

PYTHIA-4-BSM — Hands-On Session

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Preparations

The tutorial files are available from:

`http://particle.physics.ucdavis.edu/workshops/doku.php?id=2009:mc4bsm_wishlist`

Download and unpack the PYTHIA source code:

```
gunzip pythia-6.4.20.f.gz
```

Compile the PYTHIA library:

```
g77 -c -O0 pythia-6.4.20.f
```

Alternatively, for the PGS tutorial, you should compile with gfortran:

```
gfortran -c -O0 pythia-6.4.20.f
```

Now download and unpack one or more of the example LHEF files from the same website:

```
http://hep.pa.msu.edu/people/christensen/mc4bsm/mc4bsm-CH.lhe.tar.gz
```

```
http://www.physics.ucdavis.edu/~conway/research/MC4BSM/mc4bsm-MG-decayed.tgz
```

```
http://www.physics.ucdavis.edu/~conway/research/MC4BSM/mc4bsm-CH-decayed.tgz
```

General Tip: when you need to look something up in the manual, use the index in the back or the search function of your pdf reader.

1 Processing an LHEF file through PYTHIA

Download `pythia-mc4bsm.f` and open it in `emacs` or some other editor of your choice.

1. *Locate the part where it says:*

```
C...1) Open LHEF file on unit LUN, and tell Pythia where to find it.
```

You will see that a file is opened and some switches in PYTHIA are set to point to the unit number where that file is opened. This is how you tell PYTHIA which file to read. Edit the `OPEN(...)` command so that it will open the file you have chosen to work with. You do not need to edit the rest of the program.

2. *Compile `pythia-mc4bsm.f` together with `pythia-6.4.20.o`:*

```
g77 -o pythia-mc4bsm.x pythia-mc4bsm.f pythia-6.4.20.o
```

3. Run the program `pythia-mc4bsm.x`. Wait a little while it processes the file and generates events. Upon finishing, it produces two histogram files `pythia-mc4bsm-n.dat` and `pythia-mc4bsm-pt.dat`, which contain the hadron-level charged particle multiplicities (number of generator-level tracks, limited to the range 200 to 300 tracks) and p_T spectra, respectively, with no cuts applied. Start by just looking at these distributions. Start gnuplot and plot the distribution of the number of tracks by:

```
plot "pythia-mc4bsm-n.dat" using 1:2 with histeps
```

Q: Why are only the bins with an even number of tracks populated? Now plot the p_T spectrum of charged particles by:

```
plot "pythia-mc4bsm-pt.dat" using 1:2 with histeps
```

Q: Where does the p_T spectrum peak? (x axis is in GeV)

4. Run the program `pythia-mc4bsm.x` again and study the output while PYTHIA initializes. What does it say? Which warnings are given?
5. Next study the event records which are printed out while PYTHIA is running (tip: a parenthesis (`rho+`) around a particle means it has decayed), in particular the correspondence between particle names and PDG codes (`K(1,2)`). Identify the PDG codes for: pions, kaons, protons, photons, gluons, and the quarks. (tip: the PDG codes and the event record are described in the PYTHIA manual, Chapter 5.)
6. Q: how do the multiplicities change if you switch off the underlying event? Open `pythia-mc4bsm.f` in an editor and add a bit of code towards the top of the program:
- ```
CALL PYGIVE('MSTP(81)=0')
```
- Recompile and run `pythia-mc4bsm.x`.