



Development, validation and maintenance of Monte Carlo generators & generator services in the LHC era

M. Kirsanov
(INR Moscow)

LCG Generator



GOAL: to guarantee the generator support for LHC

WP1: GENERATOR SERVICES LIBRARY (GENSER)

WP2: EVENT FORMATS AND EVENT INTERFACES

WP3: SHARED EVENT FILES: FRAMEWORK & DATA BASE (MCDB)

WP4: TUNING AND VALIDATION

Florida (Coordination)

CERN (Library, Event Interfaces)

LCG-Russia (Library, Data Base)

LCG-Spain (Framework)

Collaboration with independent projects: LCG-UK (Validation, New MCs)

Contact persons/Collaborators in MC Projects and LHC Experiments

Started May 2003

Long Term Project

WP1. The LCG Generator Library (GENSER)



GOAL: to replace the obsolete CERN Library for what concerns the Generator Services

→Mandate:

- ❖ To collaborate with MC authors to prepare LCG Compliant Code
- ❖ To maintain older MC packages on the LCG supported platforms

→Clients:

- ❖ Addressed to LHC experimentalists and theorists both at CERN and in external laboratories (**Other users welcome!**)

- ✓ CVS Repository, AFS Distribution
- ✓ MC Packages & Example/Test Package
- ✓ Tested by all the LHC experiments
- ✓ Quarterly Release Scheme

**ATLAS & LHCb
PRODUCTIONS
RELY ON GENSER
CMS Joining...**

Documentation: <http://lcgapp.cern.ch/project/simu/generator>

Savannah Portal: <http://savannah.cern.ch/projects/simu/>

AFS: [/afs/cern.ch/sw/lcg/app/releases/GENSER](http://afs.cern.ch/sw/lcg/app/releases/GENSER)



WP1. The GENSER Team

- Liaisons with authors and LHC experiments ~.25 FTE
 - A. Ribon (CERN) based at CERN
 - P. Bartalini (University of Florida) based at CERN
- Coordinator of GENSER Releases (Librarian) ~.25 FTE
 - A. Pfeiffer (CERN) based at CERN
- GENSER Integrators & MC Experts ~1FTE
 - M. Kirsanov INR (Moscow) Master Integrator
 - I. Katchaev IHEP (Protvino) Integrator
 - A. Toropin INR (Moscow) Integrator
 - S. Slabospitsky IHEP (Protvino) MC Expert
 - O. Zenin IHEP (Protvino) Integrator (new)

WP1. GENSER Release



- **GENSER_1_2_0** – last major release, October 2005
 - Release policy (A.Pfeiffer)
 - Two levels of release tests (M.Kirsanov, A.Pfeiffer)
 - Started preparation to gcc4 – series compilers in collaboration with MC authors. Fruitful collaboration with T. Sjostrand and Herwig team.
- **GENSER_1_2_1** – “light” release, December 2005.
 - “Light” release procedure developed by A.Pfeiffer: unchanged libraries symlinked to previous.
 - PYTHIA and HERWIG ready to gcc4 series.

WP1. New compilers



- **gcc4**. Fedora 4 is built on it. **g77** → **gfortran**. Not all Fortran 77 features supported.
- Small problems in **PYTHIA**, a lot of problems with **HERWIG** (return to label, entry points). GENSER team collaborated with authors. **gcc4 compliant** versions prepared by **GENSER release 1.2.1**. Preliminary tests made. Note that **platforms with gcc4 are not yet supported by LCG, hence by GENSER**, but we prepare to them beforehand
- **Other generators and packages to be tested with gcc4.**
- **64 bits platforms come soon.** Tests will be needed (heard about problems with fortran codes)



WP1. Testing

Large scale MC productions involve a lot of manpower, they are expensive

A bug in MC generator, depending on its severity, can make a production mostly useless

Test thoroughly!
Test quickly!

Detailed validation of MC, comparison of distributions with previous versions and data, can take a lot of time.

Several levels of tests and validations can help



WP1. Testing

- **Level 0** test. Special script checks the existence of libraries according to definite rules (one, several or no libraries should correspond to the generator (the latter in case of external generator))
- **Level 1** test. Dedicated package in GENSER. It compiles one or several applications for each generator to be tested and runs them one by one. Each applications writes some numbers in a file. At the end this file is compared with the standard file, the problems and differences are reported.
- Next tests are outside WP1. Additional levels can be used.
- **Level 2** tests. Dedicated projects (WP4).
- **Level 3** tests. Tests inside the experiments.

WP1. Level 1 testing, more details



- **Dedicated package** in GENSER: TESTS, additional dependencies, like ROOT, moved here
- The results are often correct, but not identical, even if random numbers sequence is repeated: it is Monte Carlo! **Need to look for significant changes, taking into account statistical errors.**
- Comparison is made by a program. It detects missing results in case of test crash and continue
- **6 most important generators out of >20** are now involved in this testing. The work is to be continued. The plans for 2006 are to increase the number of tests by a factor of 4 (at least)
- The full testing takes about **1 hour** (shared and archive libraries are tested separately, generators with HEPEVT common block with sizes 10000 and 4000 also separately)
- In 2005 a pair of **bugs** and unexpected **“features”** found with level 1 testing, at least one bug in PYTHIA found with level 3 CMS. GENSER is going to take part of the latter to level 1.



WP1. Plans (2006)

Number of generators starts to saturate; accent being shifted towards **convenience, tests, validation**

- Further development of procedures for **Light Bug Fix Releases**
- Develop the package TESTS
- User support (versions **1_2_1 – 1_4_0**)
- Connection with MCDB
 - In perspective: Interplays between GENSER, MCDB & Production Framework
- Increase support for **Makefiles**
- Continue testing with **gcc 4**
- **C++ generators** Pythia 8 (Alpha version) and Herwig++ will appear in Q1 2006
- **Migrate to HepMC in the package TESTS** to provide a general approach to c++ and Fortran generators.
- Additional sub-packages pursued for inclusions (**currently approaching authors**)
 - **DPMJET, PIQUEN**
 - Any other requests from the LHC experiments ?
- Update of already introduced Sub-package versions
 - Requests from the LHC experiments are welcome

WP2. Event Formats and Event Interfaces



GOAL: standardize interfaces, support the new OO MCs

- The MC truth Interface
 - **HEPMC**
 - **January 2006: installed in LCG external**, based on the version 1.26 from M. Dobbs. Interfaces to generators split in a separate library. Further development started
 - **HEPML proposal (XML - Les Houches Agreement I compliant)**
 - Meta-data format facilitating automated documentation
- The modularization
 - Basic idea in **ThePEG, HERWIG++, SHERPA**
 - From April 2004 LCG Generator participates to the development of **ThePEG**
 - **ThePEG is in GENSER** (will be public from 1_3_0)
 - Activity coordinated with **Phenogrid** (N.Glover et al.)

WP3: Production of Shared Event Files



GOAL: to produce certified generator level events

- ❖ Use them for **benchmarks, comparisons & combinations** in **LHC W.G.**
- ❖ **Improve the quality of shared samples** with respect to **LEP W.G. era !!!**

➤ Production framework

- ✓ Proposal June 2004
- ✓ Design Available. Prototype Stage
- ✓ Active institutions: CERN, Santander, Oviedo

**In collaboration
with CMS**

➤ Production centre

➤ Configuration & Book-keeping

- ✓ ~ 0.75 FTE from LCG Russia (MSU, ITEP, JINR)
- ✓ LCG-MCDB: Deployed!

**Tested At Fermilab
Tested By CMS**

WP3. Monte Carlo Data Base (MCDB)



■ Motivations

- **To Provide Configuration, Book-keeping, Documentation, Storage for the Shared Event Files**
 - **To keep track of the full generation chain, Exploiting the Competences of Monte Carlo Experts and Monte Carlo Authors**
- **In Production. Some things to be finalized. To be populated.**



WP3. The MCDB Team

- MCDB developers
 - L. Dudko (SINP MSU Moscow)
 - S.Makarychev (ITEP Moscow)
 - S. Belov (JINR Dubna)
- Other contributors (previous shifters, designers etc.)
 - A. Kryukov, I. Seluzhenkov, A. Sherstnev, A. Vologdin (SINP MSU Moscow)
 - P. Bartalini (Florida U.)

WP4. Monte Carlo Validation and Tuning



GOAL: to cross-check MCs and compare with data

Reference distributions (multiplicities, P_T Spectra etc.)
Promoting common LHC activity on MC Tuning

➤ Standalone Studies

- ✓ Work on GENSER subpackages
- ✓ ALPGEN Validation (Perugia) → Essential to verify ALPGEN in GENSER
- ✓ HIJING Validation (JINR, Dubna) → Encouraged to contribute to JetWeb

➤ Generator analysis framework (together with CMS)

H. Naves, Oviedo

➤ Validation Framework

- ✓ JetWeb: in production
- ✓ LCG-UK (U.C.London)
- ✓ <http://jetweb.hep.ucl.ac.uk/>

[[Comp. Phys. Comm. vol 153/2 164-178 \(2003\)](#)]

Database of Data, MC & Comparisons
Web interface, Job submission

To be switched to GENSER



LCG Generator Future Plans

- **WP3: MCDB Integration, experiment specific APIs and management of large files by March 31 2006.**
- **WP4: Generator level validation framework beta version by June 30 2006.**
- **WP3: Fully operational LCG Generator production centre integrated in the grid-middleware by September 30 2006.**

Organisational Issues



WEB page

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

→ Links to relevant documentation, CVS repository, release.notes etc.

[CDS Agenda Home](#) > [Projects](#) > [LHC Computing Grid](#) > [Physics Generators](#)

→ Minutes of meetings, slides of presentations

Meetings:

→ First Tuesday of the month at 5 PM in CERN-32-1-A24 & VRVS

Simulation project mailing list:

project-lcg-simu@cern.ch

Permanent Forum on Physics and Software Issues
related to Monte Carlo development & usage



Backup



WP1. **GENSER_0_1_0: Mid Apr. 2004 (rh73_gcc32)**
GENSER_0_2_0: Mid Sep. 2004 (+ rh73_gcc323)
GENSER_1_0_0: End Mar. 2005 (+ Scientific Linux)

- ❖ HIJING (Heavy Ions): 1.36, 1.37, 1.383, 1.383b
- ❖ PYTHIA: 6.205, 6.217, 6.220, 6.221, 6.222, 6.223, 6.224, 6.227
- ❖ PYTHIA: 6.304, 6.319
- ❖ HERWIG: 6.500, 6.503, 6.504, 6.504b1, 6.505, 6.506, 6.507
- ❖ JIMMY: 4.1
- ❖ ISAJET: 7.67, 7.69, 7.71
- ❖ EvtGenLHC: 1.0, 1.2
- ❖ AlpGen: 1.3.2
- ❖ LHAPDF: 1.1, 2.0, 3.0 (LHAGLUE)
- ❖ PHOTOS: 202, 207
- ❖ TAUOLA 2.07
- ❖ TOPREX 4.09
- ❖ MCATNLO 2.31
- ❖ MADGRAPH 3.2
- ❖ **LCG EXT: SHERPA 1.05, CompHEP 4.4.0, EvtGen alpha-00-11-07**

GENSER_1_0_0:
16 Generators
1 PDF Package
~ 40 Versions

User Manual Significantly Improved



WP1. New Projects

Proposal: MC implementation of NRQCD models for prompt J/Ψ production

Presented to the March LCG Generator Meeting

Agreement with **T.Sjöstrand** for the development in **Pythia 6.3**

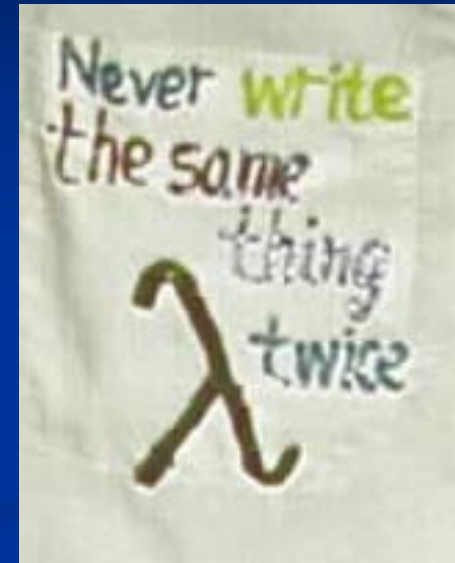
Additional resources from **INFN**:
.35 FTE dedicated to this project

V.M.
Vagnoni
INFN
Bologna
(0.2 FTE)

Between Two Different Worlds



- Small Theoretical groups
- Huge fortran packages still in development
- Need help with the new OO packages
- Need to share user support duties



LCG Generator

- ◆ Large Experimental Collaborations
- ◆ Complex OO Simulation Frameworks
- ◆ Need easy access to many generators, responsive user support, bug fixes etc.

WP1. MC Packages: Inside or Outside GENSER ?



■ Three possibilities:

- 1) To develop the MC package in GENSER: MCDB, EVTGENLHC
 - ✓ EVTGENLHC derives from EVTGEN
 - ✓ Provided (Adapted) by LHCb → Contact person P.Robbe
 - ✓ LHCb has **full access** to the package in the GENSER repository
 - ✓ Other contributors have a **limited access** (development of new decay models, decay files etc.)
- 2) To fully export the MC generator code in GENSER defining the corresponding sub-package: **MOST OF THE INSTALLED MCs**
- 3) To install the MC generator as external software packages in the LCG environment and to store in GENSER just tests suites and other related code **COMPHEP, EVTGEN**

Just a technical issue!

For each MC package an ad-hoc solution is found taking into account the user requirements

WP1. EvtGen Mini-Workshop (Topics)



■ Physics issues

- Implementation of CP violation and mixing for coherently produced B mesons
- Baryon decays
- Special decay models
- New interfaces, e.g. to create particles with known polarizations
- How to handle FSR ?
- Tuning of decay tables

■ Software issues

- EvtGen Repository
 - Where is the main version of EvtGen maintained ?
 - How do we share code updates among experiments ?
 - EvtGen code branchings (problem mentioned in CHEP2004 conclusions)
- Supported platforms
- Interfacing other generators for decays of resonances
- EvtGen particle properties (Current `evt.pdl` is not ideal)



■ Introduction of NRQCD in Pythia 6.3 series

- Having the possibility to switch on all the relevant heavy quarkonia processes at once without hooks and workarounds
- With “reliable” total cross sections and “realistic” differential P_T dependence
- Independent/“private” non-official implementations exists
- Should find an agreement between ALICE, ATLAS, CMS and LHCb on a common implementation, then provide the implementation, validate the results and tune the NRQCD free parameters
 - All (except implementation) can be made with the help of theorists/phenomenologists in the sector, which I suppose would be happy to give such a help

■ Why not making this job via Les Houches Accord instead of hard-typing into Pythia?

- Feasible solution, but maybe considering that Pythia implementations already exist and that Pythia already foresees heavy quarkonia processes, it is simpler to complete Pythia
- This depends also on the strategies of Pythia for its future beyond the LHA

WP2. HEPML Proposal

(COMPHEP Collaboration)



- All data in event file are divided in two parts
 - Header - describe the general information
 - Author, the file itself (creation date etc.), supported specifications, collider description etc.
 - Generator specific info, cuts, physical parameters etc.
 - Info for parser (format of event records etc.)
 - **Event Records** - variable data of events written in some compact format to one string (particle momenta, color chains etc.)
- Header is stored in a txt file with **XML Syntax**
- **Event Records** are (zip) compressed and attached to the Header file

[A.Sherstnev]

WP3. Monte Carlo Data Base (MCDB)



■ Motivations

- To Provide Configuration, Book-keeping, Documentation, Storage for the Shared Event Files
- To keep track of the full generation chain, Exploiting the Competences of Monte Carlo Experts and Monte Carlo Authors

■ CMS MCDB <http://cmsdoc.cern.ch/cms/generators/mcdb/>

- Only parton level files; AFS storage; No Searchable; No SQL

■ LCG MCDB [hep-ph/0404241]

- Presented to the [LCG Application Area meeting of November 24](#)
- Same authors + Additional human resources and technical support
- Core software supported by LCG Software Project Infrastructure
 - MySQL; POOL; CASTOR (RFIO); CGI; Perl; Apache
- Web Interface, Dedicated Web Server <http://mcdb.cern.ch>

WP3. MCDB Short Term Plans (Q1,Q2 2005)



- We have a working version of MCDB
 - Basic functionality is supported
 - Deployed

- But still need to do a few important things in the nearest future:
 - Adjusting operations with Castor
 - Porting MCDB to SLC3
 - Making Web-interface more convenient to end-users
 - Checking for resistance against faults
 - Design of APIs for the Production Framework (collaborations interested to contribute ?)
 - Cleanup of MCDB tree in CVS
 - Installation scripts
 - Documentation

[S.Belov]

WP3. Generator Level Production Framework



- Under the responsibility of Oviedo & Santander (0.25 FTE)
- Based on GENSER, HEPMC, ROOT/POOL
- Alpha stage
 - Prototype available
 - Need to sort out the problem of book-keeping → connection to MCDB

J.Cuevas Maestro & H.Naves Sordo
presented their progress to the
April LCG Generator Monthly Meeting

WP3. MCDB Web Interface Screen-shot



MCDB - MonteCarlo Database

<http://mcdb.cern.ch>

| top-level-menu | top-level-menu |

Some comments about this site can be here.

Search this site

Main MENU

- TOP
- Higgs
- Wjets

An events listing page

A second event

These events have been generated in frames of SM by CompHEP (version 4.2p1). Cuts on leptons are applied only. The event sample is in the old CompHEP format (use cpyth-1.* to read the events in PYTHIA). These events have been generated in frames of SM by CompHEP (version 4.2p1). Cuts on leptons are applied only. The event sample is in the old CompHEP format (use cpyth-1.* to read the events in PYTHIA).

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Search this site

- Non authorized author entry
- Authorized author entry
- Administrator's area
- Moderator entry
- News

Search this site

- Non authorized author
- Authorized author
- Administrator's area

MCDB - MonteCarlo DataBase

Article creating | Generators | Describe process | Describe model | Describe cuts

General information | Event files | Generator | Model | Process | Cuts | Article preview/save

GENERATOR: VERSION:

| |
|-------|
| 6.500 |
| 6.503 |
| 6.504 |

Only Mozilla Browser Supported
(for the time being)



LCG Generator Future Plans

Emphasis on the Collaboration with
New Object Oriented MC Projects

■ CONFIRMED MILESTONES

- **WP1: Production quality release of GENSER (1_0_0) by December 15 2004** (In late because of the re-definition of the release policy. Release was made on March 29. Delay: ~ 3.5 months).
- **WP1: First C++ Monte Carlo (SHERPA) fully integrated in GENSER by March 31 2005** (Achieved with the release of GENSER 1_0_0 on March 29).
- **WP1/WP2: First test of ThePEG integration in Herwig++ by June 30 2005 (*)**.
(*) Project conducted in collaboration with PHENOGRID
- **WP3: Generator level production framework beta version by June 30 2005 (***)**.
(***) Project conducted in collaboration with CMS
- **WP3: MCDB user document with definition of procedures to gain access through GRID certificates by September 30 2005.**
- **WP1: Pythia 8. Release of alpha version by September 30 2005.**