

# The POWHEG-BOX-WZ manual

## 1 Introduction

The POWHEG-BOX-WZ program [1] can be used to generate the QCD production of  $WZ$  events in hadronic collisions, with the  $W$  and  $Z$  bosons decaying into leptons, to NLO accuracy in QCD, in such a way that matching with a full shower program is possible. It is based upon the calculation of refs. [2], [3], [4]. The effect of  $Z$ - $\gamma$  interference, as well as the effect of off-shell singly resonant graphs, are fully included in the calculation. Anomalous coupling can also be included.

This document describes the input parameters that are specific to this implementation. The parameters that are common to all POWHEG BOX implementation are given in the `manual-BOX.pdf` document, in the POWHEG-BOX/Docs directory.

## 2 Generation of events

Do

```
$ cd POWHEG-BOX/WZ
```

```
$ make pwhg_main
```

Then do (for example)

```
$ cd test
```

```
$ ../pwhg_main
```

At the end of the run, the file `pwhgevents.lhe` will contain events for  $WZ$  production in the Les Houches format. In order to shower them with PYTHIA:

```
$ cd POWHEG-BOX/WZ
```

```
$ make main-PYTHIA-lhef
```

```
$ cd test
```

```
$ ../main-PYTHIA-lhef
```

## 3 Input parameters

Parameters in `powheg.input` that are specific to  $WZ$  production:

```
vdecaymodeW 11      ! decay mode to charged lepton of W (11=e-, -11=e+, etc.)
```

```
vdecaymodeZ 13      ! decay mode of Z (11=electron, 12=neutrino, 13=muons, etc.)
```

Only leptonic decay modes are implemented at this stage. In the case of  $Z$ -decay into neutrino, a neutrino flavour must be indicated explicitly. It is up to the user to multiply the whole cross section by three to include all neutrino flavour decays.

```
mllmin 50          ! minimum mass of Z-lepton pair in decay is 50 GeV
```

```
zerowidth 0        ! If 1 (true) use zerowidth approximation (default 0)
```

```
withinterference 1 ! If 1 (true) include interference for identical charged  
! leptons (default 1)
```

```
dronly 0           ! If 1 (true) include single resonant contributions  
! (default 1)
```

```
diagCKM 0          ! If 1 (true) use diagonal CKM (default 0)
```

If `zerowidth` is absent or not equal to one, the  $Z$  and  $W$  are given finite width. Interference effects are included if the leptons originating from the  $Z$  decay are the same flavour as those originating from the  $W$  decay, unless `withinterference` flag is set to 0. Singly resonant graphs are also included by default, unless the `dronly` flag is set to 1. The charge of the  $W$  boson is determined through its decay mode. The CKM matrix is set by default to the Cabibbo submatrix (i.e.  $V_{ub} = V_{cb} = V_{td} = V_{ts} = 0$ ,  $V_{tb} = 1$ ), assuming the PDG value  $V_{ud} = 0.974$ , unless `diagCKM = 1`, in which case a diagonal CKM matrix is used. Seven anomalous couplings are used: `delg1_z`, `delg1_g`, `lambda_z`, `lambda_g`, `delk_g`, `delk_z`, `tevscale` (see [5] for a definition of these). These are set to 0 by default, unless a non zero value is given in the `powheg.input` file.

## Bibliography

- [1] T. Melia, P. Nason, R. Rontsch, and G. Zanderighi.
- [2] L. J. Dixon, Z. Kunszt, and A. Signer, *Helicity amplitudes for  $O(\alpha_s)$  production of  $W^+W^-$ ,  $W^\pm Z$ ,  $ZZ$ ,  $W^\pm\gamma$ , or  $Z\gamma$  pairs at hadron colliders*, *Nucl.Phys.*
- [3] J. M. Campbell and R. Ellis, *An Update on vector boson pair production at hadron colliders*, *Phys.Rev.* **D60** (1999) 113006, [[hep-ph/9905386](#)].
- [4] J. M. Campbell, R. Ellis, and C. Williams, *Vector boson pair production at the LHC*, [arXiv:1105.0020](#).  
\* Temporary entry \*.
- [5] L. J. Dixon, Z. Kunszt, and A. Signer, *Vector boson pair production in hadronic collisions at order  $\alpha_s$ : Lepton correlations and anomalous couplings*, *Phys. Rev.* **D60** (1999) 114037, [[hep-ph/9907305](#)].