LHC EFT WG Fitting Exercises

Introduction

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From the original Activity Area proposal:

Discussion on issues which are either generic, i.e. they don't depend on specific final states, or that concern the interpretation, preparation and performance of global fits of ATLAS, CMS, LHCb results, together with additional existing measurements, future projections, experimental systematics related to EFT.

Experimental EFT fits: ATLAS+CMS+... combination of H+EW+Top (***)

Inputs and outputs, fitting procedures and tools (***)

- Practical considerations of limited time and experimental input
- Fitting benchmarks for synchronisation
- Comparisons of input information between experimental results
- Compare fits: experimental/theory, among different groups
- Consideration of common WG fit, framework and/or approaches (**)

Comparison to, and inclusion of, non-LHC constraints (LEP, Tevatron, flavor, g-2, EDM, etc.) in fits and/or to set priorities among targeted measurements/operators and in sensitivity optimization (***)

Theoretical systematics, and their correlations (see Area 2.) (***)

Experimental systematics, and their correlations (see Area 3.) (***)

Presentation of EFT Fits: multi-D likelihoods, covariance, flat directions, etc… (***)

Projections of EFT fit constraining power (**)

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Experimental EFT fits: ATLAS+CMS+... combination of H+EW+Top (***)

Will raise both experimental fit and common WG fit in the following

- Consideration of common WG fit, framework and/or approaches (**)

Comparison to, and inclusion of, non-LHC constraints (LEP, Tevatron, flavor, g-2, EDM, etc.) in fits and/or to set priorities among targeted measurements/operators and in sensitivity optimization (***)

Theoretical systematics, and their correlations (see Area 2.) (***)

Experimental systematics, and their correlations (see Area 3.) (***)

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Experimental Fits: Considerations and Comments

Higgs coupling combination between ATLAS and CMS at the end of Run 1 was an impressive success

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- Maximized sensitivity of LHC in extraction of Higgs properties

are also given. The combined signal yield relative to the Standard Model prediction is measured to be 1.09 ± 0.11. The combined measurements lead to observed significances for the vector boson fusion production process and for the $H \rightarrow \tau\tau$ decay of 5.4 and 5.5 standard deviations, respectively. The data are consistent with the Standard Model predictions for all parameterisations considered.

- Required agreement on common framework (kappa), conventions, fit procedures, and on systematics (sometimes challenging…)
  - This took time: collaborations published their own combinations first
  - But the foundations of the common fit were built early on. While an ATLAS-CMS EFT fit is not imminent, we can discuss the framework and ground rules of the fit now. If we do it later, it will require extra work and we will lose time (months)

Experimental Fits: Considerations and Comments

Combinations between CMS and ATLAS (like the Higgs coupling combination) are typically done at the level of “workspaces” that include detailed nuisance parameter information and correlations

- Work that involves data is performed within the collaborations. The fit to data is done at the end.

- The development of the fit model is done with simulation. Work that involves simulated samples can be more open.

- The definition of a first experimental fitting exercise that includes what to combine, conventions used, tools to be used, uncertainties to be considered, could be discussed within this WG and documented. This could start now

- Exercising this fit with simulated samples could be done in an open way if experimental collaborations agree and if colleagues outside the collaborations are interested in contributing

EFT WG Fit Exercises: other possible projects

- Perform EFT fit using data that is already public
    - Many independent groups are publishing EFT fits using data made public by the experiments. It is unclear if we want to compete with those efforts
        - We could perform a simplified fit that is well documented and that uses the recommendations of the WG. It could be a pedagogical introduction with how-tos and walkthroughs for new colleagues interested in the field
- We could provide an update to the EFT studies performed for the CERN Physics at the HL-LHC Yellow Report that would use updated experimental/theory assumptions/results and that followed the recommendations of this WG
    - Note that this could possibly use some of the infrastructure of the experimental combination project mentioned previously (no issue with experimental data in this case)

Fitting Exercises

EFT fits are ongoing within the LHC collaborations and within independent theory groups

Part of the mandate of this WG is to provide recommendations for such fits but also to discuss “combination procedures used by the experiments”

A fitting exercise is in line with the WG mandate and can help focus WG discussions on concrete scenarios and problems that will help those discussions converge, and in some cases break some degeneracies

Backup Slides

LHC EFT WG Mandate

The LHC effective field theory working group (LHC EFT WG) gathers members of the LHC experiments and the theory community to provide a framework for the interpretation of LHC data in the context of effective field theories (EFTs). The LHC EFT WG studies the physics requirements needed to facilitate an interpretation commensurate with the available measurements performed in a wide range of different processes, including Higgs bosons, top quarks, and electroweak bosons. It provides recommendations for the use of EFT by the experiments to interpret their data, and a forum for theoretical discussions of EFT issues. This includes recommendations on the theory setup as well as Monte Carlo simulation and other tools needed for EFT analyses. Further theoretical issues cover, for example, theoretical constraints, higher-order corrections, BSM interpretations. The LHC EFT WG also discusses common uncertainties and combination procedures used by the experiments. It focuses on recommendations, developments, and combinations that require coordination between the existing WGs (Higgs, Top, Electroweak), in order to allow global EFT analyses inside and outside experimental collaborations. EFT-related activities in these working groups will continue if they pertain only to that group, in close contact with the LHC EFT WG.

The steering group (SG) of the LHC EFT WG consists of experimental and theory conveners. The ATLAS and CMS experiments will each appoint 4 conveners, of which three will be contacts to each of the Higgs, Top, and Electroweak WGs. Up to 8 theorists will also be appointed by the head of LPCC, in consultation with the Higgs, Top and EW WG conveners for the selection of their 3 theory contacts. Contacts from the other LHC experiments can be envisaged as well. The mandate of the conveners is two years, renewable once, and staggering among outgoing/incoming and continuing conveners is encouraged.

The LHC EFT WG operates by holding public meetings where all relevant topics are discussed. Smaller meetings with a specific focus may be scheduled, and subgroups may be formed as deemed necessary by the SG. The subgroups would report on their activities in the plenary meetings. A special case is that of possible combinations or comparisons of experimental data. In this case the meetings will be restricted to members of the relevant experiments.

From M. Mangano