$|V_{ub}|$ & the CKM fit

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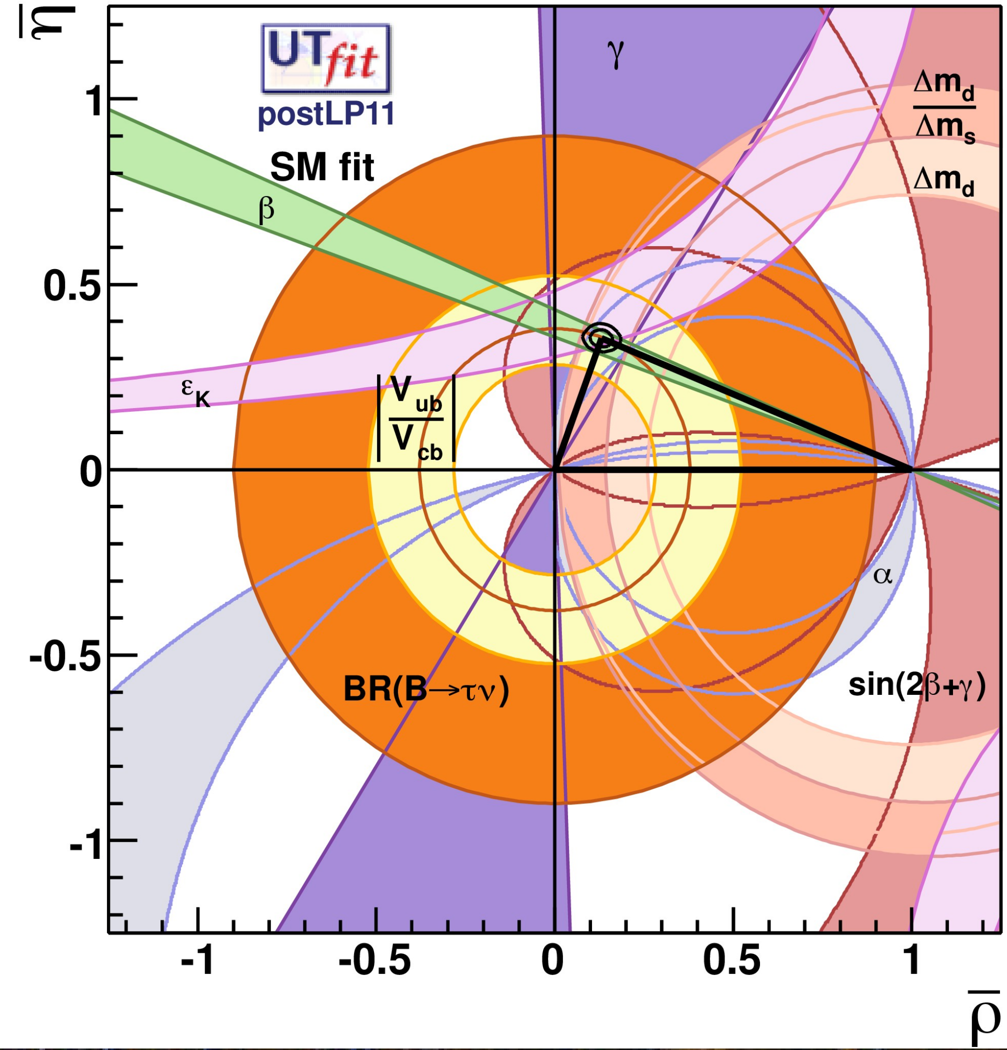
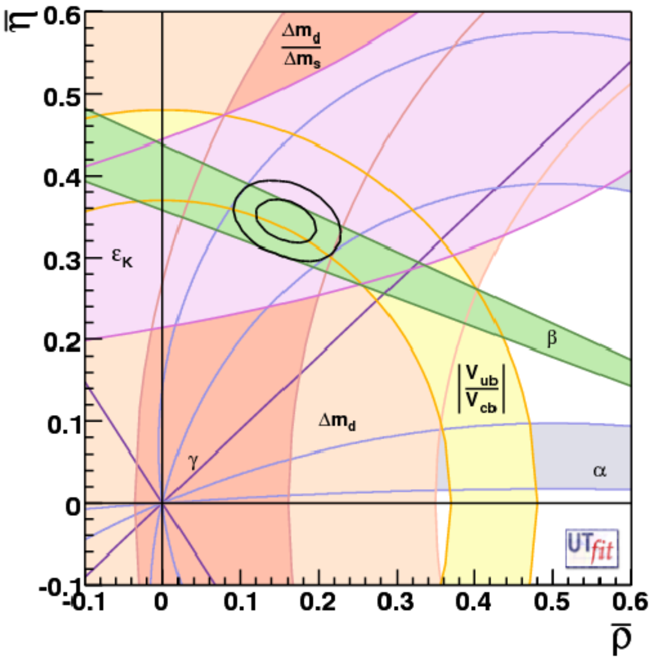


4th SuperB Collaboration Meeting – La Biodola (Isola d'Elba)

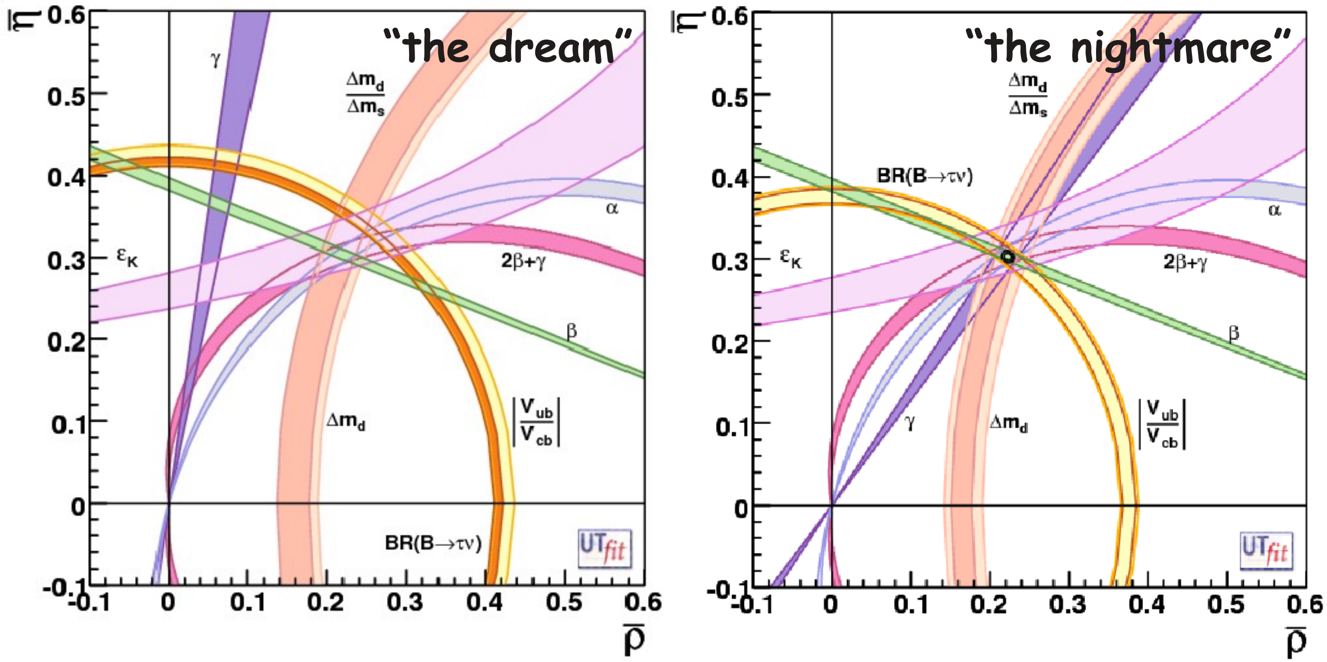
31st May 2012

CKM matrix at 1%

Today



With a SuperB in 2022

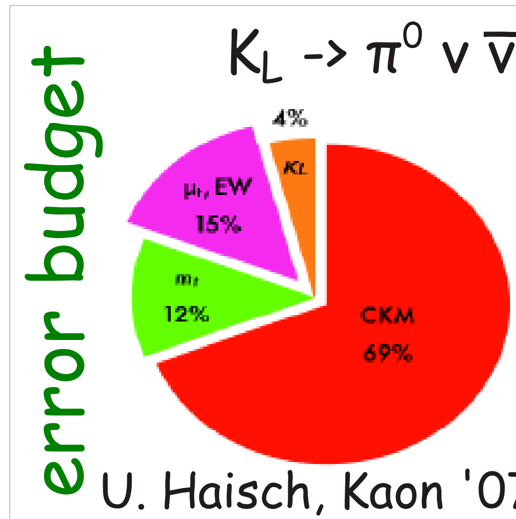


Generalized UT fits:

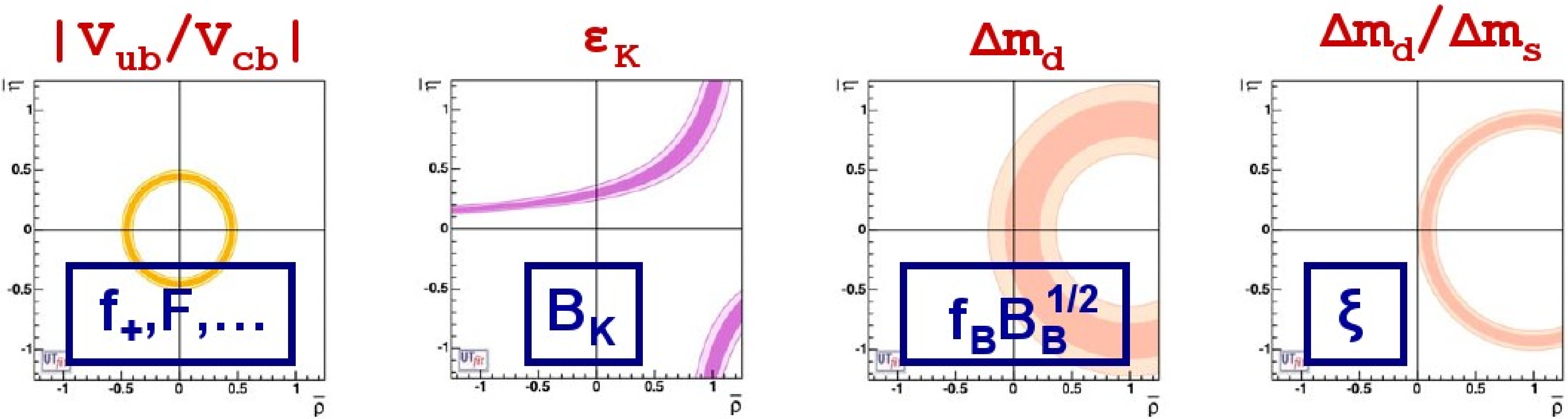
CKM at 1% in the presence of NP!

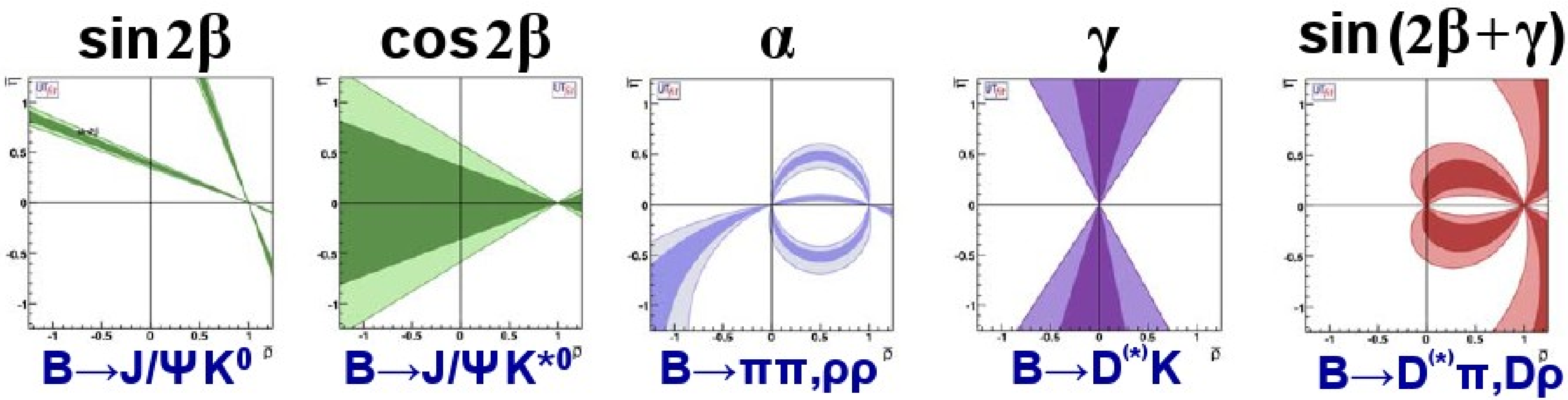
	today	SuperB
$\bar\rho$	0.187±0.056	±0.005
$\bar\eta$	0.370±0.036	±0.005

- crucial for many NP searches with flavour (not only in the B sector!)



Constraints





Parameterization of generic NP contributions to the mixing amplitudes

K mixing amplitude (2 real parameter):

$$\mathrm{Re}\,A_K = C_{\Delta m_K}\,\mathrm{Re}\,A_K^{SM} \qquad \mathrm{Im}\,A_K = C_\varepsilon\,\mathrm{Im}\,A_K^{SM}$$

B_d and B_s mixing amplitudes (2+2 real parameters):

$$A_q e^{2i\phi_q} = C_{B_q} e^{2i\phi_{B_q}} A_q^{SM} e^{2i\phi_q^{SM}} = \left(1 + \frac{A_q^{NP}}{A_q^{SM}} e^{2i(\phi_q^{NP} - \phi_q^{SM})}\right) A_q^{SM} e^{2i\phi_q^{SM}}$$

$$\phi_d^{SM} = \beta, \quad \phi_s^{SM} = -\beta_s$$

Observables:

$$\Delta m_{q/K} = C_{B_q/\Delta m_K} (\Delta m_{q/K})^{SM} \qquad \varepsilon_K = C_\varepsilon \varepsilon_K^{SM}$$

$$a_{CP}^{B_d \to J/\psi K_S} \to \sin 2(\beta + \phi_{B_d}) \qquad a_{CP}^{B_s \to J/\psi\phi} \to -\beta_s + \phi_{B_s}$$

$$a_{SL}^q = \mathrm{Im}\left(\Gamma_{12}^q / A_q\right) \qquad \Delta\Gamma^q/\Delta m_q = \mathrm{Re}\left(\Gamma_{12}^q / A_q\right)$$

UT analysis including new physics (NP)

M. Bona *et al.* (UTfit)
Phys.Rev.Lett.97:151803,2006

	ρ, η	C_{Bd}, ϕ_{Bd}	$C_{\varepsilon K}$	C_{Bs}, ϕ_{Bs}
V_{ub}/V_{cb}	X			
γ (DK)	X			
ε_K	X		X	
$\sin 2\beta$	X	X		
Δm_d	X	X		
α ($\rho\rho$,$\rho\pi$,$\pi\pi$)	X	X		
A_{SL} B_d	X	X X		
$\Delta\Gamma_d/\Gamma_d$	X	X X		
$\Delta\Gamma_s/\Gamma_s$	X			X X
Δm_s				X
A_{CH}	X	X X		X X

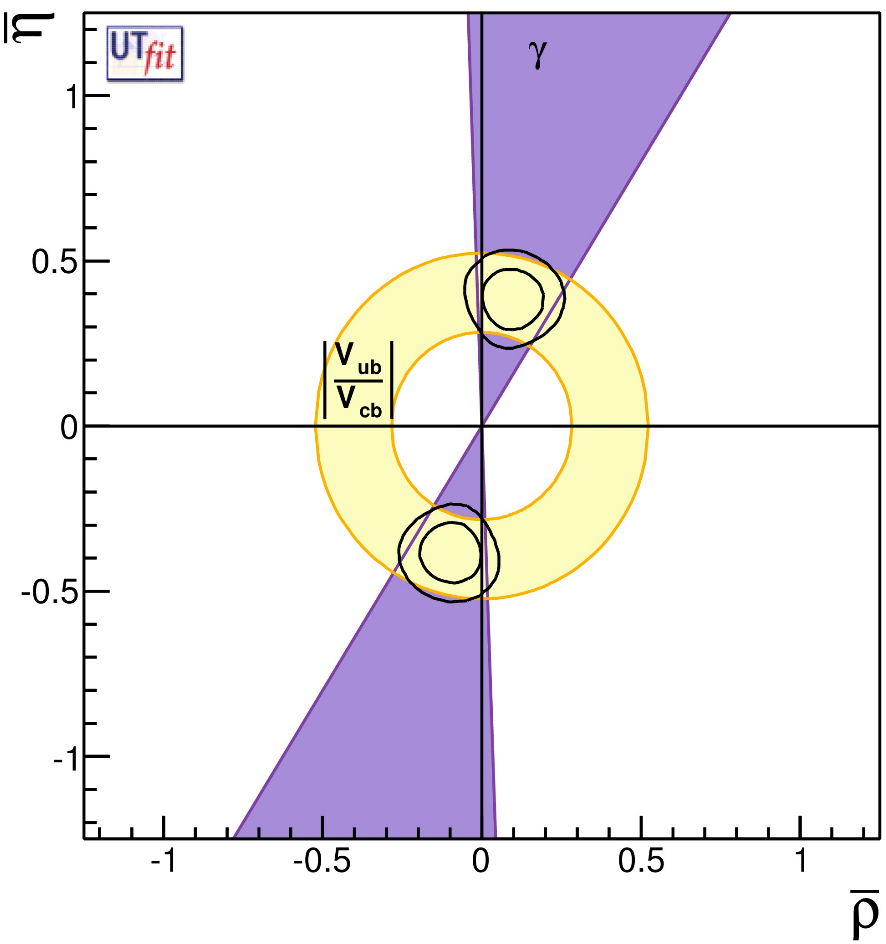
model independent assumptions

SM	SM+NP
tree level	
$(V_{ub}/V_{cb})^{SM}$	$(V_{ub}/V_{cb})^{SM}$
γ^{SM}	γ^{SM}
Bd Mixing	
β^{SM}	$\beta^{SM}+\phi_{Bd}$
α^{SM}	$\alpha^{SM}-\phi_{Bd}$
Δm_d	$C_{Bd}\Delta m_d$
Bs Mixing	
Δm_s^{SM}	$C_{Bs}\Delta m_s^{SM}$
β_s^{SM}	$\beta_s^{SM}+\phi_{Bs}$
K Mixing	
ε_K^{SM}	$C_{\varepsilon K}\varepsilon_K^{SM}$

Checking the Unitarity Clock

Assumptions:
(1) 3-generations unitarity
(2) no new physics in tree-level processes

Using only tree-level constraints:



$\gamma = (-103.9 \pm 9.2)^\circ$
$(75.7 \pm 9.2)^\circ$

$|V_{cb}| = (41.0 \pm 1.0) \times 10^{-3}$

$|V_{ub}| = (3.82 \pm 0.52) \times 10^{-3}$

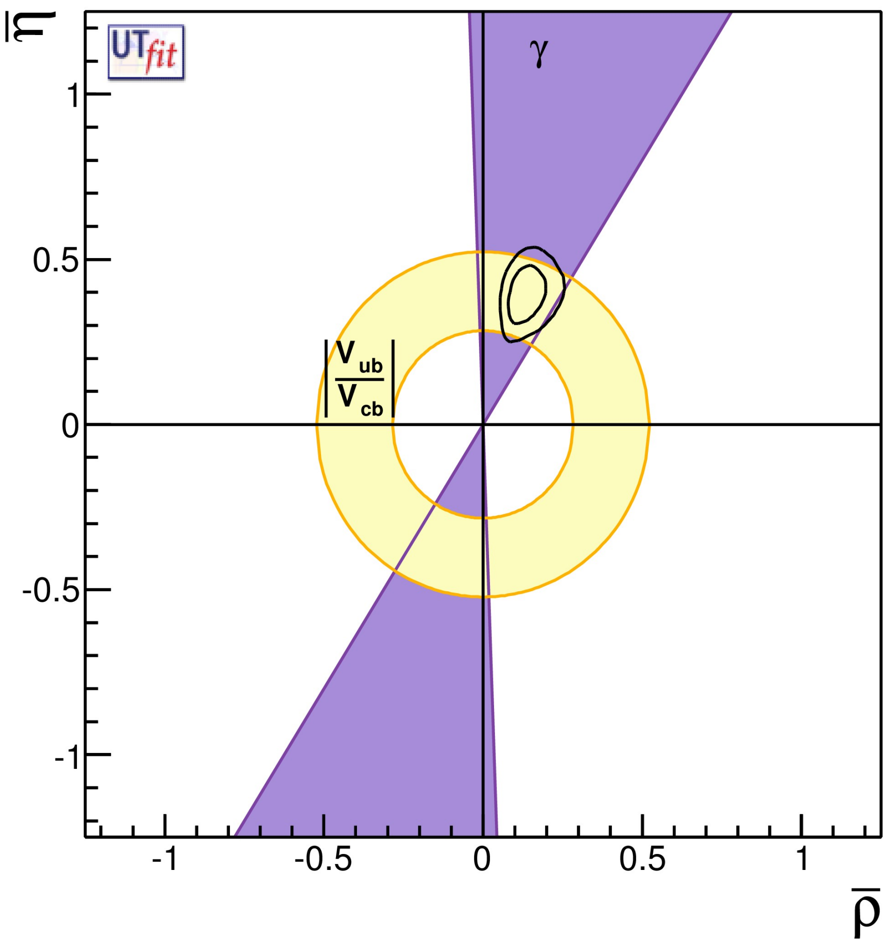
$\bar{\rho} = \pm 0.089 \pm 0.061$ (69%)

$\bar{\eta} = \pm 0.385 \pm 0.057$ (15%)

These constraints must be satisfied in any NP model

Full CKM fit in the presence of NP

Adding α and the other $\Delta B=2$ constraints, one can do better:



$$\bar\rho = 0.134 \pm 0.044 \quad (33\%)$$
$$\bar\eta = 0.403 \pm 0.058 \quad (14\%)$$

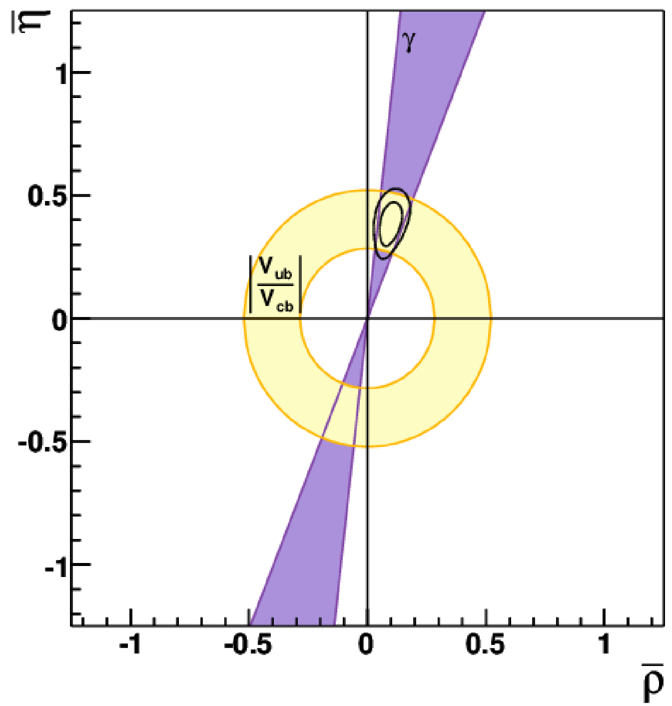
- The non-SM-like solution is disfavoured
- The SM-like solution is partly modified:
  - * error on rhobar is reduced (mainly due to α)
  - * little effect on etabar

The future of the clock

post-LHCb: $\delta\gamma \sim 4°$, $|V_{cb,ub}|$ unchanged

$\bar{\rho} = \pm 0.098 \pm 0.031\ (32\%)$

$\bar{\eta} = \pm 0.386 \pm 0.056\ (15\%)$

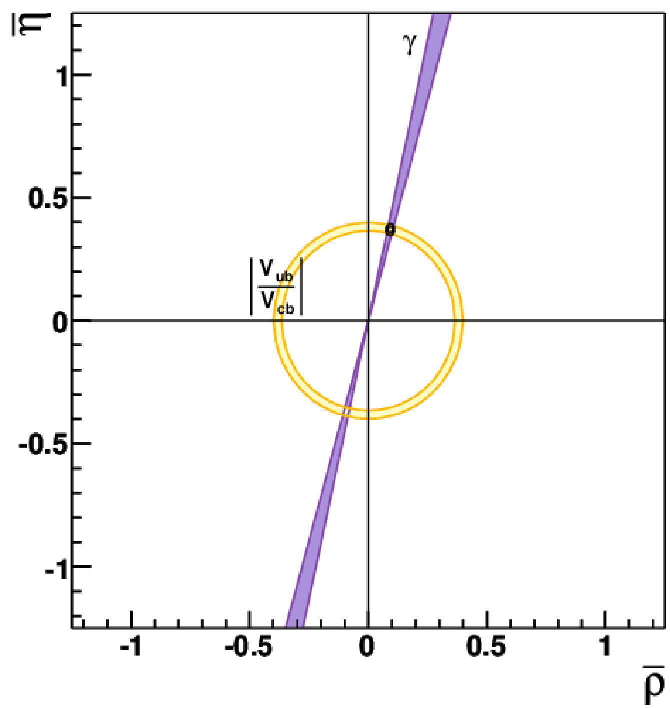


post-SuperB: $\delta\gamma \sim 1°$, $\delta|V_{cb}|/|V_{cb}| \sim 1\%$

$\delta|V_{ub}|/|V_{ub}| \sim 2\%$

$\bar{\rho} = \pm 0.093 \pm 0.007\ (8\%)$

$\bar{\eta} = \pm 0.371 \pm 0.009\ (2.5\%)$



Conclusions

* A precise determination of the CKM matrix is one of the highlights of the SuperB physics programme: it is a crucial ingredient in many NP searches within and beyond B physics
* A precise measurement of γ alone has little impact on the parameter η in particular
* A percent determination of $|V_{cb}|$ and $|V_{ub}|$ is required to achieve the goal: extremely important to assess the SuperB potential and identify possible showstoppers