LHC EFT Working Group

Meeting on Flavour Assumptions

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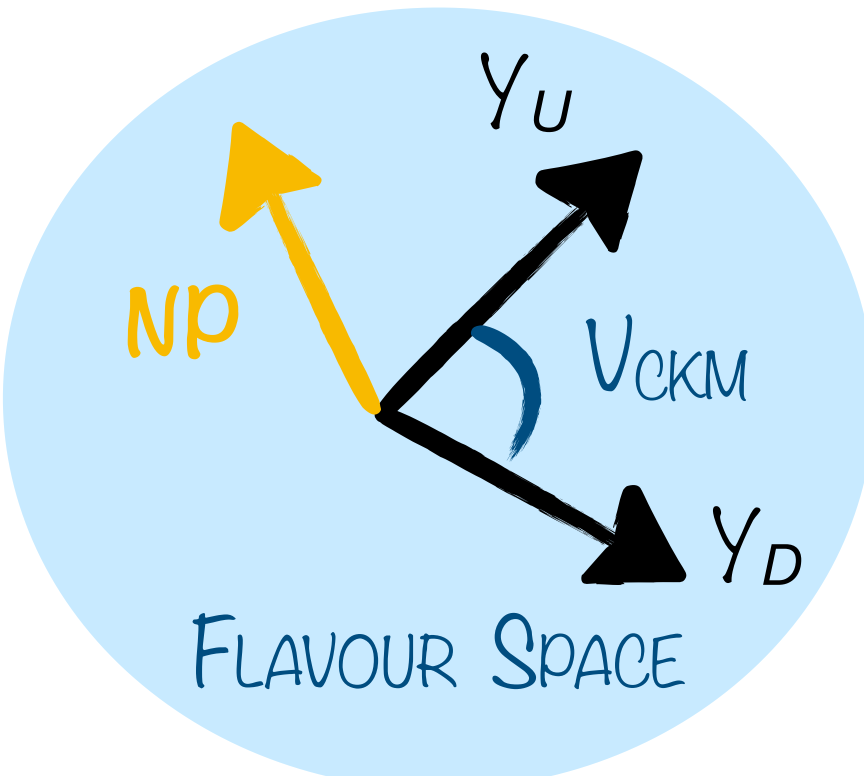
FLAVOUR BOUNDS — A modern view

$$U(3)_Q \times U(3)_u \times U(3)_d$$



Q: In which **basis** we are defining NP?

$$\mathcal{L}_{\text{SMEFT}} = \mathcal{L}_{\text{SM}} + \sum_{i,d>4} \frac{C_i \mathcal{O}_i^{(d)}}{\Lambda_{\text{NP}}^{d-4}}$$

Y_D diag $\quad \longleftrightarrow^{V_{\text{CKM}}} \quad$ Y_U diag

Basis where down-quark Yukawa matrix is diagonal

Basis where up-quark Yukawa matrix is diagonal

Orientation in Flavour space imprints phenomenology: *2 extremes at hand.*

Important point, since in the SMEFT up and down sectors are correlated!

Example: $O^{QQ}_{ijkl} = (\bar{Q}_i \gamma_\mu Q_j)(\bar{Q}_k \gamma^\mu Q_l)$

$ijkl = 1111$: $\Delta F = 0$, still subject to Flavor constraints

1) If aligned with Y_U : $d_{L,1} \to V_{1j}\, d_{L,j}$ $\Rightarrow$ $K - \bar{K}$

2) If aligned with Y_D : $u_{L,1} \to V^\dagger_{1j}\, u_{L,j}$ $\Rightarrow$ $D - \bar{D}$

going to mass basis

$\Lambda_{\rm NP}^{QQ_{1111}} \gtrsim$

1) $415\ \mathrm{TeV}$

2) $267\ \mathrm{TeV}$

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going to mass basis

$\Lambda_{NP}^{QQ_{1111}} \gtrsim$

1) $415\ \mathrm{TeV}$

2) $267\ \mathrm{TeV}$

For 3rd gen.: $\Lambda_{NP}^{QQ_{3333}} \gtrsim$

1) $9\ \mathrm{TeV}$

2) $1.5\ \mathrm{TeV}$

Top-philic!

Example: $O^{QQ}_{ijkl} = (\bar{Q}_i \gamma_\mu Q_j)(\bar{Q}_k \gamma^\mu Q_l)$

—> $\Delta F = 0$, still subject to Flavour constraints

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going to mass basis

CAVEATS TO THIS ARGUMENT?

— Specific flavour structures, e.g.:

i) Flavour Universality

ii) Minimal Flavour Violation

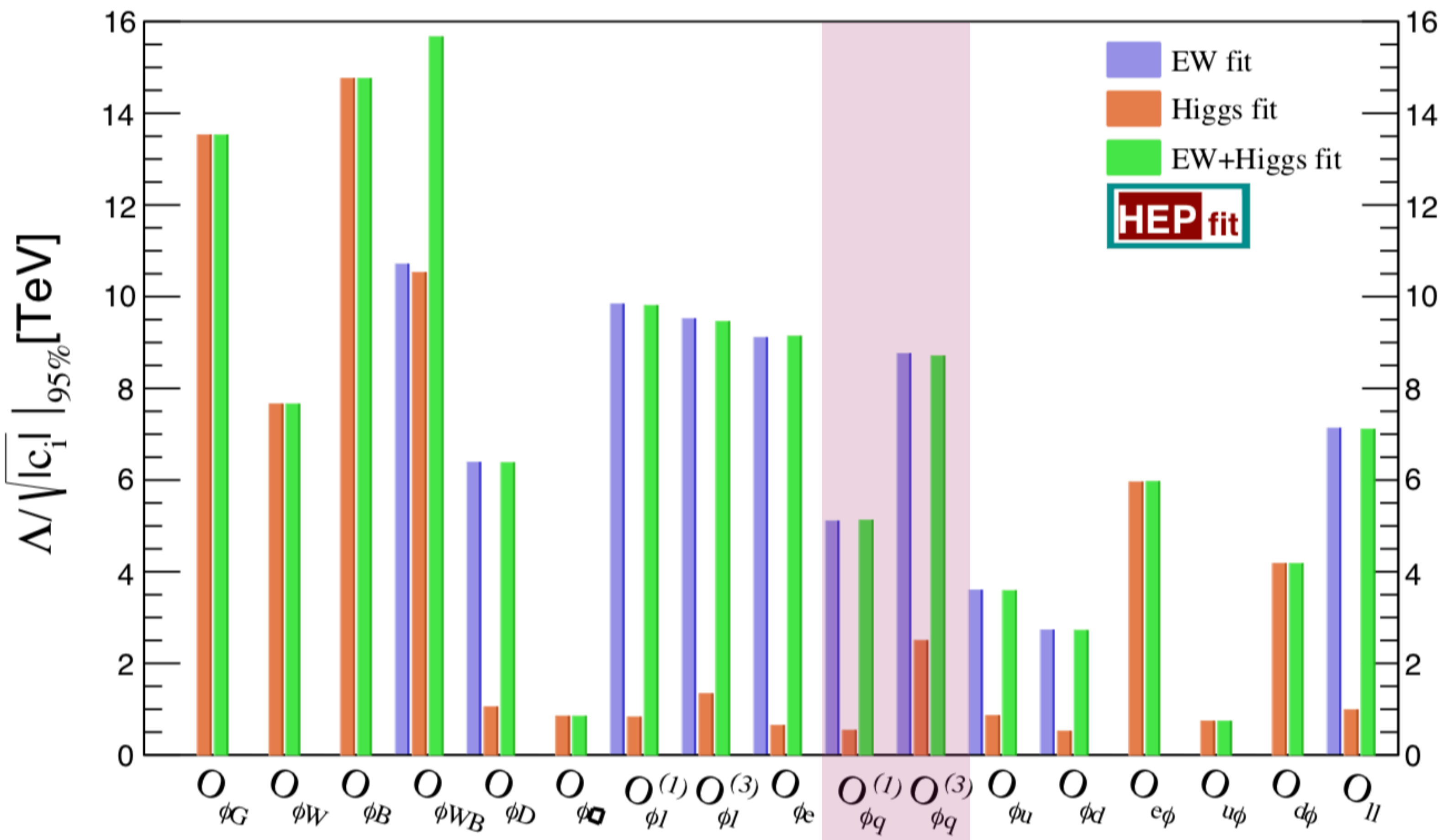
— Fully right-handed operators

Flavour bounds can be relevant even for $\Delta F = 0$ operators via SM RG flow …

$$O_{jk}^{HQ(1[3])}$$

$$\left(H^\dagger i \overleftrightarrow{D}_\mu^{[A]} H\right)\left(\bar{Q}_j \gamma^\mu \left[\tau^A\right] Q_k\right)$$

L.Reina @ LHCP '19



L.S. & M.V. '19

ij	$C_{ij}^{HQ(1,3)}$ [TeV^{-2}] Y_D diag	Y_U diag
11	$\varnothing$	$4.1^{\square}\ 10^{-3}$
12	$(8.9^{\square}, 3.8^{\square})\ 10^{-4}$	$(9.9^{\square}, 3.8^{\square})\ 10^{-4}$
13	$(7.4^{\triangle}, 6.3^{\triangle})\ 10^{-3}$	$(7.6^{\triangle}, 6.4^{\triangle})\ 10^{-3}$
22	$\varnothing$	$4.1^{\square}\ 10^{-3}$
23	$(3.0^{\triangledown}, 1.0^{\triangledown})\ 10^{-2}$	$(3.1^{\triangledown}, 1.0^{\triangledown})\ 10^{-2}$
33	$\varnothing$	$7.3^{\triangle}\ 10^{-1}$

$$\Lambda_{\rm NP} \gtrsim 15\ \text{TeV}$$

… assumption on flavour orientation once again relevant!

A fresh new UT analysis is on the way …

UTfit

www.utfit.org

https://hepfit.roma1.infn.it

HEPfit

Expanding / improving a public tool aimed @ combining high-pT + EW precision with constraints from Flavour in the SMEFT

A Flavourful SMEFT

- High-pT bounds on the SMEFT often assume CKM to play no role: OK only in very specific ansatz
- Breaking of $U(3)^5$ by New Physics is a key question: SMEFT the right tool if used wisely
- Ideal investigation of the SMEFT should exploit all available data within the least set of assumptions