

# EFT MC tools benchmarking

M.L. Mangano,  
on behalf of the

*benchmarking task-force*

*(I.Brivio, G.Durieux, F.Maltoni, O.Mattelaer, M.Trott, E.Vryonidou)*

# EFT Tools

Currently three very wide families of tools in the EFT :

1. Lagrangian, Evolution, Matching codes (Top-down)

*Examples: DEFT, Rosetta, Wilson, CoDEx, DsixTools, MatchingTools, MatchChecker*

2. Fitting tools/efforts

*TopFitter, HEPFit, SFitter, Ellis-Sanz-You, ...*

**3. MC Event generators including EFT contributions to scattering matrix elements**

# Validation & benchmarking (V&B)

A group has been set up, in coordination with the Higgs XSWG Steering Group, to focus on V&B of type-3 tools

This effort goes beyond the **Higgs**, and should provide a framework relevant to all areas of EFT of relevance to LHC, including **EW physics** (VBS, VV production, DY, ...) and **top physics** (t, tt, 4t production, rare/FCNC t decays, associated ttX production (X=V,H,...), ...)

This activity will therefore serve also the needs of the LHC top WG, and of the LHC EW WG

# The WG structure

Fabio Maltoni, Mike Trott: **conveners**

Gauthier Durieux & Olivier Mattelaer: automatic validation  
framework **development**

*Jose Santiago: contact person for HXSWG SC*

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Expressions of interest in joining the validation effort: (next page)

- Benjamin Fuks for HELC (FR/MG based)
- Athanasios Dedes for SMEFT-Rxi gauge (FR/MG based)
- Kentarou for the HC (FR/MG based)
- Gino Isidori for PO (FR/MG based)
- Simone Alioli for POWHEG
- Frank Krauss for Sherpa (tbc)
- Andy Buckley for Topfitter (FR/MG)

**Anybody interested is more than welcome to join, please contact Fabio & Mike**

# Strategy



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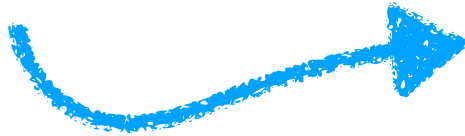
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- The same quantities are evaluated for the combinations of parameters in the second model that correspond to each operator coefficient in the first model.
- All the above information is stored as a set of events with associated weights in LHE format. Reference LHE files are made publicly available through the WG Wiki

# Ingredients

## dictionary between model 1 and 2

```
cqq1Abs1133 = 1/2*cQq11 -1/12*cQq81
cqq1Abs1331 = 1/8*cQq81 + 3/8*cQq83
cqq3Abs1133 = 1/2*cQq13 -1/12*cQq83
cqq3Abs1331 = 1/8*cQq81 -1/8*cQq83
cqq1Abs2233 = 1/2*cQq11 -1/12*cQq81
cqq1Abs2332 = 1/8*cQq81 + 3/8*cQq83
cqq3Abs2233 = 1/2*cQq13 -1/12*cQq83
cqq3Abs2332 = 1/8*cQq81 -1/8*cQq83
...
```



```
eft_dic = {
  'cQq13': {'cqq3Abs2233': '1/2', 'cqq3Abs1133': '1/2'},
  'cQq11': {'cqq1Abs1133': '1/2', 'cqq1Abs2233': '1/2'},
  'cQq81': {'cqq3Abs1331': '1/8', 'cqq1Abs2332': '1/8', 'cqq1Abs1133': '-1/12',
            'cqq3Abs2332': '1/8', 'cqq1Abs1331': '1/8', 'cqq1Abs2233': '-1/12'},
  'cQq83': {'cqq3Abs1331': '-1/8', 'cqq3Abs2233': '-1/12', 'cqq1Abs2332': '3/8',
            'cqq3Abs2332': '-1/8', 'cqq3Abs1133': '-1/12', 'cqq1Abs1331': '3/8'},
  ...}
```

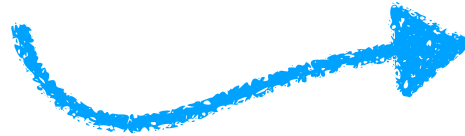


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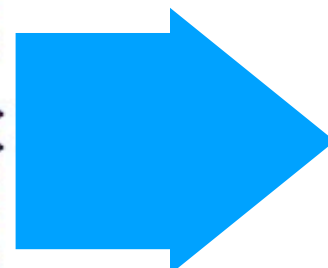
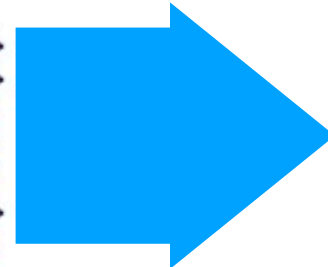
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  ...}
```



## LHE output

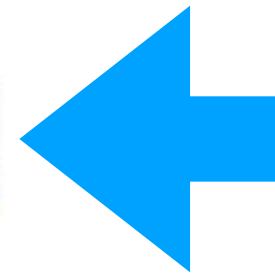
```
<event>
 4      0 +5.7925728e-01 9.11180000e+01 0.00000000e+00 1.18400000e-01
 21 -1   0   0   0   0 +0.00e+00 +0.00e+00 +5.00e+02 5.00e+02 0.00e+00 0.00e+00 9.00e+00
 22 -1   0   0   0   0 +0.00e+00 +0.00e+00 -5.00e+02 5.00e+02 0.00e+00 0.00e+00 9.00e+00
 -6  1   1   2   0   0 +1.66e+02 -3.90e+02 +2.01e+02 5.00e+02 1.72e+02 0.00e+00 9.00e+00
  6  1   1   2   0   0 -1.66e+02 +3.90e+02 -2.01e+02 5.00e+02 1.72e+02 0.00e+00 9.00e+00
```

```
<rwgt>
<wgt id='mod1-sm'> +2.1166989e-01 </wgt>
<wgt id='mod1-ctWI-int'> +1.0120350e-17 </wgt>
<wgt id='mod1-ctGI-int'> +9.9314613e-20 </wgt>
<wgt id='mod1-ctW-int'> +3.6769585e-01 </wgt>
<wgt id='mod1-ctZ-int'> -3.2187585e-01 </wgt>
<wgt id='mod1-ctG-int'> +3.0451935e-02 </wgt>
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<wgt id='mod1-ctWI-sq'> +1.5438777e+00 </wgt>
<wgt id='mod1-ctGI-sq'> +1.0589251e-02 </wgt>
<wgt id='mod1-ctW-sq'> +1.5438777e+00 </wgt>
<wgt id='mod1-ctZ-sq'> +1.1830749e+00 </wgt>
<wgt id='mod1-ctG-sq'> +1.0589251e-02 </wgt>
<wgt id='mod1-ctZI-sq'> +1.1830749e+00 </wgt>
<wgt id='mod2-sm'> +2.1166988e-01 </wgt>
<wgt id='mod2-ctWI-int'> +1.2016115e-07 </wgt>
<wgt id='mod2-ctGI-int'> +9.9515367e-09 </wgt>
<wgt id='mod2-ctW-int'> +3.6769591e-01 </wgt>
<wgt id='mod2-ctZ-int'> -3.2187587e-01 </wgt>
<wgt id='mod2-ctG-int'> +3.0451934e-02 </wgt>
<wgt id='mod2-ctZI-int'> -1.0518739e-07 </wgt>
<wgt id='mod2-ctWI-sq'> +1.5438783e+00 </wgt>
<wgt id='mod2-ctGI-sq'> +1.0589251e-02 </wgt>
<wgt id='mod2-ctW-sq'> +1.5438783e+00 </wgt>
<wgt id='mod2-ctZ-sq'> +1.1830750e+00 </wgt>
<wgt id='mod2-ctG-sq'> +1.0589251e-02 </wgt>
<wgt id='mod2-ctZI-sq'> +1.1830750e+00 </wgt>
</rwgt>
</event>
```



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process and kinematics

event wgts for individual op's, interf and square



# Ingredients

validation output

	interference			square		
	mod1	mod2	1 - mod2/mod1	mod1	mod2	1 - mod2/mod1
ctG	0.03045	0.03045	$3.284 \cdot 10^{-8}$	0.01059	0.01059	0
ctGI	$9.931 \cdot 10^{-20}$	$9.952 \cdot 10^{-9}$	$-1.002 \cdot 10^{11}$	0.01059	0.01059	0
ctW	0.3677	0.3677	$-1.632 \cdot 10^{-7}$	1.544	1.544	$-3.886 \cdot 10^{-7}$
ctWI	$1.012 \cdot 10^{-17}$	$1.202 \cdot 10^{-7}$	$-1.187 \cdot 10^{10}$	1.544	1.544	$-3.886 \cdot 10^{-7}$
ctZ	-0.3219	-0.3219	$-6.214 \cdot 10^{-8}$	1.183	1.183	$-8.453 \cdot 10^{-8}$
ctZI	$-9.981 \cdot 10^{-18}$	$-1.052 \cdot 10^{-7}$	$-1.054 \cdot 10^{10}$	1.183	1.183	$-8.453 \cdot 10^{-8}$
sm	0	0	0	0.2117	0.2117	$4.724 \cdot 10^{-8}$



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sm	0	0	0	0.2117	0.2117	$4.724 \cdot 10^{-8}$

## Note:

The minimal requirement to enable the validation for a given code is to have an LHE output, to allow it to record the SM inputs, and dump the appropriate wgts for a few phase-space points.

The validation can then be performed “on the MG5 side”, by reading in the LHE events and the model dictionary