Manual for Higgs boson production via vector-boson fusion in association with three jets in the POWHEG-BOX-V2

The VBF_HJJJ program in the POWHEG-BOX-V2 is an implementation of Higgs boson production via vector-boson fusion in association with three jets. Details of the calculation are described in Ref. [1]. If you use this program, please quote Refs. [1–4].

Running the program

Download the POWHEG-BOX-V2, following the instructions at the web site

http://powhegbox.mib.infn.it/

and go to the process directory by typing

```
$ cd POWHEG-BOX-V2/VBF_HJJJ
```

Running is most conveniently done in a separate directory. Together with the code, we provide the directory testrun that contains sample input and seed files.

For your runs, generate your own directory, for instance by doing

```
$ mkdir myruns
```

The directory must contain the powheg.input file, a file vbfnlo.dat where boson masses and electroweak input parameters are set, and, for parallel running, a pwgseeds.dat file (see manual-BOX.pdf and Manyseeds.pdf in the POWHEG-BOX-V2/Docs directory).

Before compiling make sure that:

- fastjet is installed and fastjet-config is in the path,
- lhapdf is installed and lhapdf-config is in the path,
- gfortran, ifort or g77 is in the path, and the appropriate libraries are in the environment variable LD_LIBRARY_PATH.

After compiling the executable pwhg_main in the VBF_HJJJ directory, enter the myruns directory and perform all your runs there.

We recommend running the program in a parallel mode in several consecutive steps by setting

```
manyseeds 1
```

in the file powheg.input. The four steps of grid generation, NLO calculation, upper bound generation, and event generation can then be performed in parallel, consecutively, as described, for instance, in the manual of the VBF_Z_Z directory in the POWHEG-BOX-V2.

If the default analysis is activated by setting the flag `ANALYSIS=default` in the Makefile before compiling the code, after the completion of the NLO calculation for each parallel run a file `pwg-*-NLO.top` is generated (where the * denotes the integer identifier of the run). These files contain histogram information at fixed-order accuracy for a representative experimental setup in gnuplot-friendly format. The default analysis routine can easily be replaced with a personalized one by the user.

The events that are ultimately generated in Les Houches format can be processed by a generic Monte-Carlo program. We are providing an interface to `PYTHIA 6.4.25` that can be used by generating the executable `main-PYTHIA-lhef` and running it in the directory where the event files are stored. The program then generates an output file `pwgPOWHEG+PYTHIA-output.top` that contains histograms at NLO+PS accuracy. The Monte-Carlo parameters can be modified by the user in the file `setup-PYTHIA-lhef.f`.

References

[1] B. Jäger, F. Schissler, and D. Zeppenfeld *Parton-shower effects on Higgs boson production via vector-boson fusion in association with three jets*, JHEP **1407** (2014) 125.

[2] T. Figy, V. Hankele, and D. Zeppenfeld, *Next-to-leading order QCD corrections to Higgs plus three jet production in vector-boson fusion*, JHEP **0802** (2008) 076.

[3] K. Arnold *et al.*, *VBFNLO: A Parton level Monte Carlo for processes with electroweak bosons*, Comput. Phys. Commun. **180** (2009) 1661; J. Baglio *et al.*, *VBFNLO: A Parton Level Monte Carlo for Processes with Electroweak Bosons – Manual for Version 2.7.0*, arXiv:1107.4038 [hep-ph].

[4] 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.