



Current version: 8.209

Latest version can always be found at:
<http://home.thep.lu.se/~torbjorn/Pythia.html>

The online manual is at:
<http://home.thep.lu.se/~torbjorn/pythia82html/Welcome.html>

Many interfaces to external programs:

- Interface to **LHAPDF** or other external PDF libraries.
- External showers via **VINCIA**
- Les Houches Accord files for reading events (**LHEF**) or runtime LHA interface.
- Semi-internal processes for programs like **Madgraph5**.
- **HepMC** output for programs like **RIVET**, **Delphes** etc.
- Can be compiled as a plugin to **ROOT**.
- Generalised SLHA input for any BSM model.

Today's tutorial:

- ❑ Download and install, useful options for compilation
- ❑ Read in and shower from LHE files
- ❑ Write HepMC files
- ❑ Manipulate decay table (SLHA, direct)
- ❑ Event history in Py6 format
- ❑ Use internal processes (e.g. SUSY)
- ❑ MLM matching

 Download and install, useful options for compilation

For all configure options `./configure --help`

```
./configure --enable-shared \  
--with-hepmc2=/Users/nishita/Code/HepMC/ \  
--with-fastjet3=/Users/nishita/Code/ \  
--with-root=/Users/nishita/Code/root \  
--with-lhapdf5=/Users/nishita/Code/
```

`make`

`make install` (if you used `--prefix=/installation/path/`)

The `event.list()` listing provides the main properties of each particles, by column:

- `no`, the index number of the particle (`i` above);
- `id`, the PDG particle identity code (method `id()`);
- `name`, a plaintext rendering of the particle name (method `name()`), within brackets for initial or intermediate particles and without for final-state ones;
- `status`, the reason why a new particle was added to the event record (method `status()`);
- `mothers` and `daughters`, documentation on the event history (methods `mother1()`, `mother2()`, `daughter1()` and `daughter2()`);
- `colours`, the colour flow of the process (methods `col()` and `acol()`);
- `p_x`, `p_y`, `p_z` and `e`, the components of the momentum four-vector (p_x, p_y, p_z, E) , in units of GeV with $c = 1$ (methods `px()`, `py()`, `pz()` and `e()`);
- `m`, the mass, in units as above (method `m()`).



```
particle ID      particle name
BLOCK QNUMBERS 7654321 # balleron
  1      0 # 3 times electric charge
  2      2 # number of spin states (2S+1)
  3      8 # colour rep (1: singlet, 3: triplet, 6: sextet, 8: octet)
  4      0 # Particle/Antiparticle distinction (0=own anti)
```

```
particle name    anti-particle name
BLOCK QNUMBERS 8765432 # yup yupbar
  1      2 # 3 times electric charge
  2      2 # number of spin states (2S+1)
  3      3 # colour rep (1: singlet, 3: triplet, 6: sextet, 8: octet)
  4      1 # Particle/Antiparticle distinction (0=own anti)
```

BLOCK MASS

```
#      ID code  pole mass in GeV
      7654321   800.0 # m(balleron)
      8765432   600.0 # m(yup)
```

```
#      ID      WIDTH in GeV
```

```
DECAY 7654321 2.034369169E+00 # balleron decays
```

```
#      BR      NDA      ID1      ID2      ID3      # BR( -> t b s )
      9.900000000E-01   3      6      5      3      # BR( -> t b s )
      1.000000000E-02   3      4      5      3      # BR( -> c b s )
```

- Read in and shower from LHE files
- Write HepMC files
- Modify decays

Examples: main11, main41 -> main101
Add to Makefile

List of internal processes - I

- ▶ BSM Higgses (2HDM)

Also has anomalous Higgs couplings for EFT-inspired analyses;
addition of new parameter for mixing in $h \rightarrow \tau^+ \tau^-$

- ▶ Fourth generation quarks (t' , b')

- ▶ New Gauge Bosons (Z' , W' , $R0$)

- ▶ Left-Right symmetric models

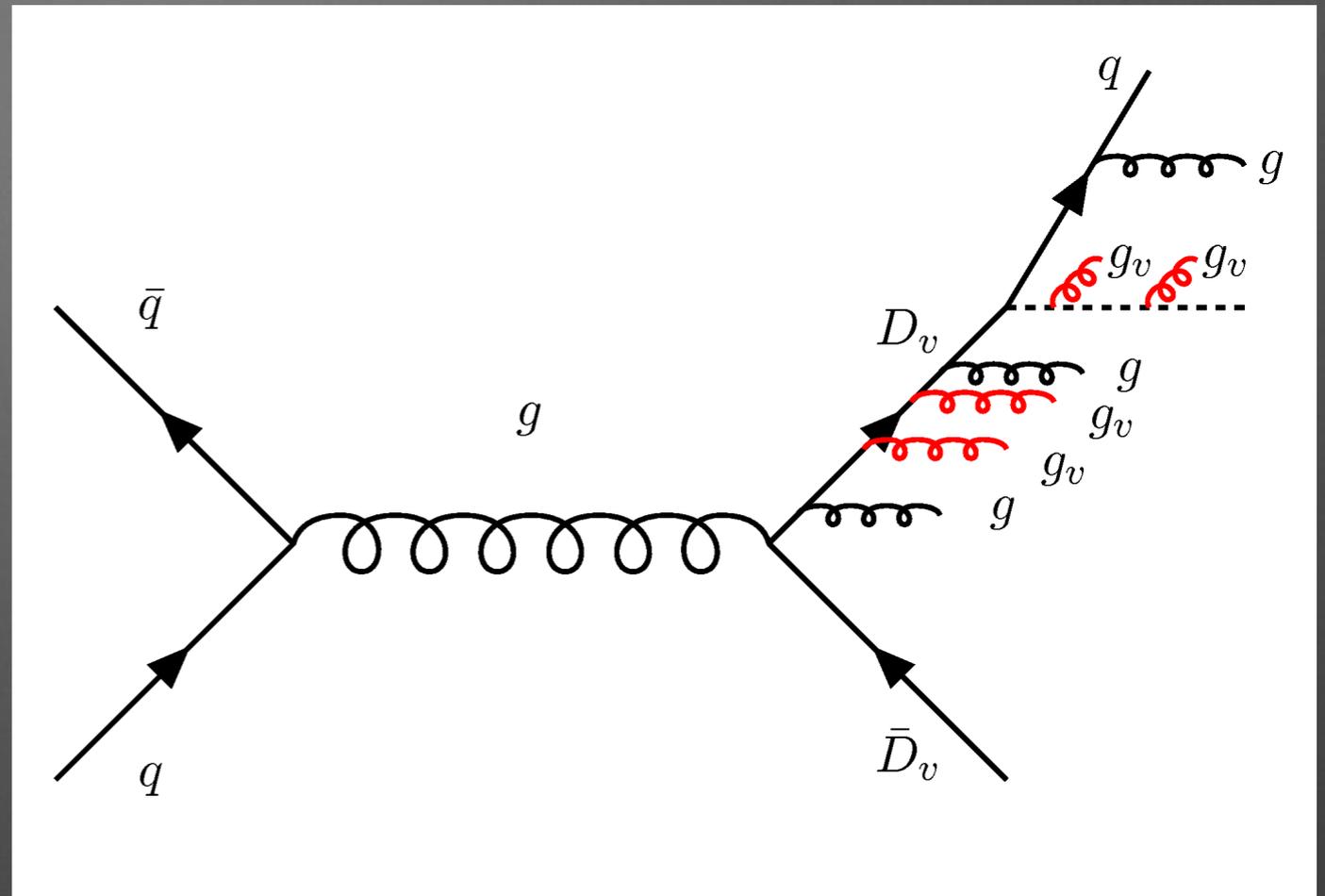
- ▶ Leptoquarks

- ▶ Compositeness

6 new processes added: excited leptons and neutrinos; Z' can now decay into excited fermions.

List of internal processes - II

- Extra dimensions:
 - Randall-Sundrum
 - Universal ED
 - Large ED
 - Unparticles



- Hidden valleys
 - Showering and hadronisation
 - in the presence of hidden gauge group

L. Carloni and T. Sjöstrand, JHEP 1009 (2010) 105

L. Carloni, J. Rathsman and T. Sjöstrand, JHEP 1104 (2011) 091

Supersymmetry

6x6 squark/slepton matrices allow processes with: CP/Flavour/R-parity violation

Can handle extra Higgses/higgsinos from NMSSM

Cross sections: All pair production (MSSM) is now validated

Event history in Py6 format (main102)

Read in initialisation at run-time, use internal processes