Digest of the 2nd LHC EFT WG General Meeting

LHC TOP WG meeting
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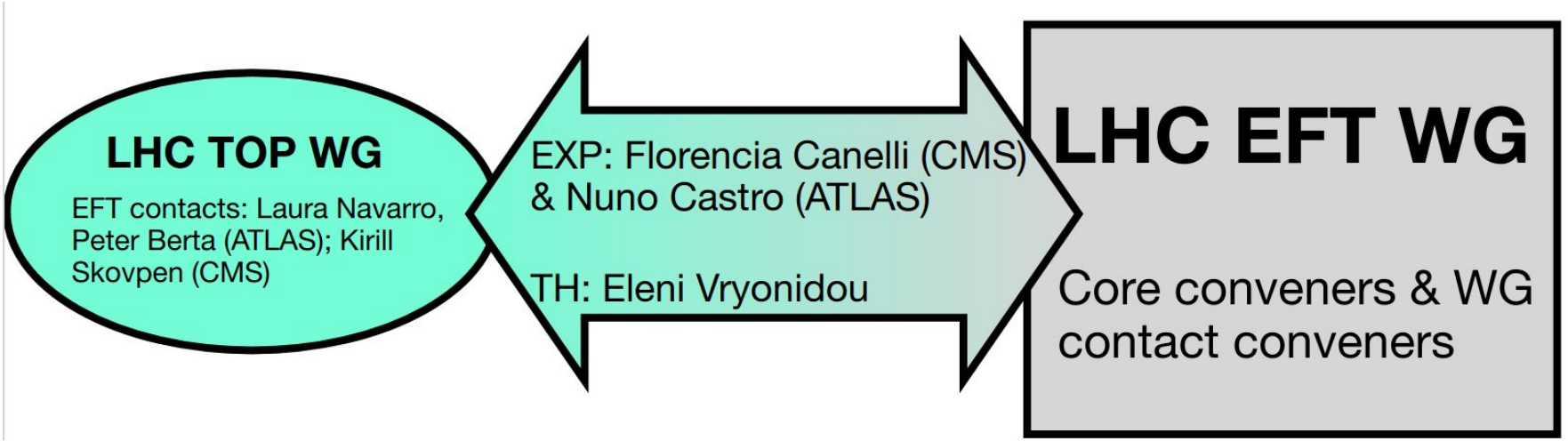
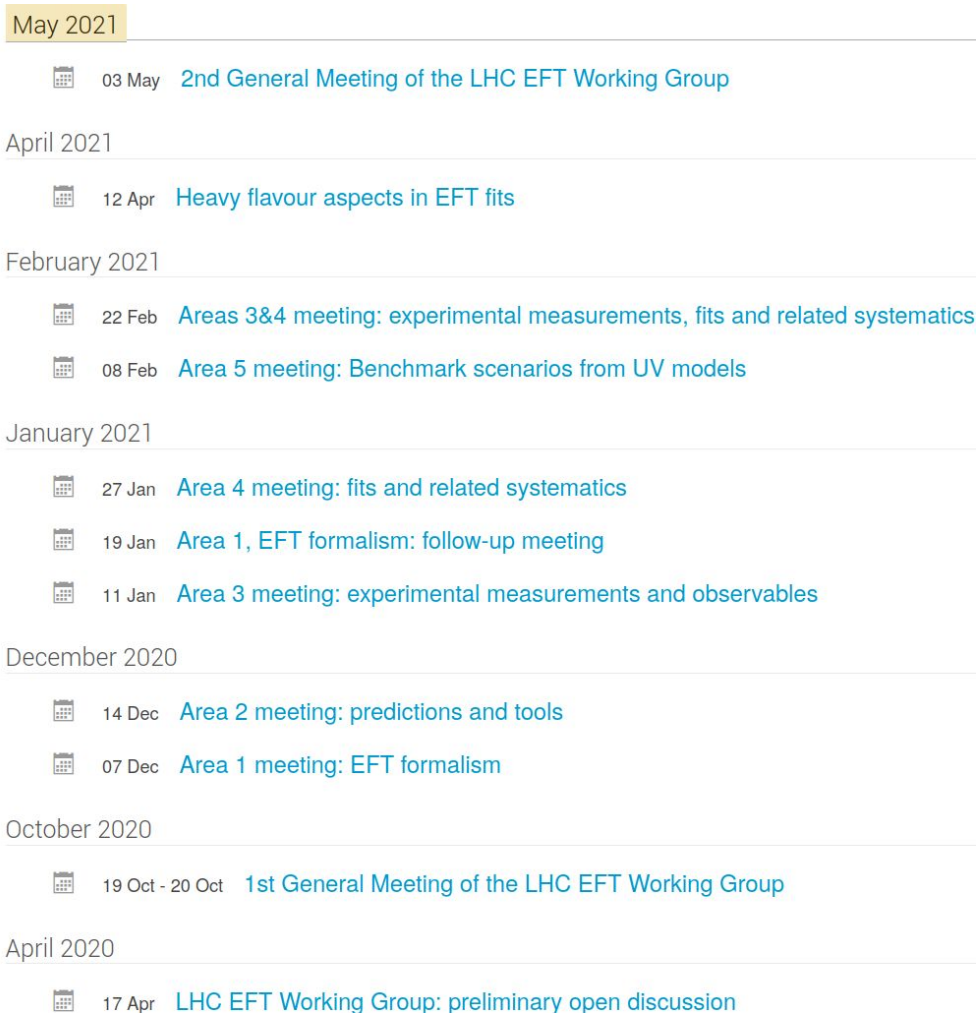
LHC EFT Working Group - Reminder

- Mandate: https://lpcc.web.cern.ch/lhc-eft-wg
  - bring together LHC experiments & Theory community towards “global” EFT interpretation of LHC data
  - focus on recommendations, developments, and combinations
  - coordination between the existing WGs (Higgs, Top, ElectroWeak)
- 1st general meeting in October 2020: https://indico.cern.ch/event/943996/
  - Summary at the LHC Top WG by Eleni V. in November 2020
- **2nd general meeting in May 2021**: https://indico.cern.ch/event/1016713/
  - Summary in this talk



LHC EFT WG activities in the past 7 months

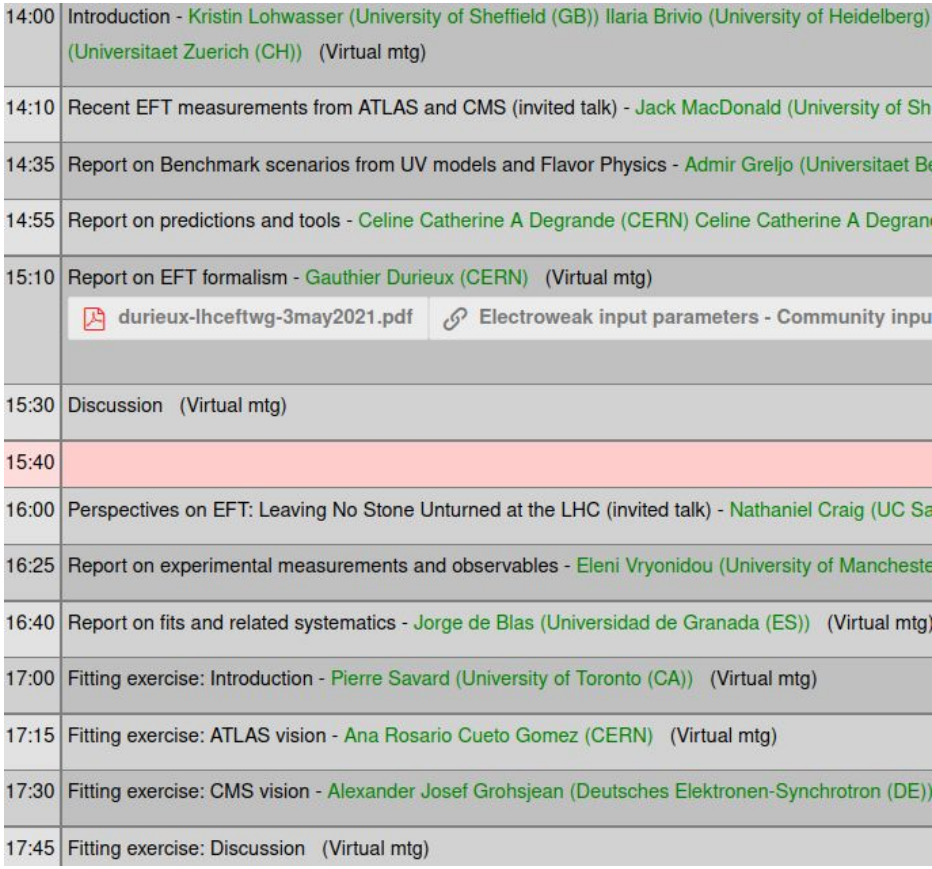
- Dedicated meetings in 6 areas:
  - Area 1: EFT Formalism
  - Area 2: Predictions and Tools
  - Area 3: Experimental Measurements and Observables
  - Area 4: Fits and Related Systematics
  - Area 5: Benchmark Scenarios from UV Models
  - Area about Flavour Physics
- Write-ups - evolving



https://indico.cern.ch/category/12671/

Agenda of the 2nd general meeting

- https://indico.cern.ch/event/1016713/
- Two invited talks:
  - Recent EFT measurements
  - Perspectives on EFT
- **Reports from the 6 areas**
  - status
  - activity
  - plans
  - write-ups (evolving)
- **Discussion of the fitting exercise**



Area 1 - EFT Formalism

Four topics:

- Common conventions, translations, common EW inputs
  - several translation tools discussed (WCxf, Rosetta)
  - Write-up on EW inputs
  - GoogleDoc community input on EW inputs
- Flavour structures, classes of BSM, symmetries
  - At the beginning of the discussion
- Truncation, uncertainties, validity
  - Write-up
  - GoogleDoc community input
- Theory constraints - unitarity, positivity, incorporation in fits
  - At the beginning of the discussion

Area 1 - EFT Formalism - summary of write-ups

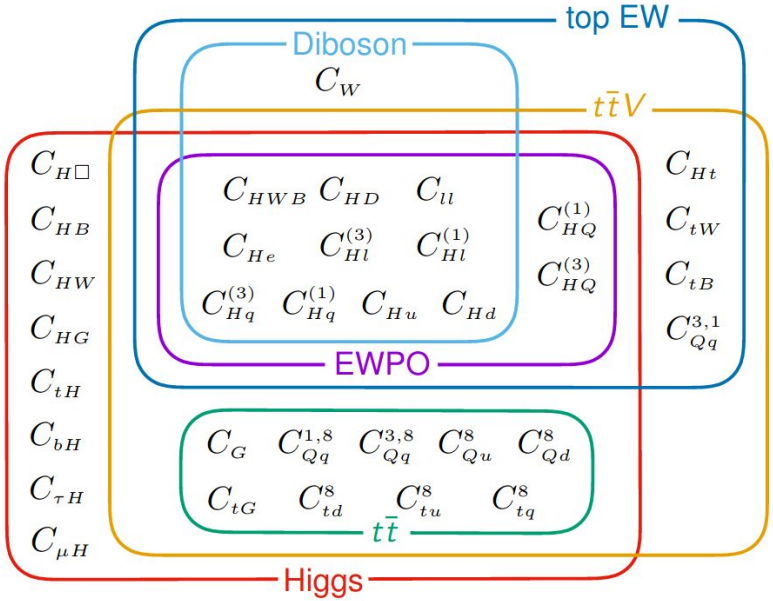
- EW input scheme
  - scheme $\{G_\mu, m_Z, m_W\}$ is preferred
  - conversion rules exist
- Truncation, uncertainties, validity
  - also discussed in the LHC Top WG guidelines note: arXiv: 1802.07237
  - SMEFT truncation of interest is at the level of dim-6 operators. Two proposals:
    - linear+quadratic dim-6 as nominal + compare with linear-only dim-6
    - linear dim-6 as nominal + uncertainty constructed from known quadratic dim-6 and dim-8 contributions
  - provide experimental results as functions of the maximal energy probed in the data employed, E_{cut}
  - no final recommendations so far

Area 2 - Predictions and Tools

- Currently no write-up, summarizing the Area 2 meeting here
- Presented review of the tools:
  - UFO models: SMEFTsim, SMEFT@NLO
  - MC generators for SMEFT: MadGraph5_aMC@NLO, Sherpa, JHUGen, Powheg, VBF@NLO
- LHC Top WG guidelines for EFT: dim6top and SMEFTsim
  - Is dim6top deprecated by the other two UFO models?
  - Should there be a common LHC Top WG recommendation?
  - ATLAS plans to use mainly **SMEFTsim (flavour symmetry "topU3l")** and if needed **SMEFT@NLO**
- Experimentalists concerns
  - higher order term (prod+decay)
  - NLO
  - reweighting
  - assumptions
  - EFT gluon interactions

Area 3 - Experimental Measurements and Observables

- Discussed different approaches for EFT interpretations of measurements:
  - differential cross sections
  - dedicated analyses
  - matrix-element observables
  - machine-learning observables
- Talk on Top measurements useful for fits
- write-up in progress. Will be added:
  - establish a detailed map between EFT operators and experimental observables
  - determine relative sensitivity of observables to operators
  - performing measurements & interpretations: pros and cons of various analyses techniques



Area 4 - Fits and Related Systematics

- Reviewed the status of fitting frameworks and their validation:
  - EFTfitter
  - Fitmaker
  - HEPfit
  - SFitter
  - SMEFiT
- Reviewed the status of the fitting experience by ATLAS and CMS
- Discussed the presentation of public experimental results in this talk
  - Always use Rivet
  - Provide **full likelihoods** or enough info
  - Detailed recommendations in the document Reinterpretation of LHC Results arXiv:2003.07868
- write-up in progress
- Suggestions can be added to GoogleDoc

Area 5 - Benchmark Scenarios from UV Models

- How do we best interpret EFT analysis in explicit models?
- A UV model predicts WCs in terms of its parameters - matching.
- The key theoretical aspect is matching the UV model onto EFT at high accuracy
- The dawn of automated one-loop matching tools
  - SuperTracer arXiv:2012.08506
  - STrEAM arXiv:2012.07851
- Goal: set benchmark scenarios:
  - Interesting phenomenology
  - Validation of different tools.
- Write-up available

Area about Flavour Physics

- It is a key to a global fit
- Most of the 2499 dim-6 operators in SMEFT are flavourful
- Flavor physics reaches into most dimensions
- Impact of flavour on top/H/EW
  - Indirect constraints on flavor-less operators
  - Flavorful New Physics can manifest itself in EW/Higgs observables
  - To be able to address these cases it is important to perform EFT fits keeping the complete flavor dependence
- No write-up so far

Fitting exercise within the LHC EFT WG

- EFT fits are ongoing within the LHC collaborations and within independent theory groups
- LHC EFT WG mandate:
  - provide recommendations for such fits
  - discuss combination procedures used by the experiments
  - **perform a fitting exercise**
    - ATLAS+CMS+... combination of H+EW+Top

Possible combinations

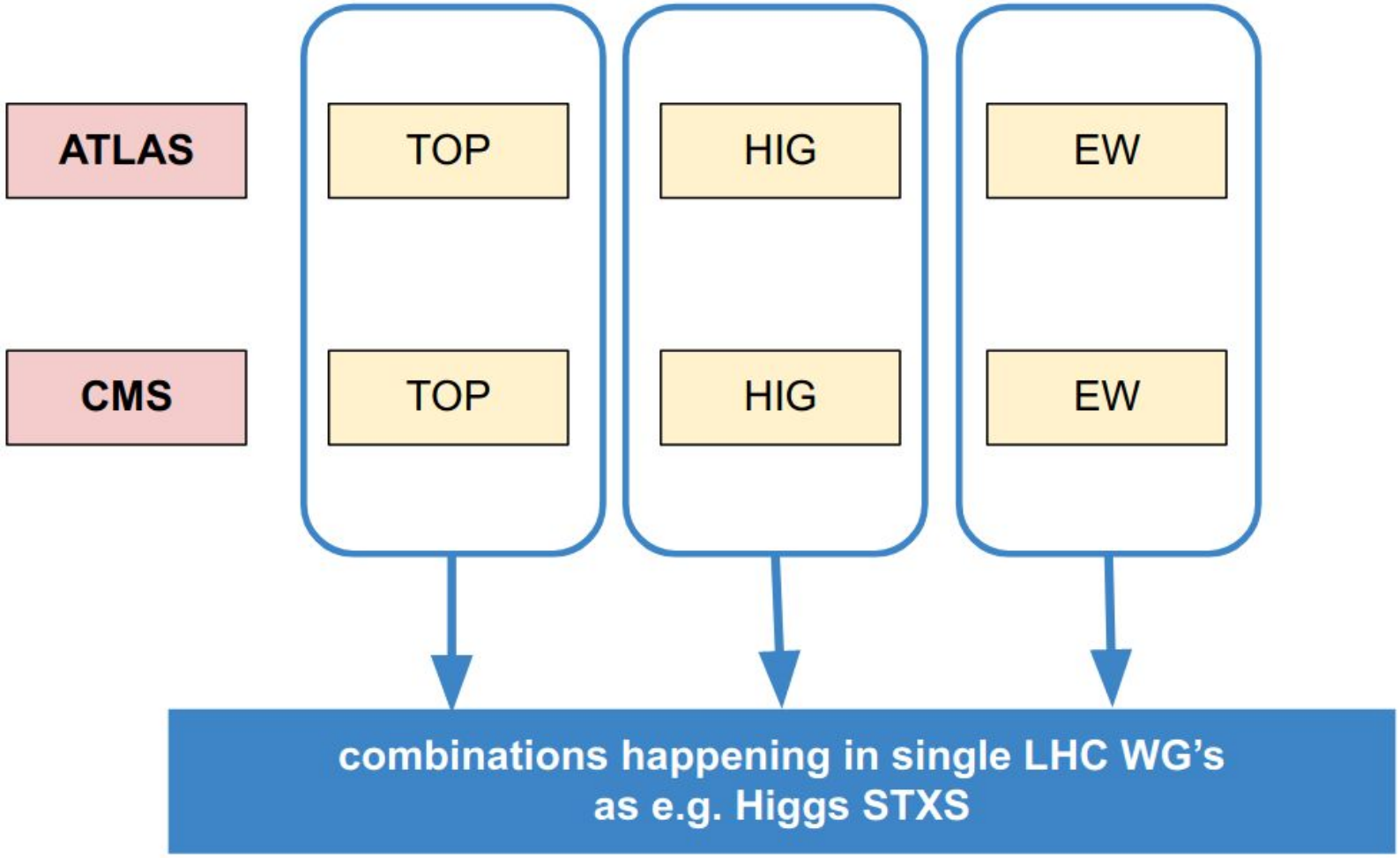
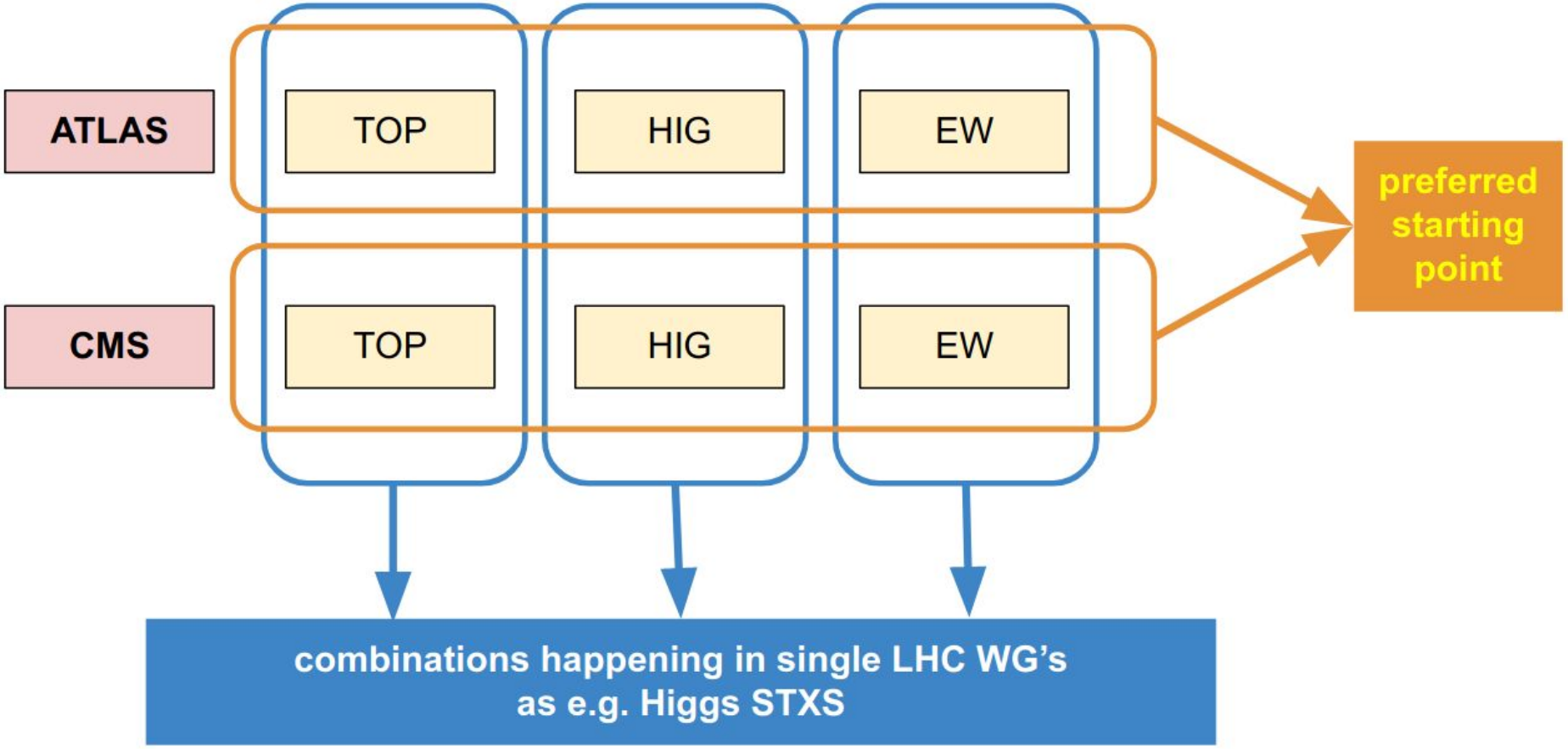


Figure from the talk from A. Grohsjean

Possible combinations



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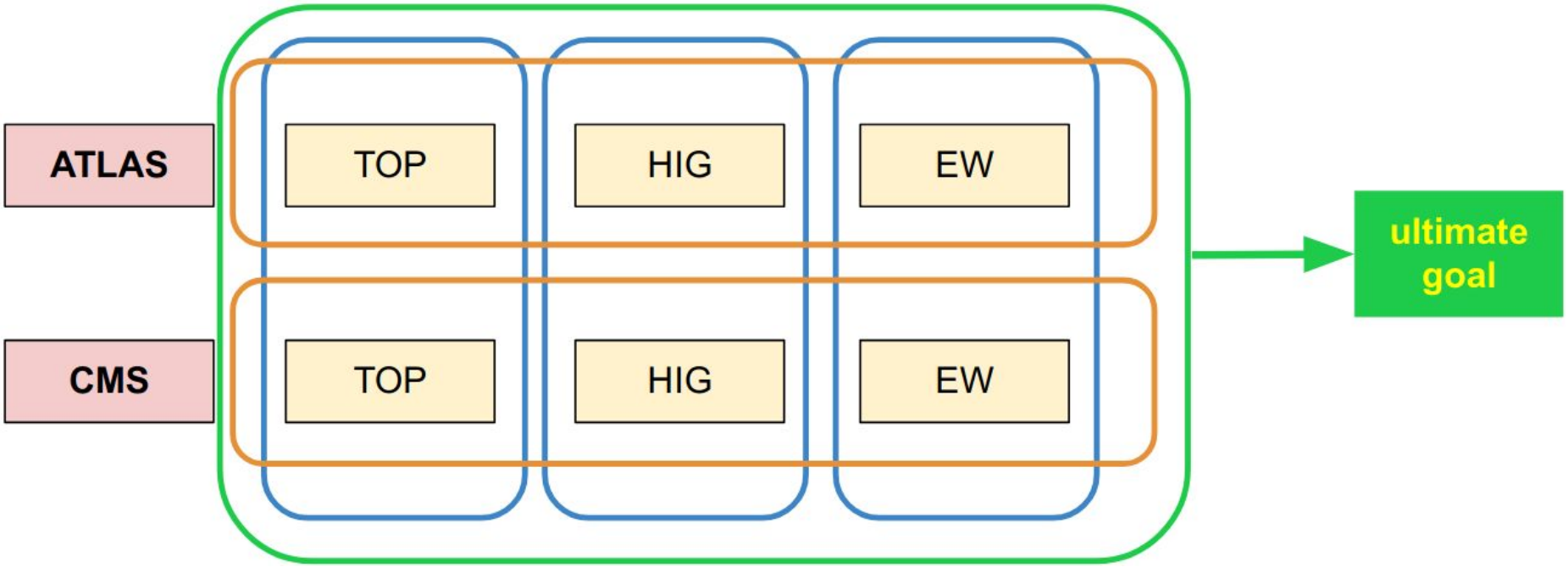

Figure from the talk from A. Grohsjean

Fitting exercise discussion at the 2nd LHC EFT WG meeting

- Important technical exercise to solve various problems
- The goal is to develop the framework and ground rules of the fit
- Might help converging to recommendations with pragmatic solutions
- First use simulated samples, no data yet
- Ideally take into account the EFT effects in backgrounds and acceptance corrections/unfolding
- Low number of measurements
  - but cover all groups: Higgs, EW and top
- Still many aspects under discussion
  - timeline
  - personpower
  - regular meetings
  - ...

Fitting exercise - ATLAS vision

- ATLAS internal global fit plans:
  - Flavour structure: “topU3l” $U(2)^3_{q,u,d} U(3)^2_{l,e}$
  - Input scheme: (m_W, m_Z, G_F)
  - SMEFTsim topU3l (for tree-level) and SMEFT@NLO (for loop-induced)
  - Single insertions of SMEFT operators for each process
  - Can benefit from the WW + H(WW) combination
  - Still many open questions: EFT validity, uncertainties in the EFT predictions,...
- Combination with CMS
  - preferring to use the above conventions
  - can be done without data
  - use internal workspaces

Fitting exercise - CMS vision

- Top group: Fit including several processes contributing to a given coupling including non-Top processes.
- CMS internal global fit plans:
  - under development
- Combination with ATLAS **based on MC**
  - can start immediately
  - using workspaces from published analyses
- Combination with ATLAS **based on Data**
  - possible only after CMS internal combination
  - be able to and jointly fit analyses performed with different technical approaches (STXS, unfolded histograms, dedicated EFT analyses at detector level...)

Summary

- LHC EFT WG efforts actively on-going
- Several write-ups available
  - possibility to comment on them
  - still work in progress
  - will lead to recommendations from the WG
- Fitting exercise
  - Important technical exercise to solve various problems
  - ATLAS+CMS+... combination of H+EW+Top
  - Many items under discussion