

Constraining new physics with Unitarity Triangle *fit*

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on behalf of **UT***fit* Collaboration

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<http://www.utfit.org>



Tree Level determination of $\bar{\rho}$ and $\bar{\eta}$

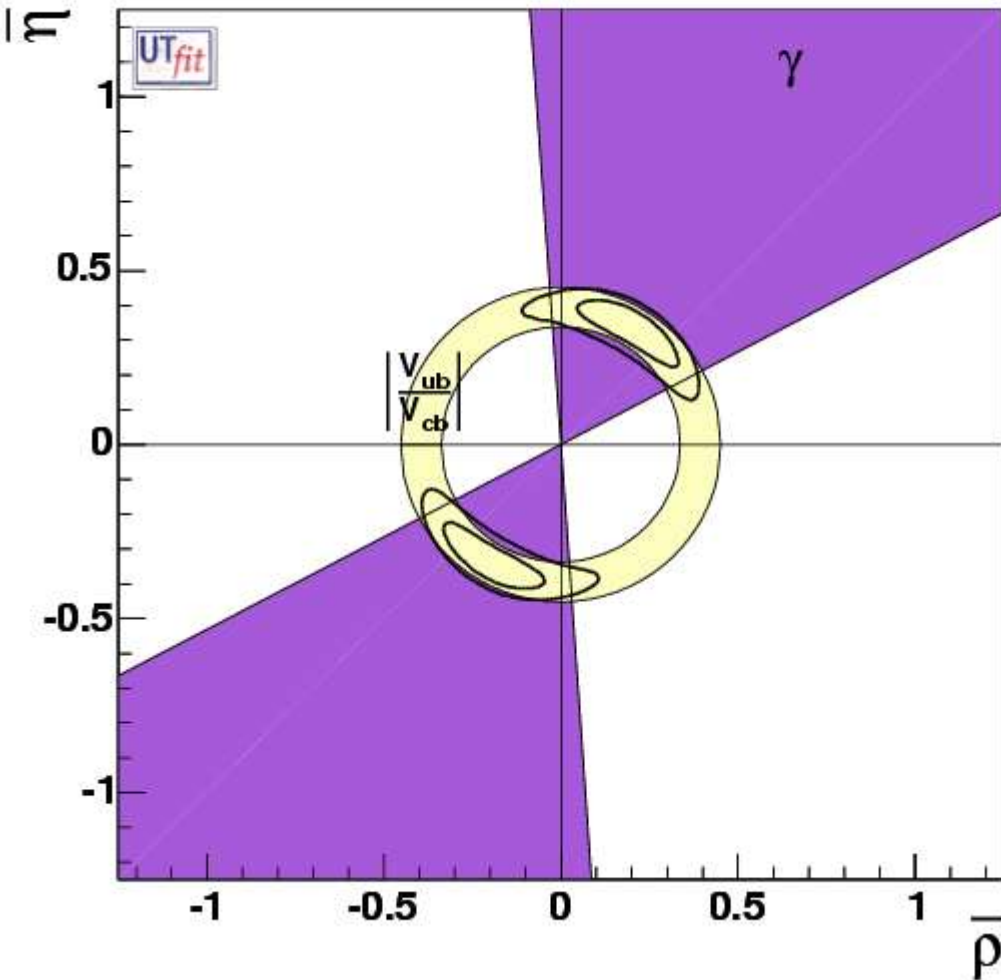
With the new measurements from the B factories, the NP free determination (up to NP effects coming from \bar{D} - D mixing) of $\bar{\rho}$ and $\bar{\eta}$ from $|V_{ub}/V_{cb}|$ and γ set a reference for all NP models in literature

$$\bar{\rho} = \pm 0.21 \pm 0.10$$

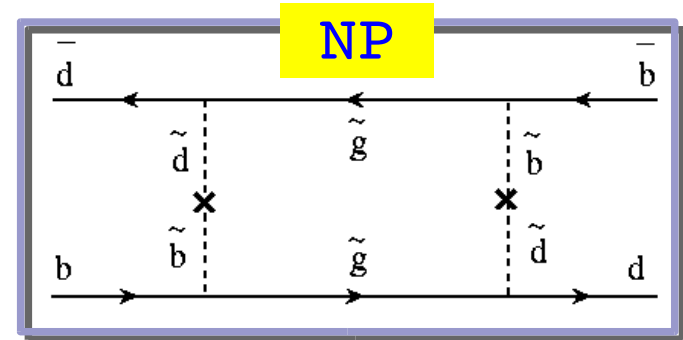
$$\bar{\eta} = \pm 0.36 \pm 0.06$$

$$\sin 2\beta = 0.724 \pm 0.074 \text{ U } -0.556 \pm 0.089$$

$$\alpha = (95 \pm 15)^\circ \text{ U } (-43 \pm 15)^\circ$$



Model independent parameterization of NP in the $|\Delta F|=2$ Hamiltonian. We can fit for these parameters together with $\bar{\rho}$ and $\bar{\eta}$



$$\diamond |\varepsilon_K|^{\text{EXP}} = C_\varepsilon \cdot |\varepsilon_K|^{\text{SM}}$$

$$\diamond \alpha^{\text{EXP}} = \alpha^{\text{SM}} - \phi_{\text{Bd}}$$

$$\diamond \Delta m_d^{\text{EXP}} = C_{\text{Bd}} \cdot \Delta m_d^{\text{SM}}$$

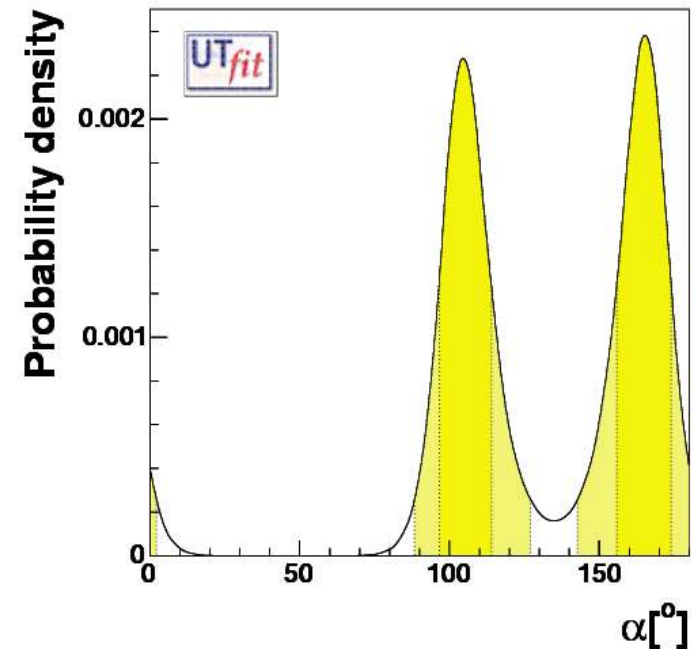
$$\diamond A_{\text{CP}}(\text{J}/\psi\text{K}^0) = \sin(2\beta + 2\phi_{\text{Bd}})$$

Assuming SU(2), $|\Delta F|=1$ NP introduces only **new weak phases to penguins in α** . We use the generalized bound on α in the $|\Delta F|=2$ analysis

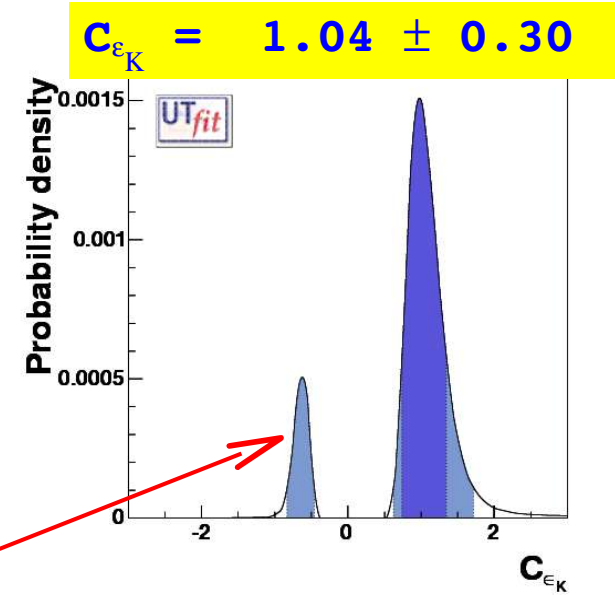
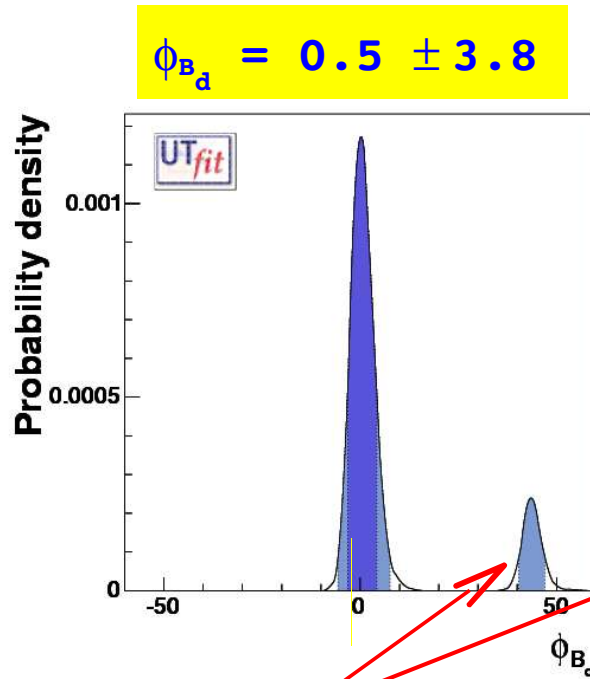
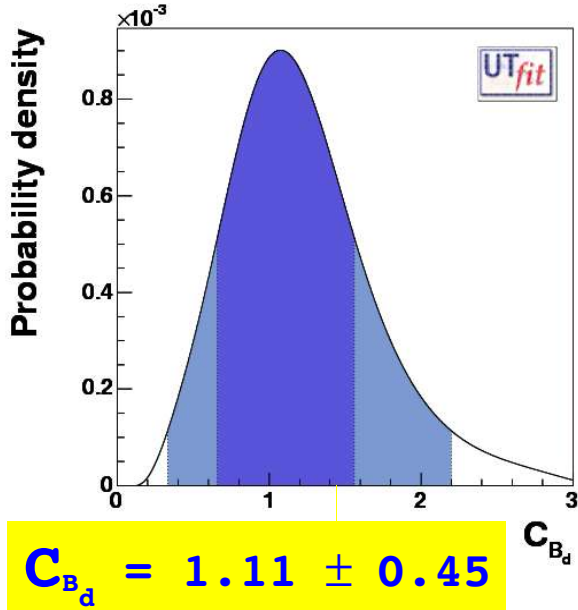
$$A^{+-} = -T e^{-i\alpha} + P e^{i\phi_P} e^{i\delta_P}$$

$$A^{+0} = -\frac{1}{\sqrt{2}} \left[e^{-i\alpha} (T + T_c e^{i\delta_{T_c}}) \right]$$

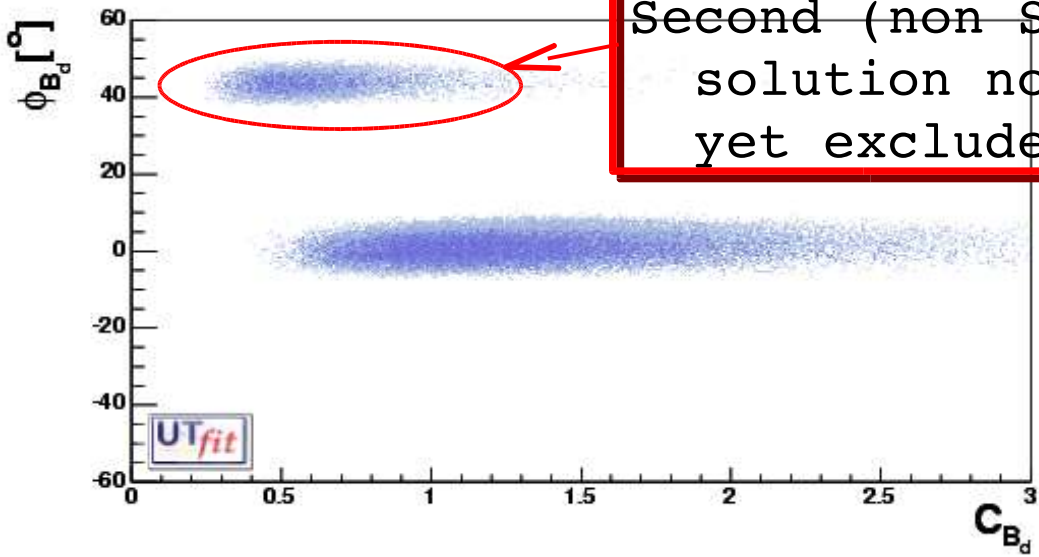
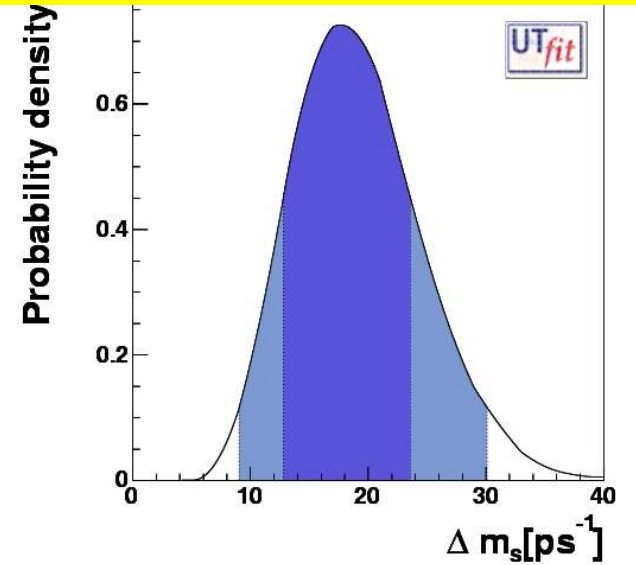
$$A^{00} = -\frac{1}{\sqrt{2}} \left[T_c e^{-i\alpha} e^{i\delta_{T_c}} + P e^{i\phi_P} e^{i\delta_P} \right]$$



Results for NP parameters and Δm_s

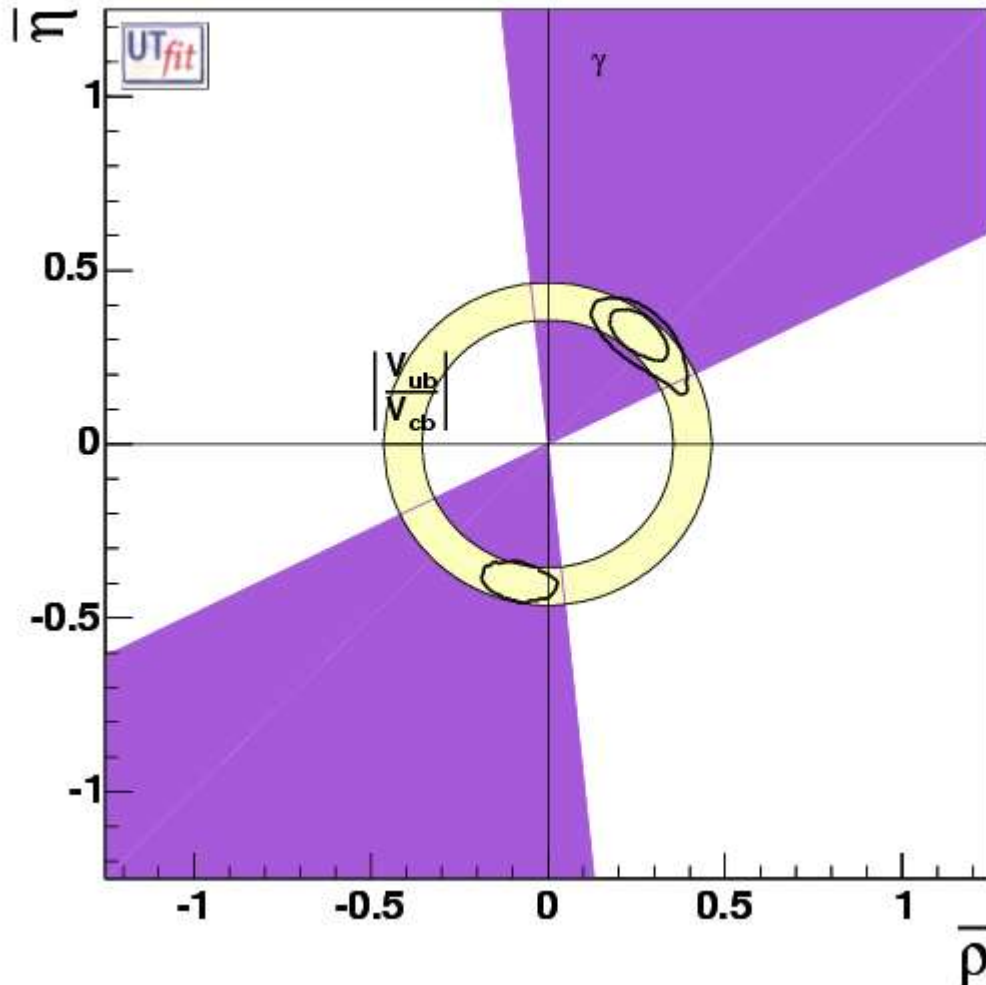


$\Delta m_s = 18.2 \pm 5.4$
(SM analysis 21.2 ± 2.3)



Second (non SM) solution not yet excluded

Generalized results for $\bar{\rho}$ and $\bar{\eta}$



$$\bar{\rho} = 0.257 \pm 0.061$$

$$\bar{\eta} = 0.317 \pm 0.054$$

$$\sin 2\beta = 0.719 \pm 0.069$$

$$\alpha = (106 \pm 12)^\circ$$

Second solution
excluded
@68% Prob.

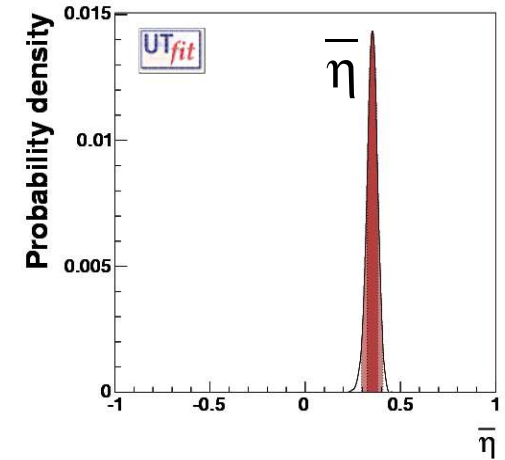
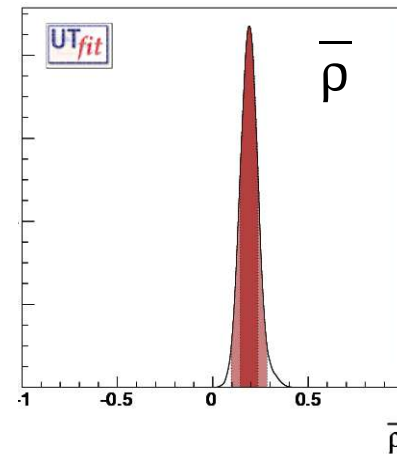
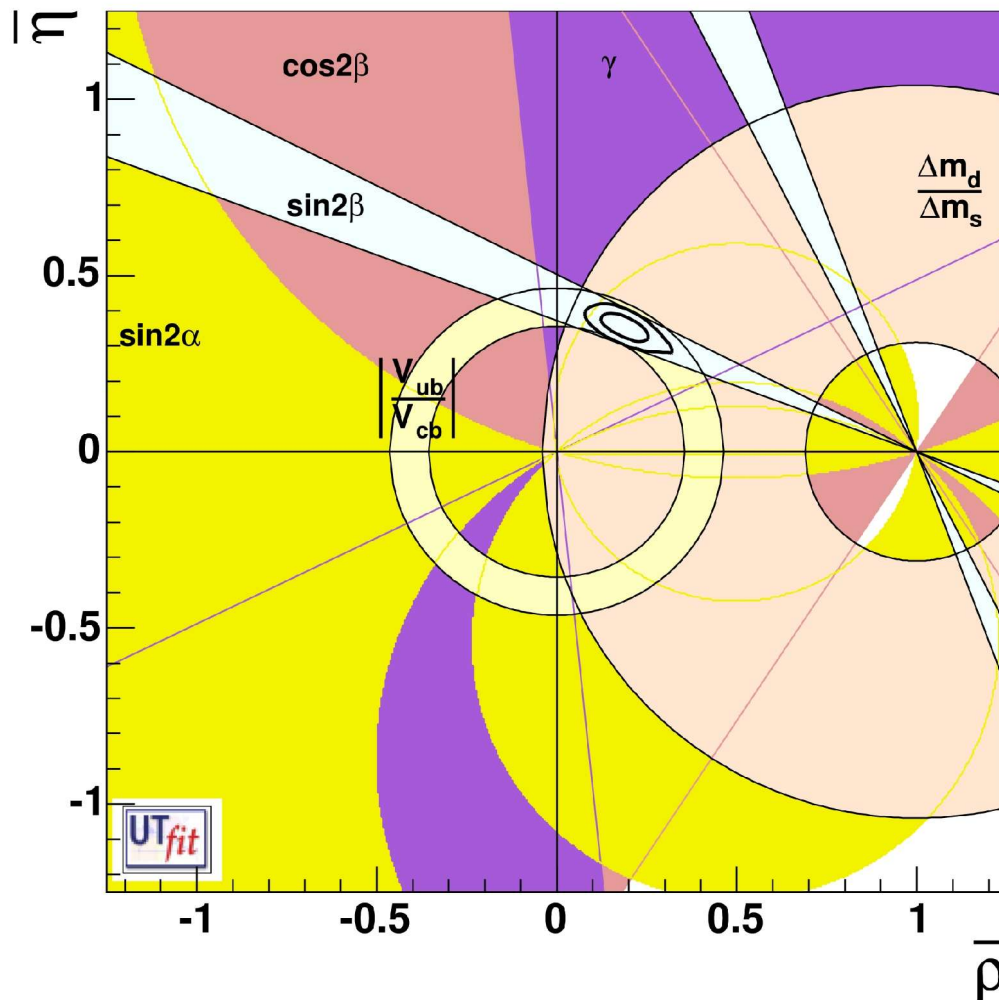
No additional flavour mixing in MFV. Only mixing processes are sensitive to NP:

Buras et al.

➤ We drop ε_K from the fit

hep-ph/0007085

➤ We use only the ratio $\Delta m_d / \Delta m_s$ (NP cancels out)



$$\bar{\eta} = 0.353 \pm 0.028$$

$$\bar{\rho} = 0.191 \pm 0.046$$

Prediction for UUT quantities

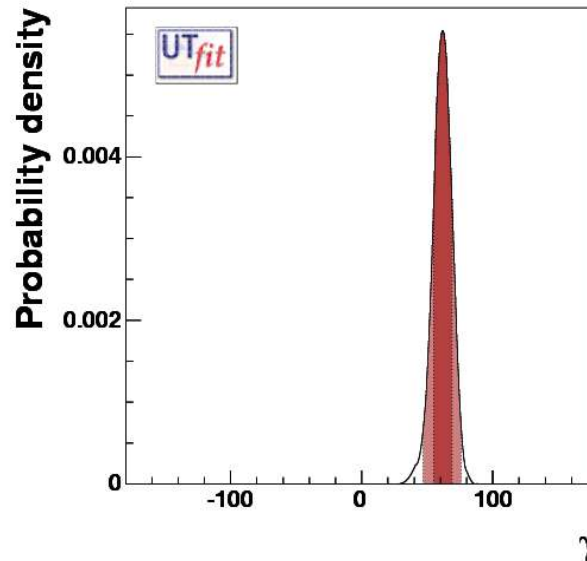
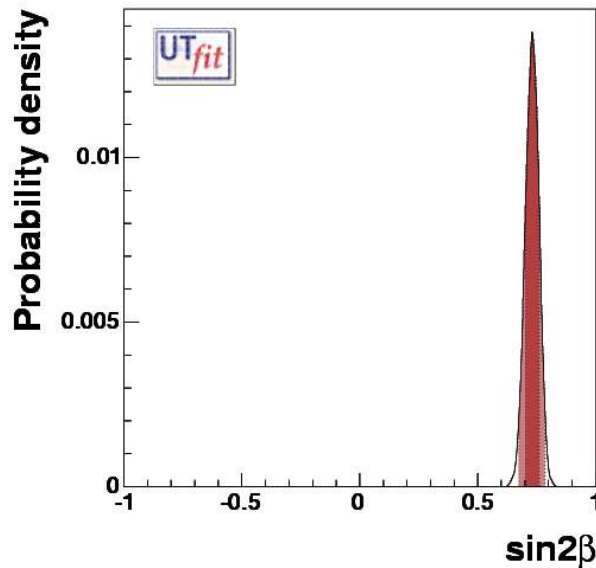
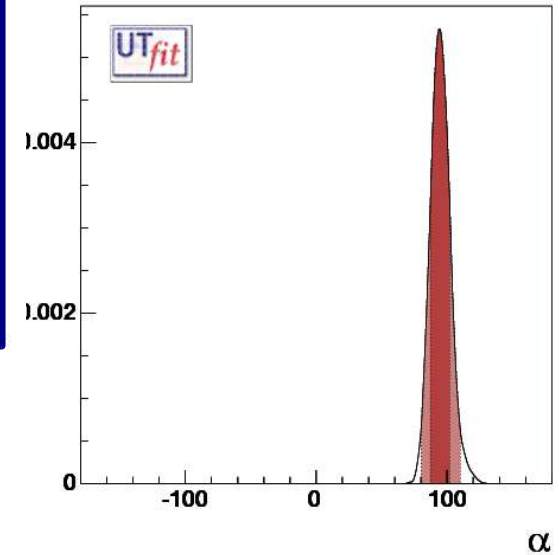
Universal Unitarity Triangle analysis

UUT (68%) UUT (95%) SM (68%) SM (95%)

UT parameters

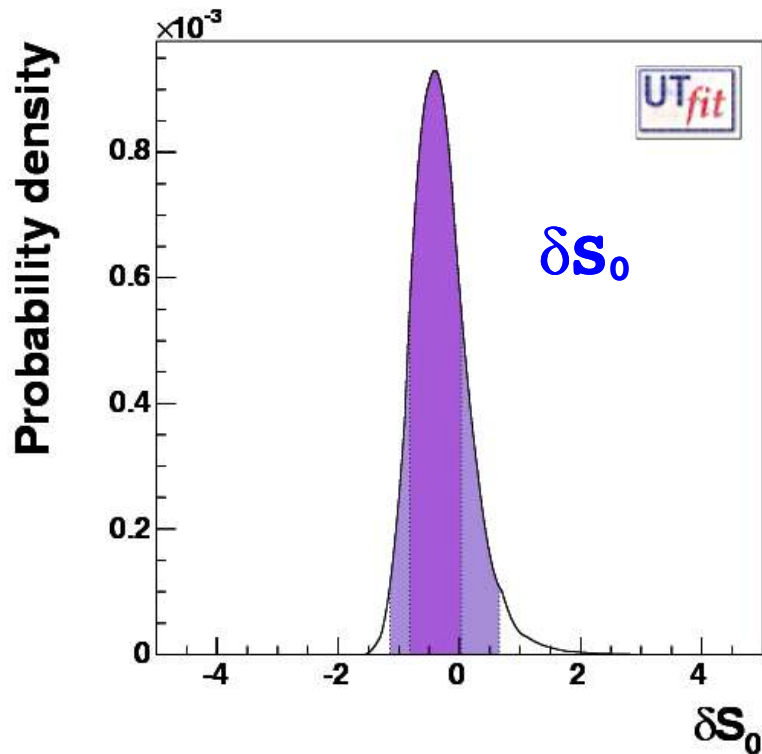
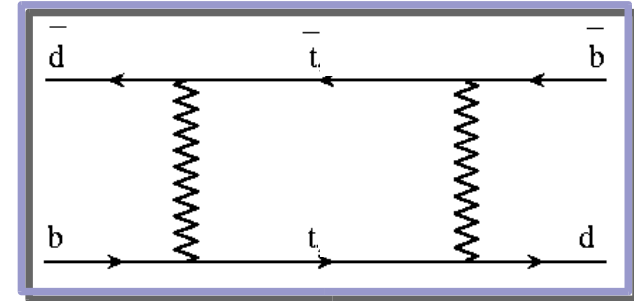
$\bar{\rho}$	0.191 ± 0.046 [0.097, 0.285]	0.207 ± 0.038 [0.129, 0.282]
$\bar{\eta}$	0.353 ± 0.028 [0.296, 0.408]	0.341 ± 0.023 [0.296, 0.386]
$\sin 2\beta$	0.733 ± 0.029 [0.675, 0.786]	0.726 ± 0.028 [0.670, 0.780]
$\alpha [^\circ]$	94.7 ± 7.4 [80.2, 110.1]	96.1 ± 7.0 [82.1, 110.0]
$\gamma [^\circ]$	61.9 ± 7.1 [47.0, 75.9]	60.3 ± 6.8 [47.0, 74.2]
$(2\beta + \gamma) [^\circ]$	109.4 ± 7.8 [92.5, 123.8]	107.3 ± 7.4 [92.6, 121.6]

As good as the
Standard analysis



Constraining NP in MFV(I)

In models with one Higgs doublet and low/moderate $\tan\beta$ (D'Ambrosio et al. [hep-ph/0207036](https://arxiv.org/abs/hep-ph/0207036)) NP enters as an additional universal contribution in top box diagrams.



$$S_0(x_t) \rightarrow S_0(x_t) + \delta S_0, \quad |\delta S_0| = 4 \left(\frac{\Lambda_0}{\Lambda} \right)^2$$

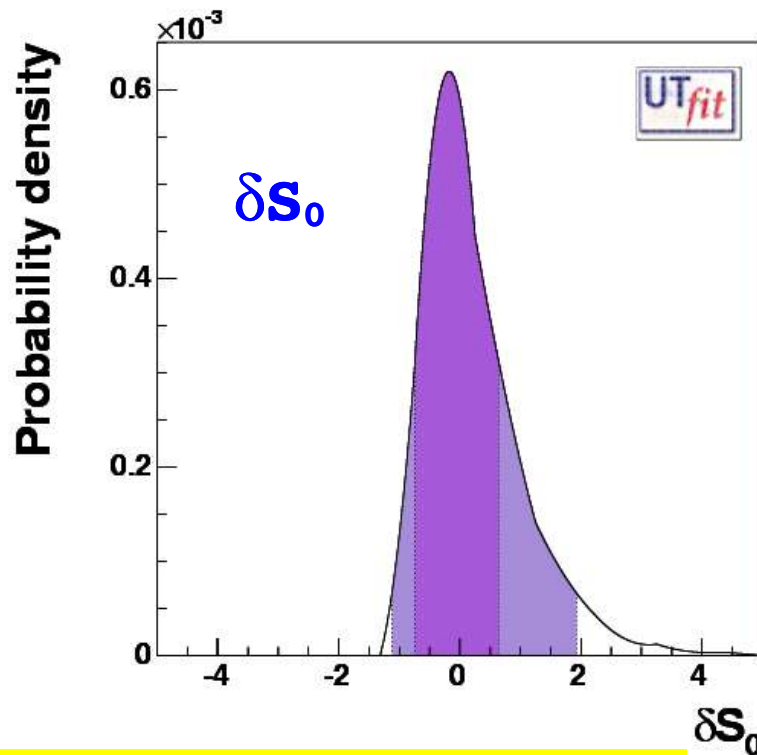
$$\Lambda_0 = \lambda_t \sin^2 \theta_w M_W / \alpha_{EM} \sim 2.4 \text{ TeV}$$

$\Lambda > 2.5 \Lambda_0$ @95% for positive δS_0

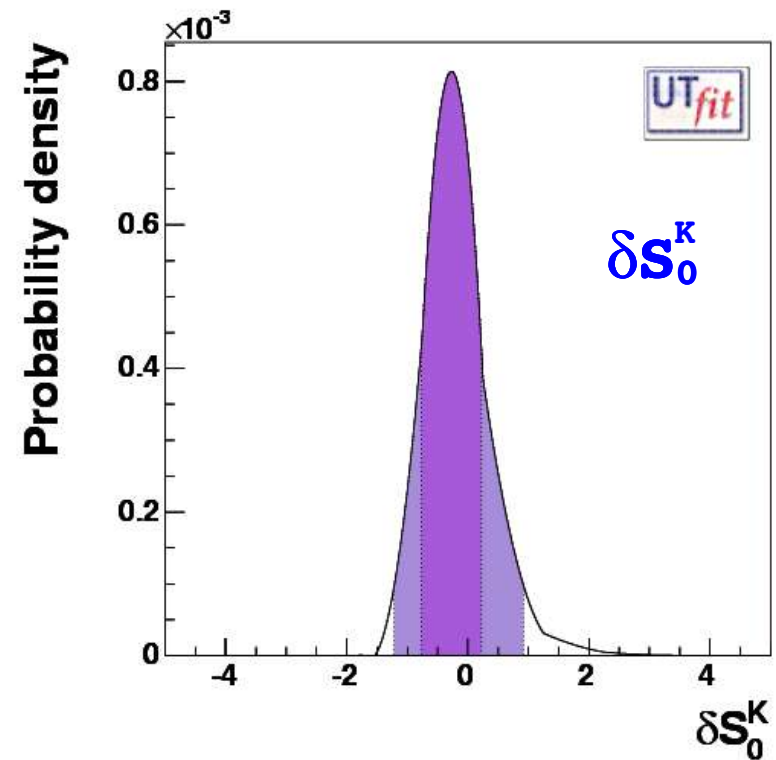
$\Lambda > 1.9 \Lambda_0$ @95% for negative δS_0

Constraining NP in MFV(II)

In the case of large $\tan\beta$, the NP corrections for ε_K are different than the one for B mixing. Two different δS_0 now



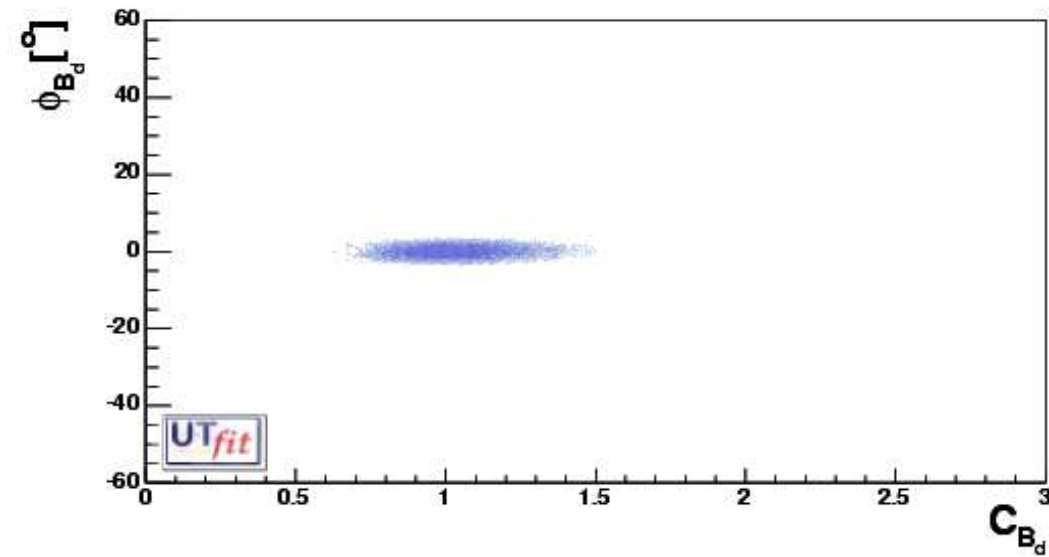
$\Lambda > 1.4\Lambda_0$ @95% for positive δS_0
 $\Lambda > 1.9\Lambda_0$ @95% for negative δS_0



$\Lambda > 2.1\Lambda_0$ @95% for positive δS_0
 $\Lambda > 1.8\Lambda_0$ @95% for negative δS_0

A look into the future

We play with a realistic **2010 scenario**: how much can we be sensitive to NP parameters if we do not find any inconsistency within the SM?



$$\begin{aligned} \sigma(C_{B_d}) &= 0.15 & \sigma(\phi_{B_d}) &= 1.6^\circ \\ \sigma(C_{B_s}) &= 0.12 & \sigma(C_{\varepsilon_K}) &= 0.12 \end{aligned}$$

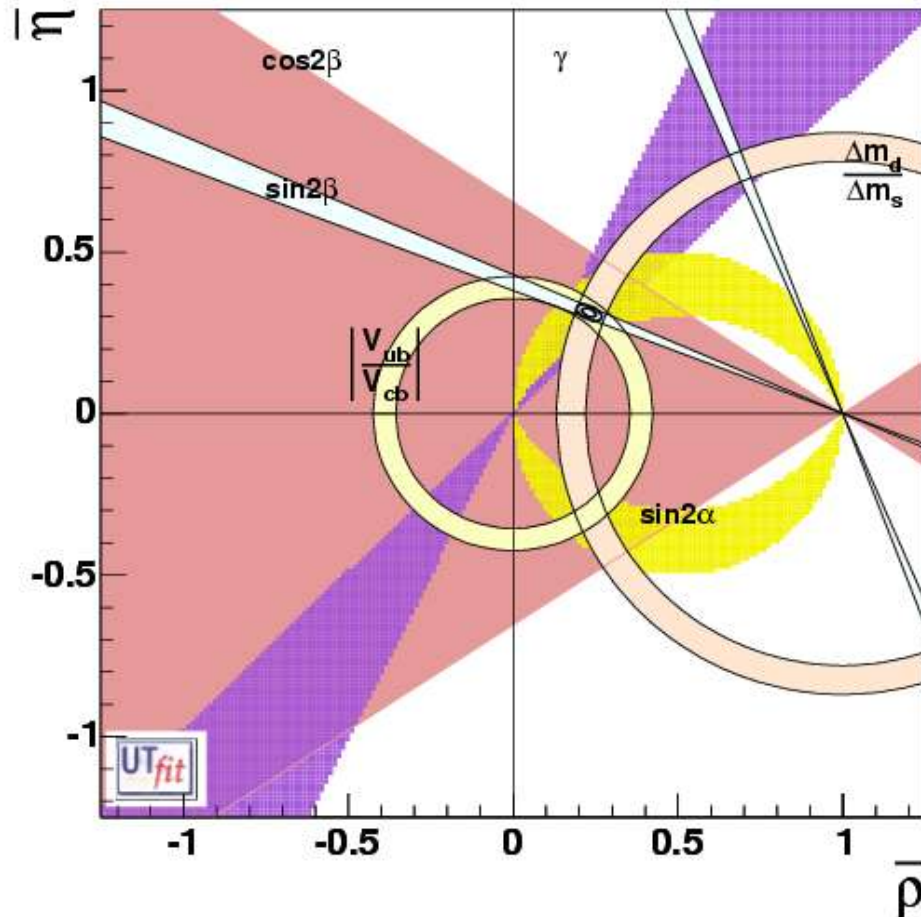
Observable	projected values/error
$\sin 2\beta$	0.695 ± 0.015 (2%)
$\alpha [^\circ]$	$(104 \pm 7)^\circ$
$\gamma [^\circ]$	$(54 \pm 5)^\circ$
B_K	0.930 ± 0.047 (5%)
$F_{B_s} \sqrt{\hat{B}_{B_s}}$ [MeV]	0.276 ± 0.014 (5%)
ξ	1.200 ± 0.037 (3%)
$ V_{cb} $ -(incl+excl) (10^{-3})	41.7 ± 0.4 (0.9%)
$ V_{ub} $ -(incl+excl) (10^{-4})	36.4 ± 1.6 (4.2%)
Δm_d	0.503 ± 0.003 (0.6%)
Δm_s	20.5 ± 0.3 ps $^{-1}$
m_t [GeV]	171 ± 3.0
$\lambda_{Cab.}$	0.2240 ± 0.008



A look into the future: MFV

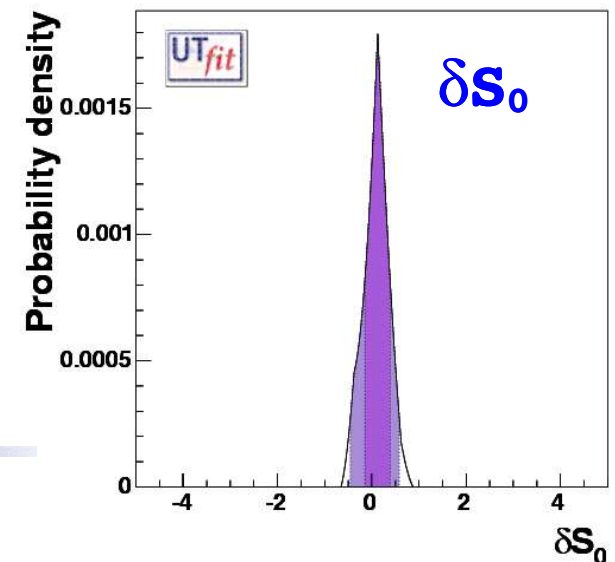
We will strongly reduce the errors on $\bar{\rho}$ and $\bar{\eta}$, in the general UUT analysis

$$\sigma(\bar{\eta}) = 0.013 \quad \sigma(\bar{\rho}) = 0.018$$



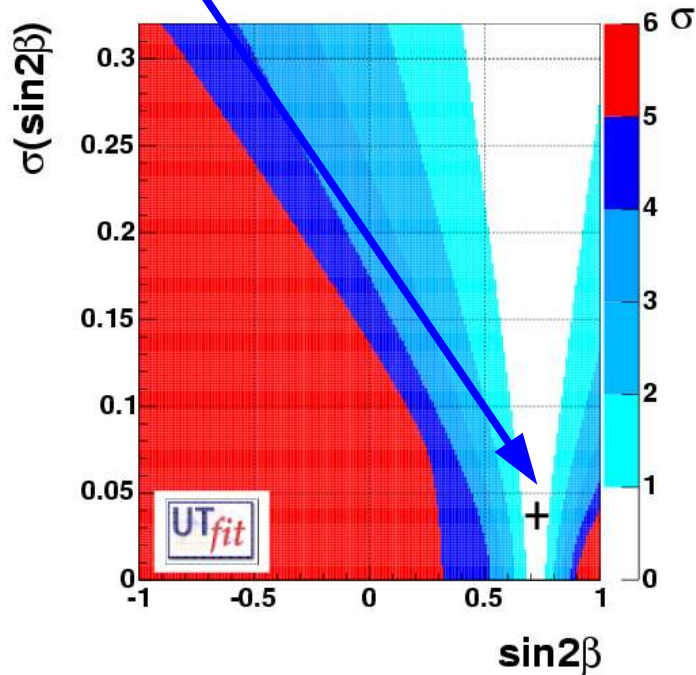
We can also improve sensitivity to NP at high scales in MFV

$$\Lambda > 3.5\Lambda_0 @95\%$$



$\sin 2\beta$ from $b \rightarrow s$ penguins

$\sin 2$ ($J/\psi K^0$)

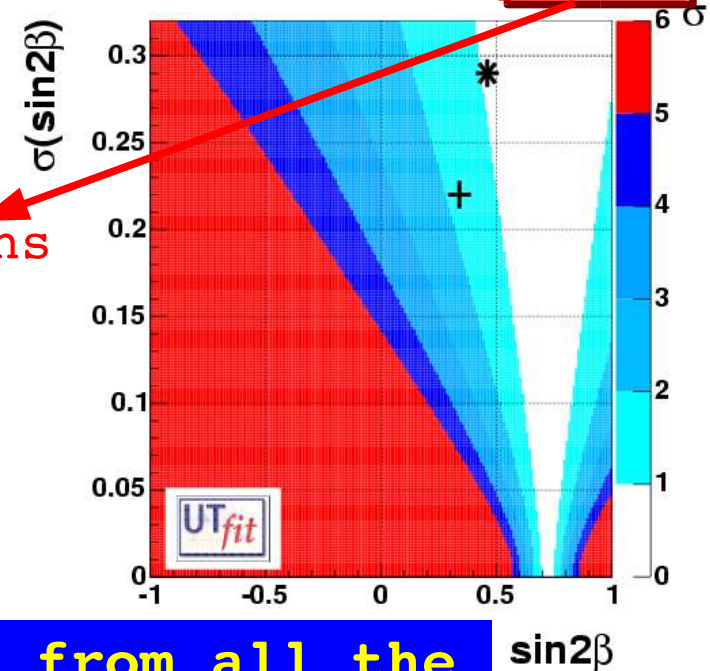


determination of $\sin 2$
from standard fit

$\sin 2\beta$ from ϕK_s

$\sin 2\beta = 0.34 \pm 0.20 \pm 0.05$ HFAG
 $\sin 2\beta = 0.46 \pm 0.28 \pm 0.05$ Skep

Correction from
Charming Penguins
model



$\sin 2$ from all the
other bounds



Conclusions

- ➔ The increased number of constraints allows a tree level determination of $\bar{\rho}$ and $\bar{\eta}$, which sets the *paradigma* for all NP models
- ➔ A generalization of UT fit beyond the SM shows the presence of a second solution, which is not killed yet by measurements
- ➔ One can generalize the analysis to UUT, in a MFV scenario, obtaining a comparable precision in $\bar{\rho}$ and $\bar{\eta}$
- ➔ In different MFV scenarios (large vs low $\tan\beta$), one can put constraints on NP
- ➔ A look to future shows how powerfull the UT fit can be to bound NP at low energy scales

