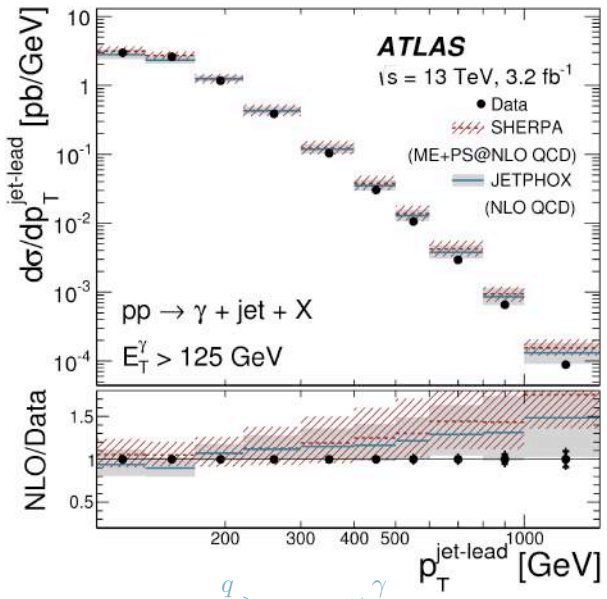
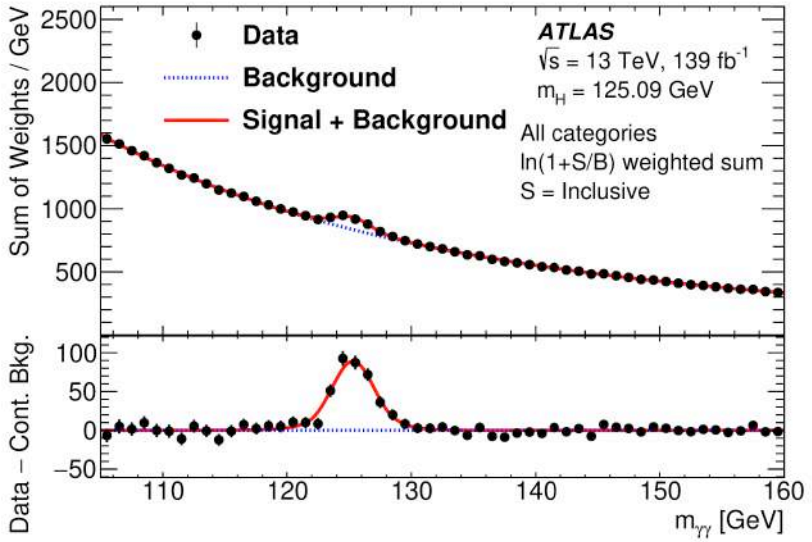
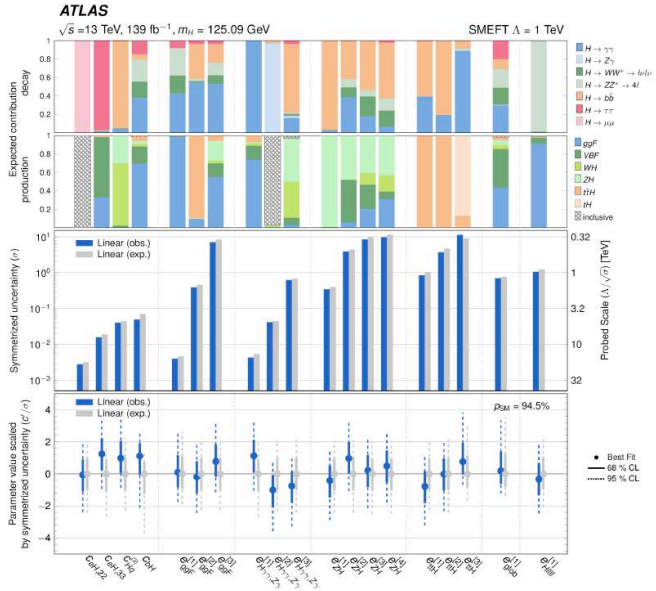
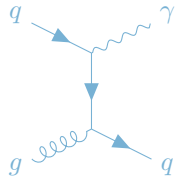
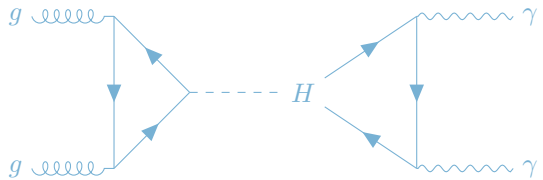
Photons, photons and what else?

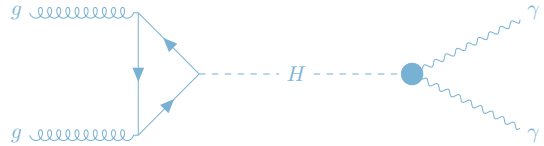










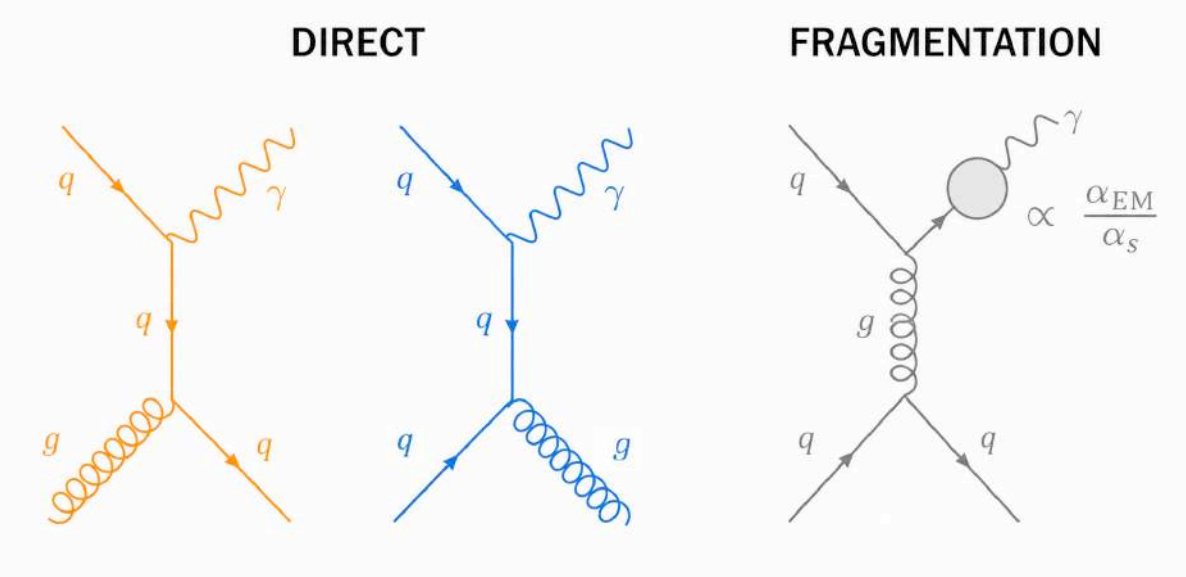


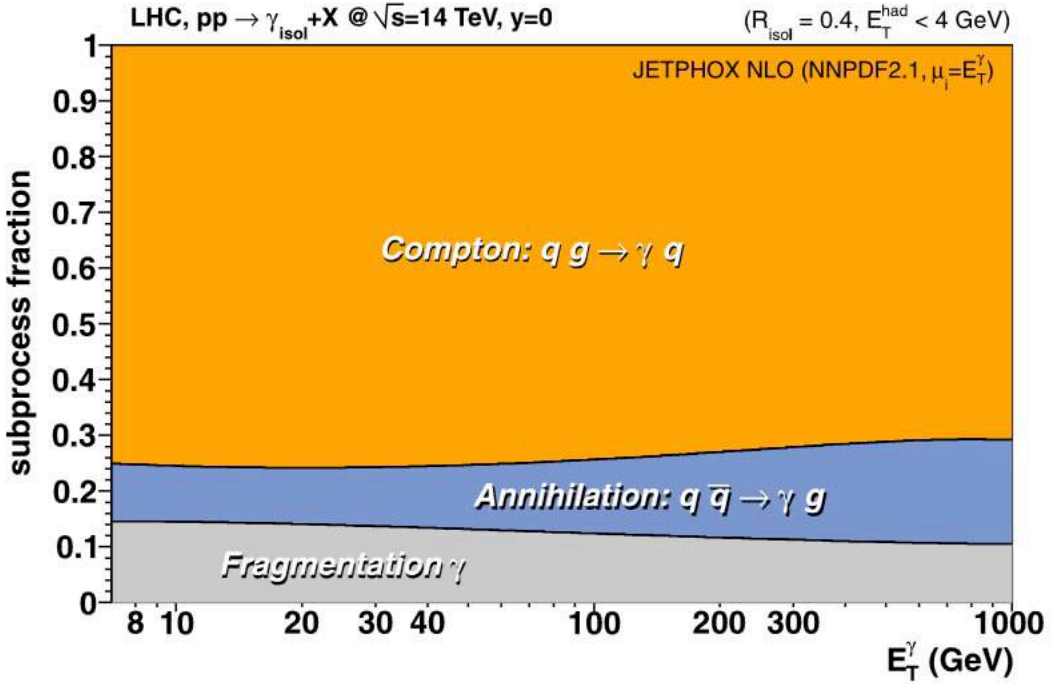
Ana Cueto
(DIS 2026)

European Research Council
Established by the European Commission

Funded by
the European Union

Photon production at the LHC





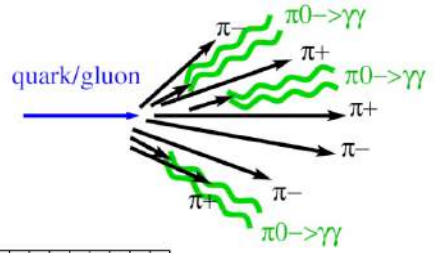
[Nucl.Phys. B860(2012) 311-338]

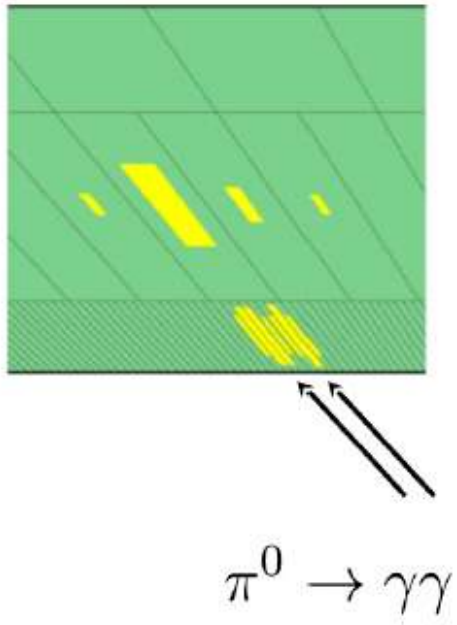
- Test of pQCD with a clean signature
- Sensitivity to gluon PDF
- Background of relevant processes
- Relevant for jet calibration

Challenges at the LHC

EXPERIMENT

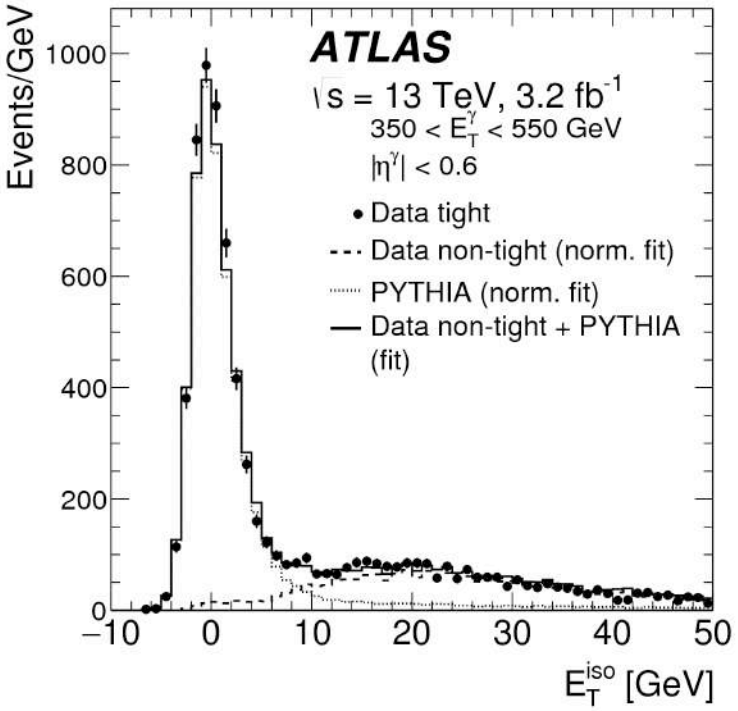
- Photons copiously produced inside jets

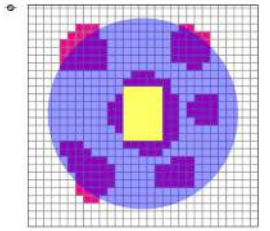




$$\Delta E = E^{S_1}_{\text{max},2} - E^{S_1}_{\text{min}}$$

$$E_{\text{ratio}} = \frac{E^{S_1}_{\text{max},1} - E^{S_1}_{\text{max},2}}{E^{S_1}_{\text{max},1} + E^{S_1}_{\text{max},2}}$$





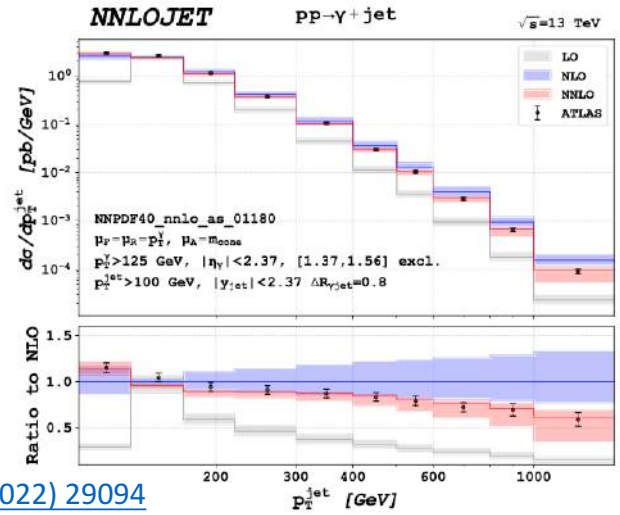
Eur. Phys. J. C 79 (2019) 639

- Discrimination based on shapes of the energy deposits in the EM calorimeters
- Isolation in a cone

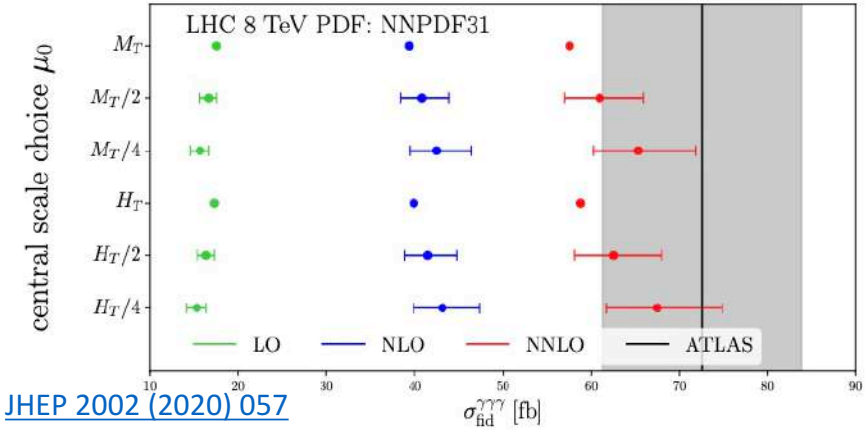
Challenges at the LHC

THEORY

- New channels opening up at higher orders



JHEP 08 (2022) 29094

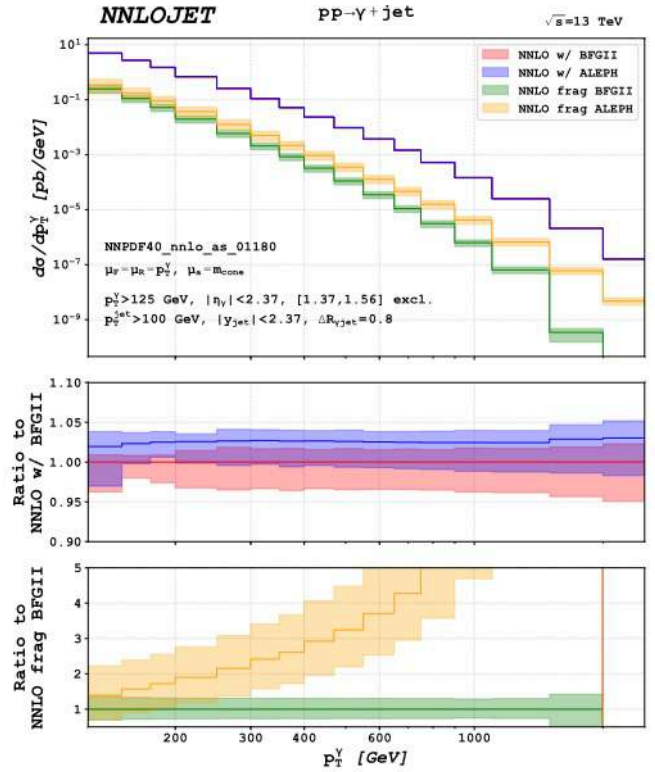


JHEP 2002 (2020) 057

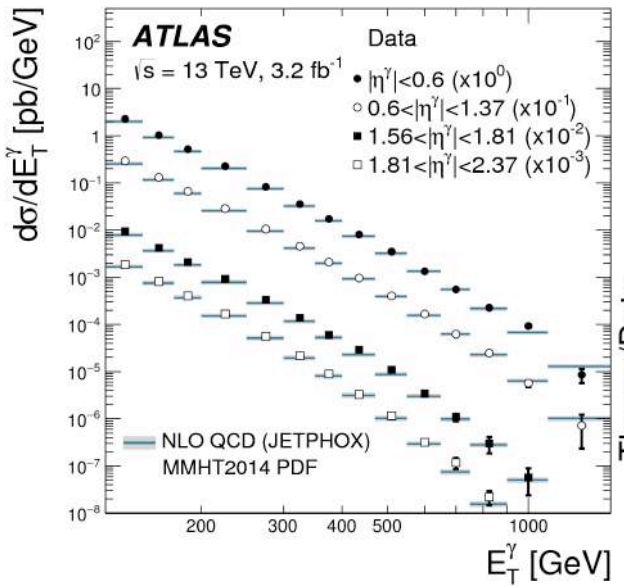
More dramatic as we increase the number of final-state photons

- Cone isolation leaves space for photon fragmentation

$D_a^{\gamma}(z, M^2)$ fulfils the inhomogeneus DGLAP equations with boundary conditions of evolution that need to be extracted from data

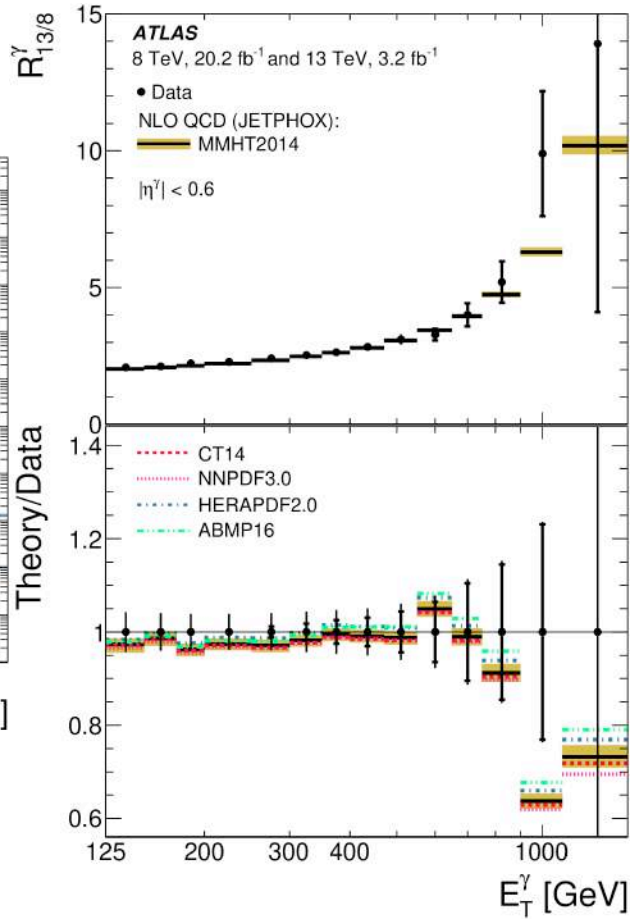


Some results



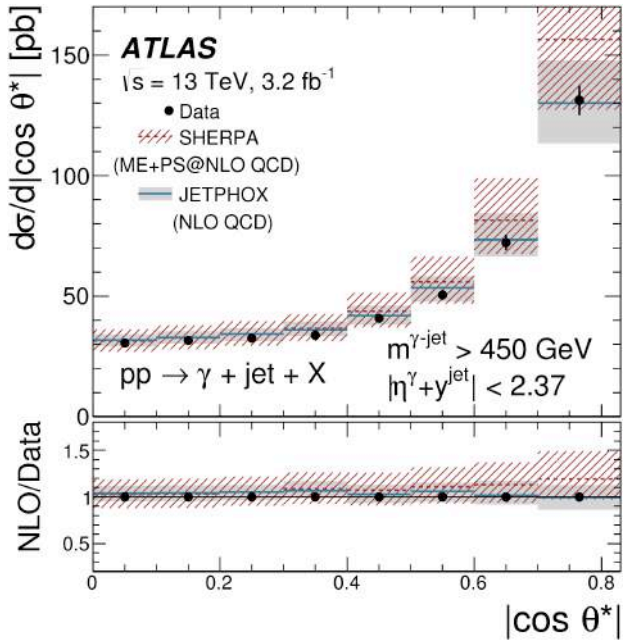
Inclusive photon

[Phys. Lett. B 770 (2017) 473]



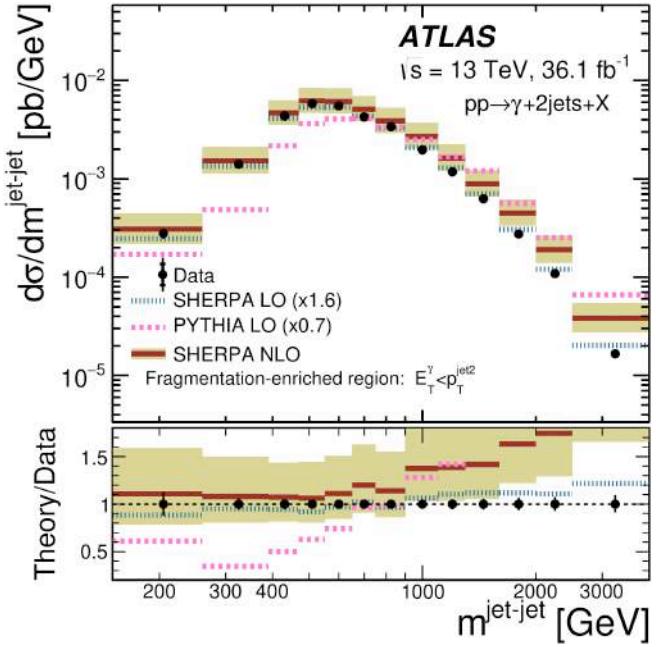
Cross-section ratios

[JHEP 04 (2019) 093]



Photon + jet

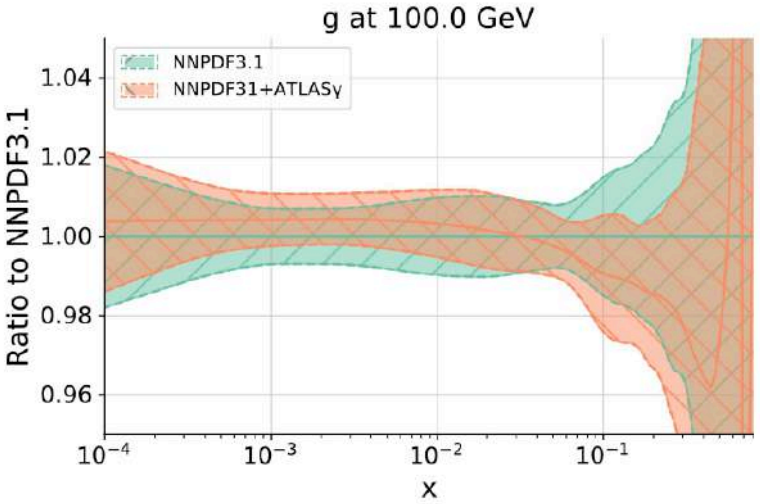
[Phys. Lett. B 780 (2018) 578,]

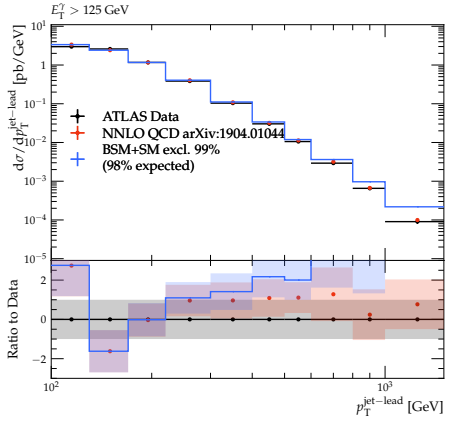


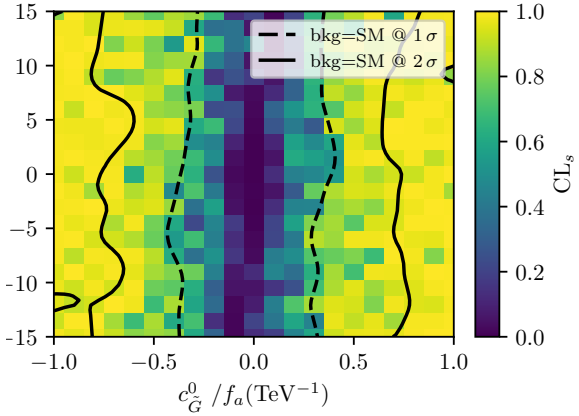
Photon + dijet

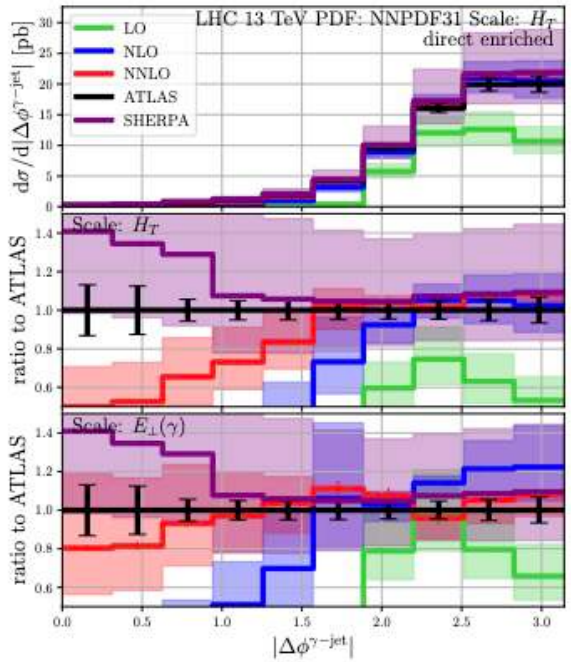
[JHEP 03 (2020) 179]

Some lessons from the LHC









- Moderate impact on gluon PDF

[Eur. Phys. J. C, 78 6 (2018) 470]

with data from

[Phys. Lett. B 770 (2017) 473]

- Sensitivity to effective axion couplings

[arXiv:2508.21660]

with data from

[Phys. Lett. B 780 (2018) 578], [JHEP 03 (2020) 179]

- Relevance of pQCD corrections

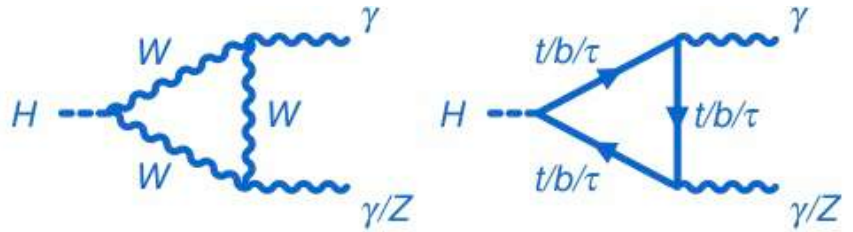
[JHEP 10 (2023) 071]

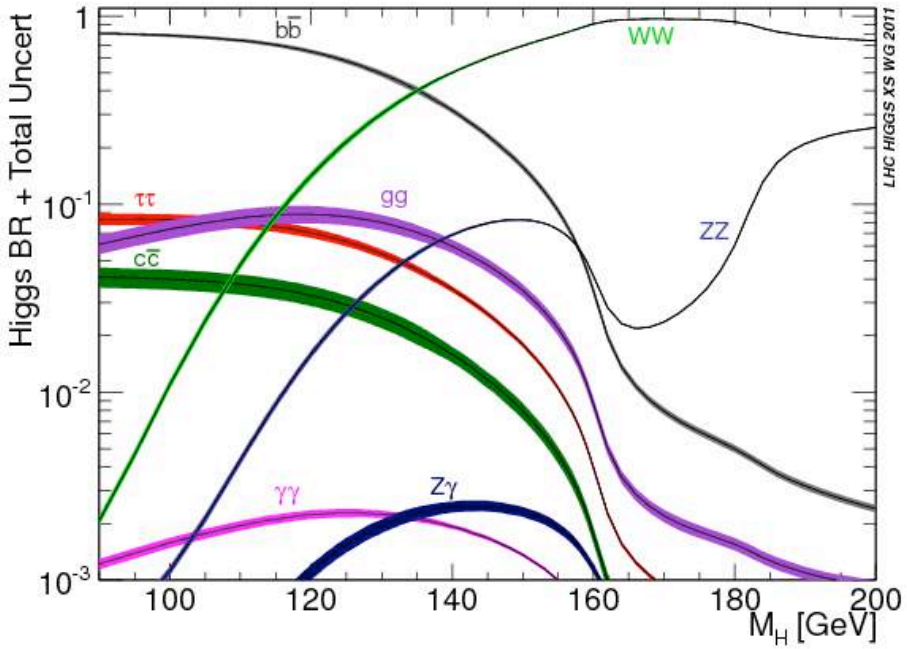
with data from

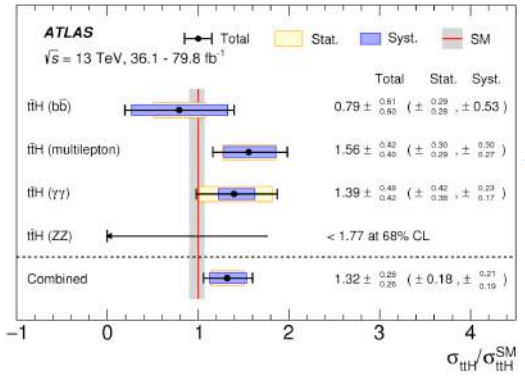
[JHEP 03 (2020) 179]

Photons from Higgs decays

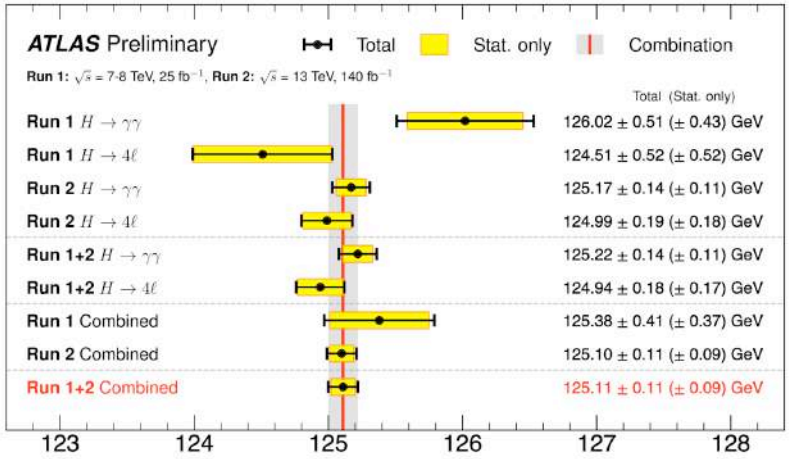
- A loop-induced process with a very small branching ratio







Phys. Lett. B 784 (2018) 173



Phys. Rev. Lett. 131 (2023) 251802

- But stable final-state particles with a clean experimental signature

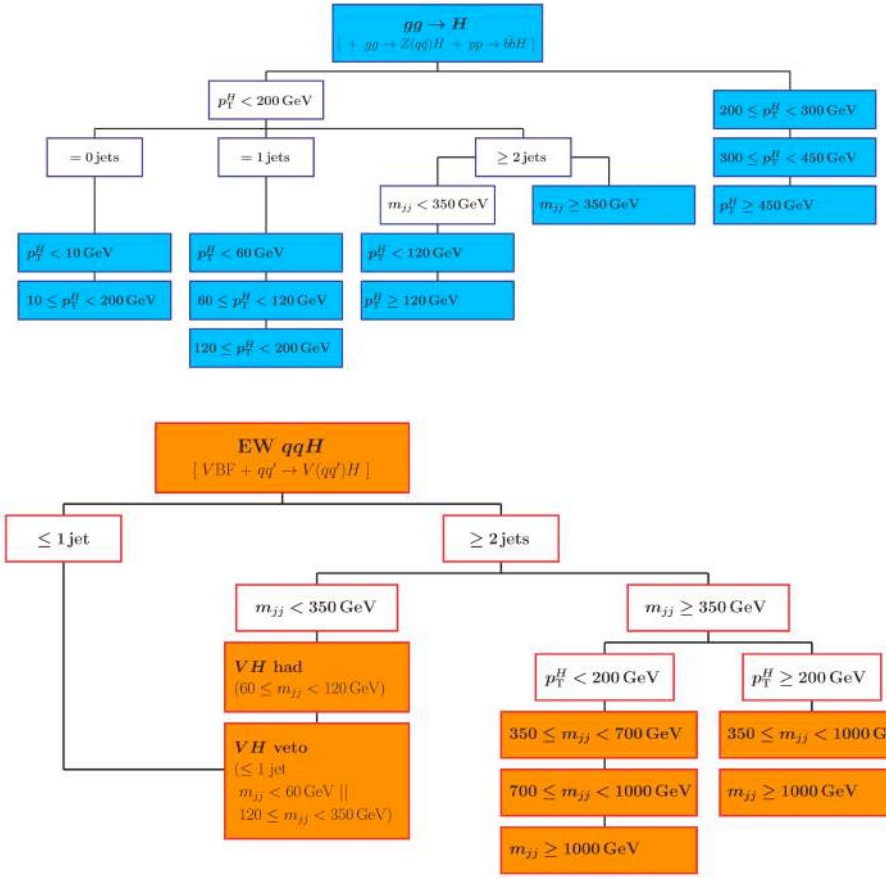
Higgs couplings

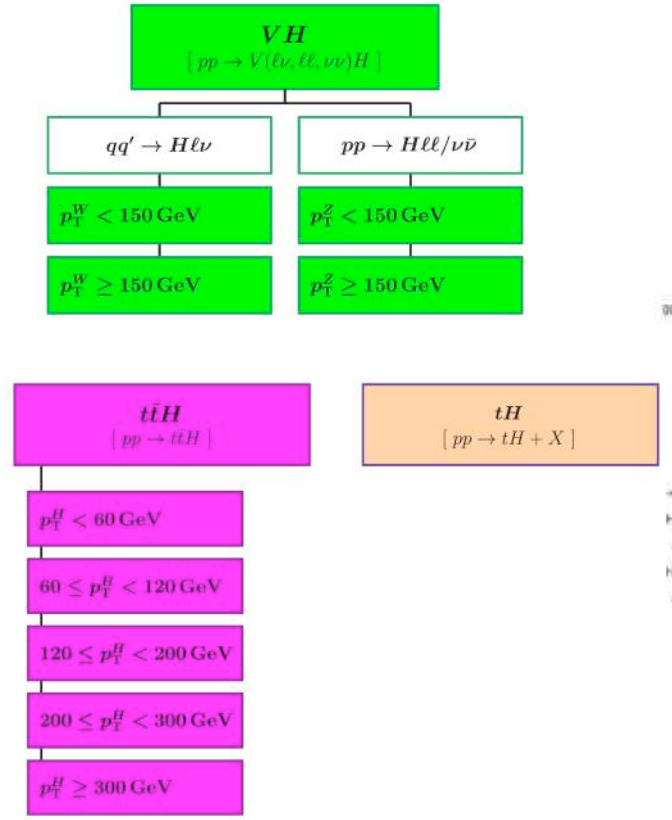
…it would be really astonishing if the H couplings would exactly be those of the minimal SM, meaning that no new physics distortions reach an appreciable contribution level. Thus, it becomes a firm priority to establish a roadmap for measuring the H couplings as precisely as possible.

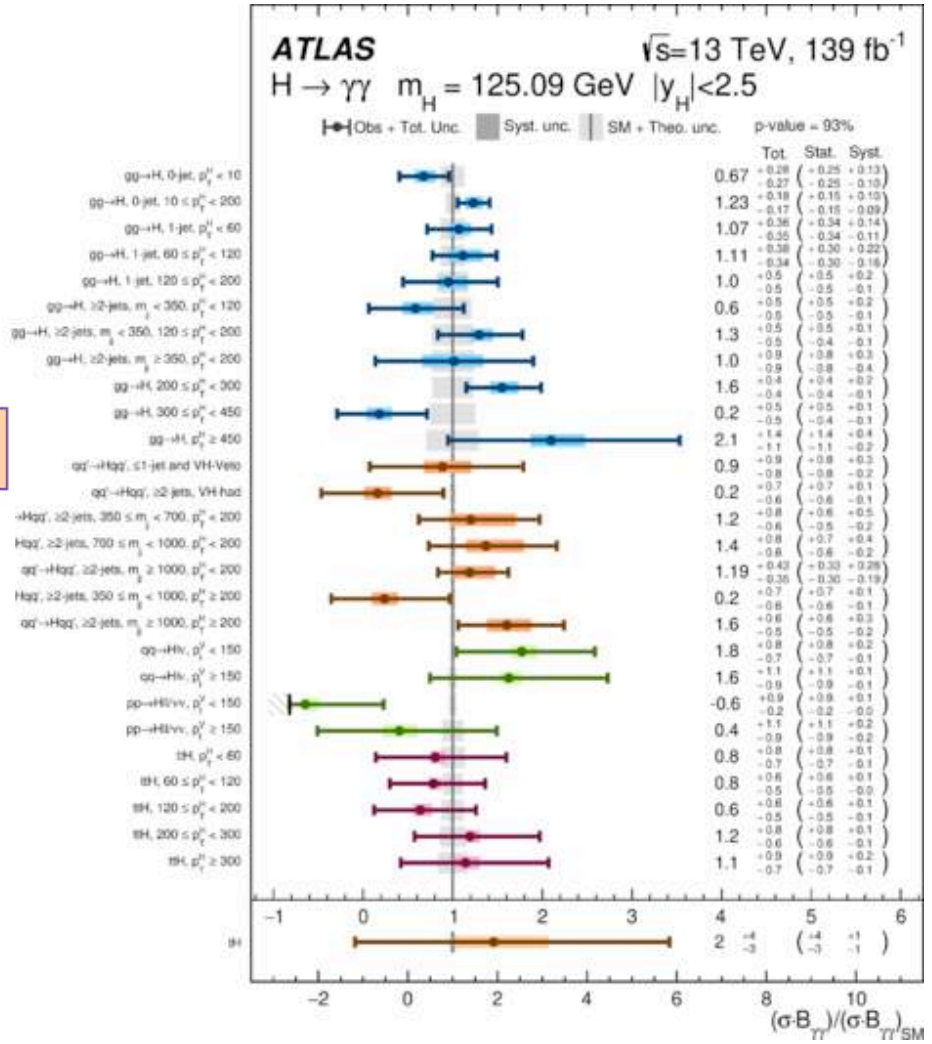
Guido Altarelli, "*The Higgs: so simple yet so unnatural*", December 2013

Higgs couplings

- Measured in the STXS scheme





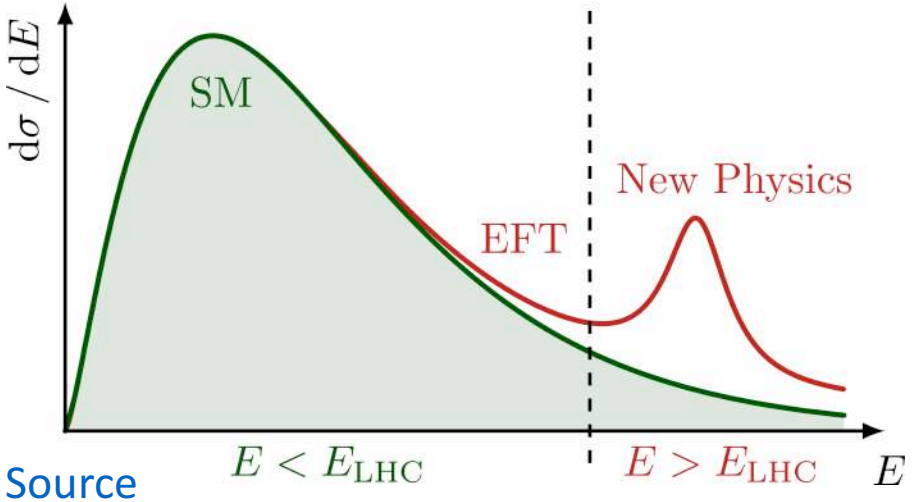


JHEP 07 (2023) 088

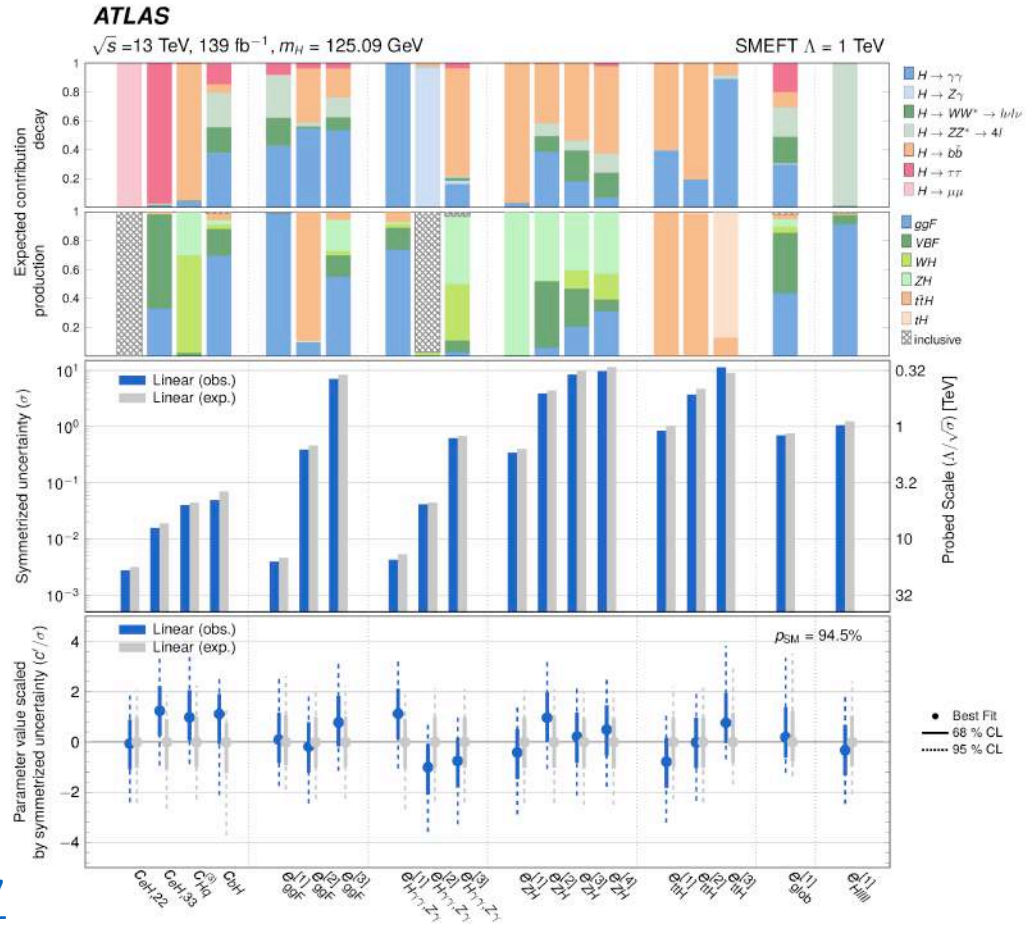
Higgs as a probe of new physics

- Even if astonishing, the Higgs seems to be described by the SM so far…
- Deviations from the SM can be tested through the SMEFT

$$\mathscr{L}_{SMEFT} = \mathscr{L}_{SM} + \sum_i \frac{c_i^{d=6}}{\Lambda^2}\mathcal{O}^{d=6} + \sum_i \frac{c_i^{d=8}}{\Lambda^4}\mathcal{O}^{d=8} + \dots$$

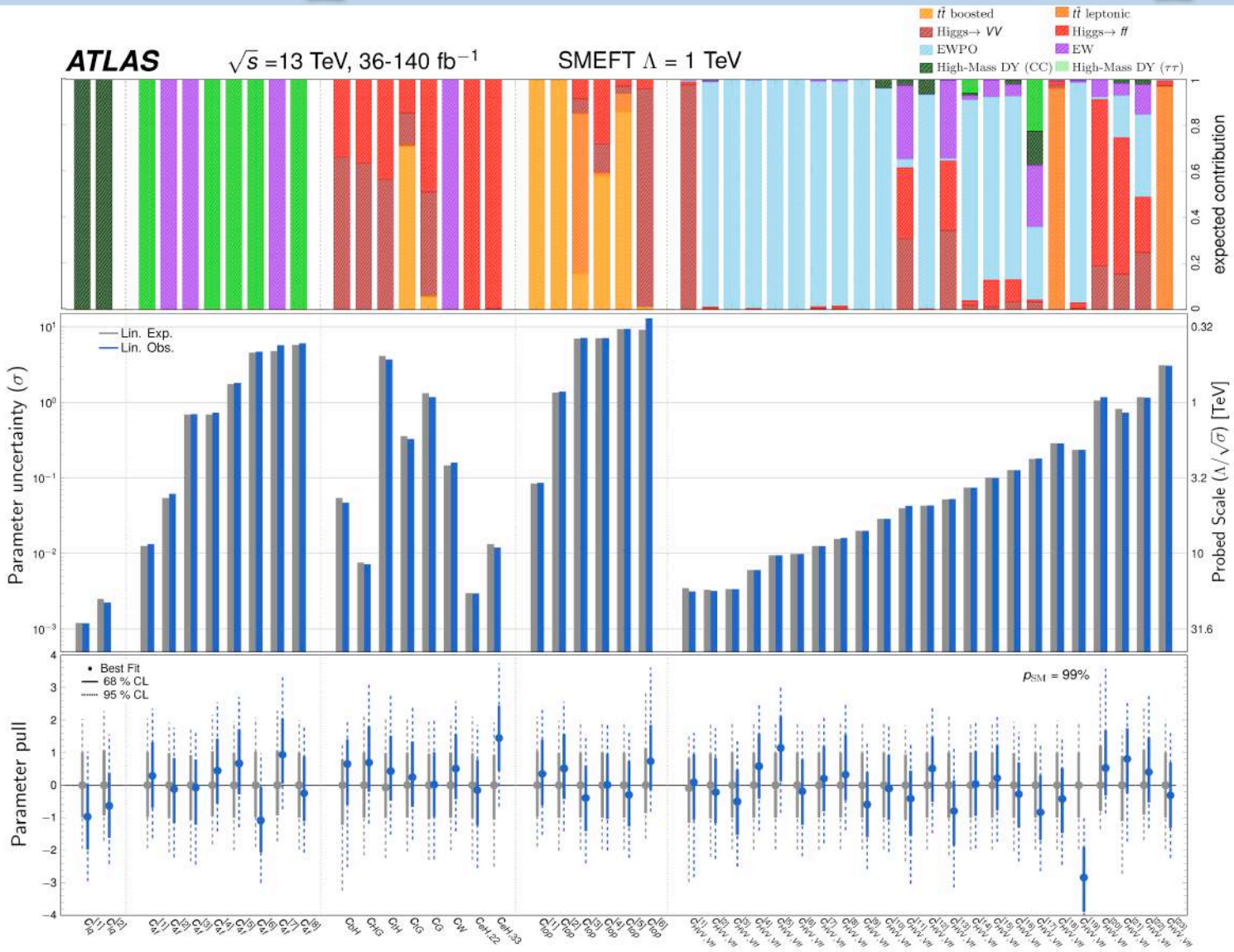


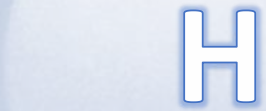
Source



JHEP 11 (2024) 097

Higgs as a probe of new physics



arXiv:2604.21670

Thanks!