News from the LHC EFT WG

Ilaria Brivio

Institut für Theoretische Physik,
Universität Heidelberg

for more details:
latest general meeting indico.cern.ch/e/1016713/
previous meetings indico.cern.ch/c/12671/

The LHC EFT Working Group

formed last year, part of the LPCC

Conveners:

ATLAS
Nicolas Berger
Nuno Castro
Kristin Lohwasser
Pierre Savard

CMS
Florencia Canelli
Pietro Govoni
Andrei Gritsan
Giovanni Petrucciani

LHCb
Patrick Owen

Theory
Ilaria Brivio
Sally Dawson
Jorge De Blas
Celine Degrande
Gauthier Durieux
Admir Greljo
Eleni Vryonidou

Goals

☞ " facilitate an **interpretation** commensurate with the available measurements performed **in a wide range of different processes, including Higgs bosons, top quarks, and electroweak bosons.**"

☞ "provides **recommendations for the use of EFT by the experiments to interpret their data**, and a **forum for theoretical discussions** of EFT issues. "

in practice (medium/long term):

◉ ATLAS+CMS combined analysis of Higgs + EW + top measurements

◉ incorporation of LHCb data

◉ help making theory studies accessible: translations, databases...

◉ help streamlining / coordinate theory studies

EFT WG – Areas

1. EFT Formalism

2. Predictions and Tools

3. Experimental measurements and observables

4. Fits and related systematics

5. Benchmark scenarios from UV models

6. (Heavy) Flavor

Outline of WG targets: **Google doc** 📄

Area 1 - EFT Formalism

☑ Recommendations for EW input parameters

→ *ad interim*, preferred set: $\{m_W, m_Z, G_F\}$
→ other sets can be used for scheme-dependence tests. e.g. $\{\alpha_{em}, m_Z, G_F\}$
→ input scheme translations in principle possible

⋯ Recommendations for truncation uncertainties, EFT validity

proposals:
☞ report meas. as a function of upper sliding cut E_{max}
☞ introduce a TH uncertainty in the measurement

☐ Recommendations for flavor assumptions
most likely: $U(2)_q \times U(2)_u \times U(3)_d$

☐ Recommendations on other symmetries, e.g. CP

☐ Dictionary between different event generation tools   ↔ area 2

☐ Incorporation of positivity / unitarity constraints

Area 2 - Predictions and Tools

☐ comparison and validation of prediction tools.

  ☑ `SMEFTsim` ↔ `SMEFT@NLO` Durieux et al 1906.12310, Brivio 2012.11343
  ☐ extend to other generators (Sherpa, POWHEG-Box, JHUGen, VBF@NLO. . .)
  ☐ extend to published results, full simulations, on-shell+decay, NLO. . .

☐ predictions database for published results

  dynamical list of refs. with structured info

  operators
  processes
  order (QED/QCD/SMEFT)
  assumptions
  scheme

  . . .

☐ NLO issues

  K-factors non-universality, running, flavor treatment, uncertainties. . .

- survey of `processes` and operators

  which processes are sensitive to which operators?

- survey of `observables` within each process

  which observables maximize sensitivity? how are they optimally defined?

  ☞ sensitivity, potential to break degeneracies, correlations, binning...

  ☞ defining **optimal observables** for EFT

- determine `relative sensitivities` of observables to operators

  which is the most constraining measurement for a given operator?

  e.g. Fisher information

- evaluate pros & cons of various `analyses techniques`

  inclusive, fiducial, diff. meas. / Matrix Element Method / Machine Learning . . .

Area 4 – Fits and related systematics

☑ feedback from fitting experience in ATLAS and CMS

☐ comparison & cross-validation in public EFT ⬚fitting tools⬚

  EFTfitter, Fitmaker, HEPfit, SFitter, SMEFiT

  → comparison on fixed **benchmark** scenarios
  → recommendations for common **output** format
  → possibility to use tools in exp. fits to incorporate e.g. LEP constraints?

☐ recommendations for ⬚output formats⬚ from exp. EFT analyses

  eg. provide covariance matrices, separate error sources...

    provide **full likelihoods**?   ↔ Reinterpretation Forum

☐ long term: define a robust procedure for EFT combinations in ATLAS+CMS

⋯ **fitting exercise**

Fitting exercise

💡 a global analysis project for the next ∼ 1 year , involving ATLAS + CMS, to:

– align **assumptions** in workspaces (flavor, input schemes, truncation, uncertainties. . .)

– align **technical aspects** (output format, naming conventions. . .)

– focus discussion on concrete issues and scenarios

– help converging on Higgs+EW+top, ATLAS+CMS combined in the long term

⋯ exact format being defined

  ‣ favored: internal ATLAS, CMS combination first

  ‣ 2 main options:

    - fit with public data (reinterpretation of existing measurements)

    - update of HL projections for EFT in yellow report (no data)

Area 5 - Benchmark scenarios from UV models

⋰ define a list of "standard" benchmark UV models
- → *fully* match at 1-loop to SMEFT
- → phenomenological relevance
- → validation of automated matching tools
  SuperTracer, STrEAM, Matchmaker

☐ match MSSM in decoupling limit to SMEFT at 1-loop
- → many full model results available for comparison to SMEFT
- → choose a set of benchmark points in MSSM
  (integrate out stops / charginos + neutralinos / . . .)

Area 6 - (Heavy) Flavor

Activities for Area 6 are being defined.

Scope:

- most of the SMEFT parameter space is flavorful!

- how to include flavor constraints in Higgs/EW/top analyses?

- explore potential LHCb input to SMEFT program

- platform for theory discussions on SMEFT / WET interplay

- explore potential input from flavor / lower-energy experiments