CMS plans for the usage of Geant4

Filippo Ambroglini – INFN Perugia
Fabio Cossutti - INFN Trieste

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Geant4 in CMS

- Up to January production version g4.8.3p01
- Currently using g4.9.1p01, QGSP_EMV as production physics list
  - Basic tests have not shown any obvious serious problem
  - Performance improvements compared to g4.9.1
- Production platform used: SLC4 + gcc3.4.5
  - RAM: 2 Gb/CPU (or core)
    - Constraint on memory footprint
- Tests ongoing with gcc 4.1.x, 4.2.x
  - and MacOSX

Feedback on g4.9.1p01

- Removal of std::deque in CHIPS reduces by ~25% the total dynamic memory allocations in events wih hadronic activity
  - single π pT=1 TeV
  - Z'→jj(700 GeV)
  - Corresponding to ~5-10% CPU speed improvement
- Reproducibility does not still seem ok in QGSP_EMV
  - In proton inelastic interactions
- Some error messages in high statistics tests under scrutiny

Messages in g4.9.1p01

- **G4HadronElastic WARNING ekin= -1.1368684e-13 after scattering of proton p(GeV/c)= 231.03124 on proton**
  - Precision in kinematics?
- ***NAN*G4QElasticCrossSect::GetExchangeT: -t=nan**
- The message:

  G4HadronicProcess: track in unusable state - 1
  ***** G4Exception : 001 issued by G4HadronicProcess**
  bailing out
  ***** This is just a warning message**
  G4HadronicProcess: returning unchanged track
- Another precision problem?

  ***** Error in G4HEInelastic::GenerateNBodyEvent**
  total mass (2.13212) >= total energy (2.04412)
- Problem in nuclei codes?

G4PDGCodeChecker::CheckPDGCode : ??? Illegal PDG encoding for nucleus PDG code=1000010011
Particle H1[21221.8] has a strange PDGEncoding

G4PDGCodeChecker::CheckPDGCode : ??? Illegal PDG encoding for nucleus PDG code=1000010011
Particle H1[1112.3] has a strange PDGEncoding

CMS production plans

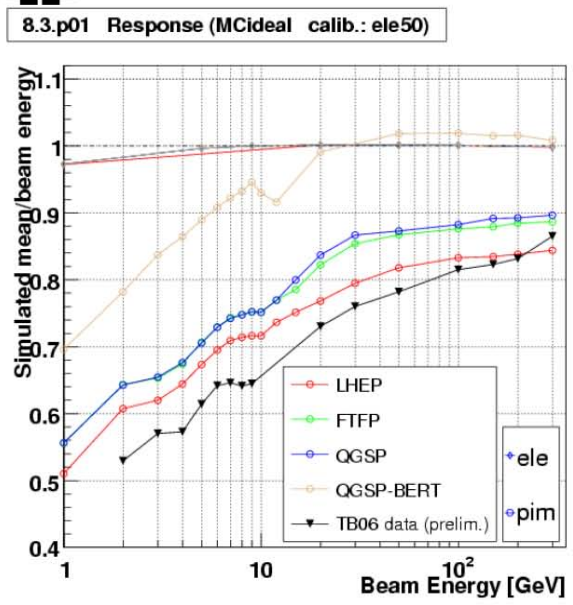
- Beginning of March: CMSSW_2_0
  - To be used for massive MC production ~O(300 Mevents)
  - Using g4.9.1p01 (if no last minute surprises)
- Open to include patches for problem fixing/performance improvements in 2_1
  - Impact on physics output to be quantified
- Open to test physics improvements
  - But their adoption in massive productions is not guaranteed this year
- For full simulation: full Geant4 is the basic choice
  - By we keep the usage of GFlash fast parameterization as an option, in case no satisfactory tuning can be achieved
  - Active work ongoing, first tuning of em showers on TB data about to start

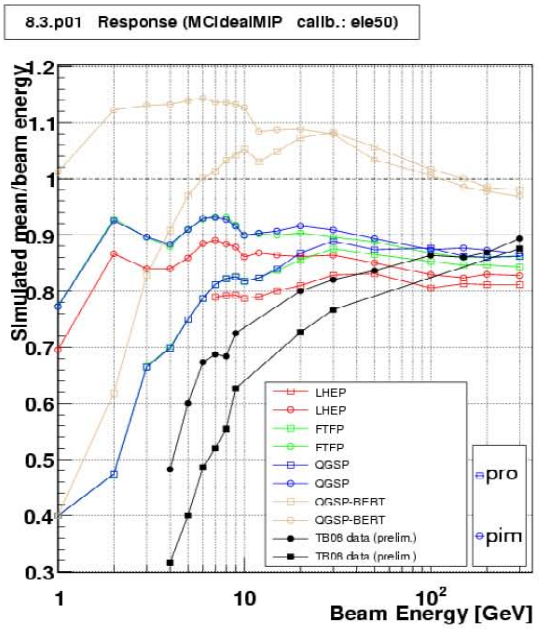
Calorimeters task force

- Recently a task force has been created with the mandate to coordinate and push the efforts for the solution of the residual problems in the comparison of the calorimeters' simulation with the test beam data
  - Current target: end of spring 2008, CMSSW_2_1
- Work on the optimization of the CMS description
  - But of course attention to G4 physics lists, tuning

Open problems in TB analysis

Gross Features





- Energy deposit in crystals and scintillators predicted by different physics models in Geant4 varies a lot
- Need better understanding/improvement of models and careful treatment in translation of energy deposit to light production
- The issue was reported to G4 team in a number of platforms
- Some level of tuning is possible at the light production phase

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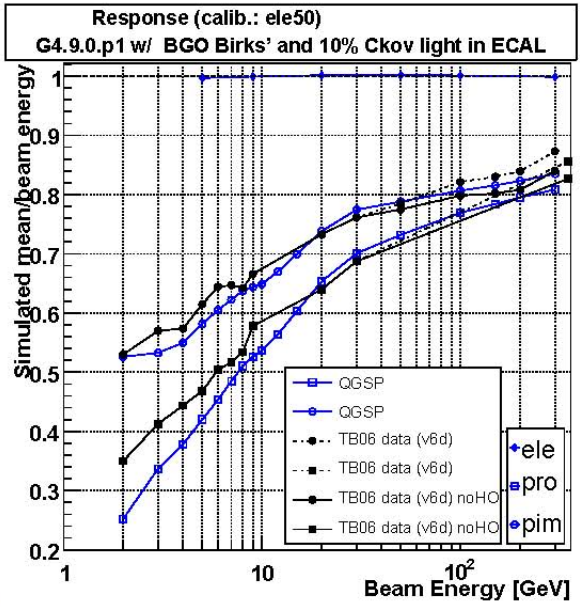
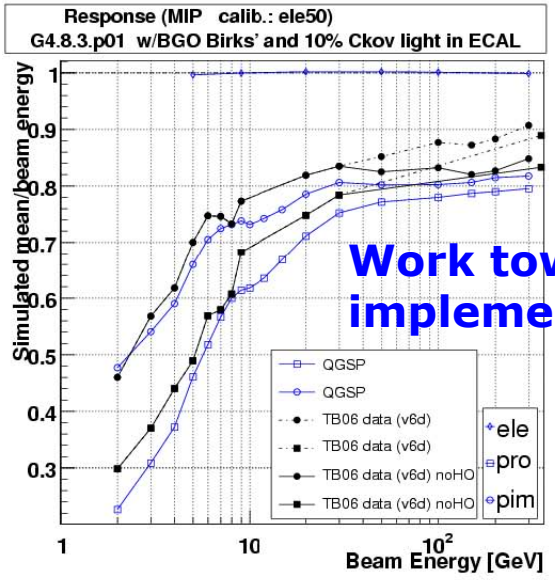
Open problems in TB analysis

First Feedback

- Include saturation effect in scintillators
- Finite contribution of Cerenkov photons in ECAL response
- Include details of instrumental effects in analyzing TB simulation data

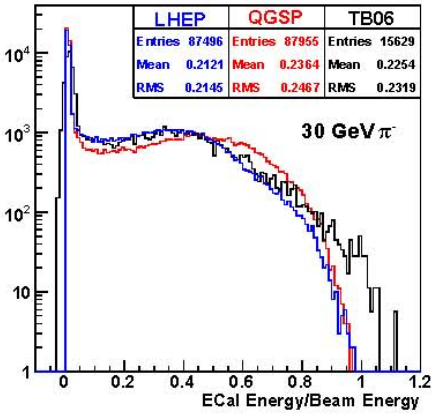


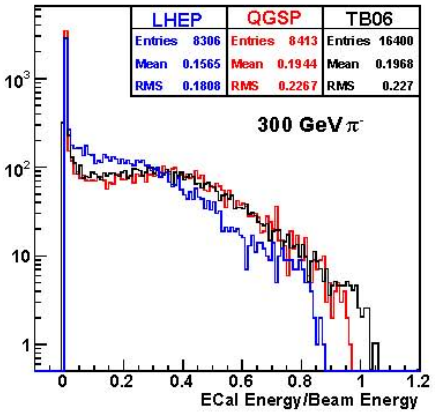


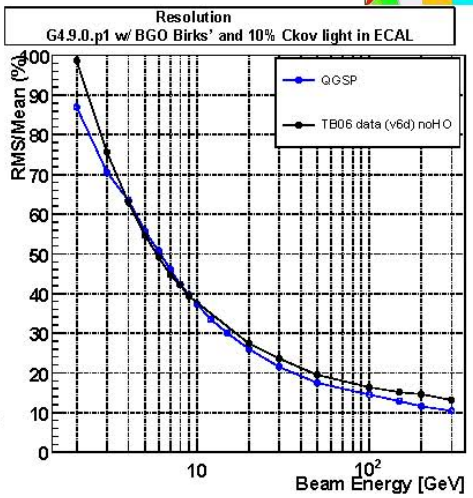
Work towards a full implementation ongoing

Open problems in TB analysis

Is this good enough?







- Response function still disagrees to the level of 4-5% (outside systematic uncertainty)
- Resolution at high energy still to match with data
- No single G4 model can explain consistently energy fraction in ECAL at all energies (π° production rate determine the shape)
- TB data from HF can be used as an additional handle. (While HF data look at the entire shower, here the higher energy part is only covered)

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Conclusions

- CMS requires g4.9.1p01 to be supported at least for 2008
  - Fixings, performance improvements
- As we enter in production mode, we would like to see significant physics (or interface) developments separated as much as possible from the above maintenance