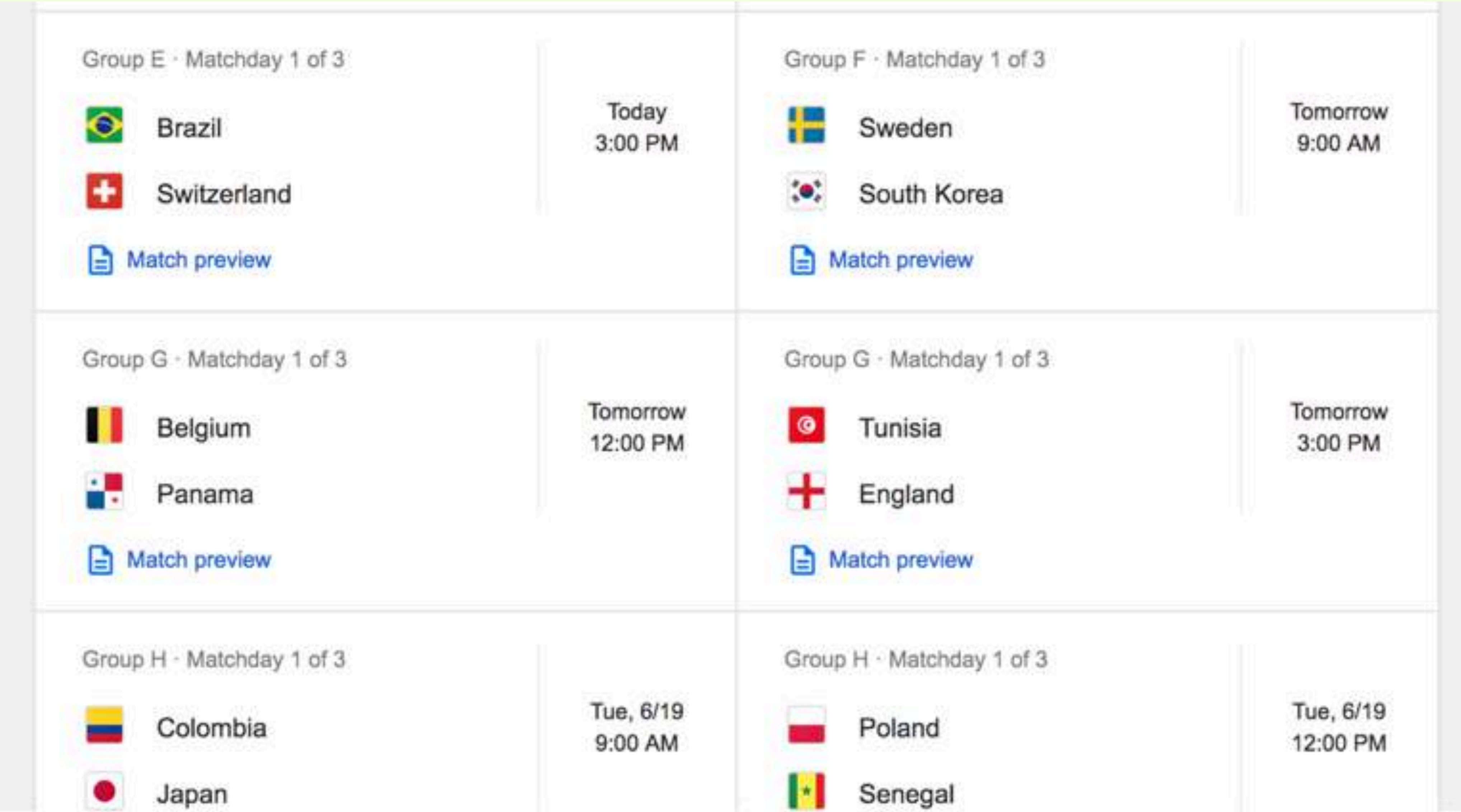
Higgs and Flavor Physics
supplementary slides

First Joint ICTP-Trieste/ICTP-SAIFR
School on Particle Physics
2018

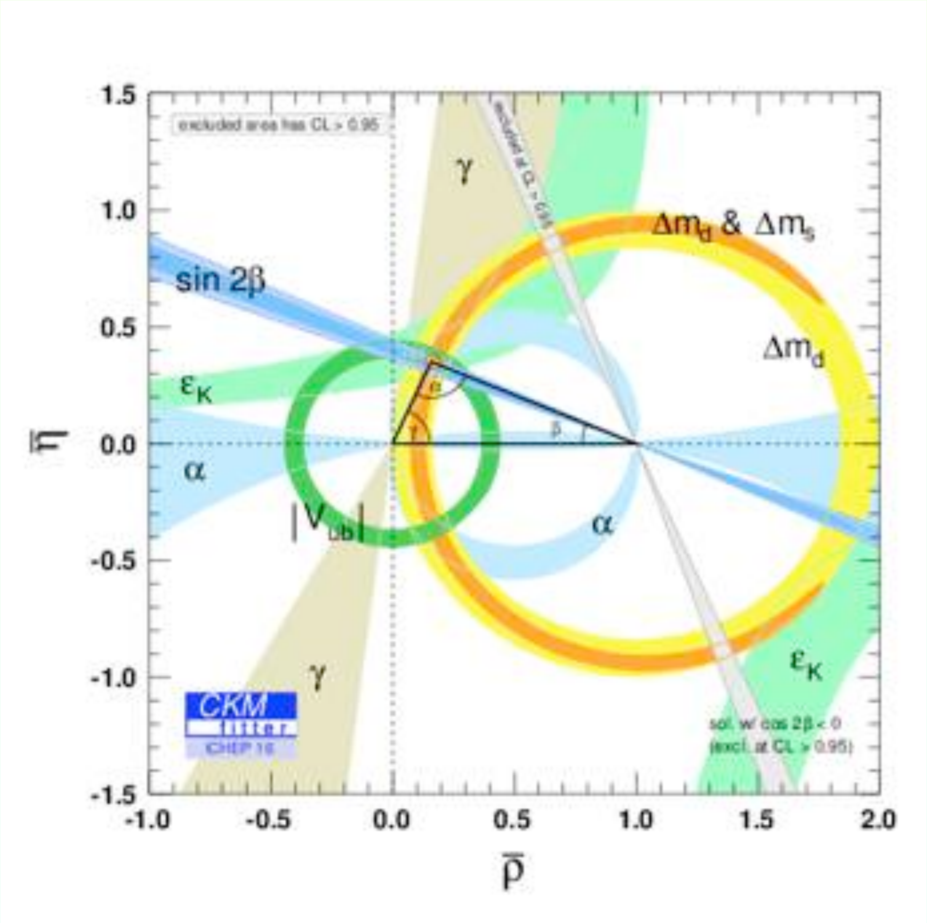
Benjamín Grinstein

Problem 1: Winter?? in São Paulo

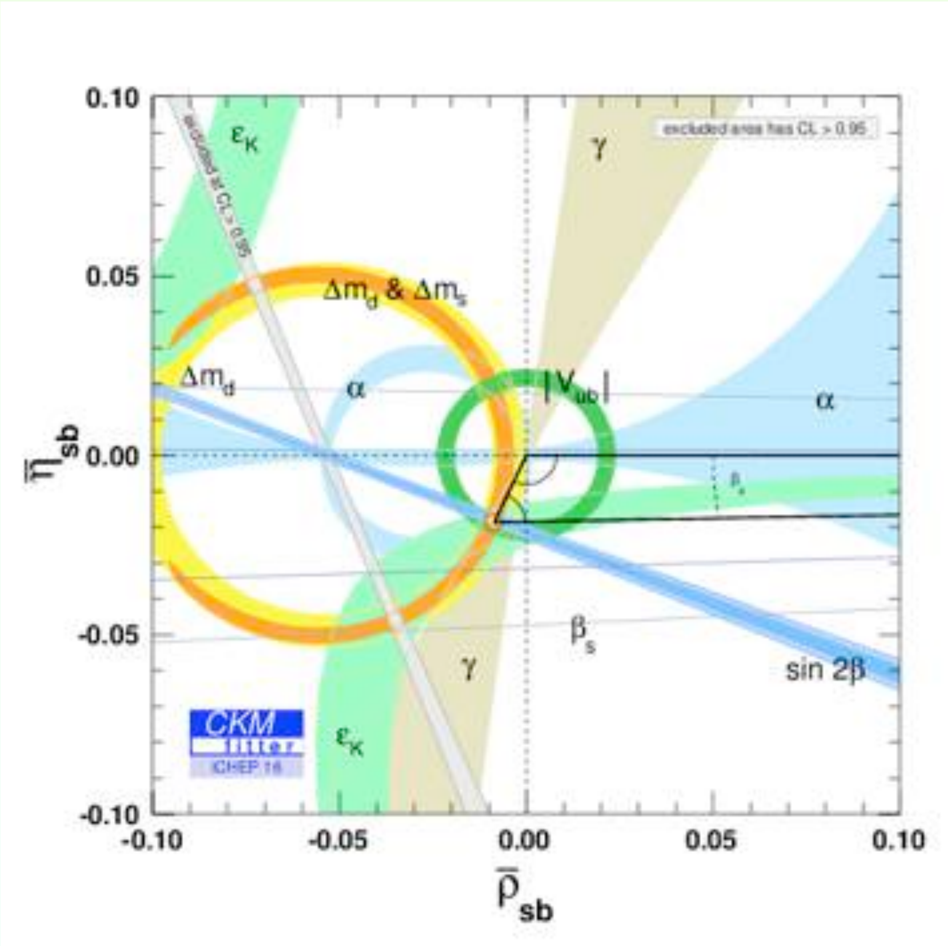
Problem 2: Schedule of lectures?



Fat



Skinny

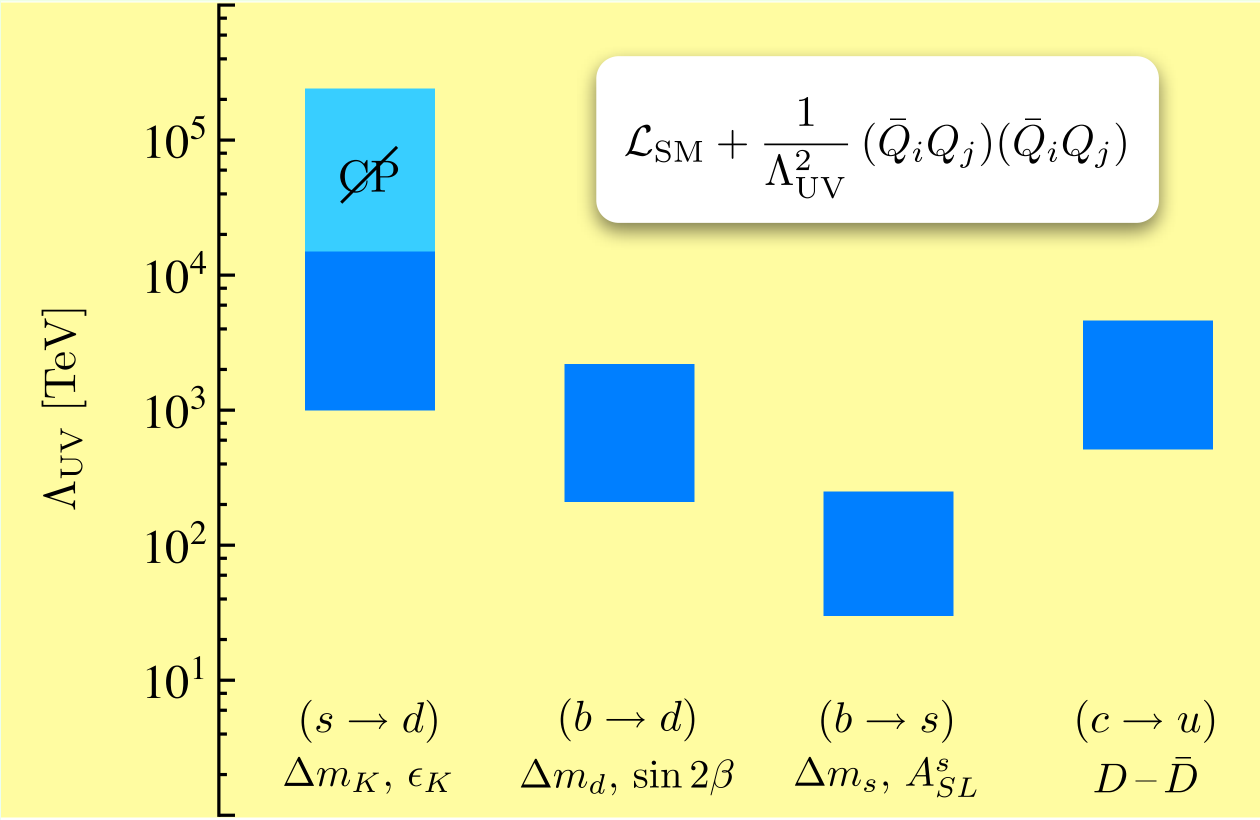


For many like these see http://ckmfitter.in2p3.fr/www/results/plots_ichep16/ckm_res_ichep16.html

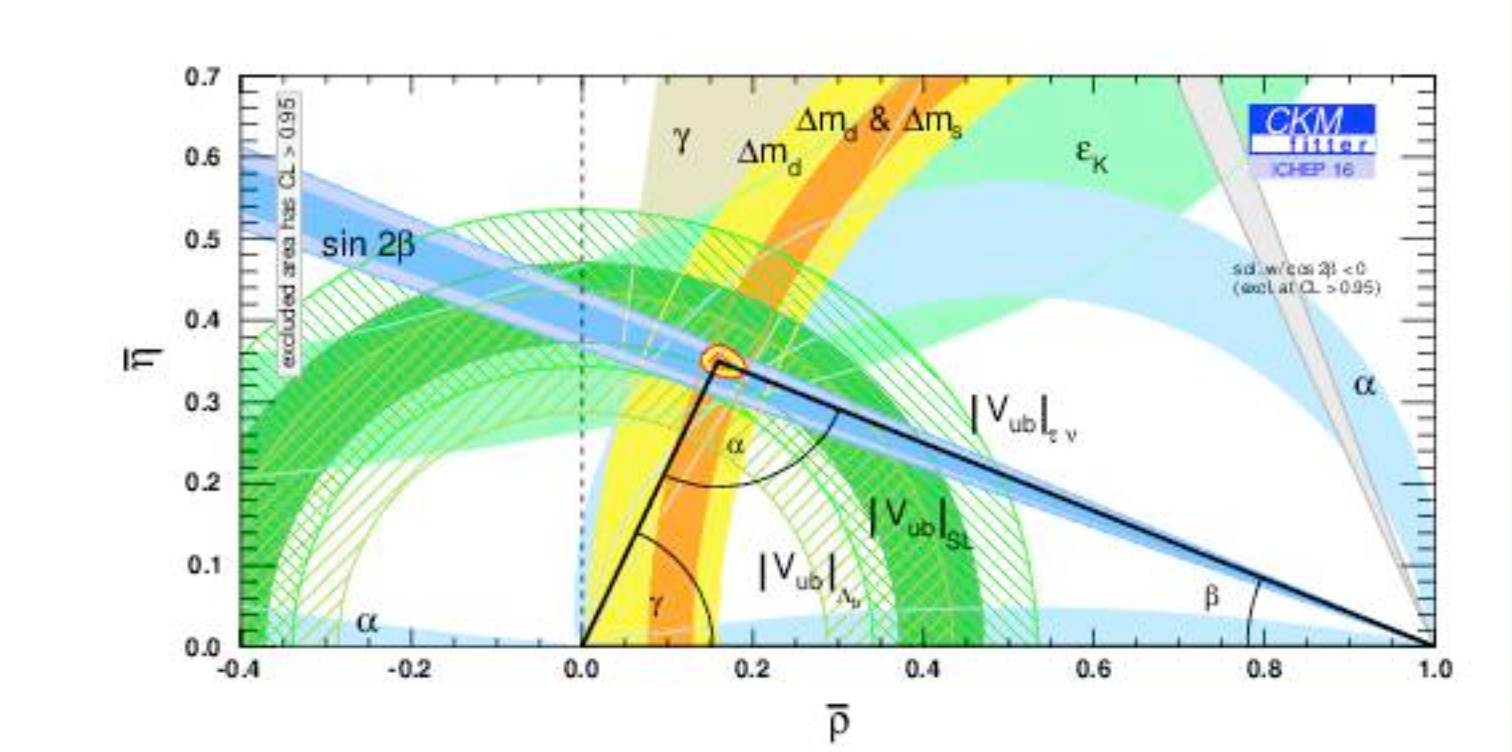
Flavor Physics: an important constraint on all new BSM models

[Neubert, EPS2011]

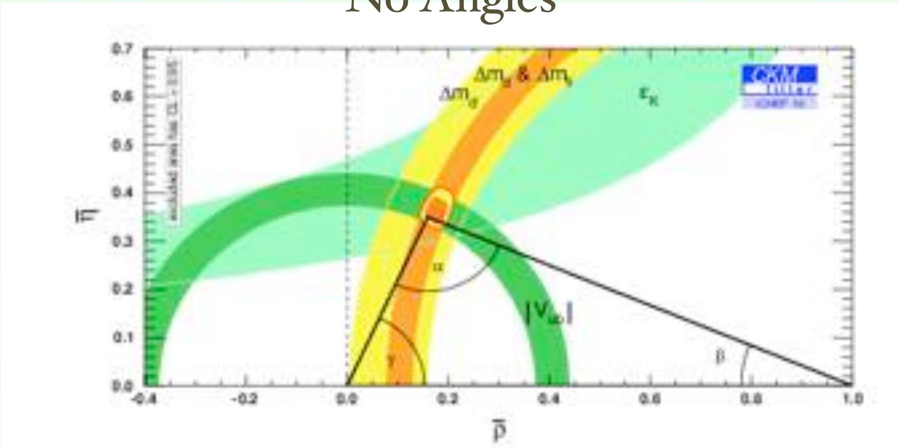
Generic bounds without a flavor symmetry



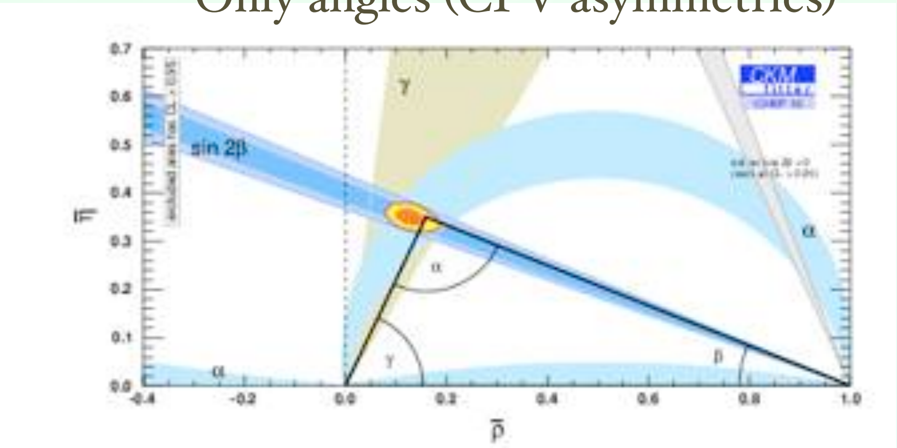
TASI Exercise: from these determine bounds with MFV assumption



No Angles



Only angles (CPV asymmetries)



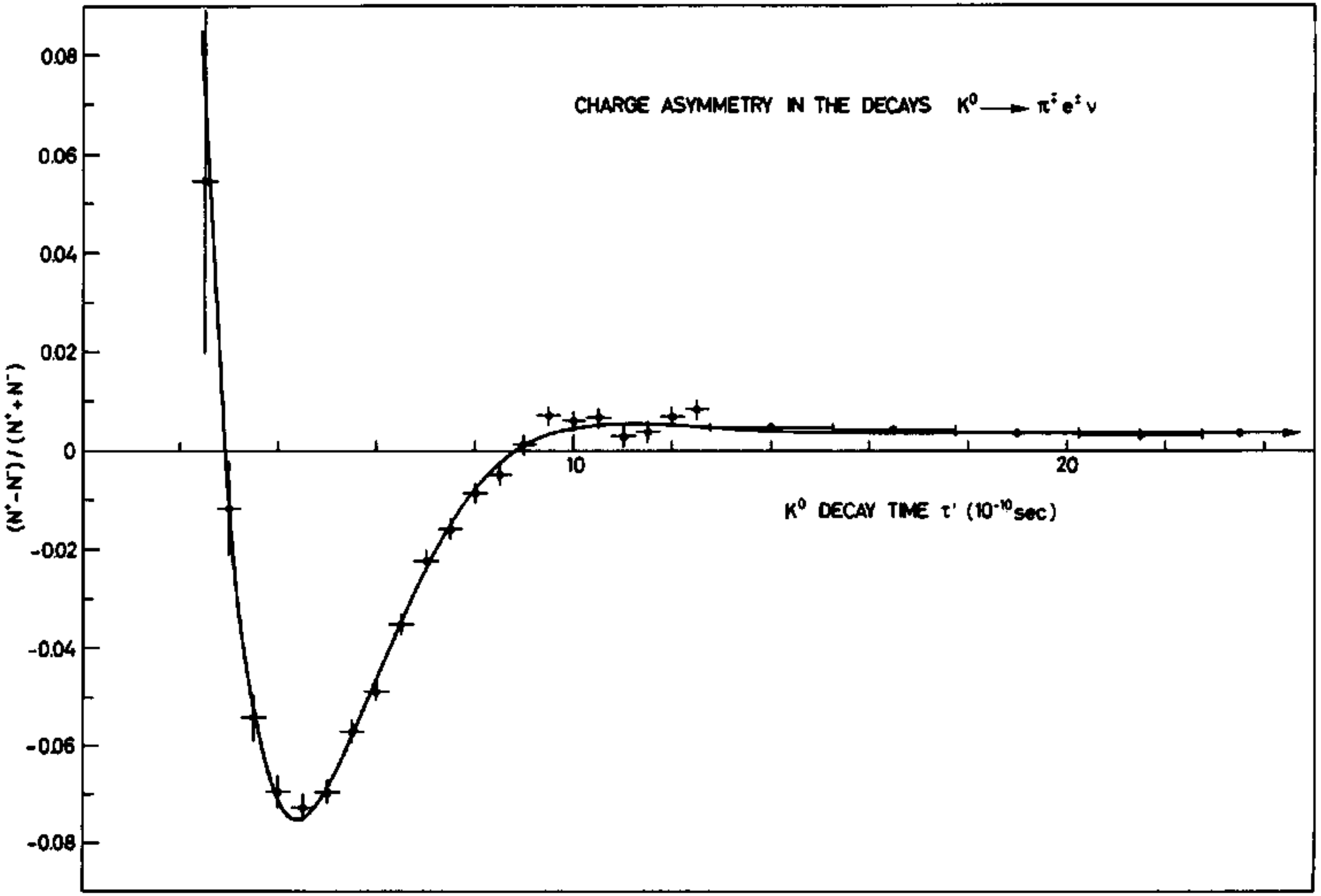


Fig. 1. The charge asymmetry as a function of the reconstructed decay time τ' for the K_{e3} decays. The experimental data are compared to the best fit as indicated by the solid line.

S. Gjesdal, et al, Phys.Lett. B52 (1974) 113

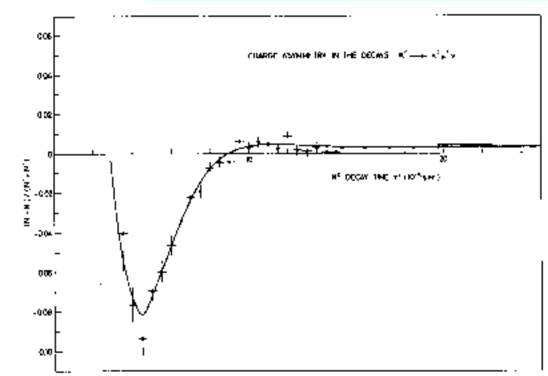


Fig. 2. The charge asymmetry as a function of the reconstructed decay time τ' for the $K_{\mu 3}$ decays. The experimental data are compared to the best fit as indicated by the solid line.

This is B^0

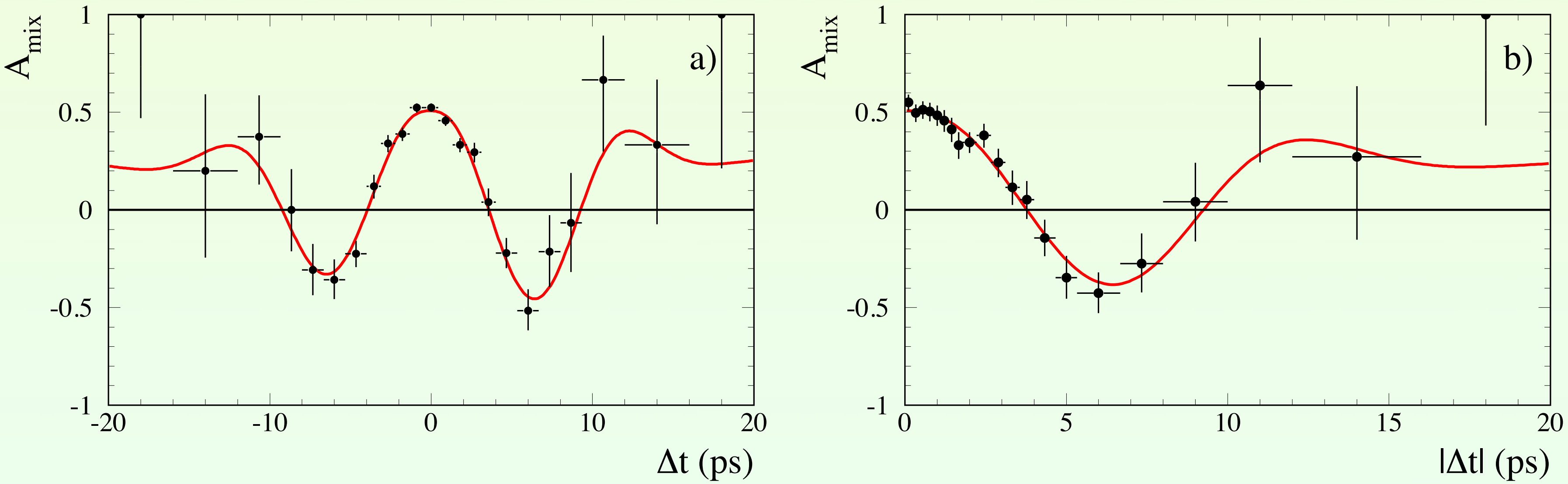
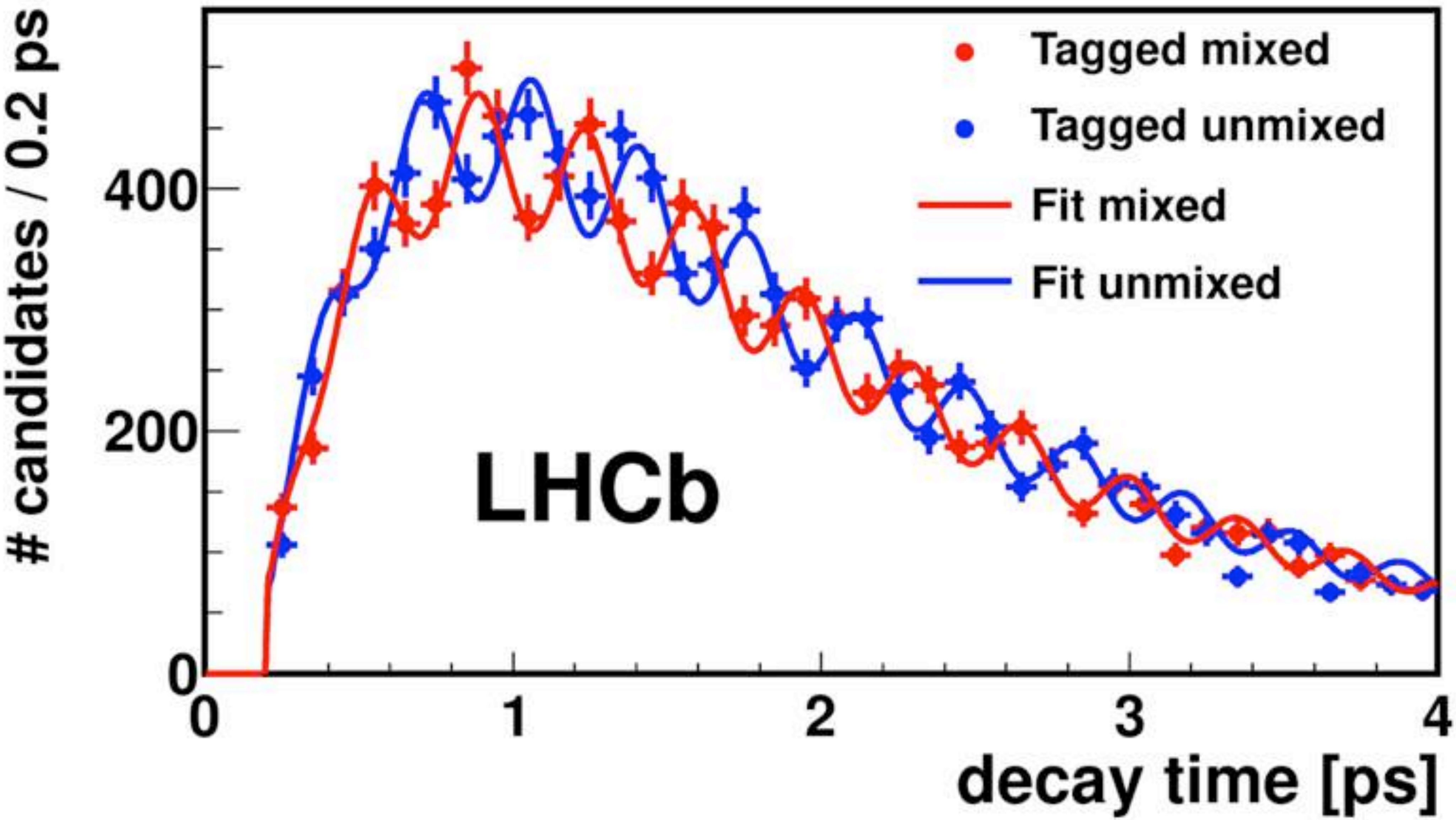


FIG. 25: Time-dependent asymmetry $\mathcal{A}(\Delta t)$ between unmixed and mixed events for hadronic B candidates with $m_{\mathrm{ES}} > 5.27\,\mathrm{GeV}/c^2$, a) as a function of Δt; and b) folded as a function of $|\Delta t|$. The asymmetry in a) is due to the fitted bias in the Δt resolution function.

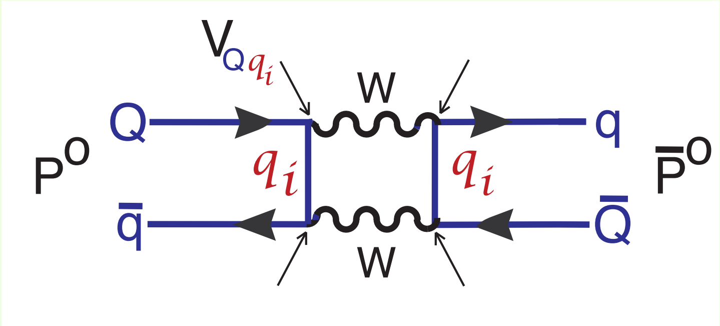
Babar, arXiv.org > hep-ex > arXiv:hep-ex/0201020

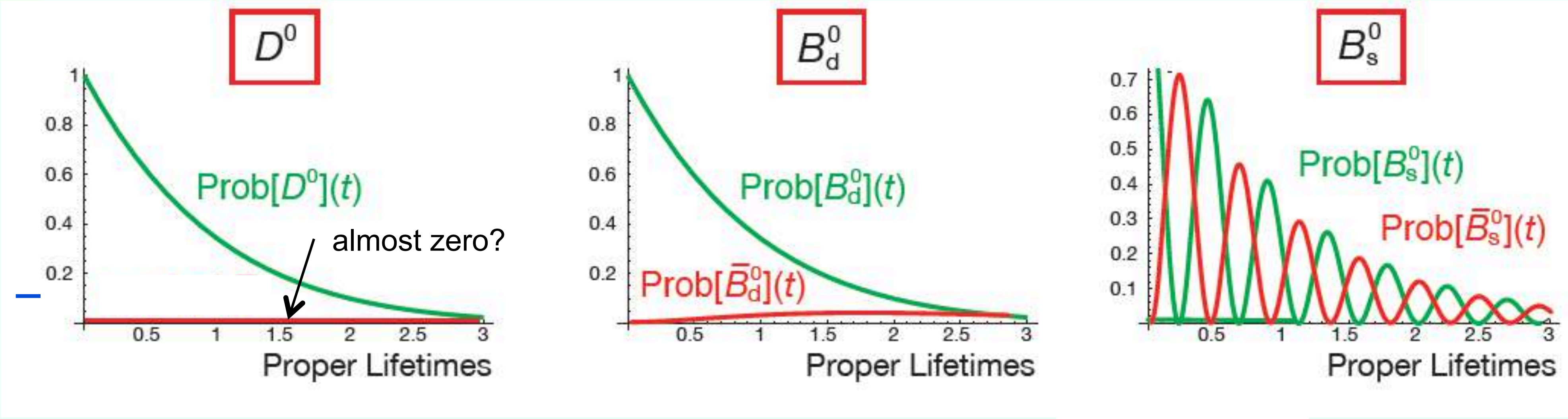
This is Bs



Tagged mixed
Tagged unmixed
Fit mixed
Fit unmixed
LHCb
candidates / 0.2 ps
400
200
0
0
1
2
3
4
decay time [ps]

Mixing: slow/fast?





Gold plated examples: $b \longrightarrow c\bar{c}s$

$B^0 \to \psi K^0_{L,S}$

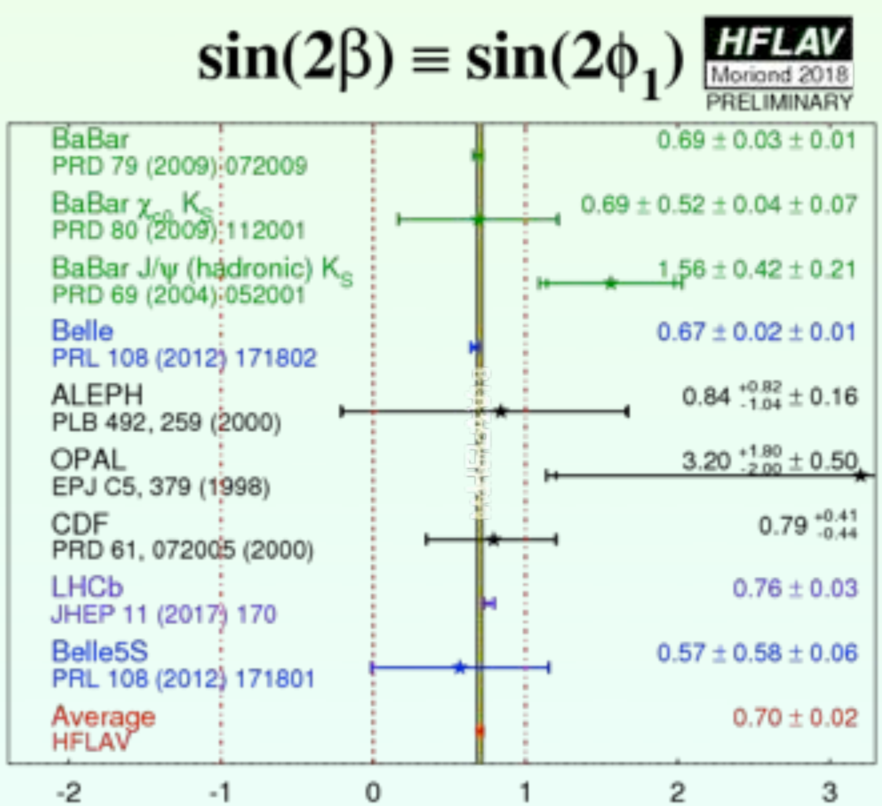
$$\lambda_{\psi K^0_{S,L}} = \mp \left(\frac{V^*_{tb}V_{td}}{V_{tb}V^*_{td}}\right)\left(\frac{V_{cb}V^*_{cs}}{V^*_{cb}V_{cs}}\right)\left(\frac{V_{cs}V^*_{cd}}{V^*_{cs}V_{cd}}\right) = \mp e^{-2i\beta}$$

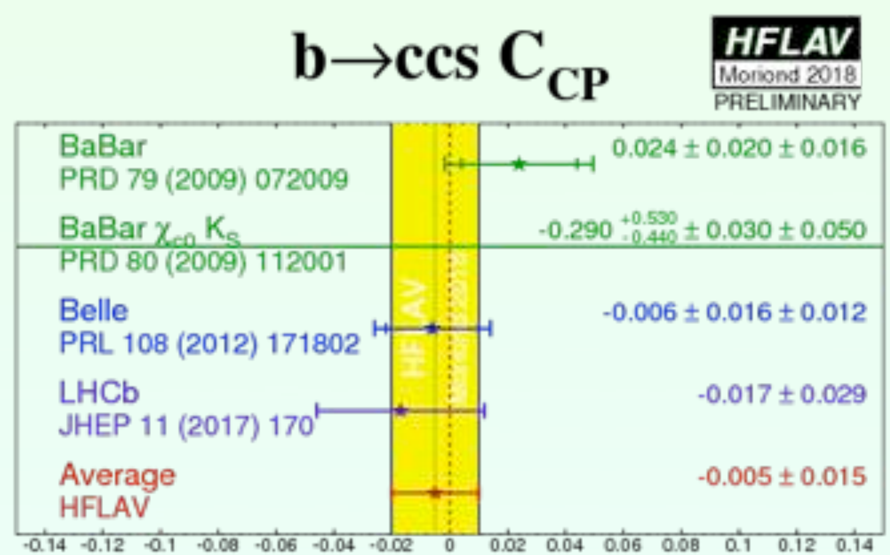
−CP of S, L

q/p

$\bar{A}_f/A_f$

p/q for K

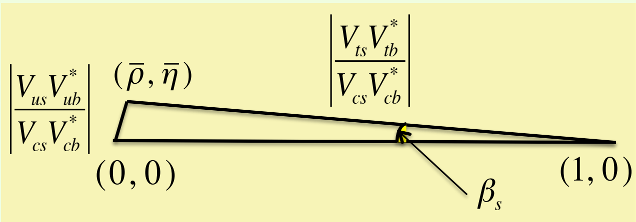




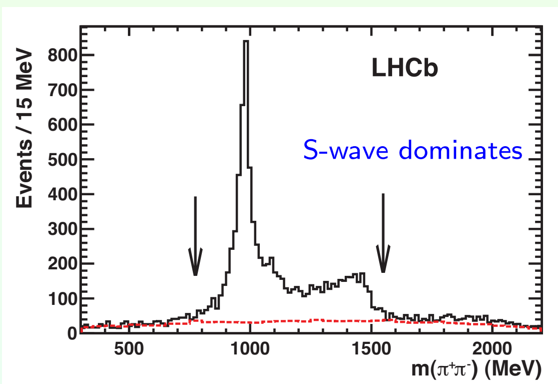
and $B_s \to \psi\phi, \psi\pi^+\pi^-$

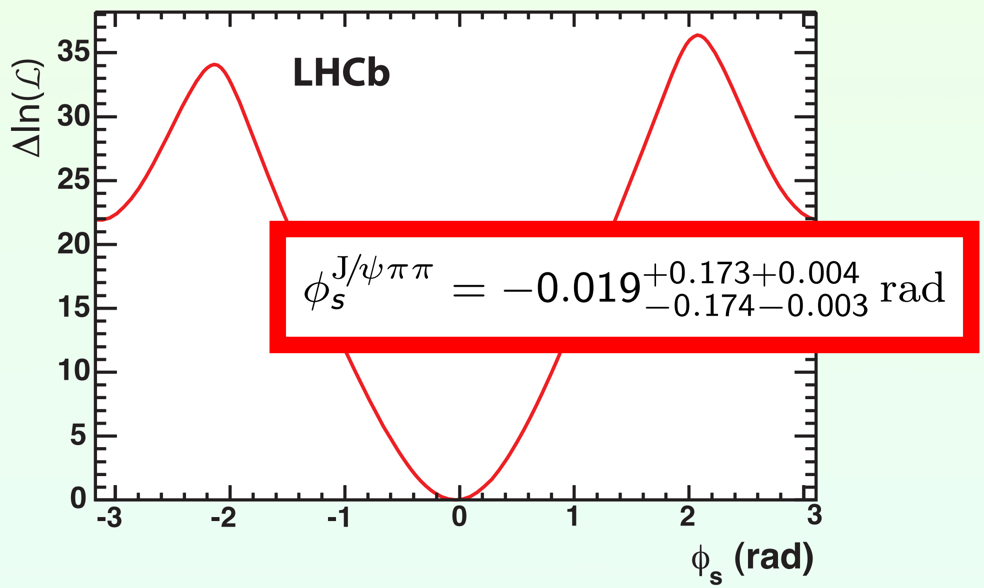
$$\lambda_{\psi\pi^+\pi^-} = -\left(\frac{V_{tb}^* V_{ts}}{V_{tb} V_{ts}^*}\right)\left(\frac{V_{cb} V_{cs}^*}{V_{cb}^* V_{cs}}\right) = -e^{-2i\beta_s}$$

small angle in squashed unitarity triangle
≈ 0 in SM



$$\varphi_s^{SM} \equiv -2\beta_s = -2\arg\left(-\frac{V_{ts}V_{tb}^*}{V_{cs}V_{cb}^*}\right) = -0.04 \text{ rad}$$





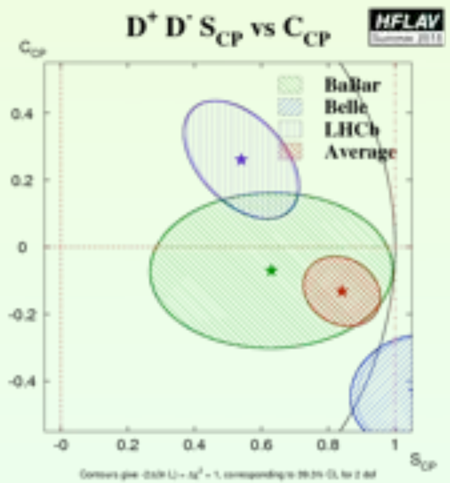
$B \to \psi\phi(K^+K^-)$ requires angular analysis, separate partial waves. Combined analysis:

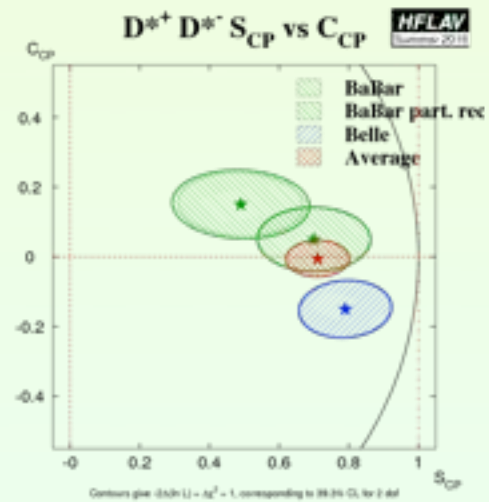
$$\boxed{\phi_s = -0.002 \pm 0.083 \pm 0.027 \,\text{rad}}$$

[G Cowan, ICHEP 2012]

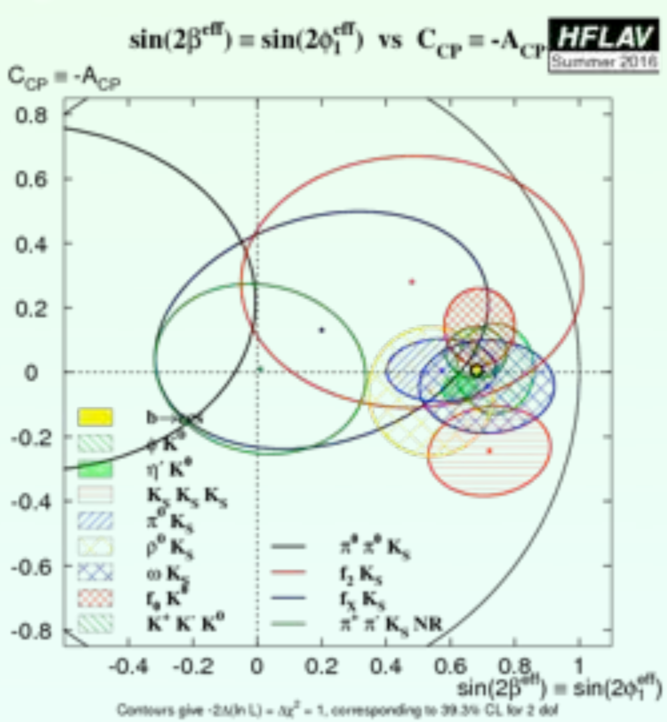
$b \to ccd$ modes

$B^0 \to D^+D^-$	$B^0 \to D^{*+}D^{*-}$	$B^0 \to D^{\pm}D^{*\mp}$
CP-eigenstate	mix of CP-odd/even	Not a CP-eigenstate
$\mathcal{S} = \sin 2\phi_1$, $\mathcal{A} = 0$	$\mathcal{S}$, $\mathcal{A}$ for each of	2 amplitudes $\times$ 2 modes
if negligible penguin	longitudinal / transverse	$\Rightarrow C, \mathcal{S}, \mathcal{A}, \Delta\mathcal{S}, \Delta\mathcal{A}$





$b \to s$ penguin modes



- No sign of deviations from standard CKM
- Many of these new: expect improvement in next generation