Validation and Benchmarking of EFT tools

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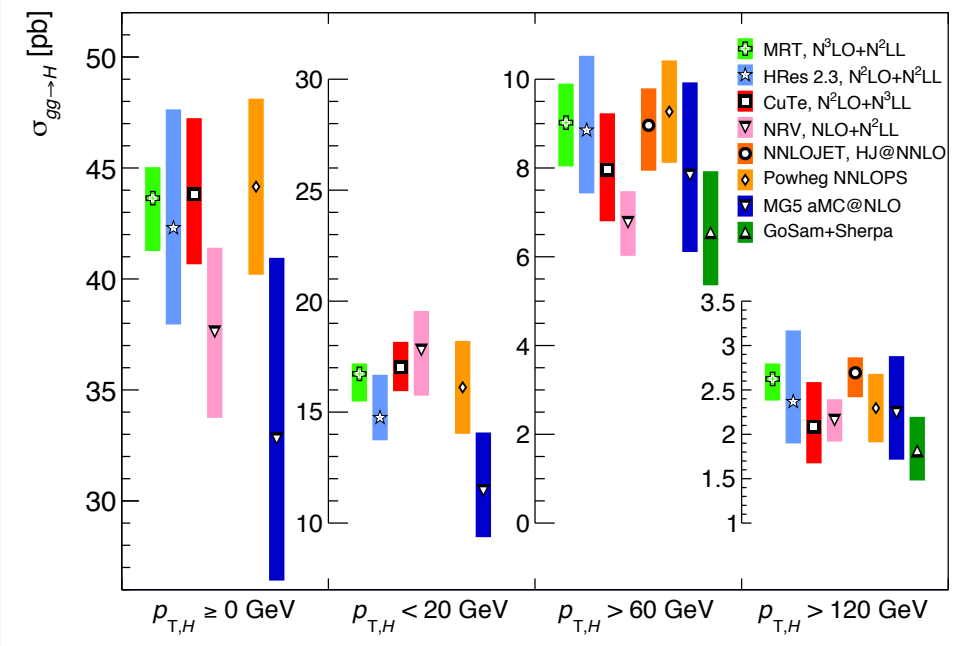
Motivation

Aim to understand and quantify differences between EFT tools

Strategies can be informed by WG1 experience

General strategy:

- Define tool use cases & applicability
- Fix common parameters
- Document benchmark processes and translations



Use cases and tools

Global EFT parameter fit to Higgs + Electroweak + top data
- SMEFTsim (+ expected implementation at NLO in QCD)

Multi-parameter fit to Higgs + Electroweak data
- SMEFTsim, HEL, BSMC

Characterization of Higgs data
- SMEFTsim, HEL, BSMC, HC

Characterization of classes of Higgs processes
- SMEFTsim, HEL, BSMC, HC, HiggsPO, HAWK, VBFNLO, WHizard, HiGlu, HPair, HiggsPair, Hto4l, Prophecy4f, EHDecay, MELA

Translation between bases and tools
- Rosetta (+ expected implementation of all operators)

Other tools?

Standards

SM parameters & scheme

> Unless otherwise specified, all the predictions correspond to a Higgs boson mass of 125 GeV, $\sqrt{s} = 13$ TeV, and the choice of SM input parameters and PDFs in Sects. I.1– I.2. We will first list

YR4, 1610.07922

EFT parameters

$$\mathcal{L}_{\text{eff}} = \mathcal{L}_{\text{SM}} + \sum_i \frac{c_i^{(5)}}{\Lambda} \mathcal{O}_i^{(5)} + \sum_i \frac{c_i^{(6)}}{\Lambda^2} \mathcal{O}_i^{(6)} + \sum_i \frac{c_i^{(7)}}{\Lambda^3} \mathcal{O}_i^{(7)} + \sum_i \frac{c_i^{(8)}}{\Lambda^4} \mathcal{O}_i^{(8)} + \cdots$$

Choose standard field and parameter definitions in each basis

Proposed procedures

1. Choose benchmark processes (B)
   - Initially inclusive production & decay processes, extend to STXS & diffXS

2. Evaluate parameter dependence of each process for each tool
   - Separate into B_{int}/B_{SM} and B_{BSM}/B_{SM} (linear & quadratic in EFT parameters)
   - Translate tool parameters into standard format if necessary
   - Preferably performed by authors with settings & translations provided to users

3. Translate each tool's results into other bases
   - Preferably performed by authors of translation tools

4. Investigate differences, iterate, document

Example

Gluon-fusion production:

HEL: σ_{int}/σ_{SM} = 8840 cG = **42** $\mathbf{c_g}/\Lambda^2$ [LHCHXSWG-INT-2017-001 (Hays, Sanz, Zemaityte)]

SMEFTsim: σ_{int}/σ_{SM} = **21** $\mathbf{c_g}/\Lambda^2$ [Zemaityte]

Looking at the model files I think HEL has a spurious factor of 2 in its ggH vertex

GC_1501 = 4 cG g_s^2 v / m_W^2, with cG = m_W^2/g_s^2 c_g/Λ^2 [JHEP 04 (2014) 110]

The operator is $|H|^2$ GG = $(v+h)^2$ GG = 2vhGG + …
and the vertex is defined as hGG

Discussion

Feedback?

Volunteers?