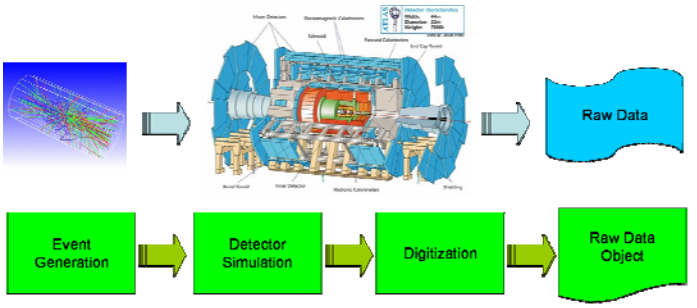
The Status of the Simulation Project for the ATLAS Experiment in view of the LHC startup

The simulation suite for ATLAS is in a mature phase ready for the LHC startup in 2009. It offers a set of pre-configured applications. Large scale productions on the Grid prove the robustness of the implementation. A fast shower simulation suite was also developed and performance comparisons have been made.

The Atlas Simulation Framework

The simulation framework is integrated in the ATLAS software framework (Athena) and runs based on dynamic loading and action on demand. The framework is written in C++ and a layer of Python interface adds flexibility for run-time configuration of the different setups and interactivity.



In order to study detector response and the effectiveness of proposed physics analysis strategies, a detailed simulation has been implemented that produces the output in a format identical to that of the real detector. The simulation is carried out through mainly three steps:

- **Event Generation**: simulation of particle collision events and immediate decays.
- **Detector Simulation**: simulation of interactions of generated particles passing through the detector.
- **Digitization**: simulation of read-out electronics.
  In addition, pile-up process that overlays multiple events from particle collisions and background due to cosmic rays, beam-gas interactions and beam halo particles can be performed before the digitization step. (See the poster 133 for more details)

Detector Description is a separate package to be share among the detector simulation, digitization and the later steps of the software chain.

Metadata handling is the latest subject of interest for the conditions monitoring and recording during the simulation process. A fast shower simulation suite was also developed in ATLAS and performance comparisons are part of the overall evaluation.

Event Generators

Various event generators are available within the ATLAS simulation suite.

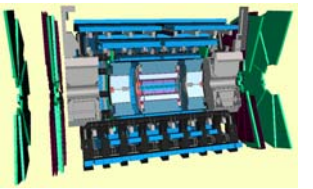
- Single particle generator: based on G4ParticleGun used for basic sub-detector response studies
- Beam Halo Generator and Cosmic Ray Generator: to simulate the background in the cavern
- physics event generators: to simulate p-p collisions, external software for physics event generation and particle decay are interfaced to Athena.

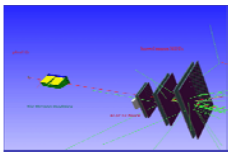
The Athena generator interfaces allow for the passing of all relevant parameters at runtime, permitting a fixed software release to be used to produce different physics configurations.
The generated events can be either passed to the detector simulation directly, or saved in a file in HepMC format so that simulation jobs can be run separately with different configuration or with different software releases.

Detector Description

A number of different detector setups are implemented and available in the package:

- ideal detector with nominal geometry parameters
- realistic detector with misalignments and distortions
- the detector during the commissioning period with displaced sub-detector parts.
- cosmic-ray setups with the cavern under 100m of rock
- combined test beam setups
- standalone test-beam setups



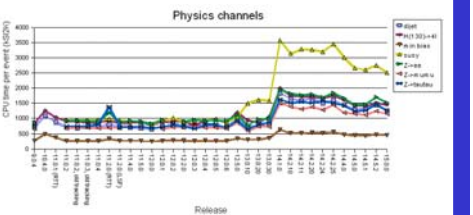


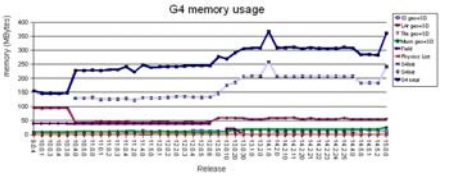
Each detector component was carefully described in all details and performance monitored. The few still missing pieces of the apparatus (forward and very forward detectors) inert material and services (toroid supports, support rails, detector feet) are about to be integrated in the current simulation suite. Detailed description of ideal and realistic geometry for each ATLAS subcomponent made possible optimization studies and validation.

Validation of the software and Large Scale Productions

In parallel to the simulation development, validation of the software under development is performed daily with a set of small scale productions for different samples of single-particle and physics events and the results are monitored constantly.

As soon as a release of the software is made, a routine validation of CPU time and memory consumptions is performed with a middle scale production of several Hundreds of events.



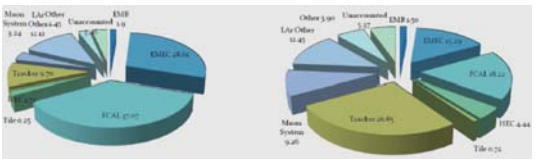


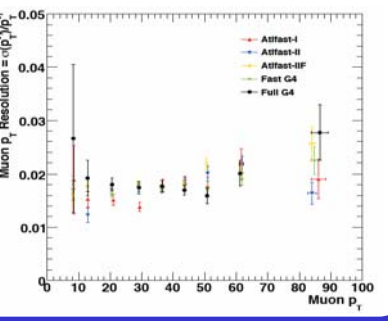
Once the release is validated, large scale productions start in order to provide data for physics analyses. Several hundred millions of events have been produced on the LHC Computing Grid in the last year, which proved the robustness of the ATLAS simulation implementation. (See the talk 128 for more details)

Detector Simulation

Geant4 is the baseline detector simulation in ATLAS and it is used for studies with detailed detector responses. Fast simulations are used for physics studies that require large statistics.

Because of the complicated detector geometry and detailed physics description used in the ATLAS Geant4 simulation, it is impossible to achieve the statistics required for physics studies with the available computing resources.
A fast shower simulation suite was developed in ATLAS and performance comparisons have been made as a part of the overall evaluation.





I. Ueda[1], A. Dell Acqua[2], M. Gallas[2], A. Di Simone[3,4], Z. Marshall[5], J. Boudreau[6], Y. Zhou[7], V. Tsulaia[6], J. Chapman[8], A. Rimoldi[9,4]
[1] The University of Tokyo, [2] CERN, [3] University of Rome II, [4] INFN, [9] Caltech & Columbia University, [6] University of Pittsburgh, [7] Academia Sinica, [8] Cavendish Lab., [9] University of Pavia