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aMC@NLO: strategy for heavy-Higgs production and interference effects

Workshop: the case of a large-mass Higgs

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I shall consider vector-boson pair production, and never talk about Higgs production *per se*

Remember that $pp \to VV$ gets contributions from $q\overline{q} \to VV$ at $\mathcal{O}(\alpha_s^0)$, $q\overline{q} + qg \to VV$ at $\mathcal{O}(\alpha_s^1)$, and $q\overline{q} + qg + gg \to VV$ at $\mathcal{O}(\alpha_s^2)$

Loop-induced $gg \to VV$ is just a part of the full NNLO cross section

$q\overline{q} \to VV$ can be dealt with (a)MC@NLO proper – it includes all contributions up to $\mathcal{O}(\alpha_s^1)$

The loop-induced $gg \to VV$ is a LO process from the viewpoint of the IR structure. Hence, it is improper to speak about (a)MC@NLO in this case. This is straight LO as far as the MC is concerned, but still one-loop (squared) as far as the matrix elements are concerned

The matrix elements we automatically compute with MadLoop

- MadLoop typically computes one-loop *amplitudes*, interferenced with Born amplitudes. One-loop squared amplitudes are a special case in v4 – but will simply be an input option in v5
- All top- and bottom-mass effects are dealt with exactly; same for off-shell (vector boson) effects
- v4 does not implement complex-mass scheme (v5 will). However, this is not important in this case
- The code of v4 is too slow to unweight events out of the box. Need to use a code that provides a cross section to reweight, and then to unweight – e.g., MCFM

This is simply the end of the story if one doesn't care about (N)NLO corrections to Higgs production

Since "Higgs production" is not meaningful for large m_H,
read the above as $\mathcal{O}(\alpha_S^3)$ or $\mathcal{O}(\alpha_S^4)$

Do we have to care? I'm not sure, since interference effects may be larger than these corrections. But let's assume we do

Call H whatever diagrams feature Higgs exchange, and nH all the others

Study impact of interference by comparing (as in MCFM)

$$|H + nH|^2 \qquad\qquad |H|^2 + |nH|^2$$

Each of these three terms can be unweighted with MadLoop

If the interference is not so large, then get from MadLoop

$$|H + nH|^2 - |H|^2$$

and add to this the "signal" computed with MC@NLO
(i.e., $|H|^2$ at $\mathcal{O}(\alpha_S^3)$)

Note: MC@NLO v4.07 has exact m_t and m_b effects only at $\mathcal{O}(\alpha_s^2)$

These can be included (all relevant matrix elements are public, and so simple that they can be written on a piece of paper)

In all the above, the Higgs can be given a real mass and a fixed width

Conclusions

$gg \to VV$ is not among our current priorities. So we have the following pragmatic questions to the experimentalists:

- What are the minimal requirements that such a code must possess?
- What is the final deadline for you to have a code, which you will use with probability significantly different from zero?

And to the theorists:

- Is it worth including m_t and m_b effects into MC@NLO for the sake of these studies?