REVIEW OF β, α AND γ MEASUREMENTS

K. TRABELSI
KEK (High Energy Accelerator Research Organization)
Institute of Particle and Nuclear Studies
1-1 Oho, Tsukuba-shi, Ibaraki-ken, 305-0801, Japan

Precision measurements of the angles of the Unitarity Triangle are part of the program to test the Standard Model and the Kobayashi-Maskawa model of CP violation. The most recent results of the B-factories are summarized.

1 Intro

In the Standard Model (SM) of particle physics, the weak interaction couplings of quarks are described by the Cabibbo-Kobayashi-Maskawa (CKM) quark mixing matrix [1,2]. The CKM matrix, V, must be unitary and the non-zero imaginary part of the CKM matrix is the origin of the CP violation in the SM. The unitarity relation$V^{\dagger}V = 1$ results in a total of nine expressions, that can be written as $\sum_{i=u,c,t} V_{ij}^{*} V_{ik} = \delta_{jk}$. Of the off-diagonal expressions ($j \neq k$), three can be transformed into the other three leaving six relations, in which three complex numbers sum to zero, which therefore can be expressed as triangles in the complex plane. One of these relations,

$$V_{ud}V_{ub}^{*} + V_{cd}V_{cb}^{*} + V_{td}V_{tb}^{*} = 0, \tag{1}$$

is of particular importance to the B system, being specifically related to flavor changing neutral current $b \leftrightarrow d$ transitions. The tree terms in Eq. 1 are of the same order and this relation is commonly known as the Unitarity Triangle (UT). Two popular naming conventions for the UT angles exist in the literature:

$$\alpha \equiv \phi_2 = \arg\left[-\frac{V_{td}V_{tb}^{*}}{V_{ud}V_{ub}^{*}}\right], \quad \beta \equiv \phi_1 = \arg\left[-\frac{V_{cd}V_{cb}^{*}}{V_{td}V_{tb}^{*}}\right], \quad \gamma \equiv \phi_3 = \arg\left[-\frac{V_{ud}V_{ub}^{*}}{V_{cd}V_{cb}^{*}}\right]. \tag{2}$$

In this report the (α, β, γ) set is used.

2 β determination

Measurements of CP asymmetries in the proper-time distribution of neutral B decay to a common final CP eigenstate state, f, provide direct information on the angles of the UT. The time-dependent asymmetry:

$$A_f(\Delta t) \;=\; \frac{\Gamma(\overline{B}^0(\Delta t) \to f) - \Gamma(B^0(\Delta t) \to f)}{\Gamma(\overline{B}^0(\Delta t) \to f) + \Gamma(B^0(\Delta t) \to f)} \tag{3}$$

can be written as

$$A_f(\Delta t) \; = \; S_f \sin(\Delta m \; \Delta t) - C_f \cos(\Delta m \; \Delta t) \qquad (4)$$

with $S_f = -2\frac{\mathcal{I}(\lambda)}{1+|\lambda|^2}$ and $C_f = \frac{1-|\lambda|^2}{1+|\lambda|^2}$. Here $\lambda = \frac{q}{p}\frac{\overline{A}_f}{A_f}$ contains terms related to $B^0 - \overline{B}^0$ mixing and to the decay amplitude (the eigenstates of the effective Hamiltonian in the $B^0\overline{B}^0$ system are $|B_\pm >= p|B^0 > \pm q|\overline{B}^0 >$). The $B \to J/\psi K^0$ decay is dominated by a single tree-level quark transition $\bar{b} \to \bar{c}c\bar{s}$, up to a correction smaller than a fraction of a percent [3]. Neglecting effects due to CP violation in the mixing (by taking $|q/p| = 1$), $S_{J/\psi K^0} = -\eta_f \sin 2\beta$, where η_f is the CP eigenvalue of f, and $C_{J/\psi K^0} = 0$. The asymmetries measured in this process and in other decays dominated by $\bar{b} \to \bar{c}c\bar{s}$ have already provided a precise measurement of $\sin 2\beta$ [4]:

$$\sin 2\beta = 0.670 \pm 0.023. \qquad (5)$$

This result combines the measurements of Belle in $J/\psi K^0$ [5] and $\psi(2S)K^0_S$ [6] as well as those of BaBar in $J/\psi K^0$, $\psi(2S)K^0_S$, $\chi_{c1}K^0_S$, $\eta_c K^0_S$ and $J/\psi K^{*0}$ [7], which are summarized in Table 1. For these modes, $C_{\bar{b}\to\bar{c}c\bar{s}} = 0.005 \pm 0.019$. It is interesting to notice that the measurement of $\sin 2\beta$ is still dominated by statistics, whereas $C_{\bar{b}\to\bar{c}c\bar{s}}$ is close to be dominated by systematics (the possible effect of tag side interference on the C measurement).

The $\sin 2\beta$ value permits two solutions for β (in [0, π]) at $(21.0 \pm 0.9)^\circ$ and $(69.0.0 \pm 0.9)^\circ$. Time-dependent angular analysis of $B \to J/\psi K^{*0}$ and time-dependent Dalitz analyses of $B^0 \to Dh^0$ ($D^0 \to K^0_S\pi^+\pi^-, h^0 = \pi^0, \eta, \omega$) measuring $\cos 2\beta > 0$ have excluded the second solution at a high confidence level (Fig. 1, right), implying:

$$\beta = (21.0 \pm 0.9)^\circ. \qquad (6)$$

Table 1: Results of fitting for CP asymmetries in the charmonium modes.

Parameter	BaBar	Belle
$J/\psi K^0_S$	$0.657 \pm 0.036 \pm 0.012$	$0.643 \pm 0.038_{\text{stat}}$
$J/\psi K^0_L$	$0.694 \pm 0.061 \pm 0.031$	$0.641 \pm 0.057_{\text{stat}}$
$J/\psi K^0$	$0.666 \pm 0.031 \pm 0.013$	$0.642 \pm 0.031 \pm 0.017$
$\psi(2S)K^0_S$	$0.897 \pm 0.100 \pm 0.036$	$0.718 \pm 0.090 \pm 0.031$
$\chi_{c1}K^0_S$	$0.614 \pm 0.160 \pm 0.040$	
$\eta_c K^0_S$	$0.925 \pm 0.160 \pm 0.057$	
$J/\psi K^{*0}(K^0_S\pi^0)$	$0.601 \pm 0.239 \pm 0.087$	
All charmonium	$0.687 \pm 0.028 \pm 0.012$	$0.650 \pm 0.029 \pm 0.018$

The $\bar{b} \to \bar{s}q\bar{q}$ penguin-dominated decays have the same weak phase as the $\bar{b} \to \bar{c}c\bar{s}$ amplitude up to corrections (at most at the 10% level) from subleading u-quark penguin diagrams leading to an effective angle β_{eff}. Since penguin loop contributions are sensitive to physics beyond the SM, it is important to have an unambiguous estimate of the deviation $\Delta S \equiv S_{\bar{b}\to\bar{s}q\bar{q}} - S_{\bar{b}\to\bar{c}c\bar{s}}$. Various estimates, using different theoretical approaches such as QCDF, pQCD and SCET, find a small value and a positive sign for ΔS for modes such as ϕK^0, $\eta' K^0$. The various modes measured by Belle and BaBar are consistent with $S_{\bar{b}\to\bar{c}c\bar{s}}$ (Fig 2). More statistics will be needed for a mode-by-mode study.

3 α determination

The direct constraint on α comes from mixing-induced CP-violating measurements, through the combination of the two-body isospin analyses of $B \to \pi\pi$ and $B \to \rho\rho$, and the Dalitz plot analysis of $B \to \rho\pi$.

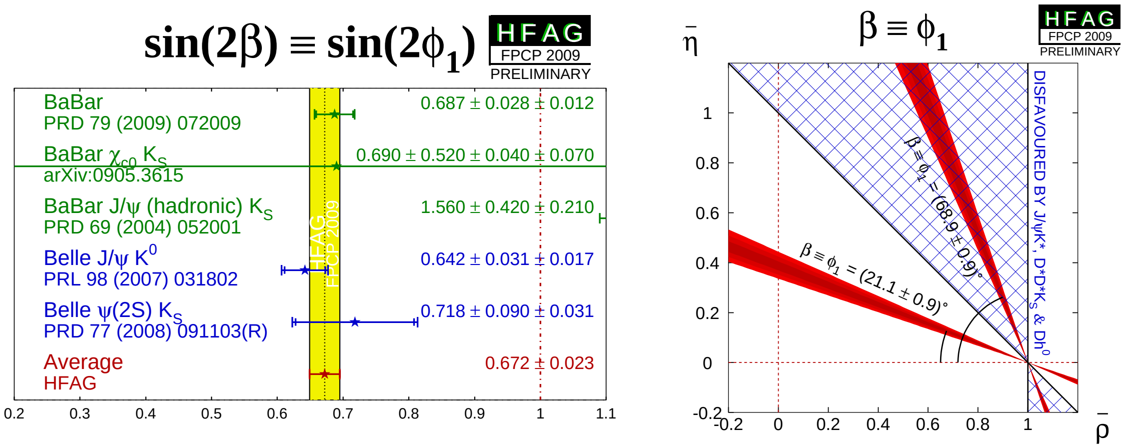

Figure 1: Averages of $\sin 2\beta$ from the B factories (left). Constraint on the $\bar{\rho} - \bar{\eta}$ plane (left).

The amplitude for $B^0 \to \pi^+\pi^-$ contains two terms, conventionally denoted "tree" (T) and "penguin" (P) amplitudes, involving a weak CP-violating phase γ and a strong CP-conserving phase δ, respectively:

$$A(B^0 \to \pi^+\pi^-) \;=\; |T|e^{i\gamma} + |P|e^{i\delta} \tag{7}$$

Expanding to the first order in $r = |P|/|T|$, we can express the S_f parameter of Eq. 4 in the case of $B^0 \to \pi^+\pi^-$ as

$$S_{\pi^+\pi^-} = \sin 2\alpha + 2r\cos\delta\sin(\beta+\alpha)\cos(2\alpha). \tag{8}$$

In the limit of vanishing small penguins $S_{\pi^+\pi^-} = \sin 2\alpha$. Additional inputs are required to determine the penguin pollution. The standard method for obtaining α relies on the isospin triangle construction [8] and requires the knowledge of not only the CP-violating parameters, $S_{\pi^+\pi^-}$ and $C_{\pi^+\pi^-}$, but also $\mathcal{B}(\pi^+\pi^-)$, $\mathcal{B}(\pi^+\pi^0)$, $\mathcal{B}(\pi^0\pi^0)$ and $C(\pi^0\pi^0)$. Results from the two B-factories are consistent. An earlier discrepancy for $C_{\pi^+\pi^-}$ between Belle and BaBar seems to get resolved with more statistics (Fig. 3). Combining these measurements for the $\pi\pi$ system, $\alpha = (92.4^{+11.2}_{-10.0})^\circ$ is obtained [9] if one considers the peak in agreement with the SM value.

The situation for $\rho\rho$ channels is more complicated than $\pi\pi$ because of the vector-vector nature of these modes which implies a mixture of CP-even and CP-odd components. The isospin analysis can be applied to each polarization state but the fact that the measured longitudinal polarization is close to unity simplifies considerably the analysis since the CP-even fraction dominates. Here also, results from the two B-factories are available (Table 2) but not always consistent.

The BaBar collaboration obtained a 3.1σ for $B^0 \to \rho^0\rho^0$ with a sample of 465×10^6 $B\overline{B}$ pairs [15] and measured $\mathcal{B}(B^0 \to \rho^0\rho^0) = (0.92 \pm 0.32(\text{stat}) \pm 0.14(\text{syst})) \times 10^{-6}$ and a longitudinal fraction $f_L = 0.75^{+0.11}_{-0.14}(\text{stat}) \pm 0.04(\text{syst})$. They use this signal to measure for the first time the CP-violating parameters of this mode [15]. The situation for Belle, with higher statistics (657×10^6) and similar efficiency, is different: no significant signal is seen (Fig. 4) and an upper limit at 90% C.L. is given, $\mathcal{B}(B^0 \to \rho^0\rho^0) < 1.0 \times 10^{-6}$. In contrast to the situation of the $\pi\pi$ system, the $B^0 \to \rho^0\rho^0$ decay has a much smaller branching fraction than the other $\rho\rho$ channels.

Recently, BaBar [13] updated their analysis of the $B^+ \to \rho^+\rho^0$ mode (Fig. 5). The impact on α is larger than one would naively expect from the improvement of the error on the branching fraction and comes primarily from an increase of the measured branching fraction relative to their previous measurement. The $B^+ \to \rho^+\rho^0$ branching fraction determines the length of

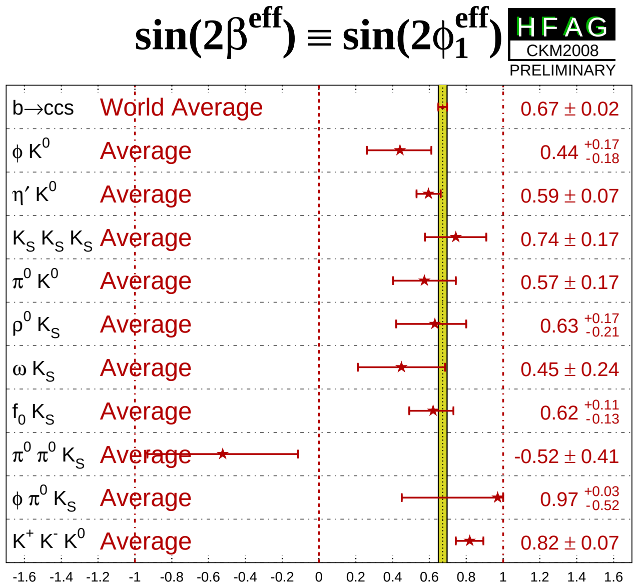

Figure 2: Comparisons of averages in the different $\bar{b} \to \bar{s}q\bar{q}$ modes.

the common base of the isospin triangles for the B and $\overline{B}$ decays. The increase in the base lengths flattens both triangles making the four possible solutions degenerate (Fig. 6, left). The α constraint from $B \to \rho\rho$ is then significantly improved and dominates the final α average (Fig. 6, right).

A combined analysis [9] of $\pi\pi$, $\rho\rho$ and $\rho\pi$ system gives $\alpha = (89.0^{+4.4}_{-4.2})^{\circ}$.

4 γ determination

The extraction of γ stems from direct CP-violation measurements in $B \to DK$ modes. The method employs the interference between $\bar{b} \to \bar{c}u\bar{s}$ and $\bar{b} \to \bar{u}c\bar{s}$ when the final state f is accessible to both D and $\overline{D}$ mesons. The theoretical uncertainty is completely negligible as there is no penguin contributions. Various methods have been proposed to exploit this strategy

Table 2: $B \to \rho\rho$ inputs from the B-factories.

Parameter	BaBar	Belle	Reference
$\mathcal{B}(\rho^+\rho^-)$ $(\times 10^{-6})$	$25.5 \pm 2.1^{+3.6}_{-3.9}$	$22.8 \pm 3.8^{+2.3}_{-2.6}$	10, 11
$f_L(\rho^+\rho^-)$	$0.992 \pm 0.024^{+0.026}_{-0.013}$	$0.941^{+0.034}_{-0.040} \pm 0.030$	10, 11
$S_L(\rho^+\rho^-)$	$-0.17 \pm 0.20^{+0.05}_{-0.06}$	$+0.19 \pm 0.30 \pm 0.07$	10, 12
$C_L(\rho^+\rho^-)$	$+0.01 \pm 0.15 \pm 0.06$	$-0.16 \pm 0.21 \pm 0.07$	10, 12
$\mathcal{B}(\rho^+\rho^0)$ $(\times 10^{-6})$	$23.7 \pm 1.4 \pm 1.4$	$31.7 \pm 7.1^{+3.8}_{-6.7}$	13, 14
$f_L(\rho^+\rho^0)$	$0.950 \pm 0.015 \pm 0.006$	$0.948 \pm 0.106 \pm 0.021$	13, 14
$\mathcal{B}(\rho^0\rho^0)$ $(\times 10^{-6})$	$0.92 \pm 0.32 \pm 0.14$	< 1.0	15, 16
$f_L(\rho^0\rho^0)$	$0.75^{+0.11}_{-0.14} \pm 0.04$		15
$S_L(\rho^0\rho^0)$	$0.3 \pm 0.7 \pm 0.2$		15
$C_L(\rho^0\rho^0)$	$0.2 \pm 0.8 \pm 0.3$		15

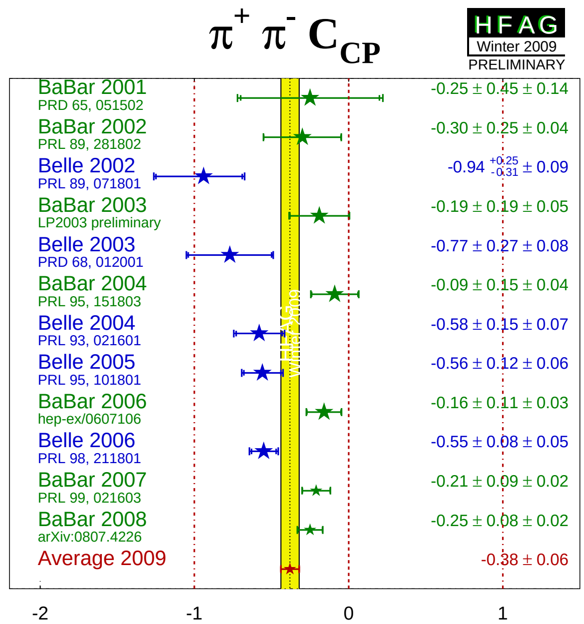

Figure 3: History of the $C_{\pi^+\pi^-}$ by the B-factories.

using different choice of the final state f: CP eigenstates (GLW method [17]), doubly Cabibbo suppressed decays (ADS method [18]), three-body decays as $D \to K_S\pi^+\pi^-$ and $D \to K_S K^+ K^-$ (GGSZ method [19]). The feasibility of the γ measurement crucially depends on the size of r_B, the ratio of the B decay amplitudes involved ($r_B = |A(B^+ \to DK^+)|/|A(B^+ \to \overline{D}K^+)|$). The value of r_B is given by the ratio of the CKM matrix elements $|V_{ub}^* V_{cs}|/|V_{cb}^* V_{us}|$ and the color suppression factor, and is estimated to be in the range 0.1-0.2 [20].

For different D decays, the B system parameters are common, which means than combining different D channels buys more than just adding statistics. It is then not surprising that three-body decays provide the most sensitivity in the extraction of γ.

The $\Delta\gamma$ shift due to $D - \overline{D}$ mixing is less than one degree for doubly Cabibbo suppressed decays and much smaller in other cases, and can eventually be included in the γ determination [21]. The effect due to CP violation in the neutral D sector is negligible in the Standard Model and at most at the 10^{-2} order if one considers new physics in the charm sector.

4.1 CP eigenstates (GLW method) and doubly Cabibbo suppressed decays (ADS method)

For the GLW method, one considers four observables: two charge-average decay rates for even and odd CP states, normalized by the decay rate into a D^0 flavor state, $R_{CP\pm}$, and two CP asymmetries for even and odd CP states. In order to avoid dependence of $R_{CP\pm}$ on errors in D^0 and D_{CP} branching ratio measurements, one uses a definition of $R_{CP\pm}$ in terms of ratio of B decay branching ratios into DK and $D\pi$ final states [20]. Studies of $B^+ \to D_{CP}K^+$, $B^+ \to D^*_{CP}K^+$ and $B^+ \to D_{CP}K^{*+}$ have been carried out (Fig. 7 (left)), each consisting of a few ten events or more, but no significant difference ($R_{CP+} - R_{CP-}$) has been yet observed.

The ADS method considers a flavor state in Cabibbo-favored $\overline{D}^0$ decays, accessible also to doubly Cabibbo-suppressed D^0 decays. So far, no signal has been observed for such modes and only upper bounds on r_B are obtained. The most recent result is from Belle [22] for the $D \to K\pi$ mode (Fig. 7 (right)) and the 90% C.L. upper limit, $r_B < 0.19$, is derived.

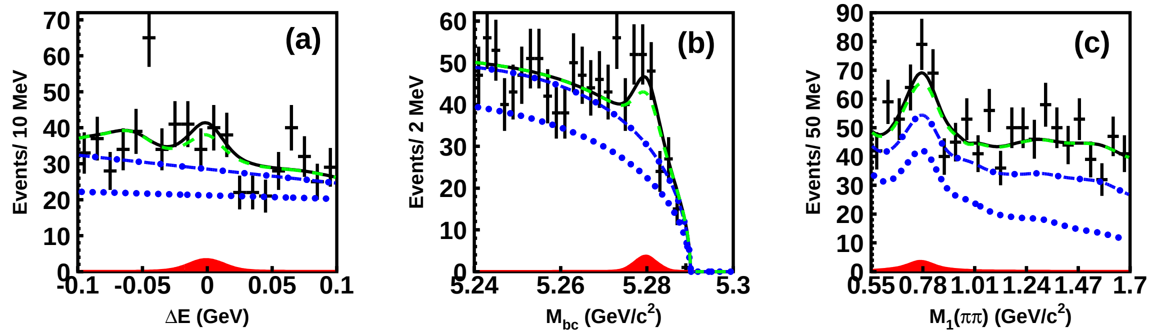

Figure 4: Projections of the four-dimensional fit onto (a) ΔE, (b) $M_{\rm bc}$, (c) $M_1(\pi^+\pi^-)$, for candidates satisfying (except for the variable plotted) the criteria $\Delta E \in [-0.05, 0.05]$ GeV, $M_{\rm bc} \in [5.27, 5.29]$ GeV/c^2, and $M_{1,2}(\pi^+\pi^-) \in [0.626, 0.926]$ GeV/c^2. The fit result is shown as the thick solid curve; the solid shaded region represents the $B^0 \to \rho^0\rho^0$ signal component. The dotted, dot-dashed and dashed curves represent, respectively, the cumulative background components from continuum processes, $b \to c$ decays, and charmless B backgrounds.

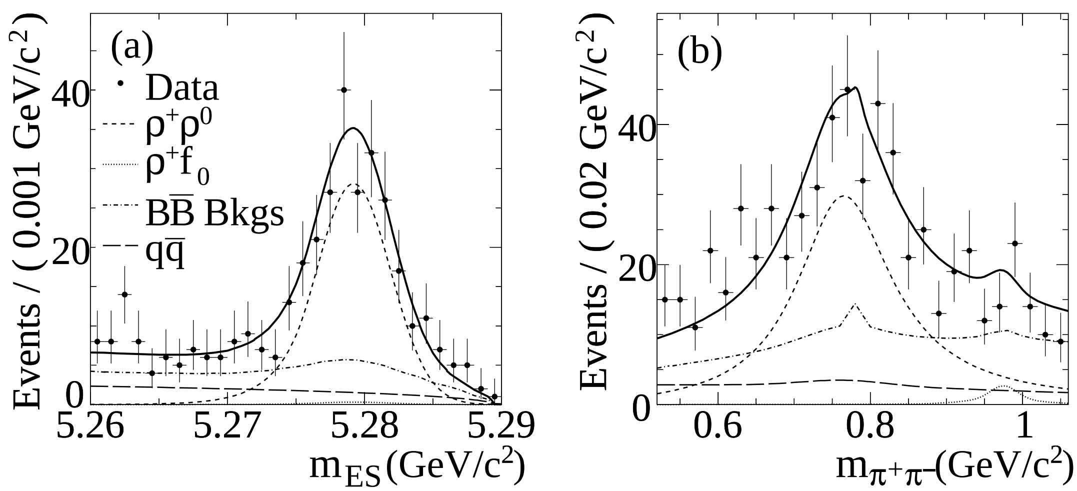

Figure 5: Projections of the fit (solid curve) onto the (a) m_{ES} and (b) $m_{\pi^+\pi^-}$ variables. A requirement on the likelihood ratio that retains 38% of the signal, 0.1% of the continuum background, and 1.3% of the $B\overline{B}$ background has been applied. The peak in the $B\overline{B}$ background at $m_{\pi^+\pi^-} \approx 0.78$ GeV/c^2 is from $B^+ \to \rho^+\omega$ events with $\omega \to \pi^+\pi^-$.

4.2 Three-body decays (GGSZ method)

The Belle collaboration uses a data sample that consists of $657 \times 10^6 B\bar{B}$ pairs [23]. The decay chains $B^+ \to DK^+$, $B^+ \to D^*K^+$ with $D^* \to D\pi^0$ are selected for the analysis. Analysis by the BaBar collaboration [24] is based on $383 \times 10^6 B\bar{B}$ pairs. The reconstructed final states are $B^+ \to DK^+$, $B^+ \to D^*K^+$ with two D^* channels: $D^* \to D\pi^0$ and $D^* \to D\gamma$ and $B^+ \to DK^{*+}$ with $K^{*+} \to K^0_S\pi^+$. The neutral D meson is reconstructed in the $K^0_S\pi^+\pi^-$ final state in all cases for BaBar and Belle collaborations and BaBar also used $K^0_S K^+K^-$ final state for the DK^+ and D^*K^+ cases.

Figure 8 shows the results of the separate B^+ and B^- data fits for $B \to DK$ mode in the $x - y$ plane for the BaBar and Belle collaborations. Confidence intervals were then calculated using a frequentist technique. The central values for the parameters γ, r and δ for the combined fit (using the $(x_\pm, y_\pm)$ obtained for all modes) with their one standard deviation intervals are presented in Tab. 3 for the BaBar and Belle analysis.

The uncertainties in the model used to parametrize the $\bar{D}^0 \to K^0_S\pi^+\pi^-$ decay amplitude

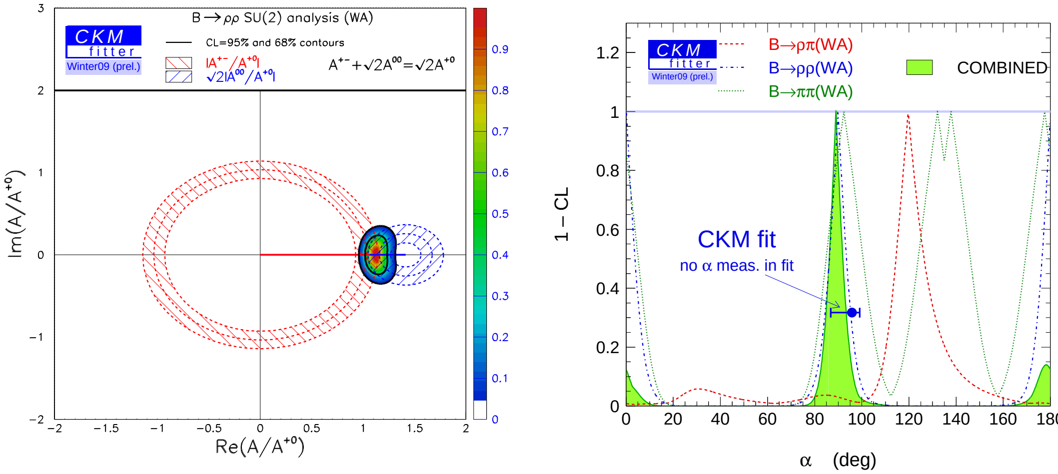

Figure 6: (Left) Isospin triangle situation for the $B \to \rho\rho$ system. (Right) Confidence level as a function of the angle α extracted from an isospin analysis of the world averages for $B \to \pi\pi$, $B \to \rho\rho$ and $B \to \rho\pi$. The shaded region is the combination, also shown is the prediction of the CKM fit without including the direct measurements.

lead to an associated systematic error in the fit result. These uncertainties arise from the fact that there is not unique choice for the set of quasi-2-body channels in the decay, as well as the various possible parametrizations of certain components, such as the non-resonant amplitude. To evaluate this uncertainty several alternative models have been used to fit the data.

Table 3: Results of the combination of $B^+ \to DK^+$, $B^+ \to D^*K^+$, and $B^+ \to DK^{*+}$ modes for BaBar and Belle analyses. The first error is statistical, the second is systematic and the third one is the model error.

Parameter	BaBar	Belle
γ	$(76 \pm 22 \pm 5 \pm 5)^\circ$	$(76^{+12}_{-13} \pm 4 \pm 9)^\circ$
$r_B(DK)$	$0.086 \pm 0.035 \pm 0.010 \pm 0.011$	$0.16 \pm 0.04 \pm 0.01 \pm 0.05$
$\delta_B(DK)$	$(118 \pm 63 \pm 19 \pm 36)^\circ$	$(136^{+14}_{-16} \pm 4 \pm 23)^\circ$
$r_B(D^*K)$	$0.135 \pm 0.051 \pm 0.011 \pm 0.005$	$0.21 \pm 0.08 \pm 0.02 \pm 0.05$
$\delta_B(D^*K)$	$(-62 \pm 59 \pm 18 \pm 10)^\circ$	$(343^{+20}_{-22} \pm 4 \pm 23)^\circ$
$\kappa r_B(DK^*)$	$0.163^{+0.088}_{-0.105} \pm 0.037 \pm 0.021$	
$\delta_B(DK^*)$	$(104^{+43}_{-41} \pm 17 \pm 5)^\circ$	

Despite similar statistical errors being obtained for $(x_\pm, y_\pm)$ in both experiments, the resulting γ error is much smaller in Belle's analysis. Since the uncertainty on γ scales roughly as $1/r_B$, the difference is explained by noticing that the BaBar $(x_\pm, y_\pm)$ measurements favor values of r_B smaller than the Belle results.

5 Conclusions

In this work we have presented a review of the most recent results on UT angles at the B Factories from Belle and BaBar experiments. An error of 5% is obtained for β and α, whereas Dalitz analyses allow to get the first significant measurement of γ.

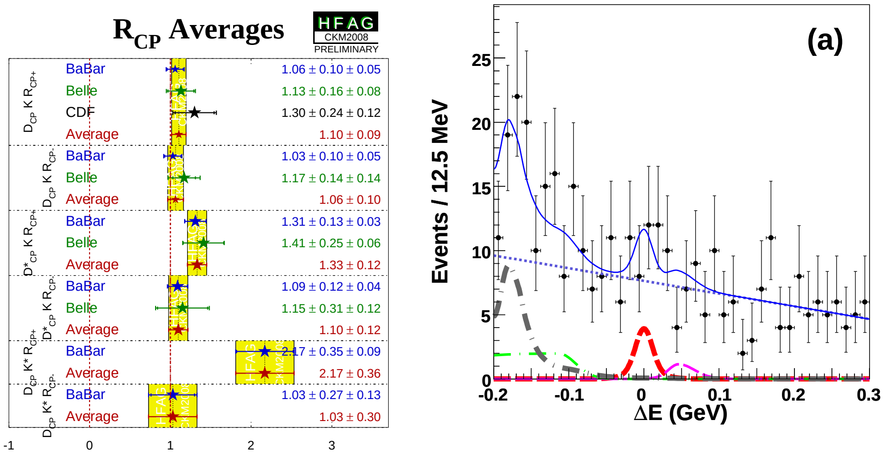

Figure 7: (Left) Compilation of the $R_{CP\pm}$ results. (Right) ΔE distribution for $B^- \to D_{\rm sup} K^-$ for the Belle analysis. The signal component is shown by red thicker dashed curve.

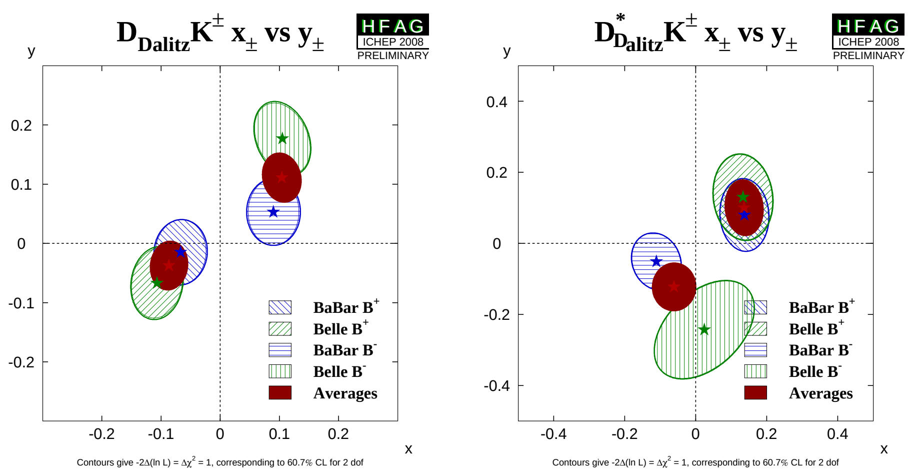

Figure 8: Results of signal fits with free parameters $x_\pm = r\cos\theta_\pm$ and $y_\pm = r\sin\theta_\pm$ for $B^\pm \to DK^\pm$ (left) and $B^\pm \to D^* K^\pm$ (right) from the BaBar and Belle latest publications. The contours indicate one standard deviation.

References

1. N.Cabibbo, *Phys. Rev. Lett.* **51**, 531 (1963).
2. M.Kobayashi and T.Maskawa, *Prog. Theor. Phys.* 49, 652 (1973).
3. M.Gronau, *Phys. Rev. Lett.* **63**, 1451 (1989), H.Boos, T.Mannel and J.Reuter, *Phys. Rev.* D **70**, 036006 (2004). M.Ciuchini, M.Pierini and L.Silvestrini, *Phys. Rev. Lett.* **95**, 221804 (2005).
4. Heavy Flavor Averaging Group: www.slac.stanford.edu/xorg/hfag/.
5. Belle Collaboration, K.-F.Chen *et al.*, *Phys. Rev. Lett.* **98**, 031802 (2007).
6. Belle Collaboration, H.Sahoo *et al.*, *Phys. Rev.* D **77**, 091103 (2008).
7. BaBar Collaboration, B.Aubert *et al.*, *Phys. Rev.* D **79**, 072009 (2009).
8. M.Gronau and D.London, *Phys. Rev. Lett.* **65**, 3381 (1990).
9. CKMfitter group, J.Charles *et al.*, *Eur. Phys. Jour.* C 41, 1. (2005), updated in ckmfitter.in2p3.fr.

10. BaBar Collaboration, B.Aubert *et al.*, *Phys. Rev.* D **76**, 052007 (2007).
11. Belle Collaboration, A.Somov *et al.*, *Phys. Rev. Lett.* **96**, 171801 (2006).
12. Belle Collaboration, A.Somov *et al.*, *Phys. Rev.* D **76**, 011104 (2007).
13. BaBar Collaboration, arXiv:0901.3522.
14. Belle Collaboration, J.Zhang *et al.*, *Phys. Rev. Lett.* **91**, 221801 (2003).
15. BaBar Collaboration, B.Aubert *et al.*, *Phys. Rev.* D **78**, 071104 (2008).
16. Belle Collaboration, C.-C.Chiang *et al.*, *Phys. Rev.* D **78**, 111102 (2008).
17. M.Gronau and D.London, *Phys. Lett.* B **253**, 483 (1991); M.Gronau and D.Wyler, *Phys. Lett.* B **265**, 172 (1991); M.Gronau, *Phys. Rev.* D **58**, 037301 (1998).
18. D.Atwood, I.Dunietz and A.Soni, *Phys. Rev. Lett.* **78**, 3257 (1997).
19. A.Giri, Y.Grossman, A.Soffer and J.Zupan, *Phys. Rev.* D **68**, 054018 (2003).
20. M. Gronau, *Phys. Lett.* B **557**, 198 (2003).
21. Y.Grossman, A.Soffer and J.Zupan, *Phys. Rev.* D **72**, 031501 (2005).
22. Y.Horii, K.Trabelsi, H.Yamamoto *et al.*, *Phys. Rev.* D **78**, 071901 (2008).
23. Belle Collaboration, arXiv:0803.3375.
24. BaBar Collaboration, B.Aubert *et al.*, *Phys. Rev.* D **78**, 034023 (2008).
25. G.J.Feldman and R.D.Cousins, *Phys. Rev.* D **57**, 3873 (1998).