CKM matrix fits including Constraints on New Physics

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Cabibbo-Kobayashi-Maskawa Matrix

$$V_{CKM} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \approx \begin{pmatrix} 1-\lambda^2/2 & \lambda & A\lambda^3(\rho - i\eta) \\ -\lambda & 1-\lambda^2/2 & A\lambda^2 \\ A\lambda^3(1-\rho-i\eta) & -A\lambda^2 & 1 \end{pmatrix} + O(\lambda^4)$$

$$\lambda \approx 0.225 \, (\textit{Wolfenstein approximation})$$

Exact and unitary to all orders in λ:

$s_{12} \equiv \lambda$ $\quad s_{23} \equiv A\lambda^2$ $\quad s_{13} e^{-i\delta} \equiv A\lambda^3(\rho - i\eta)$

Buras, Lautenbacher & Ostermaier
PRD 50, 3433 (1994)

$$\rho + i\eta = \frac{\sqrt{1-A^2\lambda^4}(\bar{\rho} + i\bar{\eta})}{\sqrt{1-\lambda^2}[1 - A^2\lambda^4(\bar{\rho} + i\bar{\eta})]}$$

Exact and unitary to all orders in λ
and phase-convention independent:

$$\lambda = \frac{V_{us}}{\sqrt{(|V_{ud}|^2 + |V_{us}|^2)}} \qquad A\lambda^2 = \frac{V_{cb}}{\sqrt{(|V_{ud}|^2 + |V_{us}|^2)}} \qquad \bar{\rho} + i\bar{\eta} = -\frac{V_{ud} V_{ub}^*}{V_{cd} V_{cb}^*}$$

CKMfitter group
EPJ C41, 1-131 (2005)

PDG 2006

CKM fits with New Physics in Neutral Meson Mixing

In a large class of NP Models mainly contributions to B mixing, e.g.:

Fleischer, Isidori & Matias, JHEP 0305, 053 (2003)

Model-independent parametrizations

$$r_q^2 e^{2i\theta_q} = \frac{\langle \bar{B}_q^0 | M_{12}^{SM+NP} | B_q^0 \rangle}{\langle \bar{B}_q^0 | M_{12}^{SM} | B_q^0 \rangle} \quad q = d, s$$

SM: $r_q^2 = 1, 2\theta_q = 0$

e.g Soares & Wolfenstein, PRD 47, 1021 (1993)
Deshpande, Dutta & Oh, PRL77, 4499 (1996)
Silva & Wolfenstein, PRD 55, 5331 (1997)
Cohen et al., PRL78, 2300 (1997)
Grossman, Nir & Worah, PLB 407, 307 (1997)

$$1 + h_q e^{2i\sigma_q} = 1 + \frac{\langle \bar{B}_q^0 | M_{12}^{NP} | B_q^0 \rangle}{\langle \bar{B}_q^0 | M_{12}^{SM} | B_q^0 \rangle} \quad q = d, s$$

SM: $h_q = 0, \; 2\sigma_q = 0$

e.g. Goto et al., PRD 53, 6662 (1996)
Agashe et al., hep-ph/0509117

Assumption 1: $\Gamma_{12} = \Gamma_{12}^{SM}$

NP contributions only in dispersive part (Short Distance physics)
not in absorptive part (Long Distance physics)

Assumption 2: 3x3 unitary CKM matrix

CKM fits with New Physics in Neutral Meson Mixing

What about NP in decay?

Decays with four flavour change (SM4FC: $b \to q_1 \bar{q}_2 q_3, q_1 \neq q_2 \neq q_3$) are dominated by Standard Model contribution

(e.g. CKMfitter group, EPJC 41, 1 (2005); Goto et al., PRD 53, 6662 (1996))

Observables which are not affected by NP then: $|V_{ud}|, |V_{us}|, |V_{ub}|, |V_{cb}|, \gamma$

Observables which are affected by NP in mixing:

- **Mixing frequency** $r_q^2 \Delta m_q^{SM}$
- **CP violation in Mixing** $A_{SL}^q(r_q^2, 2\theta_q)$
- **CP violation in the interference between decay with and w/o mixing**
  $\sin(2\beta + 2\theta_d)$
  $\cos(2\beta + 2\theta_d)$
  $\alpha = \pi - \gamma - \beta - \theta_d$
  $\sin(2\beta + 2\theta_d + \gamma)$
- **Lifetime differences** $e.g.\ \Delta\Gamma_q^{CP}{}' = \Delta\Gamma_q^{SM} \cos^2(2\theta_q)$

Some recent analyses with NP in Neutral Meson Mixing

Reference	$K^0-\bar{K}^0$	$B_d^0-\bar{B}_d^0$	$B_s^0-\bar{B}_s^0$
* Laplace et al., PRD65, 094040 (2002)		x	
	A_{SL} constraint studied for the first time		
* CKMfitter group, EPJC 41, 1 (2005)		x	
	First complete B factory analysis; real CKM excluded		
* Agashe et al. hep-ph/0509117	x	x	x
	Next-to-Minimal Flavour Violation		
* UTfit collaboration JHEP 0603, 080 (2006)	x	x	
	Combined K- and B-mixing; Minimal Flavour Violation		
* Blanke et al., JHEP 0610, 003 (2006)	(x)	x	x
	Minimal Flavour Violation		
* Ball & Fleischer, EPJ C48, 413 (2006)		x	x
	Focus: $\Delta m_{d,s}$; NP from Z' and MSSM in mass insertion approx.		
* Ligeti, Papucci & Perez, PRL 97, 101801 (2006)	(x)	x	x
	Impact of Δm_s & $\Delta\Gamma_s$ & A_{SL}^q ; NMFV		
* Grossman, Nir & Raz, PRL 97, 151801 (2006)		x	x
	Impact of Δm_s & $\Delta\Gamma_s$ & $A_{SL}^{d,s}$		
* UTfit collaboration PRL 97, 151803 (2006)	x	x	x
	Combined analysis of the three Neutral Meson systems		

Inputs I - V_{ud}, V_{us} and V_{cb}

Super-allowed β-decays: $|V_{ud}| = 0.97377 \pm 0.00027$

CKM05, hep-ph/0512039

$|V_{us}| = 0.2240 \pm 0.0011$

Moriond07, M. Jamin using:

$\Rightarrow \lambda$

Deviation from unitarity: 2.2σ

$K \to \pi l \nu$: $|V_{us}| = 0.2244 \pm 0.0013$

Error dominated by a recent preliminary LQCD calculation (UKQCD/RBC, hep-lat/0702026: 0.961±0.005)

$K/\pi \to \mu \nu$: $|V_{us}| = 0.2226^{+0.0026}_{-0.0014}$

τ decays: $|V_{us}| = 0.2225 \pm 0.0034$

Hyperon decays: $|V_{us}| = 0.226 \pm 0.005$

$B \to X_c l \nu$: $|V_{cb}| = 0.04196 \pm 0.00072$ Buchmüller & Flächer, PRD73, 073008 (2006))

$B \to D^* l \nu$: $|V_{cb}| = 0.0392^{+0.0017}_{-0.0014}$ HFAG06 & LQCD, (Hashimoto et al. PRD66, 014503 (2002))

$B \to X_c l \nu$ (average): $|V_{cb}| = 0.0416 \pm 0.0007 \Rightarrow A\lambda^2$

Inputs II(a) - V_{ub}

$$B \to X_u l\nu: \ |V_{ub}| = (4.52 \pm 0.19 \pm 0.27)\, 10^{-3}$$

HFAG06, BLNP

$$|V_{ub}| = (4.52 \pm 0.23 \pm 0.44)\, 10^{-3}$$

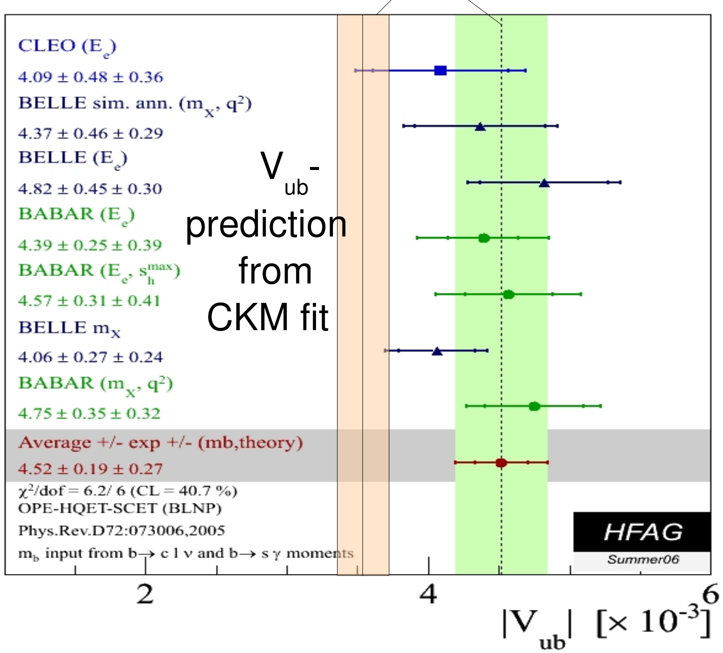
HFAG06, BLNP
Add linearily theory errors that are not “well” under control

$$B \to \pi l\nu: \ |V_{ub}| = (3.60 \pm 0.10 \pm 0.50)\, 10^{-3}$$

“Average” using HFAG06 numbers for different FF calculations

$$\text{'Average'}: \ |V_{ub}| = (4.09 \pm 0.09 \pm 0.44)\, 10^{-3} \ \Rightarrow A\lambda^3(\rho^2 + \eta^2)$$

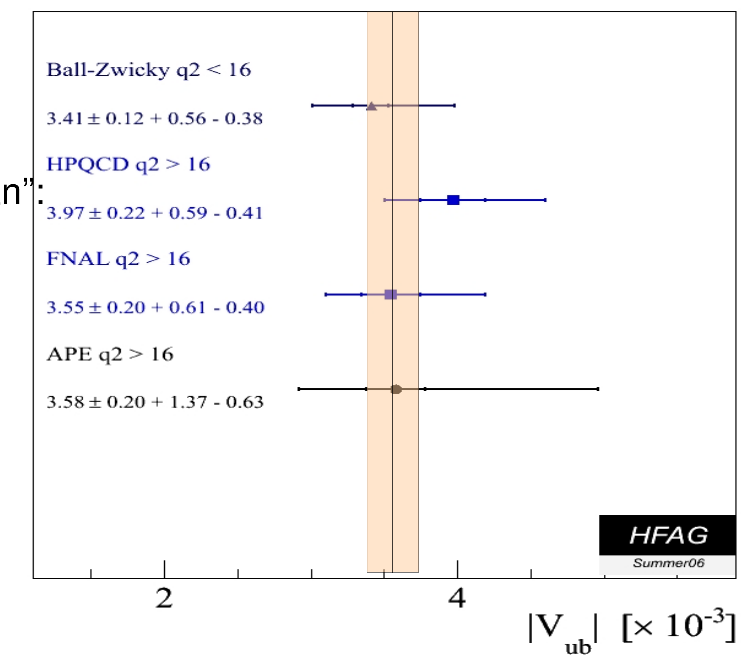
Retaining the smallest theoretical uncertainty



V_{ub} - prediction from CKM fit

All errors “Gaussian”: 2.6 σ

Scan a part of theory errors: 1.85 σ



Inputs II(b) - V_{ub}

UTfit:

$B \to X_u l \nu$: $|V_{ub}| = (4.49 \pm 0.33)\,10^{-3}$ HFAG06, BLNP

Treat all errors Gaussian

$B \to \pi l \nu$: $|V_{ub}| = (3.50 \pm 0.40)\,10^{-3}$ "Average" using HFAG06 numbers for different FF calculations

Treat all errors Gaussian

'Weighted mean would give': $|V_{ub}| = (4.09 \pm 0.25)\,10^{-3}$

'If PDG error rescaling': $|V_{ub}| = (4.09 \pm 0.49)\,10^{-3}$

Inputs III - "sin2β/cos2β"

$B \rightarrow c\bar{c}K^{0(*)}$ (HFAG06): $\sin(2\beta + 2\theta_d) = (0.678 \pm 0.025)$

$b \rightarrow c\bar{c}s$ dominated by $V_{cs}V_{cb}^*$ SM tree amplitude

gluonic penguin OZI-suppressed, Z-penguin small (Atwood & Hiller, hep-ph/0307251)

Mixing phase from $K-\bar{K}$ mixing negligible thanks to ϵ_K constraint

$\cos(2\beta+2\theta_d)<0$ excluded at (no average provided by HFAG):

Decay	BABAR (10^6 $B\bar{B}$)	Belle (10^6 $B\bar{B}$)	Remark
$B \rightarrow J/\psi K^*$	@86% CL (88) PRD 71, 032005 (2005)	Not quoted (275) PRL 95, 091601 (2005)	Model dependence eliminated in BABAR
$B \rightarrow D^0/\bar{D}^0 h^0$	@87% CL (311) hep-ex/0607105	@98.3% CL (386) PRL 97, 081801 (2006)	Dalitz Analysis (*)
$B \rightarrow D^* D^* K_S$	@94% CL (230) hep-ex/0608016	Not measured	model dependent (**)

(*) Bondar, Gershon & Krokovny, PLB 624, 1 (2005)

(**) Charles et al., PLB425, 375 (1998); 433, 441 (1998) (E); Browder et al., PRD 61, 054009 (2000)

Inputs IV - B-Mixing

Observables: $$\Delta m_q = M_H - M_L \simeq 2|M_{12}| = r_q^2 \Delta m_q^{SM}$$

$$\Delta\Gamma_q = \Gamma_L - \Gamma_H \simeq -\Delta m_q^{SM}\left[\Re\left(\frac{\Gamma_{12}}{M_{12}}\right)_{SM}\cos 2\theta_q + \Im\left(\frac{\Gamma_{12}}{M_{12}}\right)_{SM}\sin 2\theta_q\right]$$

$$A_{SL}^q = \Im\left(\frac{\Gamma_{12}}{M_{12}}\right) = -\Re\left(\frac{\Gamma_{12}}{M_{12}}\right)_{SM}\frac{\sin 2\theta_q}{r_q^2} + \Im\left(\frac{\Gamma_{12}}{M_{12}}\right)_{SM}\frac{\cos 2\theta_q}{r_q^2}$$

NLO calculations:
* Beneke et al., PLB576, 173 (2003)
* Ciuchini et al., JHEP 0308, 031 (2003)
* Lenz & Nierste, hep-ph/0612167

$$\bar{m}_t(m_t) = (163.8 \pm 2.0)\, GeV$$

Nierste, Beauty2006

$$\eta_B = 0.551 \pm 0.007$$

Buchalla, Buras and Lautenbacher, RMP 68, 1125 (1996)

$$f_{B_s} = (268 \pm 17 \pm 20)\,\mathrm{MeV} \qquad \frac{f_{B_s}}{f_{B_d}} = 1.20 \pm 0.02 \pm 0.05$$

$$\hat{B}_s = 1.29 \pm 0.05 \pm 0.08 \qquad \frac{B_s}{B_d} = 1.00 \pm 0.02\,(*)$$

N.~Tantalo, CKM workshop 2006 ``Lattice calculations for B and K mixing,'' hep-ph/0703241

except for (*)

Inputs IV - B-mixing

$\Delta m_d = (0.507 \pm 0.005)\, ps^{-1}$ (PDG07: dominated by BABAR & Belle)

$A_{SL}^d = -0.0043 \pm 0.0046$ (BABAR, Belle, CLEO, BABAR |q/p|)

SM prediction: $A_{SL}^d = (-4.8^{+1.0}_{-1.2})\, 10^{-4}$
Lenz & Nierste

$\frac{\Delta \Gamma_d}{\Gamma_d} = 0.009 \pm 0.037$ (HFAG06: BABAR, DELPHI; currently no impact on New Physics fits)

$\Delta m_s = (17.77 \pm 0.12)\, ps^{-1}$ CDF, PRL 97, 242003 (2006)

$\Delta \Gamma_s^{SM} \cos^2(2\theta_s) = (0.12 \pm 0.08)\, ps^{-1}$ D0, hep-ex/0702030

$A_{SL}^s = 0.0245 \pm 0.0196$ D0, hep-ex/0701007

$A_{SL} = -0.0028 \pm 0.0013 \pm 0.0008$ D0, PRD74, 092001 (2006)

$= (0.582 \pm 0.030)\, A_{SL}^d + (0.418 \pm 0.047)\, A_{SL}^s \approx (-2.7^{+0.6}_{-0.7})\, 10^{-4}$

SM prediction

Inputs V - K-mixing

$\epsilon_K = (2.284 \pm 0.014) 10^{-3}$ (PDG 04)

$\downarrow$ $3.7\,\sigma$ due to 5.5% reduction of BF($K_L \to \pi^+\pi^-$) (KTeV, KLOE, NA48)

$\epsilon_K = (2.232 \pm 0.007) 10^{-3}$ (PDG 06)

$\hat{B}_K = 0.78 \pm 0.02 \pm 0.09$ N.~Tantalo, CKM workshop 2006, hep-ph/0703241

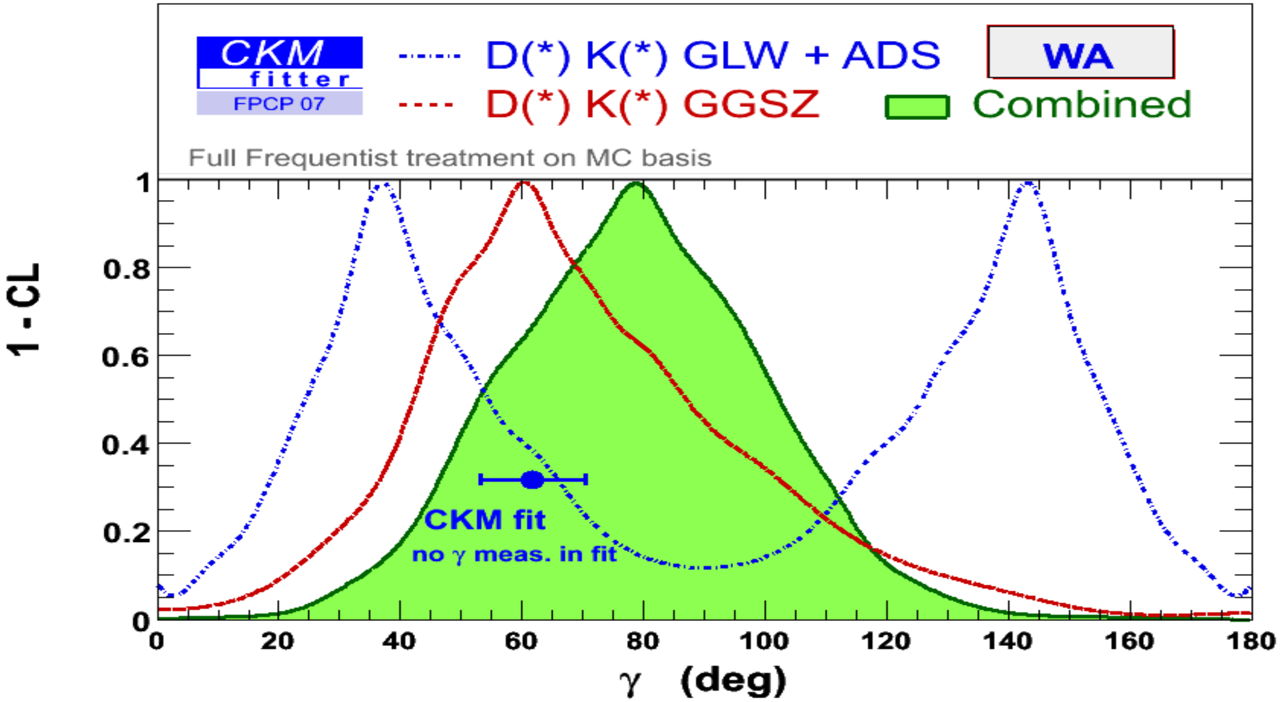
$\eta_{tt} = 0.5765 \pm 0.0065$ Herrlich & Nierste,NPB 419, 292 (1994)

$\eta_{ct} = 0.47 \pm 0.04$

$\eta_{cc}(\bar{m}_c(m_c), \alpha_s)$ Nierste, CKM workshop 2001

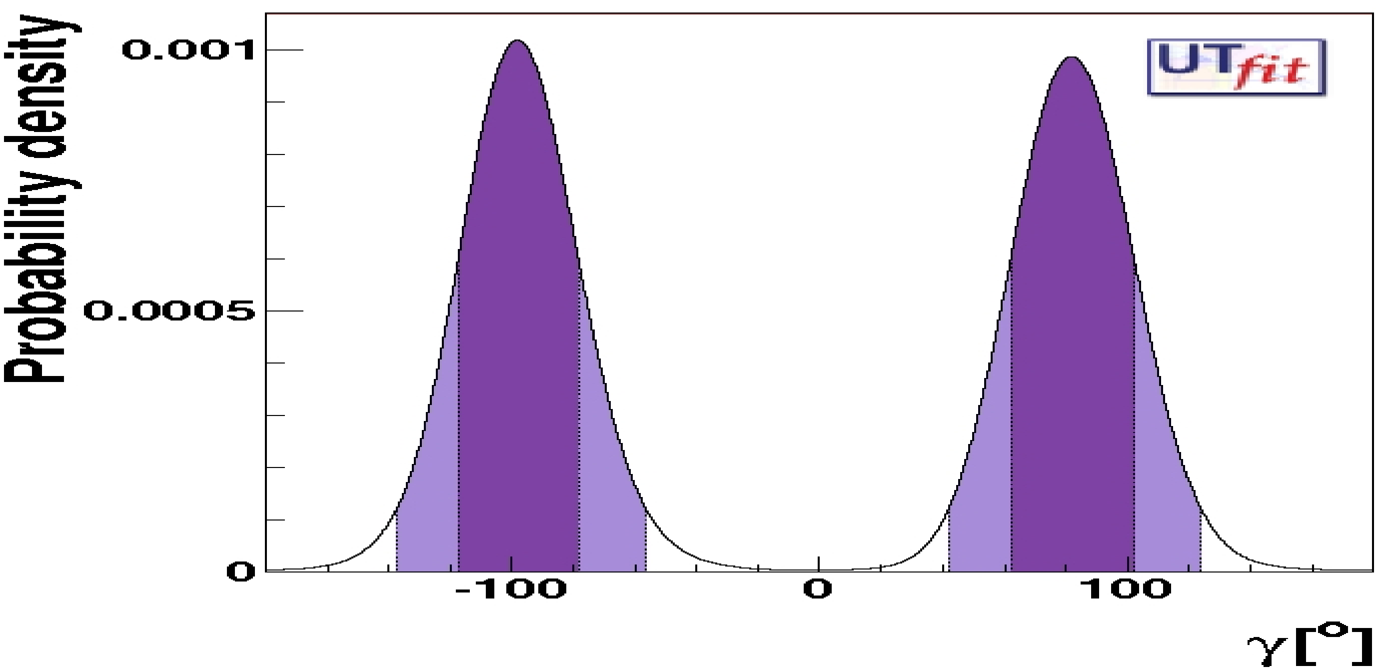
$\bar{m}_c(m_c) = (1.24 \pm 0.037 \pm 0.095)\,\mathrm{GeV}$ Buchmüller & Flächer, PRD 73, 073008 (2006)

Input VI - γ from B ->$D^{(*)}K^{(*)}$ (GLW+ADS+Dalitz)



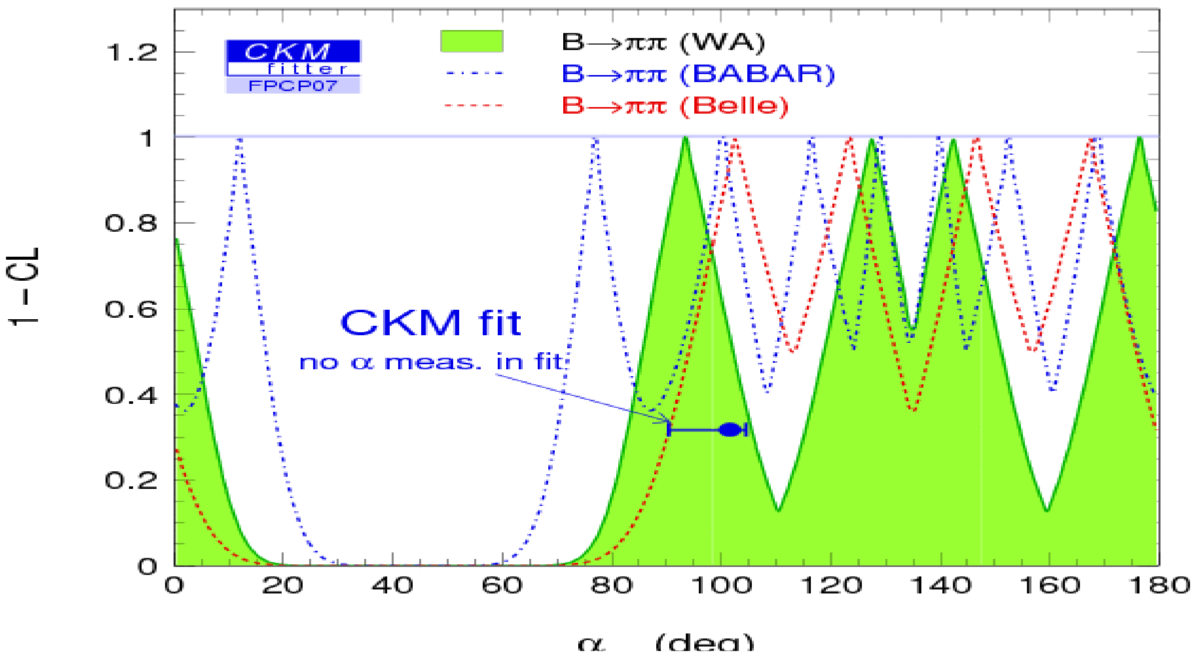
$$\gamma = (77 \pm 31)^o$$

See review talk on γ by Vincent Tisserand

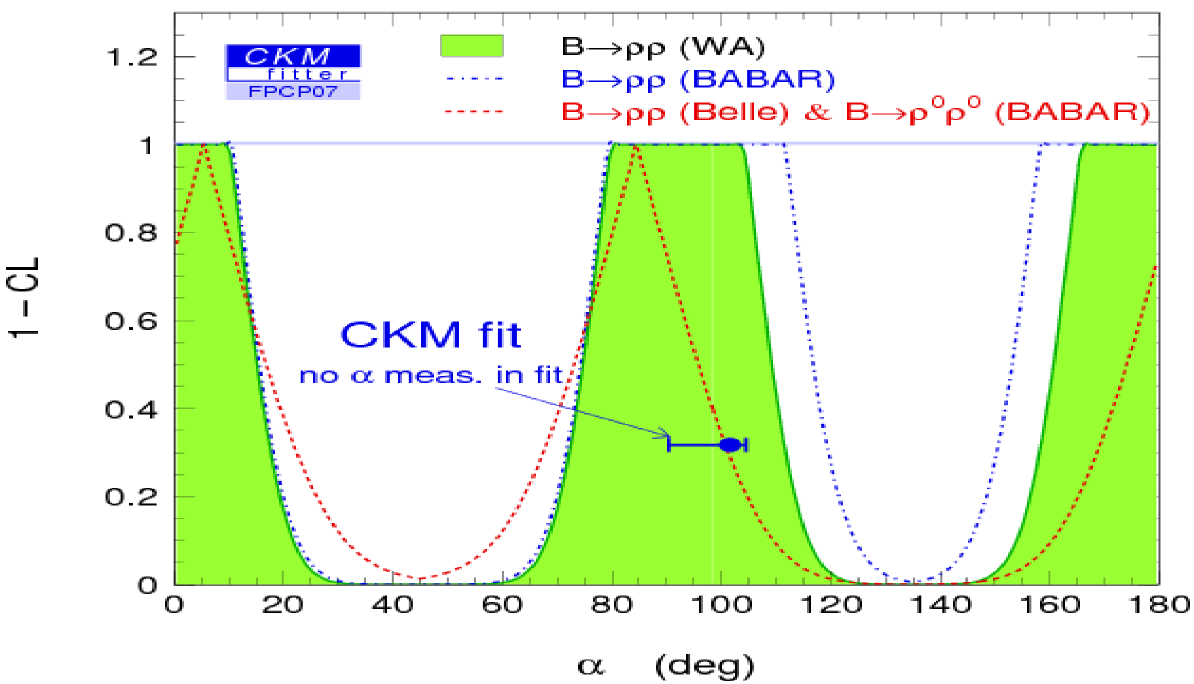


$$\gamma = (82 \pm 20)^o$$

Input VII - α from B --> ππ,ρρ (Isospin analysis)



* Isospin analysis
  Gronau & London, PRL65, 3381 (1990)
* Gluonic penguins only contribute to ΔI=1/2
  Extraction insensitive to NP in ΔI=1/2
  (except for α=0)
* Assuming no NP in ΔI=3/2: $\alpha = \pi - \gamma - \beta - \theta_d$



α extraction in SU(2) analysis within Bayesian approach not reparametrization invariant:

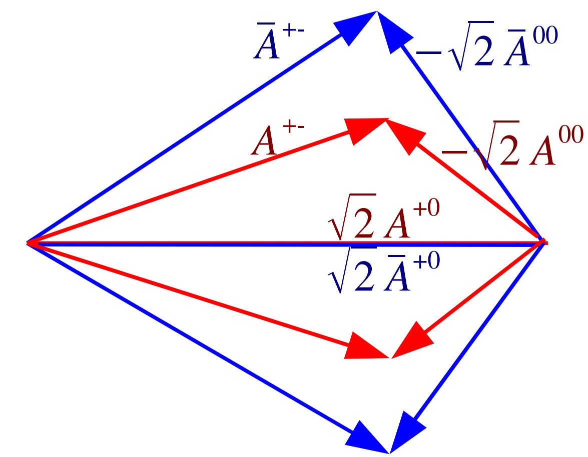
J. Charles et al., hep-ph/0607246

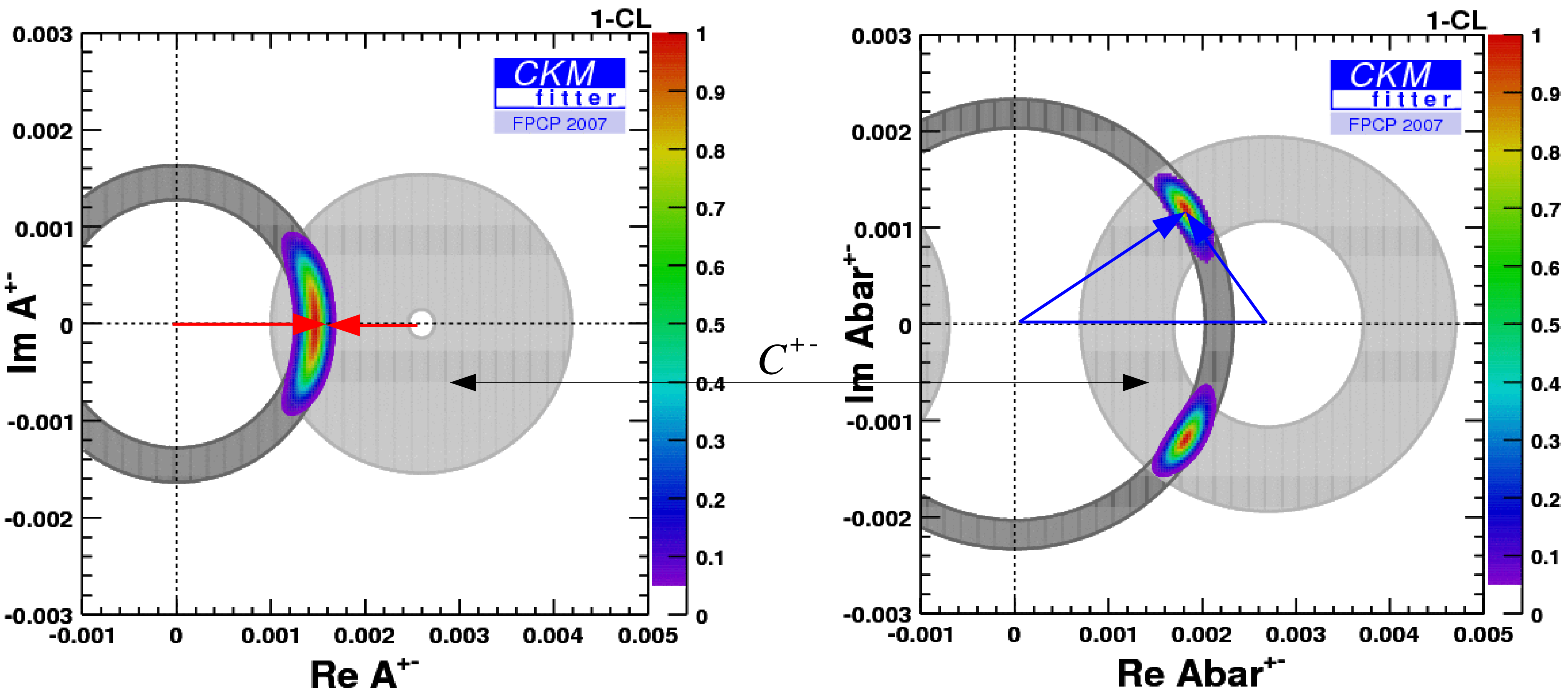
UTfit, hep-ph/0701204

J. Charles et al., hep-ph/0703073

Input VII - α from B --> $\pi\pi$ - Isospin Triangles

Why are there only 4 solutions visible for the current α analysis?

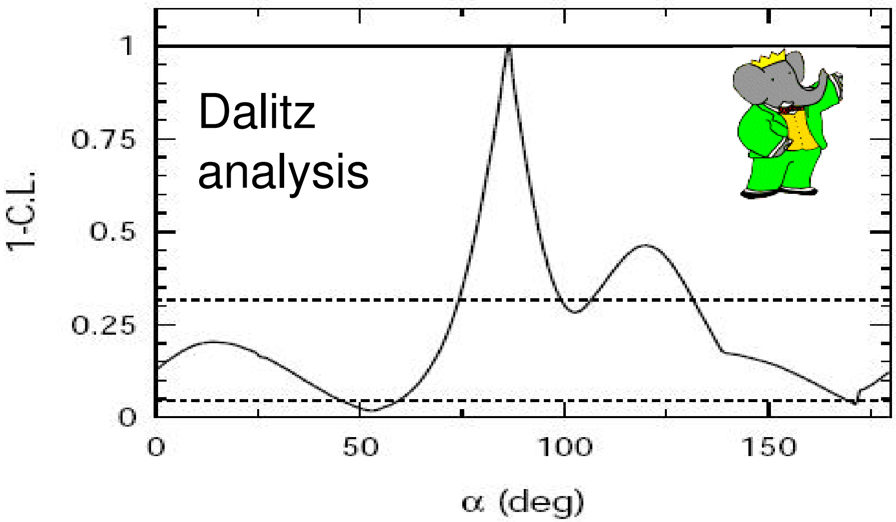




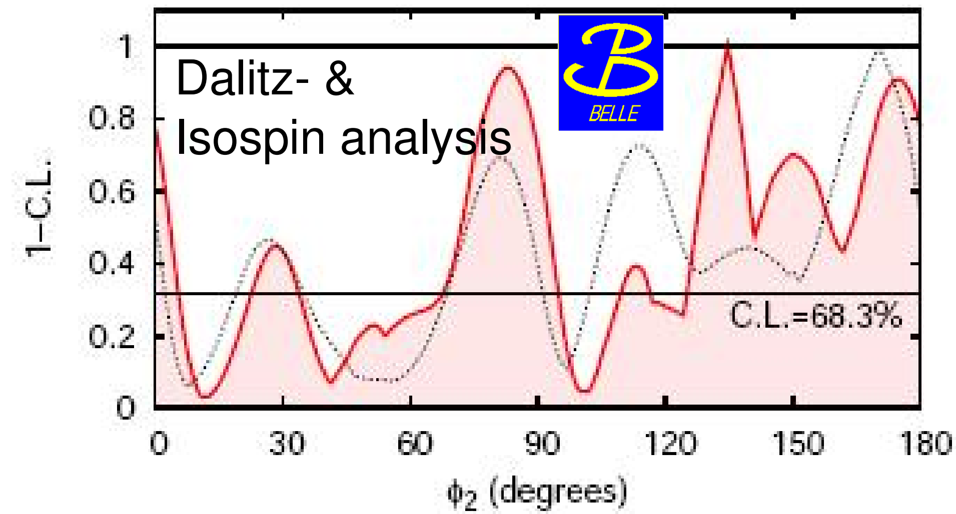
Input VII - α from B --> $\rho\pi$ (Dalitz analysis)

Snyder & Quinn, PRD48, 2139 (1993)

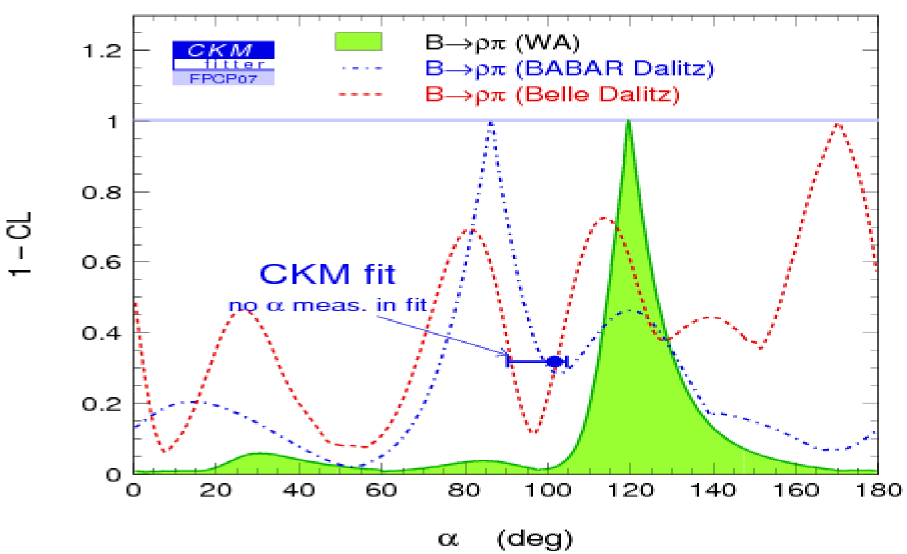
BABAR, hep-ex/0703008 (347 10^6 BB)



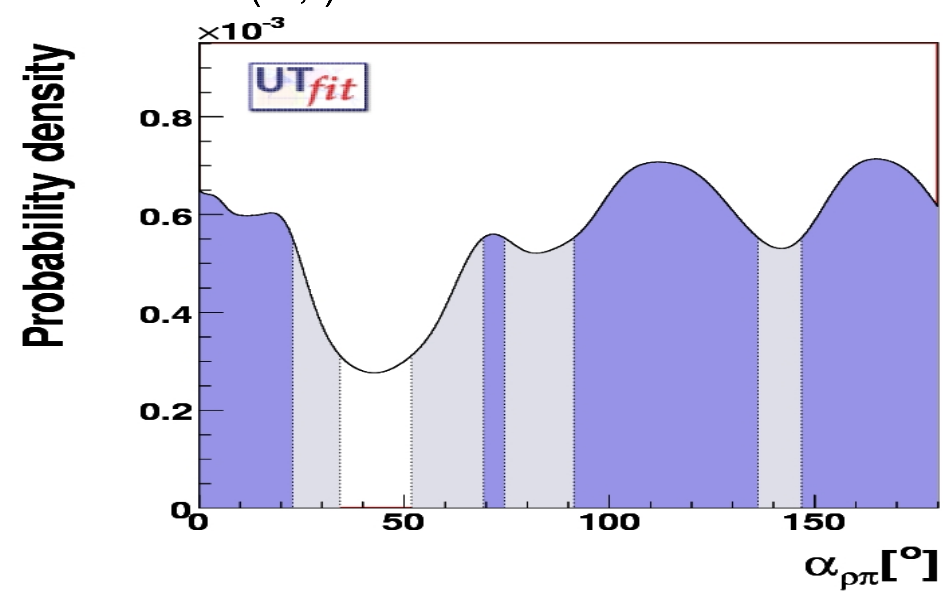
Belle, hep-ex/0701015 (449 10^6 BB)



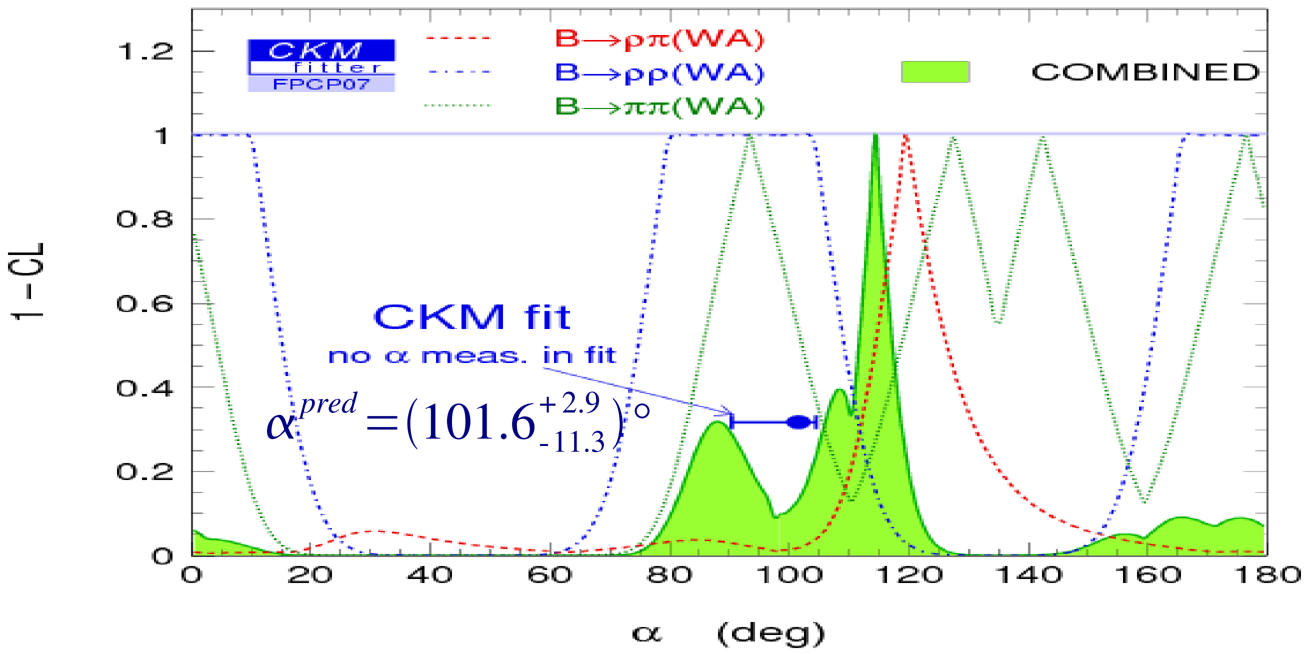
BABAR, hep-ex/0703008 (375 10^6 BB)
Belle, hep-ex/0701015 (449 10^6 BB)
Cov(U,I) taken into account (crucial !)

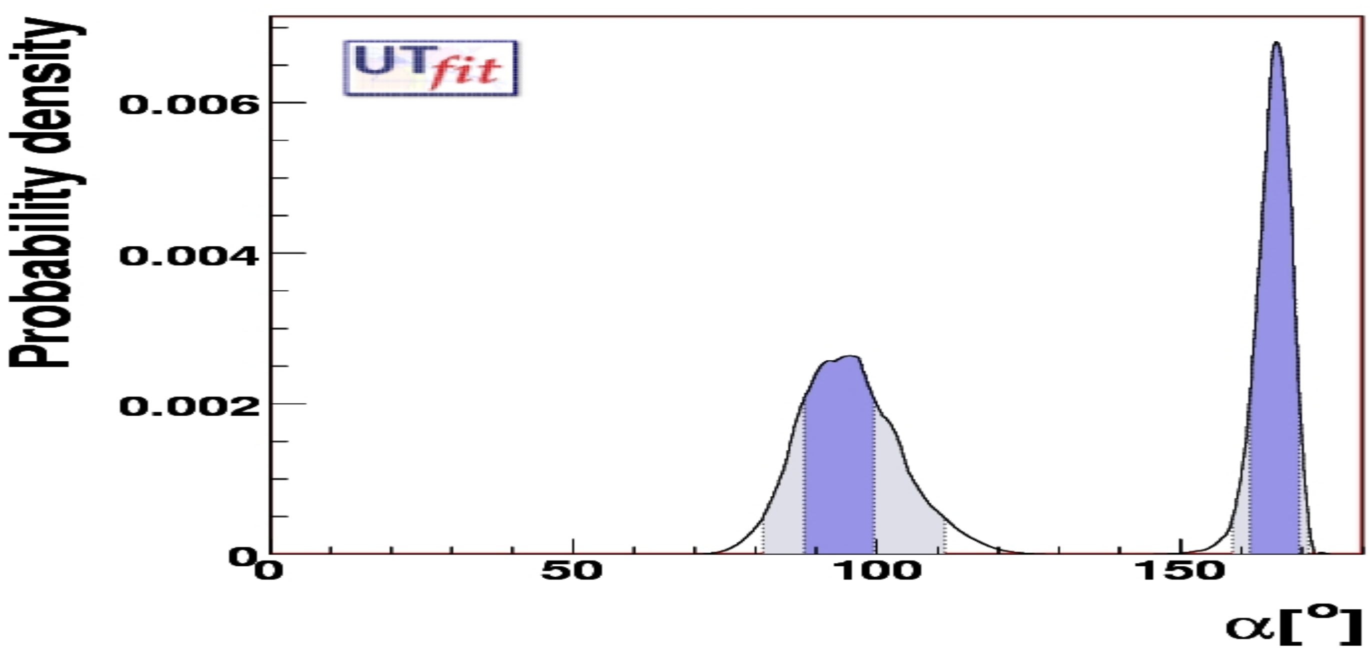


BABAR, hep-ex/0608002 (347 10^6 BB)
Belle, hep-ex/0609003 (449 10^6 BB)
Cov(U,I) not taken into account

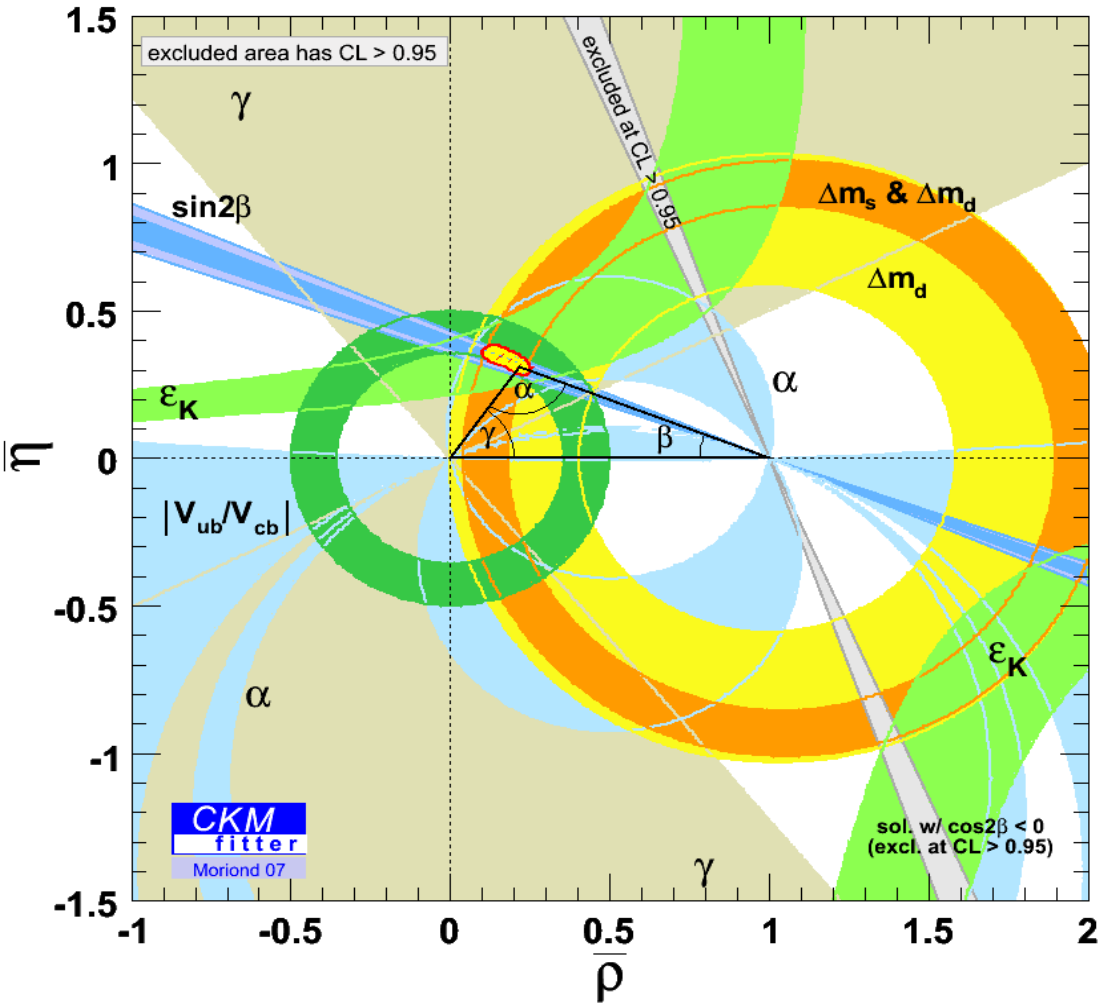


Input VII - α from B --> ππ, ρρ, ρπ (Combination)





SM fit: Results



CKMfitter (95%CL)	UTfit (95% prob)
$\lambda_{fit} = 0.2258^{+0.0016}_{-0.0017}$	
$A_{fit} = 0.817^{+0.030}_{+0.028}$	
$\bar{\rho}_{fit} = [0.108, 0.243]$	$\bar{\rho}_{fit} = [0.107, 0.222]$
$\bar{\eta}_{fit} = [0.288, 0.375]$	$\bar{\eta}_{fit} = [0.307, 0.373]$
$J_{fit} = (2.74^{+0.63}_{-0.22})\,10^{-5}$	

Note: inputs not identical

CKMfitter

$$\left|V_{ub}^{excl}\right| = (3.60 \pm 0.10 \pm 0.50)\,10^{-3}$$

$$\left|V_{ub}^{incl}\right| = (4.52 \pm 0.23 \pm 0.44)\,10^{-3}$$

or $$\left|V_{ub}^{incl}\right| = (4.52 \pm 0.19 \pm 0.27)\,10^{-3}$$

$$\left|V_{ub}^{inp}\right| = (4.09 \pm 0.09 \pm 0.44)\,10^{-3}$$

$$\left|V_{ub}^{pred}\right| = (3.54^{+0.18}_{-0.16})\,10^{-3}$$

CKMfitter (95%CL)

$\beta_{meas} = (21.4^{+2.0}_{-1.9})^\circ$	$\alpha_{meas} = [78.5^\circ, 123.8^\circ]$	$\gamma_{meas} = [26.4^\circ, 129.5^\circ]$
$\beta_{pred} = (26.8^{+2.9}_{-6.2})^\circ$	$\alpha_{pred} = [85.4^\circ, 107.1^\circ]$	$\gamma_{pred} = [50.5^\circ, 72.9^\circ]$
$\beta_{fit} = (21.5^{+2.1}_{-1.3})^\circ$	$\alpha_{fit} = [84.8^\circ, 108.5^\circ]$	$\gamma_{fit} = [50.7^\circ, 73.1^\circ]$

$B \to \tau\nu$

$$BF(B\to\tau\nu) = \frac{G_F^2 m_B}{8\pi} m_\tau^2 \left(1-\frac{m_\tau^2}{m_B^2}\right)^2 f_B^2 |V_{ub}|^2 \tau_B = (0.96^{+0.38}_{+0.20})10^{-4} (95\% CL)$$

$$f_B = (223 \pm 15 \pm 26)\,MeV$$

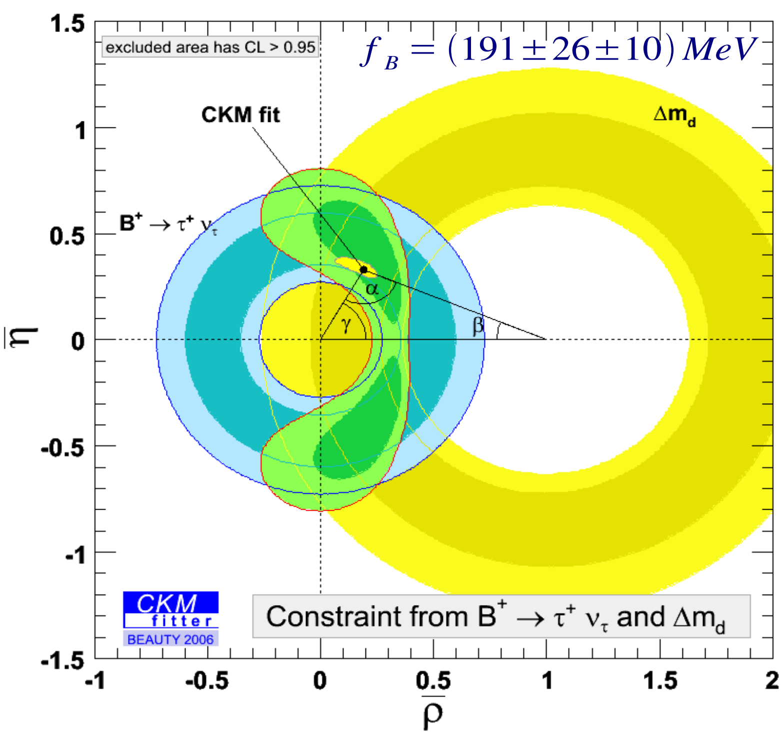
$$V_{ub}^{CKM\,fit} = (3.63^{+0.10}_{-0.08})\,10^{-3}$$

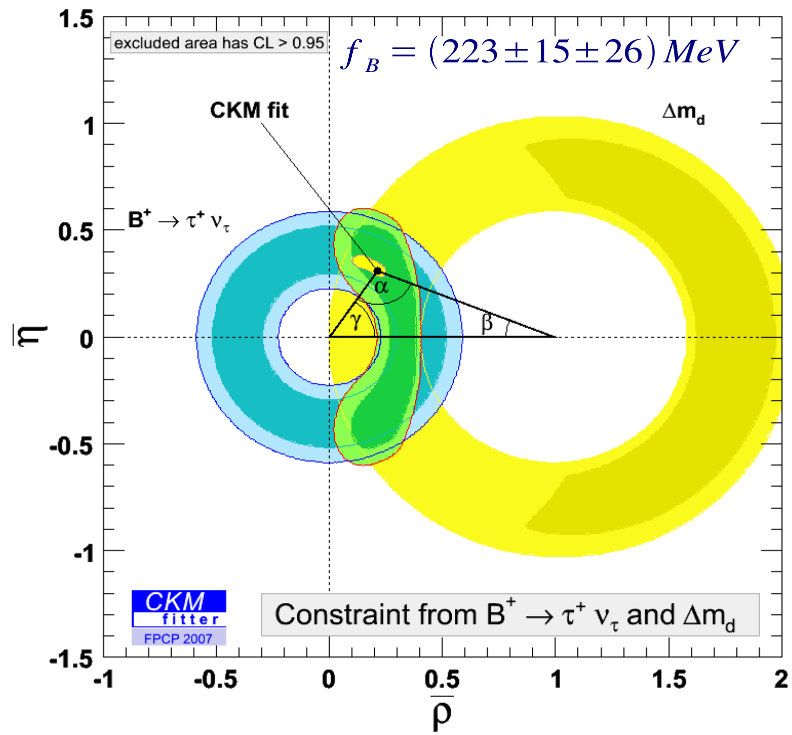
$$BF(B\to\tau\nu) = (1.06^{+0.34\,+0.18}_{-0.28\,-0.16})\times 10^{-4}$$
(320m)

$$BF(B\to\tau\nu) = (1.79^{+0.56\,+0.39}_{-0.49\,-0.46})\times 10^{-4}$$
(447m)

$$BF(B\to\tau\nu) = (1.20^{+0.40\,+0.29}_{-0.38\,-0.30} \pm 0.22)\times 10^{-4}$$
(383m, *hot topic talk by A. Gritsan*)

$$BF(B\to\tau\nu) = (1.79^{+0.56\,+0.39}_{-0.49\,-0.46})\times 10^{-4}$$
(447m)





New Physics in K-mixing

$$r_K^2 e^{2i\theta_K} = \frac{\langle \bar{K}^0 | M_{12}^{SM+NP} | K^0 \rangle}{\langle \bar{K}^0 | M_{12}^{SM} | K^0 \rangle} = 1 + h_K e^{2i\sigma_K}$$

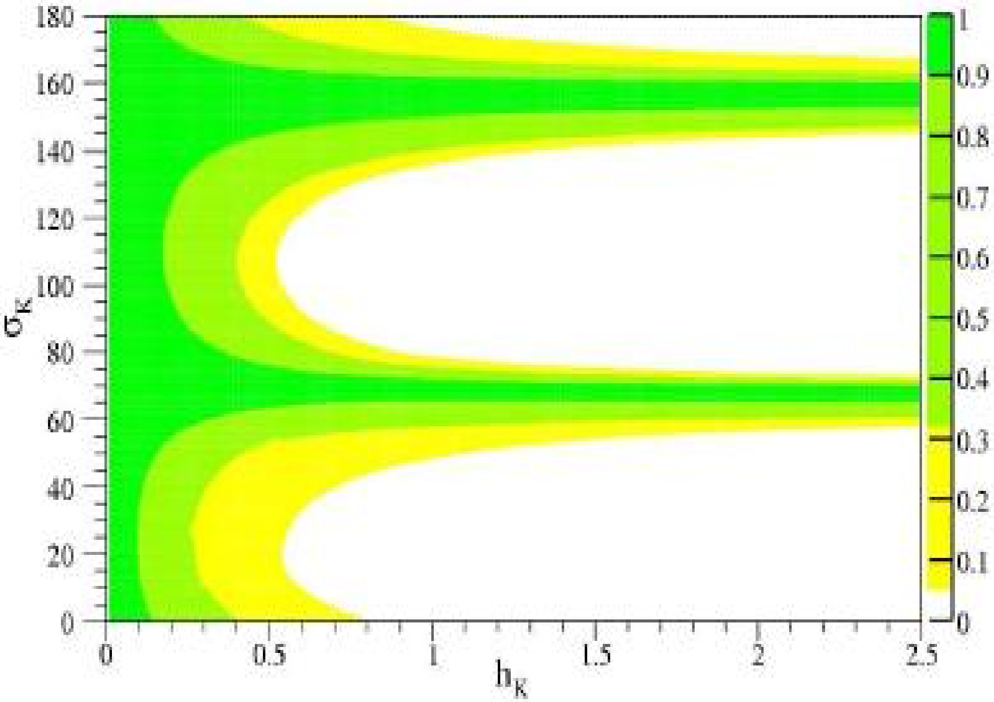
Only refers to modification of top-contribution!

The only useful constraint comes from ε_K

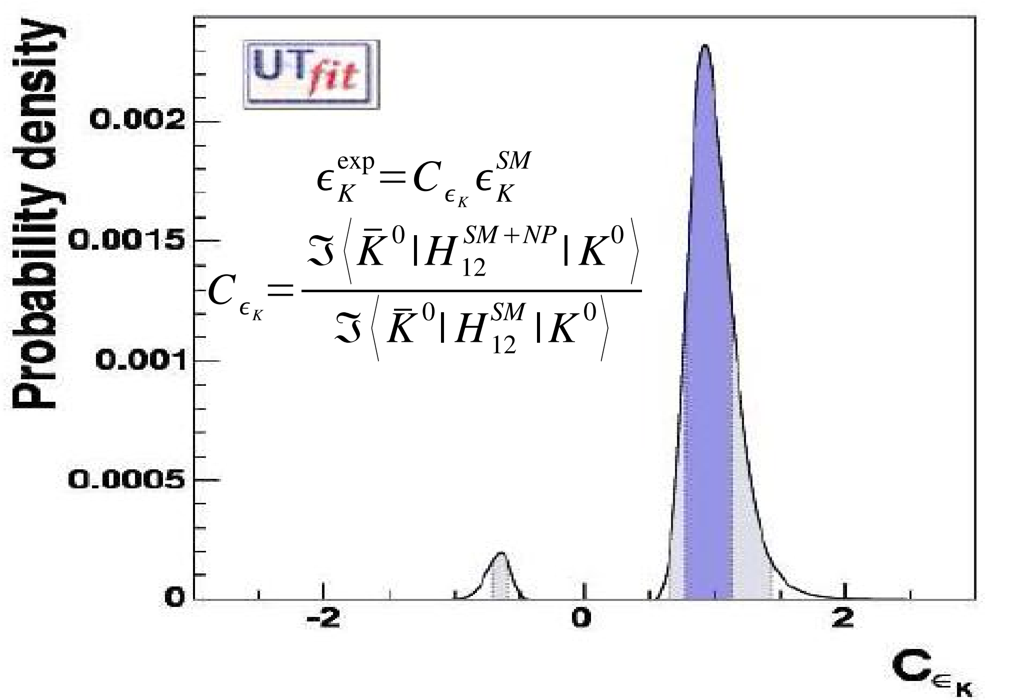
Agashe et al., hep-ph/0509117

$$\eta \left\{ (1-\rho) \left[1 + h_K \left(\cos 2\sigma_K + \frac{1}{2} \sin 2\sigma_K \left(\frac{1-\rho}{\eta} - \frac{\eta}{1-\rho} \right) \right) \right] A^2 \eta_2 S_0 + P_c(\varepsilon) \right\} A^2 \hat{B}_K = 0.187$$

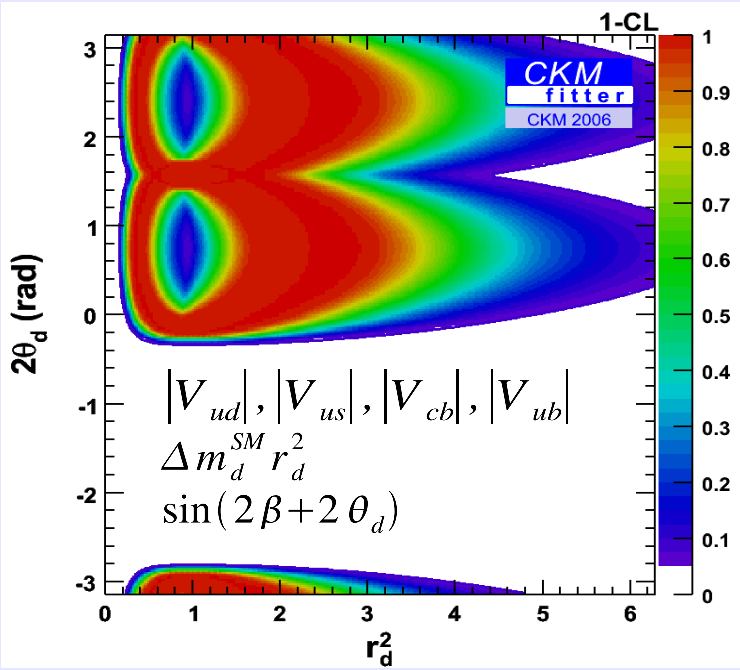
Agashe et al., hep-ph/0509117



UTfit collaboration, JHEP 0603, 080 (2006)



New Physics in Mixing: Results



$\cos(2\beta+2\theta_d)$

γ

$\alpha=\pi-\gamma-\beta-\theta_d$

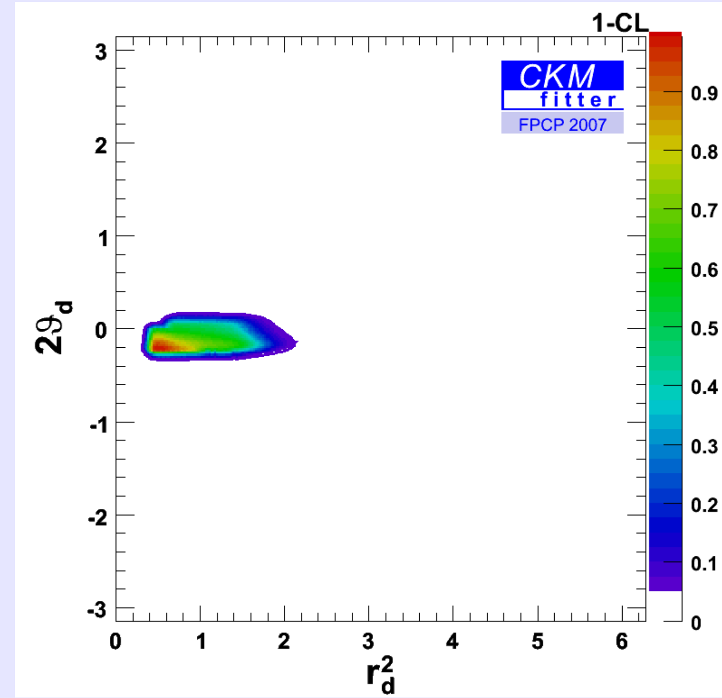
$A_{SL}^d(r_d^2, 2\theta_d)$

$A_{SL}(r_d^2, 2\theta_d, r_s^2, 2\theta_s)$

$A_{SL}^s(r_s^2, 2\theta_s)$

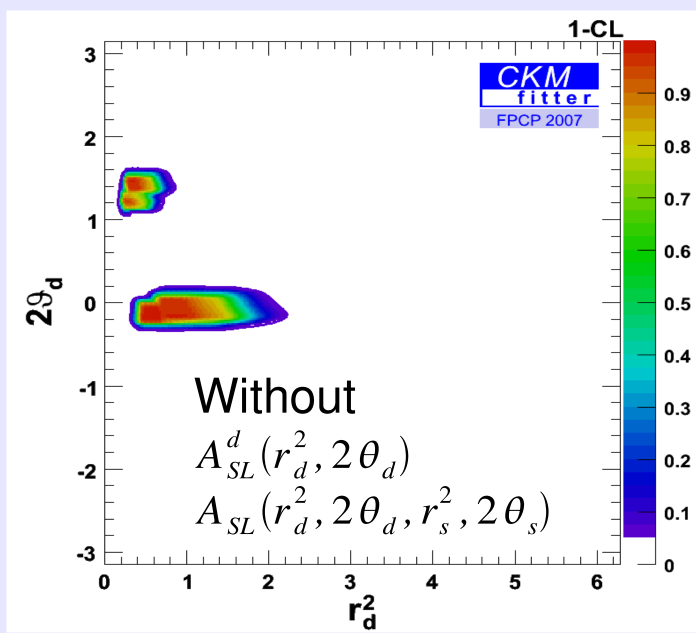
$\Delta\Gamma_s^{SM}\cos^2(2\theta_s)$

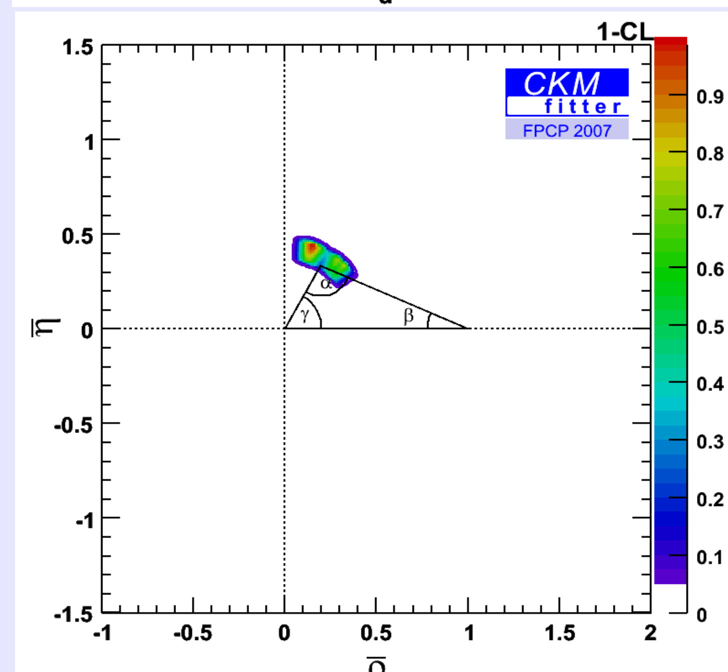
$\Delta m_s^{SM} r_s^2$



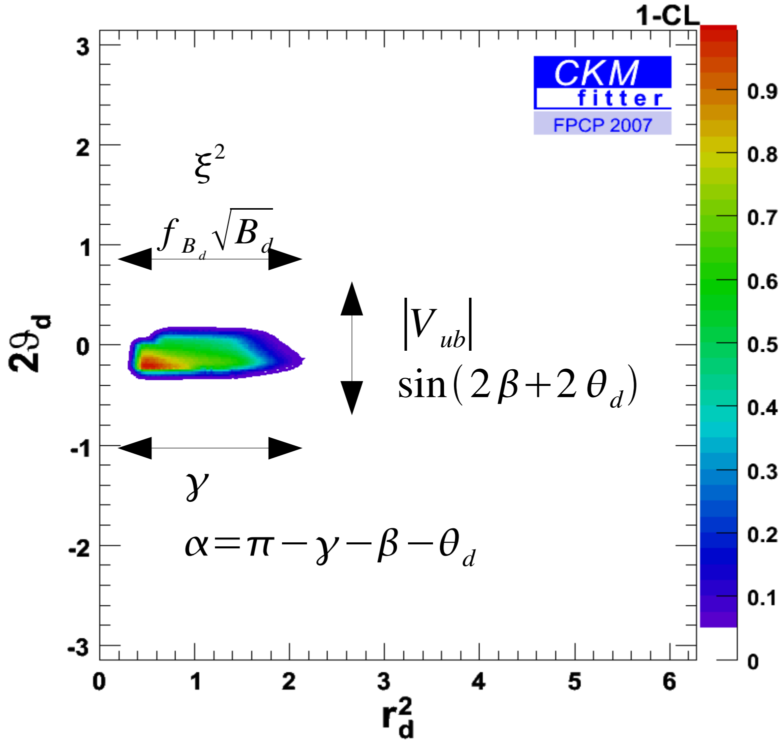
Laplace et al.,
PRD65, 094040 (2002)

CKMfitter group,
EPJC 41, 1 (2005)





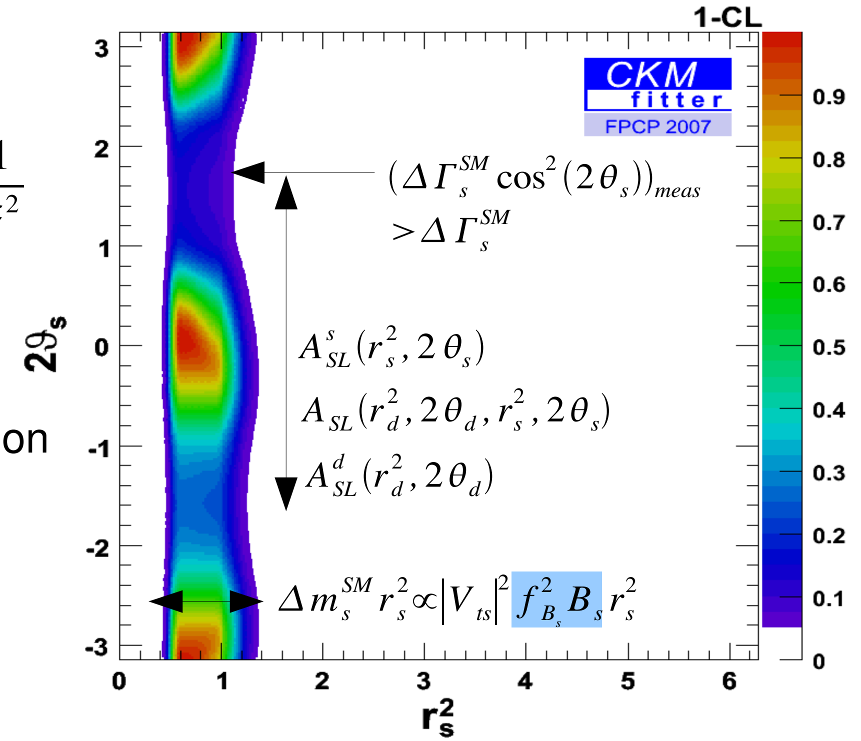
New Physics in Mixing: Results

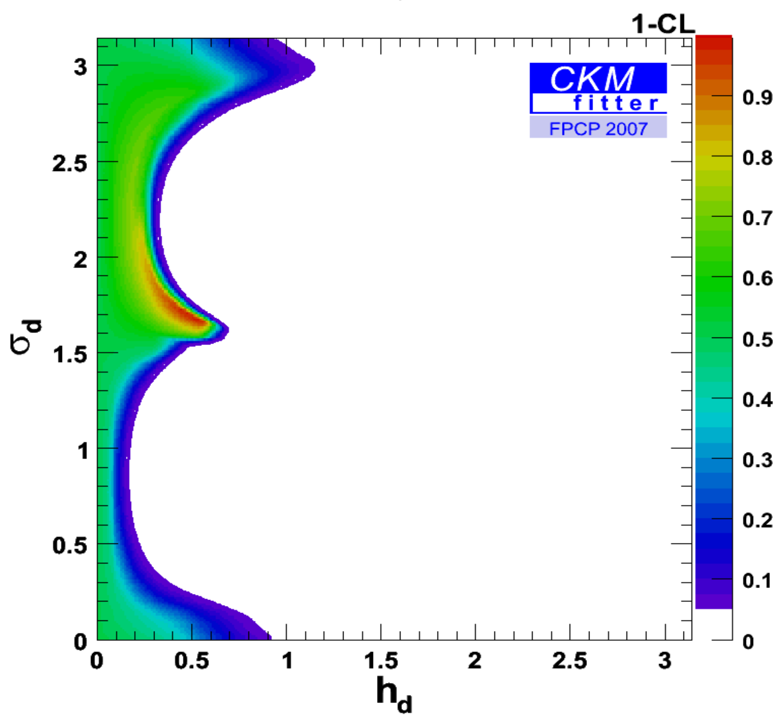


$$r_d^2 = r_s^2 \frac{\Delta m_d}{\Delta m_s} \frac{|V_{ts}|^2}{|V_{td}|^2} \frac{m_{B_s}}{m_{B_d}} \frac{1}{\xi^2}$$

Minimal Flavour Violation

$$r_d^2 = r_s^2, \quad 2\theta_d = 2\theta_s = 0$$



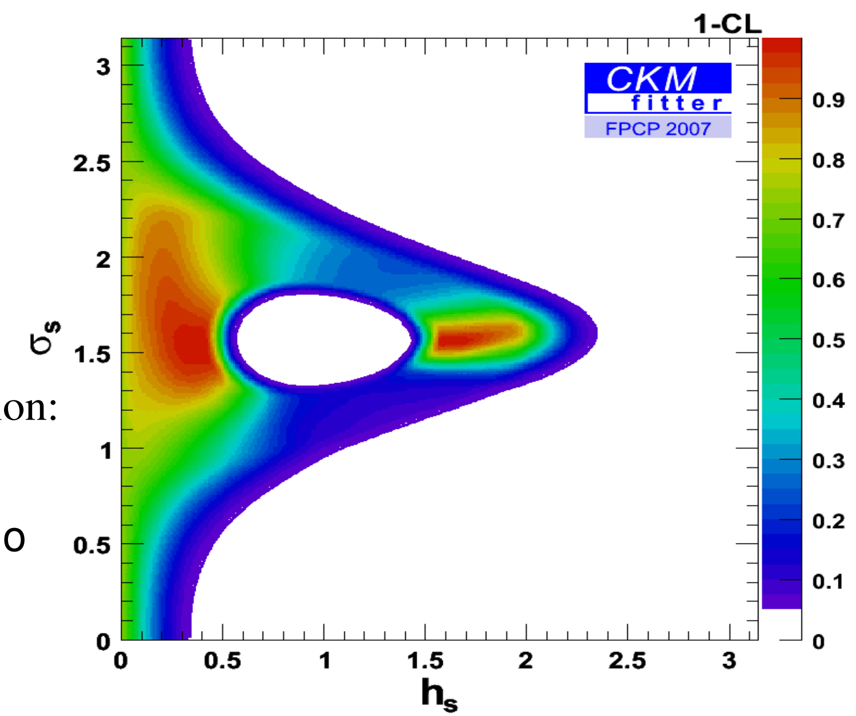


See e.g.:
Agashe et al., hep-ph/0509117
Ligeti, Papucci & Perez PRL 97, 101801 (2006)

Next-to-Minimal-Flavor Violation:

$$h_d, h_s, h_K = O(1)$$

still a possible scenario



SUMMARY

* α extraction showed significant changes in the last two years
  New α average leads to significant change in the SM CKM fit
* SM fit shows no significant deviation from CKM picture
  Deviation from unitarity due to V_{ub}(pred) – V_{ub}(input) hard to quantify
* Enormous reduction of NP parameters space in B_d mixing due to B factories
  Interplay between B factories and Hadron colliders in A_{SL}
* (Next-to-)minimal flavour violation scenario (still) possible

Constraints at 95% CL

$$V_{ud}^{fit}=0.97419\pm0.00037 \qquad V_{us}^{fit}=0.2257\pm0.0016 \qquad V_{ub}^{fit}=0.00362^{+0.00025}_{+0.00016}$$

$$V_{cd}^{pred}=0.2255\pm0.0016 \qquad V_{cs}^{pred}=0.97334\pm0.00037 \qquad V_{cb}^{fit}=0.0417\pm0.0013$$

$$V_{td}^{pred}=0.00873^{+0.00043}_{-0.00114} \qquad V_{ts}^{pred}=0.0409\pm0.0013 \qquad V_{tb}^{pred}=0.999124^{+0.000053}_{-0.000055}$$

$$\lambda_{fit}=0.2258^{+0.0016}_{-0.0017} \qquad \bar{\rho}_{fit}=[0.108,0.243] \qquad \beta_{fit}=\phi_1=(21.5^{+2.1}_{-1.3})^\circ$$

$$A_{fit}=0.817^{+0.030}_{+0.028} \qquad \bar{\eta}_{fit}=[0.288,0.375] \qquad \alpha_{fit}=\phi_2=[84.8^\circ,108.5^\circ]$$

$$J_{fit}=(2.74^{+0.63}_{-0.22})10^{-5} \qquad \gamma_{fit}=\phi_3=[50.7^\circ,73.1^\circ]$$

A few predictions (95% CL):

$$\Delta m_d^{pred}=(0.42^{+0.33}_{-0.12})\,ps^{-1} \qquad \beta_s^{pred}=(0.945^{+0.201}_{-0.069})^\circ$$

$$\Delta m_s^{pred}=(23.4^{+6.4}_{-8.2})\,ps^{-1} \qquad \epsilon_K^{pred}=(2.05^{+1.40}_{-0.71})10^{-3}$$

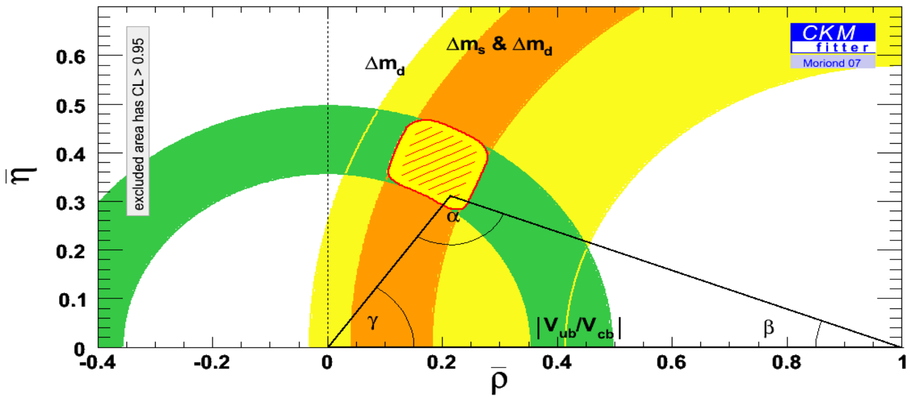
Unitarity condition in 1st family with the above-mentionned caveat:

$$V_{us,meas}=0.2240\pm0.0011$$

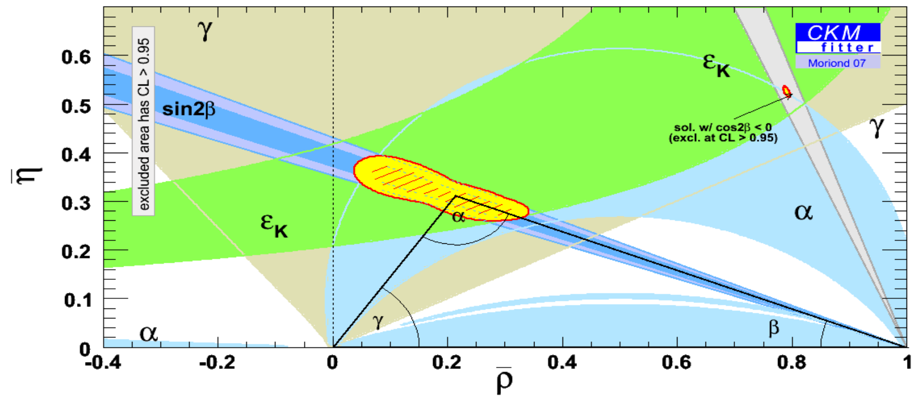
$$V_{us,pred}=0.2275\pm0.0011$$

APPENDIX

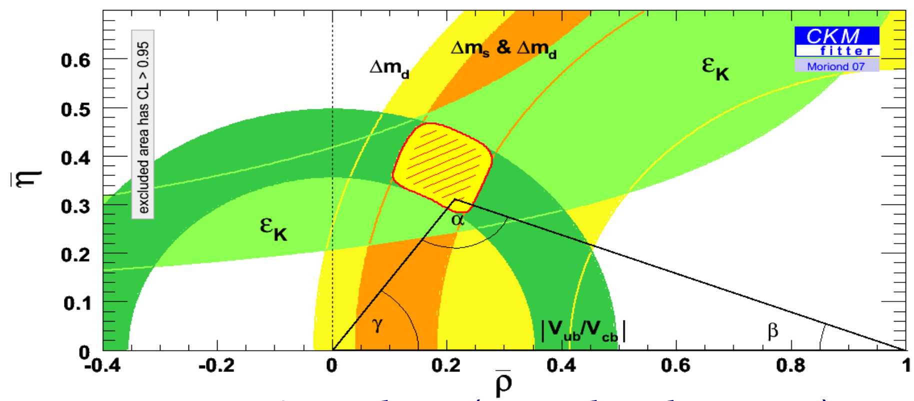
SM fit: Results



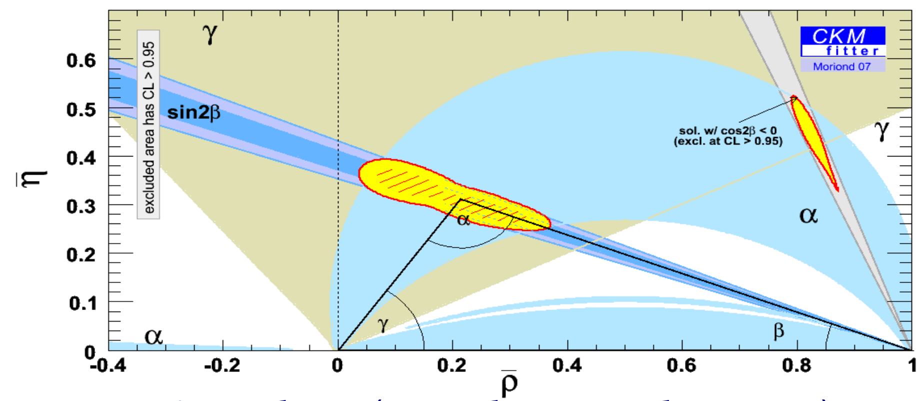
CP conserving



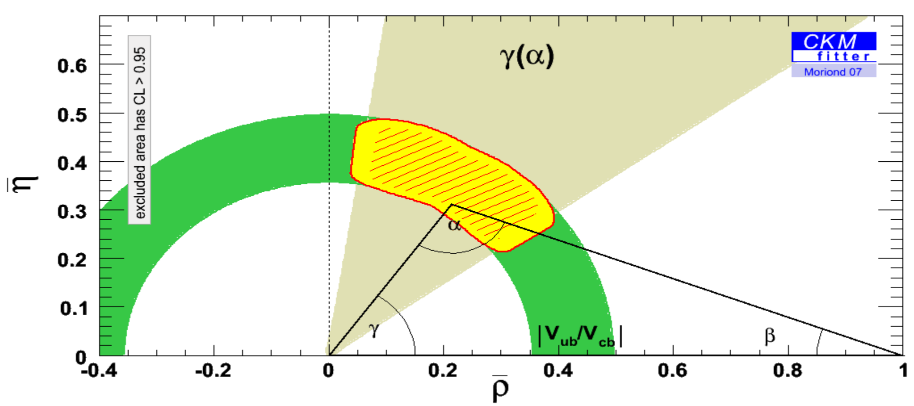
CP Violating



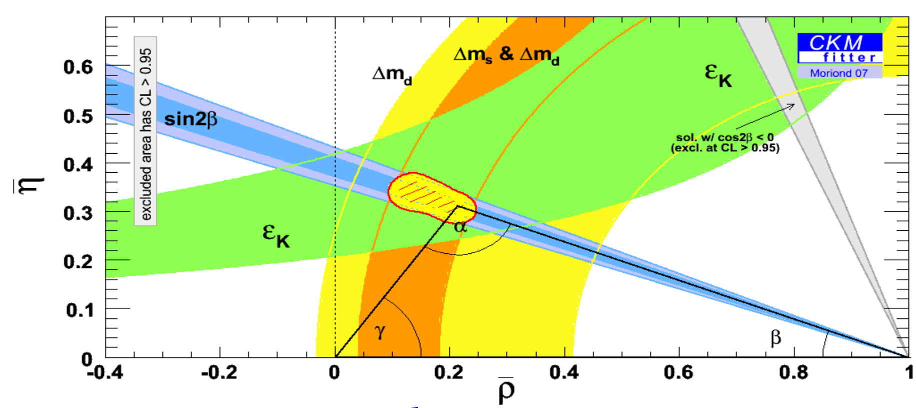
No Angles (with theory)



Angles (without theory)



tree



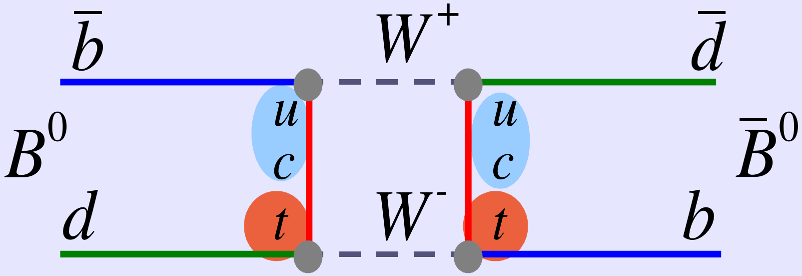
loop

Inputs: CP violation in B^0-$\bar{B}^0$ mixing

$$A_{SL}^d = \frac{1-|q/p|^4}{1+|q/p|^4} = \Im \frac{\Gamma_{12}}{M_{12}}$$

SM: $A_{SL}^d = (-4.8^{+1.0}_{-1.2})\,10^{-4}$ Lenz, Nierste, hep-ph/0612167

See also: Ciuchini et al., JHEP 0308, 031 (2003)
Beneke, Buchalla, Lenz , Nierste, PLB576, 173 (2003)



Exp.	A_{SL}^d	± stat	± sys	Method	Reference	
CLEO	0.014	0.041	0.006	had & dilept.	PRL 71, 1680 (1993); PLB490, 36 (2000) PRL 86, 5000 (2001)	
BABAR	0.0016	0.0054	0.0038	dileptons	PRL 96, 251802 (2006)	232×10^6 $B\bar{B}$
BABAR	-0.0130	0.0068	0.0049	part. D*lν	hep-ex/0607091	220×10^6 $B\bar{B}$
BABAR	-0.057	0.025	0.021	had fully rec	PRL 92, 181801(2004)	
Belle	-0.0011	0.0079	0.0070	dileptons	PRD 73, 112002 (2006)	86×10^6 $B\bar{B}$

-0.0043±0.0046 (CL=0.31) **(|q/p|=1.0022 ± 0.0023)**

α extraction

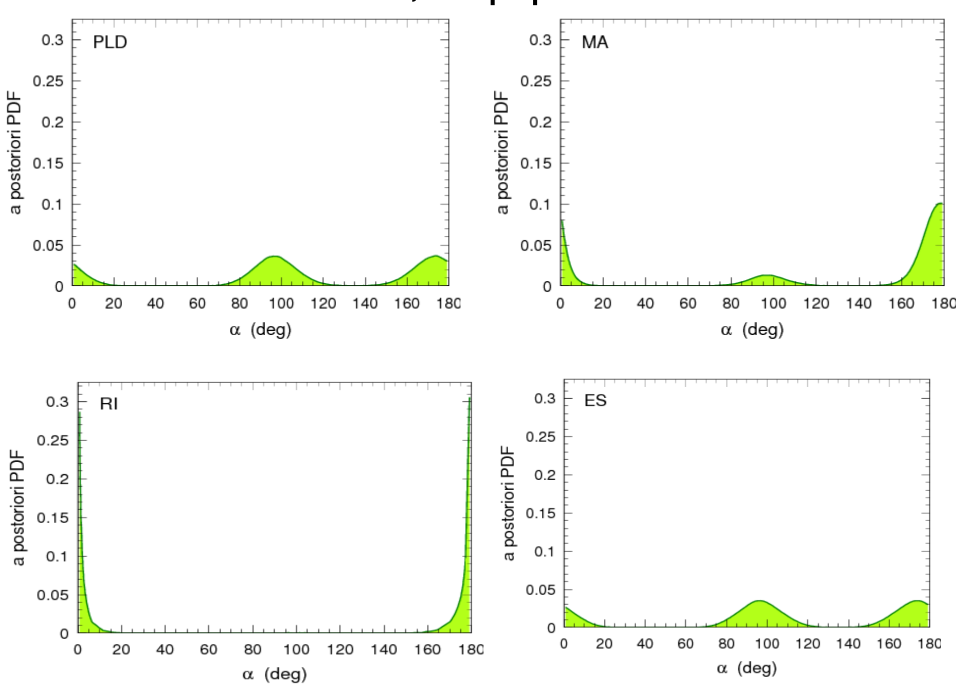
* Bayesian credibility intervals depend on the parametrization

* They become more similar but not identical with increasing probability

* Bayesian Credibility intervals and Frequentist CL intervals are different

* They become more similar but not identical with increasing probability

J. Charles et al., hep-ph/0607246



$B \to \rho\,\rho$

Parametr.	68%	95%
MA	[0-4] U [170-180]	[0-9] U [86-110] U [160-180]
RI	[0-2] U [178-180]	[0–9] U [169-180]
PLD	[0-4] U [88-108] U [166-180]	[0-13] U [80-117] U [153-180]
ES	[0-4] U [88-108] U [164-180]	[0-13] U [77-117] U [155-180]
Frequ.	[0-4] U [87-107] U [164-180]	[0-13] U [78-116] U [155–180]

=> Clear prior dependence even for 95% credibility intervals