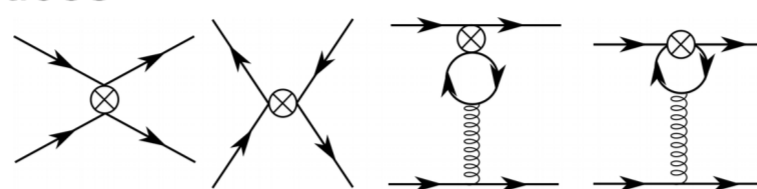


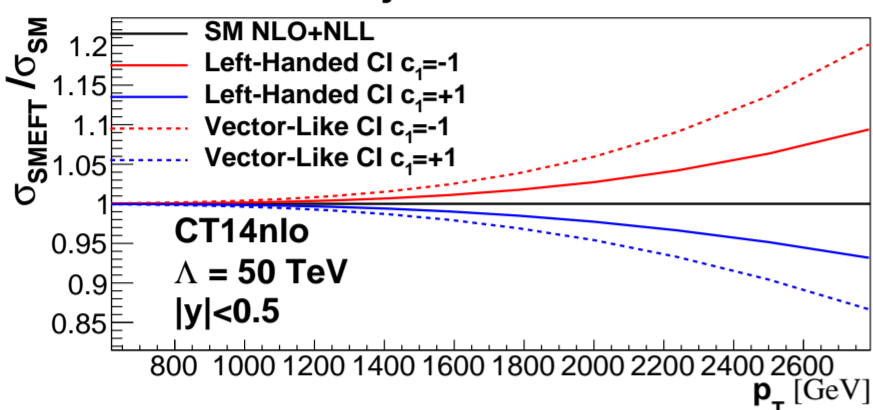
## Inclusive jet production in pp collisions

- The most fundamental process for studying the SM: possible to improve precision of proton structure and extract QCD parameters
- Probe new physics: 4-quark Contact interactions (CI)** extend the SM with effective operators allowing 4-quark vertices

$$\mathcal{L}_{\text{SMEFT}} = \mathcal{L}_{\text{SM}} + \frac{4\pi}{2\Lambda^2} \sum_n c_n O_n$$



- The CI are expected to appear as deviations from the SM jet cross-section



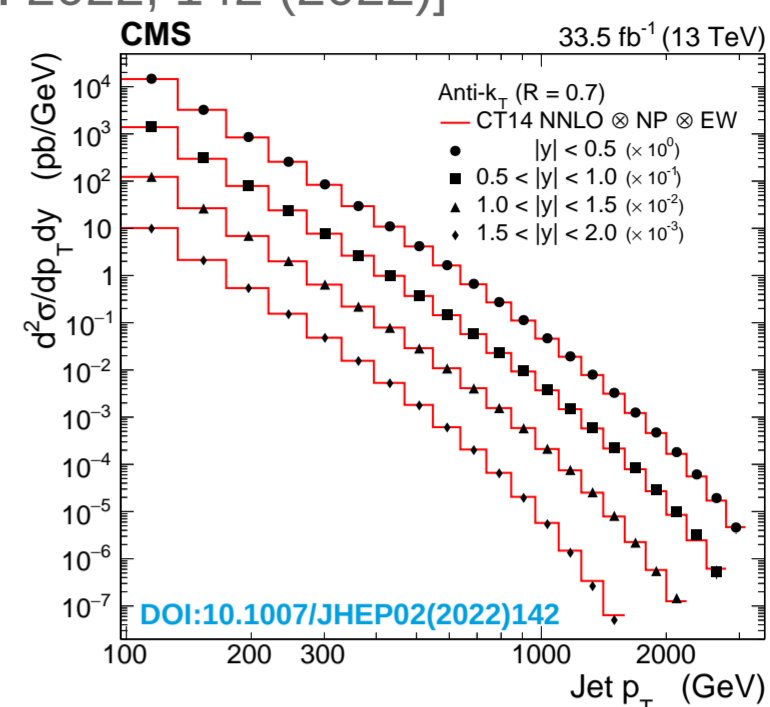
### CIJET: CI @ NLO

Operators relevant for quark substructure, Z' or extra dimension models

Type of CI	$c_1$	$c_3$	$c_5$
Purely left-handed:	free	0	0
Vector-like:	free	$2c_1$	$c_1$
Axial-vector-like:	free	$-2c_1$	$c_1$

## CMS Data in QCD analysis

CMS 13 TeV inclusive jet cross section [JHEP. 2022, 142 (2022)]

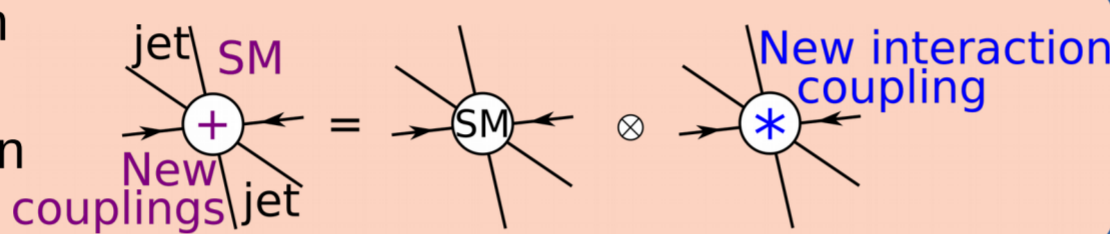


CMS 13 TeV triple-differential  $t\bar{t}$  cross-section [EPJC 80 (2020), no. 7, 658]

HERA inclusive Deep Inelastic Scattering in  $e^\pm p$  (Neutral and Charged Current cross-sections) [EPJC 75 (2015), no. 12, 580]

QCD analysis platform <https://www.xfitter.org/xFitter>

**The problem:** The SM prediction is based on PDFs obtained from data in the same kinematic region where CI are searched

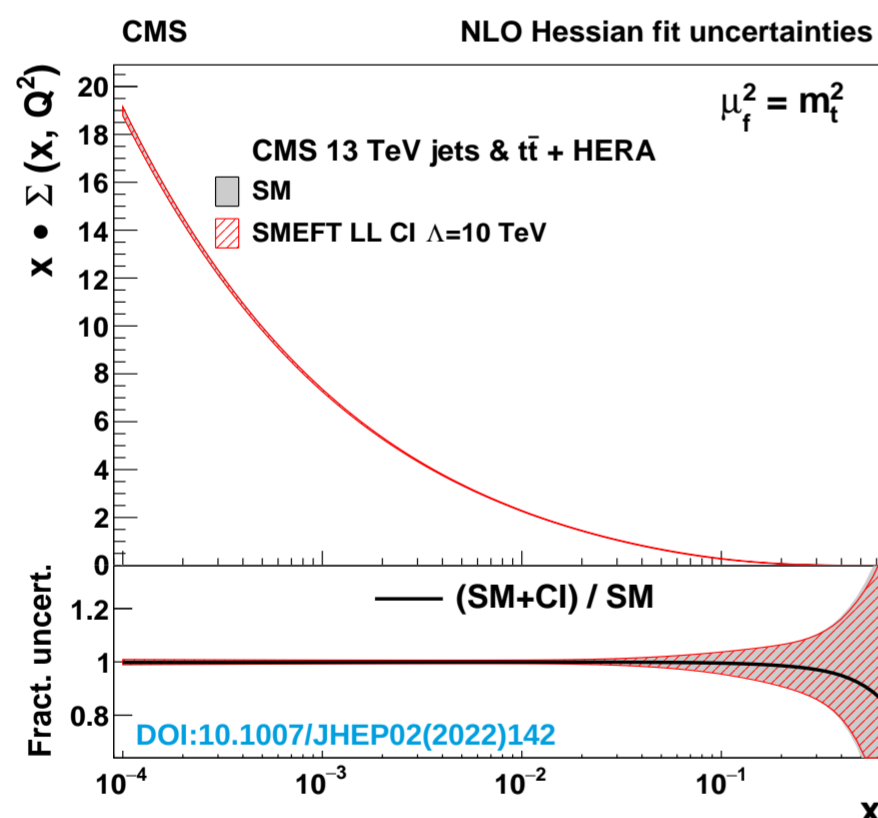


## SMEFT analysis strategy for a non-biased search

- Fit the CI Wilson coefficient  $c_1$ , PDFs, strong coupling  $\alpha_S$  and top mass  $m_t$  simultaneously in an analysis at NLO
- Use SM or, alternatively, SM+CI theory predictions. Results:

$$\alpha_S(m_Z) = 0.1188 \pm 0.0017(\text{fit}) \pm 0.0004(\text{model}) \pm 0.0025(\text{scale}) \pm 0.0001(\text{param})$$

$$m_t^{\text{pole}} = 170.4 \pm 0.6(\text{fit}) \pm 0.1(\text{model}) \pm 0.1(\text{scale}) \pm 0.1(\text{param}) \text{ GeV}$$

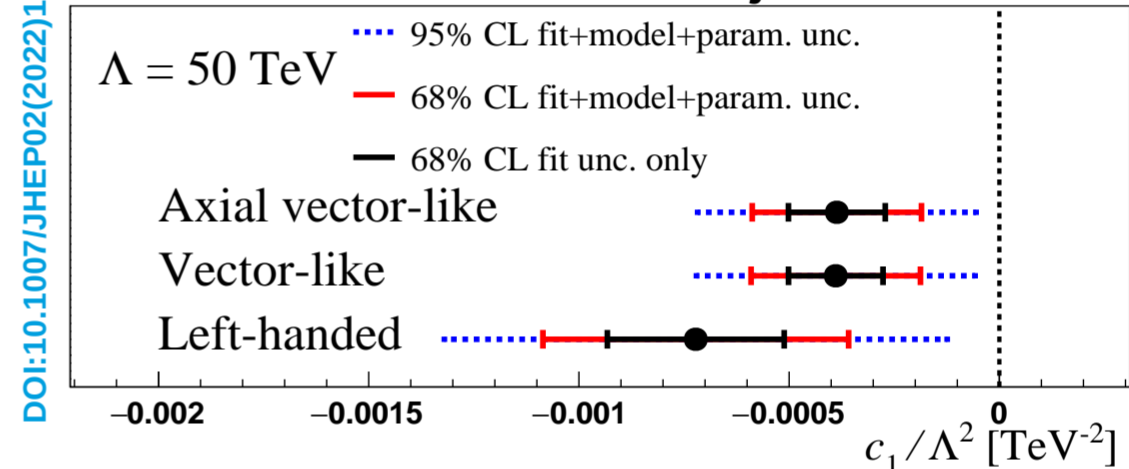


The SM and SMEFT fit results agree; differences are within fit uncertainties

→ **No risk of absorbing BSM effects in the PDF fit**

For the first time, CI limits are obtained in a non-biased way, using CMS inclusive jet cross-section data

## CMS SMEFT NLO 13 TeV jets & $t\bar{t}$ + HERA



The fits favor a constructive interference with the SM gluon exchange, but no significant deviation from the SM is observed

Conventional studies scan for  $\Lambda$ , fixing Wilson coefficient to  $\pm 1$ .

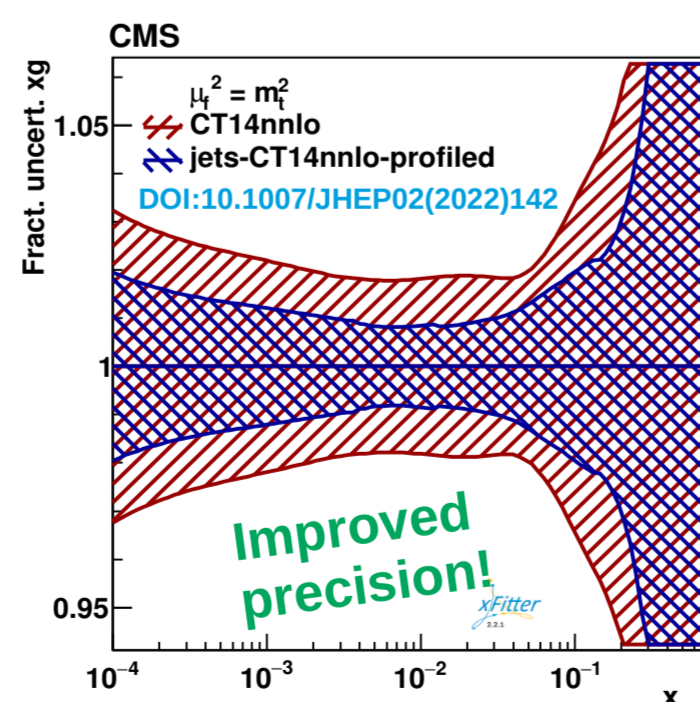
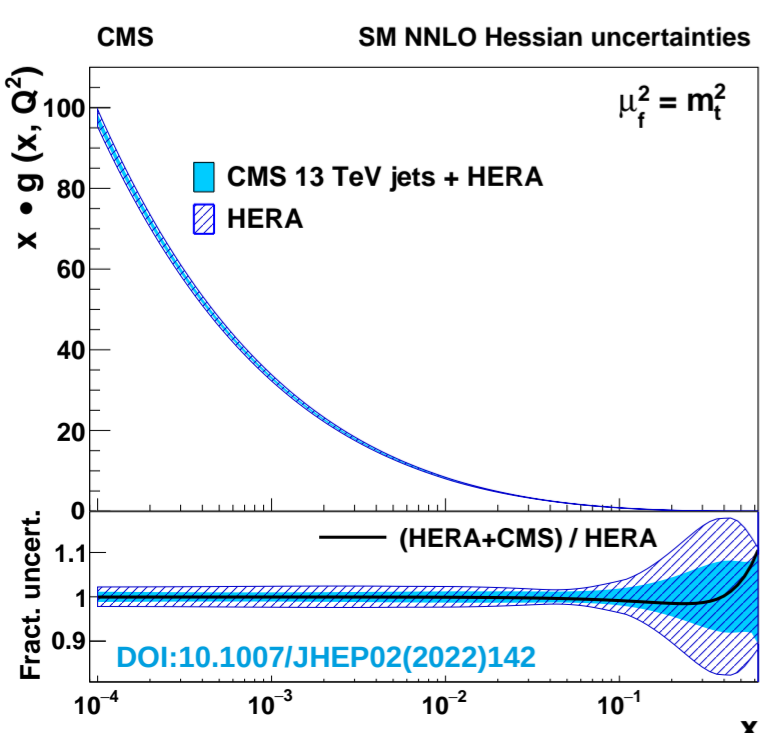
The fit results are translated into unbiased 95% CL exclusion limits on  $\Lambda$  for the CI models with  $c_1 = -1$ :

**Left handed** 24 TeV  
**Vector-like** 32 TeV  
**Axial vector-like** 31 TeV

Most stringent comparable result from ATLAS [arXiv:1703.09127]

## Impact on PDFs

- Impact in a global PDF assessed through a **profiling** procedure
- Profiling performed with CT14 at NLO and NNLO



- Combined fit of PDF,  $\alpha_S$  and  $m_t$  based on HERA DIS data
- Improved precision and removed correlations when including CMS data

## QCD analysis at NNLO

- NNLO predictions for the jet cross sections are obtained using k-factors, computed with CT14nnlo PDF

- $\alpha_S(m_Z)$  extracted simultaneously with the PDFs
- $$\alpha_S(m_Z) = 0.1170 \pm 0.0014(\text{fit}) \pm 0.0007(\text{model}) \pm 0.0008(\text{scale}) \pm 0.0001(\text{param.}).$$

- The most precise single measurement

