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PYTHIA 8 Status Report

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Apologies to participants of GENSER meeting on 22 November 2006:
only minor updates!

PYTHIA 6 status

PYTHIA 6 still being actively developed and maintained:

- multiple interactions and underlying event, with
- transverse-momentum-ordered showers
- SUSY interfaces (SLHA) and simulation
- regular bug fixes and minor improvements
- moving to CEDAR HepForge (code management, bugtracking)

Currently PYTHIA 6.409 ($\approx$ 6.408):

- 74,800 lines of code (including comments/blanks)
- 580 page PYTHIA 6.4 Physics and Manual
  T. Sjöstrand, S. Mrenna and P. Skands,
  JHEP**05** (2006) 026 [hep-ph/0603175]
- available on `http://www.thep.lu.se/~torbjorn/Pythia.html`
- together with sample main programs, old code, etc.

. . . but

- only add, never subtract

$\Rightarrow$ has become bloated and unmanageable

- is in Fortran 77, so not understood by young people

PYTHIA 8: A fresh start

Problem: PYTHIA 7 stalled, no other manpower

Solution?: take a sabbatical and work “full-time”!

($\Rightarrow$ baseline model, S. Mrenna & P. Skands join later ?)

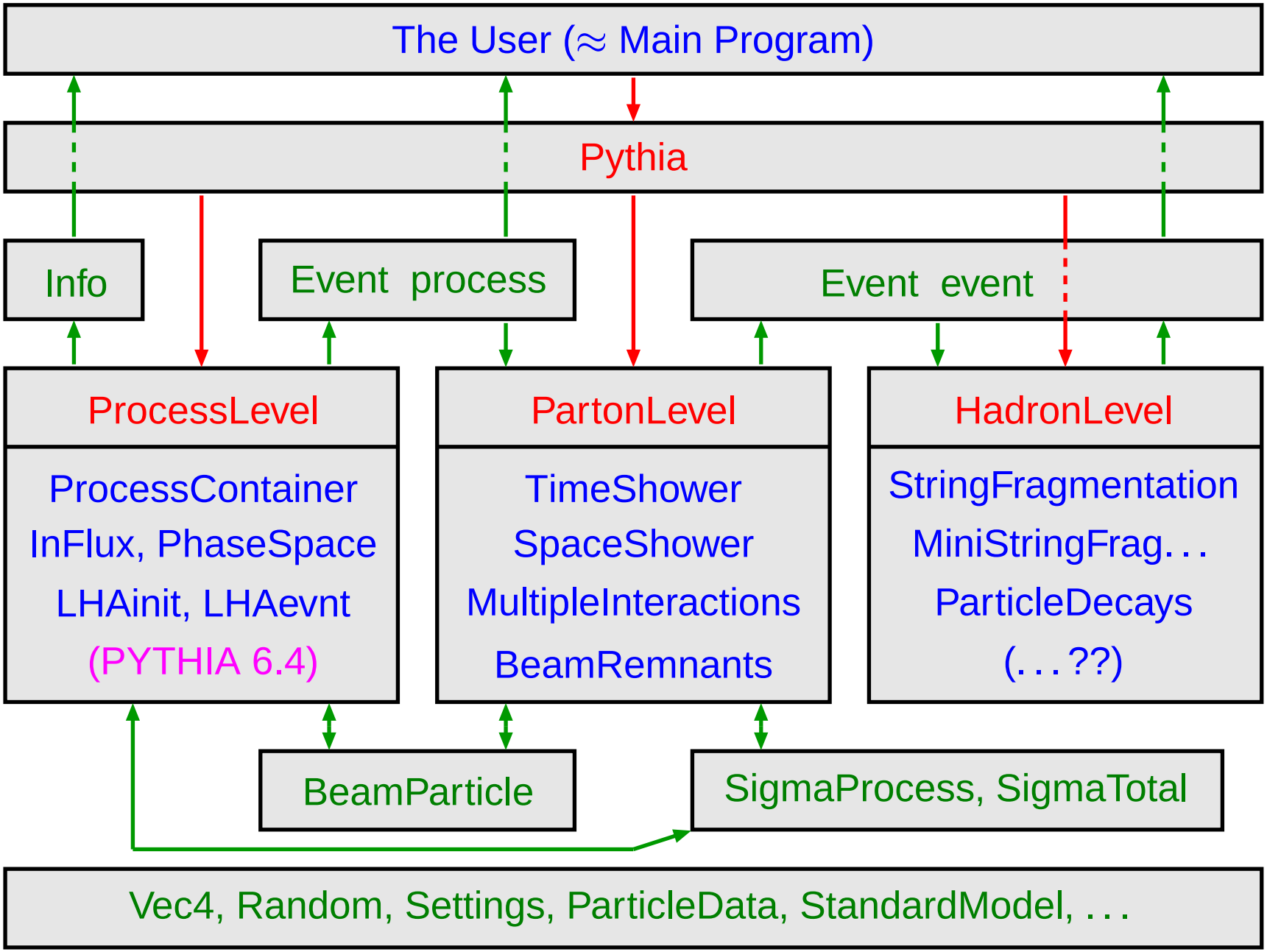
Tentative schedule (spring 2003):

time	date	processes	final states
0 =	1 Sept. 2004	—	—
1 =	1 Sept. 2005	LHA-style input	incomplete draft
2 =	1 Sept. 2006	a few processes	complete, buggy(?)
3 =	1 Sept. 2007	more processes	stable, debugged

Objectives:

- clean up, keep the most recent models
- core program completely standalone, but
- Les Houches Accord style input central
- interfaces to other libraries foreseen

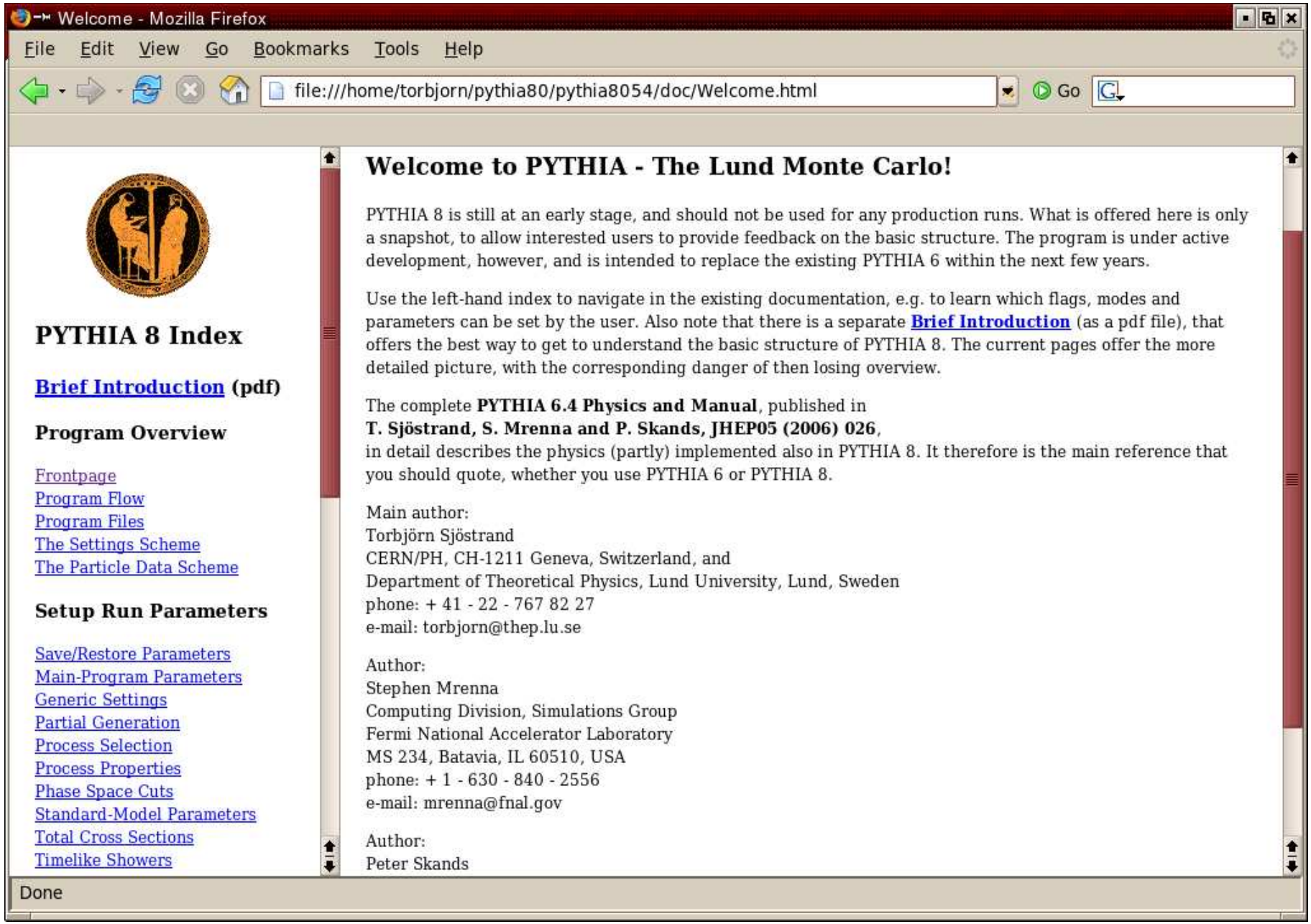
Current PYTHIA 8 structure



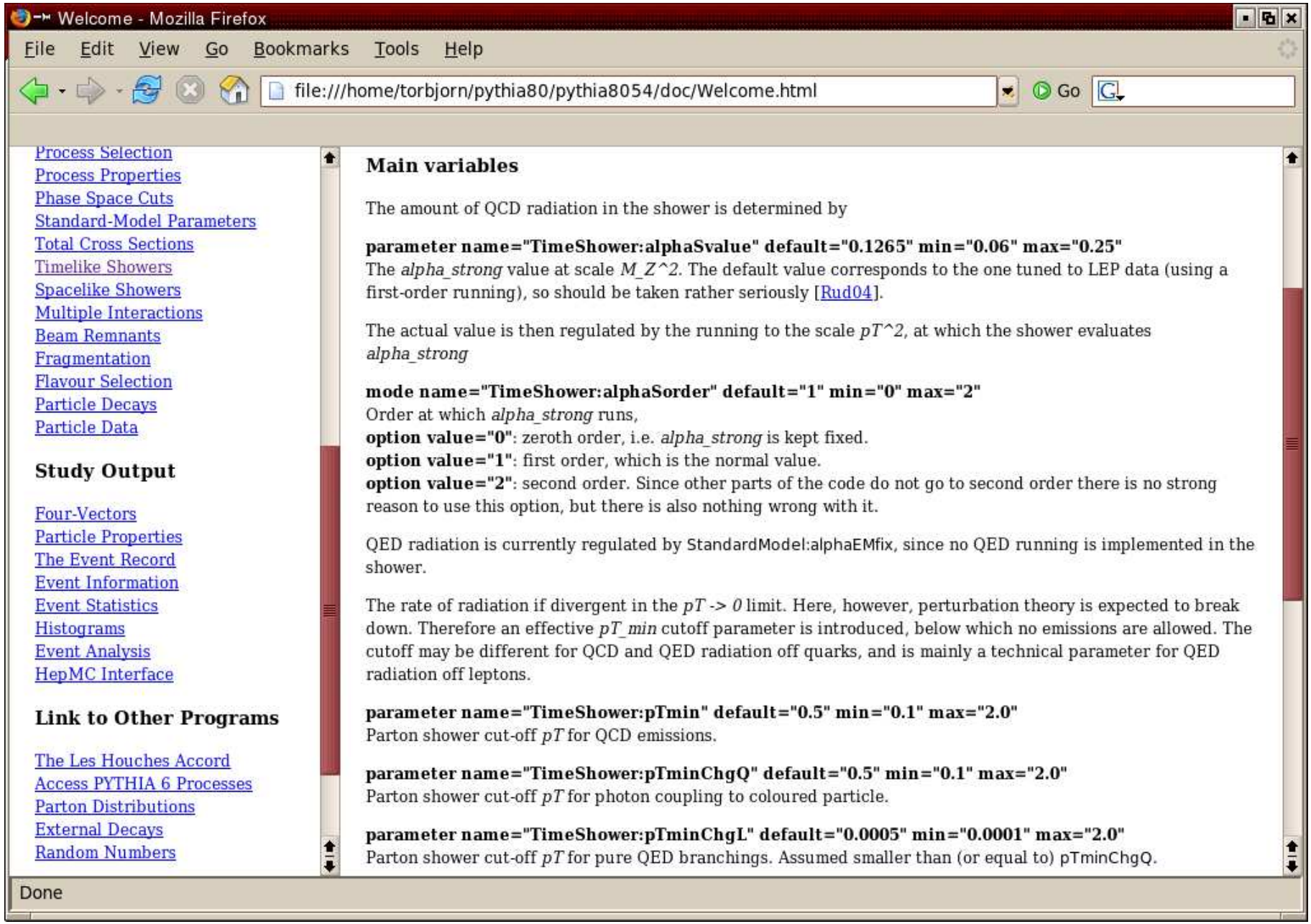
Example of a main program

```
// File: main01.cc. The charged multiplicity distribution at the LHC.
#include "Pythia.h"
using namespace Pythia8;
int main() {
  // Generator. Process selection. LHC initialization. Histogram.
  Pythia pythia;
  pythia.readString("HardQCD:all = on");
  pythia.readString("PhaseSpace:pTHatMin = 20.");
  pythia.init( 2212, 2212, 14000.);
  Hist mult("charged multiplicity", 100, -0.5, 799.5);
  // Begin event loop. Generate event. Skip if error. List first one.
  for (int iEvent = 0; iEvent < 100; ++iEvent) {
    if (!pythia.next()) continue;
    if (iEvent < 1) {pythia.info.list(); pythia.event.list();}
    // Find number of all final charged particles and fill histogram.
    int nCharged = 0;
    for (int i = 0; i < pythia.event.size(); ++i)
      if (pythia.event[i].isFinal() && pythia.event[i].isCharged())
        ++nCharged;
    mult.fill( nCharged );
  // End of event loop. Statistics. Histogram. Done.
  }
  pythia.statistics();
  cout << mult;
  return 0;
}
```

Online manual $\Longrightarrow$ GUI??



Example: timelike parton showers



Hard-process generation

Currently limited selection implemented internally:

ProcessGroup	ProcessName
SoftQCD	minBias, elastic, singleDiffractive, doubleDiffractive
HardQCD	gg2gg, gg2qqbar, qg2qg, qq2qq, qqbar2qqbarNew, qqbar2gg, gg2ccbar, qqbar2ccbar, gg2bbbar, qqbar2bbbar
PromptPhoton	qg2qgamma, qqbar2ggamma, gg2ggamma, qqbar2gammagamma, gg2gammagamma
WeakBosonExchange	ff2ff(t:gmZ), ff2ff(t:W)
WeakSingleBoson	ffbar2gmZ, ffbar2W, ffbar2ffbar(s:gm)
WeakDoubleBoson	ffbar2ZW, ffbar2WW
WeakBosonAndParton	qqbar2Wg, qg2Wq, ffbar2Wgm
Charmonium	gg2QQbar[3S1(1)]g + 18 more
Bottomonium	gg2QQbar[3S1(1)]g + 18 more
Top	gg2ttbar, qqbar2ttbar, qq2tq(t:W)
SUSY	qqbar2chi0chi0

(with resonance decays still primitive)

but can use Fortran PYTHIA 6 library transparently via LHA interface.

Can also use Les Houches Accord for any other hard process,
input via runtime C++ or Fortran interfaces or via LHE files.

Progress report and future plans

- ⋆ **August 2005, 12 month mark with 8.040**: no hard processes, simplified machinery for rest, as planned (!)
- ⋆ Then unforeseen interruption for $\sim 1/2$ year
- ⋆ Back at CERN since April 2006, progressing again (summer slowly)
- ⋆ **September 2006, 18 month mark with 8.060**: basic structure, utilities, process machinery and some hard processes, LHEF, SLHA, ...
- • Oct 2006: Decays: update tables (PDG2006, c&b from DELPHI and EVTGEN/LHC-B), new matrix elements, selection, ...
- • Nov 2006: Hadronization: $L = 1$ mesons, popcorn baryons, ministrings, ...
- • Dec 2006: Multiple Interactions: more processes, ...
- • Jan 2007: Showers: photons, LHAPDF, ...
- • Feb 2007: Showers & MI: interleave FSR with ISR and MI, ...
- • Mar 2007: Ditto & beam remnants: colour flow, reconnections, ...
- ⋆ **March 2007, 24 month mark with 8.080 (?)**: useful version
- ⋆ 3rd year: more processes, resonance decays, GUI?, **official release**
- ⋆ Debugged and tuned by LHC startup 2008 (??)
- ⋆ Overtaking Fortran version usage by 2009 (???)

Trying It Out

- Download `pythia8070.tgz` from
  `http://www.thep.lu.se/~torbjorn/Pythia.html`, link "`Future`"
- Unzip and expand with `tar xvfz pythia8070.tgz`
- Move to the thus created `pythia8070` directory
- Follow the `README` instructions (edit links to PYTHIA 6, HepMC)
- `make` will compile in $\sim$ 6 minutes
  (1/3 for archive library, 1/3 for shared, 1/3 for PYTHIA 6)
- The `pythia8070.pdf` file contains an introduction to the program
- Open `doc/Welcome.html` in a web browser for the full manual
  (in the future: GUI with xml + Javascript ?)
- The `examples` subdirectory contains 17 sample main programs
  (`make mainNN` and then `mainNN.exe > outfile`)

Makefiles, install procedure & HepMC interface by Mikhail Kirsanov.