

# Feedback on EFT Document and Next Steps from ATLAS & CMS

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- ◆ started a joined ATLAS/CMS EFT effort about a year ago
- ◆ top **EFT UFO** provided to ATLAS and CMS end of 2017: arXiv 1802.07237
  - LO only
  - all operators involving top quarks
  - 3 different options of flavor assumptions, FCNC
  - broad consensus in top/EFT theory community
- ◆ first presentation from the experimental community by **Kevin** in June

- ◆ approach:
  - perform measurements of various observables in different analysis groups:  
 $t\bar{t}$  cross sections, spin correlation, single top cross section, ...
  - optimize for minimum uncertainty of observables
  - estimate uncertainties, correlations and combine measurements
  - interpret results in terms of EFT operators → EFT parameter estimates are a byproduct
- ◆ EFT serves as common dictionary allowing to combine different measurements which would be hard to combine otherwise (e.g. W helicity and single top cross section)
- ◆ several tools on the market to perform EFT analysis: EFTFitter, HEPFit, Rivet + Professor, ...
- ◆ benefit from LHC Top WG experience with HEPData, Rivet, already ongoing combinations
- ◆ easy scalable
- ◆ especially for non-EFT-tailored analysis crucial to check acceptance corrections, e.g. MVA based single top cross-sections measurements → fiducial, simple measurements easier for EFT interpretation
- ◆ need to go beyond current systematic precision of unfolded differential measurements

- ◆ approach:
  - direct search for EFT with analysis with an optimization w.r.t. EFT parameters
  - put everything into a common likelihood
  - constrain uncertainties→ measurements of observables are only byproducts
  
- ◆ experiment specific tools in place to set limits
  
- ◆ benefit from existing likelihood-based combination approaches to preserve measurements
  - **CMS-NOTE-2017-001**
  - **next-to simplified likelihoods** based on Nucl. Phys. B 911 (2016)
  
- ◆ best sensitivity
  
- ◆ may go beyond experimental physics groups

- ◆ several new measurements in the pipeline that allow to or constraint EFT operators, e.g.
  - (differential) cross sections
  - spin correlation measurements
  - $t\bar{t}+V$
  
- ◆ getting experience with EFT simulation
  - excellent application for LO reweighting in MG5\_aMC@NLO
    - ◆ mainly unknown territory for the experiments
    - ◆ several technical challenges
  - need small “working groups” to sort out problems quickly
  - should we agree on a few benchmark points allowing for a direct comparison of selection efficiencies, acceptance ?
  - interesting to have common gridpacks ?

- ◆ What is the timescale for NLO models? Should we use NLO where available?
  - need to be able to translate limits from the common EFT model to any other model
  - dim6top should be the standard to allow for comparisons, NLO models an add-on
- ◆ Is it possible to extend the current UFO by baryon number or lepton violation?
- ◆ What is the best approach to deal with EFT in decay? Should only “stable tops” be considered?
- ◆ Which observables should we probe to maximize sensitivity?
  - no need to start with everything optimized → new pheno papers will help getting better results
- ◆ Which linear combinations of 4-fermion operators should be considered?
  - depends on observable e.g. spin observables provided by Bernreuther in JHEP12(2015)026 should provide better sensitivity if split into four isospin-zero operators with definite P and C properties and three isospin-one operators

- ◆ Do we want an experimental follow-up document?
  - idea:
    - clarify which experimental studies we need using some example measurements
  - test stability of unfolding for different shape variations
  - provide an example how to best provide correlation and systematic uncertainties in HepData
  - which additional info should we release in case of extrapolations, e.g. acceptance corrections for a few alternative operators?
  - estimating validity and quantum perturbativity of the dimension-six EFT as outlined in arXiv: 1802.07237
  
- ◆ Do we want/need to streamline EFT analyses ?
  - consensus on variables
  - choice of binning for those
  - unfolding level
  
- ◆ Should we define benchmarks for a few relevant operators to allow for a direct comparison between ATLAS and CMS? tZ FCNC as a starting point?
  
- ◆ Do we want to work on common EFT re-interpretations within Top LHC WG? Should we agree on common tools?

- ◆ almost every LHC analysis can be considered a search for new physics
- ◆ EFT provides a powerful tool to describe new physics beyond the LHC scale
- ◆ right time to re-think our research program:
  - enough data, still plenty of time before HL-LHC
  - do we probe the right quantities?
  - are we sure we don't miss anything?
  - how can we best preserve our results?
- ◆ recently provided top EFT UFO is an excellent starting point for a more coherent/common effort
- ◆ new 13 TeV EFT results in the pipeline
  - right time to exercising the machinery and combine relevant measurements depending on certain operator blocks e.g. FCNC
- ◆ limited time and person power: crucial to discuss common goals and define priorities!