

POWHEG: status and plans

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Current status of repository:

▶ **POWHEG BOX:**

- since revision 2801, common files mirrored in separate repository:

svn://powhegbox.mib.infn.it/trunk/POWHEG-BOX-NoUserProcesses

user processes: svn://powhegbox.mib.infn.it/trunk/POWHEG-BOX/XXX

▶ **POWHEG BOX V2:**

- MiNLO/MiNLO' merging, NNLOPS
- facility for QED/EW corrections
- scales and PDF reweighting on LHE file

svn://powhegbox.mib.infn.it/trunk/POWHEG-BOX-V2

user processes: svn://powhegbox.mib.infn.it/trunk/User-Processes-V2/XXX

▶ **POWHEG BOX RES:**

- can deal with intermediate resonances and radiation off them
- can also deal with EW corrections

svn://powhegbox.mib.infn.it/trunk/POWHEG-BOX-RES

user processes: svn://powhegbox.mib.infn.it/trunk/User-Processes-RES/XXX

POWHEG BOX: main features

- ▶ the POWHEG BOX output are partonic events [.lhe files]; hardest emission is already included, physical results only *after* parton shower
- ▶ POWHEG BOX can be considered a large library, with many SM processes available, and some BSM ones:

`svn://powhegbox.mib.infn.it`

- ▶ often the matrix elements for complex processes have been implemented by (or with the help of) the original authors of the NLO computations.
- ▶ public interfaces to Madgraph4, GoSam and OpenLoops are available, and have been tested and used.
- ▶ main focus mostly (N)NLO QCD corrections matched to PS.
- ▶ for a bunch of processes: also NLO EW corrections [and photon radiation].

POWHEG BOX: some recent physics applications

[results appeared after the talk I gave at the ATLAS-CMS MC workshop, 2 May 2017, with apologies for omissions]

- ▶ W^+W^- with leptonic decays at NNLO+PS [ER,Wiesemann,Zanderighi '18]
 - most CPU-intensive NNLO+PS application so far;
once NNLO grids available, $\mathcal{O}(1 \text{ to } 2 \text{ weeks})$ on lxplus to obtain final results
- ▶ VH at NNLOPS, with $h \rightarrow b\bar{b}$ decay at NLO [Astill,Bizon,ER,Zanderighi '18]
- ▶ VH & VH+1 jet: NLO QCD + EW [Granata,Lindert,Oleari,Pozzorini '17]
 - optimized handling of 1-loop amplitudes
- ▶ 5F t-channel single-top & single-top+1j NLO merging with MiNLO [Carrazza,Frederix,Hamilton,Zanderighi '18]
 - neural network fit of unknown terms in MiNLO Sudakov exponent
- ▶ 4F $t\bar{t} + b\bar{b}$ at NLO+PS [Jezo,Lindert,Moretti,Pozzorini '18]
- ▶ alternative method to generate radiation off heavy quarks [Buonocore,Nason,Tramontano '17]
- ▶ ... as well as some pheno applications, for instance study on top mass extraction [Ferrario Ravasio,Jezo,Nason,Oleari '18]

- ▶ default: **unweighted events**.
 - at times, weighted events become needed [e.g. bias to populate large-pt regions, NNLOPS reweighting]
- ▶ **negative weights**: despite the “P” of the POWHEG acronym, in some cases, they can appear.
 - in any case, limiting them is possible, through “folding”. Runs become longer, as number of calls to (real) matrix elements increases.
 - consider that fraction of neg. weighted events that passes cuts might be quite different from the fraction in the “inclusive” sample... [e.g. V+1 jet at NLO+PS without MiNLO]
 - although folding costs time, for complicated processes with complex 1-loop amplitudes, the overall overhead to the generation time might be not that bad

POWHEG BOX: technical facilities II

- ▶ standard powheg run: 4 steps [grid1 → grid2 → upper bound → events]
- ▶ each of these steps **can be parallelized**. Grids combination done by the program itself.
- ▶ in a massive parallelization, some grids might pick up unstable points: there are flags to automatically **detect “bad” grids** and avoid including them in the next steps.
- ▶ possible to generate grids without computing 1-loop amplitudes [and include them only at stage 4]
- ▶ once a lhe file is ready: possible to write **multiple weights** during a single reweighting, as well as to use zipped .lhe files
- ▶ possible to also write **multiple weights on the fly** [for scale and PDF variation]
 - full matrix elements are called multiple times → here improvements are possible.
- ▶ following a CMS request: for NNLOPS reweighting, patched DYNLOPS code with a facility to write NNLOPS weights during event generation
 - similar to what we did for NNLOPS WW [need to have multi-dim distributions available]
 - once clear that it is ok for CMS, we'll include the change in the repository

other considerations

- ▶ some of the above facilities were introduced to tackle complex processes, others come from interaction with EXP
 - likely that this approach will continue
- ▶ as far as “new architectures, accelerators and/or OpenMP/MPI parallelization” is concerned, so far there’s no effort, as far as I know
- ▶ NNLOPS reweighting works, but it’s CPU intensive [when thinking at possible future applications]
 - hope is to find a better way to achieve same accuracy, without the need of a reweighting through an external NNLO input
- ▶ MiNLO merging: for processes with light partons in the final state, there’s a proposal and results for H , $H + 1$ and $H + 2$ jets; possible avenue for further progress.

[Frederix,Hamilton '15]

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[Frederix,Hamilton '15]

Thank you for your attention!