

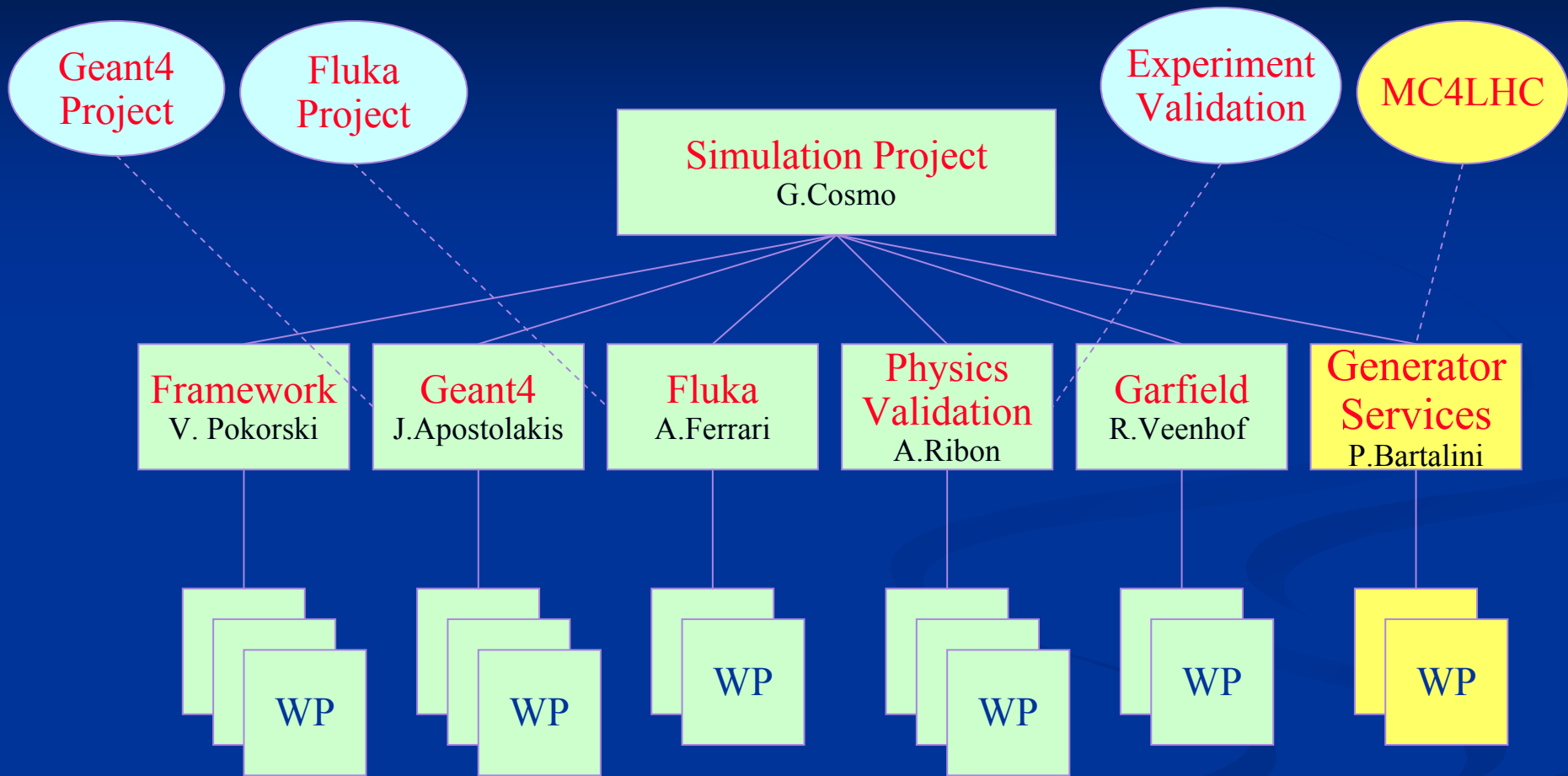


The LCG Generator Project

Supporting Monte Carlo Generators in the LHC era

P. Bartalini
(University of Florida)

LCG Simulation Project Organization



LCG Generator Services



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

New INFN (Library - Development) ~0.50 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)

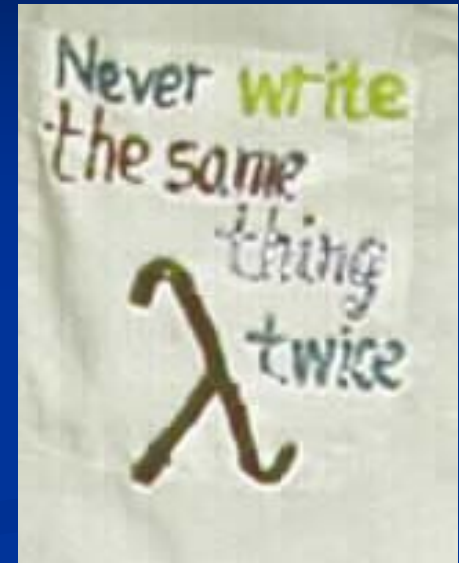
CERN, July 7 - August 2 2003

GENSER Review CERN, March 25 2004

EvtGen Miniworkshop CERN, January 20 2005

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

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)

GENSER_1_1_0: End Jun. 2005



- ❖ 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, 6.320, 6.321**
- ❖ HERWIG: **6.500, 6.503, 6.504, 6.504b1, 6.505, 6.506, 6.507**
- ❖ CHARIBDYS: **1.001**
- ❖ JIMMY: **4.1**
- ❖ ISAJET: **7.67, 7.69, 7.71**
- ❖ EvtGenLHC: **1.0, 1.2**
- ❖ AlpGen: **1.3.2, 2.0**
- ❖ CASCADE: **1.2.09**
- ❖ PHOTOS: **202, 207**
- ❖ TAUOLA **2.07, 2.07.01**
- ❖ TOPREX **4.09**
- ❖ MCATNLO **2.31**
- ❖ MADGRAPH **3.2**
- ❖ LHAPDF: **1.1, 2.0, 3.0 (LHAGLUE), 4.0, 4.1b**
- ❖ **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

Archive and Shared Libraries

WP1. GENSER 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. EvtGen

(What is EvtGen, a brief reminder)

- Monte Carlo Generator developed by D.Lange & A.Ryd
 - Designed for the Y(4S)
 - Large collection of B/D decay models
 - Based on spin density matrices and decay amplitudes
 - Presented to Beauty 2001
 - New version released recently
 - More details at <http://www.slac.stanford.edu/~lange/evtgen>
 - Widely used in the HEP
 - Babar, Belle, Cleo, Cdf, D0, ATLAS, LHCb, etc.
 - Problems with maintenance / proliferation of branches reported to CHEP 2004



- Because of **incoherent B meson production**:
 - Modification of **mixing** description
 - Modification of *CP* violation implementation
- Adaptation of decay models to B_s^0 decays
- Addition of **new decay models**
 - $B \rightarrow D K^*$
- Updates with **new measurements**
 - Strong phases in D Dalitz plots ($D^0 \rightarrow K^0 K^+ K^-$)
- Technical changes:
 - Interface with Pythia and Photos from GENSER library
 - Supported Platforms: Windows, RedHat Linux 7.3, Scientific Linux

EvtGenLHC now
developed/maintained
in GENSER



WP1. EvtGen Mini-Workshop

CERN, January 20th 2005

■ General Presentations

- Introduction to EvtGen (A.Ryd)
- The LCG Generator Project (P.Bartalini)
- Particle Properties in Herwig++ (P.Richardson)

} **Common effort on EvtGen development & maintenance**

■ Status of EvtGen in running experiments

- Babar (D.Lange)
- Cleo-c (A.Ryd)
- Belle (I.Akimassa)
- D0 (A.Sanchez)

} **Interest for a common effort on EvtGen Tuning in the framework of LCG Generator
→ Essential for the LHC!!!**

■ Status of EvtGen in LHC experiments and new developments

- Lhcb (P.Robbe)
- Atlas (M.Smizanska)
- Implementation of $B_s \rightarrow J/\Psi \phi$ (J.Catmore)
- Λ_b polarization & decays (M.Biglietti)

} **Atlas presentations at Beauty 2005
Models will be contributed to EvtGenLHC**

WP1. MC implementation of NRQCD models for prompt quarkonia production



Presented to the March LCG Generator Meeting

V.M.
Vagnoni
INFN
Bologna
(0.2 FTE)

Agreement with T.Sjöstrand for the development in Pythia 6.3

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

WP1. Short Term Plans

- USER SUPPORT FOR GENSER_1_0_0
- Introduction of “new” Test sub-package with GENSER Use Cases
 - Usage of LCG Generator tools for Configuration & Book-keeping
- Support for Makefiles
- Procedures for Light Releases
- Study scenarios in view of gcc 4
 - Specific collaboration with Herwig to perform the transition (some re-coding needed)
- Additional sub-packages pursued for inclusions (currently approaching authors)
 - TRUENOIR, DPMJET, PHOJET, NEXUS/EPOS, GRACE/GRAPPA
 - Could show up in GENSER_1_1_0 if problems are solved in time
 - Any other requests from the LHC experiments ?
- Update of already introduced Sub-package versions
 - Requests from the LHC experiments will be considered until June 30th
- Definition of responsibilities for EvtGen Development & Maintenance
- Definition of the working plan for the implementation of prompt quarkonia NRQCD models in Pythia 6.3
- Further plans quoted in MILESTONES

WP2. Event Formats and Event Interfaces



GOAL: standardize interfaces, support the new OO MCs

- The modularization
 - Basic idea in new OO Monte Carlo generators
 - From April 2004 LCG Generator participates to the development of **ThePEG** (used in **Herwig++**)
 - 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)

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: 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

- ✓ Resources from LCG Russia (MSU, ITEP, JINR)
- ✓ LCG-MCDB: Deployed on <http://mcdb.cern.ch>

**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**

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

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

■ LCG MCDB [hep-ph/0404241]

- **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://mcdm.cern.ch>**



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

Upload & document your sample



- Article creating
- Generators
- Describe process
- Describe model
- Describe cuts

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

GENERATOR: VERSION:

[Other generator/versi](#)

- 6.500
- 6.503
- 6.504

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 Milestones

Emphasis on the Collaboration with
New Object Oriented MC Projects

■ CURRENT (Q1, Q2 2005)

- WP1: Production quality release of GENSER (1_0_0) by March 31 2004 (OK)
- WP1: First C++ Monte Carlo (SHERPA) fully integrated in LCG by March 31 2005 (OK)
- 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



■ MID TERM MILESTONES (TO BE CONFIRMED)

- **WP3: MCDB user document with definition of procedures to gain access through GRID certificates by September 30 2005**
- **WP1: Procedure for light GENSER releases. By September 30 2005.**
- **WP1: Pythia 8. Release of alpha version by September 30 2005**
- **WP1: First introduction of NRQCD Prompt Quarkonia Production models in Pythia 6.3 By September 30 2005 (***)** (***) Project conducted in collaboration with LHCb
- **WP1: Agreement on responsibilities for EvtGen development in GENSER. Definition of EvtGen development plans & policy. By September 30 2005**
- **WP3: Proposal for a LCG Generator production centre integrated in the GRID middleware by December 15 2005**
- **WP1: Integration of GENSER in JetWeb by December 15 2005 (****)** (****) Project conducted in collaboration with CEDAR
- **WP1/WP2: Evaluation of possible migration of HEPMC to GENSER by December 15 2005**
- **WP3: Generator level production framework: production quality release by December 15 2005 (**)** (**) Project conducted in collaboration with CMS



■ LONG TERM MILESTONES (TO BE CONFIRMED)

- WP1: Porting of most GENSER Fortran packages to gcc4 by March 31 2006
- WP3: MCDB Integration, experiment specific APIs and management of large files by March 31 2006
- WP1: Pythia 8. Release of beta version by September 30 2006
- WP4: Generator level validation framework beta version by June 30 2006
- WP1: Finalization of NRQCD Prompt Quarkonia Production models in Pythia 6.3. By March 31 2006 (***) (***) Project conducted in collaboration with LHCb
- WP3: Fully operational LCG Generator production centre integrated in the GRID middleware by December 15 2006
- WP4: Generator level validation framework production version by June 30 2007
- WP1: Pythia 8. Release of production version by September 30 2007

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

→ Last one postponed to June 1: 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



Recent Events

- EvtGen Mini-Workshop on January 21
 - Contributions from authors + ATLAS, BABAR, BELLE, CDF, CLEO, CMS, D0, LHCb
- 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



Backup Slides

- WP1



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. Current Status

- GENSER_1_0_0 released on March 29th 2005 (MILESTONE)
 - Standardization of release policy (A.Pfeiffer)
 - 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 on March 29th 2005 (MILESTONE)



■ 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)**

EvtGen in ATLAS

$B_s \rightarrow J/\psi \phi$: Conclusions



- We have introduced interference between mixing and decay amplitudes
- Spin configuration have been validated against independent direct Monte Carlo generations
 - Scalar \rightarrow vector + vector ($B_s \rightarrow J/\psi \phi$)
- These new contributions will be added to the LHC EvtGen release

[\[J.Catmore, EvtGen miniworkshop\]](#)



EvtGen in ATLAS

$\Lambda_b \rightarrow J/\psi \Lambda$: Conclusions

- The software written for this channel has introduced tools previously missing from EvtGen
 1. Assigning production polarization to non-zero spin particles
 2. Introducing new decay model into the EvtGen suite
- A complicated spin configuration has been validated against independent direct Monte Carlo generations
 - Spin $\frac{1}{2} \rightarrow$ vector + spin $\frac{1}{2}$ ($\Lambda_b \rightarrow J/\psi \Lambda$)
- These new contributions will be added to the LHC EvtGen release

[M.Biglietti, EvtGen miniworkshop](#)

WP1. MC implementation of NRQCD models for prompt quarkonia production [V.M.Vagnoni, LHCb]



■ 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 should 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

- WP3



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.)



WP3. MCDB Short Term Plans

- 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-