LCG Generator Project

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Outline

❑ Introduction
❑ Goal and structure of the project

❑ Results since the last review:
   April 2005 - August 2006

❑ Feedback from the authors
❑ Man-power situation
❑ Summary and outlook

For more information

   http://lcgapp.cern.ch/project/simu/generator/

Goal

Provide the generator support for LHC.

❑ Mandate:
- ❑ Collaborate with MC authors to prepare LCG compliant code.
- ❑ Maintain older MC packages on the LCG supported platforms.

❑ Clients:
LHC experimentalists and theorists both at CERN and in external laboratories (others users are welcome!).

A.Ribon, 19-Sep-2006

Structure

- **WP1**: Generator Service Library (GENSER)
  - Replace the obsolete CERN library for what concerns the generator services.

- WP2: Event Format and Event Interface
  - Standardize interfaces (HepMC, HepML), and support the new OO MCs (EvtGen, Pythia8, Sherpa, ThePEG/Herwig++).

- WP3: Shared Event Files: Framework & DataBase
  - Produce certified generator level events.

- WP4: Validation and Tuning
  - Cross-check MCs and compare with data.

A.Ribon, 19-Sep-2006

Special meetings

Besides the LCG Generator monthly meeting, a number of special meetings have been organized:

❑ AA meeting dedicated to LCG Generator Services (01-June-2005)

❑ ThePEG/Herwig++ collaboration meeting (open session, CERN 29-August-2005)

❑ LHC Computing Comprehensive Review: status of the Generator Project (14-November-2005)

❑ User support meeting (09-May-2006)

❑ Monte Carlo session at the Hera-LHC workshop (06-June-2006)

❑ MC4LHC 2006 workshop (17-26 July 2006)

(WP1) GENSER releases

❑ Quartely official releases (second digit incremented).

❑ Requests from LHC experiments (new generators, new versions of existing generators, etc.) collected in LCG Generator monthly meetings.

❑ ≈3 weekly pre-releases before official releases (access to beta-testers from the experiments).

❑ Bug fixes releases (third digit incremented) . Further special releases can be arranged under request.

❑ Independent release of GENSER sub-packages : recommendation of the last LCG AA Review.

Milestone GS527 ✔

GENSER_1_4_0 (August 2006)

- **alpgen** : 2.0.5, 2.0.6
- **cascade** : 1.2.10
- **charybdis** : 1.001
- **evtgenlhc** : 1.2, 1.3
- **feynhiggs** : 2.2.10, 2.3.1, 2.3.2
- **glauber_xs** : 1.0
- **hepmc** : 1.27.02 (to be removed)
- **herwig** : 6.507, 6.507.2, 6.508, 6.508.2, 6.510, 6.510.2
- **herwigpp** : 2.0beta, 2.0beta2
- **hijing** : 1.383, 1.383.2, 1.383b, 1.383b.2, 1.383bs.2
- **hydjet** : 1.0, 1.1
- **isajet** : 7.69, 7.69.2, 7.71, 7.71.2, 7.74, 7.74.2
- **jimmy** : 4.1, 4.2, 4.2.2
- **lhapdf** : 4.2, 4.2.1, 5.0.0, 5.1, 5.2.1, 5.2.2
- **madgraph** : 3.2
- **mcatnlo** : 2.3.1, 3.1.0
- **phojet** : 1.10
- **photos** : 209, 209.2, 215, 215.2
- **pyquen** : 1.0, 1.1
- **pythia** : 6.227, 6.227.2, 6.323, 6.323.2, 6.325, 6.325.2, 6.326, 6.326.2, 6.327, 6.327.2, 6.400, 6.400.2, 6.402, 6.402.2, 6.403, 6.403.2
- **phythia8** : 041, 052, 053, 053s

GENSER_1_4_0 (cont.)

- **stagen** : 1.07
- **tauola** : 27, 27.121, 27.121.2
- **thepeg** : 2006_01_31
- **toprex** : 409

LCG external :
- **evtgen** : alpha-00-11-07, v5r4
- **comphep** : 4.2p1, 4.4.0
- **sherpa** : 1.0.5, 1.0.6
- **HepMC** : 1.26, 1.26.01, 1.26.02, 1.27.00, 1.27.01, 1.27.02, 2.00.00
- **HepPDT** : 2.02.02

In summary:
- ≈30 packages (≈25 generators, 1 PDF package), ≈90 versions;
- Platforms: `slc3_ia32_gcc323` , `slc3_ia32_gcc344`
           `slc4_ia32_gcc345` , `slc4_amd64_gcc345`
- Libraries: both shared (`.so`) and archive (`.a`)
- Global tar-ball: ≈110 MBytes (unpacked: ≈510 Mbytes)
           but individual (granular) tar-balls are available!

Milestone GS527 ✔

A.Ribon, 19-Sep-2006

Release (GENSER_1_4_0) tests

❏ 108 tests in total (of which 80 involving PDFs) on 11 packages (including HepMC):

   ❏ **lhapdf** :   40 tests of PDFs
   ❏ **pythia** :   26 tests (with 20 consisting of the same x-section computation with different PDFs)
   ❏ **herwig** :   26 tests (with 20 as above…)
   ❏ **pyquen** :   6 tests
   ❏ **photos** :   2 tests
   ❏ **tauola** :   2 tests
   ❏ **isajet** :   1 test
   ❏ **evtgenlhc** : 2 tests
   ❏ **pythia8** :   2 tests
   ❏ **herwigpp** : 1 test

A typical test consists of running ≈1000 events to compute a cross-section, and/or the fraction of events of a given type. Simple regression testing on differences of numbers.

Generators used by LHC experiments

Here is the list presented at MC4LHC 2006:

❑ ATLAS : **pythia**, **herwig**, **hijing**, **alpgen**, **mcatnlo**, **charybdis**, **tauola**, **photos**, **evtgenlhc**, **lhapdf**, **HepMC**, **HepPDT**, `AcerMC`. *future:* sherpa, horace, winhac.

❑ LHCb : **pythia**, **herwig**, **hijing**, **charybdis**, **photos**, **evtgenlhc**, **lhapdf**, **sherpa**, **HepMC**, `AcerMC`, `BcVegPy`.

❑ CMS : **pythia**, **herwig**, **lhapdf**, **hijing**, **alpgen**, **mcatnlo**, **charybdis**, **tauola**, **photos**, **comphep**, **toprex**, **hydjet**, **phojet**, **madgraph**, **feynhiggs**, **pyquen**, **sherpa**, **HepMC**,

`HDECAY, ISASUGRA, ISASUSY, Prospino, ISAWIG, SIMUB, POMWIG, MadEvent, ExHume, EDDE, DPEMC, MCFM, Truenoir.`

future: evtgenlhc, cascade, SOFTSUSY, SPHENO, SUSPECT.

Migration to **g95** and **gfortran**

❑ With gcc4 (2005), the GNU organization dropped its support for the g77 compiler.

❑ CERN and the HEP community got worried, since there is a huge Fortran legacy (Geant3, Fluka, and many generators in GENSER).

❑ R.Yaari made last year an evaluation of the candidate Fortran compilers and selected g95 and gfortran. Then it used them on CERNLIB.

❑ This summer he made a systematic test of all Fortran generators in GENSER, with both compilers. He sent feedbacks, and wrote a report:

see link in the MC4LHC 2006 agenda

A.Ribon, 19-Sep-2006

(WP2) Pythia 8

❑ Pythia 6 is still developed and maintained, but it s in Fortran 77, and now bloated and unmanageable.

❑ Pythia 7 (in C++, based on ThePEG framework) is stalled, without manpower.

❑ Solution: T.Sjostrand is taking a sabbatical and work full time, at CERN PH/SFT as research associated, to develop Pythia 8 .

❑ A fresh start, stand-alone C++, with 3 year road-map, Sep 2004 - Sep 2007.   Milestone GS702

❑ Most recent version in GENSER 1_4_0 : Pythia 8.053s . Users' feedback welcome!

(WP3) MCDB: MC event DataBase

❏ Goal: share certified MC samples between different groups.

❏ Started as CMS MCDB, used in the last 4 years especially in the Higgs group. Only parton-level files, AFS storage, no SQL queries.

❏ Features: Web interface; database; search engine; CASTOR as native storage; Grid compatible.

❏ Tools: MySQL, CASTOR, CGI, Perl, Apache.

❏ Event files in HepML : unified XML format.

For more info: http://mcdb.cern.ch
See also L.Dudko's talk at the MC4LHC 2006

MCDB - MonteCarlo Database

Search this site

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Advanced search

Main MENU

- **Top physics**
  - Exotic production
  - Single top
  - QCD tt
- **QCD**
  - B physics
  - multijets
- Software
- Requests
- **Higgs physics**
- **Gauge bosons**
  - Gamma and jets
  - 2gamma and jets
  - W and jets
  - WW and jets
  - Z and jets
  - ZZ and jets

Categories

FEEDBACK COMMENTS　　🖊 Edit　☒ Delete

Please, provide your feedback comments on the LCG MCDB project, here

published: 16th May 2005, 13:40 | author(s): Lev Doudko ..:

PROCESS PP->H->ZZ->4MU　　🖊 Edit　☒ Delete

The event sample simulates the inclusive Higgs production with decay to four muons (viz Z-bosons). It is created by the CompHEP Monte-Carlo generator. The Higgs mass value is 500 GeV. All used physics parameters and applied cuts can be found in a prt file stored in the article.

published: 19th Sep 2005, 09:42 | author(s): Alexander Sherstnev ..:

W+ AND 3 JETS　　🖊 Edit　☒ Delete

These events were preapred by CompHEP in a special hash-model, where 2 first quark generations are unified to one of hash-quarks. See details in the aricle itself.

published: 29th Sep 2005, 14:51 | author(s): Alexander Sherstnev ..:

QCD Z(2TAU)+3J EVENTS WITH ALPGEN2　　🖊 Edit　☒ Delete

Events for the Z+3jets production. Z-boson decays to tau lepton pair. The events were prepared with ALPGEN Monte-Carlo generator. They can be used for the MLM ME-PS matching procedure, since generated with ickkw=1. All generation parameters and cuts applied can be viewed in the qcd_2tau3j_unw.par parameter file.

published: 18th Oct 2005, 12:20 | author(s): Alexander Nikitenko ..:

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0000228 times visited since October 2005

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Advanced Search Query

Process pp->H->ZZ->4mu

Author(s): Alexander Sherstnev
Date of publication: 2005-09-19 09:42:37, Last correction: 2005-09-29 14:47:24
Categories: H and Z/W
Article ID: 34

Abstract:

The event sample simulates the inclusive Hig...
to four muons (viz Z-bosons). It is created by...
generator. The Higgs mass value is 500 GeV...
and applied cuts can be found in a prt file stor...

Author comments:

Process:
p,p->H->mu+,mu-,mu+,mu-

Subprocess:
G,G->mu+,mu-,mu+,mu- (cross section = 0.6...

http://mcdb.cern.ch/c...

Article

Download events file

Comments to the article

Process:

Name: pp --> mu,mu,mu,mu
PDF set: CTEQ5L
QCD scale: sqrt(S)

Model: SM, Feynman gauge

Generator: CompHEP, version: 4.2.1

Other information:
Cuts:
  5 GeV < Invariant_mass_1 < 400 GeV
  3 GeV < $P_{1}(\mu)$
  $|\eta(\mu)| < 2.4$
  5 GeV < Invariant_mass_2 < 400 GeV

Event files:
File: events_MH500_wHCHEP_BM1.pev
Size: 28200663 bytes
Cross section: 6.0382E-04pbn
Events number: 100000
Castor Path: waiting for migration (in a few hours)
Comments: Number of mixed reweighted events = 100000 (1 subprocess)

File: prt_MH500_wHCHEP_Q25.hat (download)
Size: 2692 bytes
Cross section:
Events number: 0
Castor Path: waiting for migration (in a few hours)
Comments: CompHEP kinematics module

View/post comments on article
Edit article

MODEL:

SM, Feynman gauge

NAME: *SM, Feynman gauge*

DESCRIPTION:

PARAMETERS:

PARAMETER	VALUE	DESCRIPTION
m_s	0.117	
m_b	4.85	
GG	1.21358	
m_τ	1.77699	
S_w	0.48076	
M_{HIGGS}	115	
s_{12}	0.2229	
m_c	1.65	
M_{top}	174.3	
EE	0.31345	
s_{23}	0.0412	
m_μ	0.10566	
s_{13}	0.0036	
M_Z	91.1876	

Done

Theoretical model and parameters

MCDB: status

❑ Ready to use!　　Milestone GS602 ✔

❑ CMS is migrating from the old CMS MCDB to the new LCG MCDB.

❑ Presentations of MCDB have been given to the other LHC experiments.

❑ ATLAS has little interest in MCDB.
In the past they have evaluated CMS MCDB and found some limitations in the samples, both in dimensions and in varieties.

HepML

❏ This project aims to standardize the format of files containing physics information relevant for high energy physics, and meant to be shared and exchanged between different people.

❏ The natural example is the output of matrix element generators which is the input for shower and decay generators.
Another example: experimental data results.
Collaboration between LCG and CEDAR on HepML.

❏ Content of HepML files: metadata + physics info.

❏ XML format: readable text file, standard, flexible, allows to keep versions.

A.Ribon, 19-Sep-2006

Les Houches Event Files (LHEF)

During the MC4LHC 2006 workshop, the authors have agreed on a standard file format to store process and event information, primarily output from parton-level event generators for further use by general-purpose generators.

❑ Same content of the Les Houches Accord (2001): this defines two Fortran commonblocks where information could be stored, while the actual usage has been mainly in terms of files, but without a well specified format.

❑ The information in LHEF files is embedded in a minimal XML-style structure, to allow for future evolution, likely from LCG/CEDAR HepML.

LHEF: file.lhe

```
<LesHouchesEvents version="1.0">
<!--
   # optional information
-->
<header>
 <!-- eventual XML tags -->
</header>
<init>
   compulsory initialization information
   # optional initialization information
</init>
<event>
   compulsory event information>
   # optional event information
</event>
<event>

   …
</event>

   …
</LesHouchesEvents>
```

How the events have been generated

Beam particles, energies, PDFs, processes.
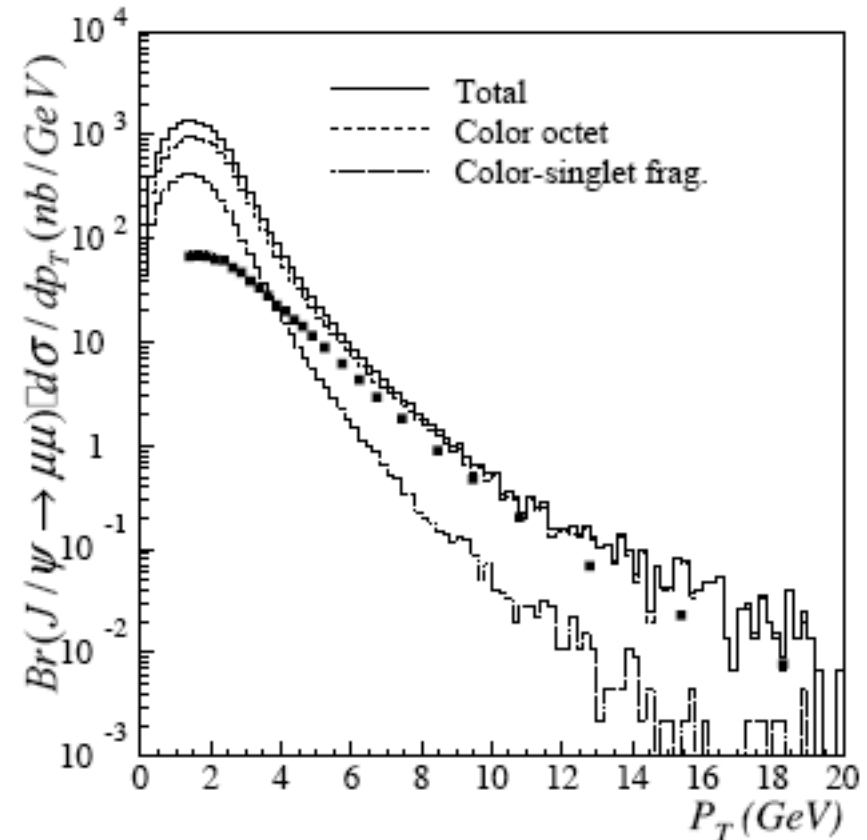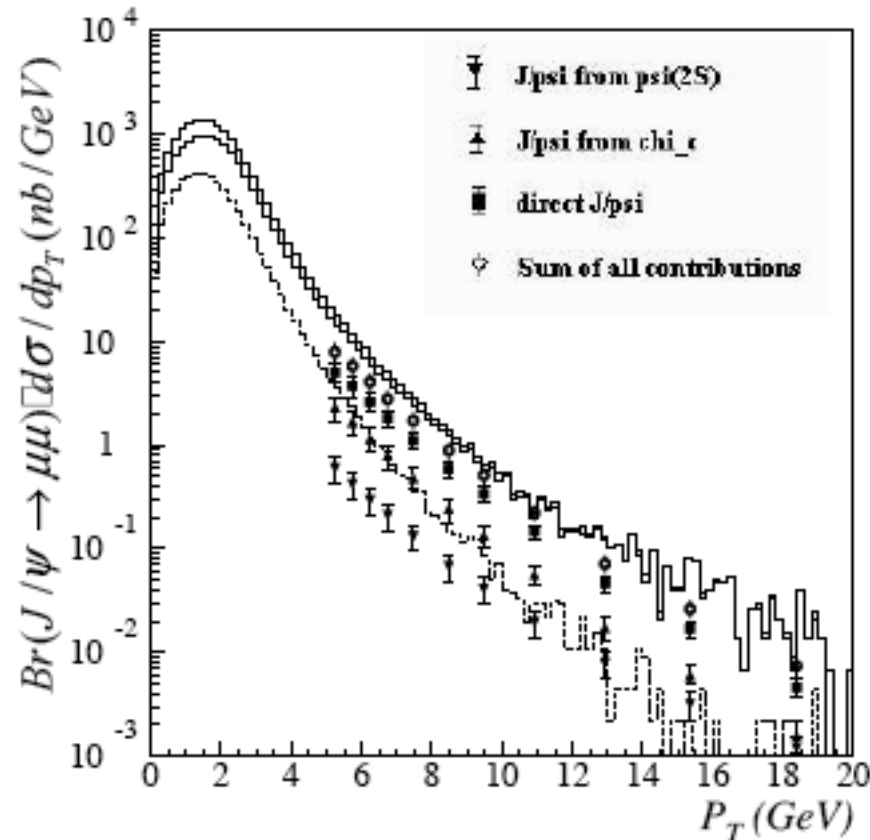
Particles generated: type, p,…

hep-ph/0609017…

(WP3) Generator Framework

❑ It is a general interface to any generator provided by GENSER. Production & Validation.

❑ It is based on: GENSER, HepMC, ROOT/POOL.

❑ Developed by CMS & LCG (resources from CMS).

❑ The CMS production is based on it.

❑ The Production framework is ready. Milestone GS535 ✔

❑ The Validation framework is in progress. Milestone GS701

A.Ribon, 19-Sep-2006

(WP4) MC Validation & Tuning: NRQCD in Pythia 6.324

❑ Prompt heavy quarkonia production:

g+g->g+[Q$\underline{Q}$] , q+g->q+[Q$\underline{Q}$] , q+$\underline{q}$ -> g+[Q$\underline{Q}$]

where **Q** is a **c** or **b** quark and **[ ]** is a quark-antiquark bound state: in Pythia 6.324 such a state can be either colour singlet, or colour octect as predicted by Non-Relativistic Quantum Chromodynamics (NRQCD).

❑ A number of NRQCD matrix elements need to be validated & tuned. M.Bargiotti did this, using CDF data on the transverse momentum distribution of J/ψ .

FULL SPECTRA @1 GeV P_T MIN CUT

Legend (left plot):
- J/psi from psi(2S)
- J/psi from chi_c
- direct J/psi
- Sum of all contributions

Legend (right plot):
- Total
- Color octet
- Color-singlet frag.

➤FERMILAB-PUB-04-440-E.

HERA-LHC Workshop, CERN
6-8 June 2006

Feedback from the authors (1)

Some of the leading authors of general purpose Monte Carlo codes have expressed some concerns, during the MC4LHC 2006 workshop:

- ❑ **Violation of some agreements**:
  - ❑ changes of the code (LHAPDF) without contacting the authors of the package.
  - ❑ a bug was found (in HERWIG) without being reported to the authors.

- ❑ **Limits in the inclusion of new C++ generators:**
  - ❑ SHERPA has suffered the most by the rotation of the integrators... SHERPA is supplied as an external package, with no tests carried out.
  - ❑ ThePEG/Herwig++ has been included in GENSER, but in a way that limits the functionalities which are offered by the original package.

Feedback from the authors (2)

❏ Native installation tools are not used:
  ❏ SCRAM and/or the current structure of GENSER does not allow to use the original installing/configuration tools provided by the generators.

❏ More testing is needed for the core generators:
  ❏ Much more testing should be devoted to the main general-purpose MC generators.
    Possibly, also feedback to the authors on migration to new platforms (e.g. 64-bits architectures).

❏ Usage of generators in the experiments
  ❏ Although GENSER includes several MC programs, CMS is using only two of them. Some of the general-purpose generators have received requests from LHC users which should be instead handled by GENSER.

Feedback from the authors (3)

❏ MC versions to be included in GENSER

    ❏ Currently the latest version that appears in the authors' web pages, few weeks before the release, is included in the GENSER release.
Authors prefer to be consulted in advance, with a deadline for new versions to be included in a release.

We recognize that most of the issues that have been pointed out reveal indeed some weaknesses that need to be fixed. We agree that the required actions have a high priority and will be taken into account in our next work-plan review. We are confident that as a result of this process the Generator Project will improve and provide a better service to all LHC community.

Current LCG man-power: 3.3 FTE

- ≈1.0 FTE for GENSER from LCG-Russia
  (M. Kirsanov, O.Zenin, A. Toropin, S. Slabospitsky)
  ≈0.6 FTE for MCDB from LCG-Russia
  (L.Dudko, A. Gusev, S. Belov)

- ≈0.7 FTE for Library and Event interfaces from CERN
  (R.Yaari, A.Pfeiffer, A.Ribon)
  + 1 Research associate for Pythia 8 (T.Sjostrand)

- ≈0.5 FTE for coordination and LHAPDF/LHAGLUE from
  Florida (P.Bartalini (0.3 FTE) + P.Bourilkov (0.2 FTE))

- ≈0.25 FTE for Validation from LCG-Italy (M. Bargiotti)
- ≈0.25 FTE for Framework from LCG-Spain (H.Naves)

Other non-LCG contributions: LHC experiments,
UK-PhenoGrid, V.Uzhisky (JINR), V.Vagnoni (INFN), etc.

Summary & Outlook

❑ The LCG Generator project has fostered the cooperation between different communities: experimentalists, theorists, and computing people.

❑ GENSER is currently used in production in three LHC experiments: ATLAS, CMS, and LHCb. And they are satisfied of the response to their requirements (bug fixings, new versions, etc.).

❑ A new product, MCDB, is ready for use.

❑ Some needed improvements (flexibility & testing) have been pointed out, and will be addressed in the forthcoming project work-plan review.

A big THANK YOU to Paolo for all his work as leader of the Project for the past 3 years!

..and welcome to Witek as the new leader!

A.Ribon, 19-Sep-2006