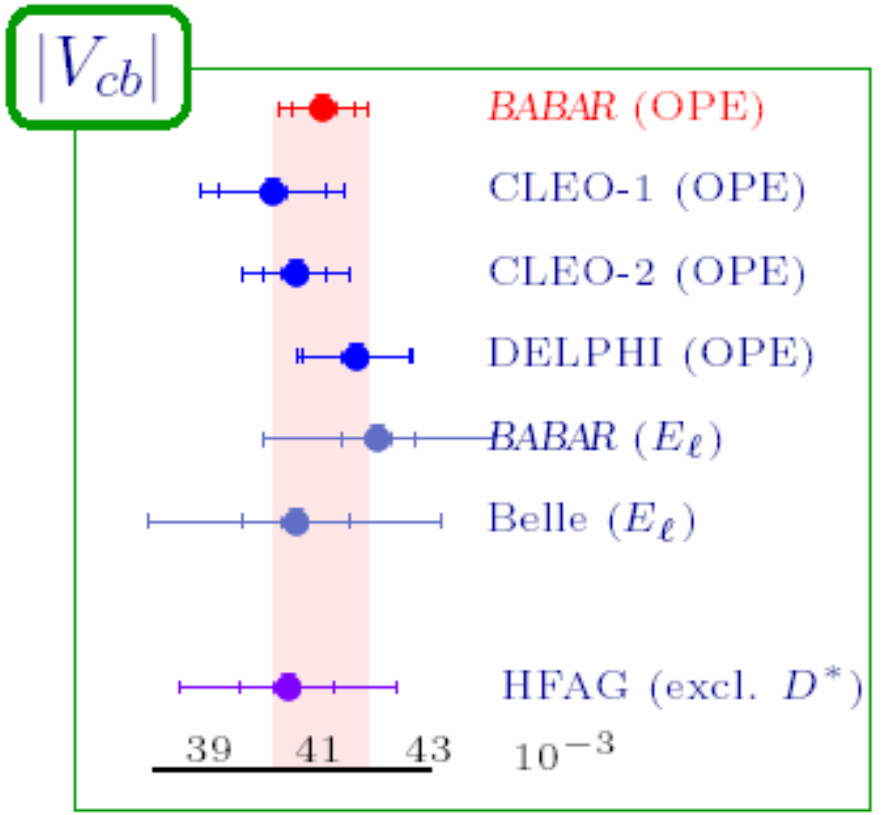
$|V_{ub}| = (3.94 \pm 0.25_{exp} \pm 0.37_{extr.syst} \pm 0.19_{th}) \times 10^{-3}$





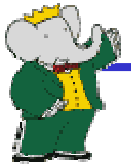
Vcb and Vub averages

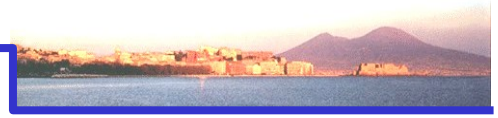




$|Vub|_{avg.} = (4.70 \pm 0.44_{stat+sys}) \times 10^{-3}$

$|Vcb|_{avg.} = (41.4 \pm 0.4 \pm 0.4 \pm 0.6_{th}) \times 10^{-3}$

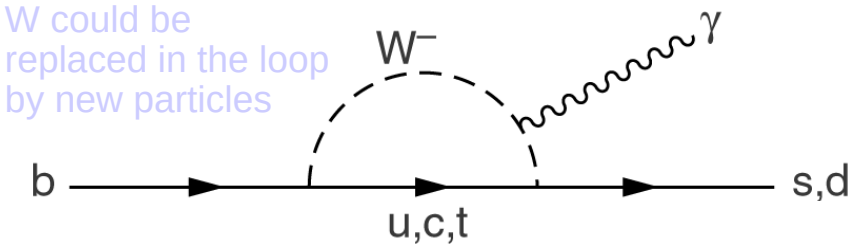




Radiative penguin decays

Radiative penguin decays: $b \to s\gamma$ and $b \to d\gamma$ are FCNC transitions

$b \to s\gamma$ rate agrees with SM prediction:



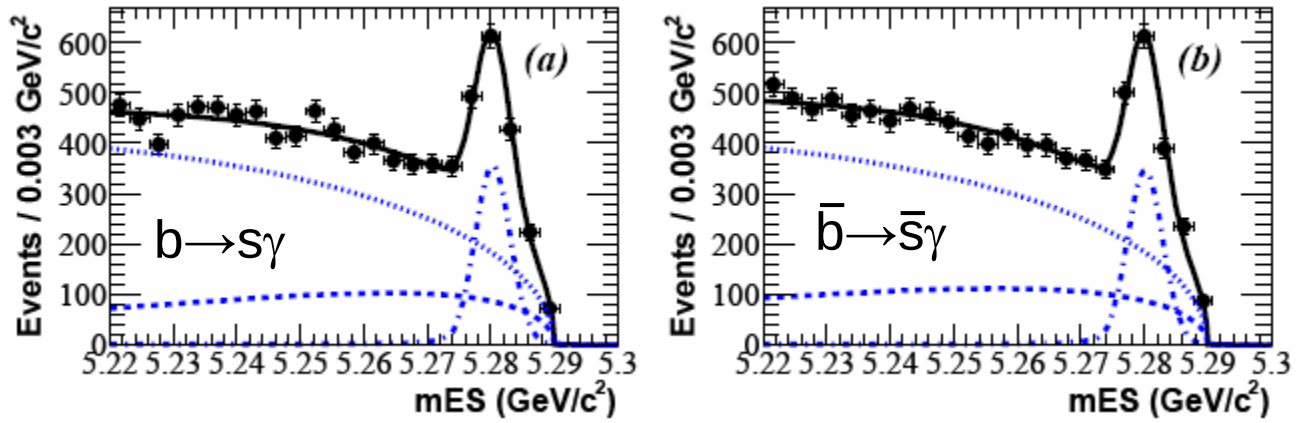
$BF(b\to s\gamma)_{TH} = 3.57 \pm 0.30 \times 10^{-4}$ (SM NLO)

$BF(b\to s\gamma)_{EXP} = 3.54 \pm 0.30 \times 10^{-4}$ (HFAG average)

$b\to d\gamma$ at discovery limits:

$BF(B \to \rho,\omega\ \gamma) < 1.2 \times 10^{-6}$

$|Vtd/Vts| < 0.19$ (90% CL)



Sum of 12 exclusive, self-tagging $B\to X_s\ \gamma$ final states

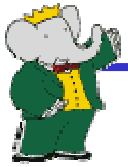
$X_s = K/K_s$ + 1-3 pions

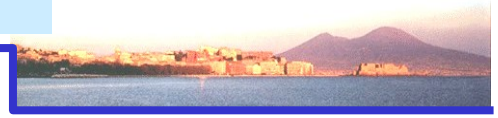
$E\gamma^* > 2.14$ GeV

No evidence of direct CP violation:

$A_{CP,\ b\to s\gamma} = 0.025 \pm 0.050 \pm 0.015$

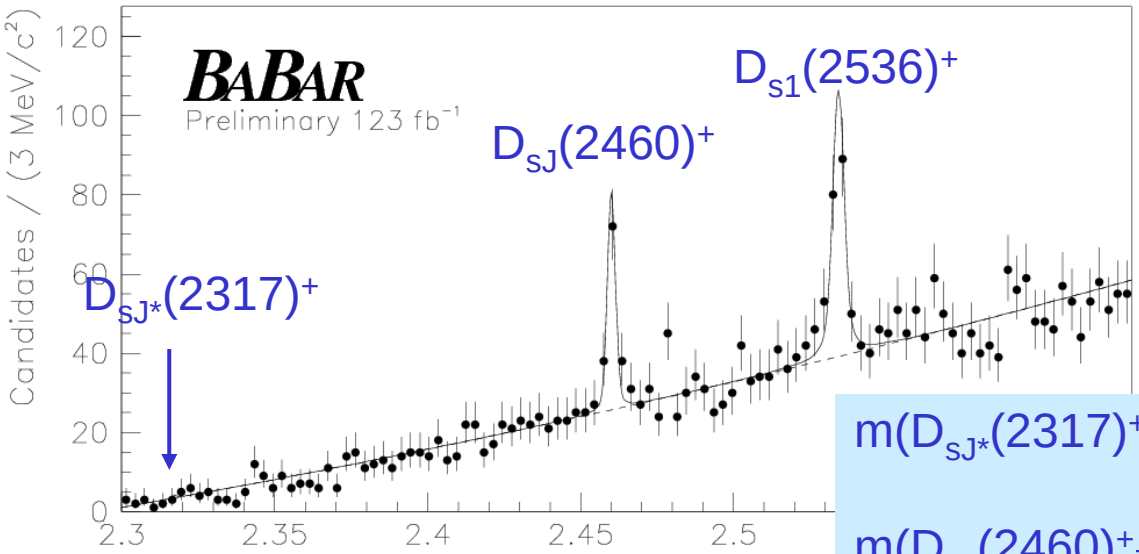
$A_{CP,\ B\to K^*\gamma} = -0.013 \pm 0.036 \pm 0.010$ (prelim.)



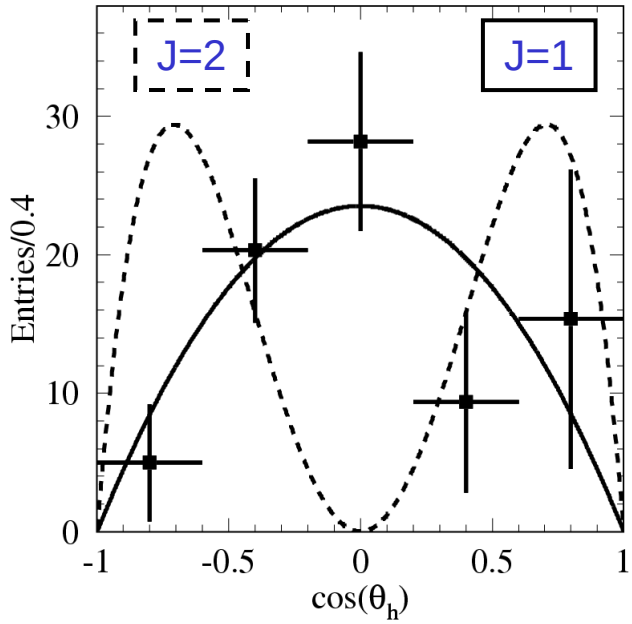


Studies of D_{sJ} properties

- $D_{sJ}^*(2317)^+$ and $D_{sJ}(2460)^+$ discovered in 2003
- Detailed studies properties and mass meas.
  - $B \to D_{sJ}^{(*)+} D^{(*)}$ angular analysis $\Rightarrow$ spin
  - Branching fraction measurements



$D_{sJ}(2460)^+ \to D_s^+\gamma$ elicity

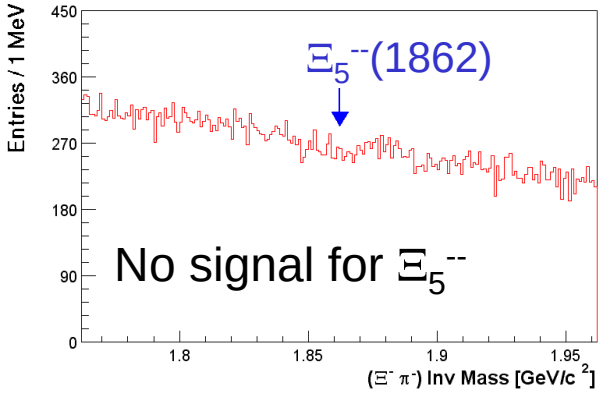


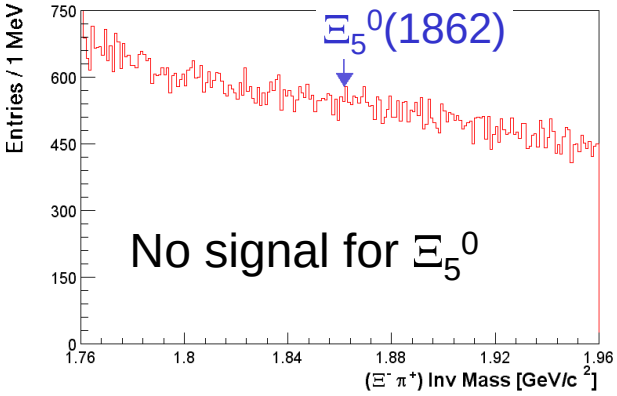
$m(D_{sJ*}(2317)^+ \to D_s^+\pi^0) =$
$2318.9 \pm 0.3 \pm 0.9$ MeV/c²

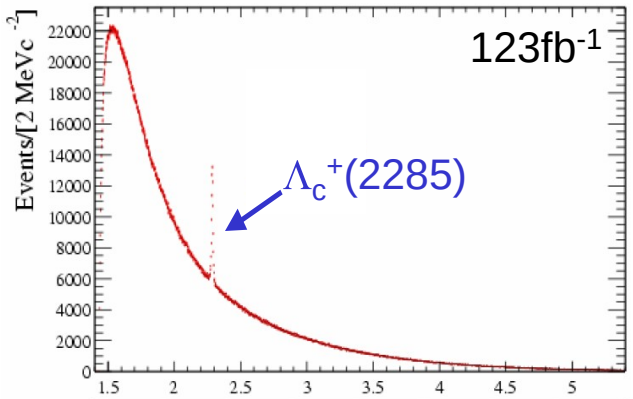
$m(D_{sJ}(2460)^+ \to D_s^+\gamma, D_s^+\pi^0\gamma, D_s^+\pi^+\pi^-) =$
$2459.4 \pm 0.3 \pm 1.0$ MeV/c²

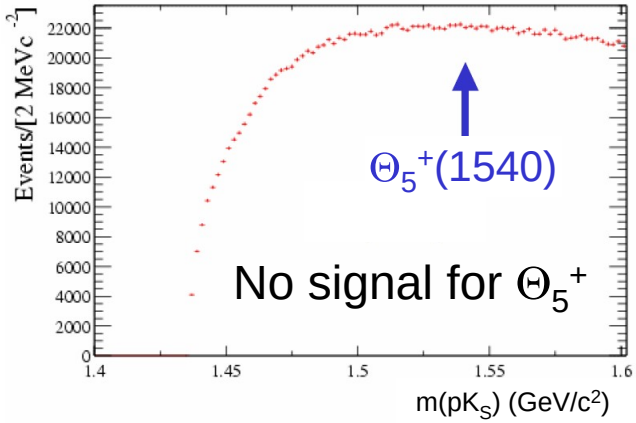
$m(D_{s1}(2536)^+ \to D_s^+\pi^+\pi^-) =$
$2534.3 \pm 0.4 \pm 1.2$ MeV/c²

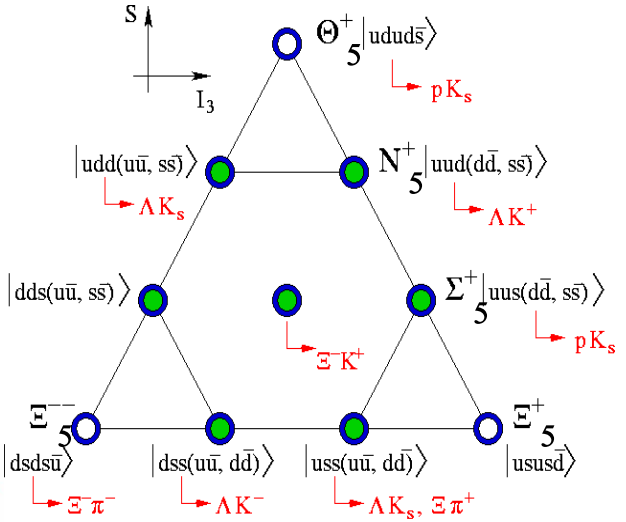
Pentaquark searches

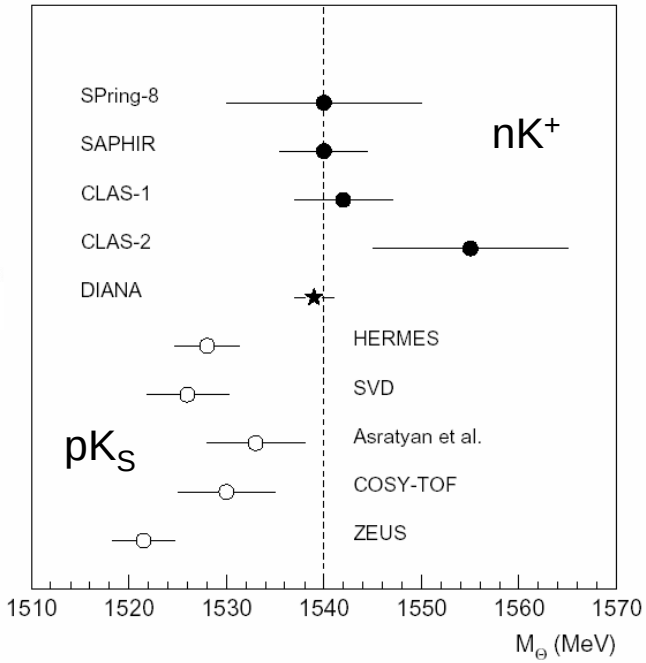




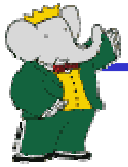






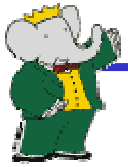


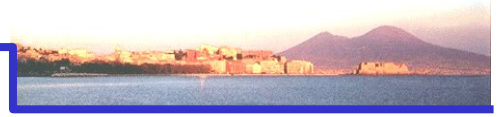
- No evidence of pentaquarks in high statistics samples
- Cross section limits well below expectations



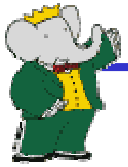
Conclusions

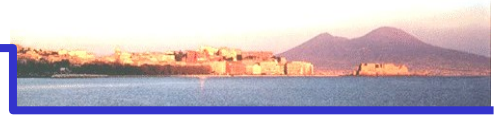
- BaBar is exploring different aspects of CP violation in B meson
  - Recent first evidence of direct CP violation
  - sin2β is becoming a precision measurement
  - First quantitative estimates of α
  - Technology for extracting γ is being established
- Some channels may probe new physics
  - b$\rightarrow$sss penguins?
- The increase of statistics in the following years will improve the experimental precision and will make more rare channels accessible





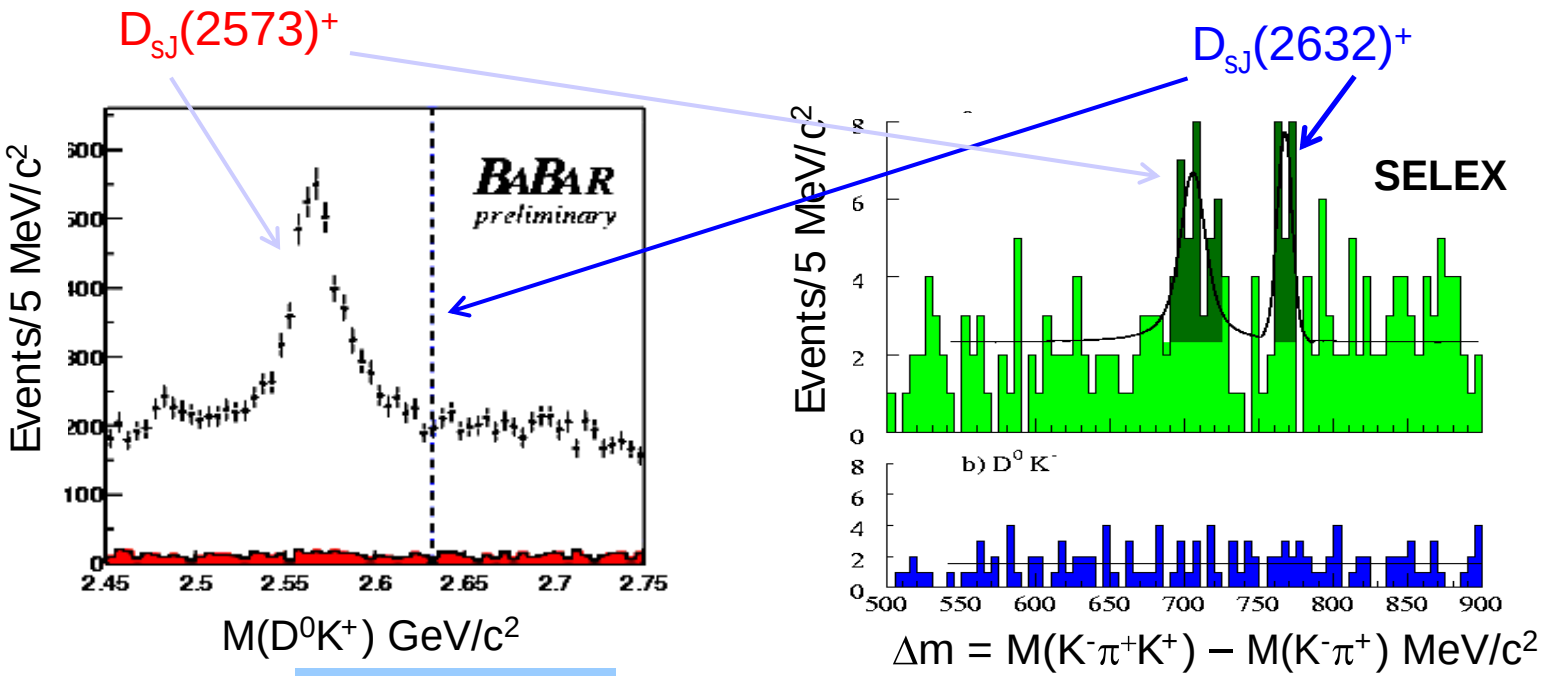
Backup





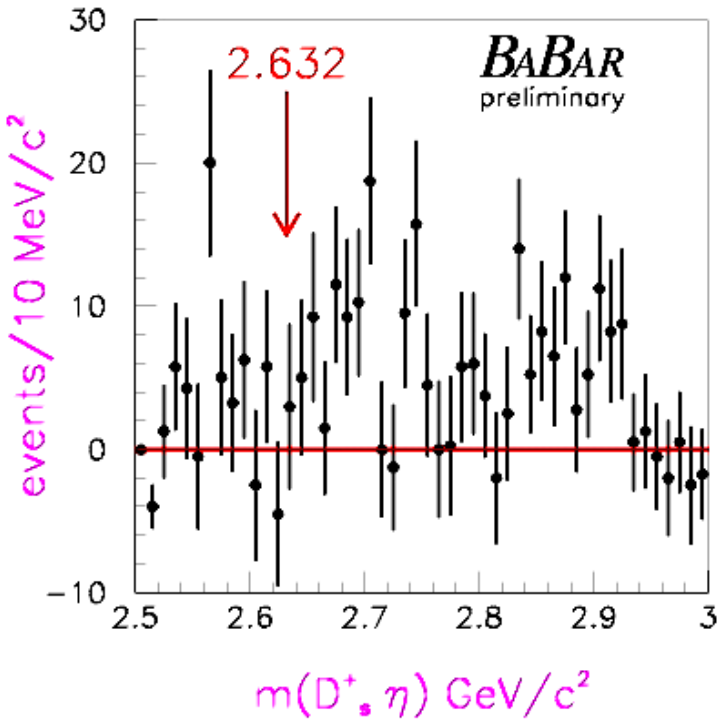
Selex $D_{sJ}(2632)^+$ state

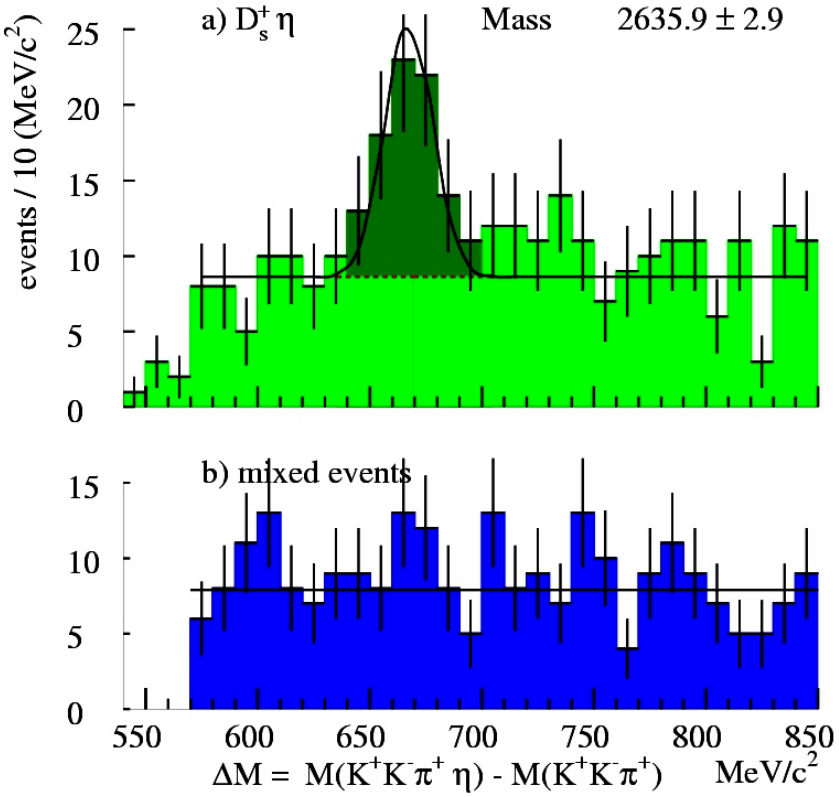
- SELEX claims evidence of a state $D_{sJ}(2632)^+$ decaying to $D_s^+\eta$ and D^0K^+(hep-ex/0406045)
- BaBar doesn't observe such signal

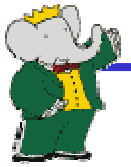


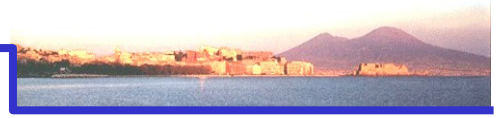
Selex $D_{sJ}(2632)^+$ state ($\rightarrow D_s^+\eta$)

No evidence of $D_{sJ}(2632)^+$ in $D_s^+\eta$,
D^0K^+, $D^{*+}K_S$ in125 fb^{-1}

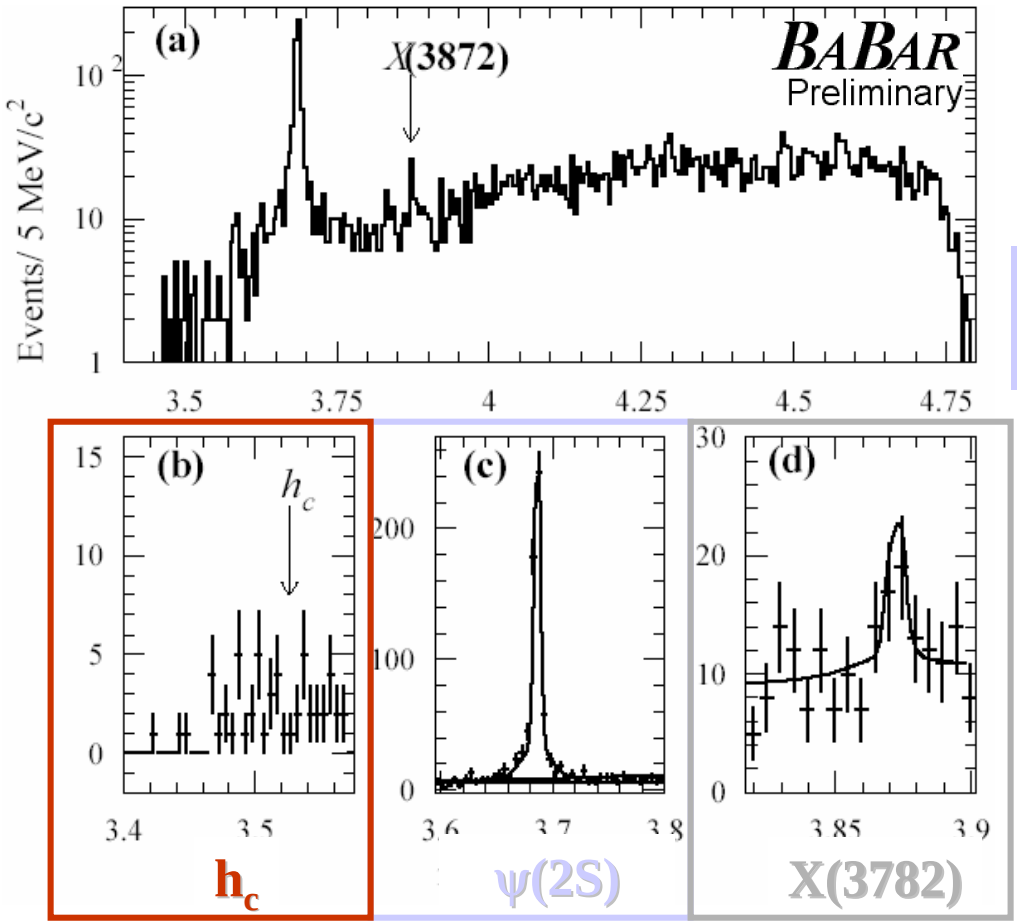








$J/\psi\pi^+\pi^-$ resonance at 3782 MeV/c^2



$N_{\psi(2S)} = 556 \pm 30$

$m_{X(3782)} = 3873.4 \pm 1.4$ MeV/c^2

No evidence of h_c found
Set an upper limit

$\mathcal{B}(B^- \to h_c K^-) \cdot \mathcal{B}(h_c \to J/\psi\pi^+\pi) < 3.4 \cdot 10^{-6}$ (90% C.L.)

$\mathcal{B}(B^- \to X(3872) K^-) \cdot \mathcal{B}(X(3872) \to J/\psi\pi^+\pi^-) = (1.28 \pm 0.41) \cdot 10^{-5}$