# Area 1. EFT formalism

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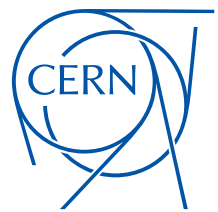
on behalf of WG conveners

2020-10-20: First general meeting

2020-12-07: First area 1 meeting

2021-01-19: Second area 1 meeting




3 May 2021
2nd General Meeting of the LHC EFT WG

# Area 1. EFT formalism

a. Bases, notations, inputs$^{***}$

common conventions, translations, common EW inputs

b. Assumptions$^{***}$

flavour structures, classes of BSM, symmetries

c. Truncation, uncertainties, validity$^{**}$

linear/quadratic, double ins., dim-8, trunc. errors, etc.

d. Theory constraints$^{**}$

unitarity, positivity, incorporation in fits

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preliminary note *here*

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# Electroweak input parameters

# Options for EFT at the LHC

with input from: A. Denner, A. Freitas, B. Pecjak
and more already received

Include non-inputs as constraints!

| $\{\alpha, G_\mu, m_Z\}$ | $\{G_\mu, m_Z, m_W\}$ | $\{\alpha, m_Z, m_W\}$ |
|---|---|---|
| +used for EWPO in the past+ | +used in tools+ | −less used− |
| +most precise inputs+ | $-m_W$ measurements actively pursued− | |
| −EFT dependent $W$ pole− | +clear model-independent meaning of mass thresholds+ | |
| −leptonic operator contaminations− | | −slightly slower convergence− |

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# Conversions for consistent combinations

- recompute (numerically)
  - for input sets available in tools

- translate (using semi-analytical expressions)

$$
\begin{aligned}
I &\longrightarrow I' \qquad \text{with} \quad I(I') = I^{\text{SM}}(I') + \delta I^{\text{EFT}}(I') + \cdots \\
O^{\text{SM}}(I) &\longrightarrow O^{\text{SM}}(I^{\text{SM}}(I')) \\
\delta O^{\text{EFT}}(I) &\longrightarrow \delta O^{\text{EFT}}(I^{\text{SM}}(I')) + \frac{\partial O^{\text{SM}}}{\partial I}(I^{\text{SM}}(I')) \quad \delta I^{\text{EFT}}(I') \\
\delta^2 O^{\text{EFT}}(I) &\longrightarrow \cdots
\end{aligned}
$$

  - smaller shifts at higher EW orders
  - leading linear modifications require only $O^{\text{SM}}$ as function of $I$

# Truncation, uncertainties, validity

# Common ground

1. dim-6 truncation in the near future
   EFT validity = dim-6 matches full model

2. well-defined squares of single dim-6 insertions "$(\text{dim-6})^2$"
   translatable exactly between dim-6 bases

3. required UV assumptions to compare dim-6 and -8 magnitudes
   UV-dependent EFT validity (e.g. using a *power counting*)

# Theory proposals A & B

based on [HXSWG '16], [LHC TOP WG '18]
A: proposal, video, slides, Contino, Falkowski, Goertz, Grojean, Maltoni, Panico, Riva, Wulzer
B: proposal, video, Degrande, Maltoni, Mimasu, Vryonidou, Zhang

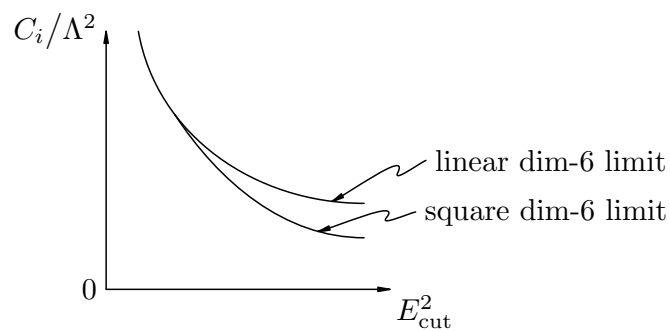
1. multi-dimensional likelihoods in EFT space
   → interpretability required for validity

2. quadratic [default] vs. linear comparison
   → qualitative validity: *broad* or *restricted*

3. control over probed scale

   (e.g. sliding upper cut=$E_{\text{cut}}$=$M_{\text{cut}}$=clipping, double differential, etc.)

   → re-design analyses, also for sensitivity
   → global combinations?




4. interpretation & validity *a posteriori*
   → retain UV independence till then
   → quantifying dim-8?

# Theory proposal C

1. $(\text{dim-6})^2$ as proxies for dim-8 interferences

2. many models encompassed in one power counting rule
   → models to be covered?

3. signal: linear dim-6
   unc.: known $(\text{dim-6})^2$ + dim-8 estimates

4. unc. fed into EXP analyses
   → folding-in UV assumption for dim-8 estimate

5. unc. $= \pm(\text{dim-6})^2 \times (1 + \sqrt{N_8}\frac{g_{\text{SM}}^2}{\mathfrak{C}_6\Lambda^2}\sqrt{1+\frac{1}{\mathfrak{C}_6^2\Lambda^4}})$
   → models covered?

# First experimental considerations

1. re-designing analyses is expensive
2. linear fits often fail (AB-2, C-3)
3. clip the EFT simulation instead of the data? (AB-3)
4. $c_i$-dependent of unc. are cumbersome (C-3,4,5)
5. ...

# Next steps

- community input
  - electroweak input parameters: *here*
  - truncation, uncertainties, validity: *here*
- input from experiments
- dedicated meeting
- recommendations

... and more topics to address!