ILC top pair production and decay with MCPWNLO

1 Introduction

This manual describes how to generate e^+e^- annihilation events at a 500 GeV ILC with NLO accuracy using the POWHEG [1] method. More details on the use and application of the program and its interface with Herwig++ [2] can be found in [3].

2 Setting the parameters

Within the directory MCPWNLO/ILCTTBAR, the file ILCTTBAR500_INPUTS.h includes all the available user parameters for the main program ILCTTBAR500.cxx for POWHEG event generation. The parameters are:

double cme: The center of mass energy in GeV e.g. 500 for ILC. This is hard-wired for the code at present.
int Pem: Polarization of the beam electrons (1 or -1).
int Pep: Polarization of the beam positrons (1 or -1).
double Mz: Pole mass of the Z boson in GeV.
int nevgen: Number of events to generate (typically $\approx 10^5$).
int rseed: Initial seed for the random number generator.
bool POWHEGprod:Set to true if the POWHEG method is to be used for production.
bool POWHEGdecay:Set to true if the POWHEG method is to be used for the decays.
bool truncpro:Set to true if the truncated shower is to be switched on in the production process.
bool truncdec:Set to true if the truncated shower is to be switched on in the decay process.

3 Generating partonic events

After setting the parameters, open the Makefile and set HERWIGDIR to the address of the Herwig folder in the directory MCPWNLO. To run ILCTTBAR500.cxx, in the directory ILCTTBAR, type the following commands :

```
make clean
make
```

This creates the executable ILCTTBAR500 and run_ilc (which is moved to HERWIGDIR). Next, type:

```
.\ILCTTBAR500
```

This runs the main program and generates the Les Houches file for interface with Herwig++. This file will be called `ILCTTBAR500.dat` and contains unweighted events with absolute weights of 1.

4 POWHEG requirements

If running `POWHEG`, go to the folder `PWInstallFiles` in the main `MCPWNLO` directory. There you will find the following files:
`Evolver.cc` `Evolver.h` `Evolver.icc` `PartnerFinder.cc` `PartnerFinder.h` `PartnerFinder.icc`
Replace the files of the same names in `/Shower/Base` folder of your Herwig++ installation directory. Then go back to the `Shower` folder (not in `Base`!) and type:

```
make
make install
```

This allows us to veto the shower and set the colour partner of the hardest emission correctly for `POWHEG`.

5 Analysis

In the folder `ILCAnalysis` in the `ILCTTBAR` directory are some analysis files which analyze the events after interfacing the Les Houches file with Herwig++.
The `SimpleILCAnalysis.cc` file contains the main program which provides histograms for various distributions. Open the `Makefile` and set `HPDIR` and `THEPEGDIR` to the folder where you installed Herwig++ and ThePEG. Compile the directory by typing the following commands

```
make
make install
```

in the `ILCAnalysis` directory. This recreates the `SimpleILCAnalysis.so` library.

6 Interfacing with Herwig++

Having generated the Les Houches file and set up the analysis handlers, the next step is to run Herwig++. It is assumed that both Herwig++ and ThePEG have already been installed on your system.

Now go to the directory `MCPWNLO/Herwig` and open the initialization file `ILCTTB.in`. This contains Herwig++ user parameters which can be set. A selection of these are:

`set Reader2:FileName TTB.dat`: This is the filename for the Les Houches file your generated file is converted into by the program `ILCTTBAR/run_ilc.cxx`. Leave this as it is!
`set Reader2:EBeamA 250.0`: The beam energy in GeV of the electrons.
`set Reader2:EBeamB 250.0`: The beam energy in GeV of the positrons.
`set LesHouchesHandler:WeightOption UnitWeight`: The weight option for the events.
`insert SimpleEE:MatrixElements 0 MEee2gZ2qq`: The hard process. Here it's set up for Z/gamma production and decay into $q\bar{q}$ pairs.
`set MEee2gZ2qq:MinimumFlavour 6`: These sets the decays exclusively into top pairs.
`set MEee2gZ2qq:MaximumFlavour 6`: These sets the decays exclusively into top pairs.
`set /Herwig/Shower/Evolver:HardVetoMode 1`: The veto mode to be applied. For `POWHEG`, this should be set to 1.
`set /Herwig/Shower/Evolver:POWHEGTOPVeto 1`: The `POWHEG` top veto mode to be applied.
`set /Herwig/Shower/PartnerFinder:PHPartnerFinder 1`: The partner finder option. This should be set to 1 for `POWHEG`.

Having set up the initialization file, run Herwig++ by typing the following commands:

```
.\run_ilc [eventfile] [number of events]
```

An example of the run command is:

```
.\run_ilc /usera/seyi/MCPWNLO/ILCTTBAR/ILCTTBAR500.dat 10000
```

where you should replace the eventfile with the path to your Les Houches file.
At the end of the run, a topdrawer file `MG_SimpleILC.top` will be produced containing the histograms booked by the analysis handler. If you have topdraw installed, you can convert this to a postscript file by typing the command:

```
td -dPOSTSCRIPT *.top
```

7 Further Information

For further information about `MCPWNLO` contact: `seyi@hep.phy.cam.ac.uk`.

References

[1] P. Nason, "A new method for combining NLO QCD with shower Monte Carlo algorithms," *JHEP* **11** (2004) 040, hep-ph/0409146.

[2] M. Bahr *et al.*, "Herwig++ Physics and Manual," *Eur. Phys. J.* **C58** (2008) 639–707, 0803.0883.

[3] O. Latunde-Dada, "Applying the POWHEG method to top pair production and decays at the ILC," *Eur. Phys. J.* **C58** (2008) 543–554, 0806.4560.