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THEPEG, HERWIG++ and ARIADNE

- Introduction
- Overview
- Status
- Current Work
- ARIADNE

Tsukuba
2006.04.22
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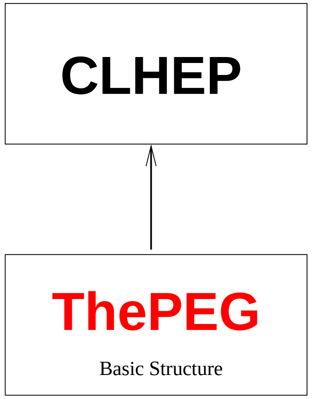

CLHEP

ThePEG

Basic Structure

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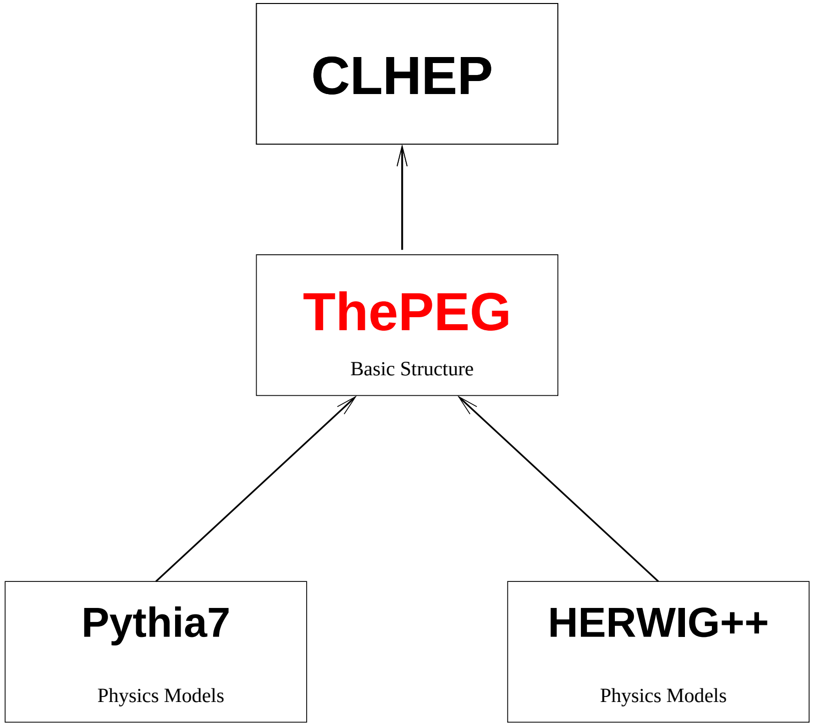

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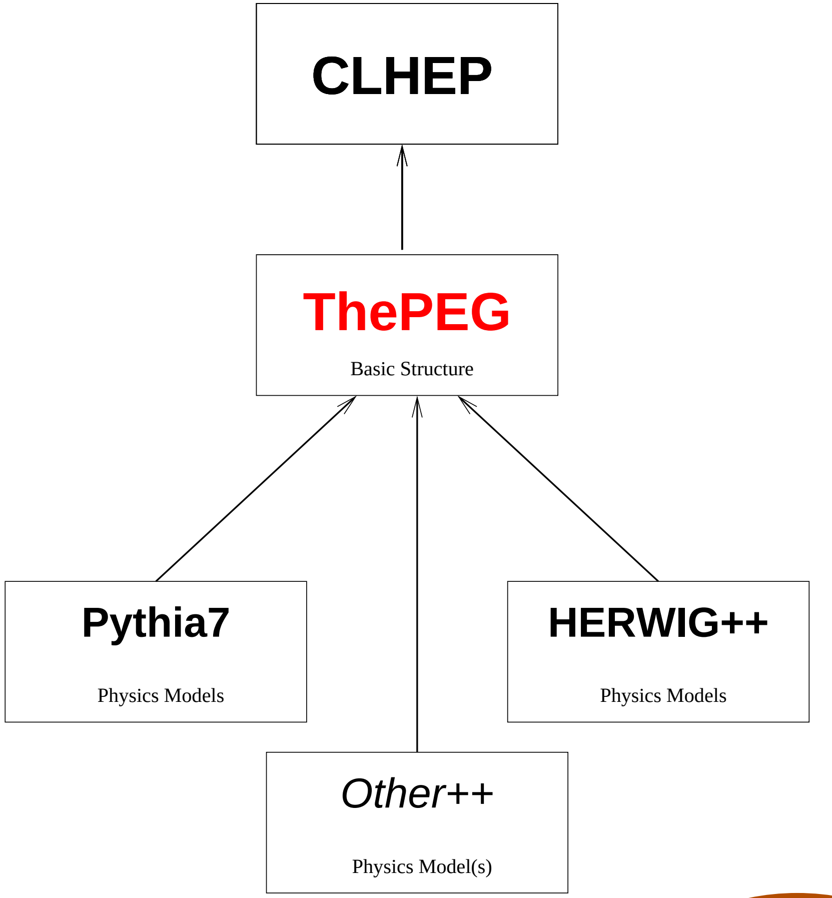

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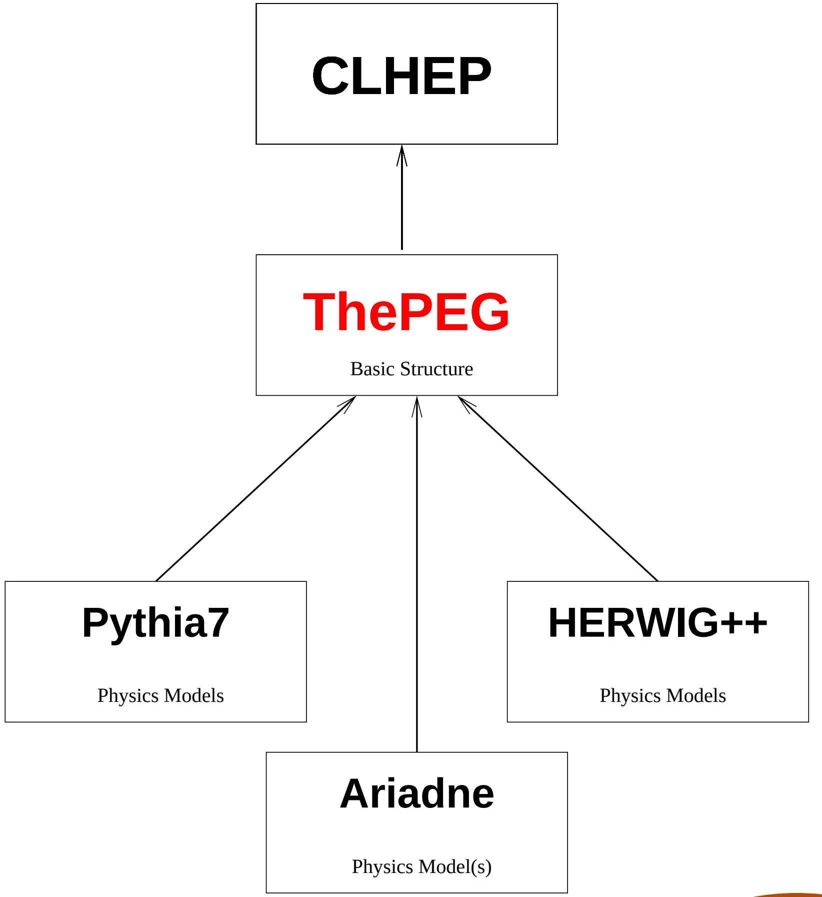

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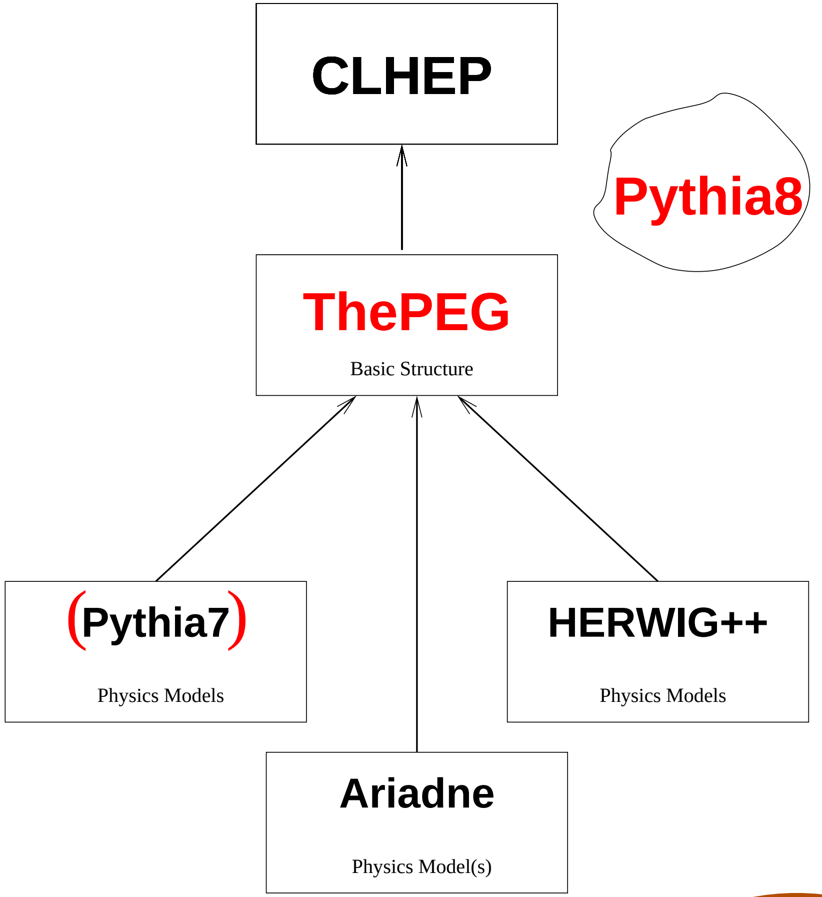
Torbjörn Sjöstrand has left THEPEG and is developing PYTHIA8 on his own.



The components of ThePEG

- Basic infrastructure: Smart pointers, extended type information, object persistency, Exceptions, Dynamic loading, . . .
- Kinematics: Extra utilities on top of CLHEP vectors, eg. 5-vectors, flat n-body decay, . . .
- Repository: Manipulation of interfaced objects. Setting of parameters and switches and connecting objects together.
- Handler classes: to inherit from to implement a specific physics model.
- Event record: Used to communicate between handler classes.
- Particle data: particle properties, decay tables, decayers etc...

ThePEG defines a set of abstract Handler classes for hard partonic sub-processes, parton densities, QCD cascades, hadronization, etc. . .

These handler classes interacts with the underlying structure using a special Event Record and a pre-defined set of virtual function definitions.

The procedure to implement e.g. a new hadronization model, is to write a new (`C++`) class inheriting from the abstract `HadronizationHandler` base class, implementing the relevant virtual functions.

When implementing models for event generation there is typically a number of parameters and options available (in addition to the parameters of the Standard Model).

ThePEG defines a uniform way of interacting with the handler classes. The sub-classes may define a set of `InterfaceBase` objects corresponding to parameters, switches or references to objects of other `Interfaced` classes.

These are then used by the `Repository` to manipulate the corresponding member variables in the handler classes.

How to use ThePEG

Running ThePEG is separated into two phases.

- Setup:

  A setup program is provided to combine different objects implementing physics models together to build up an `EventGenerator` object. Here the user can also change parameters and switches etc.

  No `C++` knowledge is needed for this. Either use simple setup files with commands or click-and-drag using the Java-based GUI.

  The Repository already contains a number of ready-built `EventGenerators`. It is also possible to specify `AnalysisHandler` object for an `EventGenerator`.

  In the end the built `EventGenerator` is saved to a file.

- Running:

  The saved `EventGenerator` can be simply read in and run using a special slave program. If `AnalysisHandlers` have been specified, this is all you have to do.

  Alternatively the the file with the `EventGenerator` can be read into any program where it can be used to generate events which can be sent to analysis or to detector simulation.

  The `ThePEG::Events` can, of course, be translated into `HepMC::GenEvents` or whatever.

The `EventGenerator` class is the main class administrating an event generation run.

It maintains global information needed by the different models: The `ParticleData` objects to be used, a `StandardModel` object with couplings etc, a `RandomGenerator`, a list of `AnalysisHandlers` etc.

It also has an `EventHandler` object to administer the actual process generation.

Status

THEPEG version 1.0α exists and is working. Snapshots of the current development code is available from http://www.thep.lu.se/ThePEG.

PYTHIA7 version 1.0α exists and is working. Snapshots of the current development code is available from http://www.thep.lu.se/Pythia7.

HERWIG++ is also based on THEPEG. Version 2.0β exists and is working. Can be obtained from http://hepforge.cedar.ac.uk/herwig/.

PYTHIA7/THEPEG includes some basic $2 \to 2$ matrix elements, a couple of PDF parameterizations, remnant handling, initial- and final-state parton showers, Lund string fragmentation and particle decays.

HERWIG++ includes a new parton shower algorithm, improved cluster fragmentation, improved hadron decays. Mainly e^+e^-, but also Drell-Yan in hadron collisions.

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Currently THEPEG runs on any platform, as long as it is Linux with gcc version 3 or later.

Current Work

The code documentation has been converted into Doxygen format. Soon to start with reference and user manual also using Doxygen.

The plan is to have many *Howto* examples to which the user community is welcome to contribute.

PYTHIA7 ⇒ PYTHIA8

- Development of PYTHIA7 has stopped
- Instead Torbjörn Sjöstrand has gone off by himself to build PYTHIA8 which will NOT be based on THEPEG.
- Hopefully it will still be possible to call PYTHIA8 modules (?) from within the THEPEG framework.

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- ARIADNE: Dipole shower with CKKW.
- ARIADNE: LDC model with multiple interactions.

CKKW in Ariadne

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Implemented for $\mathrm{e}^{+}\mathrm{e}^{-} \rightarrow$ jets and pp→W+jets

We do not want analytic Sudakovs, because real Ariadne Sudakovs resum also some logs of $1/x$. Important for reproducing small-x HERA data.

The dipole model basically only describes emission of gluons. $g \to q\bar{q}$ put in by hand. Initial-state $q \to g$ has not been put in. Important for eg. Higgs production at the LHC.

A first ThePEG version of Ariadne expected this year.

Rivet

“Robust Independent Validation of Experiment and Theory”

Object oriented C++ replacement for HZTool. Easy comparison (validation) of event generators with published data.

Part of the CEDAR project: http://www.cedar.ac.uk/

Includes jet algorithms and similar tools as does HZTool.

Based on the concept of `Projections`.

An analysis object takes an `HepMC` event, applies a number of `Projections` and fills histograms.

A `Projection` may use the original events as well as other `Projections`.

Several different analysis objects/classes are administered by the `RivetHandler`. If the same `Projection` is used in several analyses, the actual projection is only done once.

Conclusions