

LHC EFT Working Group

Summary of the first General Meeting and Outlook



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LHC EFT Working Group

- Established in Summer 2020 to bring together LHC experiments & Theory community towards “global” EFT interpretation of LHC data
- Full mandate & list of 15 conveners at <https://lpsc.web.cern.ch/lhc-eft-wg>
 - LHC WG Contacts: Jorge de Blas (Theory), Nicolas Berger (ATLAS), Giovanni Petrucciani (CMS)
- Draft document outlining the targets and priorities for the WG: <http://cern.ch/go/P7sV>
 - Up for discussion in the first General Meeting

First General Meeting

Held on october 19-20: indico.cern.ch/e/943996

- Introduction & Theory overview
- Report on EFT efforts in ATLAS & CMS
- Reports on EFT activities in the LHC
Electroweak, Higgs and Top groups
- Talks on related but external topics:
 - EFT projections for the European Strategy
 - LHC Reinterpretation Forum
 - Non-LHC EFT inputs, especially flavour
- EFT WG goals & priorities

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- Reports & invited talks are already excellent summaries: I can't summarize them further.
- So, I'll focus on the last point, and add *my thoughts*^[*], especially on the work ahead between EFT & Higgs WG.

[] no claims of endorsement from the WG*

- EFT WG goals & priorities 

EFT WG: working areas

1. EFT Formalism
2. Predictions and tools
3. Experimental measurements and observables
4. Fits and related systematics
5. Benchmark scenarios from UV models

1: EFT formalism

- Choice of basis, notation, inputs
 - and tools to convert between conventions
 - choice of EWK input scheme: $\{ G_F, m_Z, m_W \}$?
- Assumptions to reduce # of operators
 - CP, Flavour, specific BSM benchmarks?
- Truncation, uncertainties, validity:
 - Treatment of $1/\Lambda^4$ terms, estimate impact?
 - Treatment of data or predictions at $E^2 > \Lambda^2$?
- Theory constraints:
 - unitarity, positivity, ...: bounds? how to use in fits?

1: EFT formalism

- Choice of basis, notation, inputs
 - and tools to convert between conventions
 - choice of EWK input scheme: $\{ G_F, m_Z, m_W \}$?
- Assumptions to reduce # of operators
 - Useful for LHC Higgs WG results & tools to be compatible with any common LHC EFT choice.
 - Warsaw basis preferred in general SMEFT tools & fits (though with non-unique conventions)
 - Mapping to Higgs observables non-diagonal but easy at LO; more complex at NLO.

2: Predictions and tools

- Survey analytic & numerical predictions, assumptions used, interplay of tools
 - Including MC reweighting tools & approaches
- Higher orders in SM coupling expansion
 - Uncertainties? factorization of SM corrections?
- Treatment of unstable particles: t, W, Z, H
- Cross-validation of tools, comparisons of observable calculations & uncertainties
- Common MC generation or settings?
- EFT in PDFs, α_s , shower, hadronization, ...

2: Predictions and tools

- LHC Higgs WG natural place for validation of tools, compilation and comparisons of predictions on Higgs observables (and including Higgs-specific tools)
 - many benchmarking efforts in past YRs
 - predictions in common bins (e.g. diff., STXS) useful also for direct usage in fits
- Higgs decays good for analytic results? (e.g. $H \rightarrow \gamma\gamma$ @ NLO SMEFT)
- EFT in PDFs, α_s , shower, hadronization, ...

3: Experimental measurements and observables

- Survery mapping between operators and channels / observables
- Analysis strategies & experimental outputs
 - Different approaches: fiducial and differential measurements, STXS, dedicated EFT extractions
 - Detector effects & experimental systematics
 - Presentation of results: covariances, likelihoods
 - EFT in backgrounds: impact? presentation?
 - Legacy measurements & reinterpretations

3: Experimental measurements and observables

- Higgs WG has good tradition of defining reference observables (STXS, diff. bins, ...)
 - investigate also use of ME or MVA observables made from fiducial info?
- EFT in backgrounds, whenever not fitted in situ in each bin ($\gamma\gamma$), especially if potentially affected by similar operators (e.g. VV/VH?)
 - may be relevant with more precision?

– Legacy measurements & reinterpretations

4. Fits and related systematics

- Common fits to H+EWK+Top
 - Start with a reduced, proof of concept fit to gain practical experience on needs?
 - Comparisons of experimental & theory fits
- Non-LHC constraints: comparison, inclusion?
- Treatment of exp. and theory systematics
- Presentation of results (e.g. flat directions)

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- Non-LHC constraints: comparison, inclusion?
- Treatment of exp. and theory systematics
- Presentation of results (e.g. flat directions)
 - Synergy with Higgs WG effort on Higgs-driven fits: inputs, tools, challenges, ...

5: Benchmark scenarios from UV models

- Matching of EFT operators to BSM models
 - Define restricted subsets of operators
 - BSM models going beyond SMEFT (e.g. HEFT)
- Comparisons of EFT constraints sensitivity wrt direct searches

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- LHC-HXSWG-2019-006 [arXiv:2009.01249] is already an excellent start
- HH, “HwH”, $H \rightarrow Z\gamma$ places to probe for SMEFT vs HEFT differences

Next steps:

- Meetings on all the 5 areas
 - Call for contributions sent out on the lhceftwg@cern.ch egroup yesterday.
See next slide for dates & organizers.
 - Meetings will be held remotely on Zoom, in the european afternoon time window
- Goals:
 - Gather & review inputs on topics
 - Define short term deliverables & work plan.
→ Follow up with topical meetings, and converge to documents or recommendations

Area meeting dates & organizers

1. Dec. 7: EFT Formalism
Ilaria Brivio, Sally Dawson, Gauthier Durieux, Pierre Savard
2. Dec. 14: Predictions and tools
Ilaria Brivio, Céline Degrande, Pietro Govoni, Giovanni Petrucciani, Eleni Vryonidou
3. Jan. 11: Experimental measurements and observables
Nuno Castro, Pietro Govoni, Andrei Gritsan, Eleni Vryonidou
4. Jan. 27: Fits and related systematics
Nicolas Berger, Florencia Canelli, Nuno Castro, Jorge de Blas, Giovanni Petrucciani
5. Feb. 8: Benchmark scenarios from UV models
Sally Dawson, Admir Greljo, Kristin Lohwasser

Indico: <https://indico.cern.ch/category/12671/> (empty for now)