LHCb production experience with Geant4

LCG Applications Area Meeting
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Outline

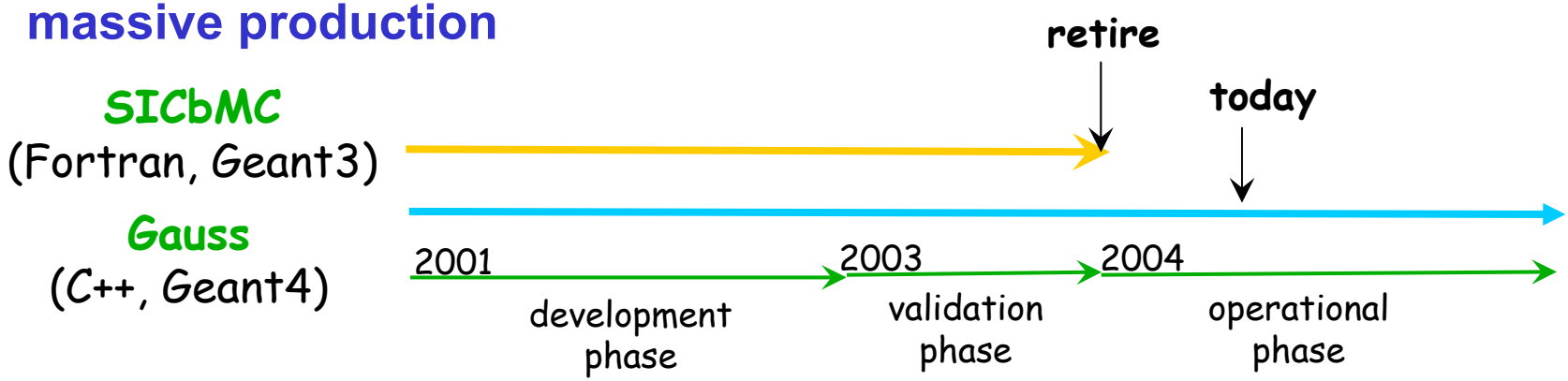
- DC04 goals
- Gauss validation
- Gauss in production – the DC04 experience
- Summary

DC04 goals

- **LHCb data challenge (DC04) started 3rd of May 2004**
  - **Physics studies**
  - **robustness test of the LHCb software and production system**
  - **incorporation of LCG application area software**
  - **use of LCG resources**
  - **new Gauss simulation in production environment**

Validation of Gauss as THE simulation application

- **Gauss has replaced the Geant3 based simulation for this year massive production**



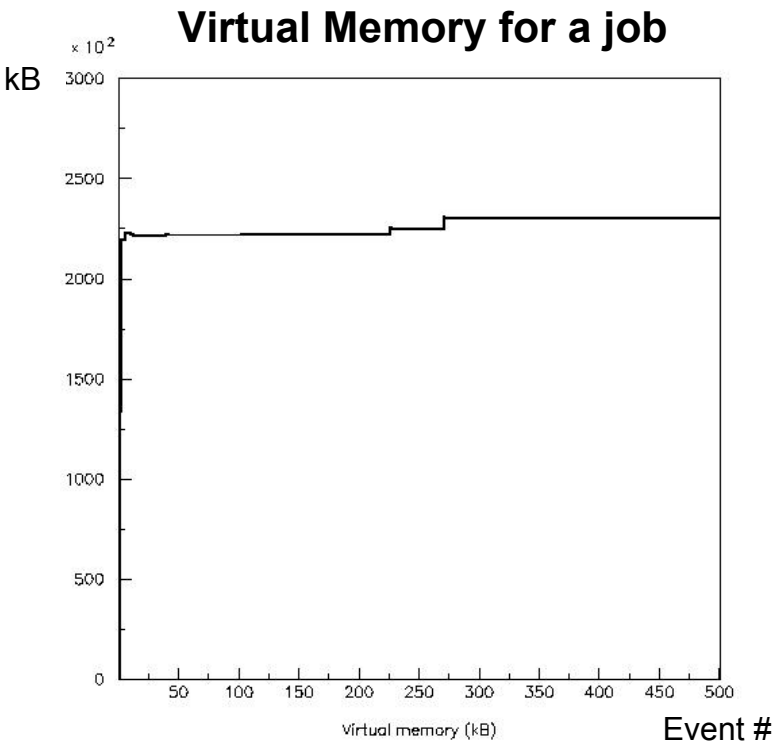
- **Requirements for Gauss to be fully operational:**
  - **complete**
    - all detectors simulated
    - all information needed in later processing provided
  - **stable**
    - low crash rate, reasonable CPU time
  - **validation of physics**
    - comparison with the Geant 3 simulation (validation as replacement)
    - comparison with test beam data (tuning of physics setting, ex. RICH)

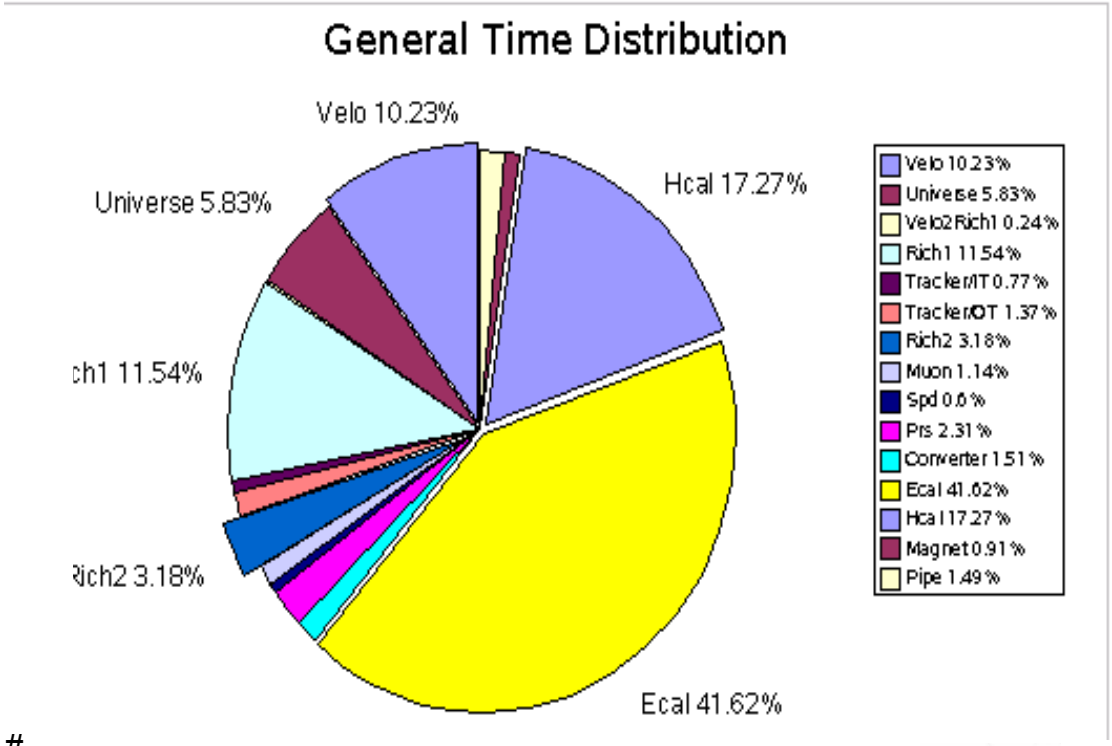
Gauss benchmarking with Geant4 6.1

Memory usage ~220 MB and stable (no significant memory leaks)

CPU time performance (2.4GHz PIV, gcc 3.2 –O2)

- **minimum bias ~ 22 s/event**
- **BBbar inclusive ~ 65 s/event**

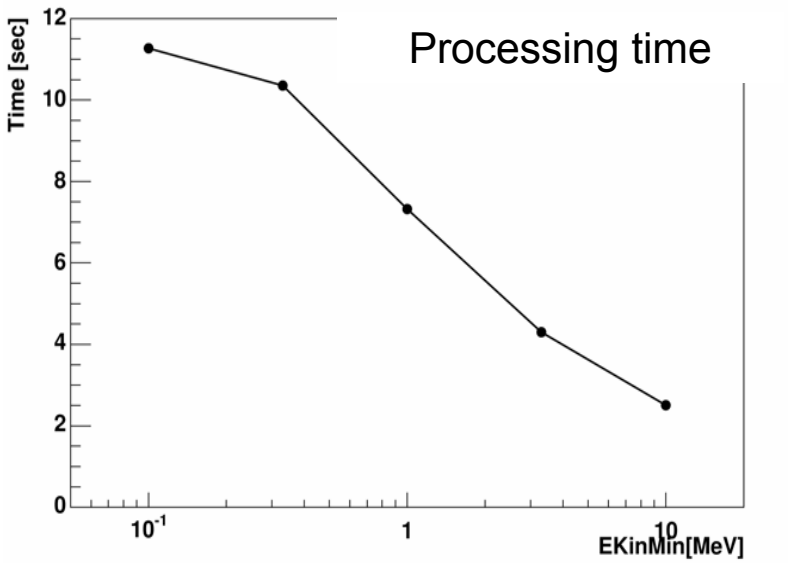




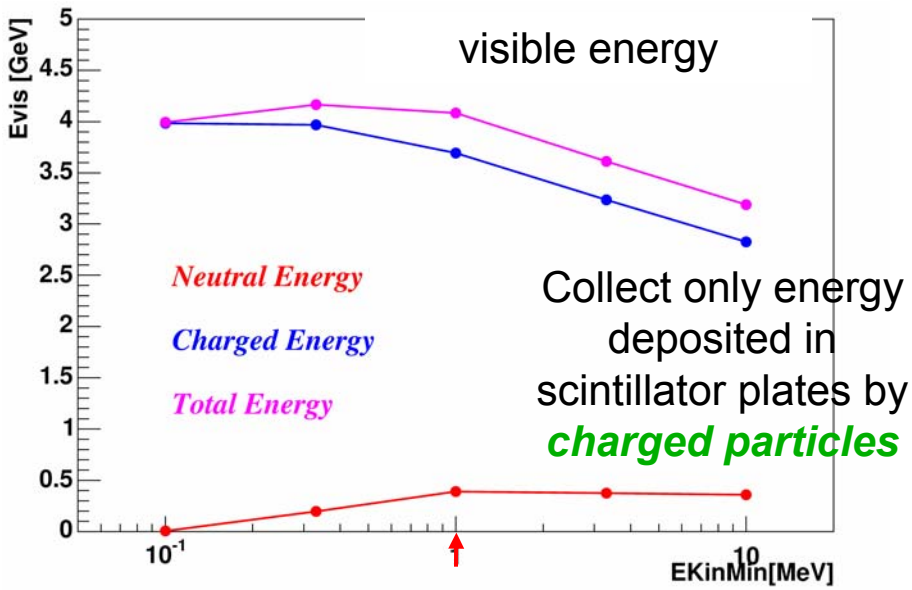
Choice of tracking cuts

- Introduce tracking cuts on E_{kin} of particles (special stepping actions)

Effect of cut value for ECAL with 30 GeV electron particle gun



Energy threshold below which the particle is not tracked.



Collect only energy deposited in scintillator plates by ***charged particles***

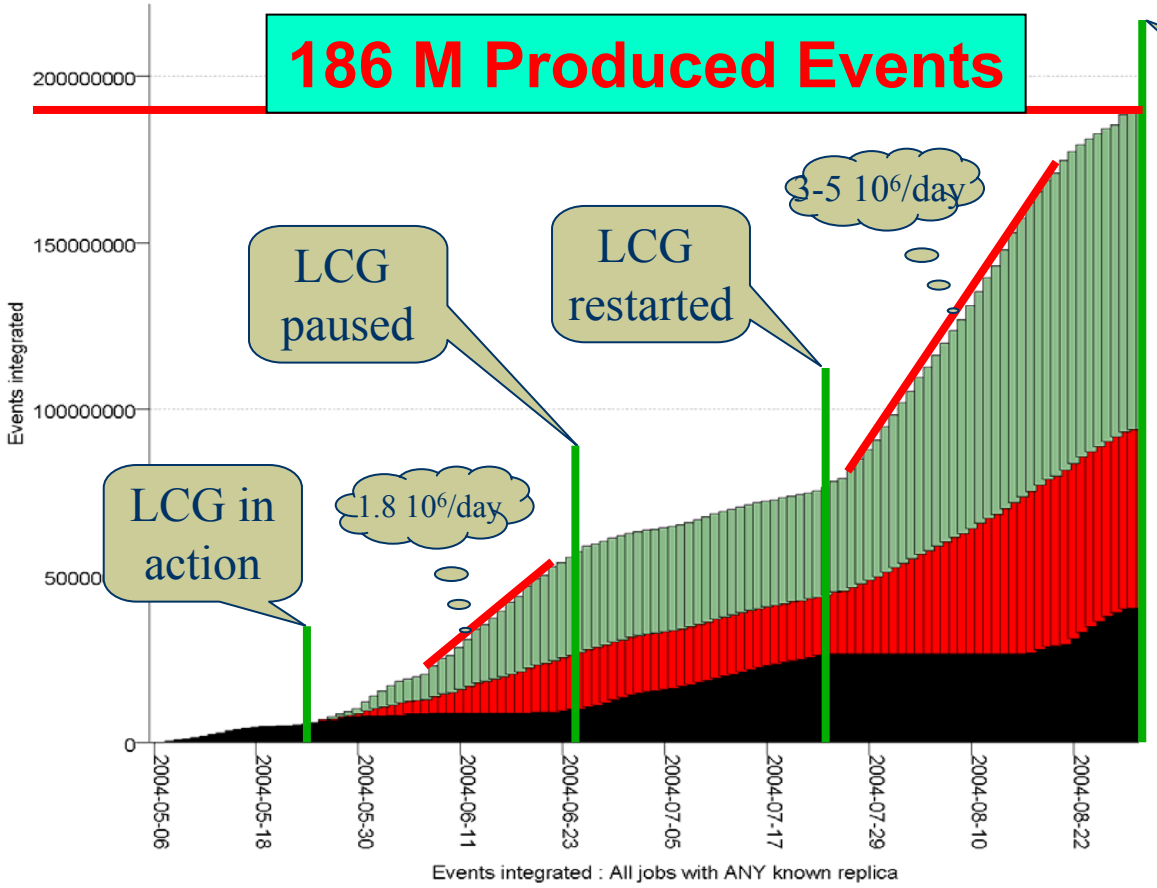
Value Used

- Study the relation between tracking cuts and production cuts
- Investigate production cuts per region

Gauss in production

- **Gauss used in DC04**
  - **Pythia 6.205 for pp-collision generation**
  - **EvtGen v5r0 (LHCb modification from α – 00 – 11 – 07) for B decays**
  - Geant4 6.1 for detector simulation
  - **three versions of Gauss - fix bugs identified in production**
    - **in conversion of MCtruth**
    - **particle getting stuck during tracking**

Gauss in production (May – August)



Still producing data ~ 210 M up to now

In each job 3 sets of 500 events produced with Gauss for spill-over

Data produced in ~ 60 different sites

Crash Analysis

- On 97718 jobs run between 16 August and 19 October
  - A job is made of several steps
    - 3 (signal + 2 minbias) Gauss (detector simulation) – 500 events

    or
    - 4 (b-incl + 3 minbias) Gauss – 500 and 3*300 events
  - Followed by digitization and reconstruction
- 529 jobs crashed in one of the Gauss runs
  - 58 (+7) stopped before (during) the 1st event due to various "system" reasons
  - 85 stopped in the event generator step
  - 278 stopped in the Geant4 step which includes GiGa interface
  - 2 in Hadronic processes
  - 32 for unknown reason (Gaudi or "system" reasons)
  - No output
- Crashes occurred in step 1: 425, step 2: 33, step 3: 29, step 4: 13
- Crashes in Geant4-GiGa : ~50% of all the crashes
  but less than 1 per mil of the runs

Debugging Gauss in production

- More than 50% of the crashes are independent of Geant4
- For the 50% occuring in the Geant4 step
  - Detailed information available when a problem occurs for foreseen reason is very useful
    - As it is done in Hadronic processes
- Detailed printout for normal situation
  - very important when developing or adopting a new Geant4 version
  - should be under the control of the user to not clutter log files during production

Summary

- Gauss, the Geant4 based simulation application has been successfully validated as replacement of the LHCb Geant3 simulation application
- It has been used (and continues to) in DC04 to produce over 210M events in ~300000 runs with a failure rate in Geant4 < 1 per mil of the runs
- Data produced with Gauss in DC04 will be intensively scrutinized in the coming months
  - Introduce more realism and details in Gauss
    - understand better both the simulation and test beam data
  - Investigate alternative, new paths to those adopted currently in Gauss
    - delta rays production
    - production/tracking cuts per region
    - investigation of tracking in magnetic field (parameters, regions)