From the creators of JHEP12(2019)098 …

THE TOP-QUARK ELECTRO-WEAK COUPLINGS AFTER LHC RUN2

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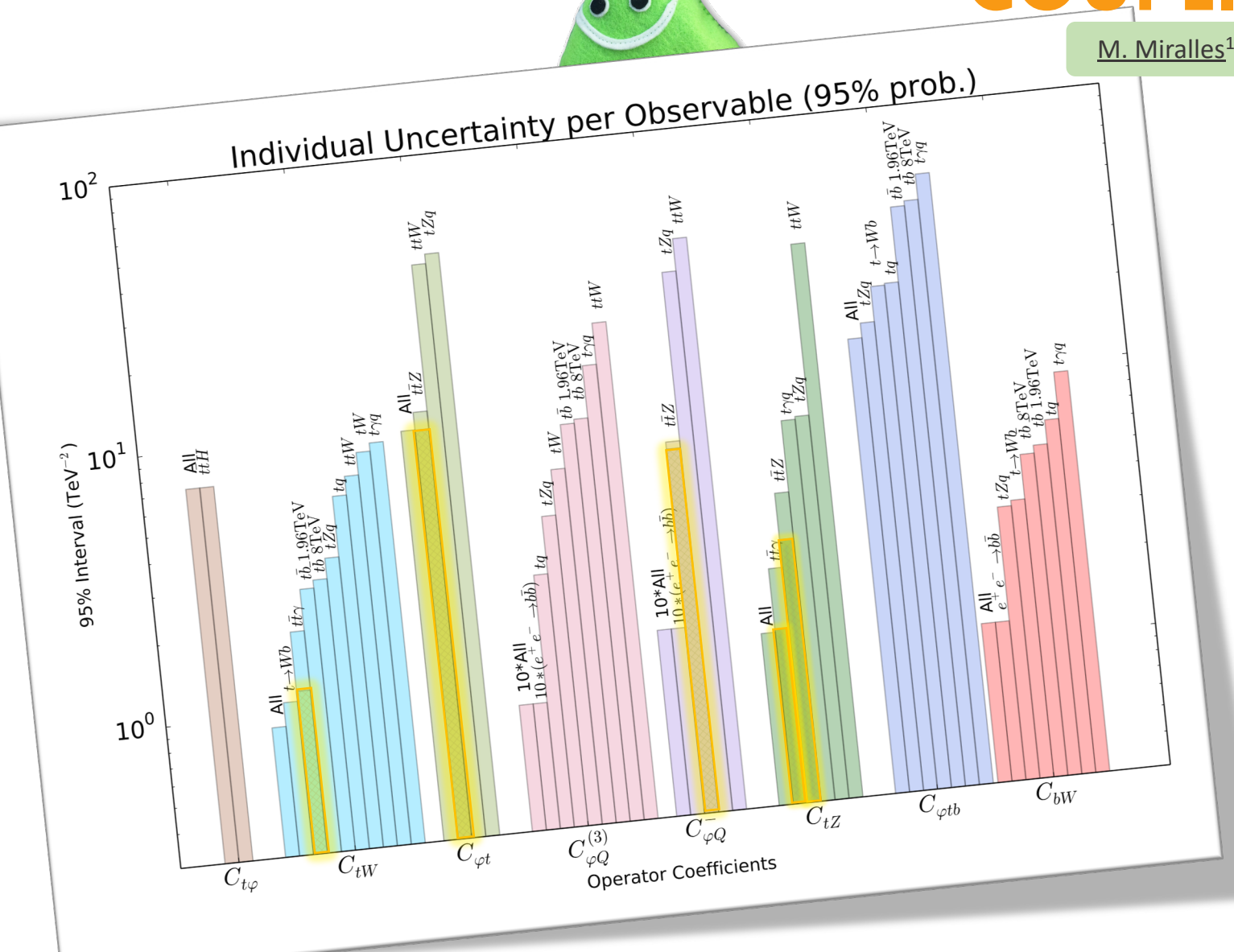


Global fit of the **top electro-weak (EW) couplings** to current available data

For the **very first time** we include

- ☆ **Differential measurements** for $pp \to t\bar{t}Z$ and $pp \to t\bar{t}\gamma$
- ☆ QCD predictions at **NLO**

Yeah!

Including **latest LHC data** we are able to significantly **improve** over previous fits

How do we do all this ?

We adopt an **EFT description** to parametrise the deviations from the SM

$$\mathcal{L}_{EFT} = \mathcal{L}_{SM} + \frac{1}{\Lambda^2}\sum_i C_i O_i + \mathcal{O}(\Lambda^{-4})$$

We show results for **8 D6 operators** in the **Warsaw Basis**

- ☆ Left/Right couplings of top/bottom to Z: $O_{\varphi t}, O_{\varphi Q}^{-}, O_{\varphi Q}^{(3)}$
- ☆ EW dipole operators: O_{tZ}, O_{tW}, O_{bW}
- ☆ Top Yukawa: $O_{t\varphi}$
- ☆ Charged current interaction: $O_{\varphi tb}$

Dependence studied with **MG5_aMC@NLO**[5]

UFO models:

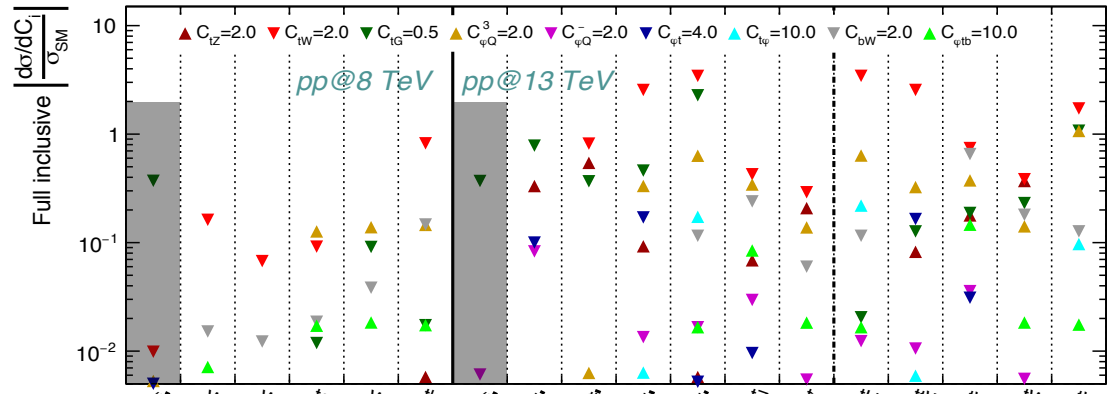
SMEFTatNLO for all except $O_{bW}, O_{\varphi tb}$ with TEFT_EW

*[1][2][3][4]

Process	Observable	$\sqrt{s}$	$\int \mathscr{L}$	Experiment
$pp \to t\bar{t}H$ NLO	cross section	13 TeV	140 fb^{-1}	ATLAS
$pp \to t\bar{t}W$ NLO	cross section	13 TeV	36 fb^{-1}	CMS
$pp \to t\bar{t}Z$ NLO	(differential) x-sec.	13 TeV	140 fb^{-1}	ATLAS
$pp \to t\bar{t}\gamma$ NLO	(differential) x-sec.	13 TeV	140 fb^{-1}	ATLAS
$pp \to tZq$ NLO	cross section	13 TeV	140 fb^{-1}	CMS
$pp \to t\gamma q$ NLO	cross section	13 TeV	36 fb^{-1}	CMS
$pp \to tb$ (s-ch) NLO	cross section	8 TeV	20 fb^{-1}	ATLAS+CMS
$pp \to tW$ LO	cross section	8 TeV	20 fb^{-1}	ATLAS+CMS
$pp \to tq$ (t-ch) NLO	cross section	8 TeV	20 fb^{-1}	ATLAS+CMS
$t \to W^+ b$ LO	F_0, F_L	8 TeV	20 fb^{-1}	ATLAS+CMS
$p\bar{p} \to t\bar{b}$ (s-ch) LO	cross section	1.96 TeV	9.7 fb^{-1}	Tevatron
$e^-e^+ \to b\bar{b}$ LO	R_b , A_{FBLR}^{bb}	$\sim$ 91 GeV	202.1 pb^{-1}	LEP

Two extra operators $O_{bZ}, O_{\varphi b}$ with **LEP/SLD data** that is still very sensitive

Full picture of **observable sensitivity** to inclusive processes



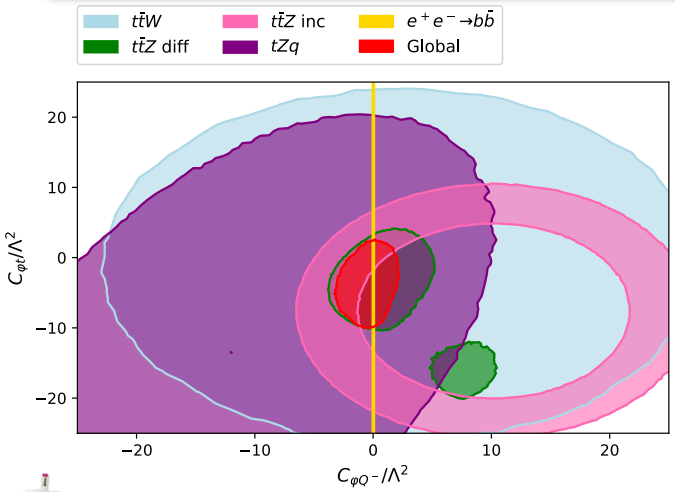
[6]

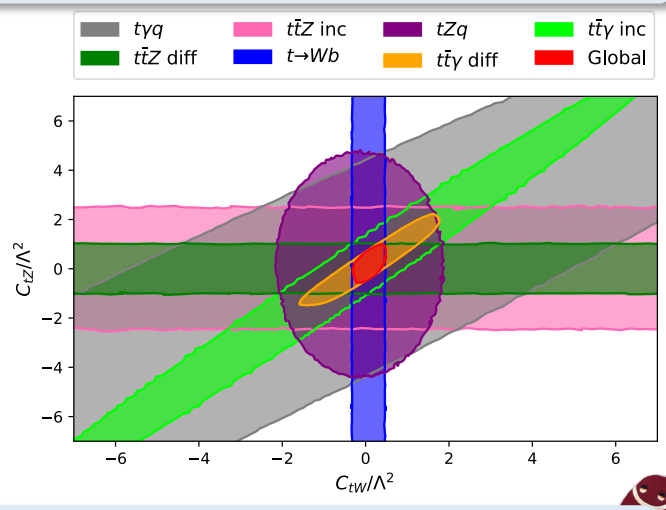
The fit is performed as a **Bayesian statistical analysis** of the model

*[1] ATLAS, [2] CMS, [3] Tevatron, [4] LEP, [5] MG5, [6] HEPfit

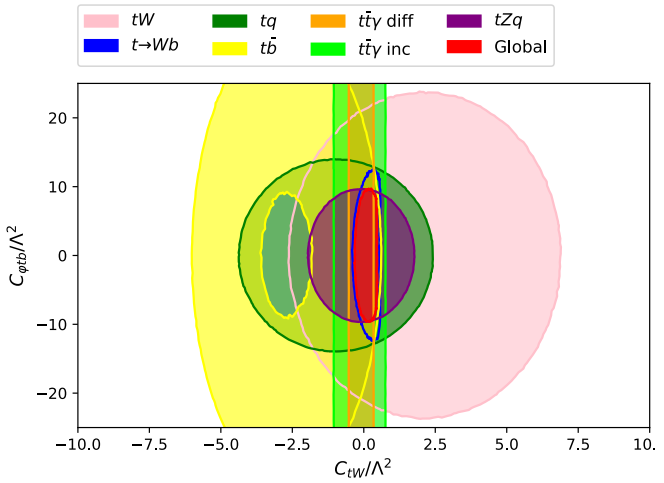
Towards a global fit

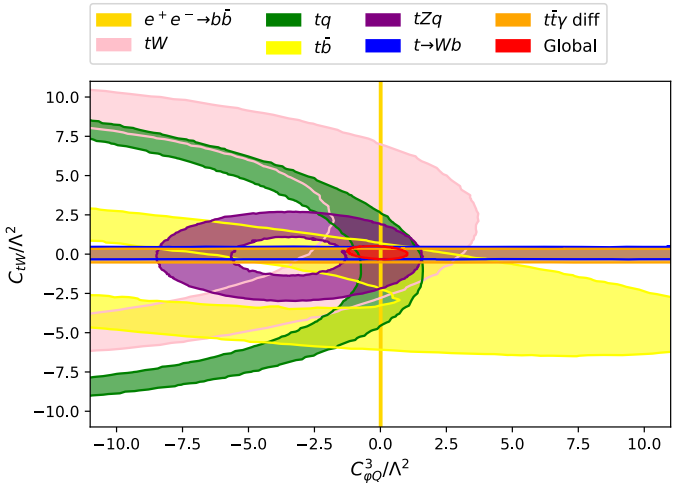
Global fit results, marginalizing over **all other Wilson coefficients** are shown



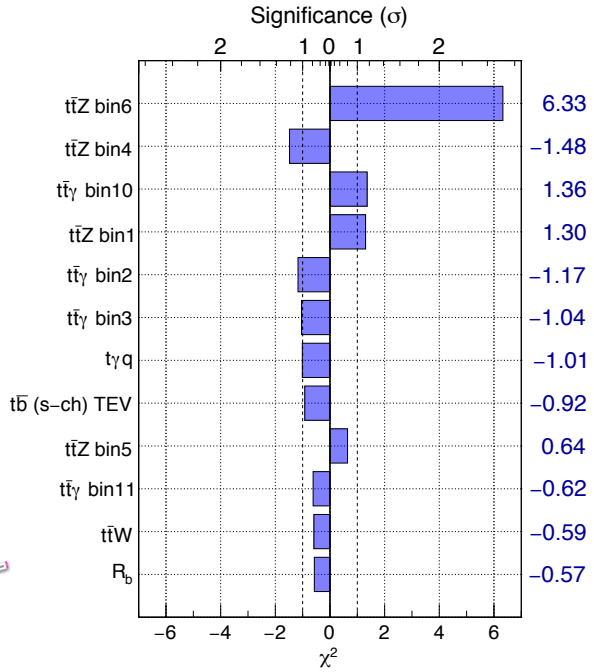


- 2D 95% probability contours showing complementarity between different measurements and the power of differential $t\bar{t}Z$ and $t\bar{t}\gamma$ ones
- Watch out for: LEP in $C_{\varphi Q}^{-}, C_{\varphi Q}^{(3)}$; $t\bar{t}Z$ in $C_{tZ}, C_{\varphi t}$; $t\bar{t}\gamma$ and Whel. in C_{tW}; tZq in $C_{\varphi tb}$





The beloved Standard Model



How well does the SM describe data?

- **SM fit**, including all the observables (30 bins) offers very good agreement with $\chi^2 = 20.7$ (p-value ~0.90)
- Largest contributions from a few $t\bar{t}Z$ and $t\bar{t}\gamma$ differential p_T bins

Bounds of a Global EFT fit

Linear Fit (Λ^{-2}) SM – D6 interference

- $C_{\varphi t}, C_{\varphi Q}^{-}, C_{\varphi Q}^{(3)}, C_{tZ}, C_{tW}, C_{t\varphi}, (C_{\varphi b})$

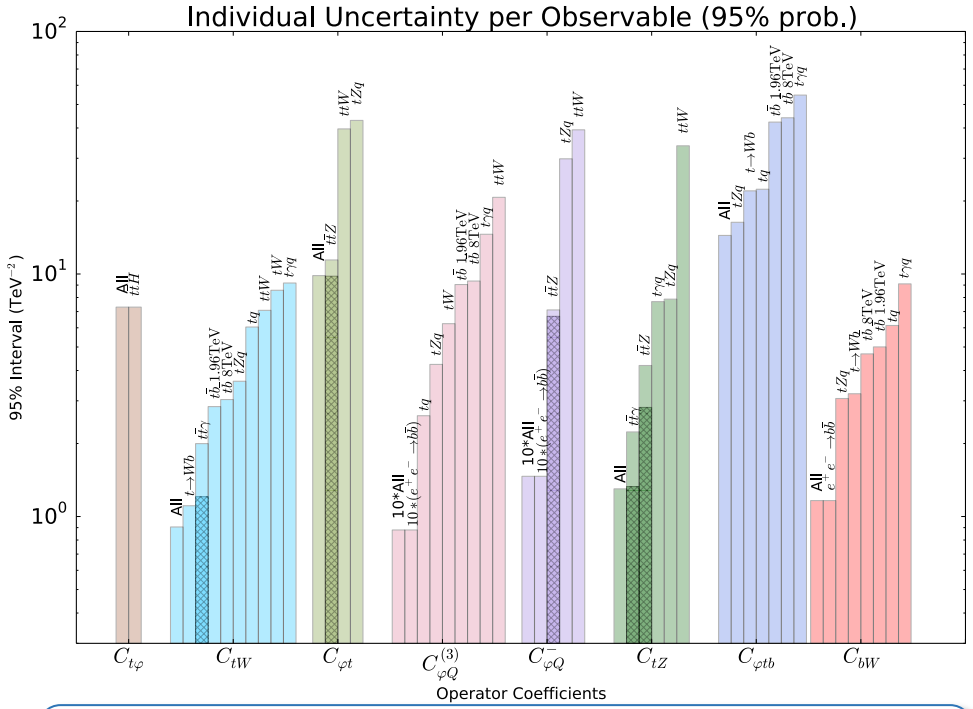
Linear + Quadratic Fit ($\Lambda^{-2}+\Lambda^{-4}$) SM – D6 + D6 – D6 interf.

- $\ldots, C_{\varphi tb}, C_{bW}, (C_{bZ})$

In both fits, published correlations between differential p_T bins, LEP observables and W helicity fractions have been included

Fit	$\chi^2/d.o.f.$	p-value
SM	20.7/29	0.87
EFT Lin.	17.2/22	0.75
EFT Quad.	19.2/19	0.44

Final Global fit bounds



Differential measurements are indicated as darker bars

Robustness of the fit:

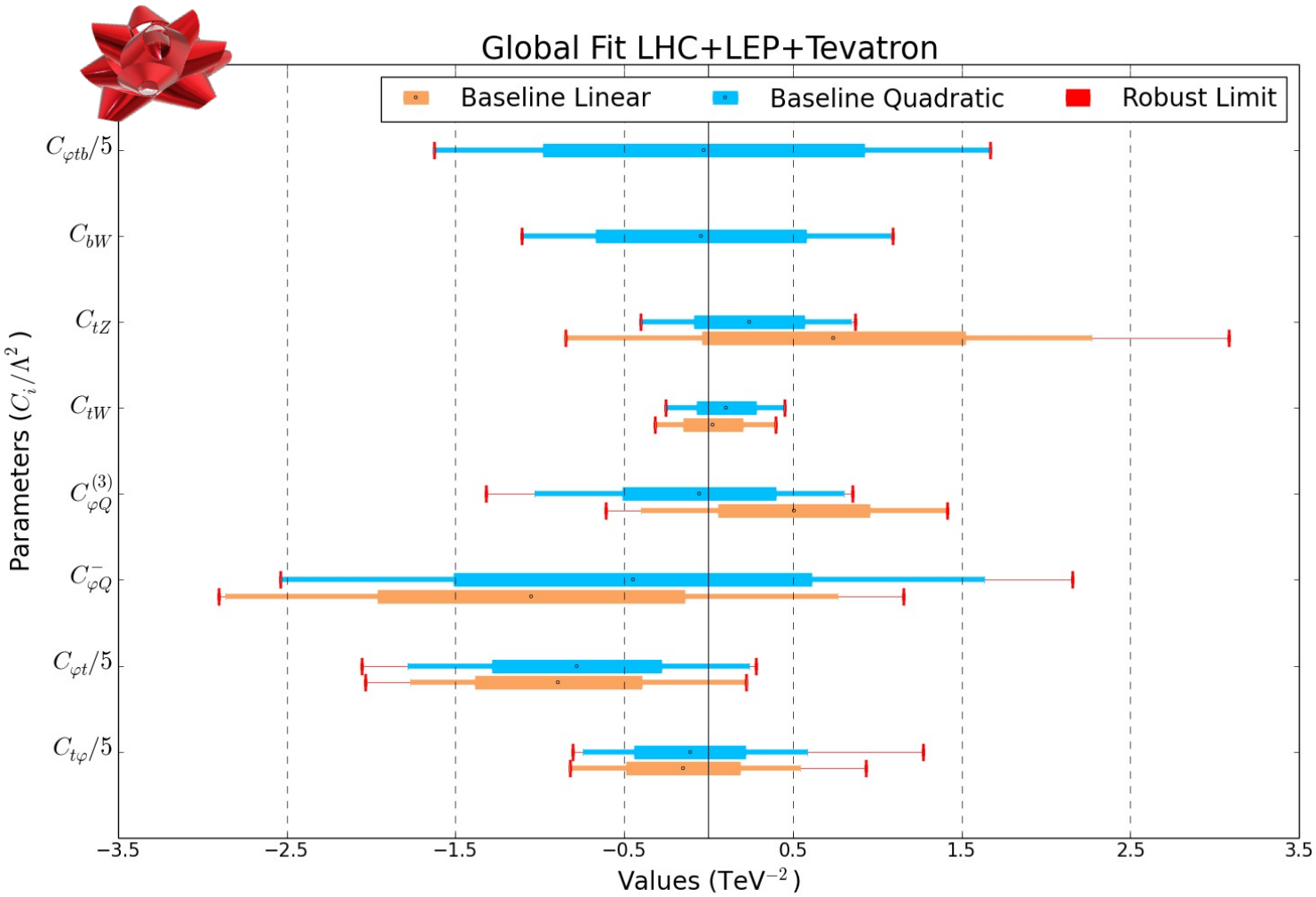
- ☆ Effect of two additional 4-fermion op. O_{tu}^{8} and O_{td}^{8}
- ☆ MC theory scale uncertainties in EFT parametrisations
- ☆ Correlations between different observables (ansatz of non-published correlations has been estimated)

An envelope with the effect of the above on the fit is shown as the Robust Limit

We are able to present a **significant improvement** on all Wilson coefficients

- ☆ **Differential measurements** improve C_{tZ} limits by a factor 2
- ☆ More **consistent** central values with SM
- ☆ **LEP data** is still very competitive and generates some of best constraints
- ☆ Compatibility with 0 within 2σ and 95% prob. bounds ± 0.4 to ± 8 TeV^{-2}

Linear, Λ^{-2} terms (SM – D6 interf.) | Quadratic, $\Lambda^{-2} + \Lambda^{-4}$ terms (D6 – D6 interf.)



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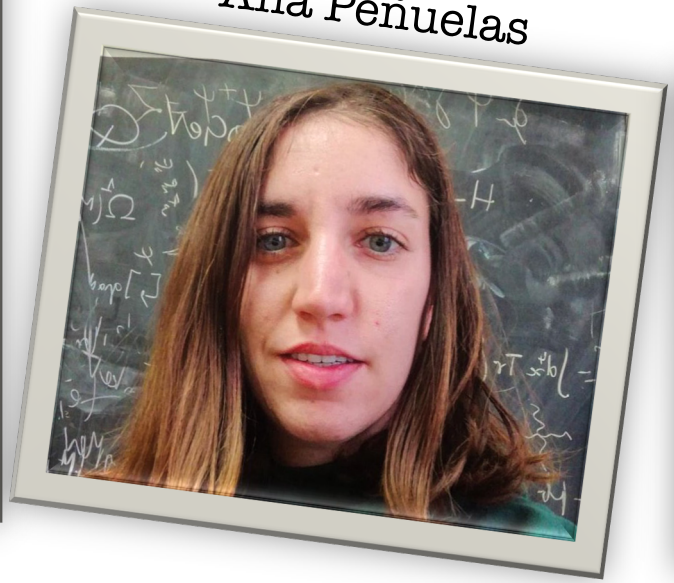

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THANKS FOR THE ATTENTION!

Me