

The POWHEG BOX user manual: Higgs boson production in vector-boson fusion

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ABSTRACT: This note documents the use of the package POWHEG BOX for Higgs boson production in vector-boson fusion processes. Results can be easily interfaced to shower Monte Carlo programs, in such a way that both NLO and shower accuracy are maintained.

KEYWORDS: POWHEG, Shower Monte Carlo, NLO.

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1. Introduction

The POWHEG BOX program is a framework for implementing NLO calculations in Shower Monte Carlo programs according to the POWHEG method. An explanation of the method and a discussion of how the code is organized can be found in refs. [1, 2, 3]. The code is distributed according to the “MCNET GUIDELINES for Event Generator Authors and Users” and can be found at the web page

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

In this manual, we describe the POWHEG NLO implementation of Higgs boson production in vector-boson fusion processes, as described in ref. [4]

2. Generation of events

Build the executable

```
$ cd POWHEG-BOX/VBF_H
$ make pwhg_main
```

Then do (for example)

```
$ cd testrun-lhc
$ ../pwhg_main
```

At the end of the run, the file `pwgevents.lhe` will contain 500000 events for Higgs boson production in vector-boson fusion processes in the Les Houches format.

In order to shower them with PYTHIA do

```
$ cd POWHEG-BOX/VBF_H
$ make main-PYTHIA-lhef
$ cd testrun-lhc
$ ../main-PYTHIA-lhef
```

3. Process specific input parameters

In order to improve the efficiency for the generation of events, the optional parameter `withdamp` should be set to 1, i.e. there should be the following line in the input file `powheg.input`

```
withdamp 1 ! (default 0, do not use) use Born-zero damping factor
```

The default invariant Higgs boson mass is distributed according to a Breit-Wigner (BW) with a running width. In case one is interested in the generation of a Higgs boson invariant mass with a fixed width, the following line should be present in the `powheg.input` file

```
whiggsfixedwidth 1 ! if 1, use old behaviour with fixed width Breit-Wigner  
! default is running width
```

The complex-pole scheme according to Passarino et al. is activated by the flag

```
complexpolescheme 1 ! complex-pole scheme according to Passarino et al.
```

In case the POWHEG BOX is interfaced to PYTHIA or HERWIG, it is possible to select the Higgs boson decay products by setting the optional parameter `hdecaymode` to one of the allowed values

```
hdecaymode -1 ! -1 no decay  
! 0 all decay channels open  
! 1-6 d dbar, u ubar, ..., t tbar  
! 7-9 e+ e-, mu+ mu-, tau+ tau-  
! 10 W+W-  
! 11 ZZ  
! 12 gamma gamma
```

References

- [1] P. Nason, “A new method for combining NLO QCD with shower Monte Carlo algorithms,” *JHEP* **0411** (2004) 040 [arXiv:hep-ph/0409146].
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