The LCG Generator Project

Recent developments in
GENSER, MCDB & Generator Interfaces/Framework:

Status & Plans

P. Bartalini

(University of Florida)

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) ~0.25 FTE
CERN (Library, Event Interfaces) ~0.50 FTE
LCG-Russia (Library, Data Base) ~1.75 FTE
LCG-Spain (Framework) ~0.25 FTE
Collaboration with independent projects: LCG-UK (Validation, New MCs)
Contact persons/Collaborators in MC Projects and LHC Experiments

Started May 2003
Long Term Project

Workshop on MC's for the LHC (MC4LHC)
CERN, July 7 - August 2 2003

GENSER Review CERN, March 25 2004

EvtGen Miniworkshop CERN, January 20 2005

Recent, Current & Forthcoming Events

- **EvtGen Mini-Workshop on January 21**
  - Contributions from authors + ATLAS, BABAR, BELLE, CDF, CLEO, CMS, D0, LHCb
  - Results & Follow-ups will be reported to **Beauty 2005** (Assisi, June 20-24 2005)
- **LCG Generator Monthly Meeting of February 24**
  - GENSER, the Generator Library: Status & Plans (I.Katchaev)
- **LCG Generator Monthly Meeting of March 24**
  - MCDB, the Monte Carlo Data Base: Status & Plans (S.Belov)
  - MC implementation of NRQCD models for prompt J/Ψ production (V.M.Vagnoni)
- **Internal Review of LCG AA on March 30-31**
  - My presentation: Current Status, Plans & MILESTONES of LCG Generator
  - Some general information included also in G.Cosmo presentations
- **LCG Generator Monthly Meeting of April 28**
  - Generator Level Production Framework: Status & Plans (H.N.Sordo & J.C.Maestro)
- **Application Area Meeting of June 1**
  - Dedicated to Physics Generators Tools
  - Status of GENSER, MCDB, Pythia 8, Herwig++, contributions/feedbacks from the LHC Experiments

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 Code
- ✓ 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

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 ~.25 FTE
  - A. Pfeiffer (CERN) based at CERN
- GENSER Integrators for Q1+Q2 2005 ~1FTE
  - S.Makarychev ITEP (Moscow) from 2004 to 31/01/2005 (30%)
  - I. Katchaev IHEP (Protvino) from 11/01/2005 to 11/03/2005
  - S. Slabospitsky IHEP (Protvino) from 14/02/2005 to 28/02/2005
  - A. Sherstnev SINP MSU (Moscow) from 28/03/2005 to 28/04/2005
  - M. Kirsanov INR RAS (Troitsk) from 10/05/2005 to 31/07/2005

WP1. GENSER Release

- **GENSER_1_0_0 (MILESTONE) released on March 29th 2005 (initially scheduled end 2004)**
  - Change in release policy (A.Pfeiffer)
  - Additional time required to wait for bug fixes from MC authors and to redefine the way to assign tags to the sub-packages.
  - Further delay due to the lack of coverage from integrators:
    - I.Katchaev left on March 11st
    - A.Sherstnev joined on March 29th
  - Huge work done. Few late fixes.
    - On top of the already mentioned GENSER integrators, librarian, liaison persons, many thanks to the MC authors, to the contact persons & helpers in the experiments and to the members of LCG-SPI

- **First general purpose C++ generator (SHERPA) introduced in LCG-EXT and supported in GENSER examples & tests (MILESTONE) on schedule**

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. EvtGen Mini-Workshop (Program)

- General Presentations
  - Introduction to EvtGen (A.Ryd)
  - The LCG Generator Project (P.Bartalini)
  - Particle Properties in Herwig++ (P.Richardson)
- Status of EvtGen in running experiments
  - Babar (D.Lange)
  - Cleo-c (A.Ryd)
  - Belle (I.Akimassa)
  - D0 (A.Sanchez)
- Status of EvtGen in LHC experiments and new developments
  - Lhcb (P.Robbe)
  - Atlas (M.Smizanska)
  - Implementation of $B_s \rightarrow J/\Psi\ \varphi$ (J.Catmore)
  - Λ_b polarization & decays (M.Biglietti)

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)*

WP1. Short Term Plans (Q1,Q2 2005)

- USER SUPPORT FOR GENSER_1_0_0
- Connection with MCDB
  - Introduction of "new" Test sub-package with GENSER use cases
  - In perspective: Interplays between GENSER, MCDB & Production Framework
- Support for Makefiles
- Procedures for Light Bug Fix Releases
- Study scenarios in view of gcc 4
- Additional sub-packages pursued for inclusions (currently approaching authors)
  - CASCADE, DPMJET, PHOJET, NEXUS/EPOS, GRACE/GRAPPA
  - Any other requests from the LHC experiments ?
- Update of already introduced Sub-package versions
  - Requests from the LHC experiments will be considered until June 15th
- Definition of responsibilities for EvtGen development & maintenance
- Evaluation of solutions for the MC implementation of NRQCD models for prompt J/Ψ production
- Further plans quoted in MILESTONES

WP2. Event Formats and Event Interfaces

GOAL: standardize interfaces, support the new OO MCs

- **The modularization**
  - **Basic idea in ThePEG, HERWIG++, SHERPA**
  - **From April 2004 LCG Generator participates to the development of ThePEG**
    - → We started with improving the doxygen documentation (A.Ribon)
    - → Activity coordinated with **Phenogrid** (N.Glover et al.)
    - → Relevant for the **Herwig++** development

- **The MC truth Interface**
  - **HEPML proposal (XML - Les Houches Agreement I compliant)**
    - → Meta-data format facilitating automated documentation
  - **HEPMC**
    - → Under the responsibility of **CLHEP**
    - (still some problems with translators, proliferation of branches)

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**

- **Dedicated presentation from the main author: Lev Dudko**

WP3. The MCDB Team

- **MCDB developers for Q1+Q2 2005 ~ 0.75 FTE**
  - S.Makarychev (ITEP Moscow) from 2004 to 31/01/2005 (70%)
  - S. Belov (JINR Dubna) from 06/03/2005 to 09/05/2005
  - L. Dudko (SINP MSU Moscow) from 10/05/2005 to 10/06/2005
- **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

❖ **Basic Sanity Checks**
❖ **Reference distributions (multiplicities, P_T Spectra etc.)**
❖ **Promoting common LHC activity on MC Tuning**

➤ **Standalone Studies**

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

➤ **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

Will switch soon to GENSER

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 becouse 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.**

LCG Generator Future Plans

- **PROPOSED MILESTONES**

    - **WP3: Proposal for a LCG Generator production centre integrated in the grid-middleware by September 30 2005.**

    - **WP1: Agreement on responsibilities for EvtGen development in GENSER. Definition of EvtGen development plans & policy. By September 30 2005.**

    - **WP1: Integration of GENSER in JetWeb by December 15 2005 (**).**
      (**) Project conducted in collaboration with CEDAR

    - **WP3: Generator level production framework: production quality release by December 15 2005 (***).**
      (***) Project conducted in collaboration with CMS

    - **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:
    → Last Thursday of the month at 5 PM in CERN-32-1-A24 & VRVS
    → Next one postponed to June 1 (and beginning at 4:30 PM): Status of
    GENSER, MCDB, Pythia 8, Herwig++, contributions/feedbacks from the
    LHC Experiments.

Simulation project mailing list:
    project-lcg-simu@cern.ch

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

Backup

Backup

- GENERAL

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**

Never write the same thing twice λ
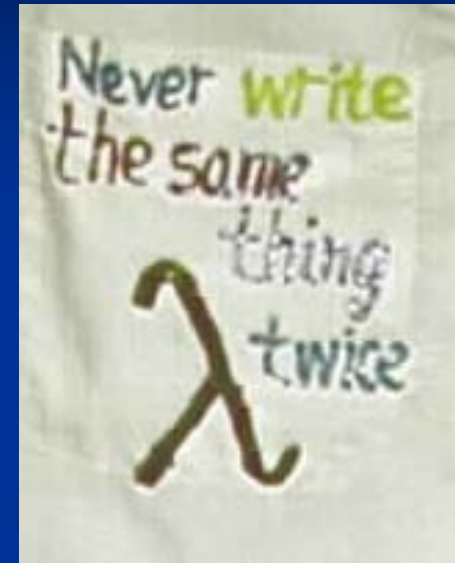
LCG Generator

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

Backup Slides

- WP1

WP1. <u>GENSER</u> Repository Structure

GENSER_1_0_0

```
        |
        |--- config/
        |--- doc/
        |--- include/
        |--- logs/
        |--- release.notes
        |--- rh73_gcc323/lib/
                        bin/
                        tests/
        | ---include/
        |--- src/herwig/data/
                        doc/
                        dummy/
                        examples/
                        includes/
                        src/
```

MC Package version provided as CVS Tag

WP1. MC Packages: Inside or Outside <u>GENSER</u> ?

- **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

Backup Slides

- WP2

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]

Backup Slides

- WP3

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 convinient 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