The V2 extensions of the POWHEG BOX

Radiation from resonances

In the POWHEG BOX V2 it is possible to include strong radiation generated from decaying resonances. In order to do so, the init_processes.f file, where the lists of Born and Real processes are defined, should also define the following arrays:

```
integer flst_bornres(1:nlegborn,flst_nborn)
```

whose entries are zero for the initial state particles and for the particles directly produced in the reaction, while, for particles coming from the decay of a resonance, it is equal to the position of the resonance in the particle list. Thus, for example, in $t\bar{t}$ production and decay:

```
flst_born(1:nlegborn,j)   =[0,  0,  6, -6, 24,-24,-11, 12, 13,-14,  5,  -5]
flst_bornres(1:nlegborn,j)=[0,  0,  0,  0,  3,  4,  6,  6,  7,  7,  3,   4]
```

with the $t\bar{t}$ pair coming from the production process, with the corresponding bornres entry equal to 0. The W^+ and the b come from the decay of the top, which is the 3rd entry, so that the bornres entry is 3; the e^+ and the ν_e come from the W^+, which is the 6th entry, and so on.

An analogous array flst_realres is supplied for the real emission graph. In this case, the radiated parton can either arise from production (realres entry equal to zero) or from a resonance (realres entry equal to the resonance position).

The BOX, on the basis of the provided lists, sets up the parameter flst_nreson equal to the number of resonances that can radiate. This includes radiation from production, that is treated as a fictitious resonance, indexed by 0. Furthermore, the array flst_reslist is set up, that contains the index of each resonance that can radiate. Its first entry is always 0, corresponding to radiation in production. If there are no radiating resonances, the BOX sets flst_nreson to 1, flst_reslist(1)=0.

The user must provide a setreal routine that returns the matrix element for radiation of a specific resonance. In order to do so, the setreal routine must inspect the variable kn_resemitter, which is a pointer to the resonance that is radiating, and supply the corresponding real matrix element. The setvirtual routine should provide the sum of the virtual contributions for the production and decay processes.

Electroweak processes

The POWHEG BOX is now capable to handle certain electroweak processes, where soft-photon radiation is generated with the shower method. The following variables are relevant for this extension:

flg_with_em must be set to true in the initialization of the user process

pdf_nparton must be set to 22, if incoming photons from parton densities are considered

em_muren2 must be set to the (squared) renormalization scale for the EW corrections

em_alpha must be set to $\alpha_{\rm em}$.

The BOX is capable of handling photon initial and final state radiation from charged particles. It has been presently tested only with W and Z production with leptonic decays.

Bibliography

[1] T. Melia, P. Nason, R. Rontsch, and G. Zanderighi, *W^+W^+ plus dijet production in the POWHEGBOX*, 1102.4846. * Temporary entry *.

[2] T. Melia, K. Melnikov, R. Rontsch, and G. Zanderighi, *Next-to-leading order QCD predictions for W^+W^+jj production at the LHC*, *JHEP* **1012** (2010) 053, [1007.5313].

[3] S. Alioli, P. Nason, C. Oleari, and E. Re, *A general framework for implementing NLO calculations in shower Monte Carlo programs: the POWHEG BOX*, *JHEP* **1006** (2010) 043, [1002.2581].