UT$_{fit}$ updated results on the CKM angle γ

on behalf of the UTfit collaboration:
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Outline

- Updated results on γ from all the available constraints

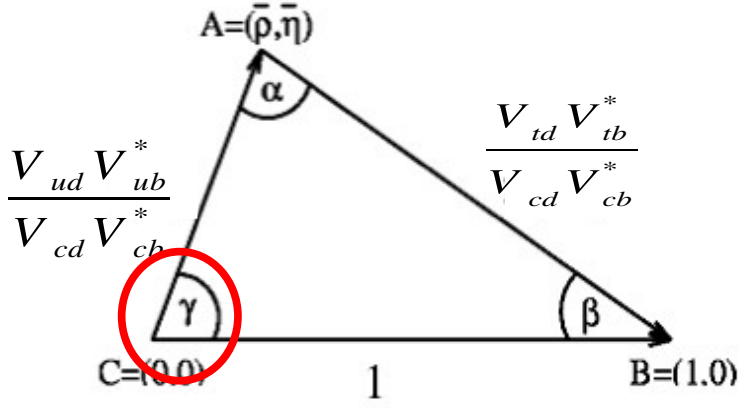
- Crosschecks with the BaBar Dalitz analysis
- Crosschecks with the Belle Dalitz analysis

- Conclusions

Experimental inputs

B→DK decays can proceed both through b→c and b→u transitions: we are sensitive to the relative weak phase γ in the interference

$$\gamma = arg\{\frac{V_{ud}V_{ub}^*}{V_{cd}V_{cb}^*}\}$$



$$B^{\pm} \to D^0(\bar{D}^0)K^{\pm}$$

$$B^0 \to D^0(\bar{D}^0)K^{*0}$$

$D^0 \to K_S\pi^0, K_S\omega, K^+K^-, \pi^+\pi^-$	**GLW**
$D^0 \to K^{\mp}\pi^{\pm}, K^{\mp}\pi^{\pm}\pi^0, K^{\mp}\pi^{\pm}\pi^{\pm}\pi^{\mp}$	**ADS**
$D^0 \to K_S\pi^+\pi^-, K_SK^+K^-, \pi\pi\pi^0$	**GGSZ (Dalitz)**

Experimental inputs: charged B

NEW: see V.Tisserand talk (thursday)

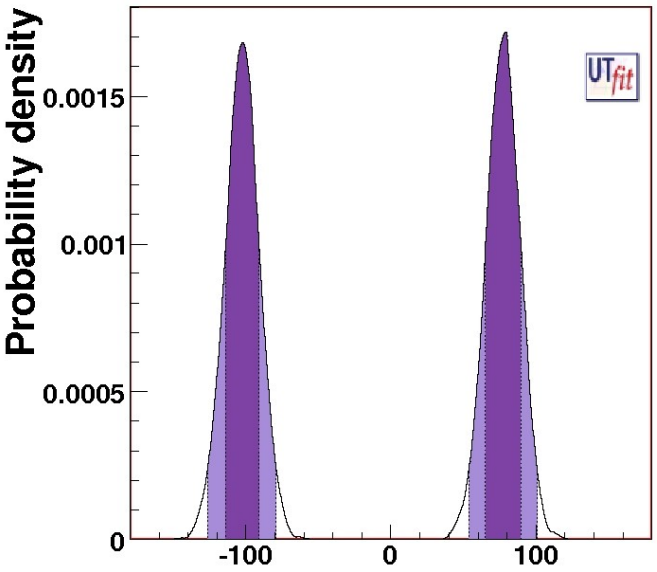
	DK	D^*K	DK^*
GLW	**Babar 382M** (K^+K^-, $\pi^+\pi^-$, $K_S\omega$, $K_S\pi^0$) **Belle 275M** (K^+K^-, $\pi^+\pi^-$, $K_S\omega$, $K_S\pi^0$, $K_S\phi$)	**Babar 382M** (K^+K^-, $\pi^+\pi^-$, $K_S\omega$, $K_S\pi^0$) **Belle 275M** (K^+K^-, $\pi^+\pi^-$, $K_S\omega$, $K_S\pi^0$, $K_S\phi$)	**Babar 379M** (K^+K^-, $\pi^+\pi^-$, $K_S\omega$, $K_S\pi^0$, $K_S\phi$)
ADS	**Babar** (**232M** $K^+\pi^-$, **226M** $K^+\pi^-\pi^0$) **Belle 657M** ($K^+\pi^-$)	**Babar 232M** ($K^+\pi^-$)	**Babar 379M** ($K^+\pi^-$)
DALITZ	**Babar 382M** ($K_S\pi^+\pi^-$, $K_SK^+K^-$) **Belle 635M** ($K_S\pi^+\pi^-$)	**Babar 382M** ($K_S\pi^+\pi^-$, $K_SK^+K^-$) **Belle 635M** ($K_S\pi^+\pi^-$, **635M** $D^0\pi^0$, **386M** $D^0\gamma$)	**Babar 382M** ($K_S\pi^+\pi^-$) **Belle 386M** ($K_S\pi^+\pi^-$)

Dalitz method: D Dalitz model uncertainty taken from BaBar analysis (with correlations)

Experimental inputs: neutral B

	DK^*
GLW	
ADS	**Babar 465M** ($K^+\pi^-$, $K^+\pi^-\pi^0$, $K^+\pi^-\pi^+\pi^-$)
DALITZ	**Babar 371M** ($K_S\pi^+\pi^-$)

Results



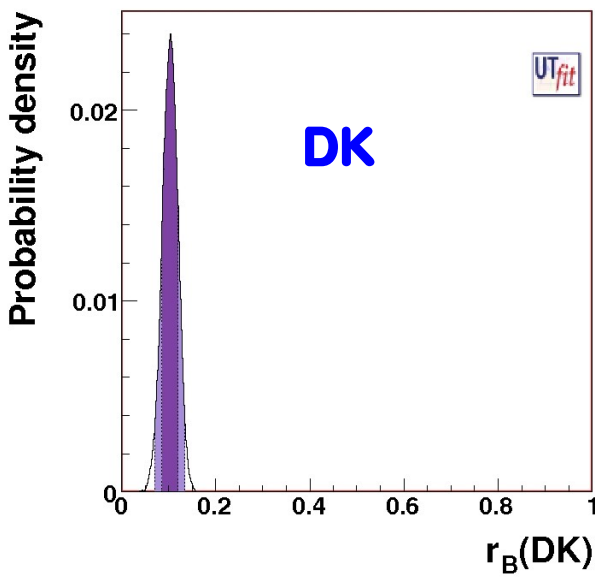
$$\gamma = (78 \pm 12)^{o}$$

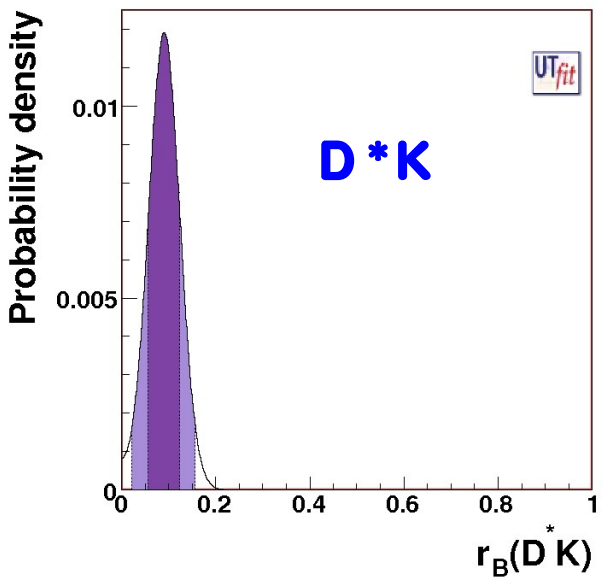
Updated for CKM 2008
(since ichep'08 new BaBar GLW DK*)

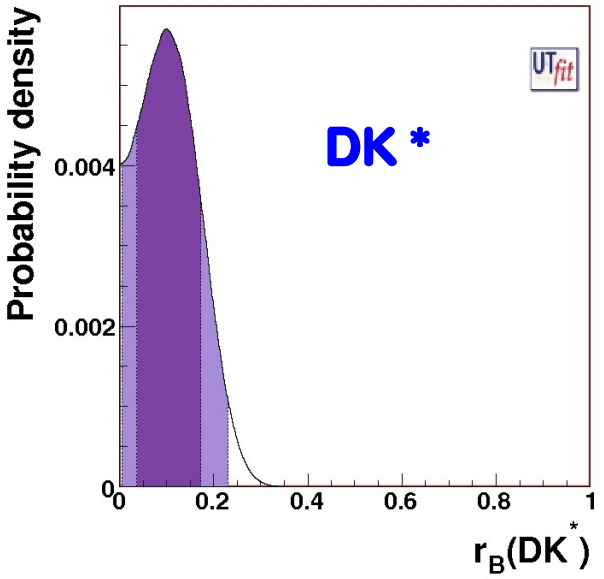
$$r_B(DK) = 0.102 \pm 0.017$$

$$r_B(D^* K) = 0.089 \pm 0.034$$

$$r_S(DK^*) = 0.103^{+0.068}_{-0.064}$$

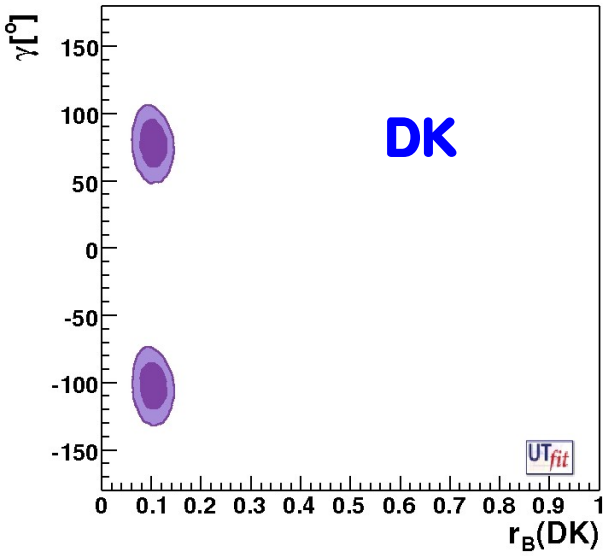


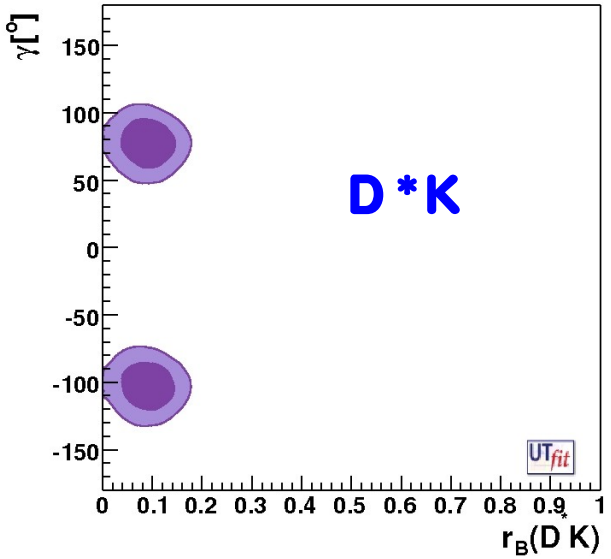


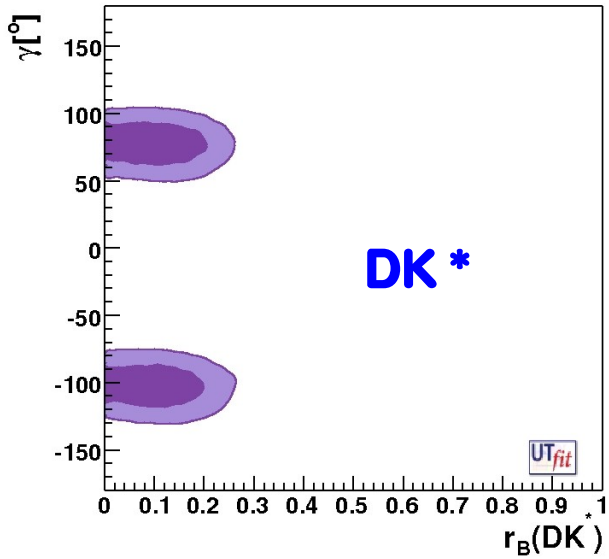


Results

Updated for CKM 2008

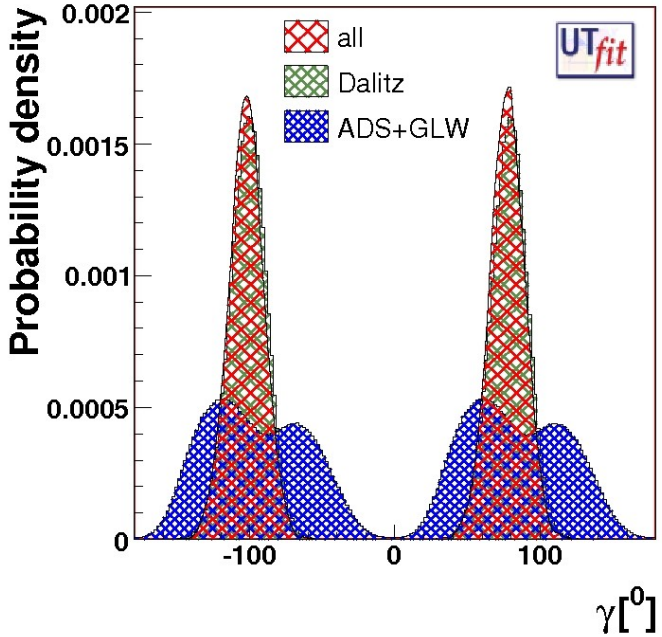


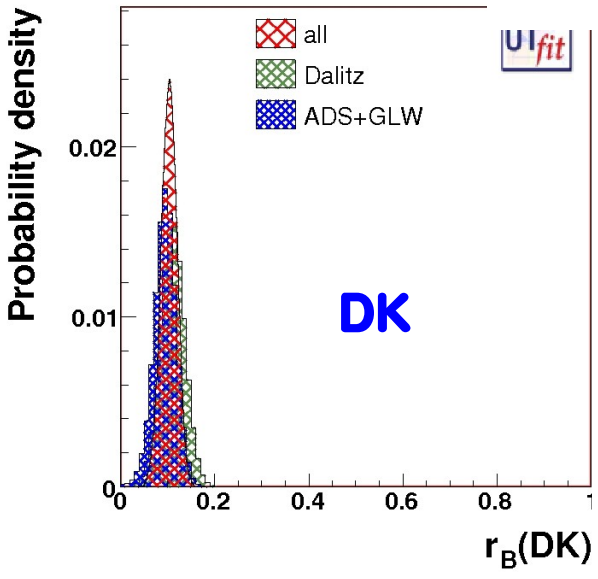


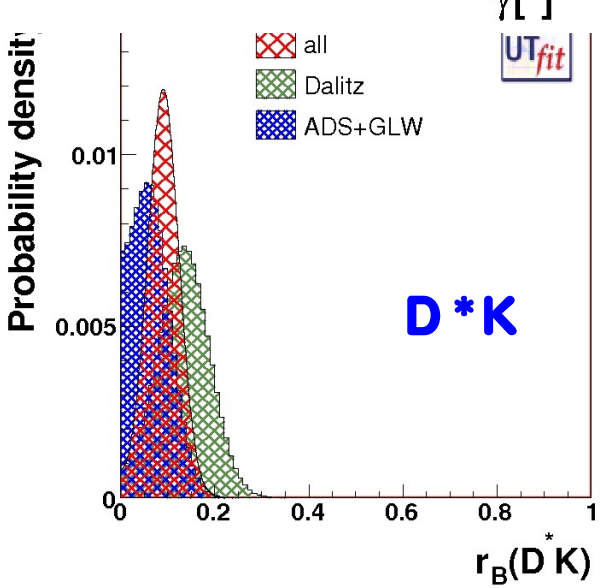


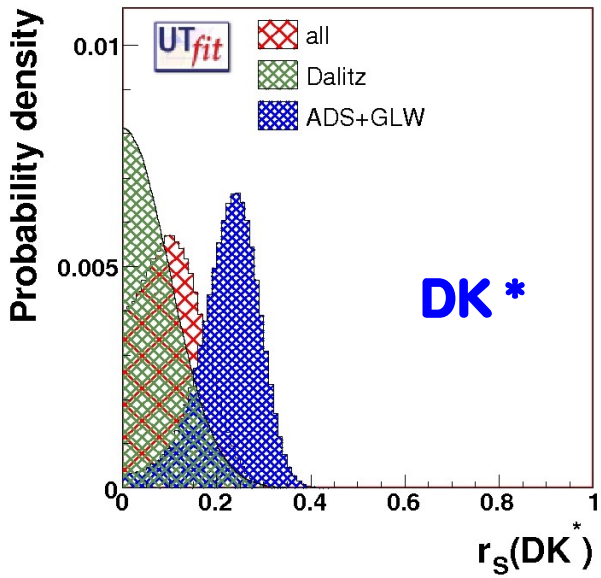
Results

Updated for CKM 2008







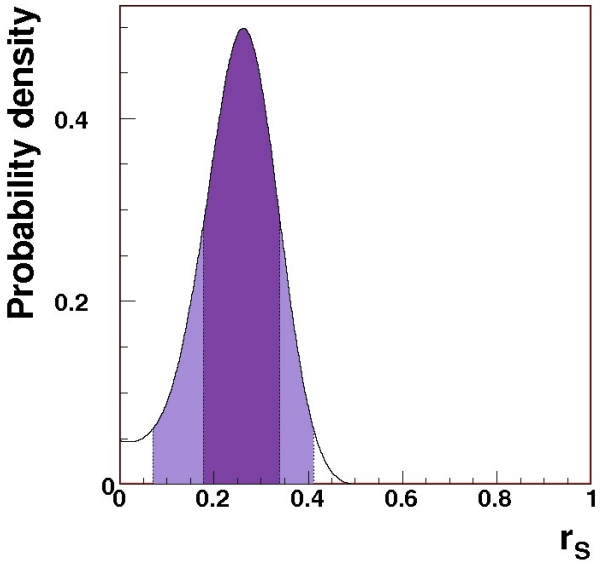


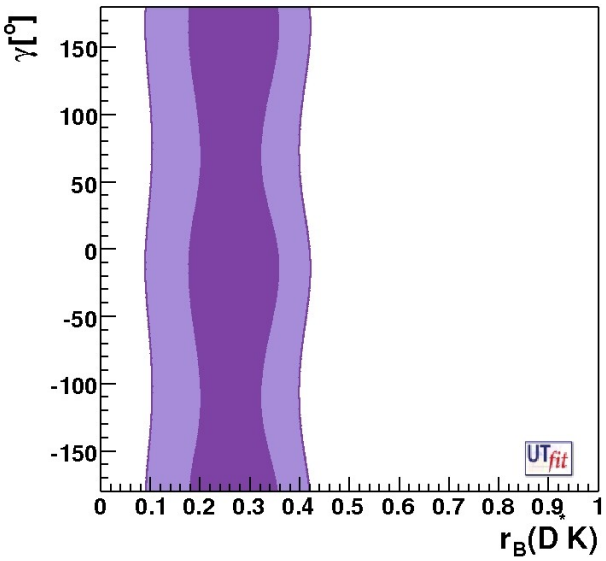
Results

Updated for CKM 2008

ONLY NEUTRALS (BaBar)

$$r_S(DK^{*0}) = 0.26 \pm 0.08$$





..almost no impact on gamma for the moment..

Results

Updated for CKM 2008

68% prob. interval	95% prob. interval
$\gamma = (78 \pm 12)^o$	$\gamma \in [54, 100]^o$
$r_B(DK) = 0.102 \pm 0.017$	$r_B(DK) \in [0.069, 0.133]$
$r_B(D^* K) = 0.089 \pm 0.034$	$r_B(D^* K) \in [0.021, 0.156]$
$r_S(DK^*) = 0.103^{+0.068}_{-0.064}$	$r_S(DK^*) \in [0.005, 0.233]$

Crosschecks

Dalitz analysis: Babar extraction

statistical
+experimental
systematics

model uncertainty

$$\gamma = (76^{+24}_{-25} \pm 5)^o$$

DK

1σ interval

$r_B = 0.086 \pm 0.036 \pm 0.011$

$r_B < 0.157$ 2σ interval

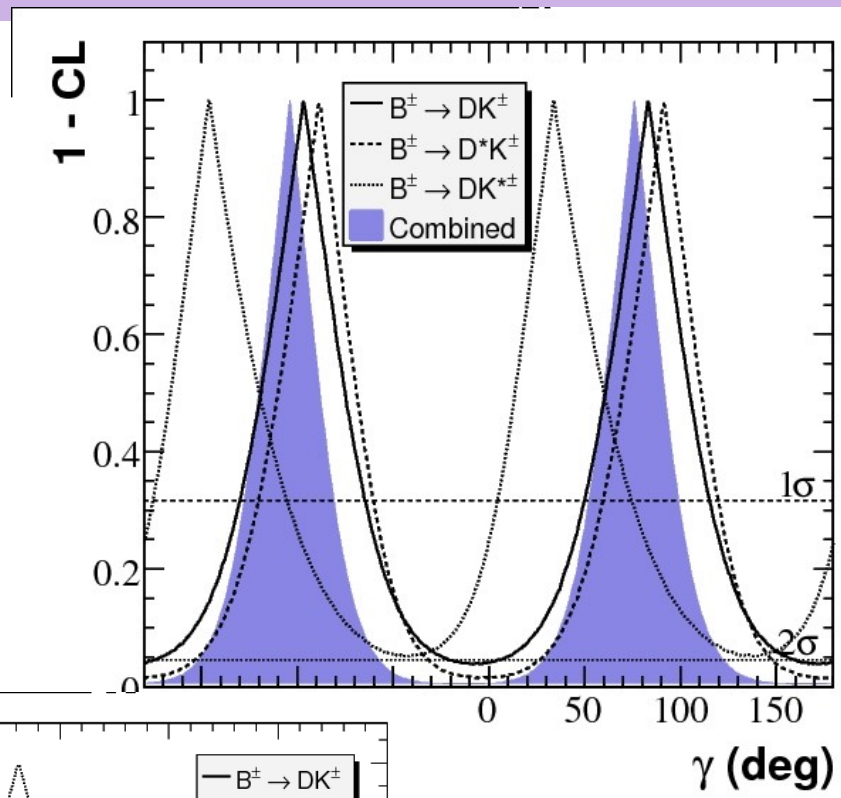
D*K

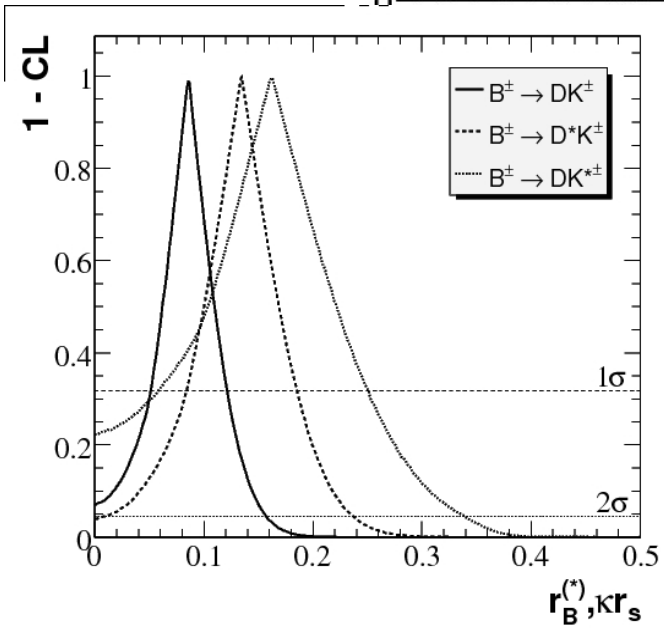
$r_B^* = 0.135 \pm 0.052 \pm 0.005$

$r_B^* \in [0.011, 0.237]$

DK*

$r_S < 0.377$





Crosschecks

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$\gamma = (76^{+24}_{-25} \pm 5)^o$

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D*K

$r_B^* = 0.135 \pm 0.052 \pm 0.005$

$r_B^* \in [0.011, 0.237]$

DK*

$r_S < 0.377$

our extraction

UTfit

$\gamma = (78 \pm 25)^o$

DK 68% prob. interval

$r_B = 0.076 \pm 0.037 \pm 0.006$

$r_B < 0.135$ 95% prob. interval

D*K

$r_B^* = 0.123 \pm 0.057 \pm 0.005$

$r_B^* \in [0.003, 0.216]$

DK*

$r_S < 0.298$

WELL CONSISTENT (only difference in DK*, where lower stat. may lead to overestimate of the error on γ)

Crosschecks

Dalitz analysis: Belle extraction

(only statistical +experimental systematics considered)

$\gamma = (76^{+13}_{-14})^o$

DK 1σ interval

$r_B = 0.16 \pm 0.04$

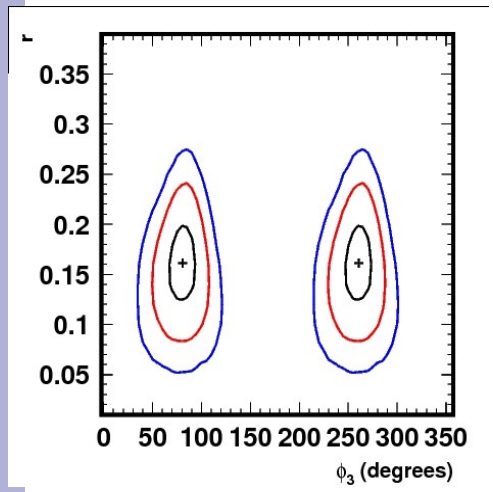
$r_B \in [0.08, 0.24]$

2σ interval

D*K

$r_B^* = 0.21 \pm 0.08$

$r_B^* \in [0.05, 0.39]$



our extraction

$\gamma = (76^{+13}_{-14})^o$

DK 68% prob. interval

$r_B = 0.15 \pm 0.04$

$r_B \in [0.08, 0.23]$

95% prob. interval

D*K

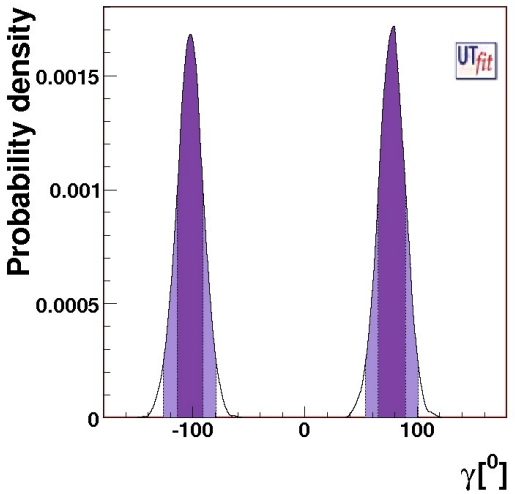
$r_B^* = 0.18 \pm 0.09$

$r_B^* < 0.32$

VERY WELL CONSISTENT!

Conclusions

- All the available constraints combined
- World average γ, known with an error ~12°



$\gamma = (78 \pm 12)^o$
$r_B(DK) = 0.102 \pm 0.017$
$r_B(D^* K) = 0.089 \pm 0.034$
$r_S(DK^*) = 0.103^{+0.068}_{-0.064}$

- Some crosscheck made: our results consistent with the one obtained from BaBar and Belle with a frequentistic approach

Backup slides

The CKM matrix and the Unitarity Triangle

weak interaction eigenstates

$$\begin{pmatrix} d' \\ s' \\ b' \end{pmatrix} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \begin{pmatrix} d \\ s \\ b \end{pmatrix}$$

mass eigenstates

Cabibbo Kobayashi Maskawa

V_{CKM} Unitary matrix

UNITARITY CONDITION:

$$V_{CKM}\, V_{CKM}^{+} = V_{CKM}^{+}\, V_{CKM} = 1$$

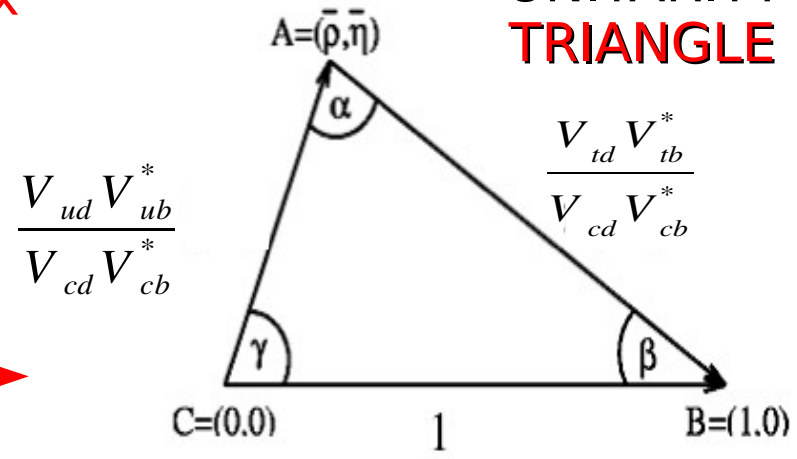
six independent relations,

within them we choose:

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

B physics

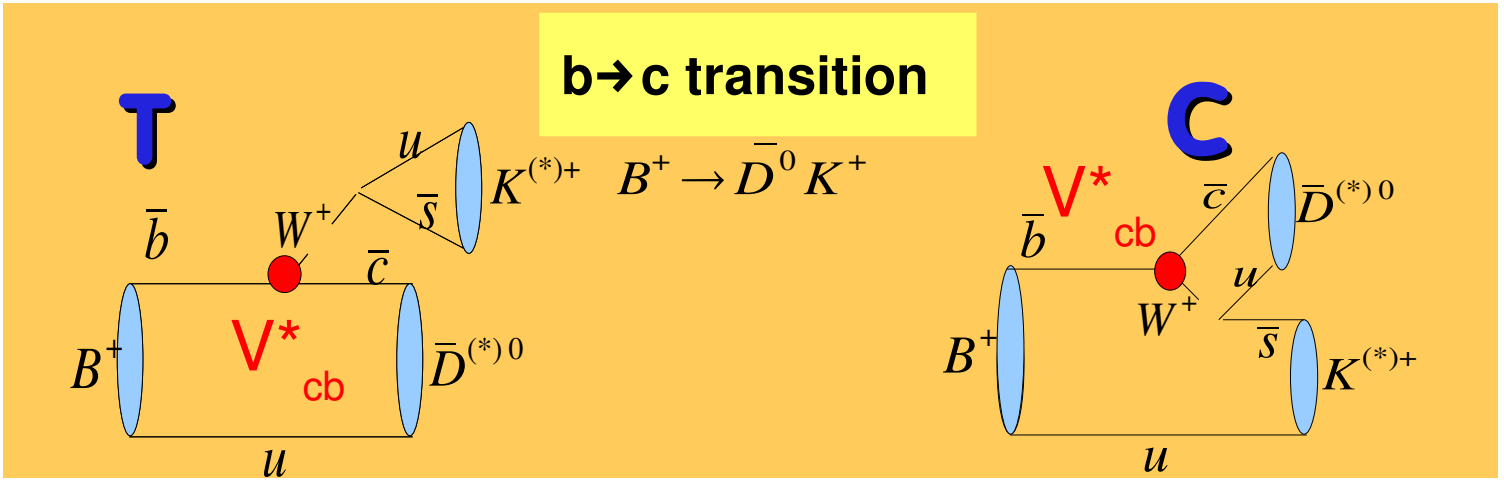
UNITARITY TRIANGLE



In a complex plane $(\bar{\rho}, \bar{\eta})$

γ in charged B→DK decays

γ weak phase between b→c and b→u transition



T = tree

C = colour-suppressed

A = annihilation

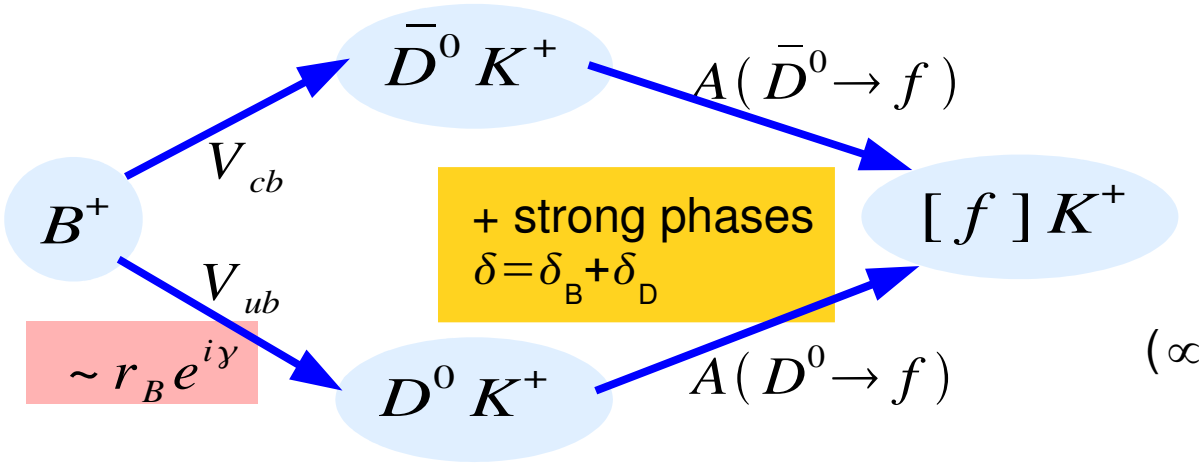
|C|/|T| ~ 0.3
|A|/|C| ~ 0.2

Interference scheme

CP violation detectable when there are two paths to reach the same final state.

Interference in the B→DK system allows the determination of γ

$$|A_1 + A_2 e^{i\phi}|^2 = A_1^2 + A_2^2 + 2A_1 A_2 \cos(\phi)$$



interference

$\propto \cos(\delta + \gamma)$

($\propto \cos(\delta - \gamma)$ for B^-)

Main characters: γ, r_B, δ

Sensitivity to γ is driven by the ratio $\mathbf{r_B = |A(b \to u)|/|A(b \to c)|}$ (channel-dependent).

Different methods

Different methods proposed to study the $B \to D^0 K$ decays,

- **GLW method**:

  D^0 mesons reconstructed in two-body CP-eigenstate final states: K^+K^-, $\pi^+\pi^-$ (CP even) $K_s\pi^0$, $K_s\omega$ (CP odd)

- **ADS method**:

  D^0 mesons reconstructed in non CP-eigenstate final states: $K^-\pi^+$, $K^-\pi^+\pi^0$

} more sensitive to r_B

- **GGSZ (Dalitz) method**:

  D^0 mesons reconstructed in three-body CP-eigenstate final states: $K_s\pi^+\pi^-$, $K_sK^+K^-$, $\pi^+\pi^-\pi^0$

} the one that gives the best error on γ

All methods used by Babar and Belle.

Best determination from Dalitz analyses: error on $\gamma \sim 20°$-$25°$