Geant4 Performance : CMS View

Julia Yarba

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Geant4 Performance in CMS Application: Revisit History

- Spring 2006: CMS Simulation team investigated why Geant4.7.1-based simulation went into infinite loop on NaN
- CMS opted for a temporary solution:
  - "NaN-trap" based on the system function isnan(...)
  - "traps" placed in MagFld and SD methods
  - skip event if NaN detected
- NaN rates from CMS MCProduction tests:
  - Minbias: 0-2 events skipped out of 1000 (mult. 20-1500)
  - QCD: ~2% of events skipped (mult. several hundreds)
  - Heavy Ion: ~65% of events skipped (mult. 2500-40000)
- However, use of isnan(...) costs ~3% CPU overhead

CMS Simulation: Debugging NaN's

- Debugging CMS simulation code with FPE switched ON:
  - Several flaws in the CMS application (geometry)
  - Cases of numerical instabilities in Geant4 core code: unprotected sqrt(a-b) in geometry, hadronic physics
- Bug reported to Geant4 developers, fixed in Geant4.8.1
- Preliminary tests of the Geant4.8.1(p01)-based release with Heavy Ion events indicate significant performance improvement – 75 events went without any NaN
- In the near future CMS plans production-type tests of the release based on Geant4.8.1(p01), for more reliable estimates
- Whether we caught all NaN's – most likely, not...

Further Look at the Geant4 Performance

- Several software experts plan to look at the Geant4 performance aspects, starting from CMS application:
  - Mark Fishler (Fermilab)
  - Jim Kowalkowski (Fermilab)
  - Marc Parerno (Fermilab)
- Aspects to address :
  - Timing performance – profile CMS application using VTune (commercial perf. analysis suite from Intel)
  - Safety features, numerical (in)stabilities
- Work has began, expect more detailed information in the near future