Recent results from BaBar

Measurements of the unitarity triangle angles, and selected other results

Katherine George
Queen Mary, University of London

Klystron Gallery of the 2-mile long PEP-II accelerator

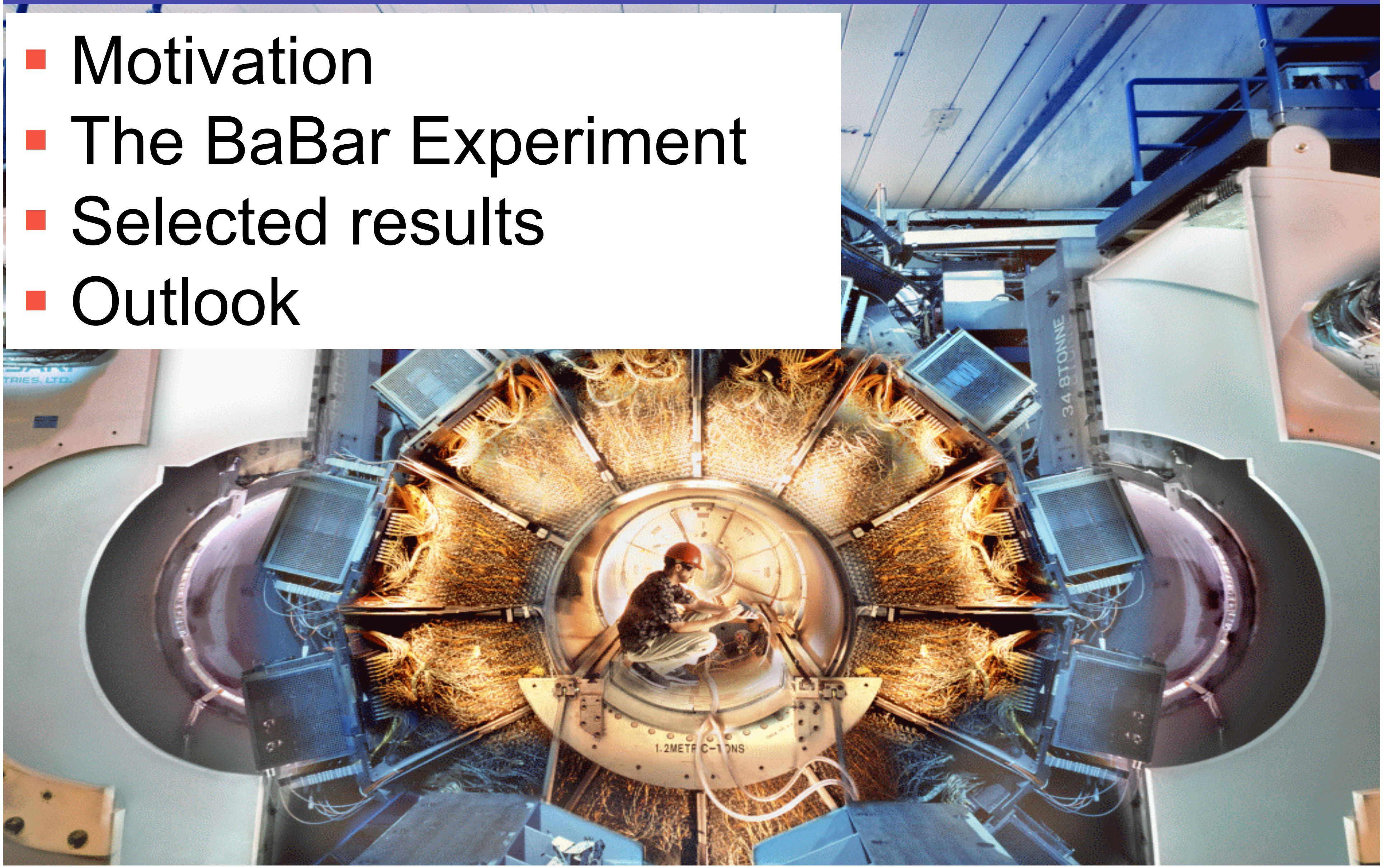
SLAC Research Yard

BaBar Detector

Seminar at UCL - February 2nd 2007

Overview

- Motivation
- The BaBar Experiment
- Selected results
- Outlook



Motivation

- Study of *CP* Violation in the B meson system to explain the matter-antimatter asymmetry in the universe.
- *C* and *P* symmetries are broken in weak interactions [Lee, Yang (1956), Wu et al. (1957)]

C	charge conjugation	particle ↔ anti-particle
P	parity	$x \to -x$, $y \to -y$, $z \to -z$

- To create a matter-dominant Universe, *CP* symmetry must be broken
  - This is one of three necessary conditions Sakharov (1967)
- Within the standard model, the complex phase in the CKM matrix causes *CP* violation

CP violation and New Physics

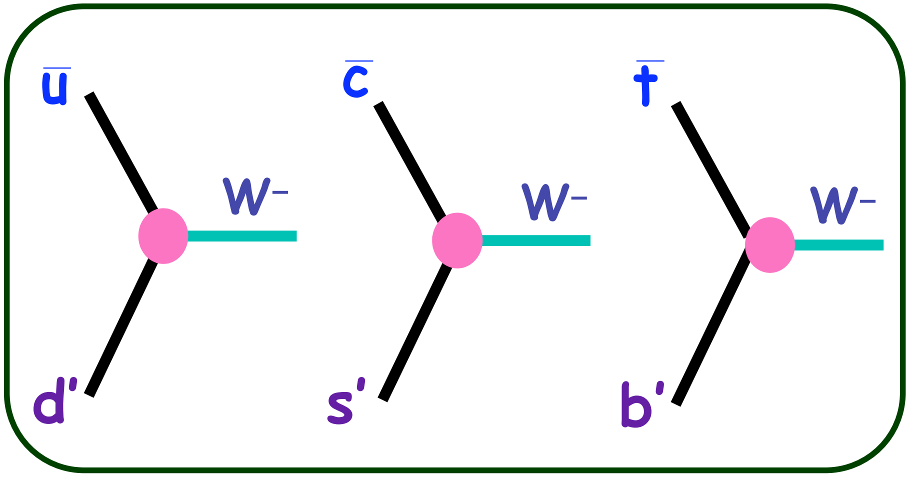
Are there additional (non-CKM) sources of *CP* violation?

- The CKM mechanism fails to explain the *amount* of matter-antimatter imbalance in the Universe
  - … by several orders of magnitude
- New Physics beyond the SM is expected at 1-10 TeV scale
  - e.g. to keep the Higgs mass < 1 TeV/c^2
  - Almost all theories of New Physics introduce new sources of *CP* violation (e.g. 43 of them in supersymmetry)

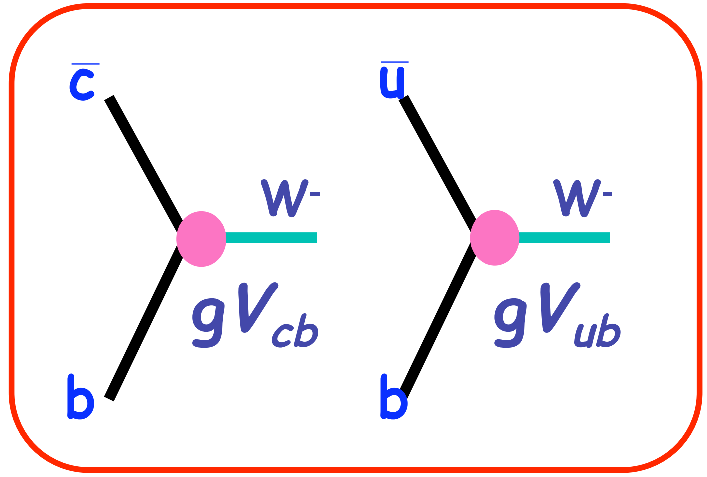
New sources of *CP* violation almost certainly exist

  - Precision studies of the CKM matrix may uncover them

The Cabibbo-Kobayashi-Maskawa (CKM) Matrix



Quarks 'couple' within the same generation

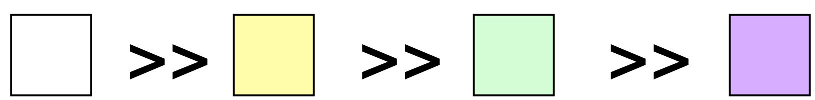


Also 'couple' between generations

$$V_{CKM} = \begin{bmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{bmatrix}$$

CKM matrix

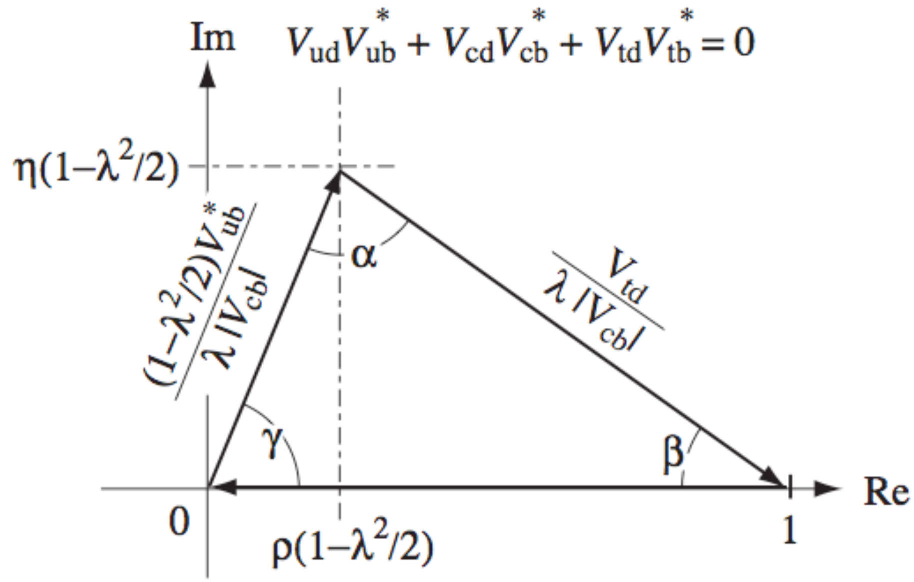
- V_{ij} is the coupling of ith and jth quarks
- Hierachy



The Unitarity Triangle (UT)

$$V_{CKM} = \begin{bmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{bmatrix}$$

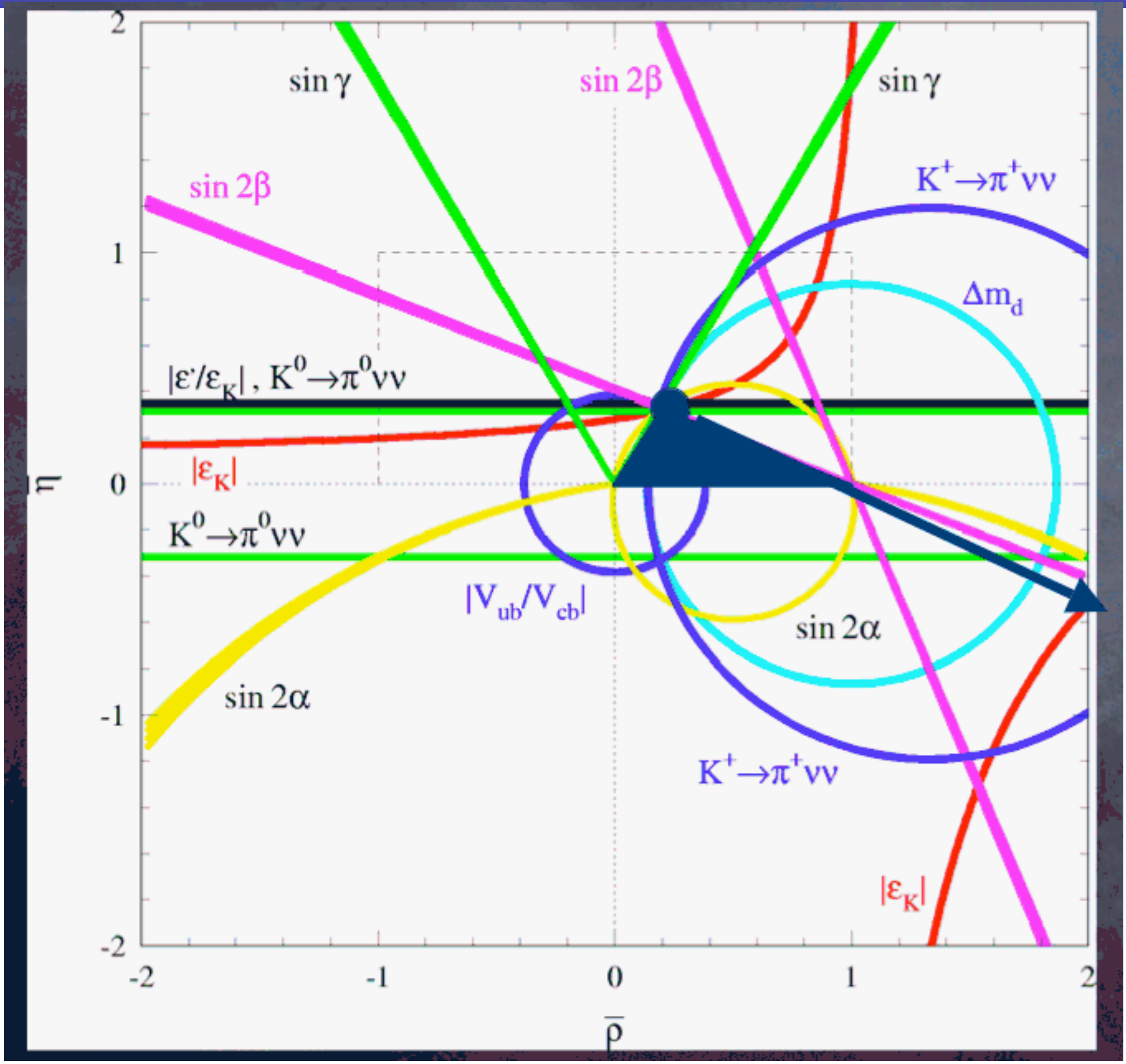
- $V_{CKM}^{\dagger} V_{CKM} = 1$ gives us



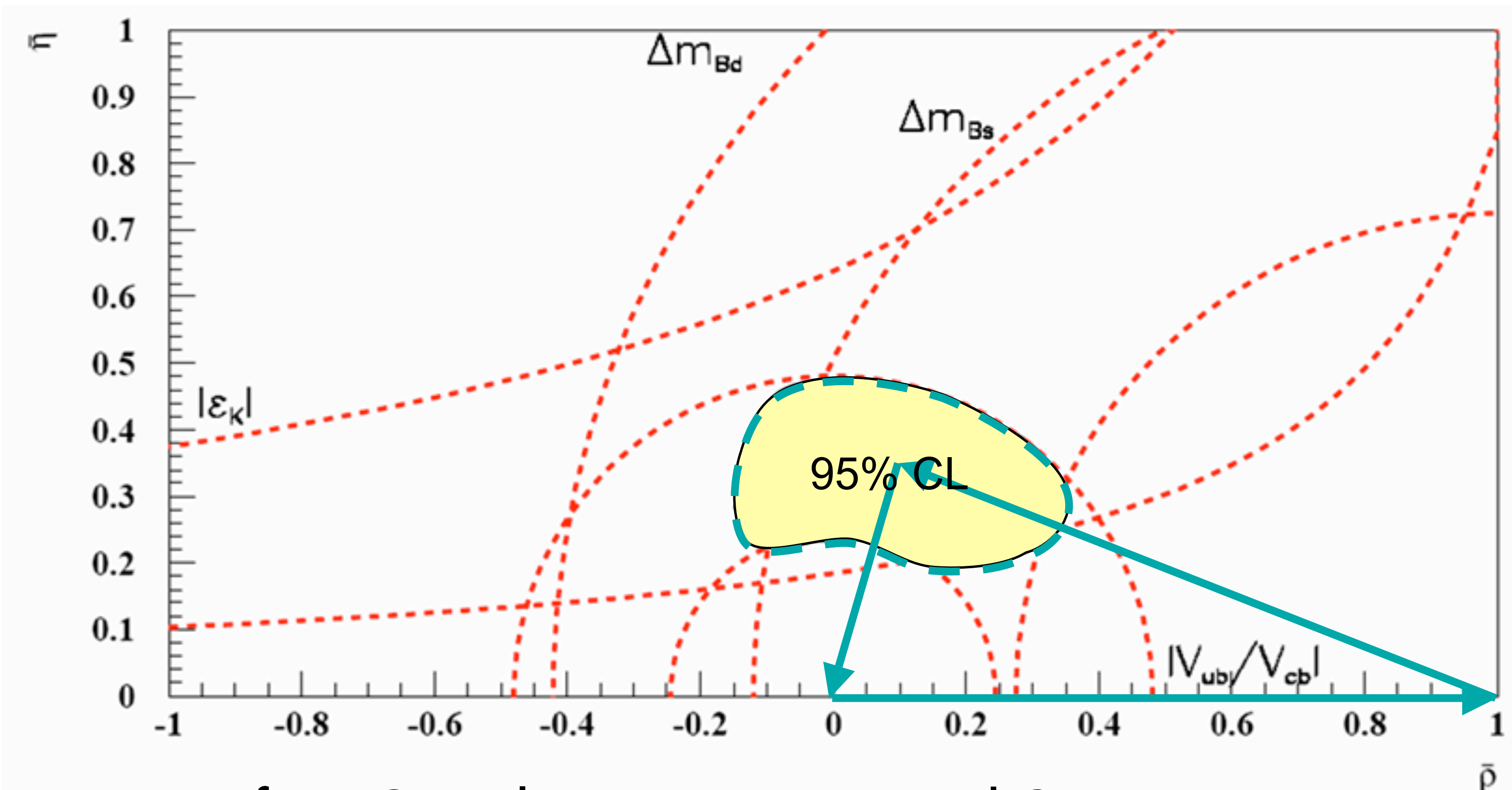
$$\alpha \equiv \arg\left(-\frac{V_{td}V_{tb}^*}{V_{ud}V_{ub}^*}\right), \quad \beta \equiv \arg\left(-\frac{V_{cd}V_{cb}^*}{V_{td}V_{tb}^*}\right), \quad \gamma \equiv \arg\left(-\frac{V_{ud}V_{ub}^*}{V_{cd}V_{cb}^*}\right)$$

- So, in theory, we can measure α, β and γ; and the sides of the triangle.
- If the triangle doesn't close, then our picture is incomplete ....

$\bar{\rho}$-$\bar{\eta}$ plane



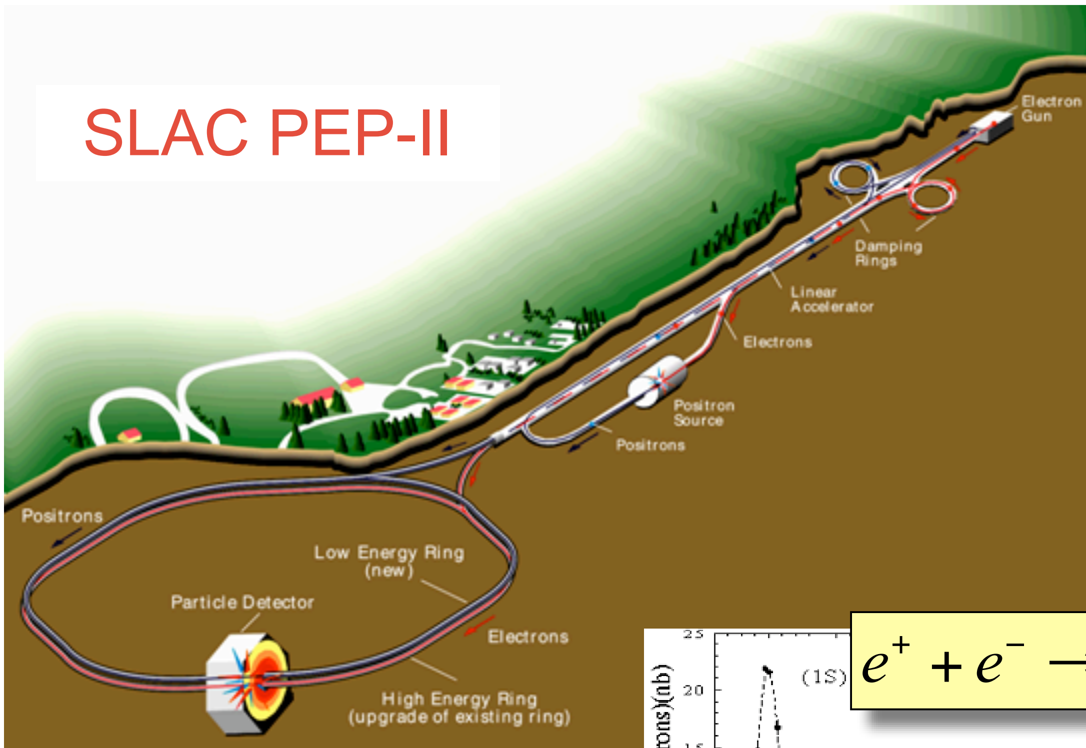
The "*pre B-factory*" Unitarity Triangle

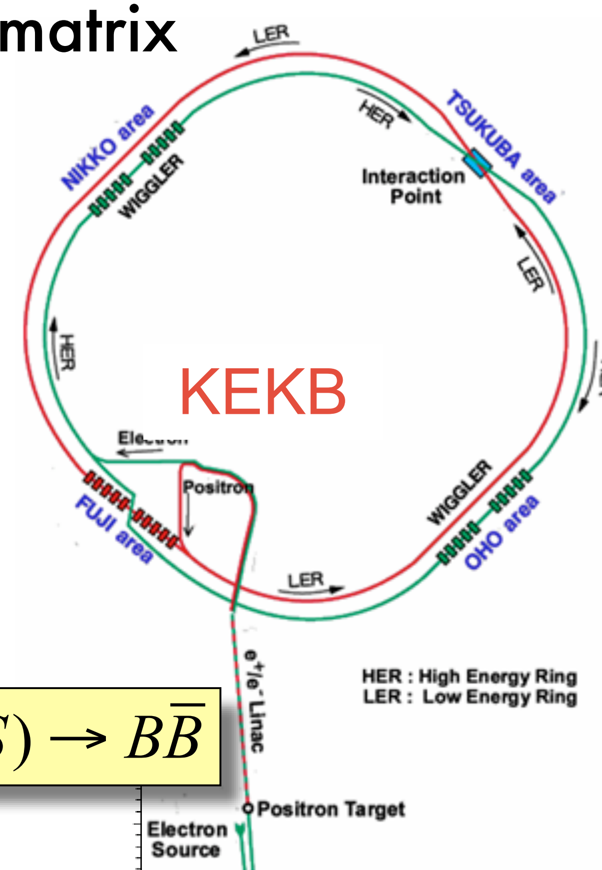


- Inputs from CP violating quantity ε_K and CP conserving quantities Δm_{Bd} , Δm_{Bs} and $|V_{ub}/V_{cb}|$

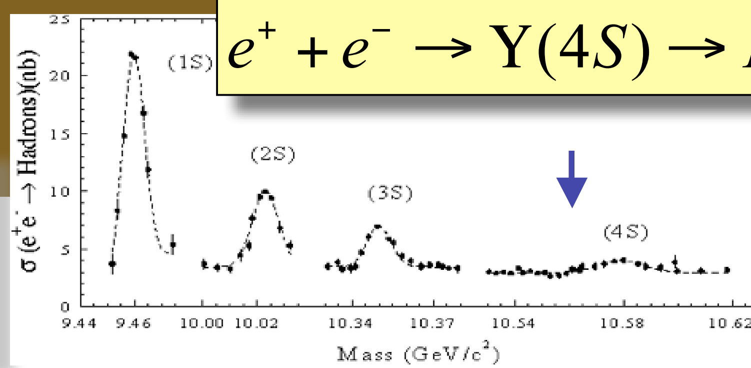
B Factories

- Designed specifically for precision measurements of the *CP* violating phases in the CKM matrix



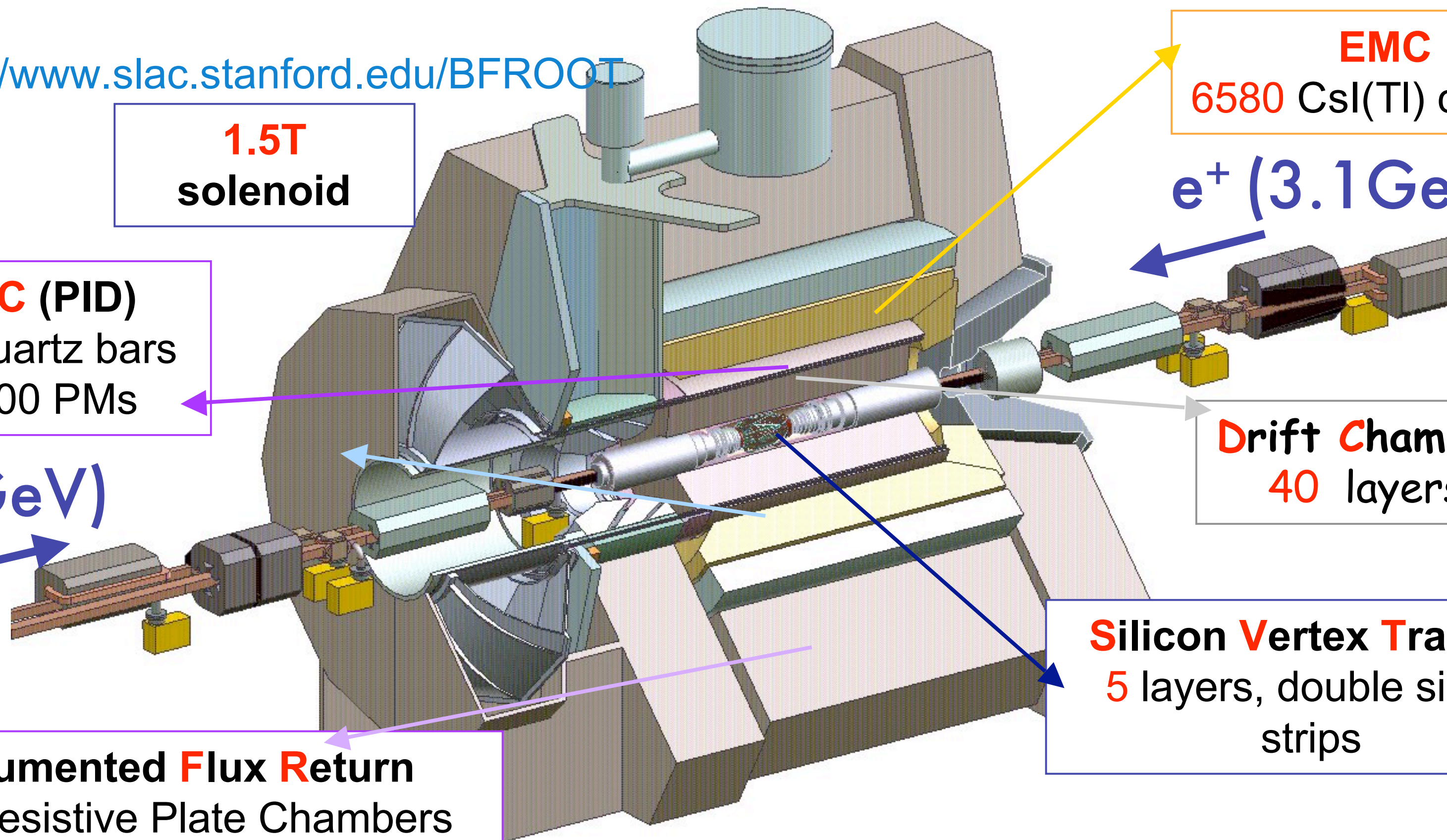


$$e^+ + e^- \rightarrow \Upsilon(4S) \rightarrow B\bar{B}$$

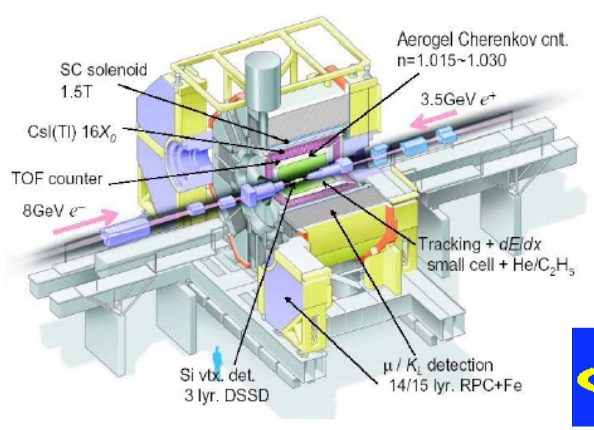


Produce ~10^8 *B*/year by colliding e^+ and e^- with E_{CM} = 10.58 GeV

http://www.slac.stanford.edu/BFROOT



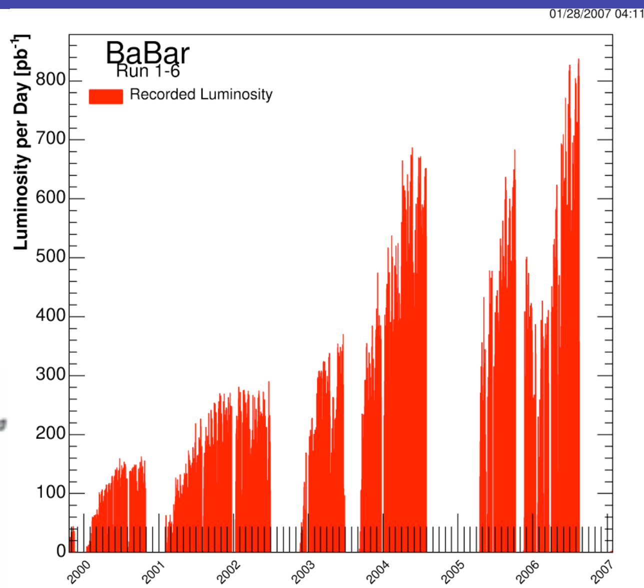
Collaboration founded in 1993
Detector commissioned in 1999
Data-taking scheduled until 2008

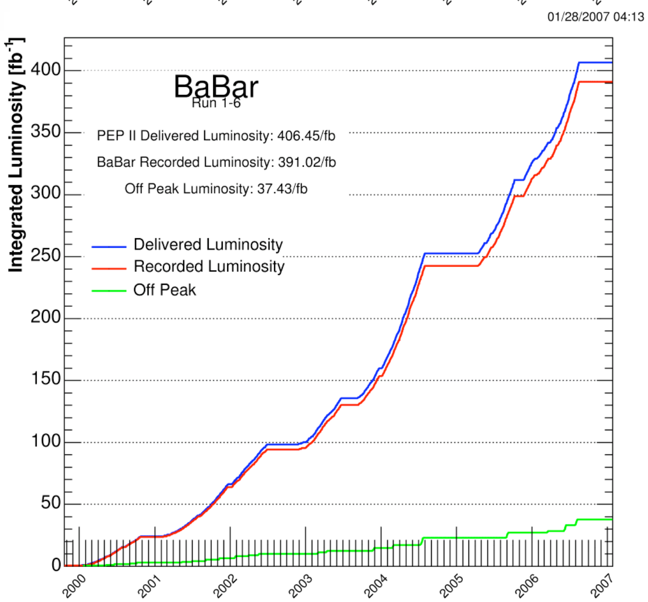


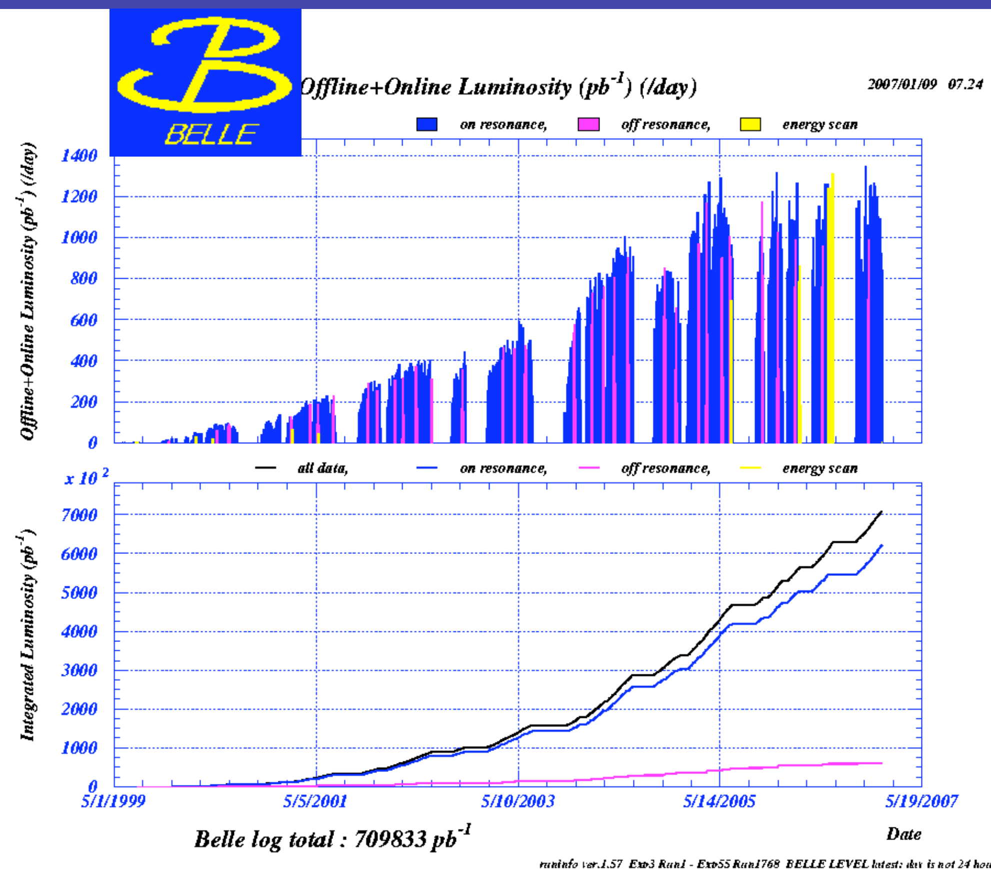
- Belle : 8 GeV electrons, 3.5 GeV positrons
- BaBar : 9 GeV electrons, 3.1 GeV positrons

http://belle.kek.jp/

Integrated data sample



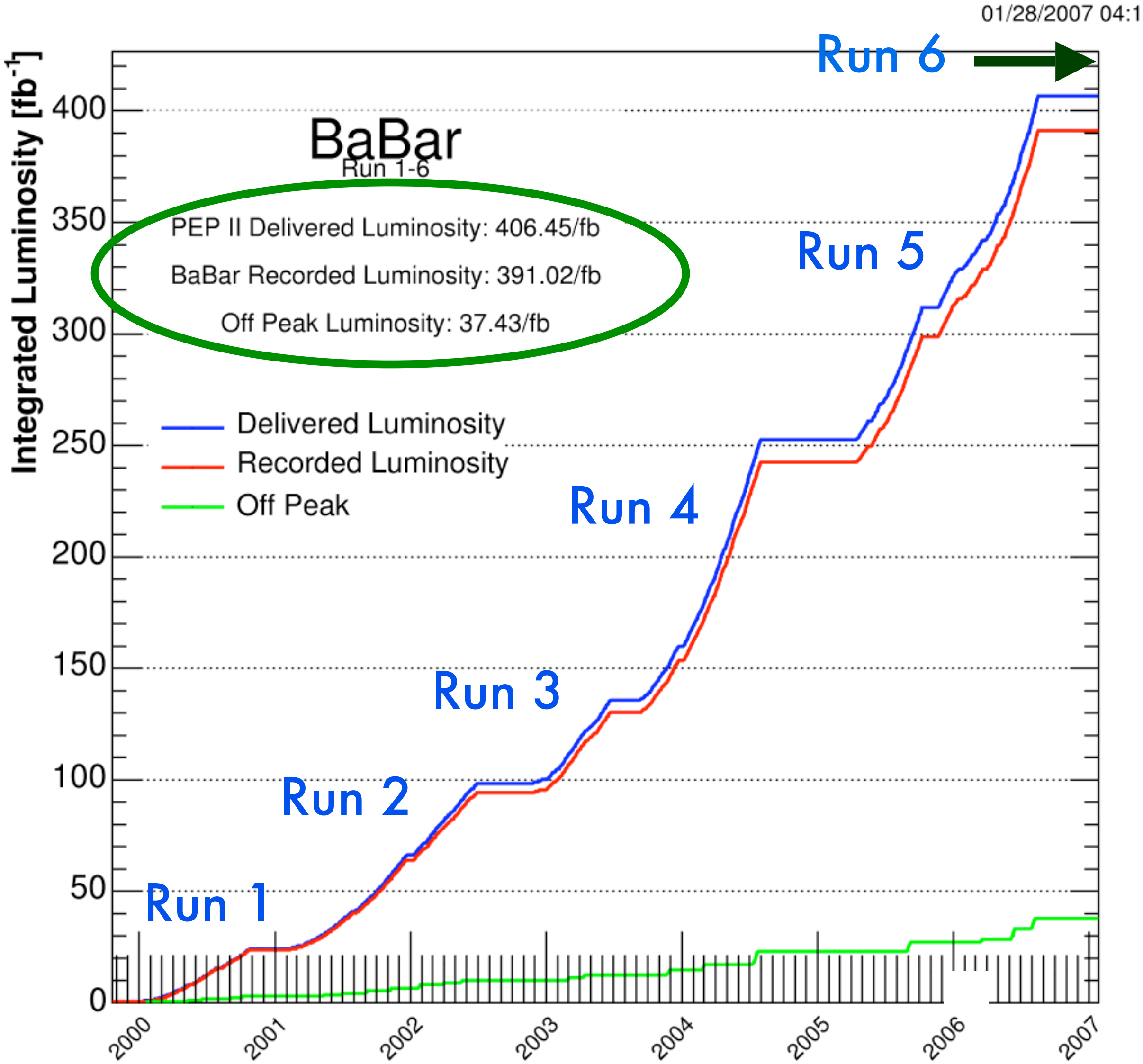




- Integrated luminosity
  - 391.02/fb (709.83/fb) ==> Total > 1ab^{-1}
- Peak luminosity
  - 12.07 x $10^{33}cm^{2}s^{-1}$ ($17.12x10^{33}cm^{2}s^{-1}$)

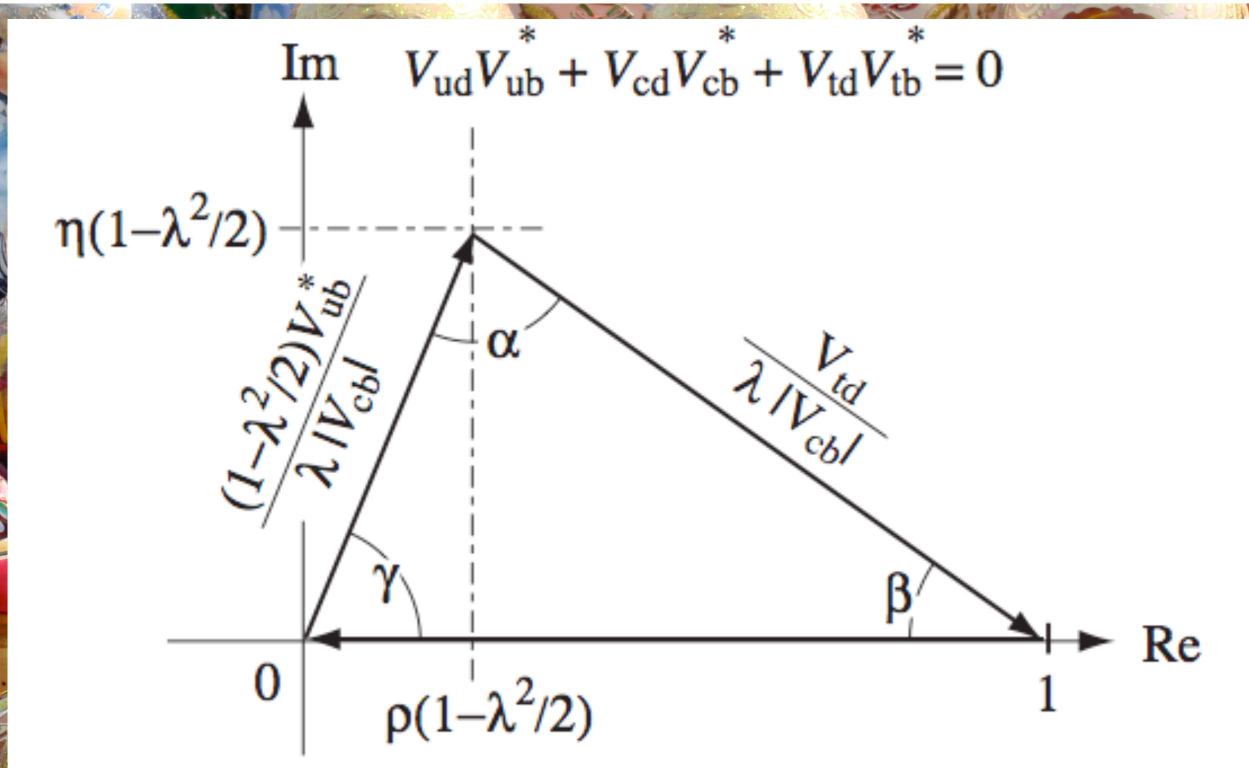
BaBar status

- Most recent period of data-taking was Run 5
  - April'05 - Aug'06
- 4 month shutdown
  - BaBar muon system upgrade
- Run 6 has just started
- End of data-taking in Summer '08

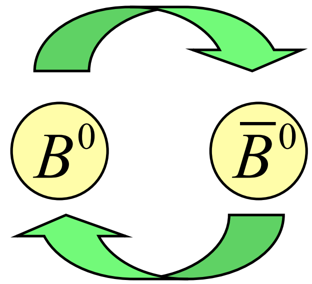


B Factory CKM Measurements

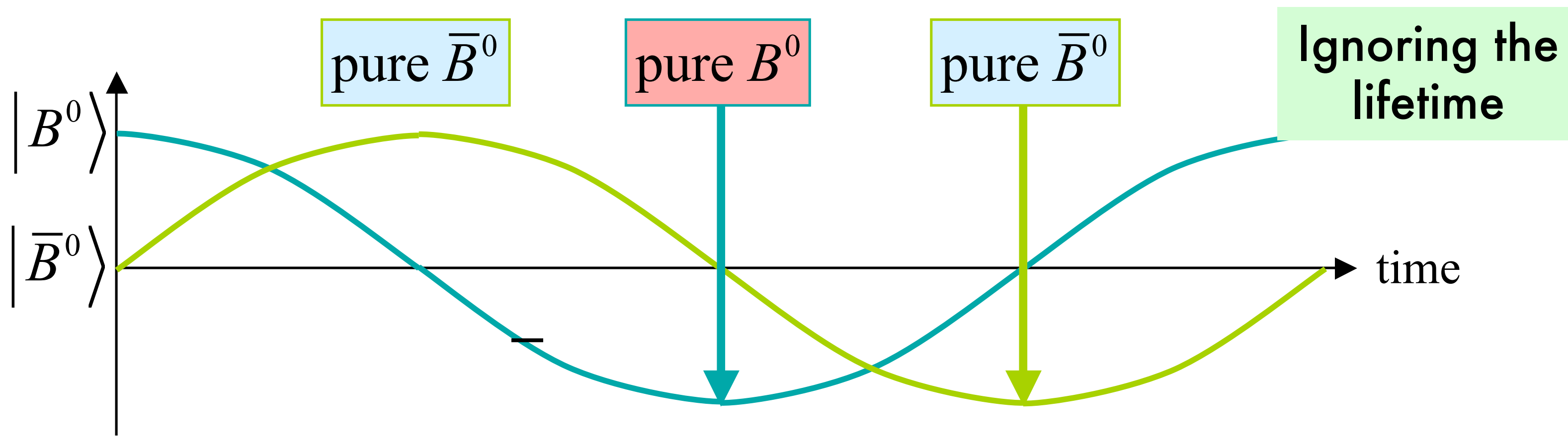
Measurements of the angles and sides of the Unitarity Triangle



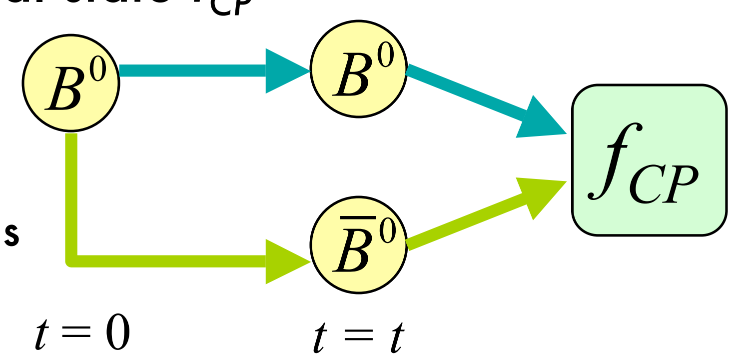
B^0 mixing and decay

$B^0 = (\bar{b}d)$  $\bar{B}^0 = (b\bar{d})$

- Starting from a pure $|B^0\rangle$ state, the wave function evolves as



- Suppose B^0 and B^0 can decay into a same final state f_{CP}
  - Two paths can interfere
  - Decay probability depends on:
    - the decay time t
    - the relative complex phase between the two paths

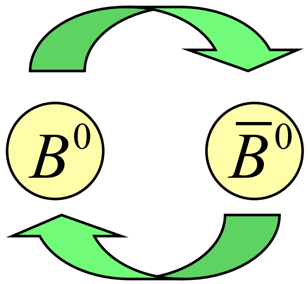


- Time-dependent asymmetry A_{CP}

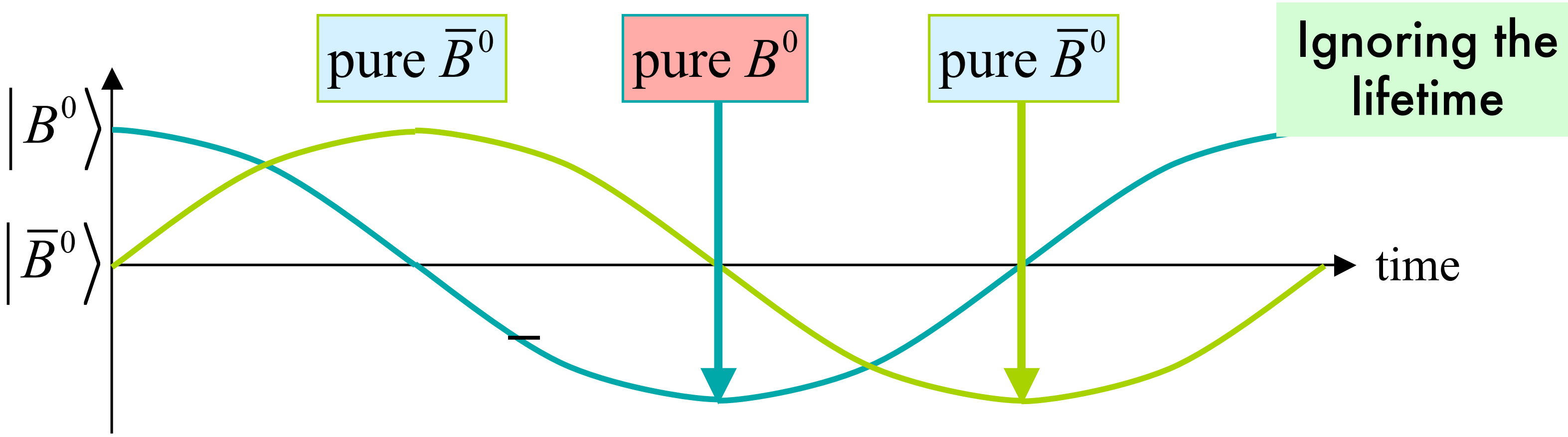
$$A_{CP}(t) = \frac{N(\bar{B}^0(t) \to f_{CP}) - N(B^0(t) \to f_{CP})}{N(\bar{B}^0(t) \to f_{CP}) + N(B^0(t) \to f_{CP})} = S\sin(\Delta m \Delta t) - C\cos(\Delta m \Delta t)$$

B^0 mixing and decay

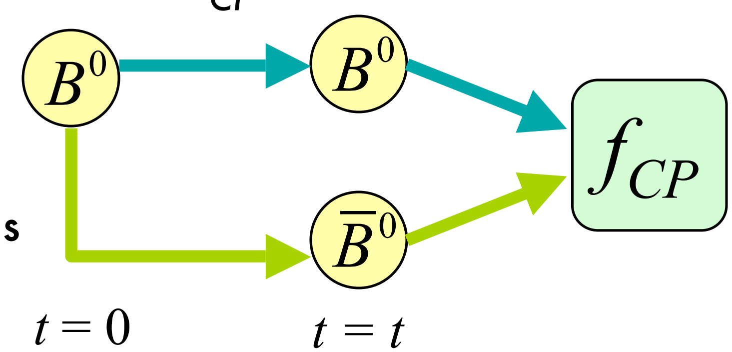
$B^0 = (\bar{b}d)$ $\quad$ $\bar{B}^0 = (b\bar{d})$



- Starting from a pure $|B^0\rangle$ state, the wave function evolves as



- Suppose B^0 and B^0 can decay into a same final state f_{CP}
  - Two paths can interfere
  - Decay probability depends on:
    - the decay time t
    - the relative complex phase between the two paths



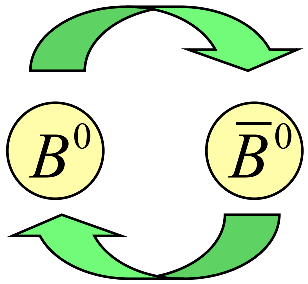
- Time-dependent asymmetry A_{CP}

$$A_{CP}(t) = \frac{N(\bar{B}^0(t) \to f_{CP}) - N(B^0(t) \to f_{CP})}{N(\bar{B}^0(t) \to f_{CP}) + N(B^0(t) \to f_{CP})} = S\sin(\Delta m \Delta t) - C\cos(\Delta m \Delta t)$$

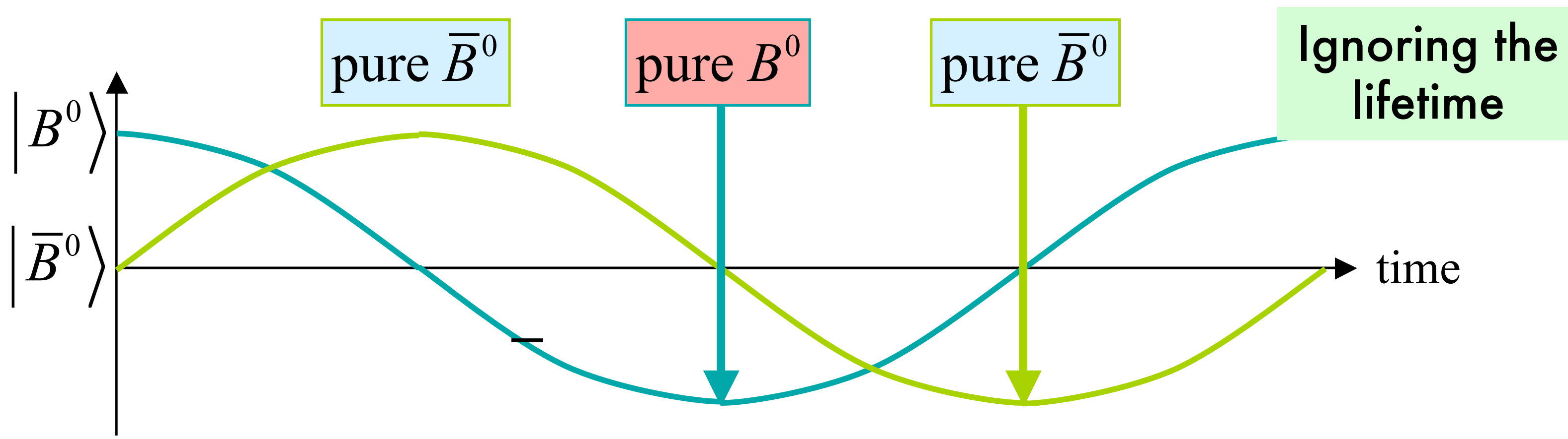
Parameters of interest ....

B^0 mixing and decay

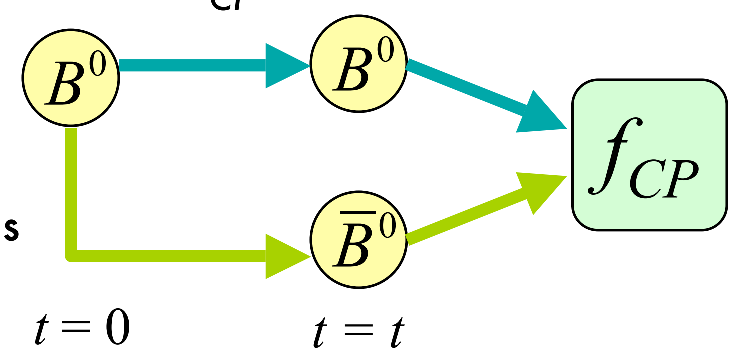
$B^0 = (\bar{b}d)$ $\bar{B}^0 = (b\bar{d})$



- Starting from a pure $|B^0\rangle$ state, the wave function evolves as



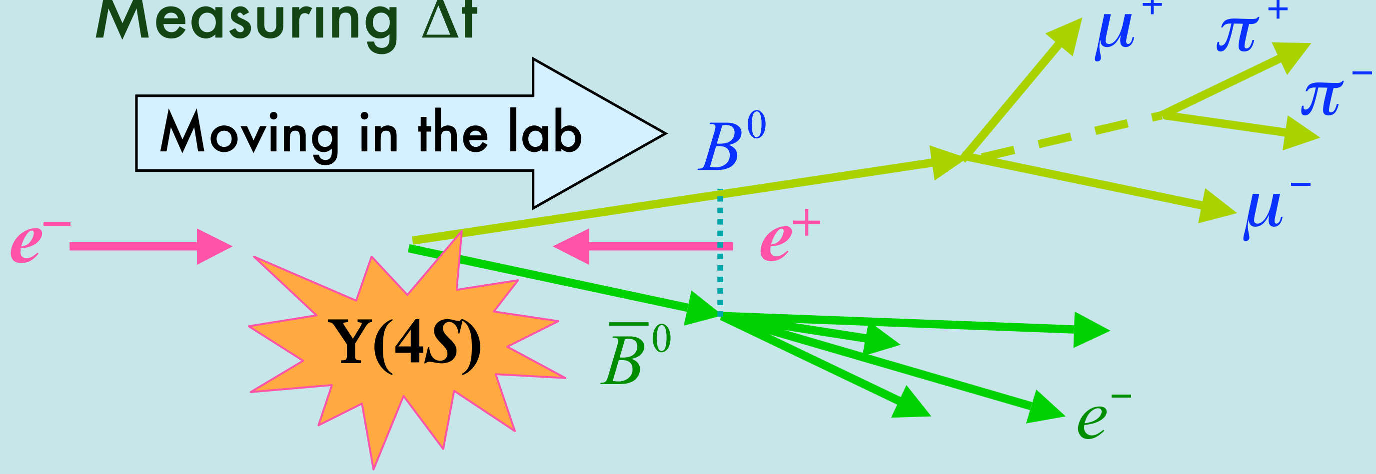
- Suppose B^0 and B^0 can decay into a same final state f_{CP}
  - Two paths can interfere
  - Decay probability depends on:
    - the decay time t
    - the relative complex phase between the two paths
- Time-dependent asymmetry A_{CP}



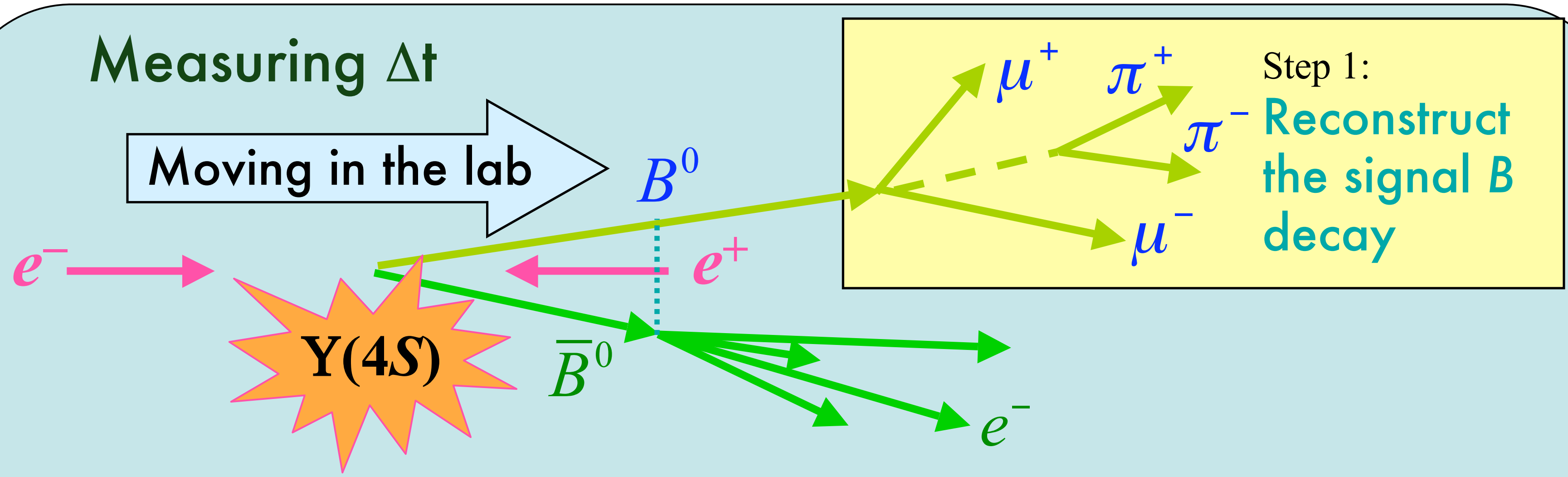
$$A_{CP}(t) = \frac{N(\bar{B}^0(t) \to f_{CP}) - N(B^0(t) \to f_{CP})}{N(\bar{B}^0(t) \to f_{CP}) + N(B^0(t) \to f_{CP})} = S\sin(\Delta m \Delta t) - C\cos(\Delta m \Delta t)$$

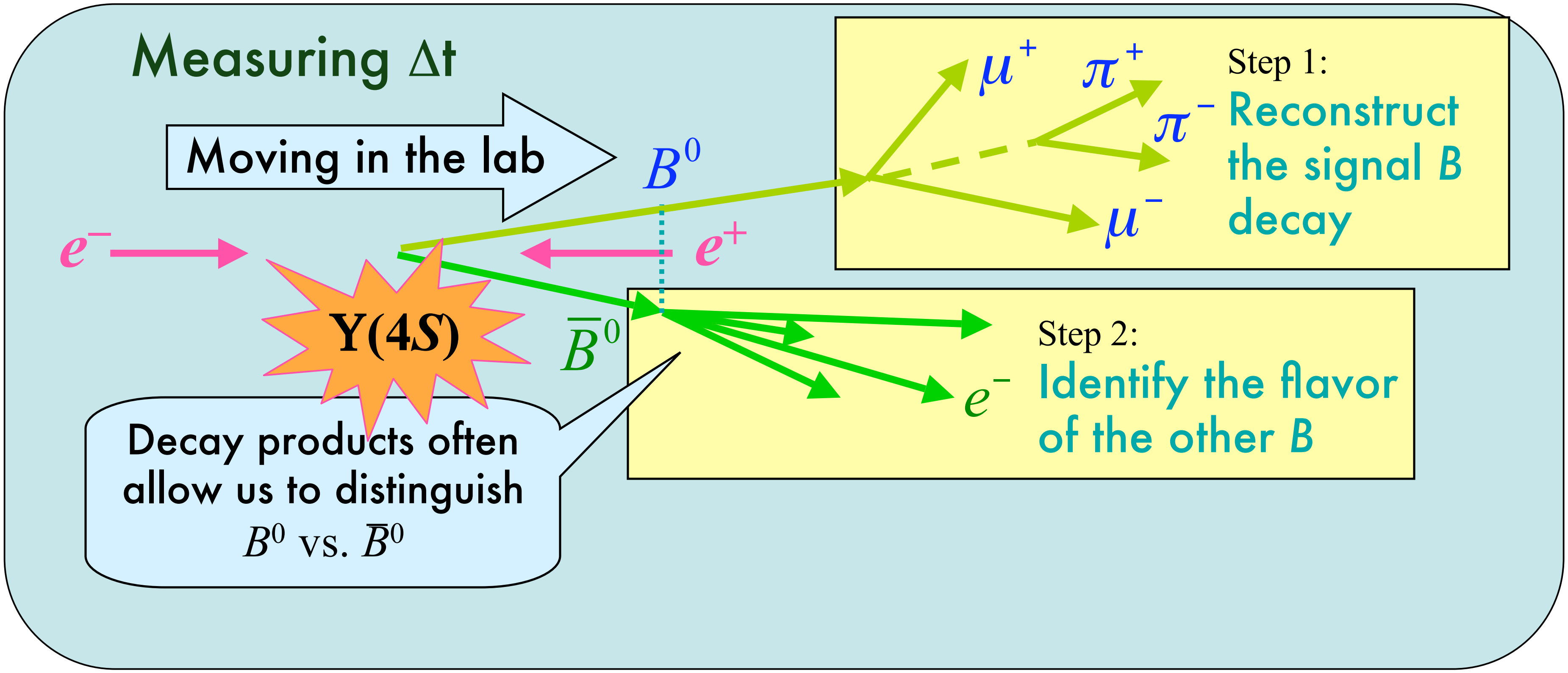
...but need to measure Δt first.

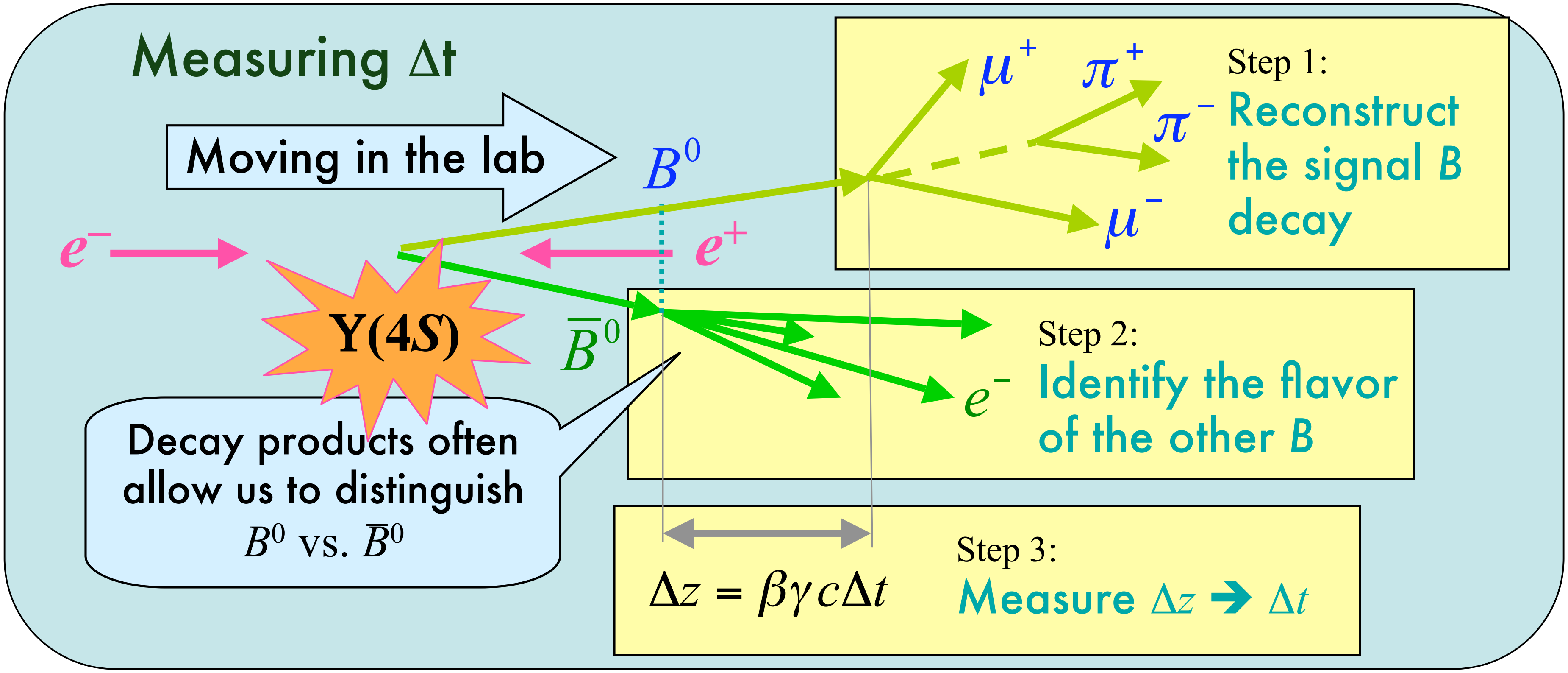
Measuring Δt



Measuring Δt

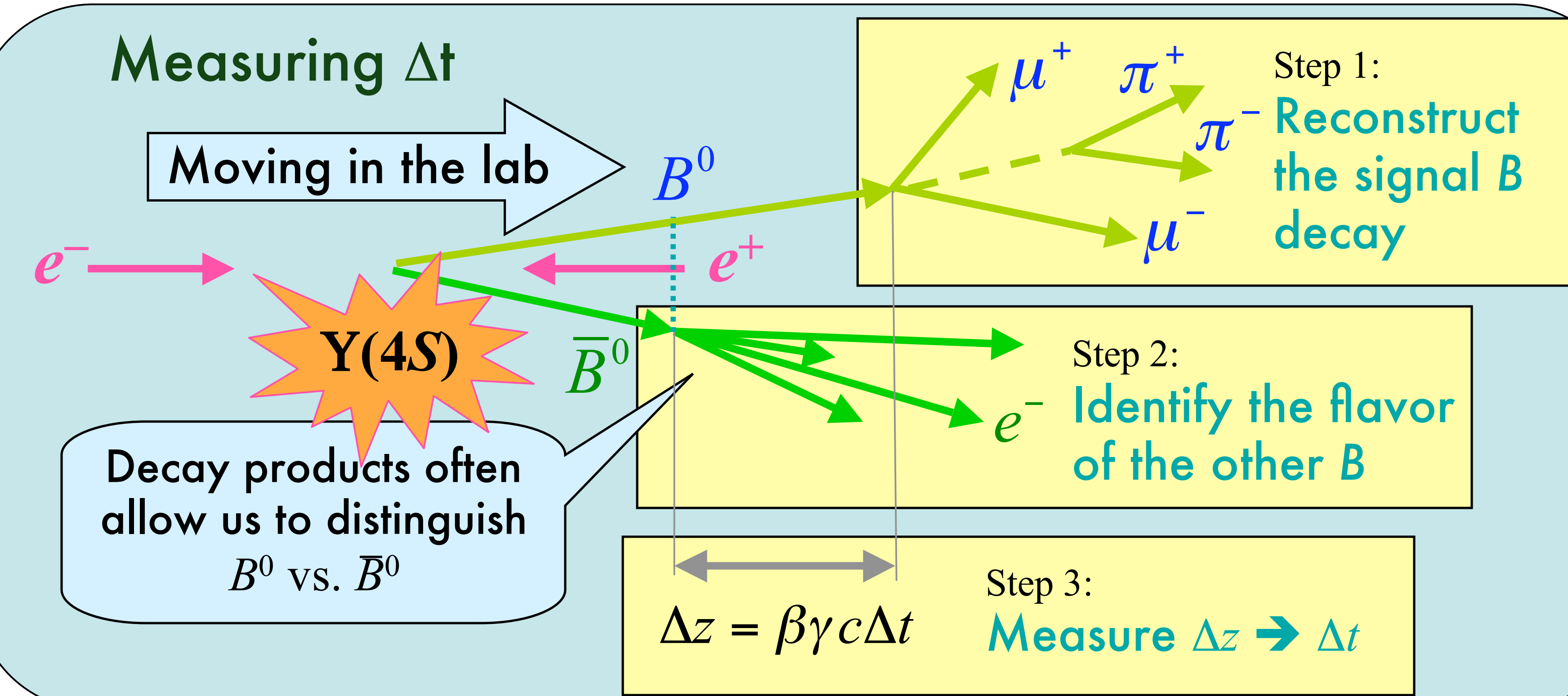



Measuring Δt
Moving in the lab
B^0
e^-
e^+
Υ(4S)
$\overline{B}^0$
μ^+
π^+
π^-
μ^-
Step 1:
Reconstruct the signal B decay
e^-
Step 2:
Identify the flavor of the other B
Decay products often allow us to distinguish B^0 vs. $\overline{B}^0$



Measuring Δt
Moving in the lab
B^0
e^-
e^+
Υ(4S)
$\overline{B}^0$
Decay products often allow us to distinguish B^0 vs. $\overline{B}^0$
μ^+
π^+
π^-
μ^-
Step 1:
Reconstruct the signal B decay
e^-
Step 2:
Identify the flavor of the other B
$\Delta z = \beta\gamma c \Delta t$
Step 3:
Measure Δz → Δt

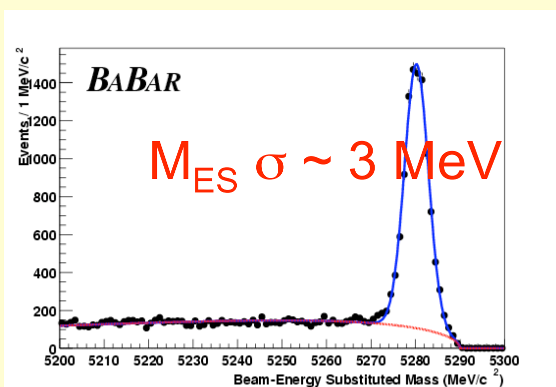
Measuring Δt

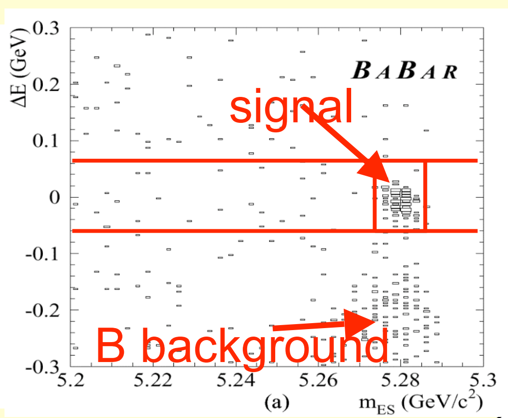


Typical analysis variables

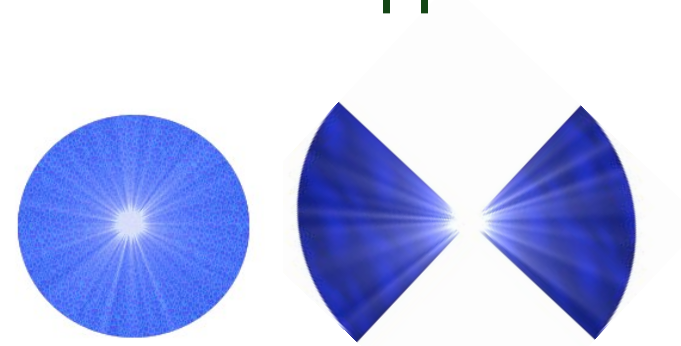
$$m_{ES} = \sqrt{(E^*_{beam})^2 - P_B^2}$$

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



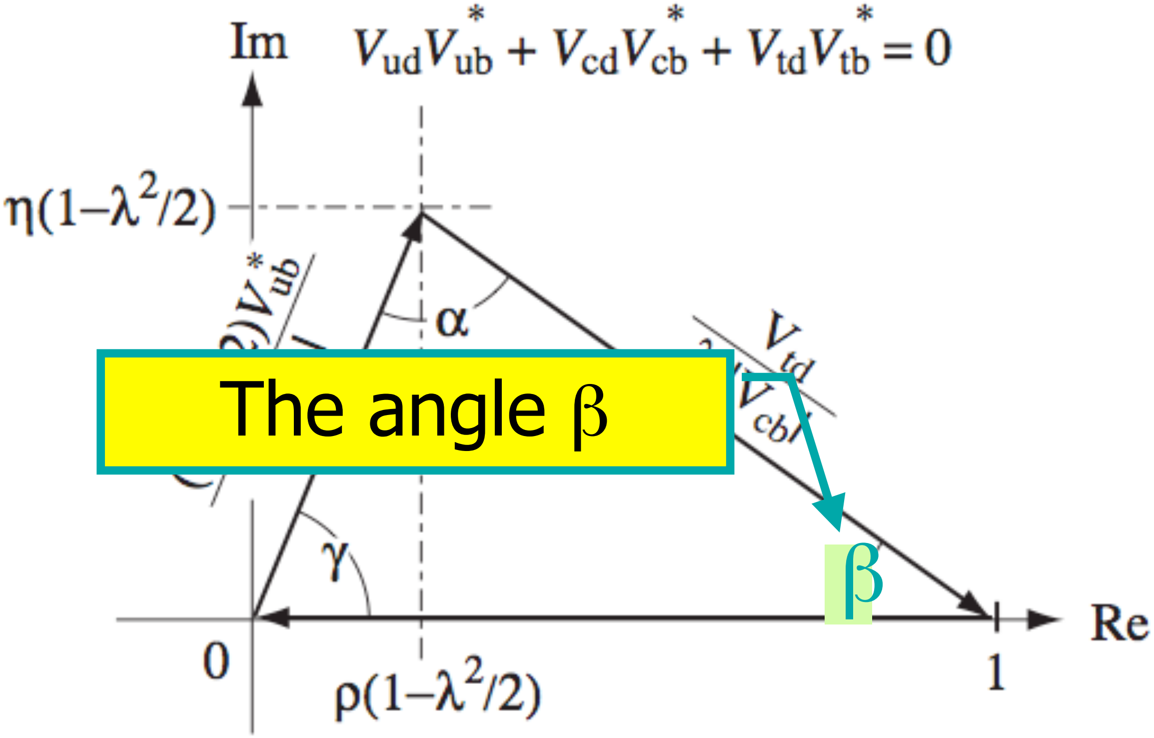


Continuum suppression



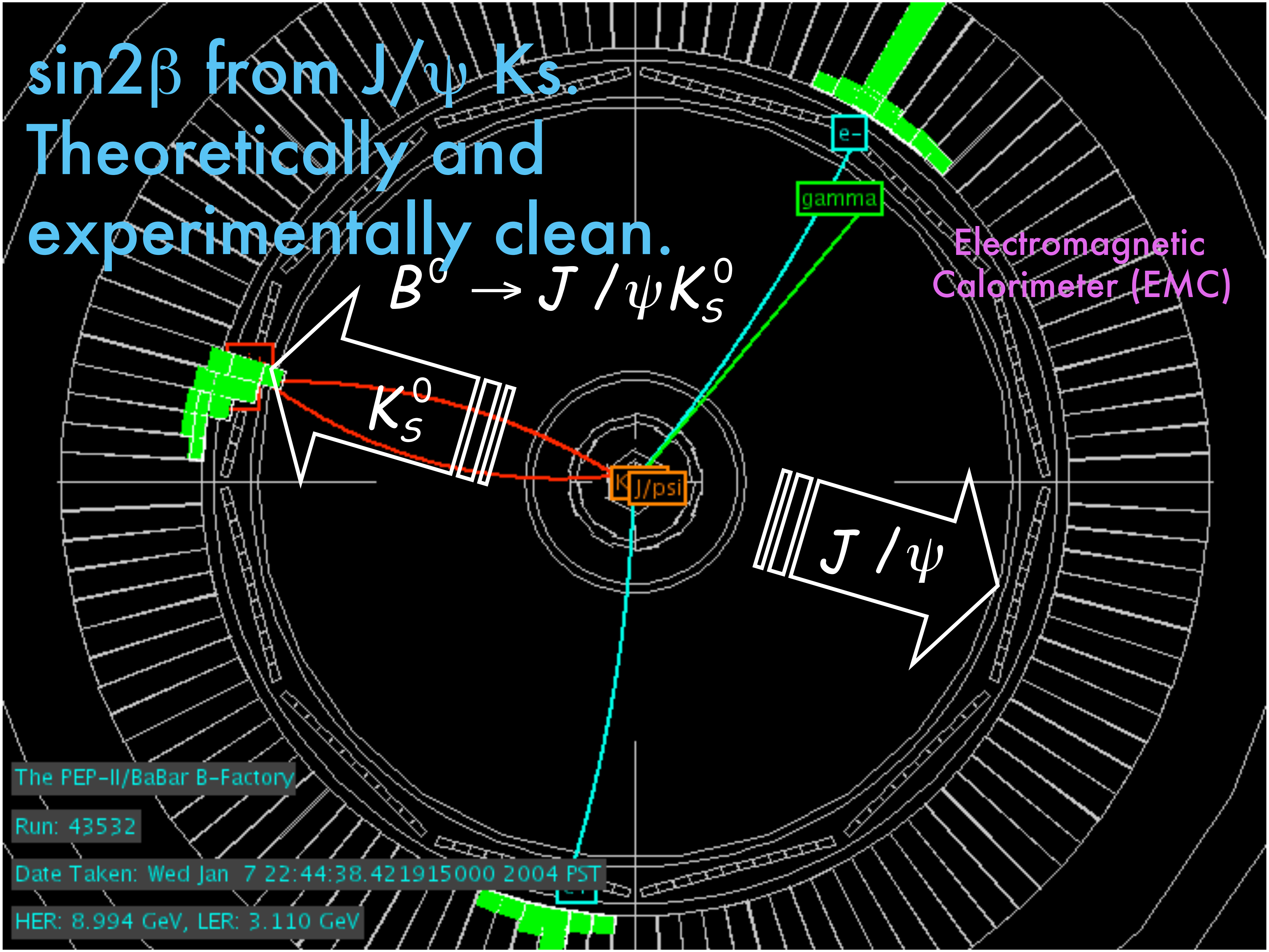
B events tend to be spherical
Continuum (ee to qq) events are 'jetty'

The angle β

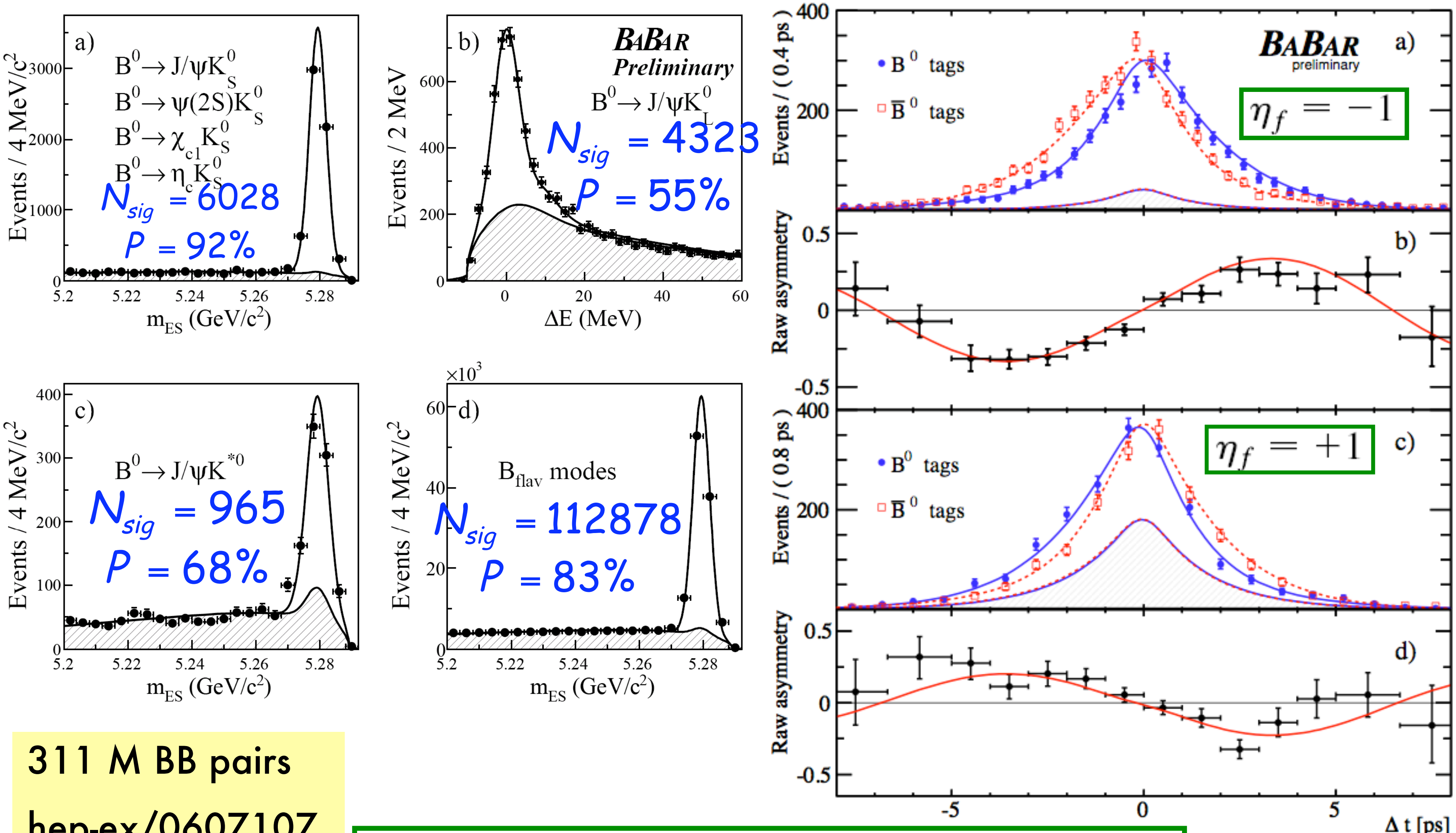


$$\alpha \equiv \arg\left(-\frac{V_{td}V_{tb}^*}{V_{ud}V_{ub}^*}\right), \quad \beta \equiv \arg\left(-\frac{V_{cd}V_{cb}^*}{V_{td}V_{tb}^*}\right), \quad \gamma \equiv \arg\left(-\frac{V_{ud}V_{ub}^*}{V_{cd}V_{cb}^*}\right)$$

sin2β from J/ψ Ks. Theoretically and experimentally clean.



BaBar charmonium sample



311 M BB pairs

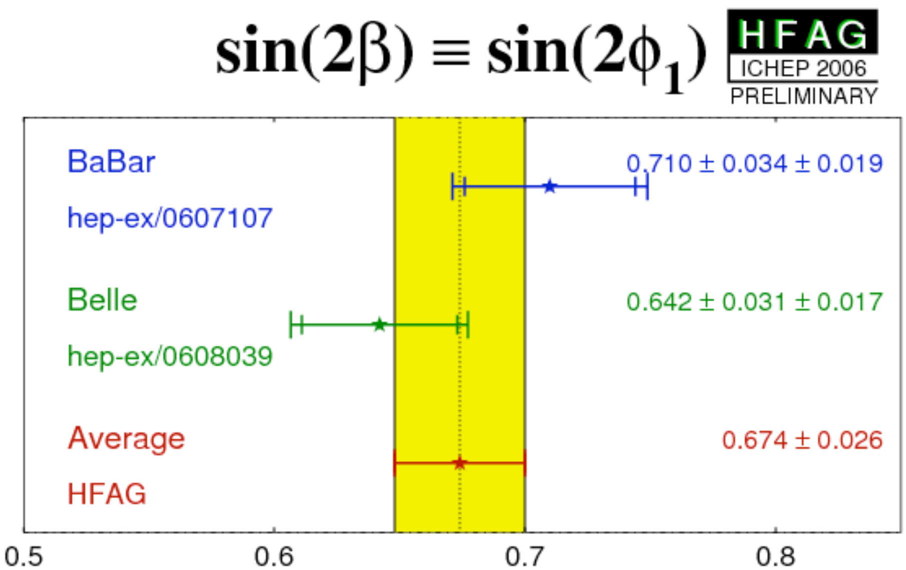
hep-ex/0607107

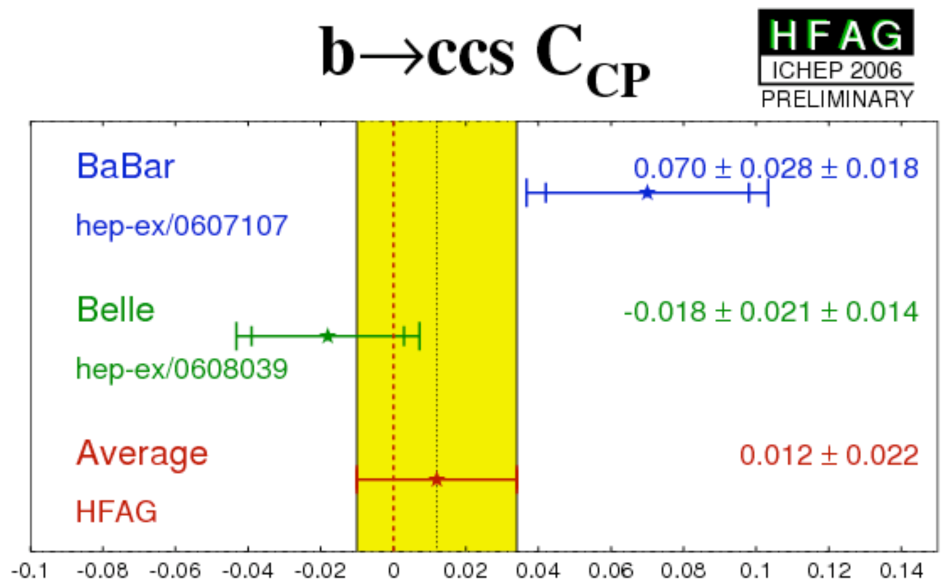
$$\sin 2\beta = 0.710 \pm 0.034(\text{stat}) \pm 0.019(\text{syst})$$

HFAG Averages

http://www.slac.stanford.edu/xorg/hfag/

Belle : 535 M BB pairs, BaBar : 348 M BB pairs





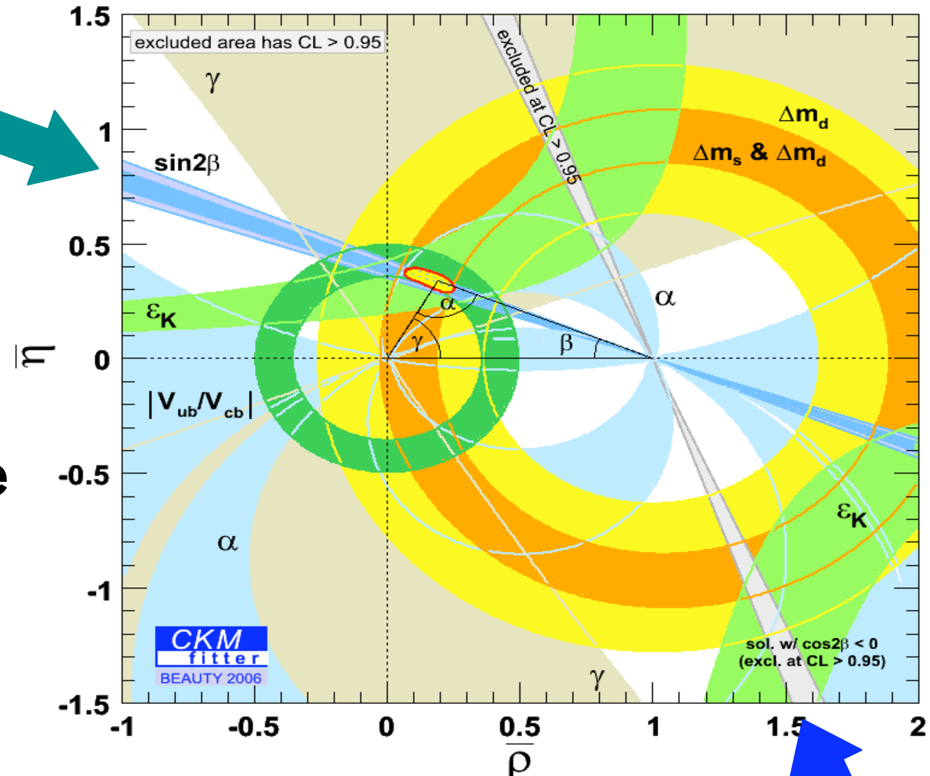
- sin2β measured to approx. 4% precision
- BaBar $|\lambda| = 0.932 \pm 0.026$ (stat) $\pm$ 0.017 (syst)
  - 2.6σ deviation from $|\lambda| = 1$
    - 2.2σ deviation from $|\lambda| = 1$, including systematics

4-fold ambiguity in the $\bar{\rho}$-$\bar{\eta}$ plane

- Measuring sin(2β) from $b \to c\bar{c}s$ decay modes leaves a 4-fold ambiguity on β as shown in the $\bar{\rho}$-$\bar{\eta}$ plane:

cos2β > 0

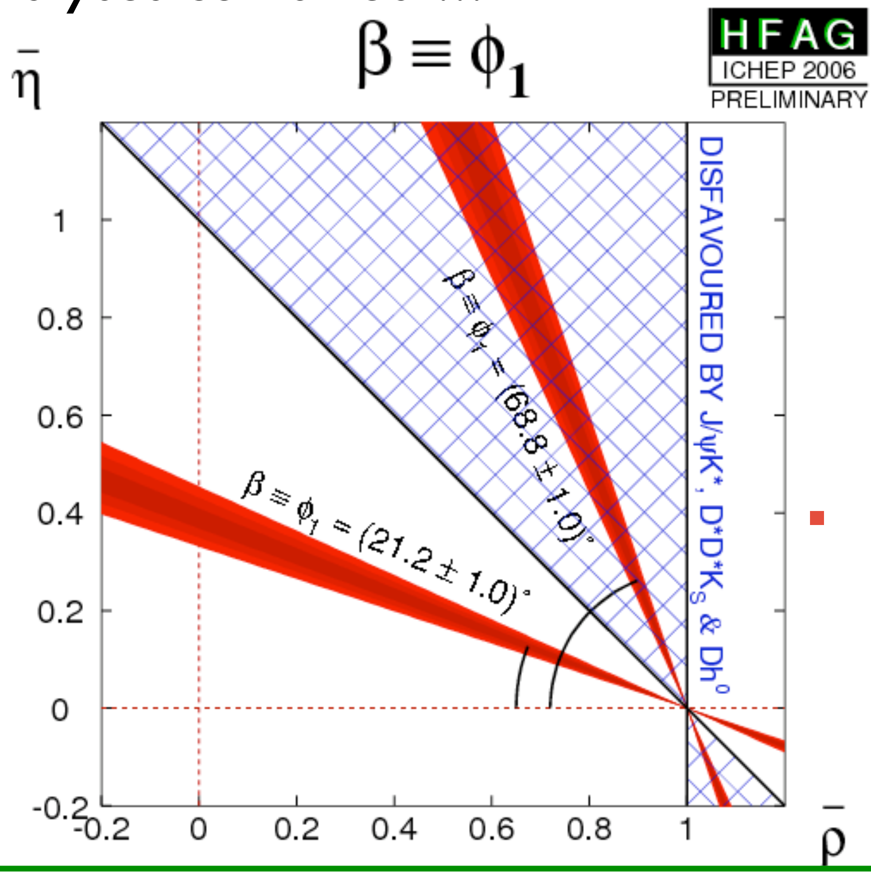
- Resolve by measuring the sign of cos(2β).
- Use strong phase information e.g. Dalitz mode to distinguish between different interference effects in cos2β > 0 and cos2β < 0.



cos2β < 0

Impact of cos2β measurements

- BaBar (see right) + Belle $B^0 \to D^{(*)0}h^0$ and $B^0 \to J/\psi K^*$ analyses combined …



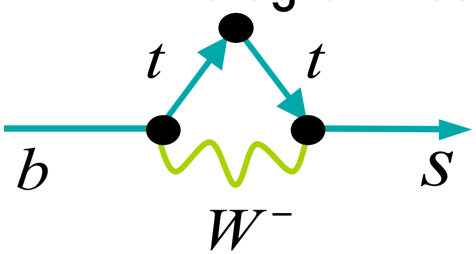
Inputs from BaBar …

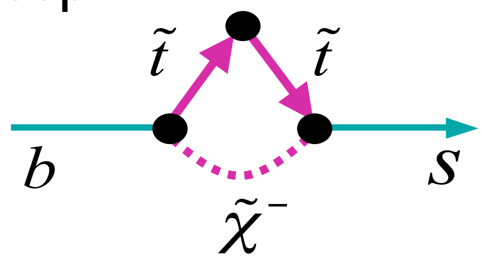
- $B^0 \to D^{(*)0}h^0$
  - Time-dependent Dalitz analysis of $D^0 \to K_S\pi^+\pi^-$
  - 311 M BB pairs
  - Model independent
  - Varying strong phase of the Dalitz plot resolves the $(\beta,\pi/2 - \beta)$ ambiguity.
  - Prefers $\beta = 22^\circ$ to $\beta = 68^\circ$ at 87% CL
    - hep-ex/0607105
- $B^0 \to D^{*+}D^{*-} K_S$
  - Model-dependent time-dependent analysis
  - 232 M BB pairs
  - $\cos(2\beta) > 0$ at 94% CL
    - Phys.Rev. D74 (2006) 091101

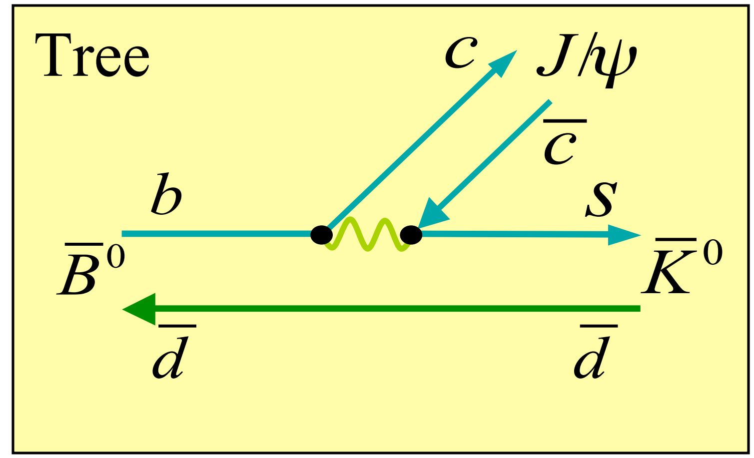
⟹ Standard Model solution of $\beta = (21.1 \pm 1.0)^\circ$ is strongly favoured.

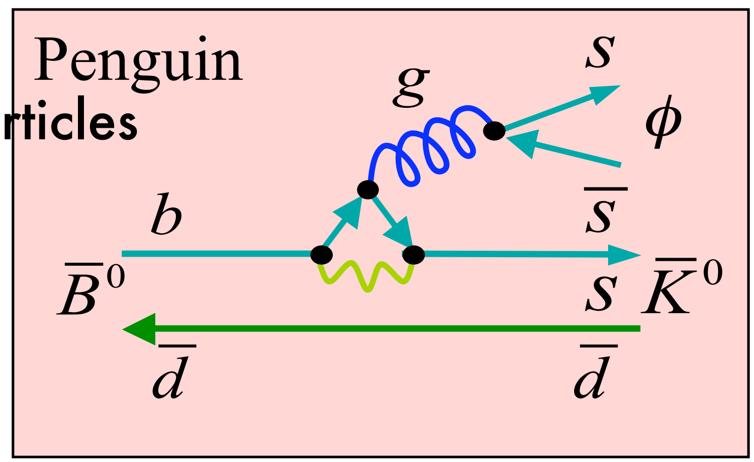
Angle β from penguin decays

- The "Golden" mode is $b \to c\bar{c}s$
- Alternative decay mode is $b \to s\bar{s}s$
  - *b* cannot decay directly to s
  - diagram has a loop





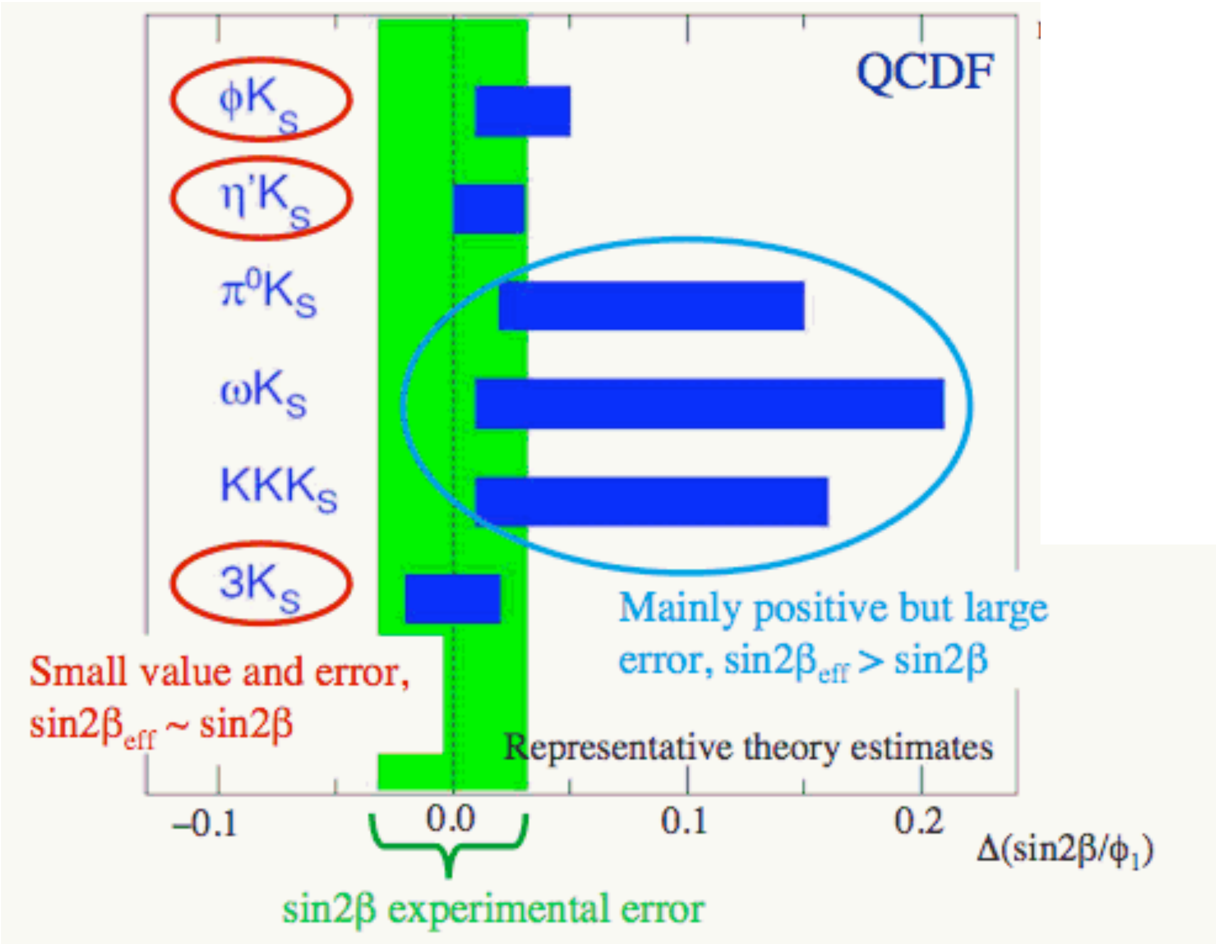




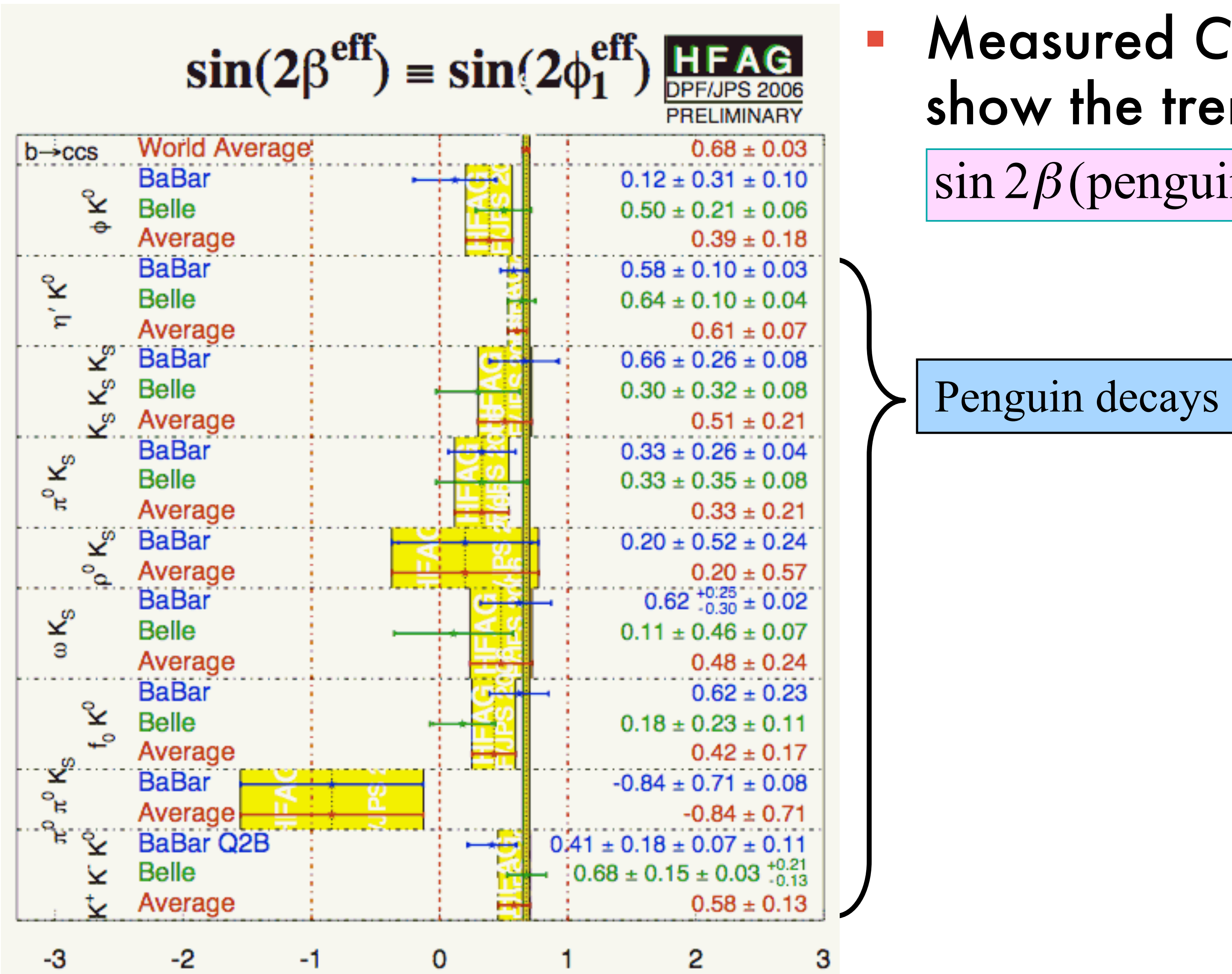
- The loop is entirely virtual
  - could be made of unknown heavier particles
- Most New Physics scenarios predict multiple new particles ~100-1000 GeV
- Alternative measurements of β - to compare penguins with trees is a sensitive probe for New Physics [e.g. hep-ph/0701172]
  - e.g. ϕK^0, $\eta' K^0$, $\pi^0 K^0$, $\rho^0 K^0$, ωK^0

Theoretical estimates

- Channel dependent estimations of $\sin 2\beta_{eff}$ - $\sin 2\beta$
  - e.g. QCDF, Soft Collinear Effective Theory (SCET), SU(3).



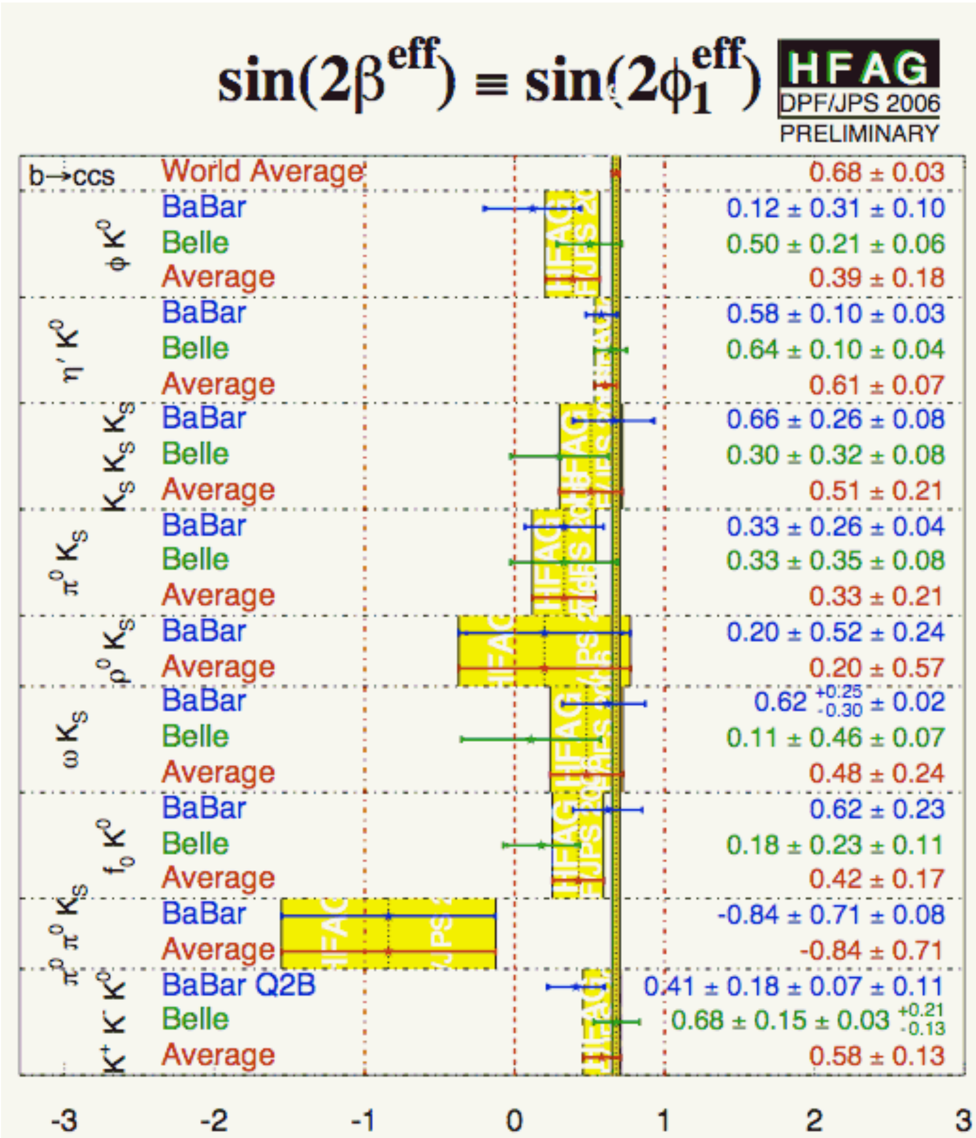
Hints of New Physics ?



- Measured *CP* asymmetries show the trend.

$\sin 2\beta(\text{penguin}) < \sin 2\beta(\text{tree})$

Hints of New Physics ?



- Measured *CP* asymmetries show the trend.

$\sin 2\beta(\text{penguin}) < \sin 2\beta(\text{tree})$

Penguin decays

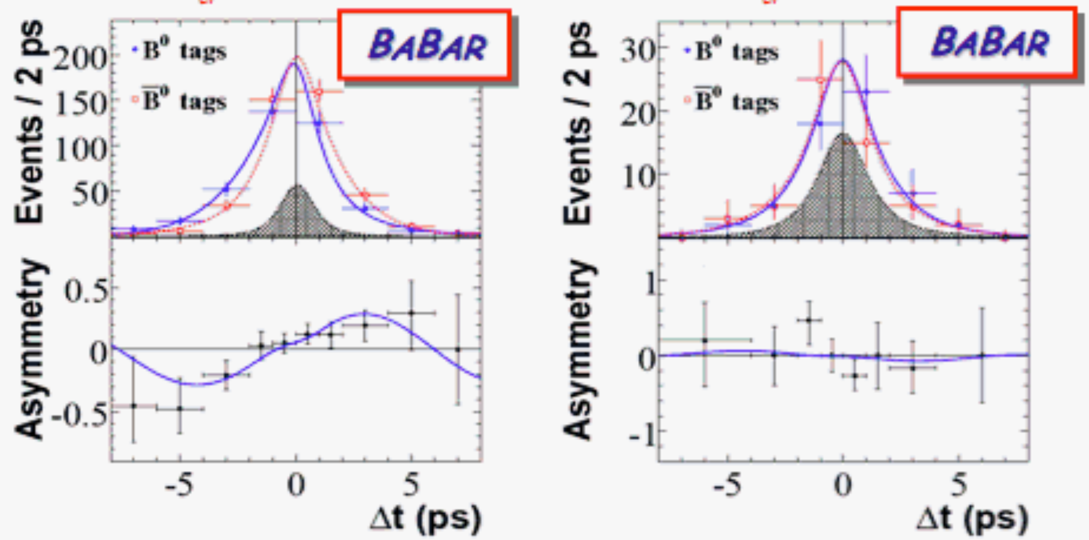
More data is needed to draw any firm conclusions.

More likely to put limits on any potential New Physics rather than discover it.

Observation of CP violation in η'K

- $B^0 \to \eta' K^0$ Penguin mode with large BF: ~ 65×10^{-6}

$\eta' K^0_S$ ($\eta_{f_{CP}} = -1$) modes $\eta' K^0_L$ ($\eta_{f_{CP}} = +1$) modes



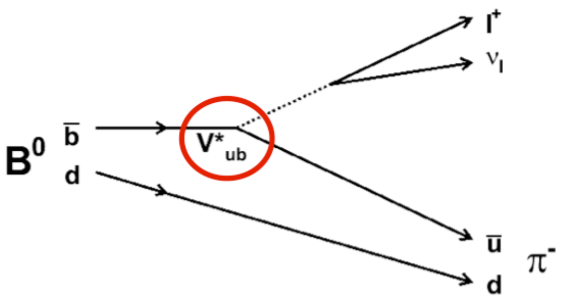
$\eta' K^0_S$ & $\eta' K^0_L$

$S = +0.58 \pm 0.10 \pm 0.03$
$C = -0.16 \pm 0.07 \pm 0.03$

384 M $B\bar{B}$ pairs
1252 ± 50 CP events

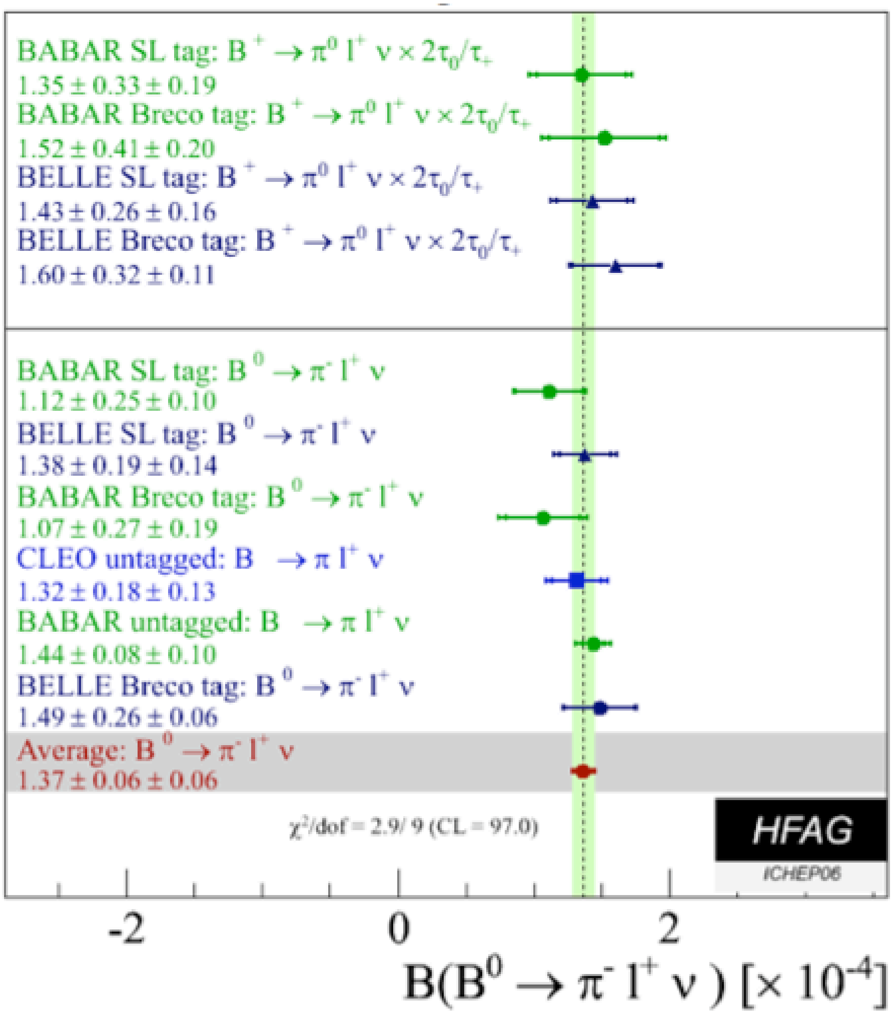
First observation (5.5σ from *S*=0) of CP violation (Indirect CP asymmetry) in a *b*→*s* penguin mode, in agreement with the SM prediction

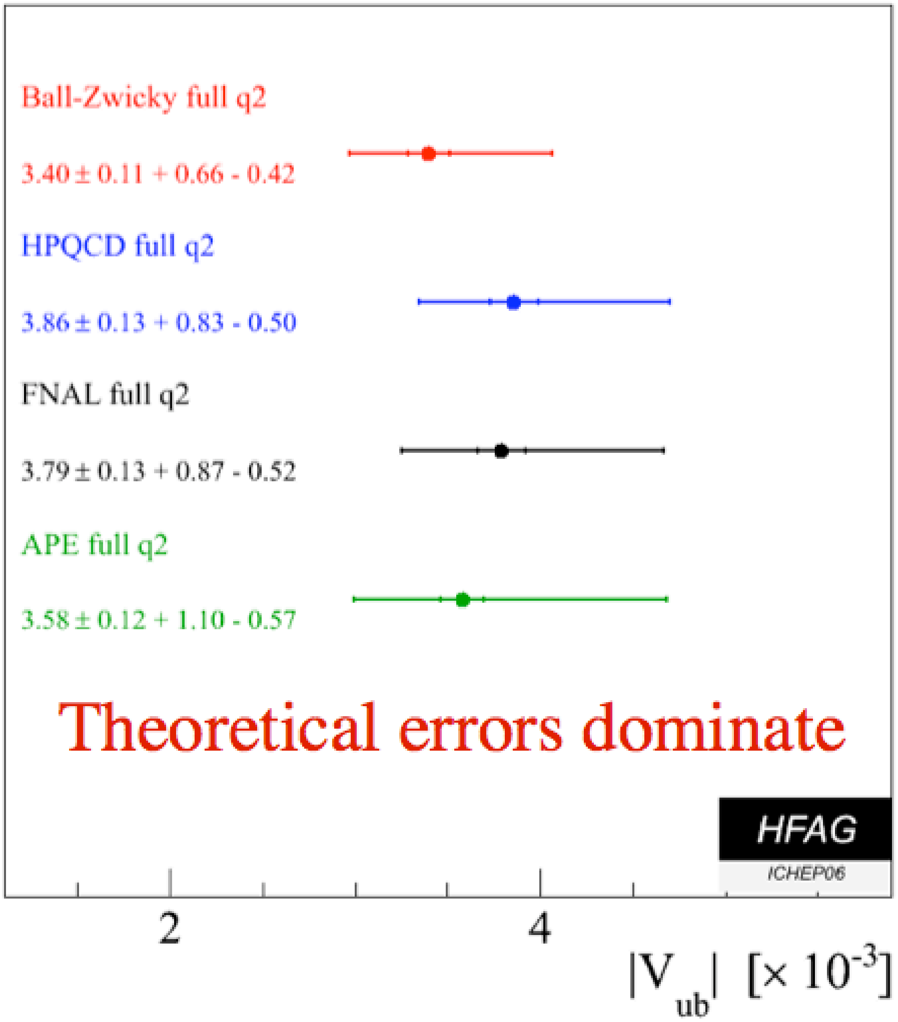
PRL 98, 031801 (2007)



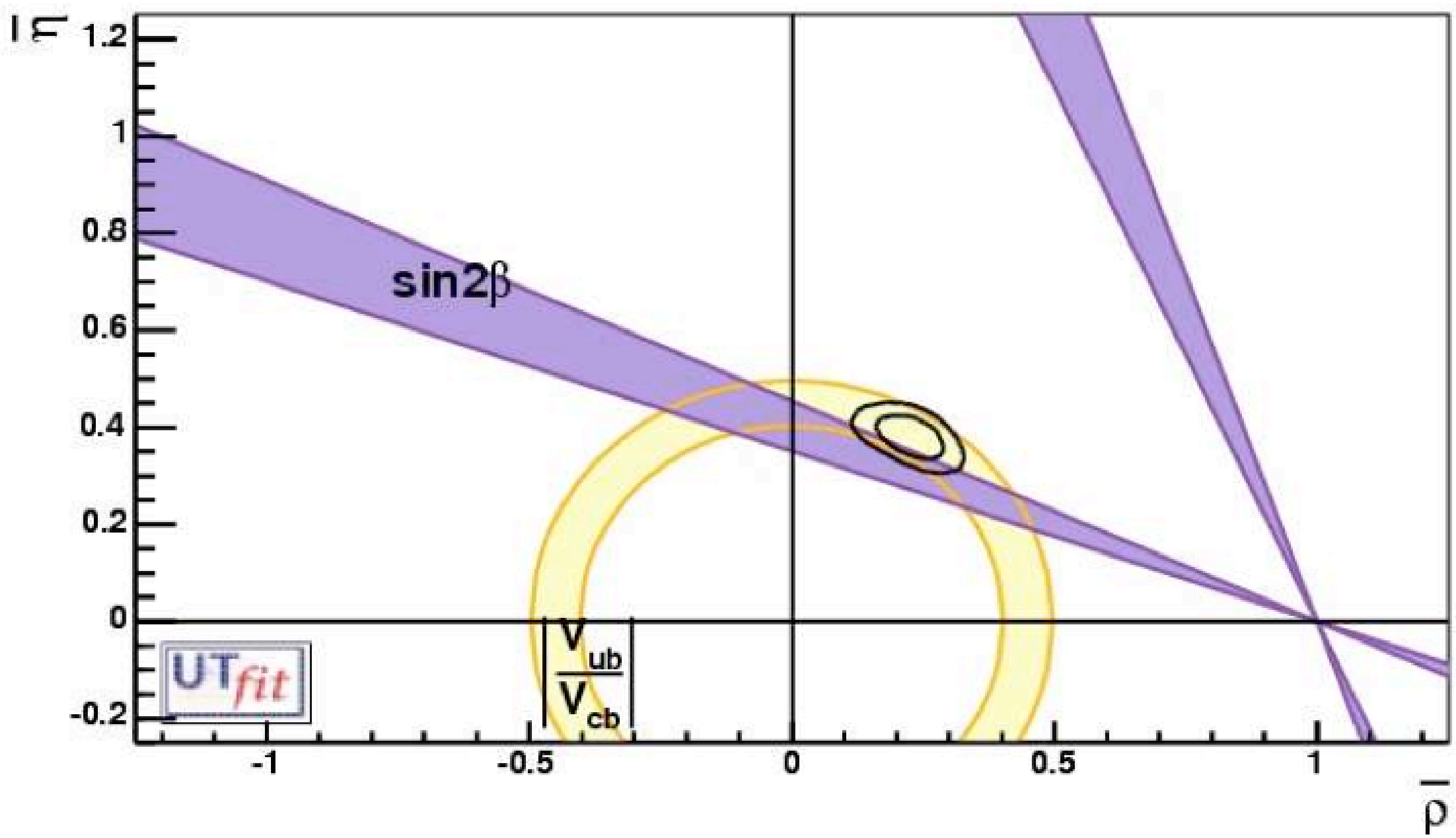
V_{ub} : Semileptonic b→u decays

- Exclusive $B^{0/+} \rightarrow \pi^{+/0} l^+ \upsilon_l$
- Form factor from theory (for B →π) transition





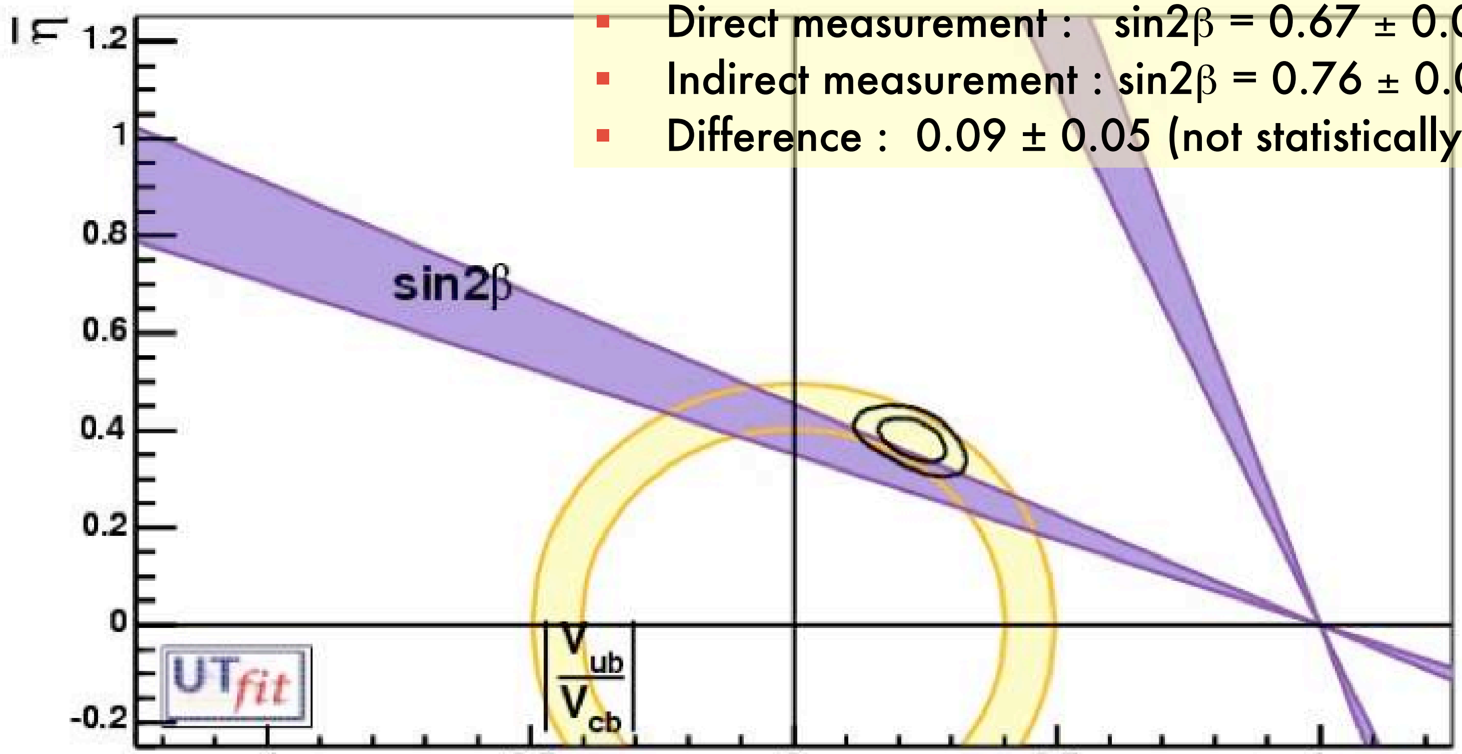
V_{ub} versus sin2β



- Direct measurement : sin2β = 0.67 ± 0.03
- Indirect measurement : sin2β = 0.76 ± 0.04
- Difference : 0.09 ± 0.05 (not statistically significant)

V_{ub} versus $\sin2\beta$

- Direct measurement : $\sin2\beta = 0.67 \pm 0.03$
- Indirect measurement : $\sin2\beta = 0.76 \pm 0.04$
- Difference : 0.09 ± 0.05 (not statistically significant)

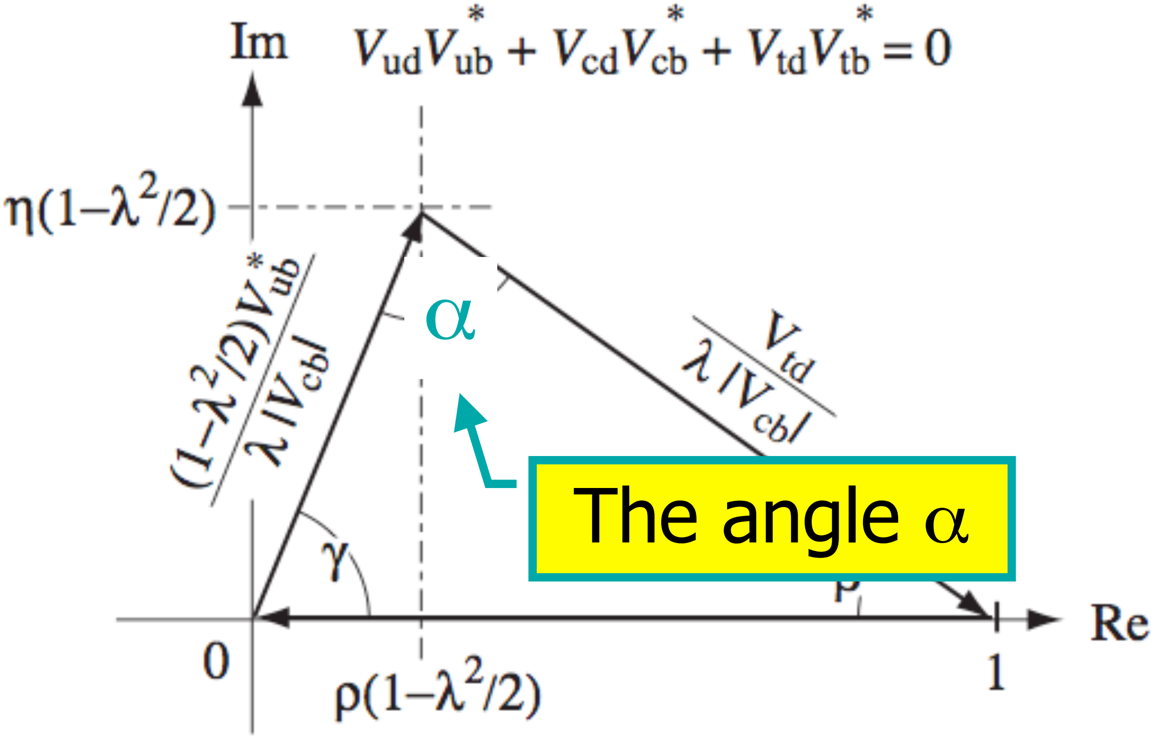


- Model independent New Physics in B mixing ?
  - Effect would be to add a new amplitude A_d^{NP}

$$A_d = A_d^{SM}\left[1 + \left|A_d^{NP}/A_d^{SM}\right| e^{i2\varphi_d^{NP}}\right]$$

  - Modifies $\beta \rightarrow \beta + \phi_d^{NP}$

The angle α



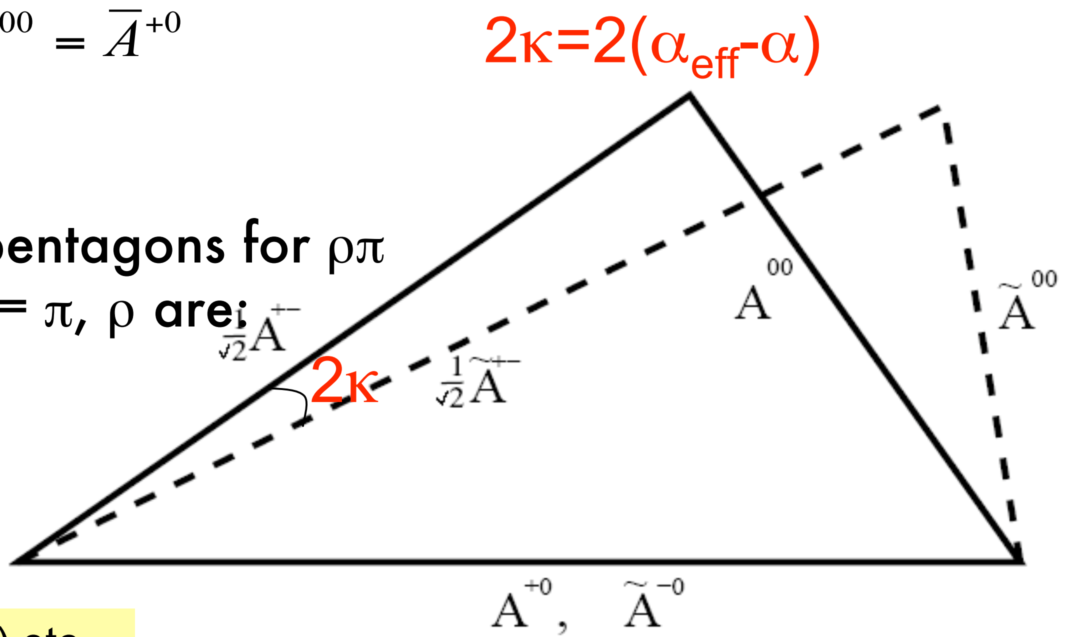
$$\alpha \equiv \arg\left(-\frac{V_{td}V_{tb}^{*}}{V_{ud}V_{ub}^{*}}\right), \quad \beta \equiv \arg\left(-\frac{V_{cd}V_{cb}^{*}}{V_{td}V_{tb}^{*}}\right), \quad \gamma \equiv \arg\left(-\frac{V_{ud}V_{ub}^{*}}{V_{cd}V_{cb}^{*}}\right)$$

Isospin analysis : B →ρρ, ρπ, ππ

- Different B →ρρ, ρπ, ππ final states can be related to each other through isospin amplitudes [SU(2) isospin symmetry].
- Amplitude relations can be used to constrain the penguin shift in the time-dependent measurements of these decays.

$$\frac{1}{\sqrt{2}} A^{+-} + A^{00} = A^{+0}$$

$$\frac{1}{\sqrt{2}} \bar{A}^{+-} + \bar{A}^{00} = \bar{A}^{+0}$$



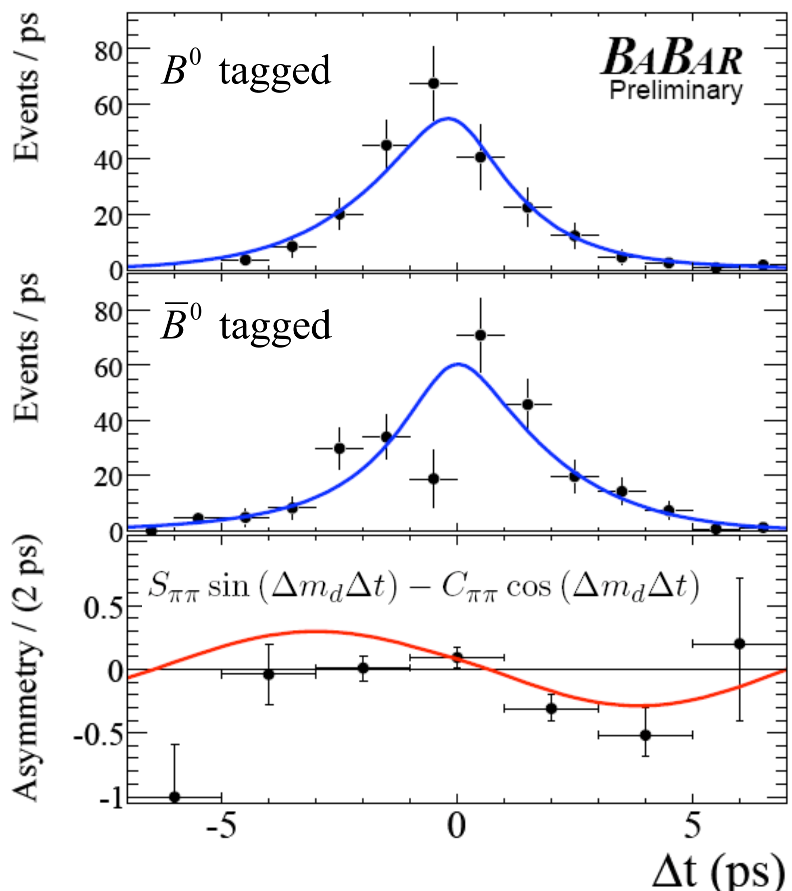
  - Triangles for ππ, ρρ and pentagons for ρπ
- Inputs to measuring α from h = π, ρ are:
  - $B^0 \rightarrow h^+h^-$ + C.C
  - $B^0 \rightarrow h^0h^0$ + C.C
  - $B^+ \rightarrow h^+h^0$ + C.C
  - $S_{h+h-} = \sqrt{1-C^2}\,\sin(2\alpha + 2\kappa)$

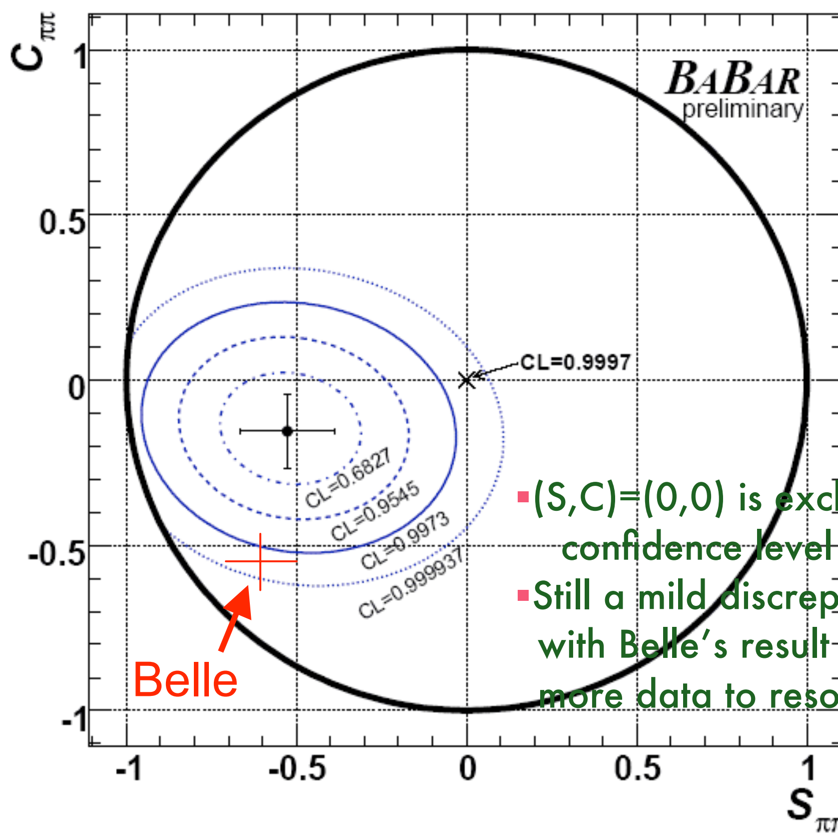
ππ: Gronau & London PRL**65**, 3381 (1990) etc.
ρπ Snyder-Quinn: PRD**48**, 2139 (1993) etc.

$B^0 \to \pi^+\pi^-$: Evidence for direct CP violation

- Updated measurement using 347 M BB pairs (675 ± 42 signal events)
- BaBar data shows evidence for CP violation at 3.6σ using the S and C measurement in $B \to \pi^+\pi^-$.

$$S_{\pi\pi} = -0.53 \pm 0.14 \pm 0.02$$
$$C_{\pi\pi} = -0.16 \pm 0.11 \pm 0.03$$





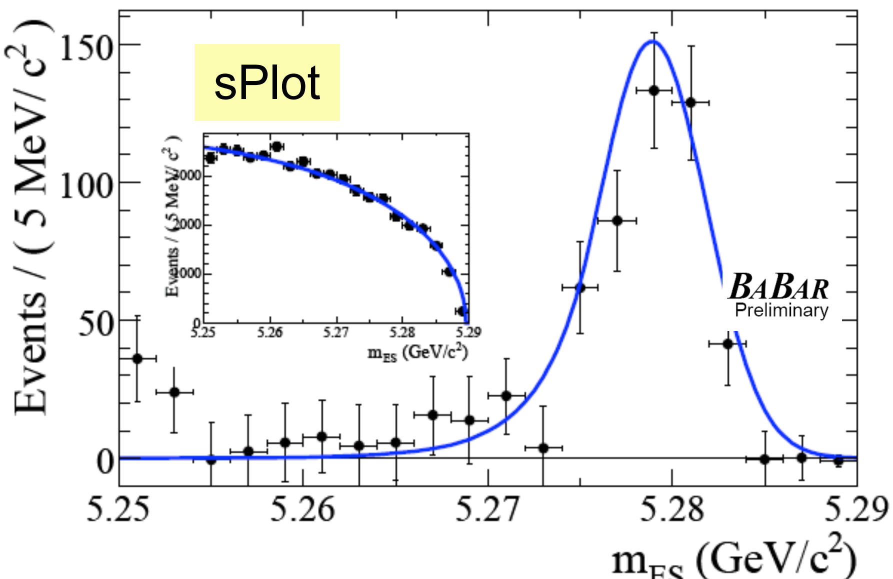
- (S,C)=(0,0) is excluded at a confidence level of 0.9997.
- Still a mild discrepancy with Belle's result ⇒ need more data to resolve this.

Belle (hep-ex/060803), 535 M BB pairs (1464 ± 65 signal events).
Direct CP violation (5.5 σ) and mixing-induced CP violation (5.6 σ)

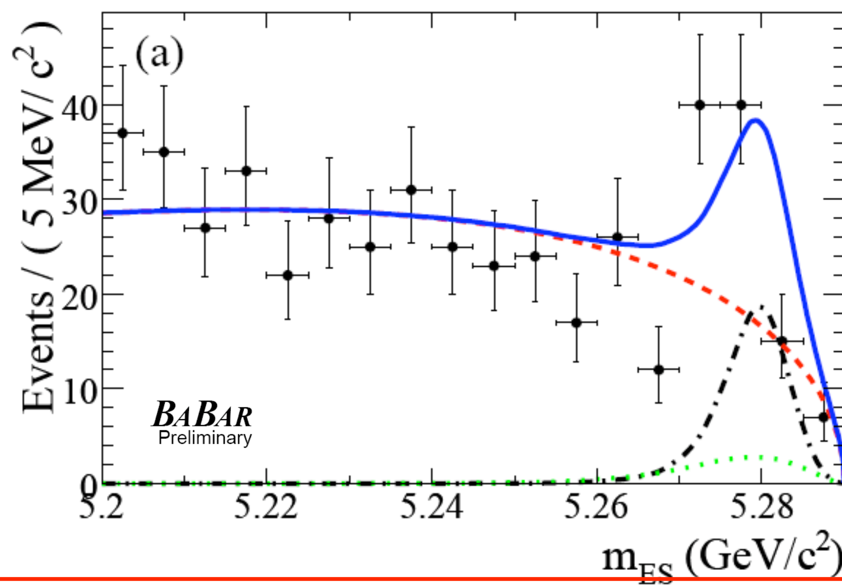
The other sides of the ππ triangle

- 347 M BB pairs.

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



$B^0 \to \pi^0\pi^0$



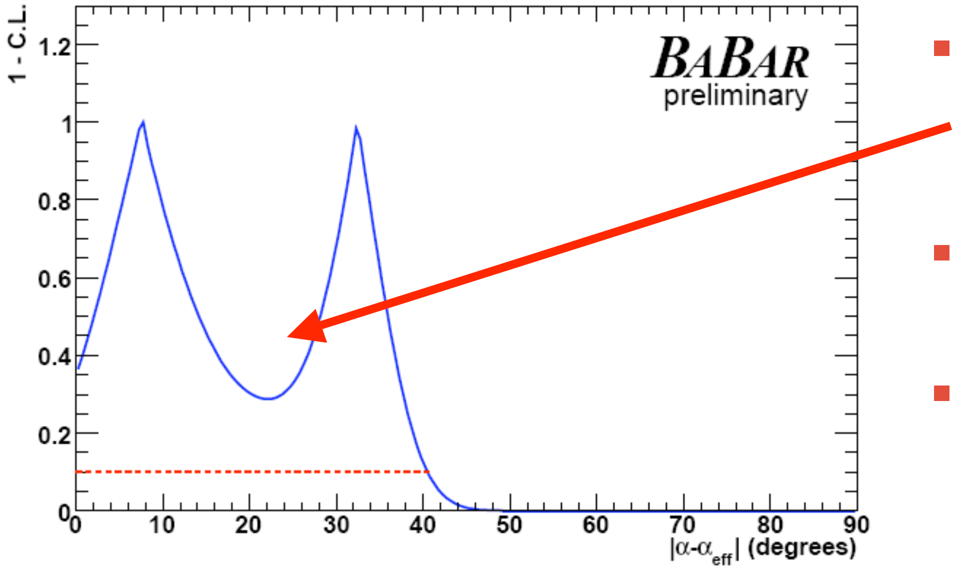
$$\mathcal{B}(B^\pm \to \pi^\pm\pi^0) = (5.12 \pm 0.47 \pm 0.29) \times 10^{-6}$$
$$\mathcal{A}_{\pi\pi^0} = -0.019 \pm 0.088 \pm 0.014$$

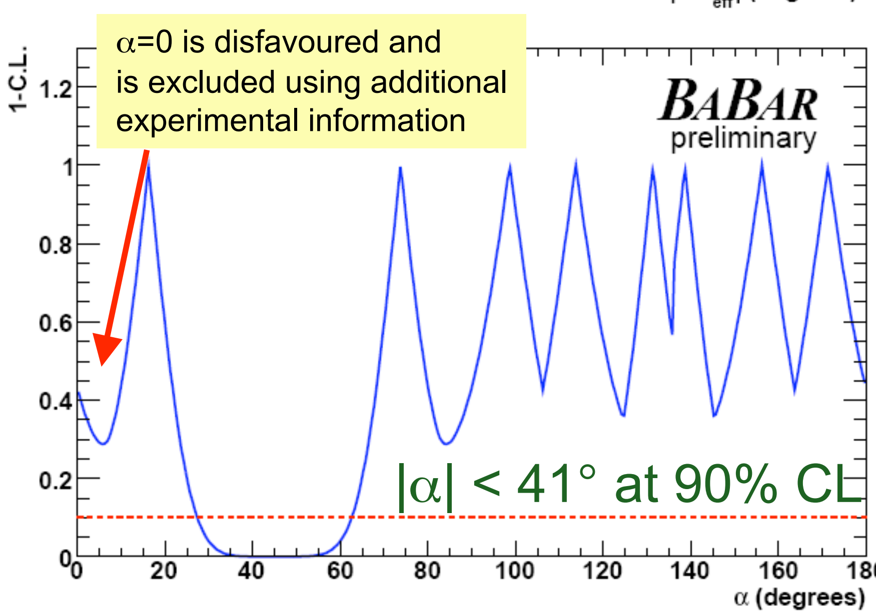
572±53 events

$$\mathcal{B}(B^0 \to \pi^0\pi^0) = (1.48 \pm 0.26 \pm 0.12) \times 10^{-6}$$
$$C_{\pi^0\pi^0} = -0.33 \pm 0.36 \pm 0.08$$

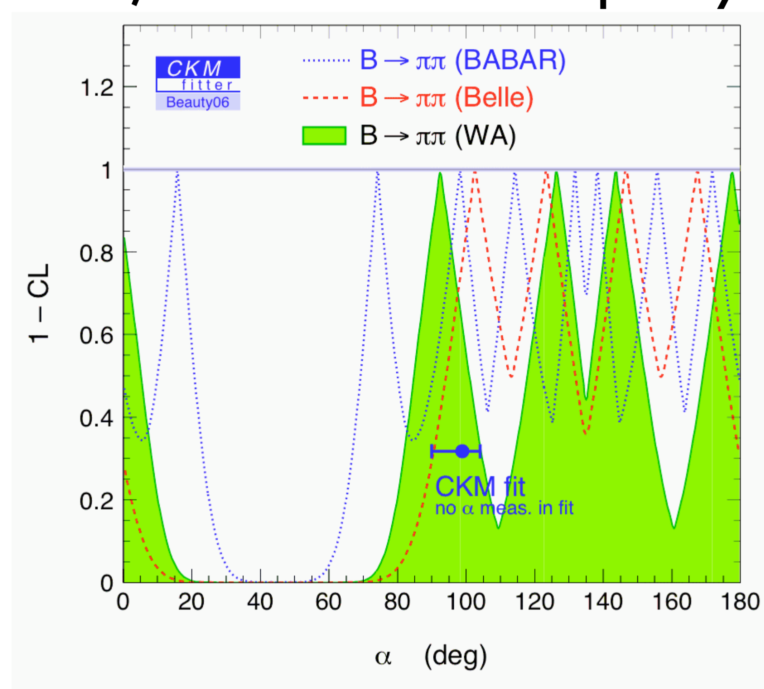
140±25 events

B→ππ isospin analysis



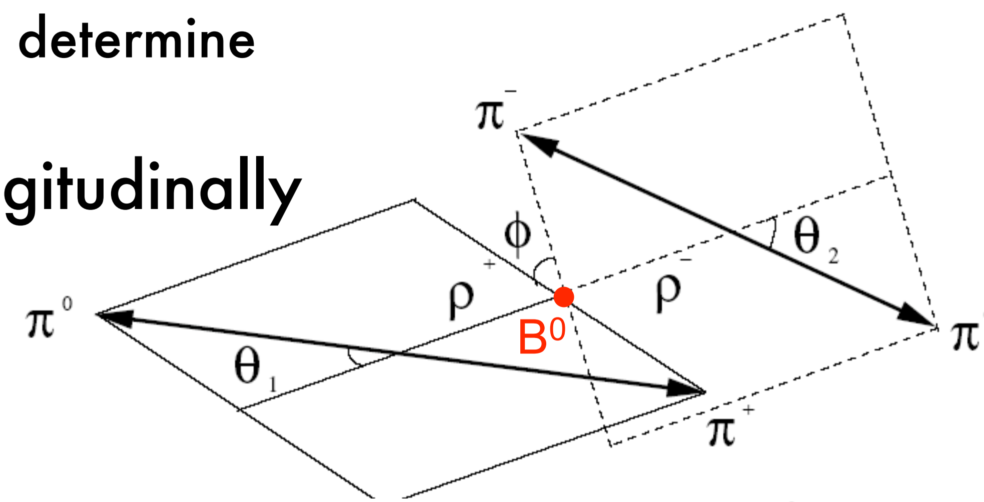


- The measurement of C^{00} is starting to distinguish between possible solutions for $\delta\alpha$.
- Need more data before the dip starts to become significant.
- More data should resolve the Belle/BaBar 2.3σ discrepancy.



Measuring α with B→ρρ decays

- Theory more complicated and experimentally more challenging than ππ.
  - But the data tells us that penguins are better constrained than ππ.
- B→VV decay;
  - Need angular analysis to determine CP content.
- $\rho^+\rho^-$ is almost 100% longitudinally polarized
  - Simplifies analysis a lot!



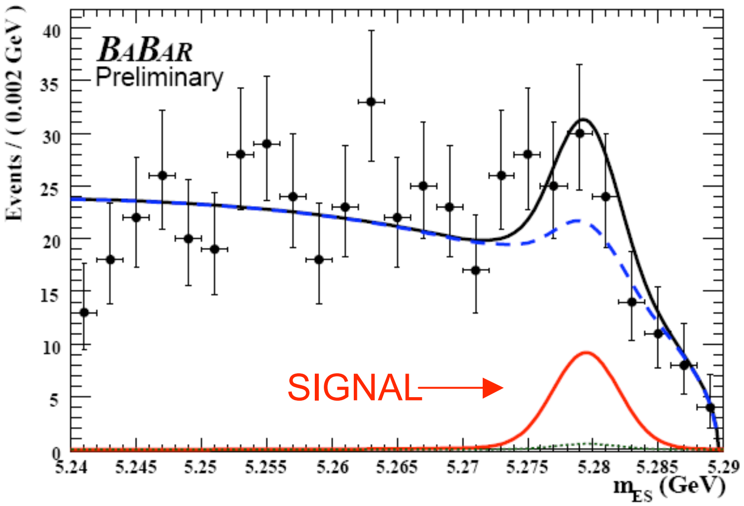
$$\frac{d^2\Gamma}{\Gamma d\cos\theta_1 d\cos\theta_2} = \frac{9}{4}\left(f_L \cos^2\theta_1 \cos^2\theta_2 + \frac{1}{4}(1-f_L)\sin^2\theta_1 \sin^2\theta_2\right)$$

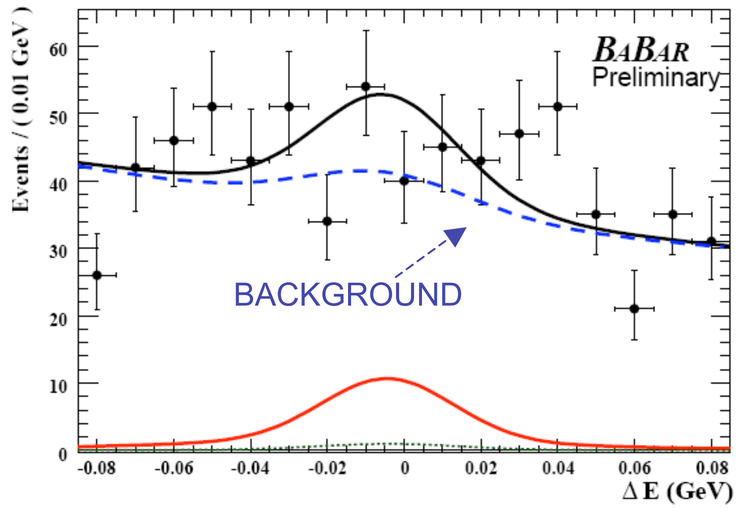
Longitudinal (CP even)

Transverse (Mixed CP state)

One side of the ρρ triangle : $\rho^0\rho^0$

- Updated measurement using 347 M BB pairs - submitted to PRL.





Previous result UL < 1.1×10^{-6} (central value was 0.54×10^{-6})

$$\mathcal{B}(B^0 \to \rho^0\rho^0) = [1.16^{+0.37}_{-0.36}\ (\text{stat.}) \pm 0.27\ (\text{syst.})]\times10^{-6}$$

$$f_L = 0.86^{+0.11}_{-0.13}\ (\text{stat.}) \pm 0.05\ (\text{syst.})$$

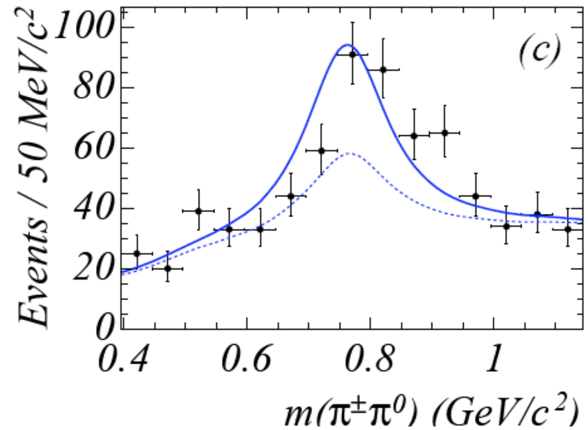
$$N(\rho^0\rho^0) = 98^{+32}_{-31} \pm 22$$
$$N(\rho^0 f^0) = 12^{+18}_{-17} \pm 13$$
$$N(f^0 f^0) = -5^{+7}_{-6} \pm 12$$

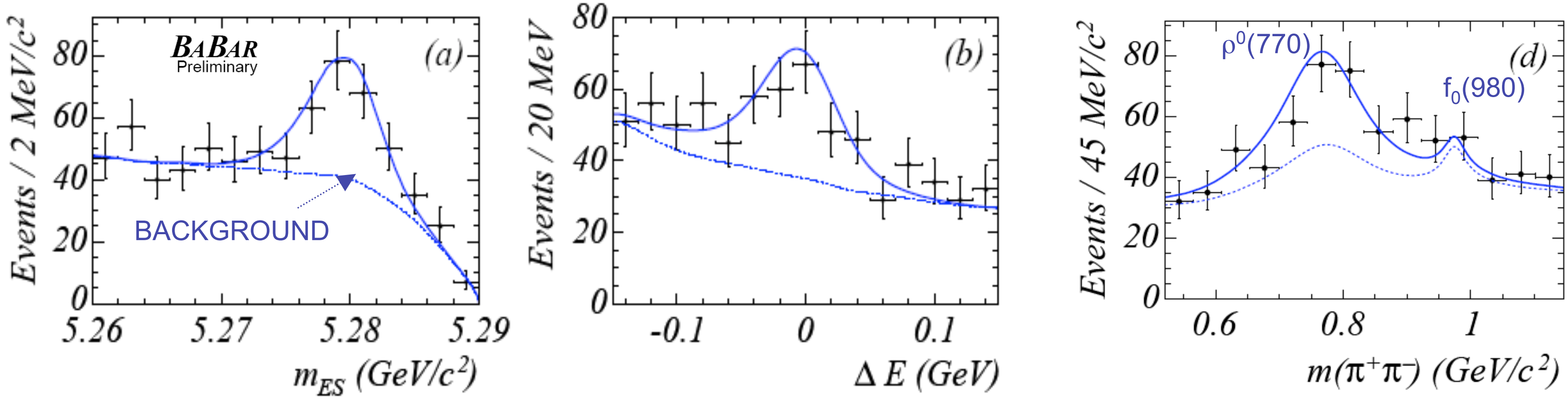
- 3σ evidence for $\rho^0\rho^0$ with systematic errors.
  - Leads to a weaker constraint on penguin pollution.

Another side of the ρρ triangle : $\rho^+\rho^0$

- Updated measurement using 232 M BB pairs.
  - Phys. Rev. Lett. 97, 261801 (2006)
- Simultaneous fit for $B^+ \to \rho^+ f_0(980)$.
- Smaller branching fraction measured (than on Run1+2 data)
  - Leads to a weaker constraint on penguin pollution
  - Fit:

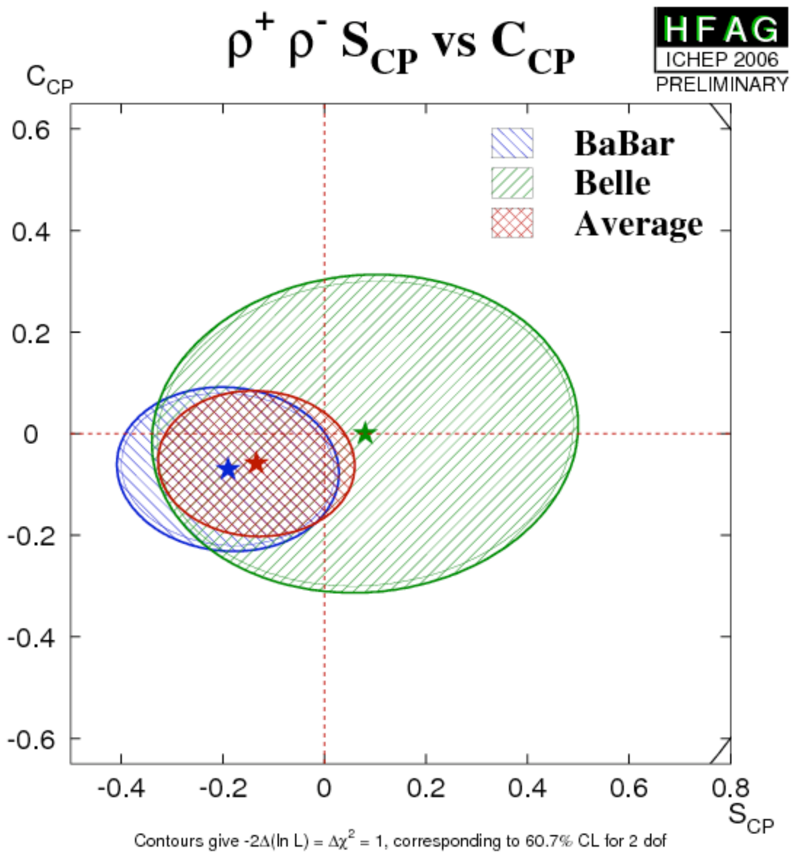
$$390 \pm 49 \text{ events}$$
$$\mathcal{B} = (16.8 \pm 2.2 \pm 2.3) \times 10^{-6}$$
$$f_L = 0.905 \pm 0.042^{+0.023}_{-0.027}$$

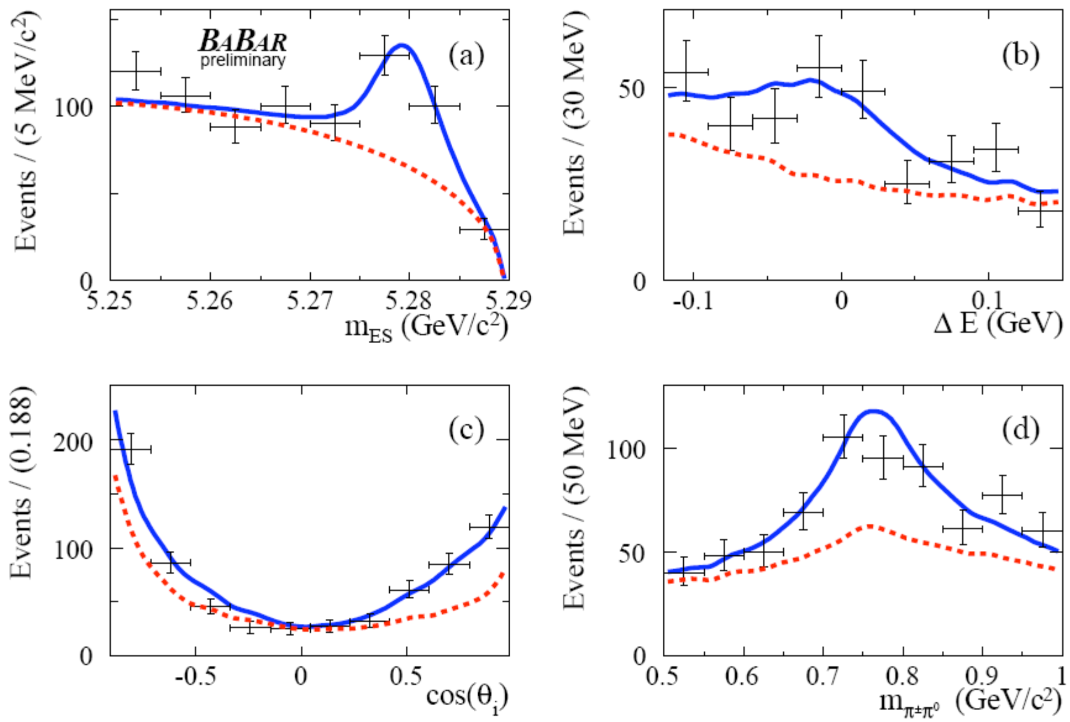




$B^0 \to \rho^+\rho^-$

- 347 M BB pairs.
- hep-ex/0607098.





$$\mathcal{B}(B^0 \to \rho^+\rho^-) = (23.5 \pm 2.2(\text{stat}) \pm 4.1(\text{syst}))\times 10^{-6},$$

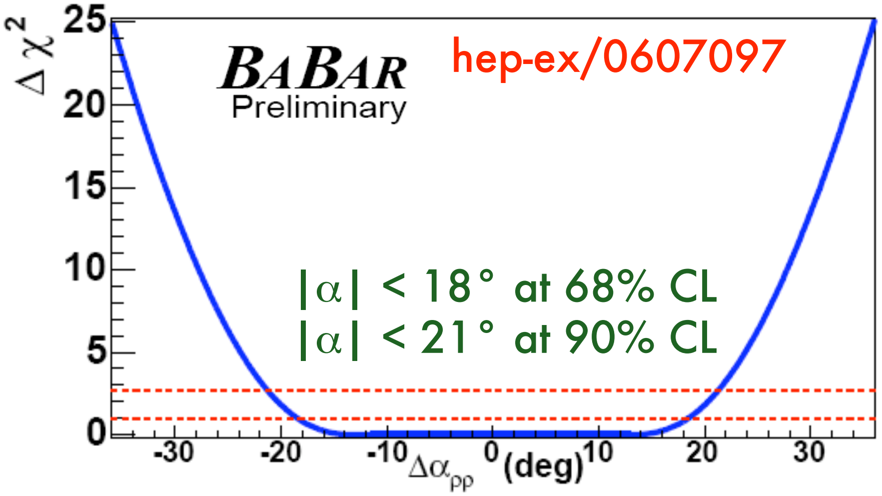
$$f_L = 0.977 \pm 0.024(\text{stat})^{+0.015}_{-0.013}(\text{syst}),$$

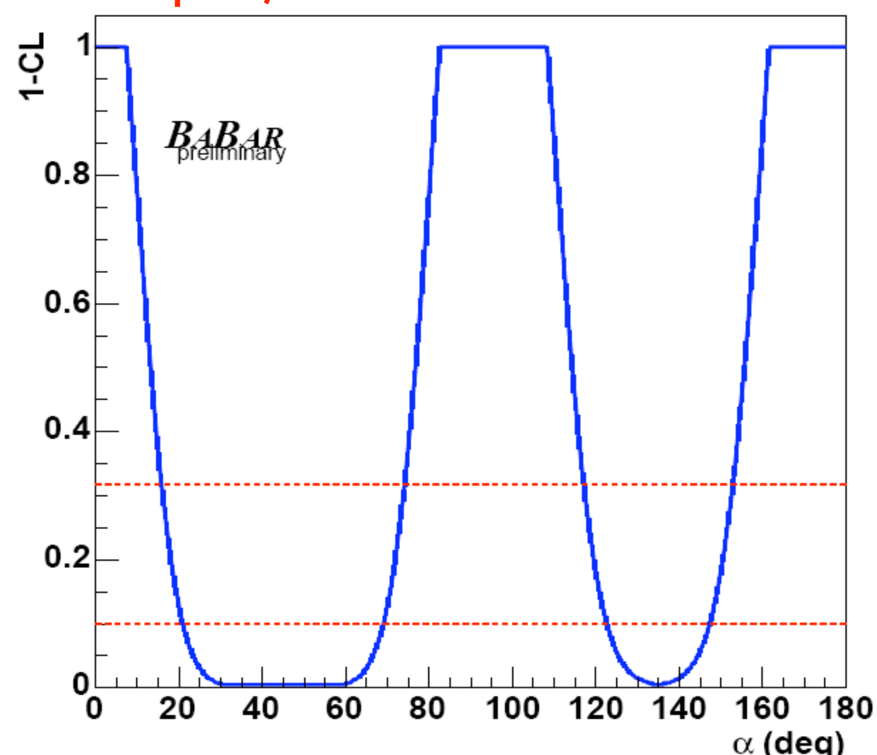
$$S_{\text{long}} = -0.19 \pm 0.21(\text{stat})^{+0.05}_{-0.07}(\text{syst}),$$

$$C_{\text{long}} = -0.07 \pm 0.15(\text{stat}) \pm 0.06(\text{syst}).$$

Updated constraint on α from $B \to \rho\rho$

- Penguin pollution is constrained to be <18° (68% CL).



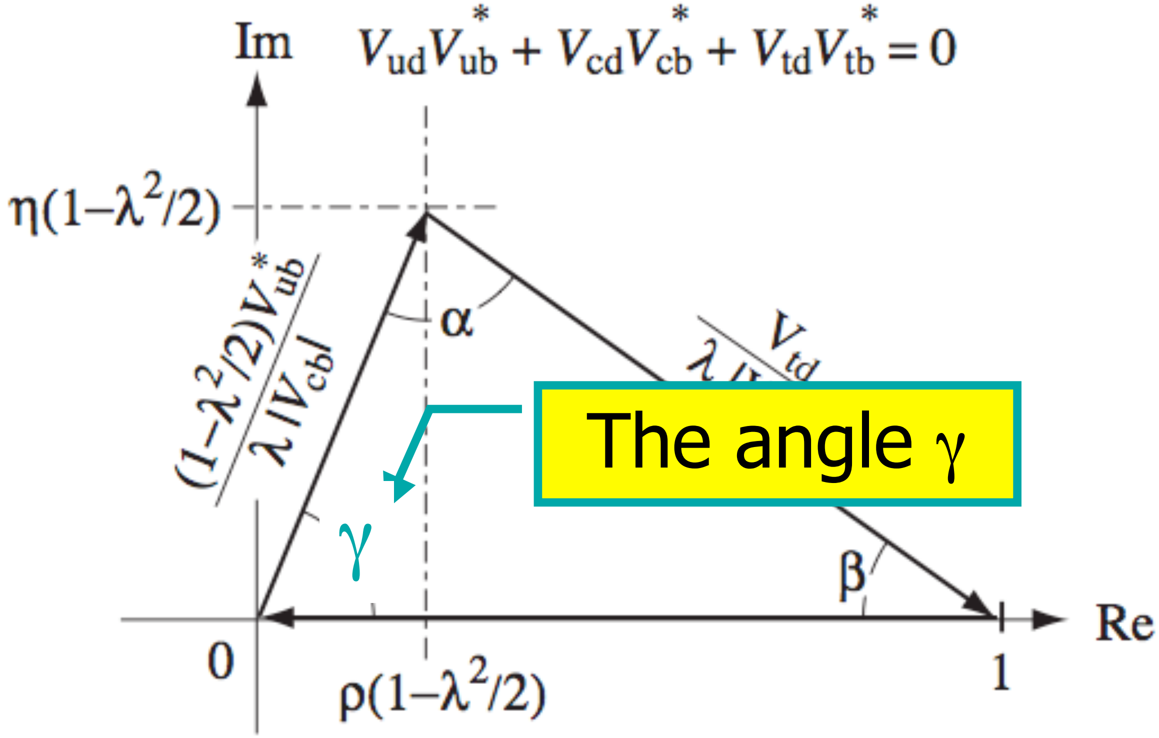


- Combination of:
  - Evidence for $\rho^0\rho^0$
  - Lower branching fraction for $\rho^+\rho^0$

results in a weakened constraint on α (was α=(100±13)°)

$$\alpha_{\rm eff} = (95.5^{+6.9}_{-6.2})^\circ$$
$$\alpha = [74, 117]^\circ \text{ at } 68\% \text{ CL}$$

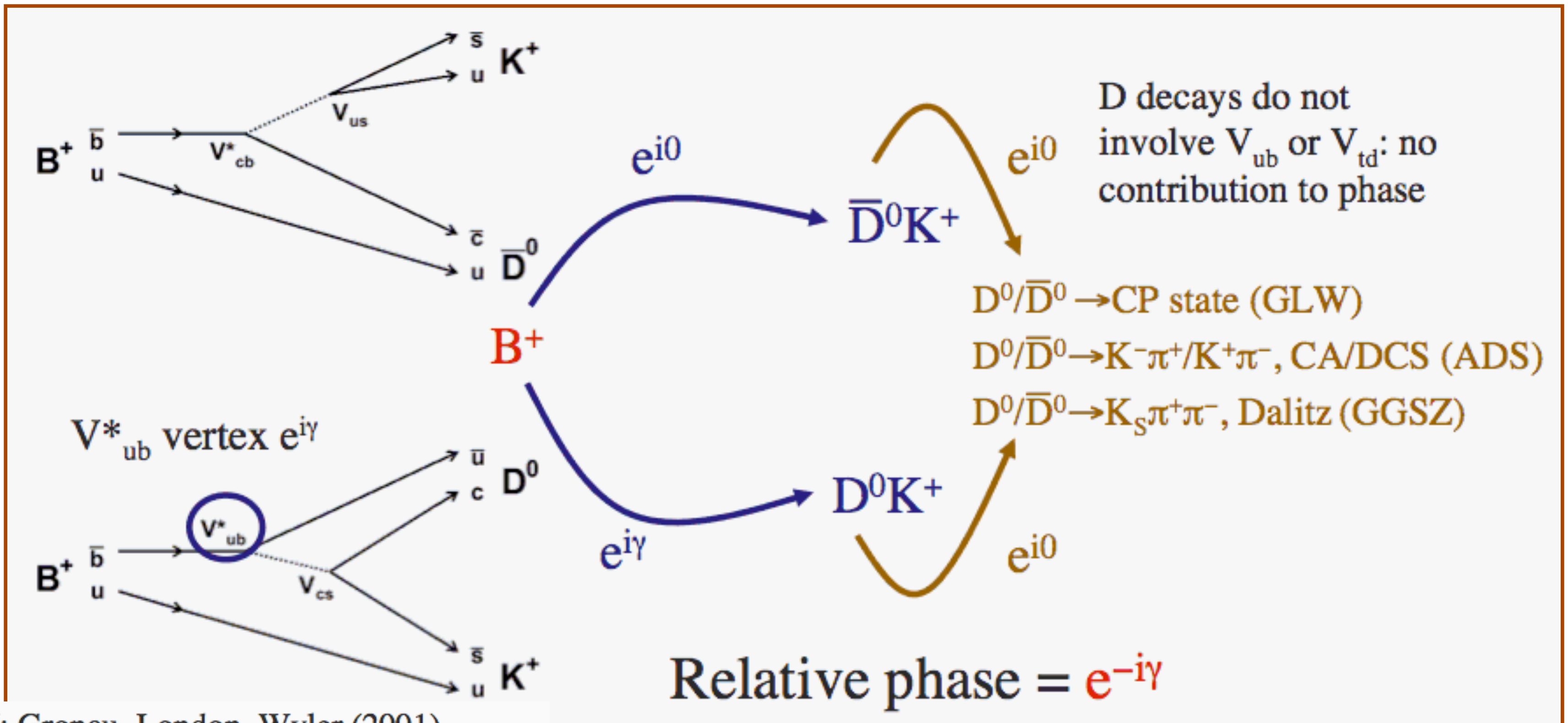
The angle γ



$$\alpha \equiv \arg\left(-\frac{V_{td}V_{tb}^*}{V_{ud}V_{ub}^*}\right), \quad \beta \equiv \arg\left(-\frac{V_{cd}V_{cb}^*}{V_{td}V_{tb}^*}\right), \quad \gamma \equiv \arg\left(-\frac{V_{ud}V_{ub}^*}{V_{cd}V_{cb}^*}\right)$$

The angle γ

- No 'golden channel for γ.
- Combine measurements from several theoretically clean modes e.g. $B^+ \to D^{(*)}K^{(*)}$.
- Measure γ with direct CP violation from interference when D^0 and $\bar{D}^0$ decay to the same final state.



GLW: Gronau, London, Wyler (2001)
ADS: Atwood, Dunietz, Soni (1997)
GGSZ: Giri, Grossman, Soffer, Zupan (2003)

The angle γ

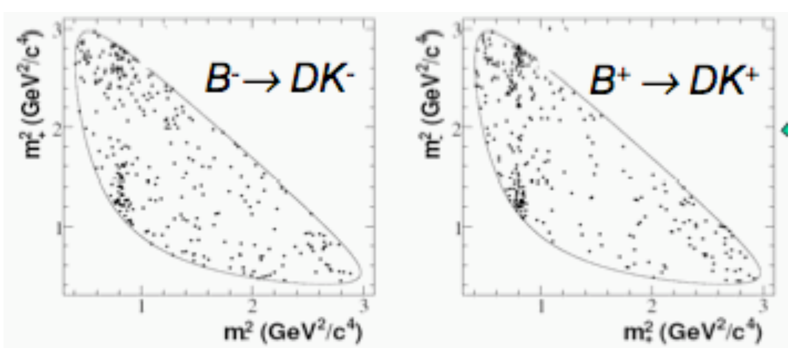
- γ from $B \to D^{(*)0}K$, $D^0 \to K_S\pi\pi$ — UPDATED, 347M BB
- γ from $B \to D^0K^*$, $D^0 \to K_S\pi\pi$ — OLD, 227M BB
- Additional constraints & combined γ result from
  - $B^- \to D^0K$, $D^0 \to K^+\pi^-\pi^0$ — NEW, 227M BB
  - $B^- \to D^{(*)0}K^{(*)-}$, $D^0 \to K^+\pi^-$ — PUBLISHED, 232M BB
  - $B^- \to D^{(*)0}_{CP}K^{(*)-}$ — UPDATED & PUBLISHED, 232M BB

Different observables
"Dalitz"
"ADS"
"GLW"

- Dalitz analyses most promising …

γ from $B \to D^{(*)0}K$, $D^0 \to K_S\pi\pi$: results

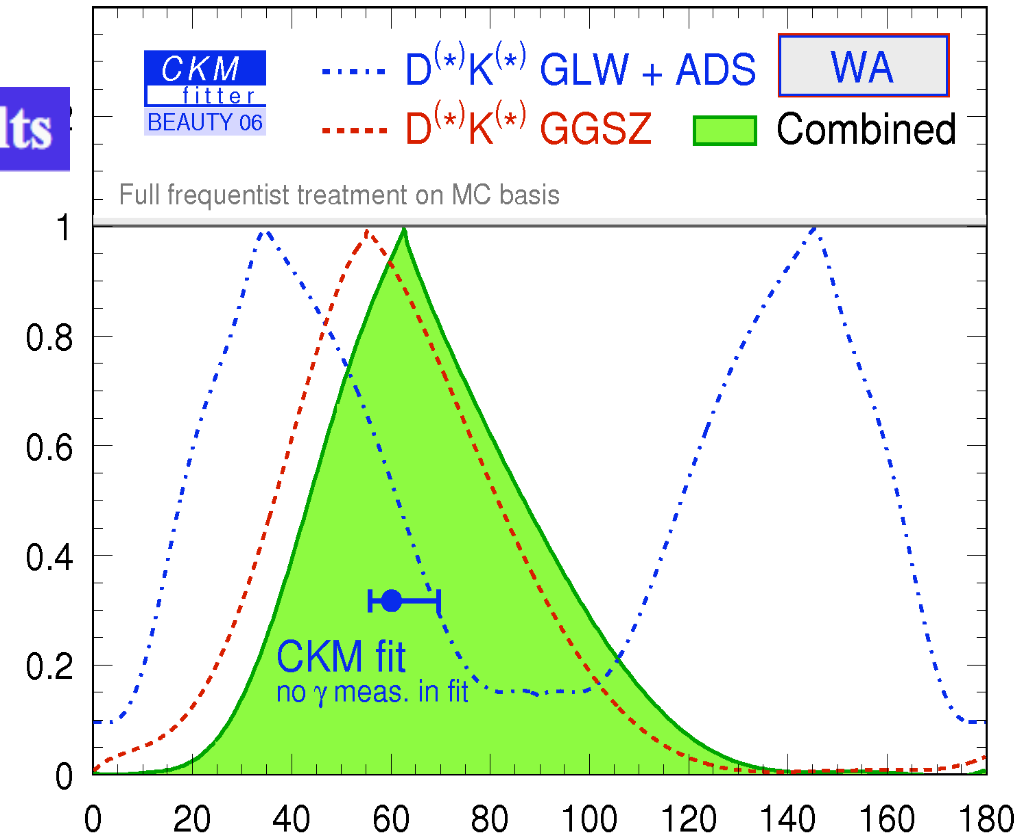
347 *10⁶ BB pairs
BABAR-CONF-06/038



$$\gamma \bmod 180° = (92 \pm 41 \pm 11 \pm 12)°$$

Stat Syst Dalitz

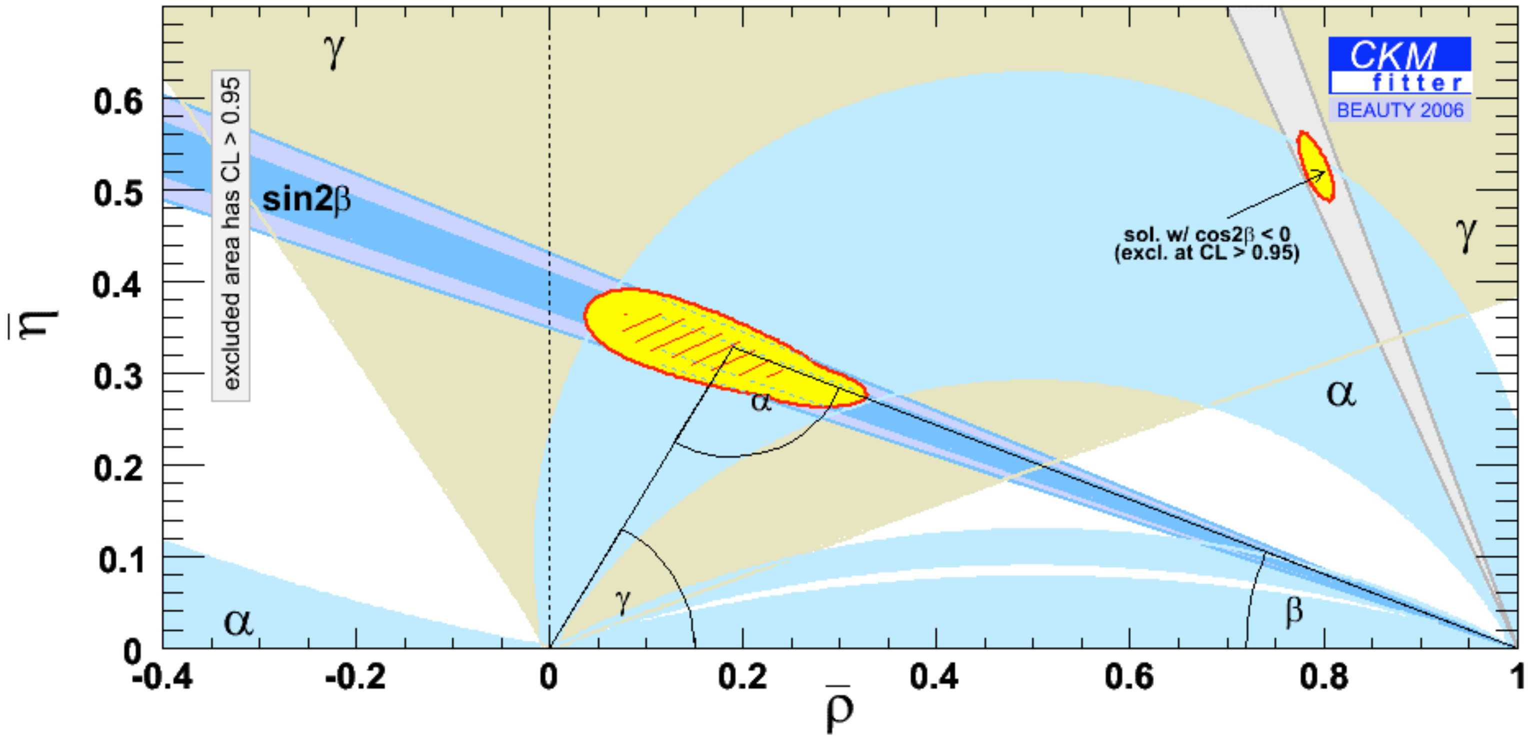
- Indirect constraint: $\gamma = 59^{+9}_{-4}\,°$

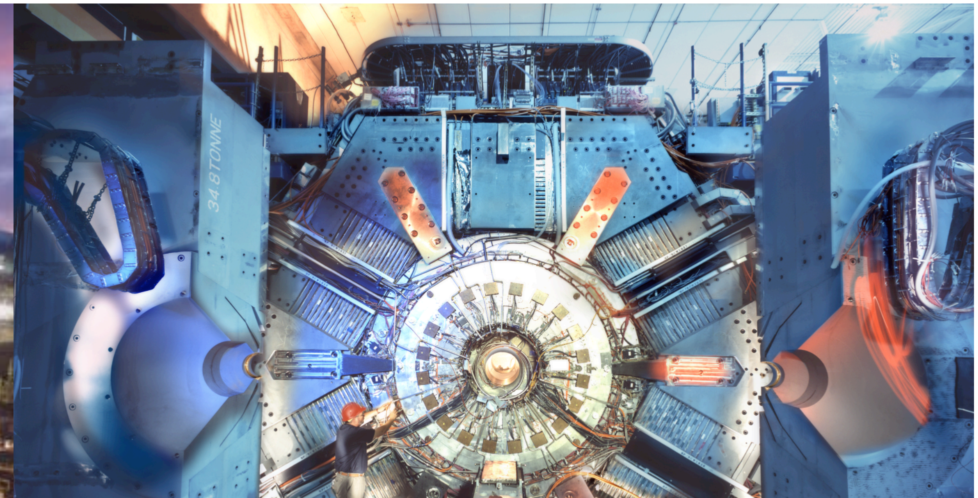


$\gamma[\text{combined}] = 62^{+38}_{-24}\,°$.

The UT today

Angles from *CP* asymmetries



Other results … not just from *B* decays

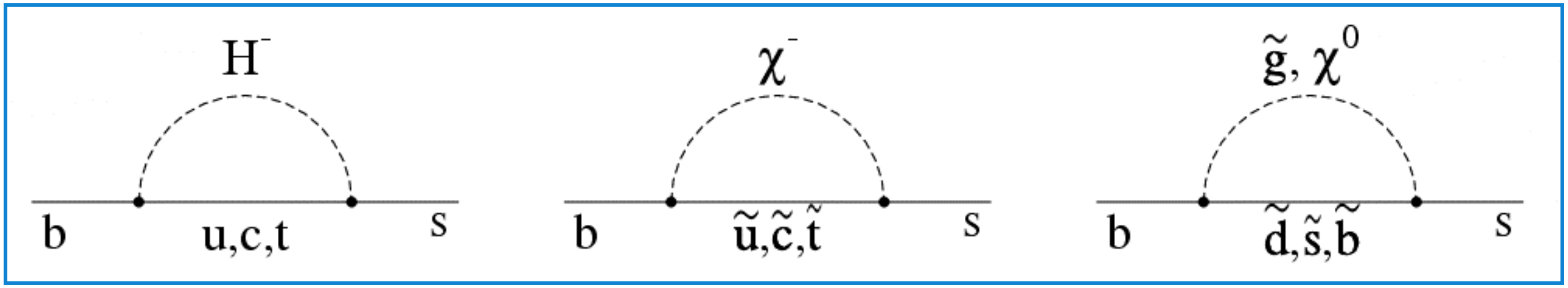

Other results … not just from *B* decays

Many new results from BaBar in the tau, charm and EW penguin sectors, also rare B decays, charmonium spectroscopy, ….

Radiative B decays : Flavor Changing Neutral Currents

- FCNC processes are sensitive to new particles in loops

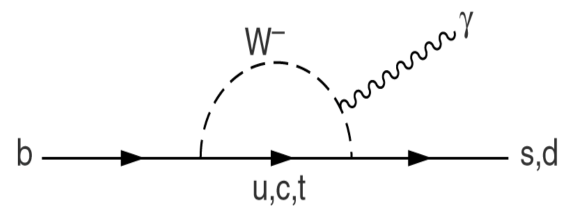
Higher mass particles
can contribute via loop



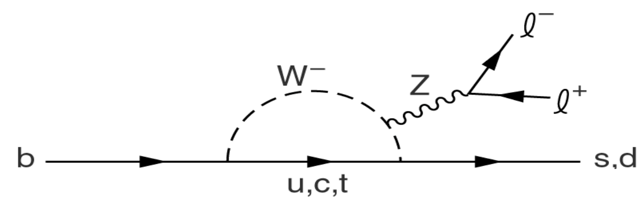
Radiative B decays : Flavor Changing Neutral Currents

- FCNC processes are sensitive to new particles in loops
  - b to sγ : inclusive and exclusive measurements
  - b to sl^+l^- : additional signatures from kinematics
  - b to dγ : further suppressed in SM.
  - b to dl^+l^- : still looking ….

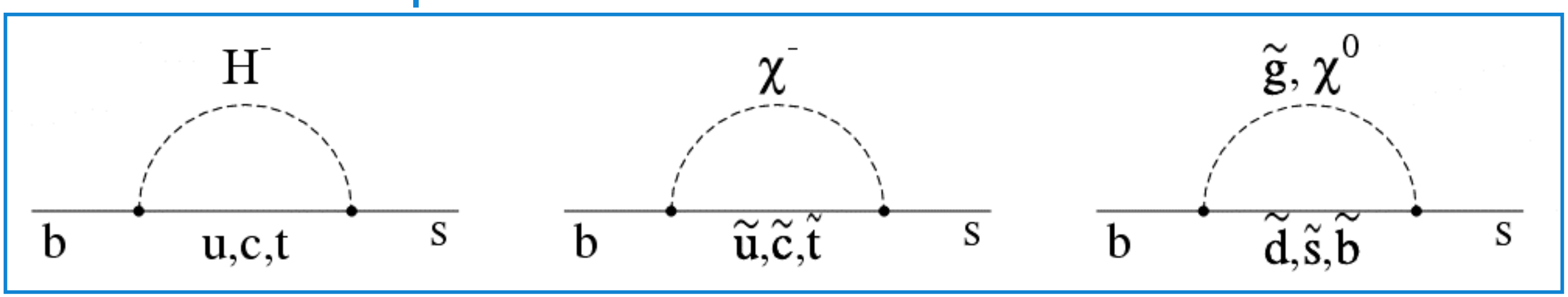
$B \rightarrow K^{(*)} l^+ l^-$



$B \rightarrow \rho/\omega\, \gamma$



Higher mass particles
can contribute via loop



Radiative B decays : Flavor Changing Neutral Currents

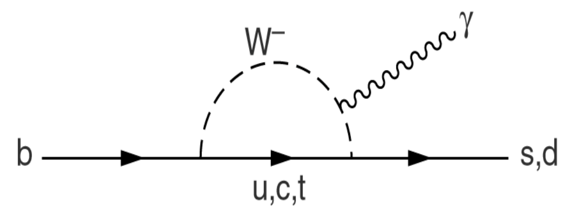
- FCNC processes are sensitive to new particles in loops
  - b to sγ : inclusive and exclusive measurements
  - b to sl^+l^- : additional signatures from kinematics
  - b to dγ : further suppressed in SM.
  - b to dl^+l^- : still looking ....

$B \rightarrow \pi\, l^+ l^-$

hep-ex/0607048

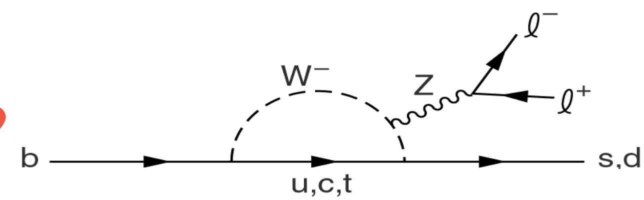
$B \rightarrow K^{(*)}\, l^+ l^-$

Phys.Rev. D73 (2006) 092001

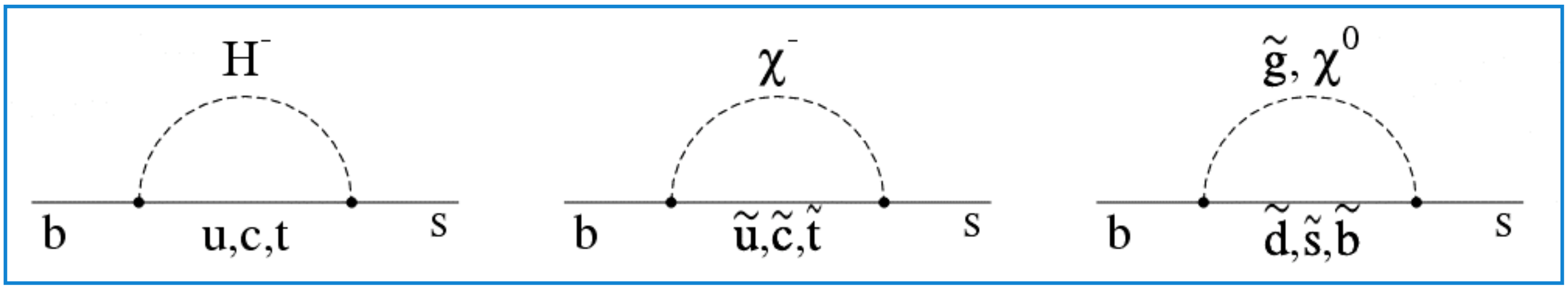


$B \rightarrow \rho/\omega\, \gamma$

hep-ex/0607099
Submitted to PRL



Higher mass particles can contribute via loop



Extraction of $|V_{td}/V_{ts}|$ with $B \to \rho(\omega)\gamma$ decays

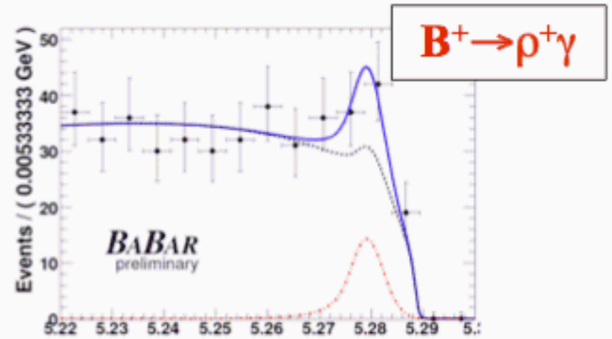
$$\frac{\overline{BF}(B \to (\rho/\omega)\gamma)}{BF(B \to K^*\gamma)} = \left|\frac{V_{td}}{V_{ts}}\right|^2 \left(\frac{1 - m_\rho^2/M_B^2}{1 - m_{K^*}^2/M_B^2}\right)^3 \zeta^2 [1 + \Delta R]$$

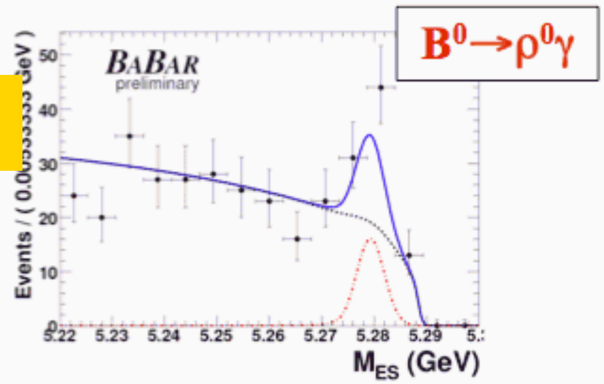
SU(3) breaking corrections:

Form factor ratio $1/\zeta = 1.17 \pm 0.09$ *hep-ph/0603232*	Annihilation amplitude corrections $\Delta R = 0.1 \pm 0.1$

A.Ali, A.Parhomenko hep-ph

- Use SU(3) to relate $B^0 \to \rho(\omega)\gamma$ to $B^0 \to K^*\gamma$
- **Reconstructed decays:**
  - $B \to \rho^+\gamma$, $\rho^+ \to \pi^+\pi^0$
  - $B \to \rho^0\gamma$, $\rho^0 \to \pi^+\pi^-$
  - $B \to \omega\gamma$, $\omega \to \pi^+\pi^-\pi^0$
- Belle : Observed $\rho\gamma$ in 2005
  - $\Rightarrow$ First direct measurement of $|V_{td}/V_{ts}|$
- BaBar : Confirmed Belle $\rho^0(\omega)\gamma$
  - First evidence for $B^+ \to \rho^+\gamma$





316 /fb

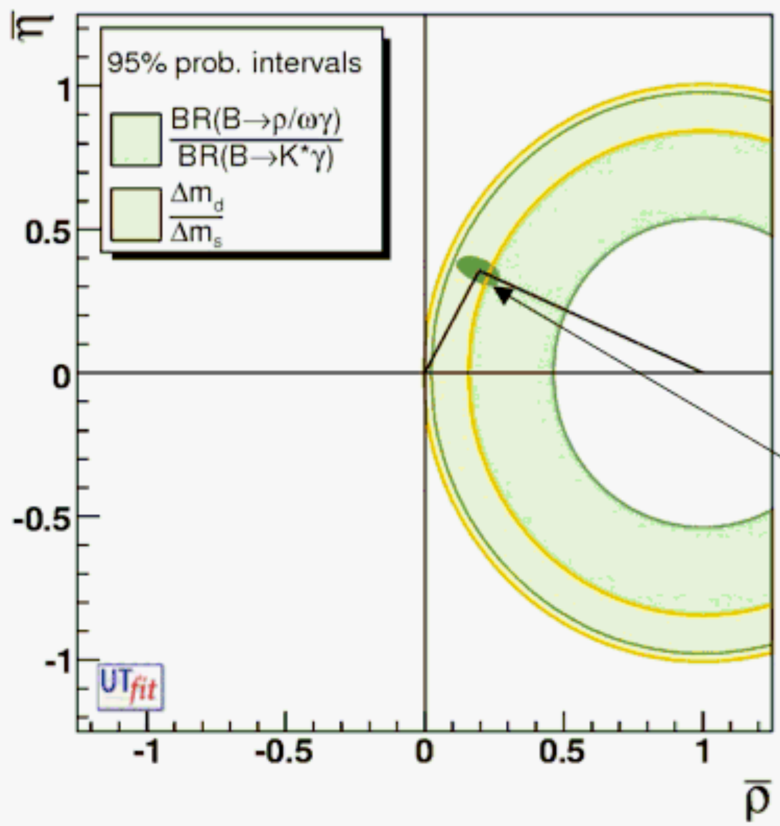
Mode	n_{sig}	Significance	$\epsilon(\%)$	$\mathcal{B}(10^{-6})$
$B^+ \to \rho^+\gamma$	$42.4^{+14.1}_{-12.6}$	4.1σ	11.6	$1.06^{+0.35}_{-0.31} \pm 0.09$
$B^0 \to \rho^0\gamma$	$38.7^{+10.6}_{-9.8}$	5.2σ	14.5	$0.77^{+0.21}_{-0.19} \pm 0.07$
$B^0 \to \omega\gamma$	$11.0^{+6.7}_{-5.6}$	2.3σ	8.1	$0.39^{+0.24}_{-0.20} \pm 0.03$

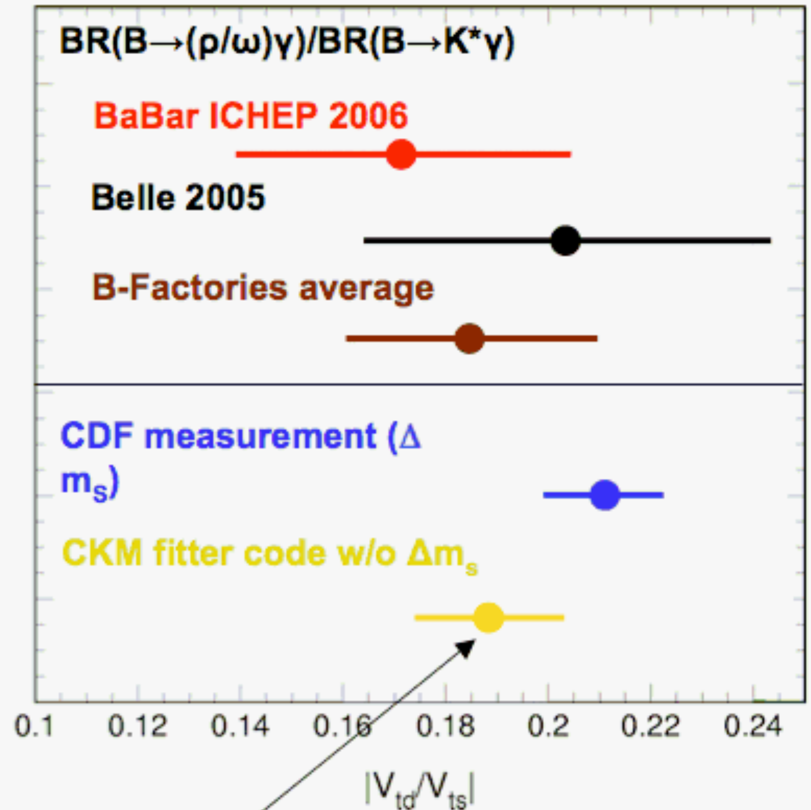
Extraction of $|V_{td}/V_{ts}|$ with $B \to \rho(\omega)\gamma$ decays

Combined fit result:

$$\overline{\mathrm{BF}}[B \to (\rho/\omega)\gamma] = (1.01 \pm 0.21 \pm 0.08) \times 10^{-6}$$

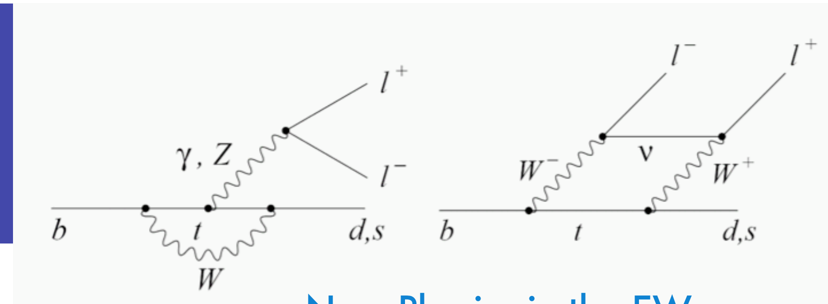
$$\left|\frac{V_{td}}{V_{ts}}\right| = 0.171^{+0.018}_{-0.021}(\mathrm{exp})^{+0.017}_{-0.014}(\mathrm{theory})$$





Global CKM fit excluding Δm_s and $B \to \rho(\omega)\gamma$

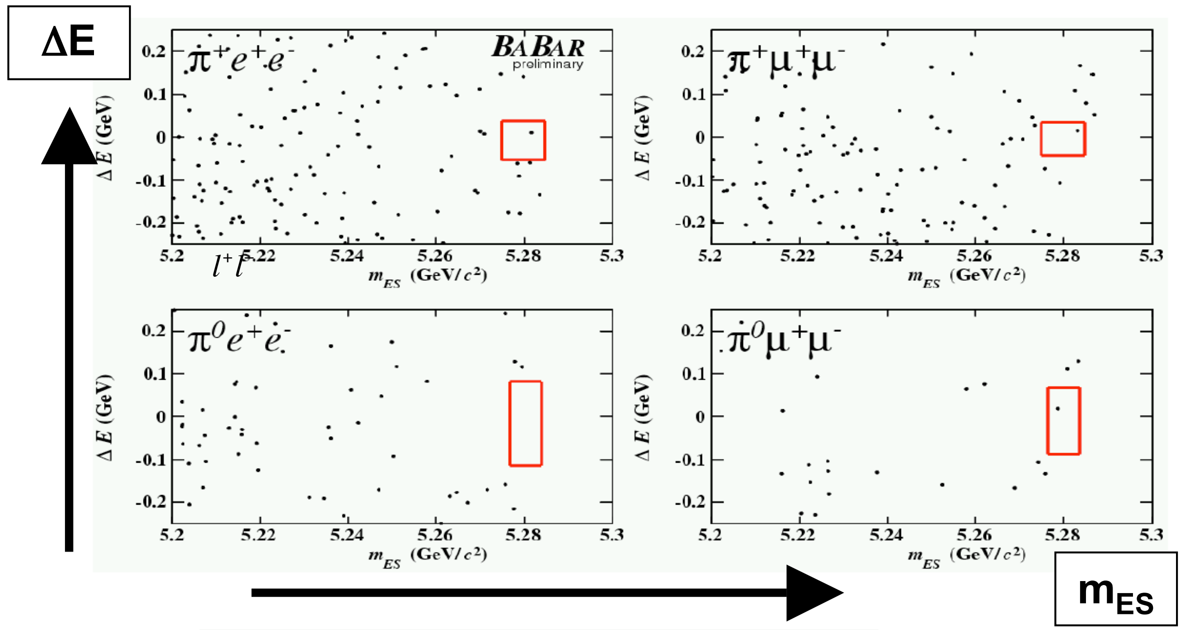
Search for B $\to \pi\, l^+ l^-$



New Physics in the EW penguin and box diagrams ?

- Reconstruct $B \to \pi\ell^+\ell^- \ (\pi = \pi^+ \text{or } \pi^0)$ and perform cut-and-count analysis in m_{ES} and ΔE
- Last measurement by Mark-II experiment (1990).
- ICHEP'06 preliminary
  - 232 M BB pairs

Mode	BF UL 90% C.L. (10^{-7})
$B^+ \to \pi^+ e^+ e^-$	1.72
$B^0 \to \pi^0 e^+ e^-$	1.29
$B^+ \to \pi^+ \mu^+ \mu^-$	2.47
$B^0 \to \pi^0 \mu^+ \mu^-$	4.56
$B^+ \to \pi^+ e^+ \mu^-$	1.72
$B^0 \to \pi^0 e^+ \mu^-$	1.50

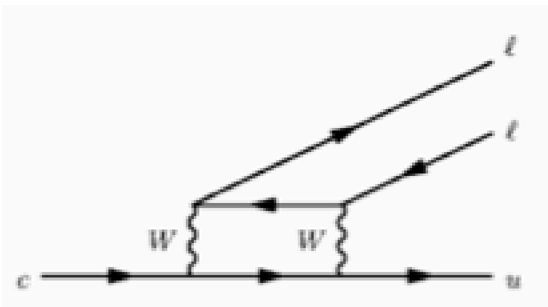


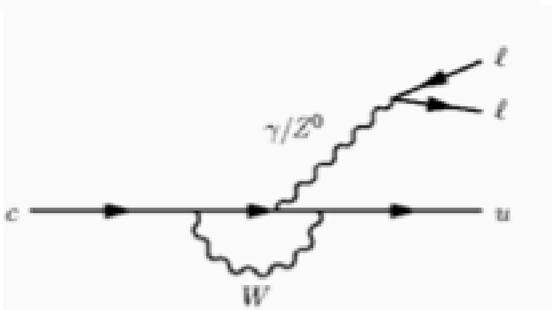
- Standard Model prediction: $\mathrm{BF}[B \to \pi l^+ l^-] = 3\times10^{-8}$
- Find: $\mathcal{B}(B^+ \to \pi^+\ell^+\ell^-) = 2 \times \frac{\tau_{B^+}}{\tau_{B^0}} \mathcal{B}(B^0 \to \pi^0\ell^+\ell^-) < 7.9 \times 10^{-8}$
- Standard Model limit is just around the corner .... ?

Flavor Changing Neutral Currents in D decays

- Searches for rare FCNC decays $X_C \to X_u l^+ l^-$

charm hadron (X_C) · π, K, p (X_u) · e,μ ($l^+ l^-$)

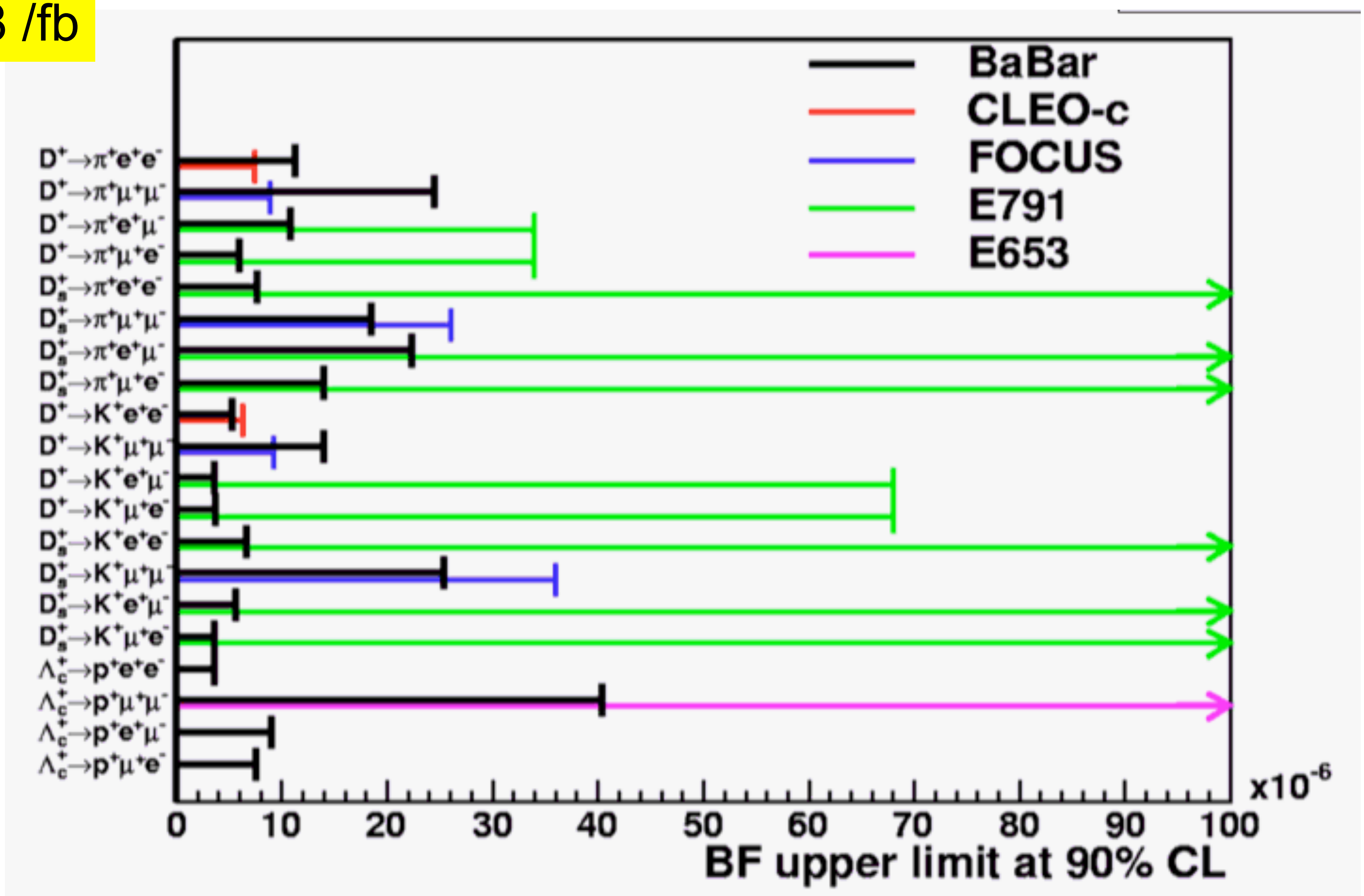




- Standard Model expectation
  $$B(X_c \to X_u l^+ l^-) = O(10^{-8})$$
- New physics e.g. R-parity violating SUSY may enhance the rate:
  $$B(X_c \to X_u l^+ l^-) \le O(10^{-5})$$

Flavor Changing Neutral Currents in D decays

288 /fb



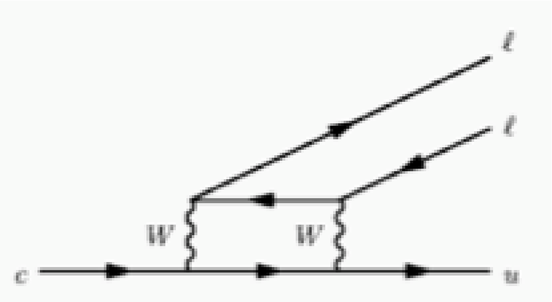
Flavor Changing Neutral Currents in D decays

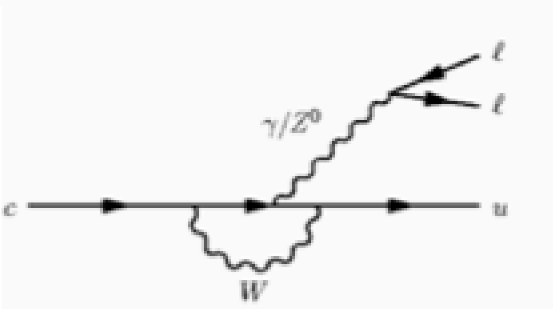
- Searches for rare FCNC decays $X_C \to X_u l^+ l^-$

charm hadron (X_C)

π, K, p (X_u)

e, μ ($l^+ l^-$)



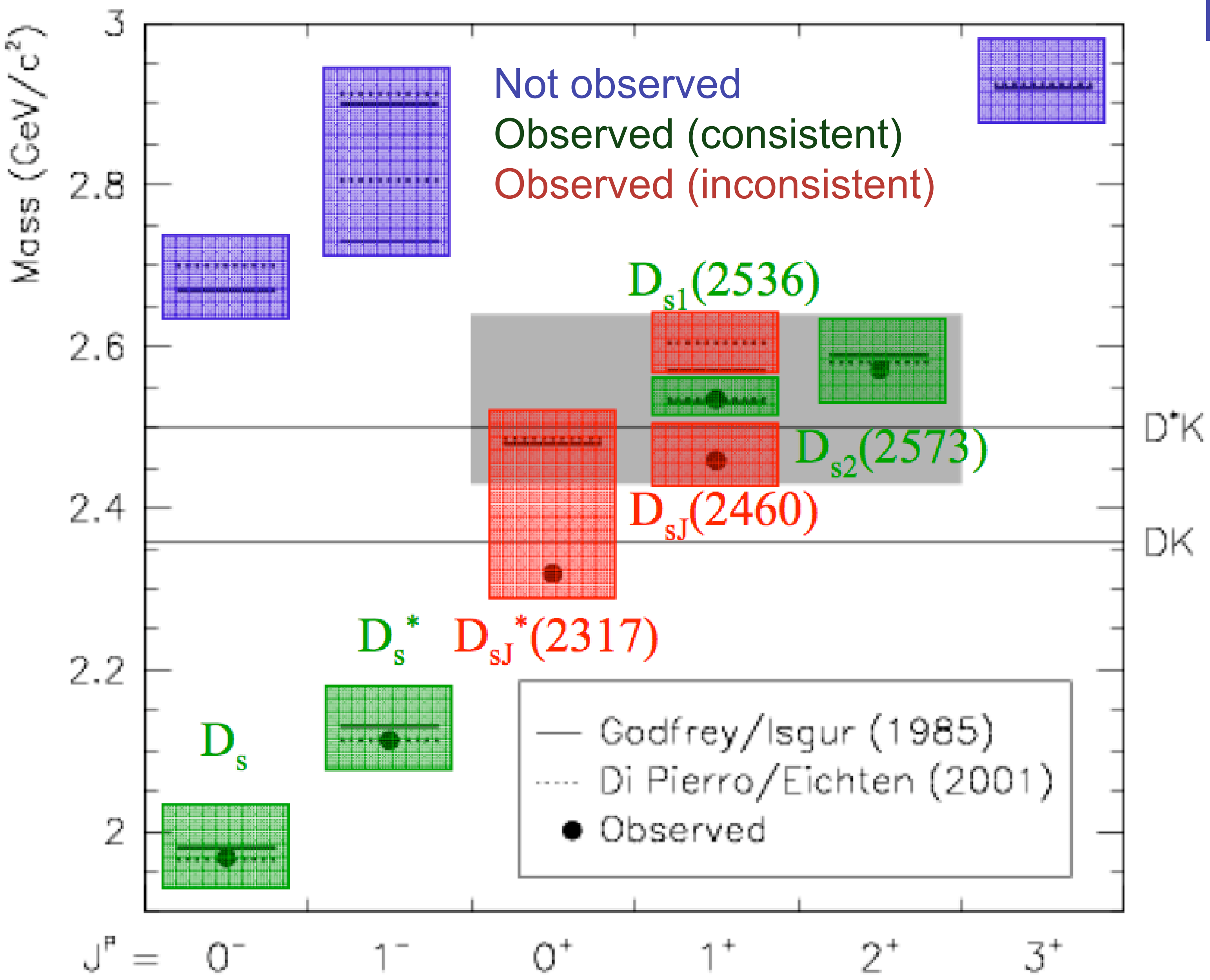


- Standard Model expectation
  $$B(X_c \to X_u l^+ l^-) = O(10^{-8})$$
- New physics e.g. R-parity violating SUSY may enhance the rate:
  $$B(X_c \to X_u l^+ l^-) \leq O(10^{-5})$$

- BaBar measures all of the $X_C \to X_u l^+ l^-$ modes
- Upper limits $\sim O(10^{-5} - 10^{-6})$
  - Many better than other experiments (hep-ex/0607051)

Mesonic ($\bar{c}s$) charm states

Run 1- 5 ≈ 480 M cc pairs



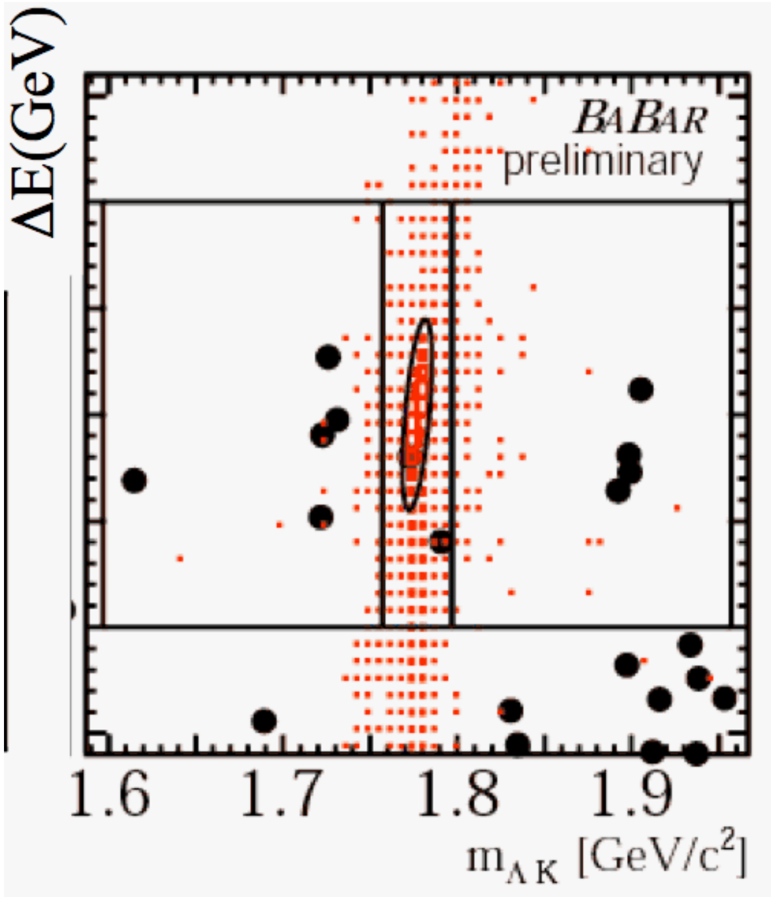
Meson	Mass, Width	Branching Ratio
$D_{sJ}^*(2317)^+$	$m = (2319.6 \pm 0.2 \pm 1.4) MeV/c^2$ $\Gamma < 3.8 MeV/c^2$	Upper limits (UL) for $D_s\gamma$, $D_s\pi^0\pi^0$, $D_s\gamma\gamma$, $D_s^*\gamma$, $D_s\pi\pi$
$D_{sJ}(2460)^+$ hep-ex/0605036	$m = (2460.1 \pm 0.2 \pm 0.8) MeV/c^2$ $\Gamma < 3.5 MeV/c^2$	UL for $D_s\pi^0(\pi^0)$, $D_s^*(2317)\gamma$, $D_s\gamma\gamma$, $D_s^*\gamma(,\pi^0)$ $\frac{B(D_s^+\gamma)}{B(D_s^+\pi^0\gamma)} = 0.337 \pm 0.036 \pm 0.38$ $\frac{B(D_s^+\pi^+\pi^-)}{B(D_s^+\pi^0\gamma)} = 0.077 \pm 0.013 \pm 0.008$ $B(D_{sJ}(2460)^+ \to D_s^{*+}\pi^0) = (56 \pm 13 \pm 9)\%$
$D_{s1}(2536)^+$	$\Delta m = (524.85 \pm 0.02 \pm 0.04) MeV/c^2$ $\Gamma = (1.03 \pm 0.05 \pm 0.12) MeV/c^2$	-
$D_{s2}(2573)^+$	$m = (2572.2 \pm 0.3 \pm 1.0) MeV/c^2$ $\Gamma = (27.1 \pm 0.6 \pm 5.6) MeV/c^2$	-
$D_{sJ}(2860)^+$	$m = (2856.6 \pm 1.5 \pm 5.0) MeV/c^2$ $\Gamma = (47 \pm 7 \pm 10) MeV/c^2$	-

Meson	Mass, Width	Branching Ratio
$D_{sJ}^{*}(2317)^{+}$	$m = (2319.6 \pm 0.2 \pm 1.4) MeV/c^2$ $\Gamma < 3.8 MeV/c^2$	Upper limits (UL) for $D_s\gamma$, $D_s\pi^0\pi^0$, $D_s\gamma\gamma$, $D_s^*\gamma$, $D_s\pi\pi$
$D_{sJ}(2460)^{+}$ hep-ex/0605036	$m = (2460.1 \pm 0.2 \pm 0.8) MeV/c^2$ $\Gamma < 3.5 MeV/c^2$	UL for $D_s\pi^0(\pi^0)$, $D_s^*(2317)\gamma$, $D_s\gamma\gamma$, $D_s^*\gamma(,\pi^0)$ $\frac{B(D_s^+\gamma)}{B(D_s^+\pi^0\gamma)} = 0.337 \pm 0.036 \pm 0.38$ $\frac{B(D_s^+\pi^+\pi^-)}{B(D_s^+\pi^0\gamma)} = 0.077 \pm 0.013 \pm 0.008$ $B(D_{sJ}(2460)^+ \to D_s^{*+}\pi^0) = (56 \pm 13 \pm 9)\%$
$D_{s1}(2536)^{+}$	$\Delta m = (524.85 \pm 0.02 \pm 0.04) MeV/c^2$ $\Gamma = (1.03 \pm 0.05 \pm 0.12) MeV/c^2$	
$D_{s2}(2573)^{+}$	$m = (2572.2 \pm 0.3 \pm 1.0) MeV /$ $\Gamma = (27.1 \pm 0.6 \pm 5.6) MeV / c$	
$D_{sJ}(2860)^{+}$	$m = (2856.6 \pm 1.5 \pm 5.0) MeV/c^2$ $\Gamma = (47 \pm 7 \pm 10) MeV/c^2$	-

- Picture of D_{sJ} particles is now better described.
- Inconsistency with models concerning masses.
- More statistics will help esp. for determining widths.

Searches for baryon and lepton number violation in τ decays

- Search for both B-L conserved and violating processes
- B-L conservation : allowed in the SM
- B-L violation : baryogenesis may require a Δ(B-L) = 2 component

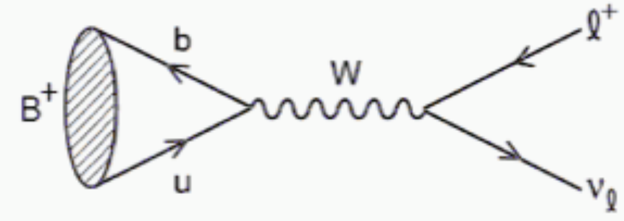


hep-ex/0607040

Channel	B-L	Background	N	@90% CL
$\tau^- \to \bar{\Lambda}\pi^-$	C	0.42±0.42	0	<5.94 10^{-8}
$\tau^- \to \Lambda\pi^-$	V	0.56±0.56	0	<5.76 10^{-8}
$\tau^- \to \bar{\Lambda}K^-$	C	0.26±0.26	0	<7.19 10^{-8}
$\tau^- \to \Lambda K^-$	V	0.12±0.12	1	<14.6 10^{-8}

Leptonic B decays

$B^+ \to (e^+, \mu^+, \tau^+)\nu$



$$\mathcal{B}(B^+ \to l^+ \nu_l) = \frac{G_F^2 m_B m_l^2}{8\pi}\left(1 - \frac{m_l^2}{m_B^2}\right) f_B^2 |V_{ub}|^2 \tau_B$$

- Standard Model (SM) branching fractions:
  e: $O(10^{-12})$ μ: $O(10^{-7})$ τ: $O(10^{-4})$

229 M BB

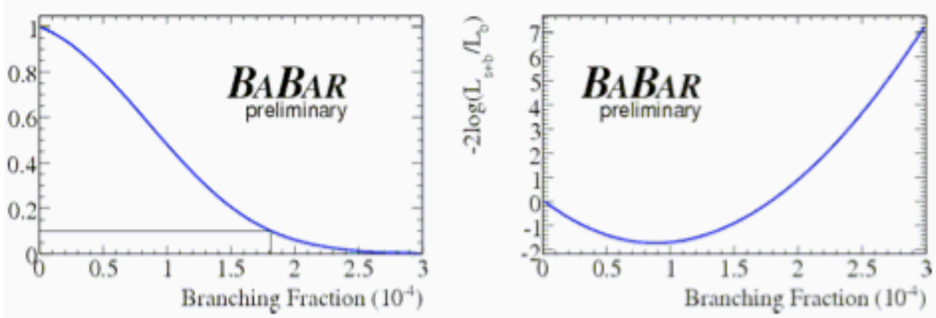
$BR(B^+ \to e^+ \nu) < 7.9 \times 10^{-6}$ at the 90% C.L.
$BR(B^+ \to \mu^+ \nu) < 6.2 \times 10^{-6}$ at the 90% C.L.

324 M BB

PRELIMINARY

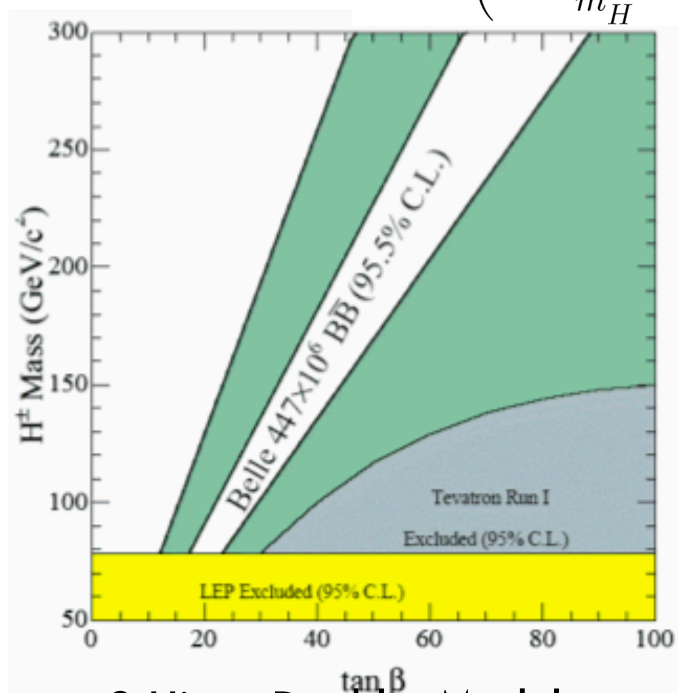
$BR(B^+ \to \tau^+ \nu) < 1.8 \times 10^{-4}$ at the 90% CL

$BR(B^+ \to \tau^+ \nu) = (0.88^{+0.68}_{-0.67}(stat.) \pm 0.11(syst.)) \times 10^{-4}$



$f_B |V_{ub}| = \left|7.0^{+2.3}_{-3.6}(stat.)^{+0.4}_{-0.5}(syst.)\right| \times 10^{-4}$ GeV

- τ mode: current sensitivity at SM level
  - W (suppressed by V_{ub}) can be replaced by e.g. charged Higgs to enhance/suppress branching fraction by factor $r_H = \left(1 - \frac{m_B^2}{m_H^2}\tan^2\beta\right)^2$



e.g. 2 Higgs Doublet Model
W.S. Hou, PRD **48**, 2342 (1993).

BaBar at ICHEP'06

- http://www-public.slac.stanford.edu/babar/ICHEP06_talks.htm

BaBar Talks at ICHEP 2006

The BaBar Collaboration presented its 114 new results in 24 parallel session talks and two plenary talks.

Plenary sessions

Measuring Vub: measurements related to gamma and semileptonic B decays (R. Kowlewski)

Rare B and Tau decays and the search for New Physics (R. Barlow)

Heavy Quark Session

1. Hot Topics in Heavy Quark Physics (U. Mallik)
2. Study of B decays to Open Charm final states with the BaBar experiment (G. Calderini)
3. Study of the decays of Charm mesons with the BaBar experiment (M. Bondioli)
4. Study of two-body Charmless B decays with the BaBar experiment (M. Bona)
5. Study of multi-body Charmless B decays with the BaBar experiment (T. Latham)
6. Shape function from radiative B decays with the BaBar experiment (M. Convery)
7. b-->c lnu decays and measurement of Vcb with the BaBar experiment (R. Dubitzky)
8. b-->u lnu decays and measurement of Vub with the BaBar experiment (R. Dubitzky)

CKM physics Session

1. Measurements of Charmless hadronic Branching Fractions (E. Di Marco)
2. Measurements of the CP angle alpha with the BaBar experiment (A. Telnov)
3. Measurements of the CP angle gamma with the BaBar experiment (G. Marchiori)
4. Study of exclusive radiative and electroweak penguin B decays with the BaBar experiment (D. Kowalsky)
5. Search for mixing and CP violation in D decays with the BaBar experiment (M. Wilson)
6. easurements of the CP angle beta in Charmless B decays (A. Lazzaro)
7. Measurements of CP violation in B-->Charm decays (K. George)
8. Search for leptonic B decays with the BaBar experiment (S. Sekula)

Spectroscopy session

1. Quarkonium spectroscopy with the BaBar experiment (X. Lou)
2. Study of recently observed mesonic Charm states with the BaBar experiment and possible observation of new states (D. Del Re)
3. Observation of new baryonic Charm states and search for pentaquarks with the BaBar experiment (P. Kim)
4. Study of Charmed Baryons with the BaBar experiment (B. Petersen)

Soft QCD session

1. Measurement of form factors with the BaBar experiment (S. Li)
2. Tests of QCD in final states with Charm and Charmonium hadrons at the B-Factories (C. Patrignani)

Beyond the Standard Model Session

1. Search for Physics Beyond Standard Model with BaBar and Belle Detectors (G. Hamel de Monchenault)

Hard QCD session

1. Initial state radiation (ISR) study at BaBar and the application to R measurement and hadron spectroscopy (E. Solodov)

BaBar at ICHEP'06

- http://www-public.slac.stanford.edu/babar/ICHEP06_talks.htm

BaBar Talks at ICHEP 2006

The BaBar Collaboration presented its 114 new results in 24 parallel session talks and two plenary talks.

Plenary sessions

Measuring Vub: measurements related to gamma and semileptonic B decays (R. Kowlewski)

Rare B and Tau decays and the search for New Physics (R. Barlow)

Heavy Quark Session

1. Hot Topics in Heavy Quark Physics (U. Mallik)
2. Study of B decays to Open Charm final states with the BaBar experiment (G.

Charmless B decays with the BaBar experiment (T. Latham)

6. Shape function from radiative B decays with the BaBar experiment (M. Convery)
7. b-->c lnu decays and measurement of Vcb with the BaBar experiment (R. Dubitzky)
8. b-->u lnu decays and measurement of Vub with the BaBar experiment (R. Dubitzky)

CKM physics Session

1. Measurements of Charmless hadronic Branching Fractions (E. Di Marco)
2. Measurements of the CP angle alpha with the BaBar experiment

experiment (M. Wilson)

6. easurements of the CP angle beta in Charmless B decays (A. Lazzaro)
7. Measurements of CP violation in B-->Charm decays (K. George)
8. Search for leptonic B decays with the BaBar experiment (S. Sekula)

Spectroscopy session

1. Quarkonium spectroscopy with the BaBar experiment (X. Lou)
2. Study of recently observed mesonic Charm states with the BaBar experiment and possible observation of new states (D.

BaBar experiment (S. Li

2. Tests of QCD in final sta Charmonium hadrons a Patrignani)

Beyond the Standard Mod

1. Search for Physics Beyo with BaBar and Belle De de Monchenault)

Hard QCD session

1. Initial state radiation (IS and the application to R measurement and hadron spectroscopy (E. Solodov)

Subsequent updates presented at
- TAU'06
- 4th CKM Workshop, Nagoya, Japan.

BaBar at ICHEP'06

- http://www-public.slac.stanford.edu/babar/ICHEP06_talks.htm

BaBar Talks at ICHEP 2006

The BaBar Collaboration presented its 114 new results in 24 parallel session talks and two plenary talks.

Plenary sessions

Measuring Vub: measurements related to gamma and semileptonic B decays (R. Kowlews

Rare B and Tau decays and the search for New Physics (R. Barlow)

Heavy Quark Session

1. Hot Topics in Heavy Quark Physics (U. Mallik)
2. Study of B decays to Open Charm final states with the BaBar experiment (G.

Charmless B ... the BaB... Lath...

6. ... function ... radiative B d... BaBar ex... Conv...
7. ... decays ... measurement ... with the BaBar ex... ent (R. Dubitzky)
8. b-->u lnu decays and measurement of Vub with the BaBar experiment (R. Dubitzky)

CKM physics Session

1. Measurements of Ch... hadronic Bra... Di Marco)
2. Measureme... alpha with ...

... the CP angle beta ... decays (A.

... ents of CP violation in B- ... n decays (K. George)

... ch for leptonic B decays with ... BaBar experiment (S. Sekula)

... e BaBar

... served mesonic Charm ... experiment and ... w states (D.

... harmonic Charm states

... BaBar experiment (S. Li

2. Tests of QCD in final sta... Charmonium hadrons a... Patrignani)

Beyond the Standard Mod

1. Search for Physics Beyo... with BaBar and Belle De... de Monchenault)

Hard QCD session

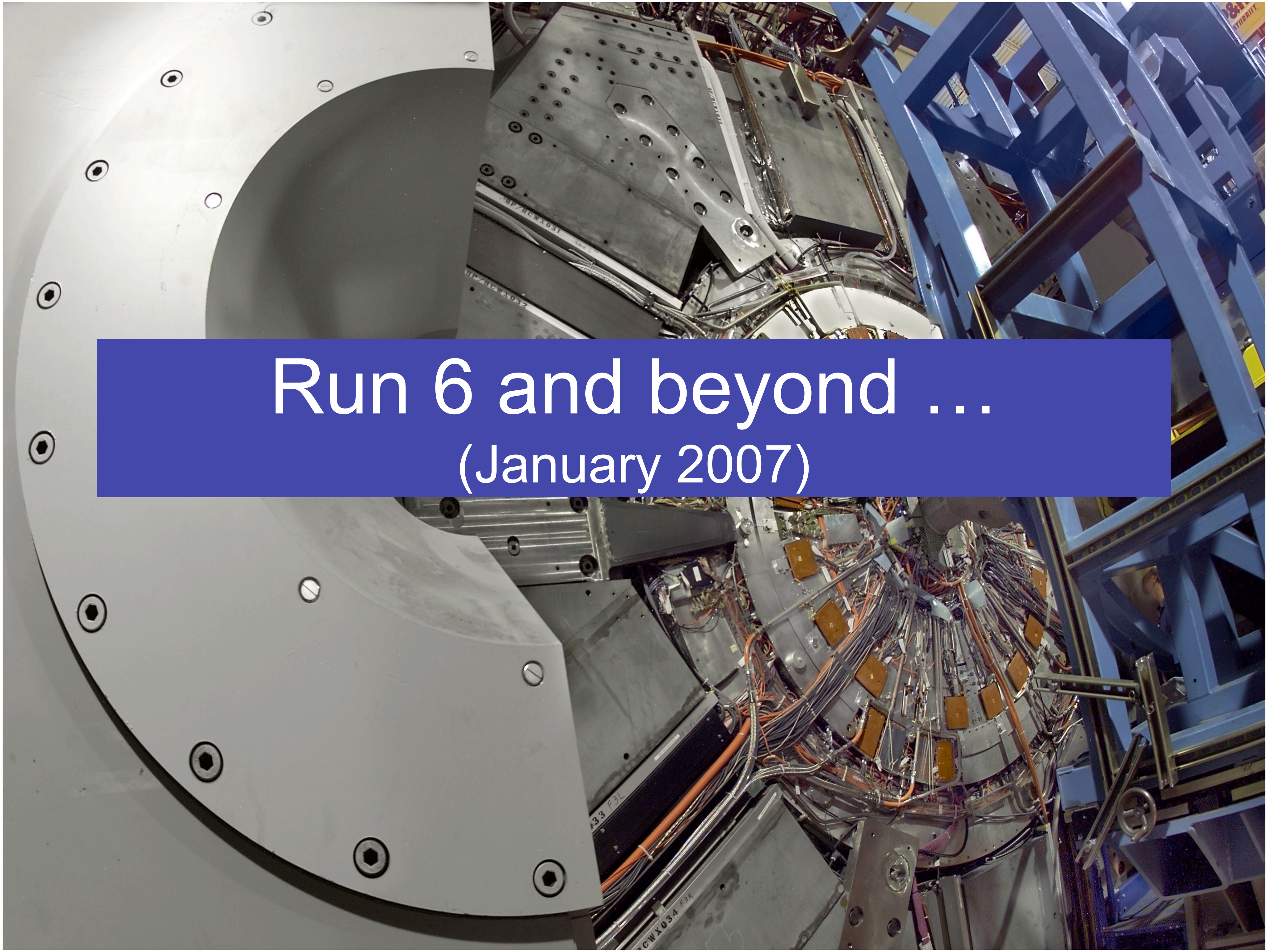
1. Initial state radiation (IS... and the application to R measurement and hadron spectroscopy (E. Solodov)

Subsequent updates pr...
- TAU'06
- 4th CKM Works... Japan.

Expecting many new results at the forthcoming winter conferences.

Run 6 and beyond …

(January 2007)



PEP-II luminosity records

Last update:
August 18, 2006

Peak Luminosity

12.069×10^{33} $cm^{-2}sec^{-1}$ **August 16, 2006**

1722 bunches 2900 mA LER 1875 mA HER

Integration records of delivered luminosity

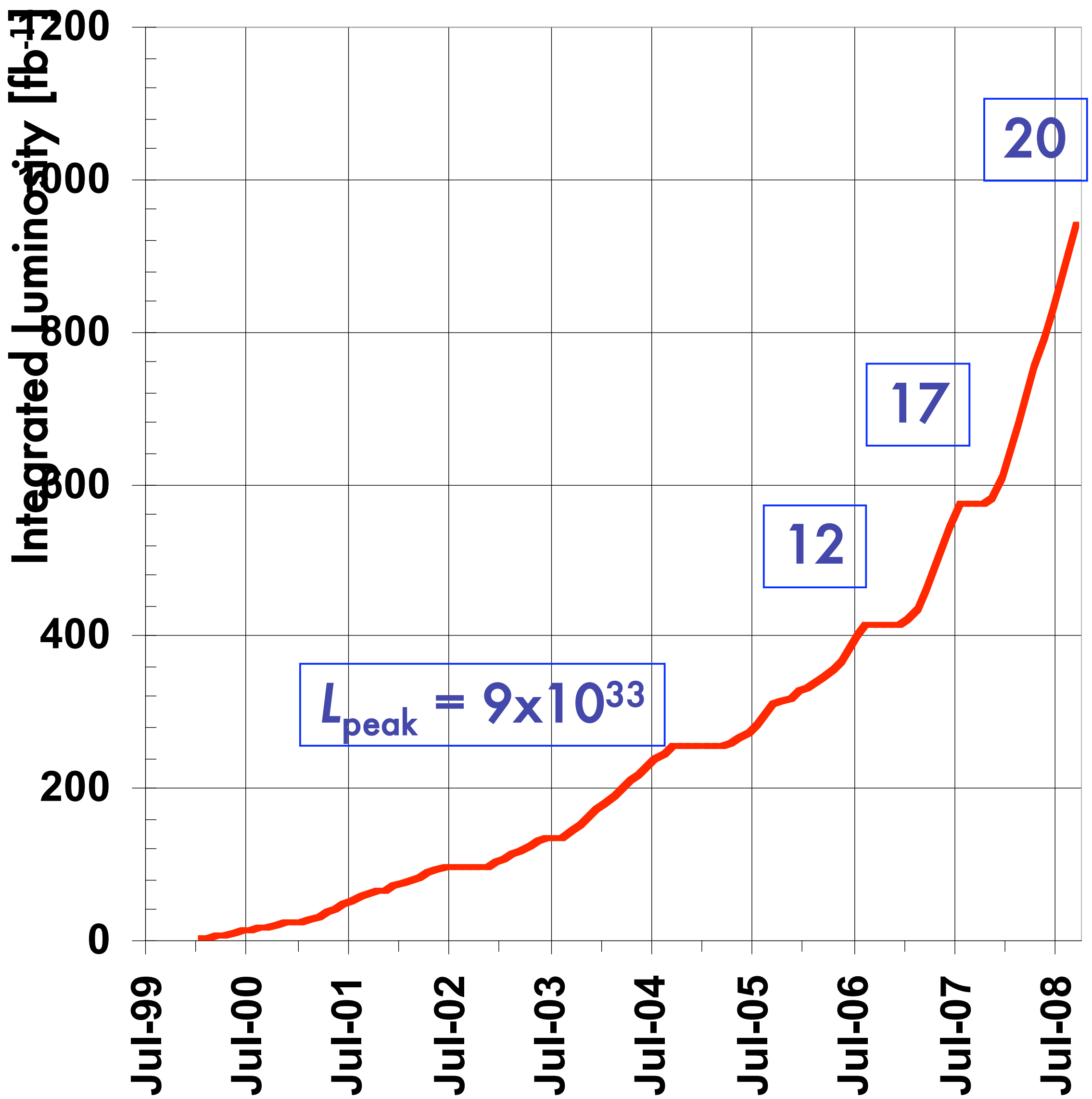
Best shift (8 hrs, 0:00, 08:00, 16:00)	339.0 pb^{-1}	**Aug 16, 2006**
Best 3 shifts in a row	910.7 pb^{-1}	**Jul 2-3, 2006**
Best day	849.6 pb^{-1}	**Aug 14, 2006**
Best 7 days (0:00 to 24:00)	5.385 fb^{-1}	**Jul 27-Aug 3, 2006**
Best week (Sun 0:00 to Sat 24:00)	5.111 fb^{-1}	**Jul 30-Aug 5, 2006**
Peak HER current	1900 mA	**Aug 15, 2006**
Peak LER current	2995 mA	**Oct 10, 2005**
Best 30 days	19.315 fb^{-1}	**Jul 19 – Aug 17, 2006**
Best month	17.036 fb^{-1}	**July 2004**

Total delivered 410 fb^{-1}

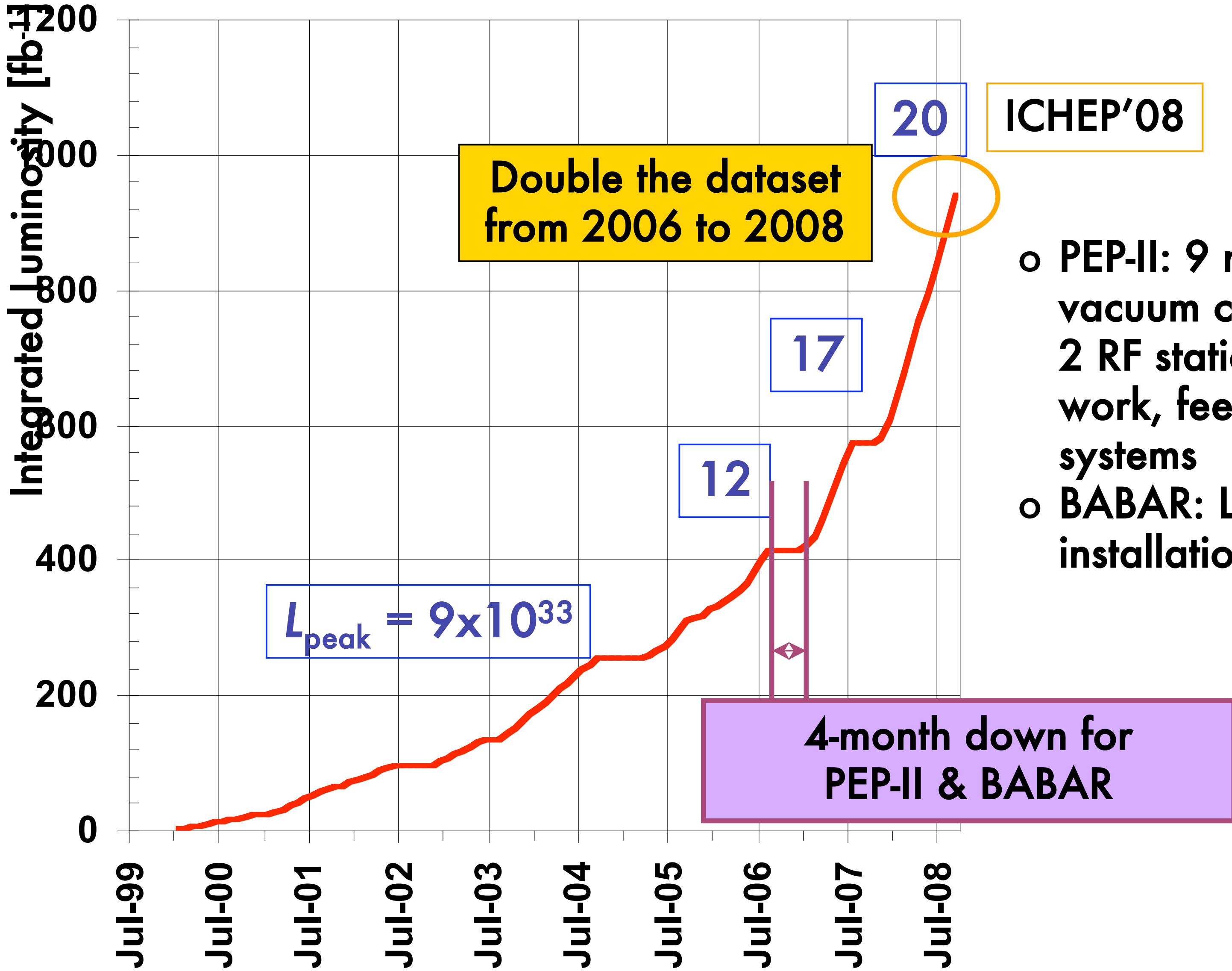
PEP-II parameters and design goals

Parameter	Units	Design	Aug 2006	2007-08 goal
I+	mA	2140	2900	4000
I-	mA	750	1875	2200
Number of bunches		1658	1722	1732
β_y^*	mm	15-20	11	8-8.5
Bunch length	mm	15	11-12	8.5-9
ξ_y		0.03	0.044-0.065	0.054-0.07
Luminosity	$x10^{33}$	3.0	12.1	20
Int lumi / day	pb^{-1}	130	910.7	1300

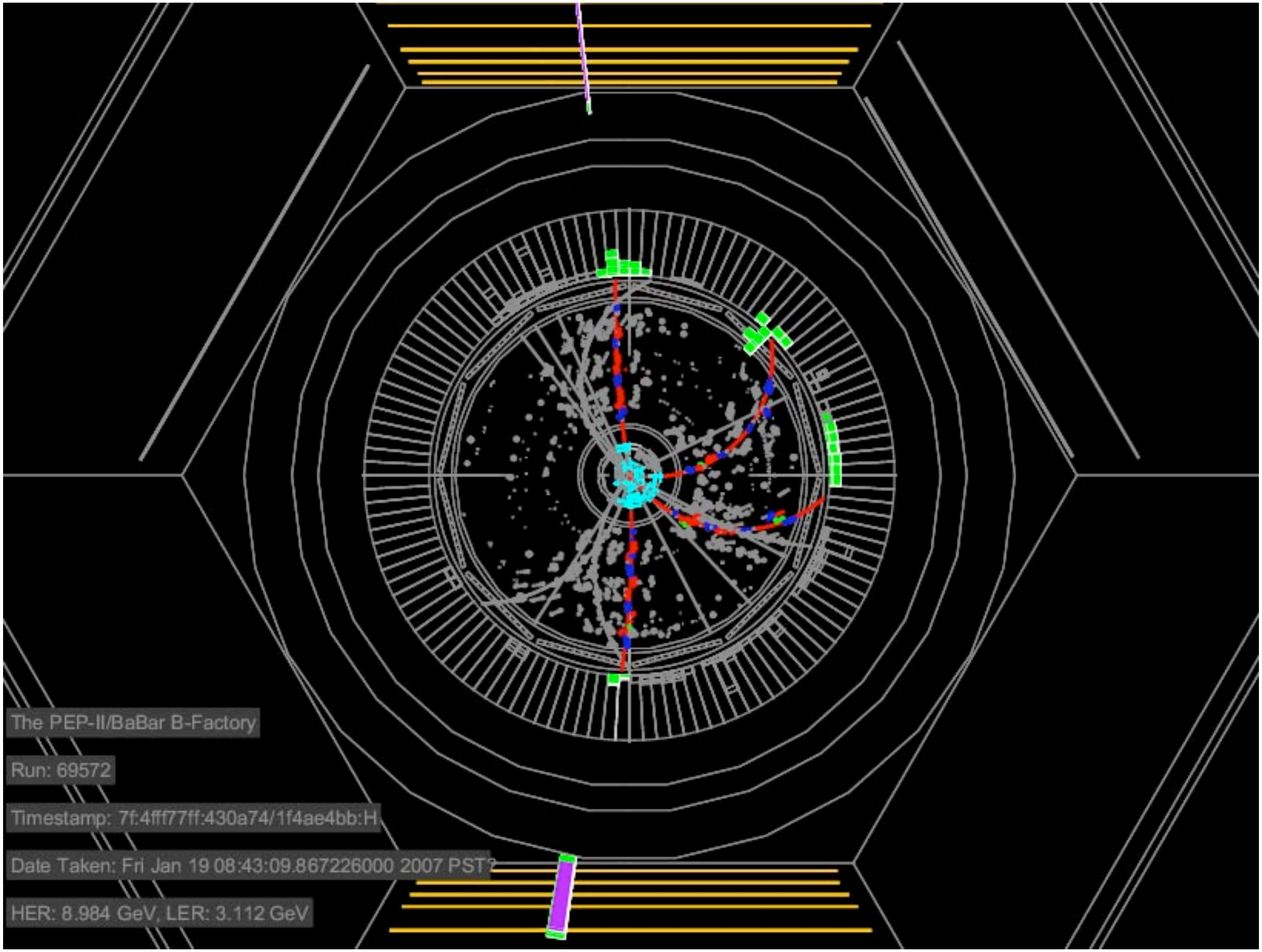
Projected data sample growth



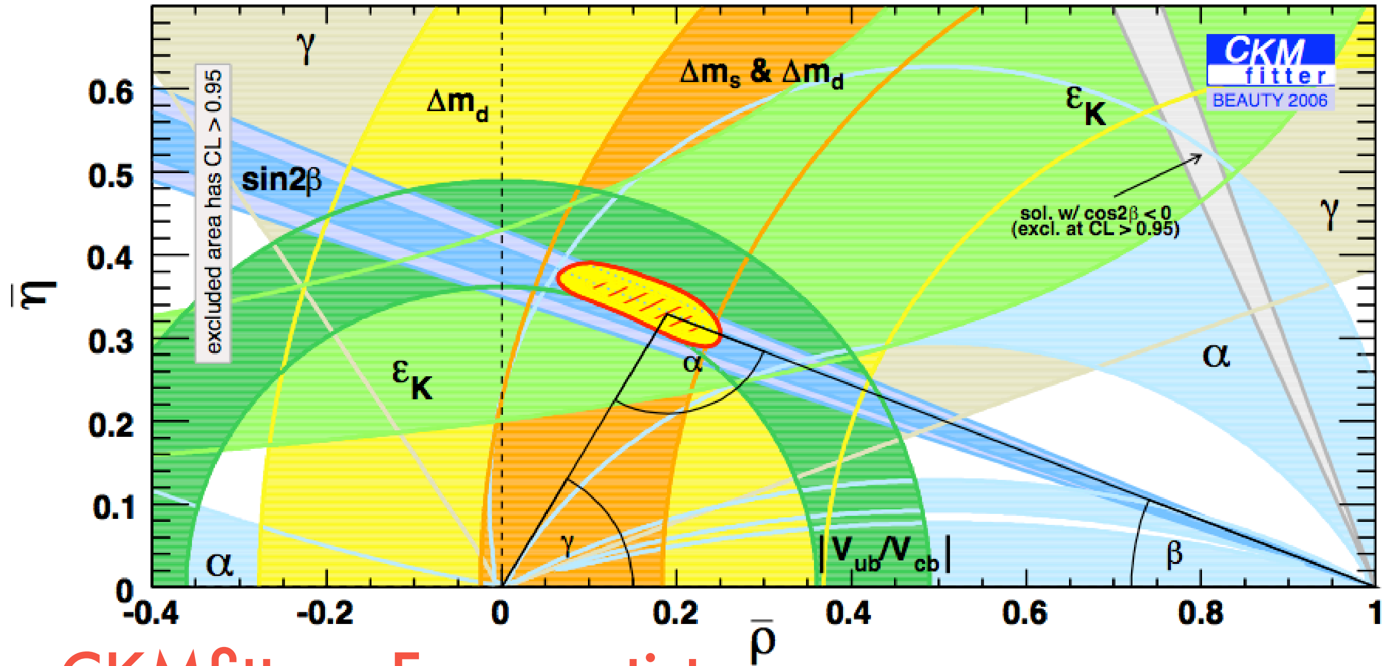
Projected data sample growth



- PEP-II: 9 new vacuum chambers, 2 RF stations, BPM work, feedback systems
- BABAR: LST installation

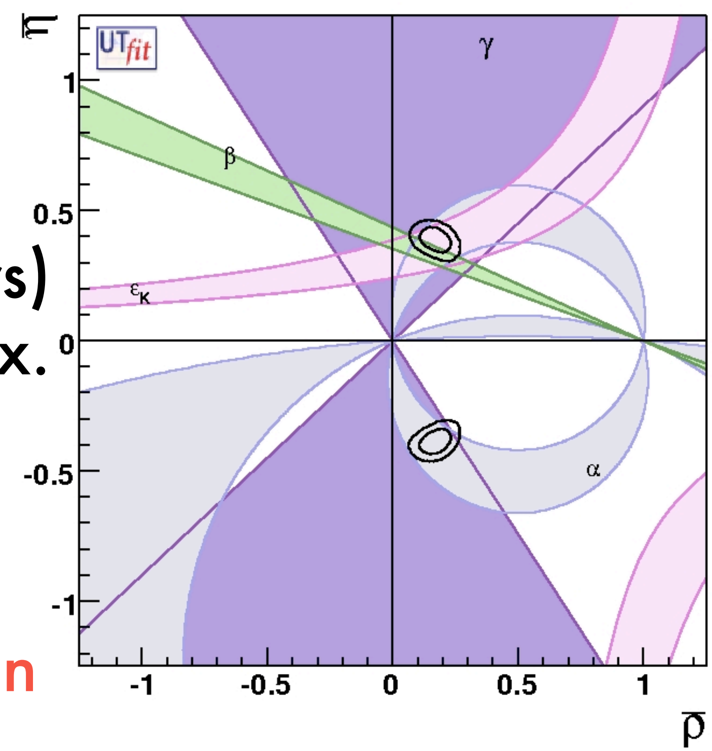

The PEP-II/BaBar B-Factory
Run: 69572
Timestamp: 7f:4fff77ff:430a74/1f4ae4bb:H
Date Taken: Fri Jan 19 08:43:09.867226000 2007 PST
HER: 8.984 GeV, LER: 3.112 GeV

To conclude



CKMfitter - Frequentist

- Same conclusion.
  (irrespective of your statistical preferences)
- All measurements agree (within errors) with the SM picture of the CKM matrix.



UTFit - Bayesian

Summary

- The *B* Factories continue to perform increasingly precise measurements of the UT and other observables
  - will continue to do so for the next few years ...
- Some measurements are statistics limited e.g. angles.
- Sides measurements e.g. V_{ub} are mainly theory limited.
- More data $\Rightarrow$ new techniques and decay modes.
  - Some tension between V_{ub} and sin2β ?
  - Some tension between sin2β (tree v penguin) ?

Summary

- The *B* Factories continue to perform increasingly precise measurements of the UT and other observables
  - will continue to do so for the next few years …
- Some measurements are statistics limited e.g. angles.
- Sides measurements e.g. V_{ub} are mainly theory limited.
- More data ⇒ new techniques and decay modes.
  - Some tension between V_{ub} and $\sin 2\beta$?
  - Some tension between $\sin 2\beta$ (tree v penguin) ?
- Help to limit NP through loops (rather than discover it)

Summary

- The *B* Factories continue to perform increasingly precise measurements of the UT and other observables
  - will continue to do so for the next few years ...
- Some measurements are statistics limited e.g. angles.
- Sides measurements e.g. V_{ub} are mainly theory limited.
- More data $\Rightarrow$ new techniques and decay modes.
  - Some tension between V_{ub} and sin2β ?
  - Some tension between sin2β (tree v penguin) ?
- Help to limit NP through loops (rather than discover it)
- Not just *B* physics - τ, charm, spectroscopy, new particles.

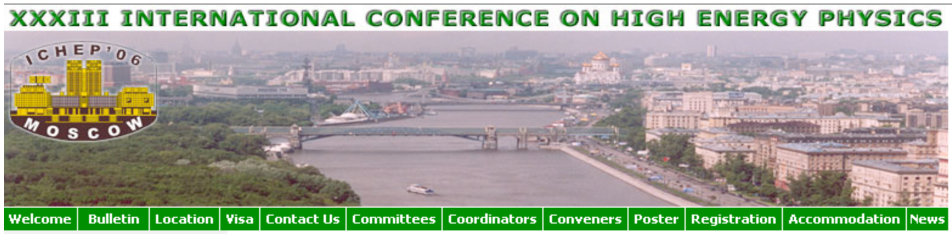
Summary

- The *B* Factories continue to perform increasingly precise measurements of the UT and other observables
  - will continue to do so for the next few years …
- Some measurements are statistics limited e.g. angles.
- Sides measurements e.g. V_{ub} are mainly theory limited.
- More data $\Rightarrow$ new techniques and decay modes.
  - Some tension between V_{ub} and $\sin 2\beta$?
  - Some tension between $\sin 2\beta$ (tree v penguin) ?
- Help to limit NP through loops (rather than discover it)
- Not just *B* physics - τ, charm, spectroscopy, new particles.
- By the end of the experiment's lifetime, aim to
  - Reach nearly 7 x design luminosity
  - Record 10 x design of integrated luminosity per day
  - Accumulate 1 ab^{-1} of data

Summary

- The *B* Factories continue to perform increasingly precise measurements of the UT and other observables
  - will continue to do so for the next few years …
- Some measurements are statistics limited e.g. angles.
- Sides measurements e.g. V_{ub} are mainly theory limited.
- More data $\Rightarrow$ new techniques and decay modes.
  - Some tension between V_{ub} and $\sin 2\beta$?
  - Some tension between $\sin 2\beta$ (tree v penguin) ?
- Help to limit NP through loops (rather than discover it) ??
- Not just *B* physics - τ, charm, spectroscopy, new particles.
- By the end of the experiment's lifetime, aim to
  - Reach nearly 7 x design luminosity.
  - Record 10 x design of integrated luminosity per day.
  - Accumulate 1 ab^{-1} of data.

BaBar at ICHEP'06



- http://www-public.slac.stanford.edu/babar/ICHEP06_talks.htm

BaBar Talks at ICHEP 2006

The BaBar Collaboration presented its 114 new results in 24 parallel session talks and two plenary talks.

Plenary sessions

Measuring Vub: measurements related to gamma and semileptonic B decays (R. Kowlews

Rare B and Tau decays and the search for New Physics (R. Barlow)

Heavy Quark Session

1. Hot Topics in Heavy Quark Physics (U. Mallik)
2. Study of B decays to Open Charm final states with the BaBar experiment (G.

6. ... function ... radiative B d... BaBar ex... Conv...
7. ... decays ... measurement ... with the BaBar ex... ent (R. Dubitzky)
8. b-->u lnu decays and measurement of Vub with the BaBar experiment (R. Dubitzky)

Charmless B... the BaB... Lath...

CKM physics Session

1. Measurements of Cha... hadronic Bra... Di Marco)
2. Measureme... alpha with ...

... CP angle beta ... decays (A.

... ents of CP violation in B- ... n decays (K. George)

... ch for leptonic B decays with ... BaBar experiment (S. Sekula)

... the BaBar ... served mesonic Charm ... experiment and ... ew states (D.

... harmonic Charm states

... BaBar experiment (S. Li

2. Tests of QCD in final sta... Charmonium hadrons a... Patrignani)

Beyond the Standard Mod...

1. Search for Physics Beyo... with BaBar and Belle De... de Monchenault)

Hard QCD session

1. Initial state radiation (IS... and the application to R measurement and hadron spectroscopy (E. Solodov)

Subsequent updates pr...
- TAU'06
- 4th CKM Works... Japan.

Expecting many new results at the forthcoming winter conferences.


More
Slides?!
™ and © Nelvana, All Rights Reserved

http://today.slac.stanford.edu/feature/babar-replume.asp

BaBar Re-feathers its Nest

Like a bird in molt, the BaBar detector is temporarily vulnerable while it acquires better plumage.

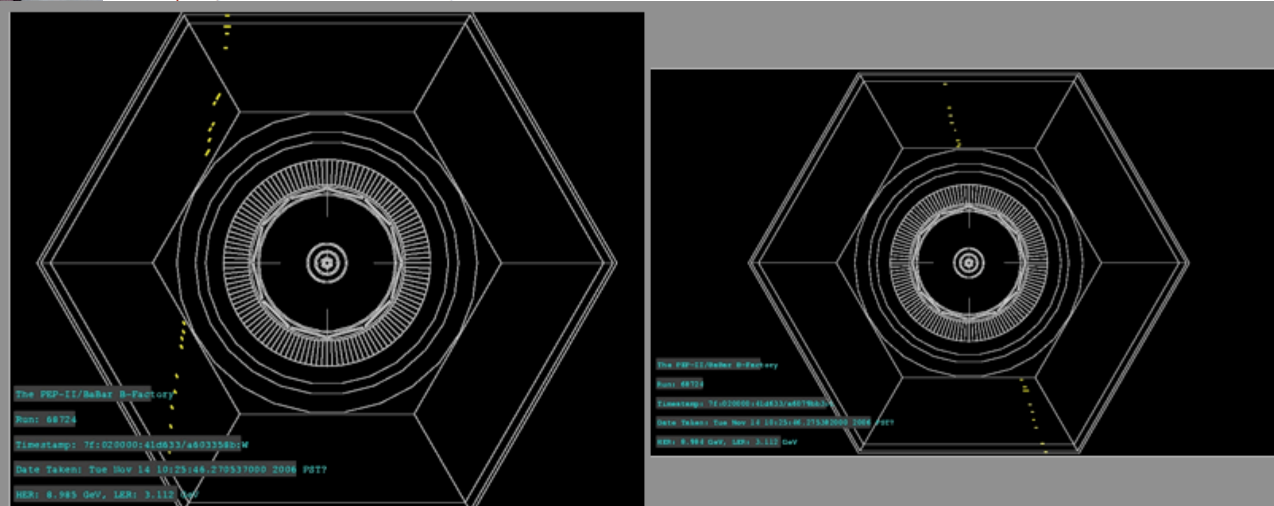
At the end of the summer, crews opened the "doors" that seal the front end of the detector, exposing its belly. In a delicate operation, the collaboration has been putting new muon detectors in four of the six sides of the 3-story-tall hexagon that makes up the overall detector's outer layer. With the final sextant successfully installed on Monday, BaBar now sports a vastly improved system for identifying muons and reconstructing rare but important decays.

"This is the most invasive change to BaBar in its history. The detector was not designed to be taken apart. It's tricky," said LST commissioner Mark Convery.

The performance of the original muon detectors, called Resistive Plate Chambers, declined unexpectedly and steadily soon after BaBar turned on in 1999. By 2002 it had become clear they could not be saved.

"We had no choice but to replace them, even though the project would require an enormous effort by BaBar and SLAC engineering and technical staff under severe time pressure," reported Stewart Smith of Princeton University, BaBar's spokesperson at the time the decision was made.

"A lot of the physics we're going after at this point requires identifying muons. The detectors were losing one percent efficiency a month. Without replacing the muon system, there would be no efficiency left before the experiment's scheduled end," said BaBar Technical Coordinator Bill Wisniewski.



Muon crossing sextant 2, 3, 4
Run #68724 taken on 14-Nov-2006

Muon crossing sextant 2, 5 (installed on 2004)
Run #68724 taken on 14-Nov-2006

- Upgrade to the BaBar muon system now complete.