
Simulation and Physics



Software Project Panel

G. Corti, G. Gracia



LHCb Simulation and Physics

- **Analysis and Simulation programs in LHCb will be integrated within the Gaudi Architecture.**
- **Gaudi provides a set of services (histograms, data stores, detector data...) and tools which can be used by different applications.**
 - Each application can configure the different services according to its particular needs
- **We will use the same framework for all kind of applications, simulation, reconstruction, analysis, and for batch and interactive jobs.**

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LHCb Simulation

What are the plans and status of GEANT4 migration and validation? What are the plans and responsibilities of the experiment in the validation process? How is the collaboration and software process for GEANT4 working and what needs to be changed?

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LHCb Simulation status

- **Current simulation program used in production is written in FORTRAN and uses GEANT3**
- **GEANT4 use in LHCb is still very limited (Started summer 1999)**
 - First prototype to integrate G4 and Gaudi (as a Gaudi Service).
 - This prototype is being used in the electromagnetic calorimeter test beam.
- **LHCb contribution to GEANT4 (in collaboration with G4 developers):**
 - Porting of G4 to NT and testing it on this platform
 - Migration to C++ ISO/ANSI standard
 - Testing of G4 releases on NT

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Migration Plan

- **The limited LHCb manpower is focusing on the reconstruction & analysis: Migration to G4 has a lower priority**
- **Start migration during this year:**
 - Further development of the G4/Gaudi integration
 - Interface G4 with Detector Description Data Base (DDDB)
 - Migrate the detector description from G3 to DDDB and G4
 - Small programs for test beams simulation.
 - Start writing the experiment simulation program using G4
- **We plan to complete the migration during next year**
- **Validation of G4 will be done with real data (test beams) and comparison with current G3 program**

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GEANT4 MoU

The uptake of G4 in the experiments is very slow. As far as we know no experiment uses it in production yet. What is the reason?

Comments arising from our (very limited) experience

- The TSB is mainly composed of developers, very few *full time users* \bar{P}
Development is not driven by the needs of real users. Each person in the TSB should play a well defined role (user or developer)
- The decisions taken by the TSB are not always followed-up by the core group of developers.
- GEANT4 developers should help experiments to launch their G4 activities
 - That would result on immediate feedback and on user driven development of G4
- A GEANT4 support service is needed in each major lab which hosts experiments using it (CERN in our case).
- The MOU should be between institutes and labs (no experiments!) that provide the manpower for development Signatories to the MoU should be those who manage resources.

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LHCb Geometry

How is the experiment geometry specified? Is there one common specification in use for reconstruction, GEANT4 and other simulation?

(See Radovan Cytracek presentation at CHEP 2000
<http://chep2000.pd.infn.it/paper/pap-a155.pdf>)

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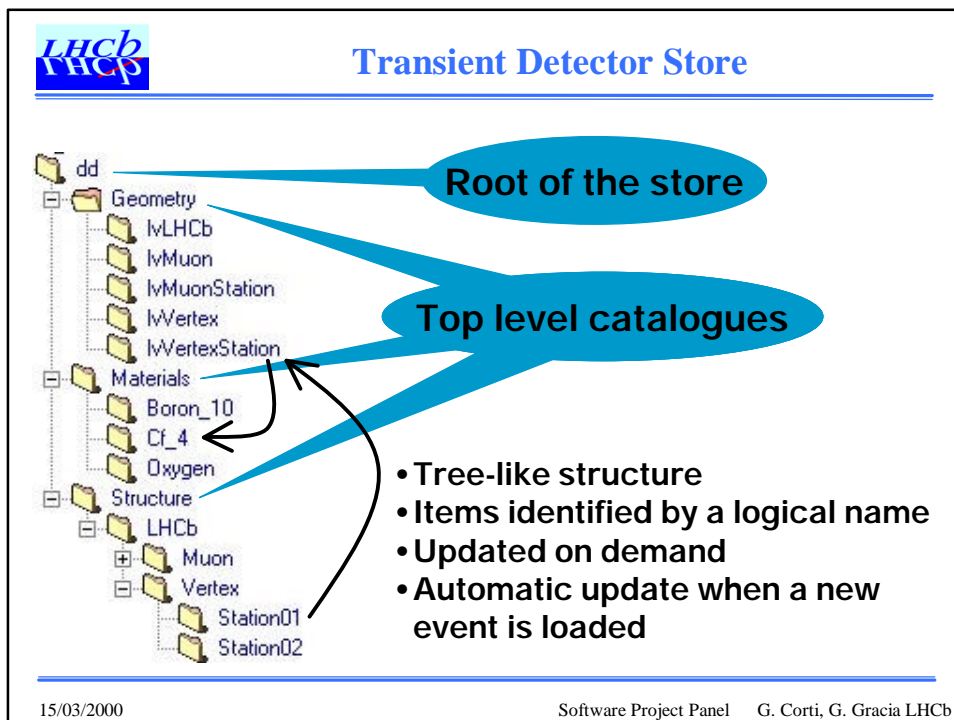
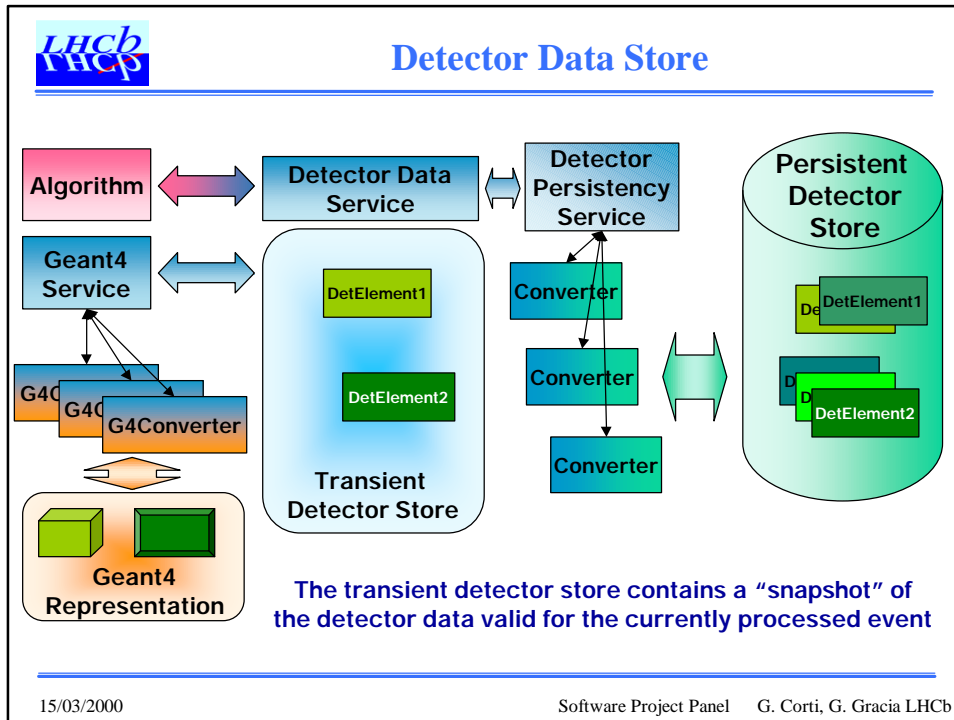


Detector Description in Gaudi

- **Detector description provides**
 - Single source of detector data for all clients
 - Simulation, reconstruction, analysis, test beam
 - It is not detector geometry only
 - Logical detector structure, geometry & positions, materials, mapping electronic channels to detector cells, detector control data needed for reconstruction, calibration and alignment data
 - Versioning of all detector data based on event time, run #, etc.
- **We use XML as our persistent data format.**
 - Currently XML are stored as ASCII files

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Upon which Generators is the experiment relying? Where and how will the long-term support for these generators come from? How will they be interfaced to the experiment's software suite and who is responsible for this?

- **There is currently no C++ generator in production**
- **We consider generator and decay as two different programs.**
 - As we are a B-physics experiment we are particularly worried about the software which controls the decay.
 - If there is a tool providing satisfactory results for both we will use it. Currently they are separated in our software.



Generators

- **Generators and decay packages used**

Year	1999	2000	2001	2005
Generator	Pythia 5.7	Pythia 6.1	Pythia 6.1 Herwig 5.8	Pythia 7.x Herwig++
Decay	Pythia 5.7	QQ 9.2	QQ 9.2	BPACK (?)

- **Support for these packages:**

- Pythia & Herwig well established and supported packages (Lund and Milano/Cambridge by theory groups)
- QQ Developed by CLEO. Currently co-maintained by CDF/CLEO/LHCb and the FNAL simulation group.
 - We hope QQ can be frozen in 2002 and used only for cross checks since then on
- BPACK (?)

- **The interface with GEANT4 will be done using the data store.**

- Adopt standard format if there is any (StdHep...).

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Fast simulation?

What are the experiment's plans for fast simulation?

- We aim to have only one simulation program with detailed simulation where needed and fast parametrization of the response every time is possible. We will have the possibility to switch from fast to detailed mode in some places.

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Computing for Physics

How does the interface with physics groups work? How is the responsibility divided between Software and Computing groups and "Physics groups" for physics algorithms, physics object definition and identification?

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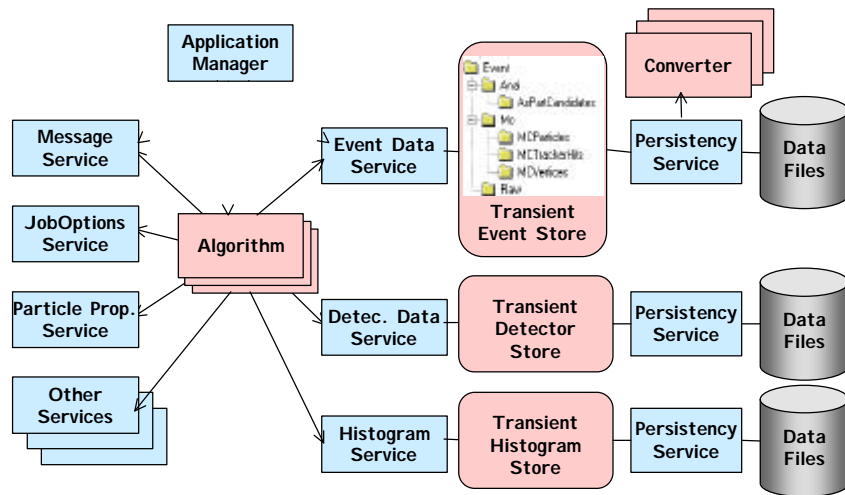


Interaction between Computing & Physics

- **Currently Physics Groups = Detector Groups (TDR writing phase)**
 - “Physics software” for detector reconstruction and optimization
 - Several physicists developing software in each group
- **Technically:**
 - Computing group: basic structure of algorithms and data, framework and services (toolkits)
 - Physicists working in detector groups: specific physics contents of Algorithms and Data Objects using necessary services

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- **Collaborative effort**
 - Personal interactions between physicists and computing group experts during code development of specific software
 - Feed-back on basic structure from physicist based on their need leading to improvements, new functionality added, bug fixes
 - Code Reviews of Detector software by Computing Group
 - Software contact person for each detector group + generators + physics analysis for directions, decisions, to ensure communication
 - The Computing group provides documentation for framework and services (via web)



Mock Data Challenge

- **What Mock Data Challenge, or other activities, which exercise the full spectrum of software from simulation through to physics object data, is being planned? How will the success of these exercises be accessed?**

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Mock Data Challenge

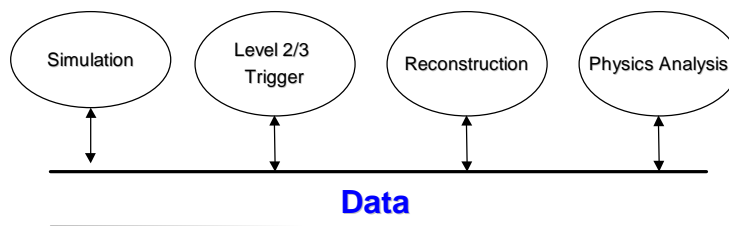
- **Until 2002 various detailed simulation studies are planned, requiring to evaluate the effect of different choices on the physics channels analysis.**
 - Detector optimization studies (VELO, RICH, etc.)
 - Trigger studies (L2, L3, etc.)
- **Each simulation study requires ~ 10⁶ events**
- **Mock Data Challenge will use the ongoing simulation studies to test the software and computing infrastructure**
- **In 2004-2005, before data taking, plan to use the installed extra CPU capacity to generate large production sample (10⁸ - 10⁹ events) for physics background studies**
 - For LHCb simulation is a problem for both CPU and storage resources
 - Keep the Generator part and repeat only GEANT4 part when detector experience is available.

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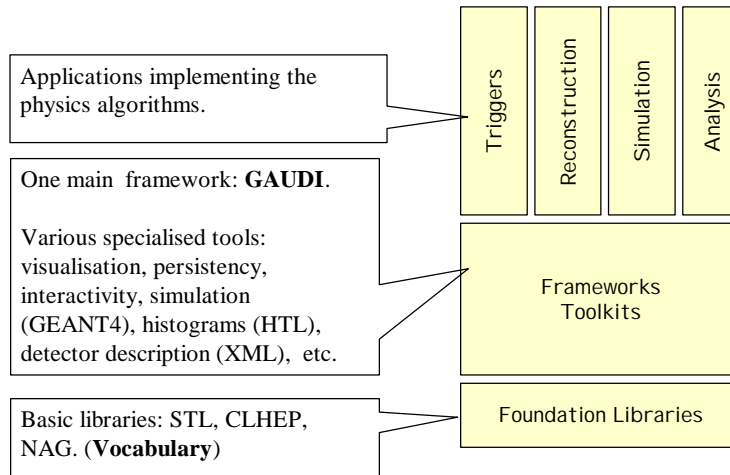
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- **What is the decomposition into trigger, reconstruction, simulation and physics analysis software? What are common parts? How do you expect that the current choices will evolve? Which decisions do you foresee in the future?**

- **Trigger, Reconstruction, Simulation and Physics Analysis Software are application in different processing stages.**
- **Each is a producer and/or consumer of data for other stages**



- **They also share software:**
 - Foundation libraries
 - Frameworks (in particular GAUDI, the main framework)



- **Plug-and-Play mechanism for concrete packages**
 - Packages can be common or not
 - Maximize the common packages
- **We foresee to integrate new specialized tools providing new functionality and to chose concrete implementations were the choice is still open**
- **The choice of packages will change in the future when new ones become available (we don't know what will be available in 2005)**