Indirect constraints on top quark operators from a global SMEFT analysis

F. Garosi, D. Marzocca, A. Rodriguez-Sanchez, A. Stanzione

Assumption: only operators involving top quarks are generated at tree level (19 dim-6 operators)

$$\mathcal{L}_{\rm SMEFT} = \mathcal{L}_{\rm SM} + \sum_i \frac{c_i^{(6)}}{\Lambda^2}\mathcal{O}_i^{(6)} + \ldots .$$

E.g. :

$$\mathcal{O}_{Hq}^{(1)} = (H^\dagger i \overleftrightarrow{D}_\mu H)(\bar{q}^3 \gamma^\mu q^3)$$

$$\mathcal{O}_{\ell q}^{(1),\alpha\beta} = (\bar{\ell}^\alpha \gamma_\mu \ell^\beta)(\bar{q}^3 \gamma^\mu q^3)$$

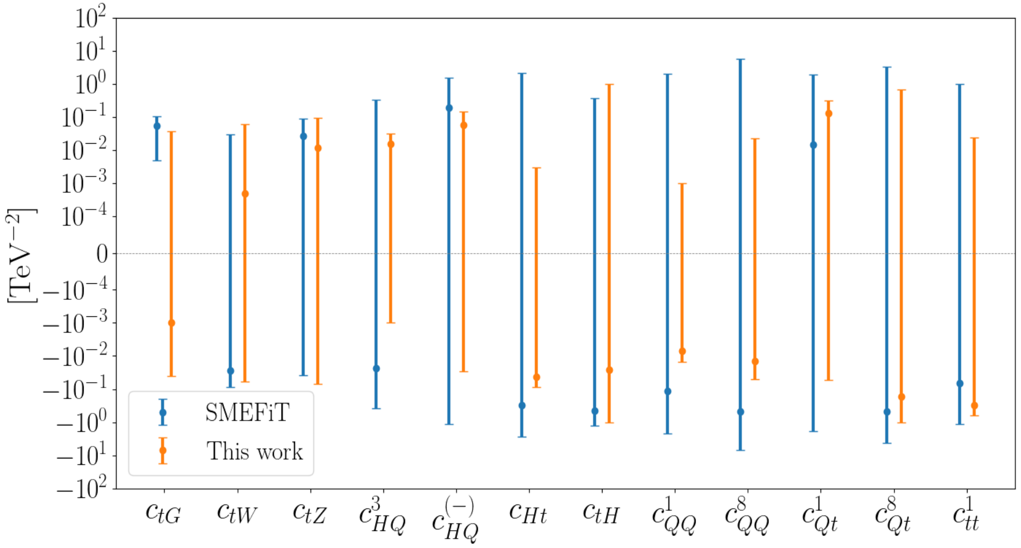
We study the impact of these operators on a large set of low energy observables →

- B and K physics
- Higgs measurements
- Z and W decays
- Cabibbo angle
- g-2
- Lepton decays
- LFU tests
- LFV decay channels

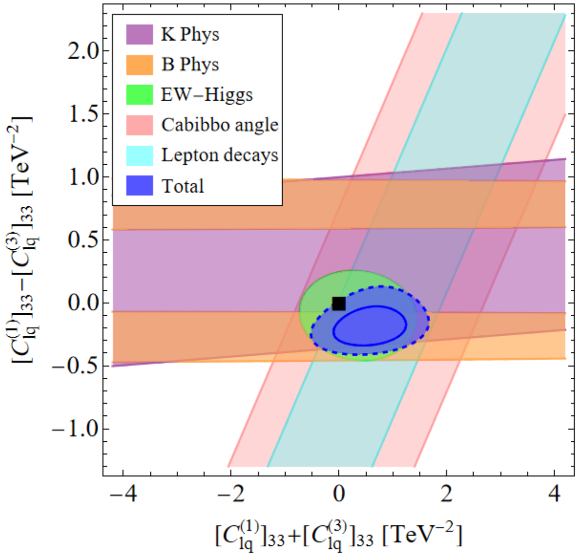
RGE and 1-loop matching procedures are considered

We build a global likelihood and study some applications:

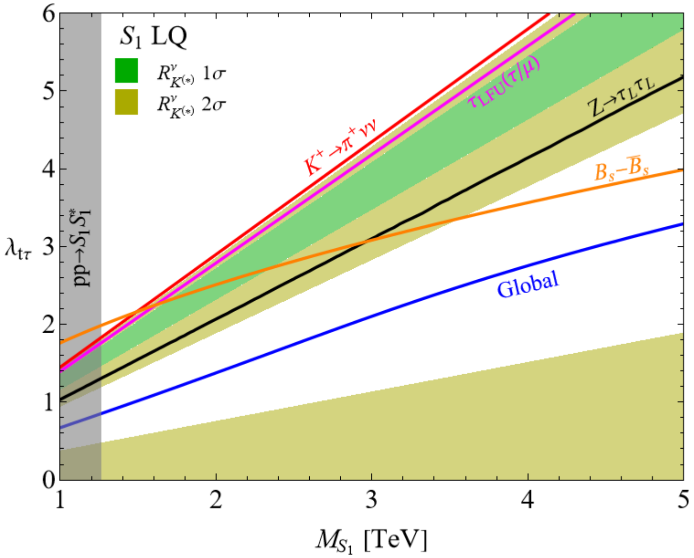
Individual Fits



Pairwise Fits



Consequences for UV models



Relevance of B_c for the Standard Model and beyond

Nicola Losacco Dipartimento di Fisica, Università di Bari, INFN Bari

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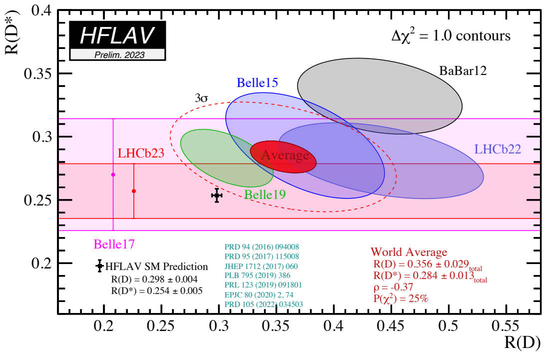
$b \to c\, \ell\, \bar{\nu}$ anomalies



$$R\left(D^{(*)}\right) = \frac{\mathcal{B}\left(\bar{B} \to D^{(*)}\, \tau^- \bar{\nu}_\tau\right)}{\mathcal{B}\left(\bar{B} \to D^{(*)}\, \ell^- \bar{\nu}_\ell\right)}$$

→ need to improve theoretical hadronic uncertainties

$$\mathbf{B_c} \to \mathbf{M_{c\bar{c}}}\, \ell\, \bar{\nu}$$

→ symmetry of the problem: heavy quark spin symmetry

4-plet organization helps to get hints on the structure of debated states: $\chi_{c1}(3872)$ ↙ $X(3872)$ ↘ $\chi_{c1}(2P)$

both negative and positive parity states J/ψ, η_c and χ_{cJ}, h_c

doublet

$$H(v) = \frac{1+\not{v}}{2}\left[B_c^{*\mu}\gamma_\mu - B_c\gamma_5\right]\frac{1-\not{v}}{2}$$

$$H'(v') = \frac{1+\not{v}'}{2}\left[\Psi_c^{*\mu}\gamma_\mu - \eta_c\gamma_5\right]\frac{1-\not{v}'}{2}$$

4-plet

$$\mathcal{M}^\mu(v') = \frac{1+\not{v}'}{2}\left[\chi_{c2}^{\mu\nu}\gamma_\nu + \frac{1}{\sqrt{2}}\chi_{c1,\gamma}\epsilon^{\mu\alpha\beta\gamma}v'_\alpha\gamma_\beta + \frac{1}{\sqrt{3}}\chi_{c0}\left(\gamma^\mu - v'^\mu\right) + h_c^\mu\gamma_5\right]\frac{1-\not{v}'}{2}$$

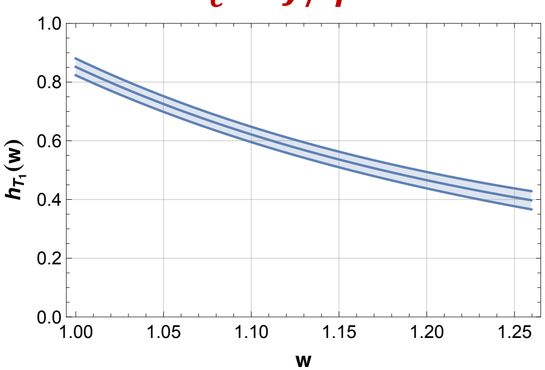
$$\langle M'(v')|\, J_0\, |M(v)\rangle = -\Delta(w)\mathrm{Tr}\left[\bar{H}'(v')\Gamma H(v)\right]$$

↓ heavy quark expansion

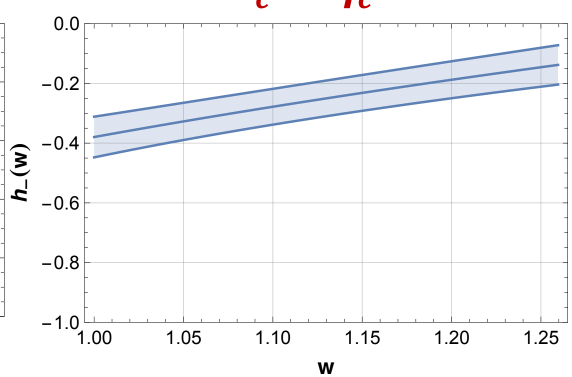
↘ universal function describing the form factors at LO

few results:

$B_c \to J/\psi \ell \bar{\nu}$



$B_c \to \eta_c\, \ell\, \bar{\nu}$



$B_c \to \chi_{cJ}(h_c)\ell\,\bar{\nu}$