The pmcs_herwig_x Executable

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Abstract

This brief note describes the *pmcs_herwig_x* executable and relevant features associated with it.

1 Introduction

PMCS is a parameterised simulation of the the DØ detector[1]. It takes events from an event generator, typically PYTHIA[2], and models the detector resolution effects. This note is intended as an aid to users of the *pmcs_herwig_x* executable. This executable uses the HERWIG [3] product to generate events.

2 Compiling and Running

A summary of getting started with PMCS can be found on the PMCS homepage[1]. This section only notes a couple of features pertaining specifically to the herwig executable. The first thing to note is that when compiling you must have the line binherwig in the file pmcs/SUBDIRS. To run cd to the directory pmcs/rcp and enter the command

$$pmcs\_herwig\_x - rcpframe\_pmcs\_herwig.rcp$$

At present this executable cannot be used with mcrunjob or d0tools. To run there must be a herwig.cmd file in the directory where running to direct which process to generate and to provide other information needed by herwig.

2.1 Switches in the herwig.cmd File

A full list of switches can be found in the herwig manual[3], a few of the more important are listed here.

- *EVENTS* Number of events to generate.
- *PROCESS* Process to generate. A list can be found in Reference [3], typical processes are $Z/\gamma^* \to \mu^+\mu^-$ (1353) or $Z/\gamma^* \to e^+e^-$ (1351).
- *PDFLIB* PDF to be used. The choice is restricted to those PDFs available in the last release of PDFLIB[4].
- *EMMIN and EMMAX* The limits on the centre of mass energies for the hard scatter.

3 Minor Bugs

There is a minor bug in the d0_mcpp code that results in about 5% of events generated by Herwig being unusable. This is due to the absence of the particles produced from the hard scatter in the event record. If you are only interested in final state distributions then this won't affect you, but if you are looking to calculate an acceptance care must be taken to exclude these bad events from the inefficient sample. It is uncertain how this bug manifests itself in more complex events than Drell Yan production, where it is signalled by an absence of leptons from the hard scatter.

4 Comparison With Pythia

Included are some plots comparing the output of *pmcs_herwig_x* with *pmcs_pythia_x*. 50,000 $Z/\gamma^* \rightarrow \mu^+\mu^-$ events in the mass range 50 to 130 GeV were generated with both HERWIG and PYTHIA. The PDF used was CTEQ5L and the default tune of PYTHIA was used, resulting in disagreement in the Z p_t distribution, due to the poor description of this distribution by PYTHIA. As HERWIG does not model final state radiation, this was turned off in PYTHIA by setting the switch MSTP(71) to zero.

The first set of plots (Figures 1 to 4) show a comparison of various distributions at the generator level. Those events where no muons are produced from the hard scatter are excluded, resulting in less than 50,000 events produced by HERWIG. Therefore the number of entries in the HERWIG plot is normalised to the number of entries in the PYTHIA plot.

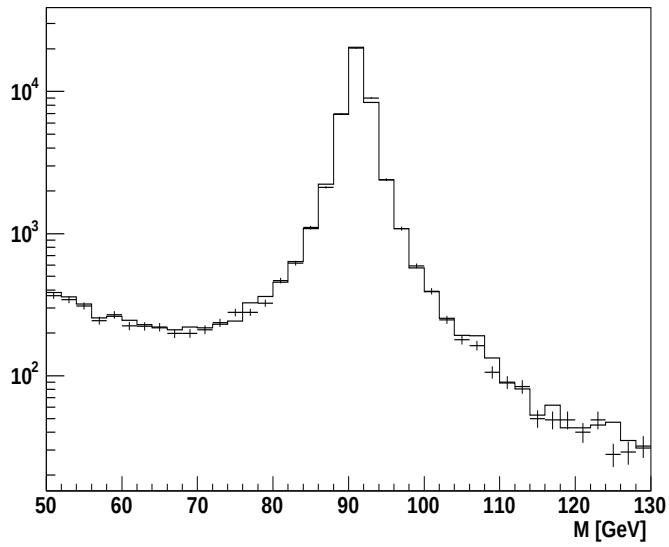

Figure 1: Generated invariant mass distribution of all di-muon pairs using HERWIG (points) and PYTHIA (line).

The second set of plots (Figures 5 and 6) show comparisons after PMCS has modeled detector resolution and efficiencies. The $Z/\gamma^* \rightarrow \mu^+\mu^-$ event selection[5] has also been applied. In the plots below the two samples have been normalised to the same area. The acceptance has been checked for consistency to be 0.244 ± 0.001 with PYTHIA and 0.243 ± 0.001 with HERWIG.

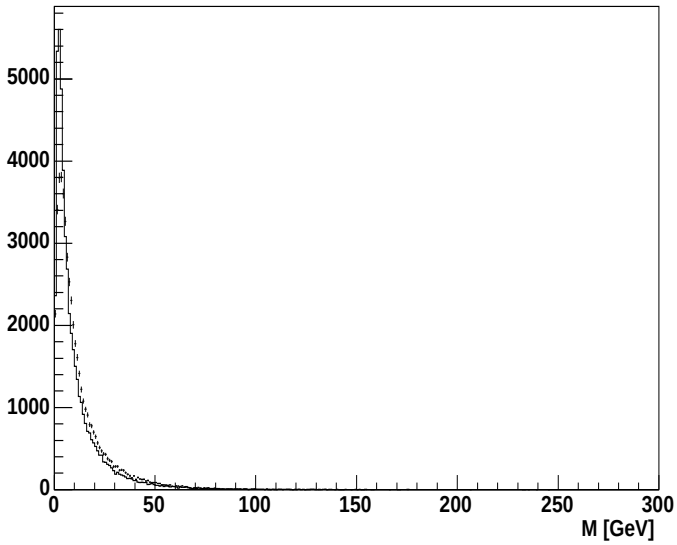

Figure 2: Generated p_t distribution of the Z boson using HERWIG (points) and PYTHIA (line).

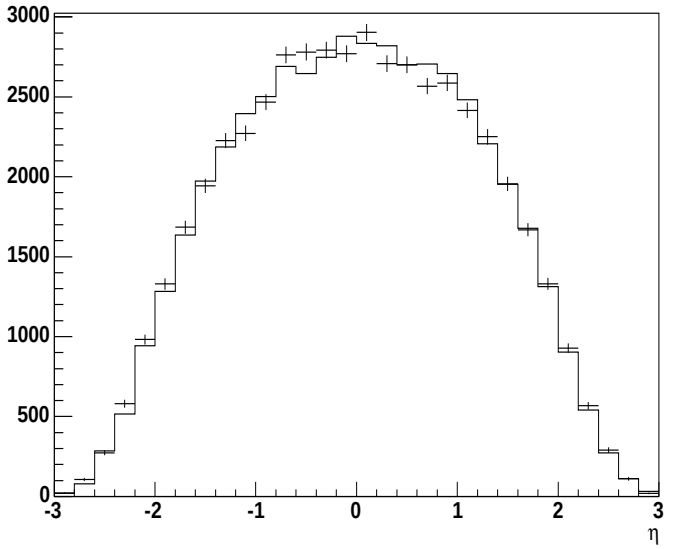

Figure 3: Generated rapidity distribution of the Z boson using HERWIG (points) and PYTHIA (line).

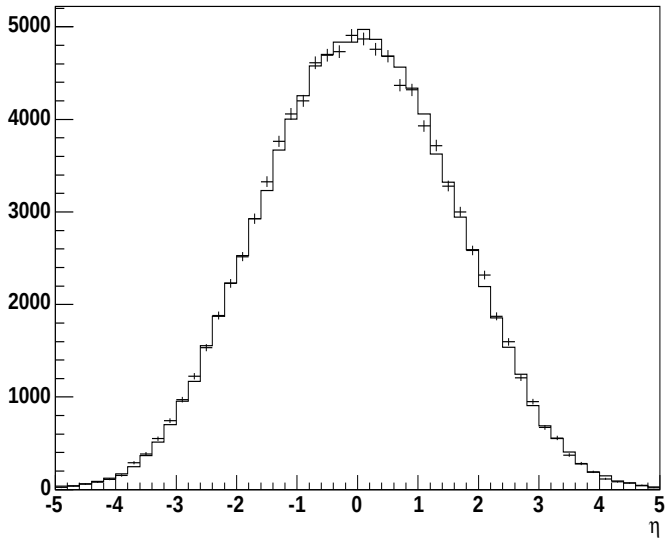

Figure 4: Generated rapidity distribution of the muons using HERWIG (points) and PYTHIA (line).

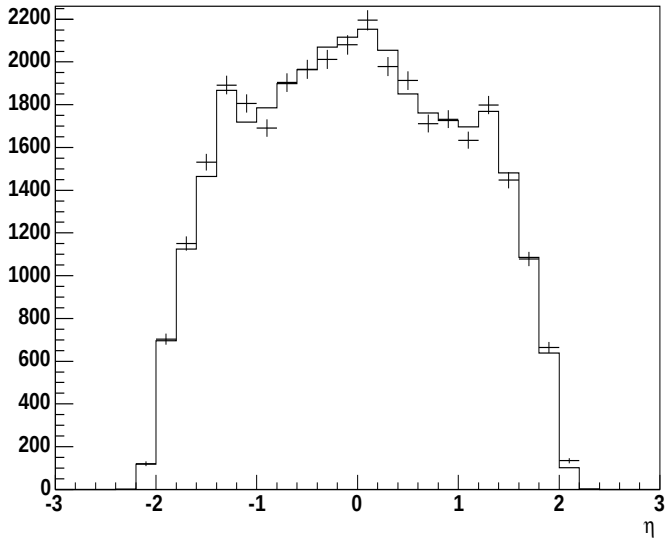

Figure 5: Smeared rapidity distribution of the muons passing the $Z \to \mu^+\mu^-$ event selection using HERWIG (points) and PYTHIA (line).

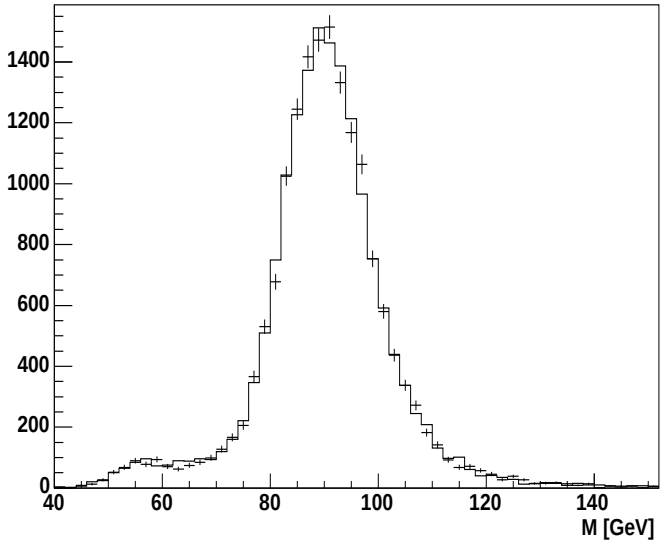

Figure 6: Smeared invariant mass distribution of di-muon pairs passing the $Z \to \mu^+\mu^-$ event selection using HERWIG (points) and PYTHIA (line).

5 Conclusions

PMCS has been interfaced with herwig to produce the *pmcs_herwig_x* executable. This note has given a brief description of some of the features associated with this executable.

References

[1] S Eno *et al*,
http://www-d0.fnal.gov/computing/MonteCarlo/pmcs/pmcs_doc/pmcs.html

[2] T. Sjöstrand *et al* Computer Physics Commun. **135**, 238 "Pythia v6.2 Physics and Manual" (2000)

[3] G. Corcella *et al* JHEP **101**, 238 "HERWIG 6.5: an event generator for Hadron Emission Reactions With Interfering Gluons (including supersymmetric processes)" (2001)

[4] H Plothow-Besch, Computer Physics Commun **75** 396 (1993)
H Plothow-Besch, Int J Mod Phys A **10** 2901 (1995)

[5] E. Nurse and P. Telford, DØ Note **4573** "Measurement of the Cross section for Inclusive Z Production in Di-muon Final States at $\sqrt{s} = 1.96$ TeV" (2004)
E. Nurse and P. Telford, DØ Note **4689** "Measurement of the Cross section for Inclusive Z Production in Di-muon Final States at $\sqrt{s} = 1.96$ TeV" (2005)