The POWHEG-BOX-WZ manual

1 Introduction

The POWHEG-BOX-WZ program [5] 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. [3], [1], [2]. The effect of Z-γ 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 `pwgevents.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 ZZ pair production:

```
only-e 1       !  only e e e nue (all charges)
only-mu 1      !  only mu mu mu numu
only-tau 1     !  only tau tau tau nutau
emumu 1        !  e mu mu nue
muee 1         !  mu e e numu
...
```

More conditions can be easily added, by editing the `alloweddec` function in the `init_processes.f` file. Notice that conditions must all be fulfilled. Thus, for example, `only-e` and `only-mu` are both set to 1 you get no events. If no conditions are specified, you get all possible 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. $V_{\rm ub} = V_{\rm cb} = V_{\rm td} = V_{\rm ts} = 0$, $V_{\rm tb} = 1$), assuming the PDG value $V_{\rm ud} = 0.974$, unless diagCKM = 1, in which case a diagonal CKM matrix is used. Seven anomalous couplings are used: `delg1_z`, `de1g1_g`, `lambda_z`, `lambda_g`, `delk_g`, `delk_z`, `tevscale` (see [4] 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] John M. Campbell and R. Keith Ellis. An Update on vector boson pair production at hadron colliders. *Phys.Rev.*, D60:113006, 1999.

[2] John M. Campbell, R. Keith Ellis and Ciaran Williams. Vector boson pair production at the LHC. *JHEP*, 1107:18, 2011.

[3] Lance 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.*, B531:3–23, 1998.

[4] Lance 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.*, D60:114037, 1999.

[5] Tom Melia, Paolo Nason, Raoul Rontsch and Giulia Zanderighi. W+W-, WZ and ZZ production in the POWHEG BOX. *JHEP*, 1111:78, 2011.