Citius, altius, fortius

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Where can HL-LHC bring additional precision?

Spoiler: at LHC we are often dominated by systematics. More statistics often do not help.

Possible improvements, where?

- Go to rare processes. Example: $t \to c\,H, H \to \gamma\gamma$

→ well explored, ask María & María

- Go fully differential, ex. $t \to W\,b \to l\,\nu\,b$ 4-D distribution

→ under construction, seen in Carlos Escobar talk

- Go to high Q

→ I'll outline some proposals

The effect of non-standard interactions of dimension higher than 4 grows with energy `Q´

∂_ν in $\sigma^{\mu\nu}$ terms, no propagator in 4-fermion terms…

On the other hand, SM cross sections decrease with Q.

And PDFs decrease with Q.

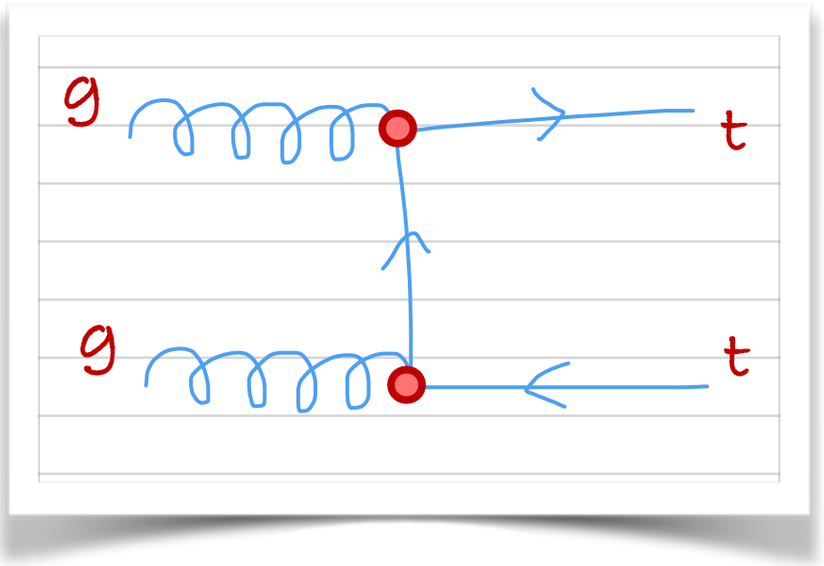
Overall, going to high Q enhances the potential effect of non-standard interactions. There is a balance between this enhancement and the larger uncertainties (systematic & statistical)

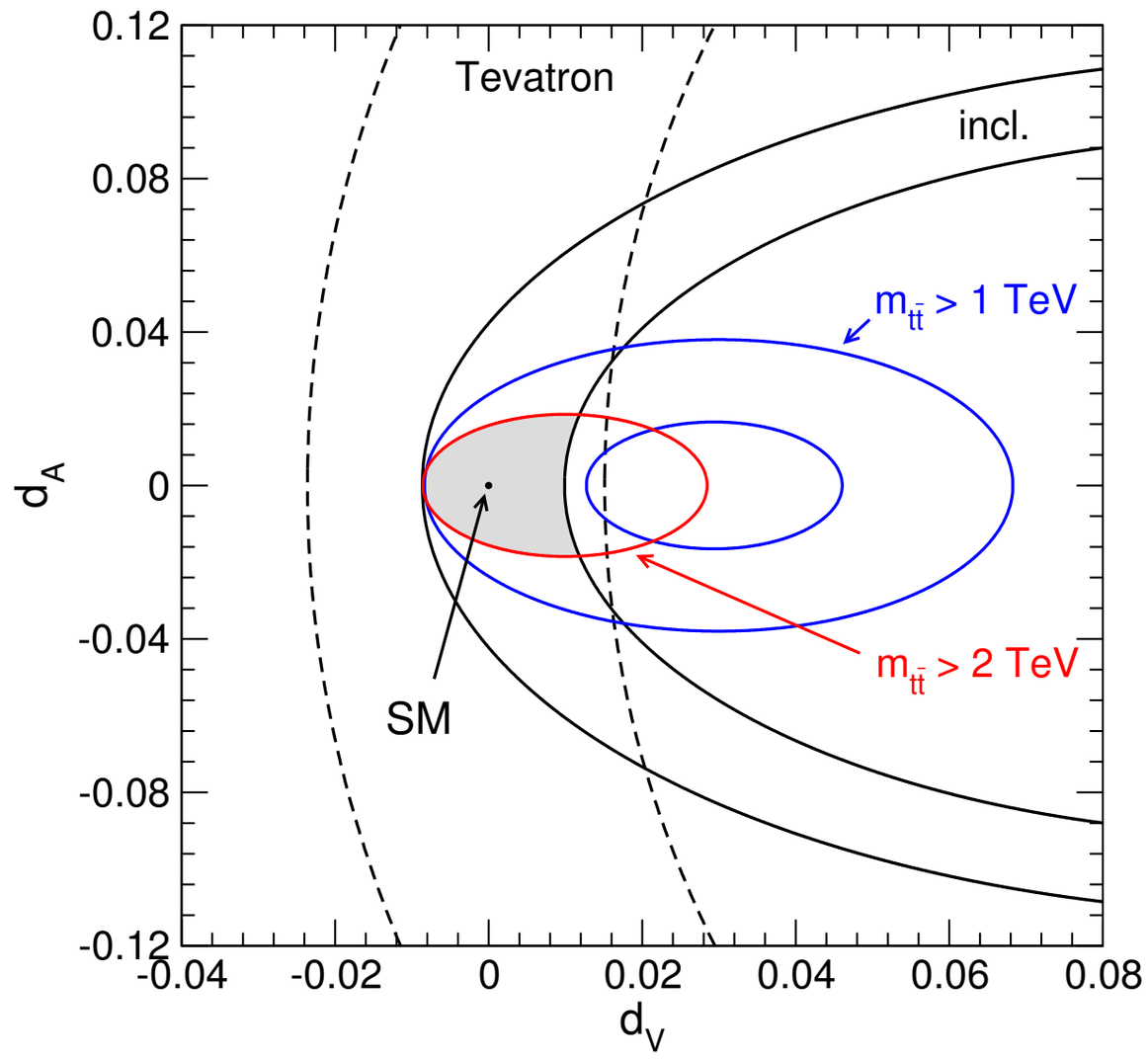
Example 1

pp → *tt* with top chromoelectric / chromomagnetic dipole moments

JAAS, Fuks, Mangano 1412.6654

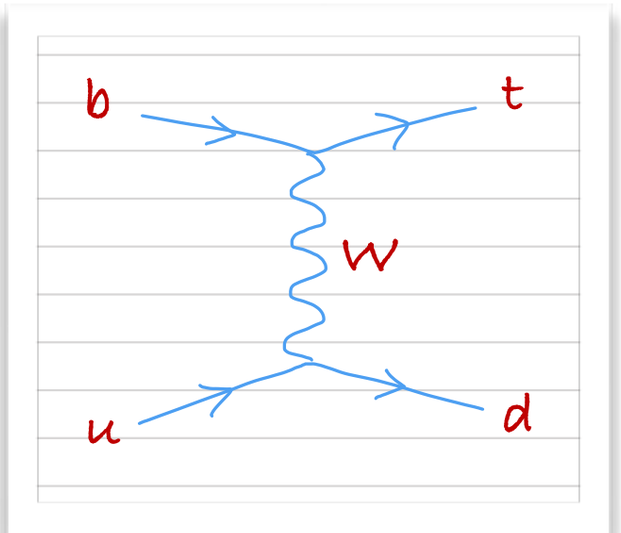
$$\mathcal{L}_{\rm tg} = -g_s \bar{t}\gamma^\mu \frac{\lambda_a}{2} t\, G^a_\mu + \frac{g_s}{m_t}\bar{t}\sigma^{\mu\nu}(d_V + i d_A \gamma_5)\frac{\lambda_a}{2} t\, G^a_{\mu\nu}$$

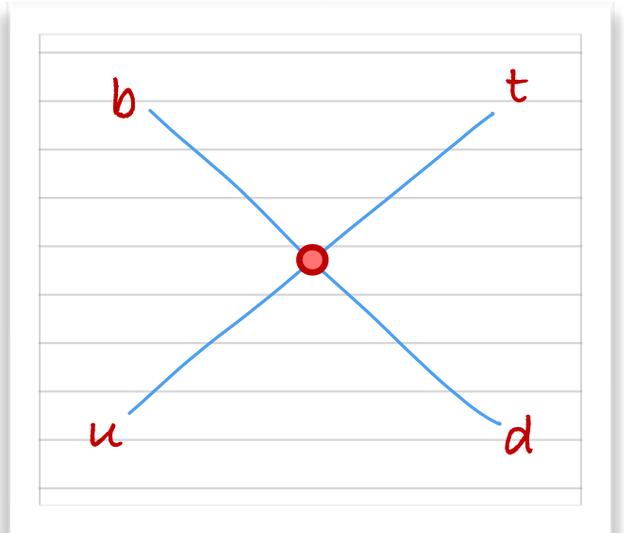




Example II

t-channel single top production with four-fermion operators

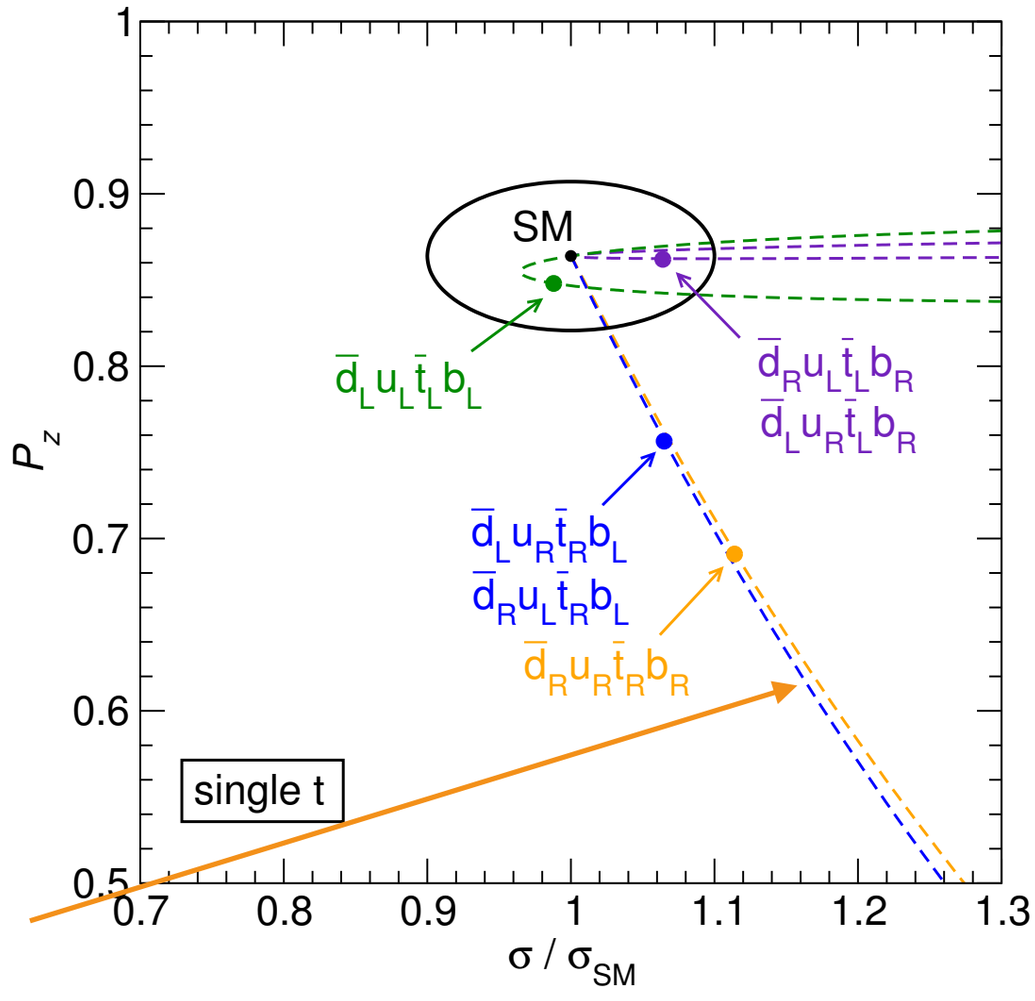




$$\sigma = A_0 + A_{\rm int}\,\frac{C}{\Lambda^2} + A_2\left(\frac{C}{\Lambda^2}\right)^2$$

$$P_z = \left[B_0 + B_{\rm int}\,\frac{C}{\Lambda^2} + B_2\left(\frac{C}{\Lambda^2}\right)^2\right]/\sigma$$

JAAS, Degrande, Khatibi 1701.05900



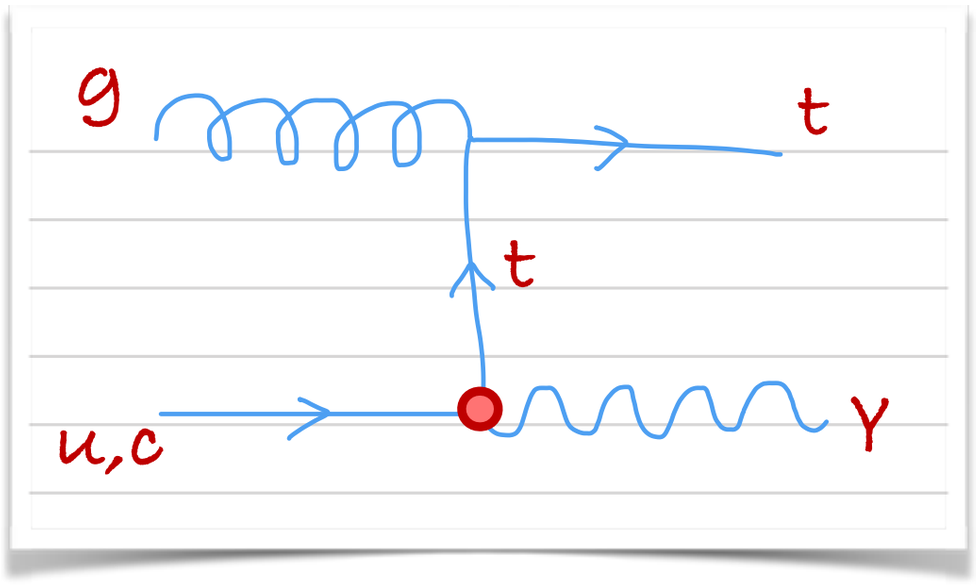
- Inclusive: $A_2/A_0 = 0.11\ \text{TeV}^4$, $B_2/B_0 = -0.11\ \text{TeV}^4$
- p_T (top) > 200 GeV: $A_2/A_0 = 2.1\ \text{TeV}^4$, $B_2/B_0 = -2.6\ \text{TeV}^4$

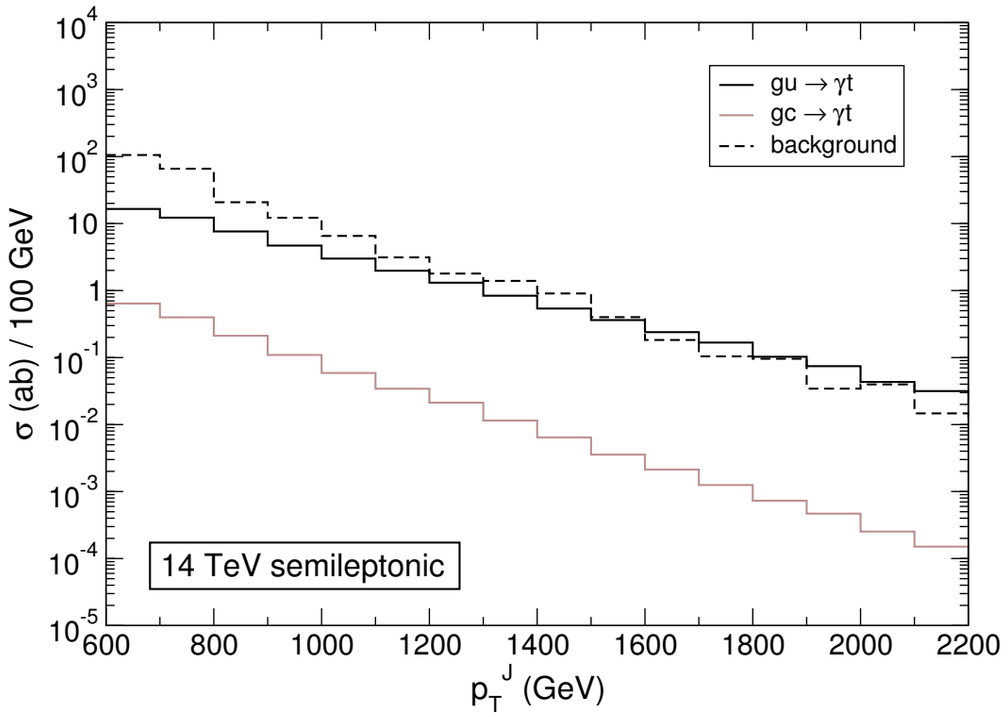
Example III

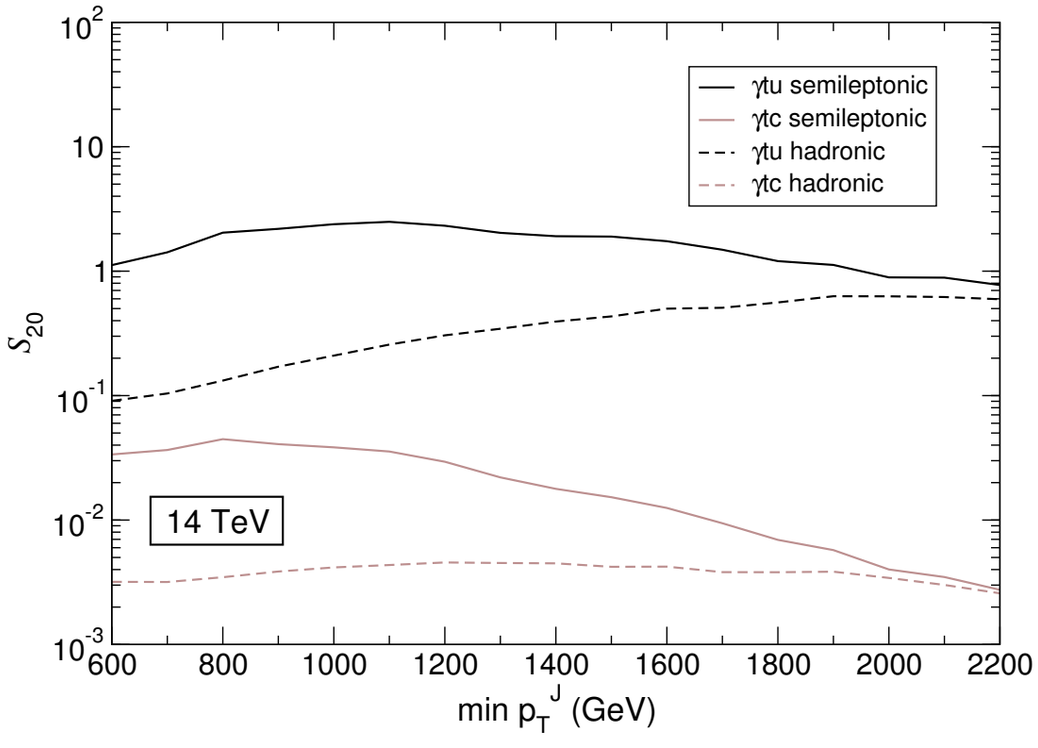
Single γ*t* (or *Zt*) FCNC top production

JAAS, 1709.03975

$$\mathcal{L}_{\gamma t} = -e\bar{q}\,\frac{i\sigma^{\mu\nu}q_\nu}{m_t}\left(\lambda^L_{qt}P_L + \lambda^R_{qt}P_R\right)t\,A_\mu + +\text{H.c.}$$







It is well established

— though we still don't have measurements —

that anomalous interactions from dim-6 operators are better probed at high Q, despite drawbacks:

- larger systematics
- smaller statistics
- non-resolved objects (tops, *Z*/*W* bosons, …)

Effective field theory remains consistent: Λ probed is larger than the scales involved.

Open to suggestions!