
Geant4 EM simulation status and LHC start

V.Ivanchenko, 7 February 2008

Outline

- Status of EM standard
- LHC requirements
- Some validation results
- Testing suite
- Proposed plan for 2008

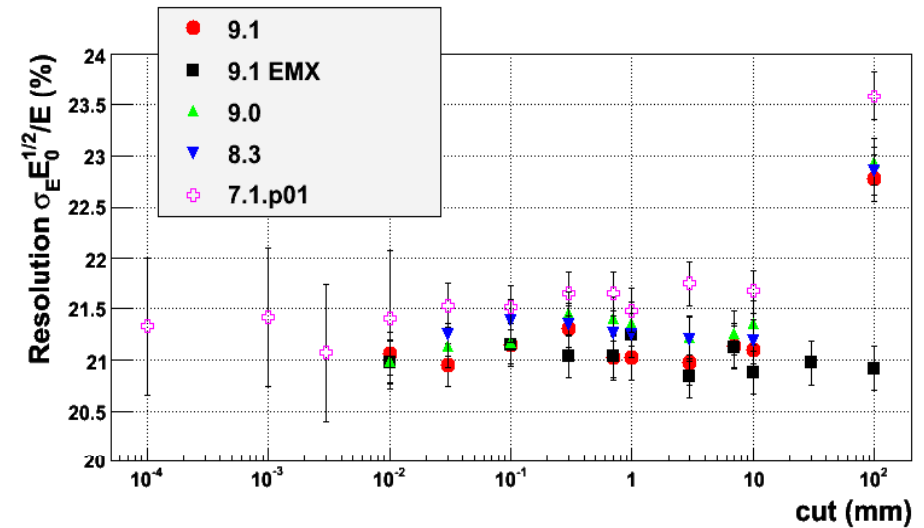
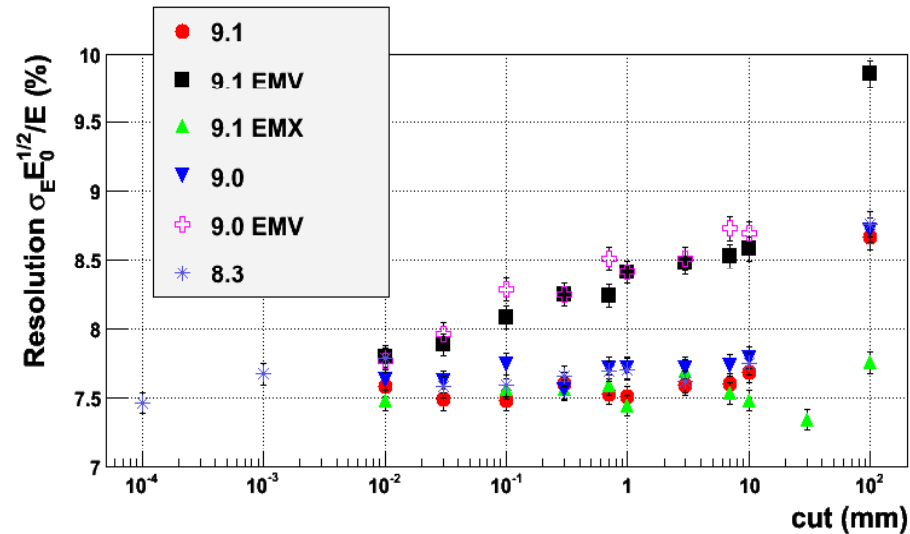
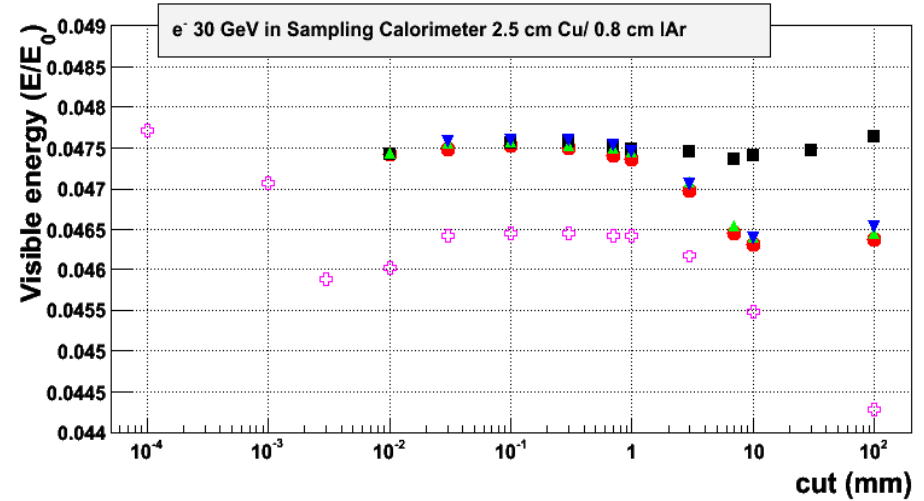
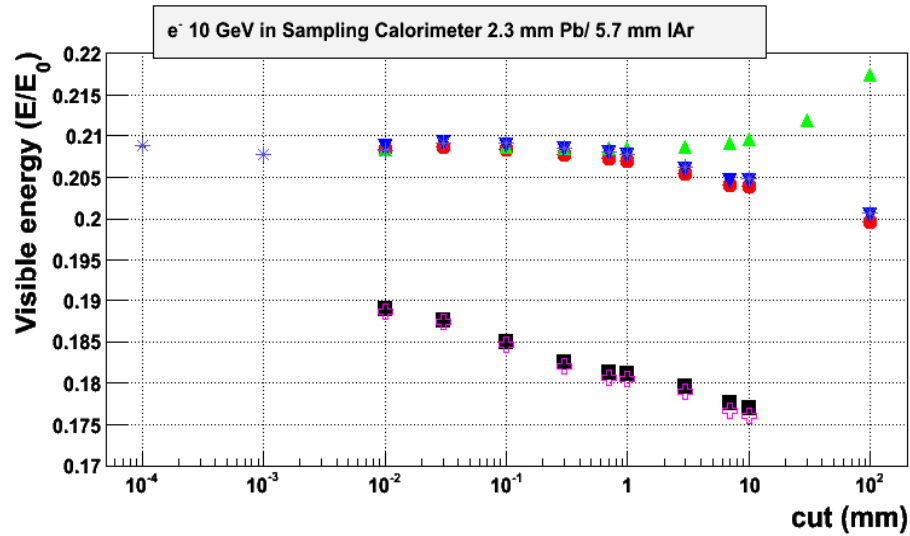
Status of EM standard

- Since release 7.1 the design of EM physics is stable
- The list of processes is complete
- Since release 8.0 EM standard provides HEP simulation with accuracy within few %
 - Calorimeter response is stable within 1%
- The testing suite have been developed and executed regularly

LHC requirements and concerns

- For today following releases are assumed to be used for production:
 - LHCb – 7.1p01
 - ATLAS – 8.3p01
 - CMS – 9.1p01 (?)
- Frequent modifications of our msc model are of concerns of all LHC experiments
 - ATLAS may not migrate to 9.1 only because of change of calorimeter response
 - Situation when we should support 3 releases simultaneously is difficult
 - Slow migration from one G4 version to another connected also with previous experience of getting new bugs

ATLAS calorimeters responses



Testing suite

- The testing suite is in progress
 - <http://vnivanch.web.cern.ch/vnivanch/verification/verification/electromagnetic>
- Testing suite helped in past to avoid big problems
- For the releases 8.3 and 9.1 at the last moment an important problems of proton/ion simulation were identified by individual efforts of A.Bagulya, T.Toshiyuki, Y.Tomohiro
 - We need to be able to identify problems earlier

Testing suite

- **Should be a stable G4 application**
 - The same geometry, cuts, other parameters
 - Compare with data or with previous releases
 - Exercise Physics Lists provided for LHC and other users
 - Automatic running
 - Should be committed
- **Private tests of developer is a different thing**
 - Should exist in parallel

Testing suite status

■ Calorimeter tests

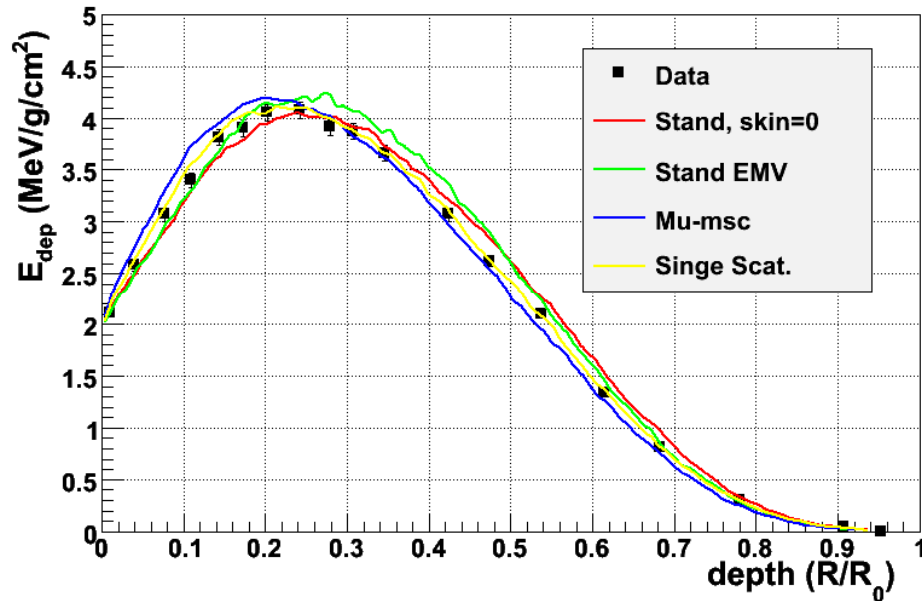
- ATLAS barrel and HEC
- CMS crystals
- LHCb
- ZEUS test beam
- ILC structure – needed

■ Electron transport

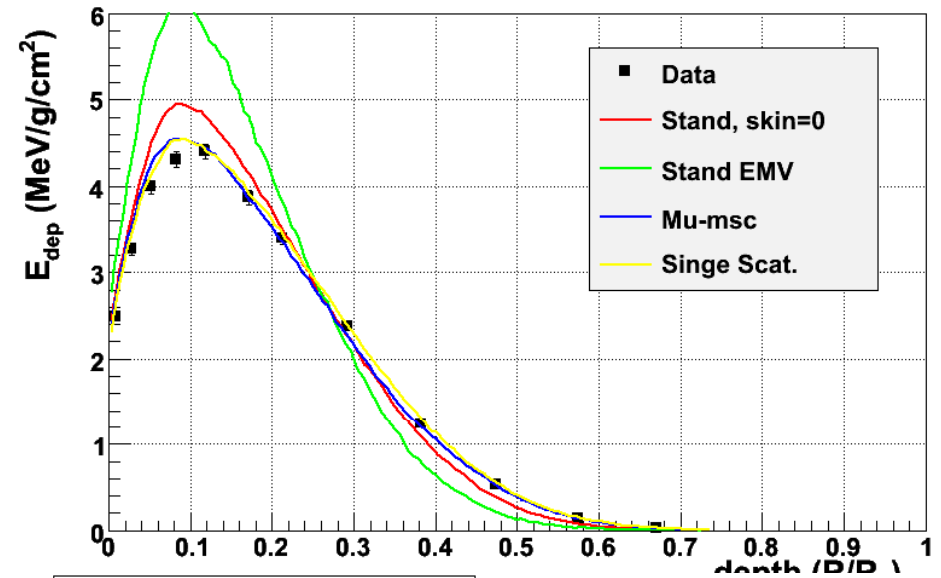
- Test37 – Sandia data
- FanoCavity
- FanoCavity2
- ?

Test37

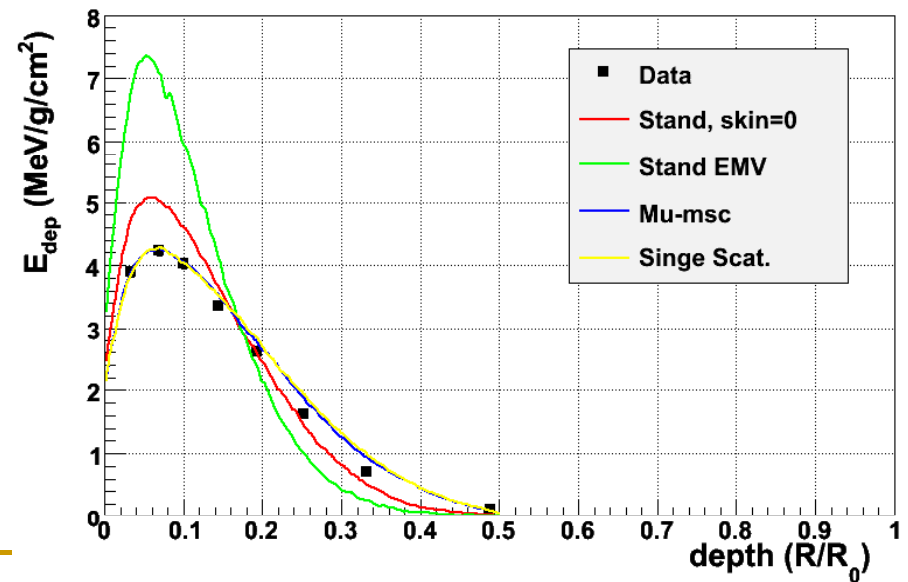
e^- 0.521 MeV in Al, Geant4 9.1



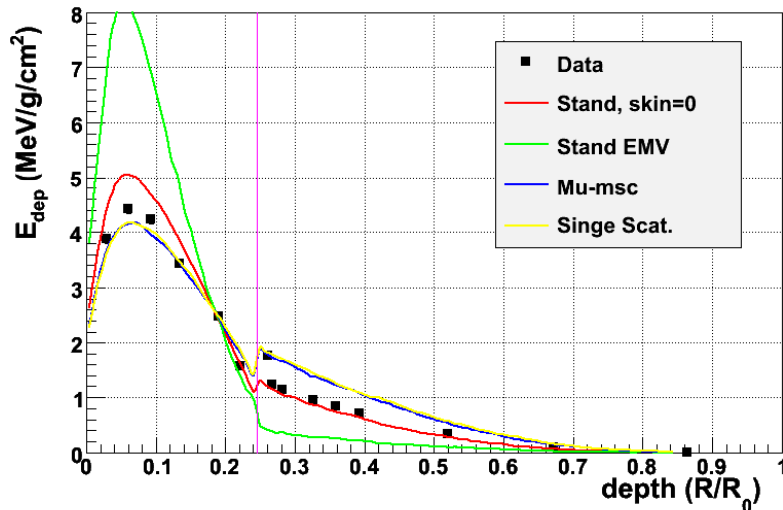
e^- 0.5 MeV in Mo, Geant4 9.1



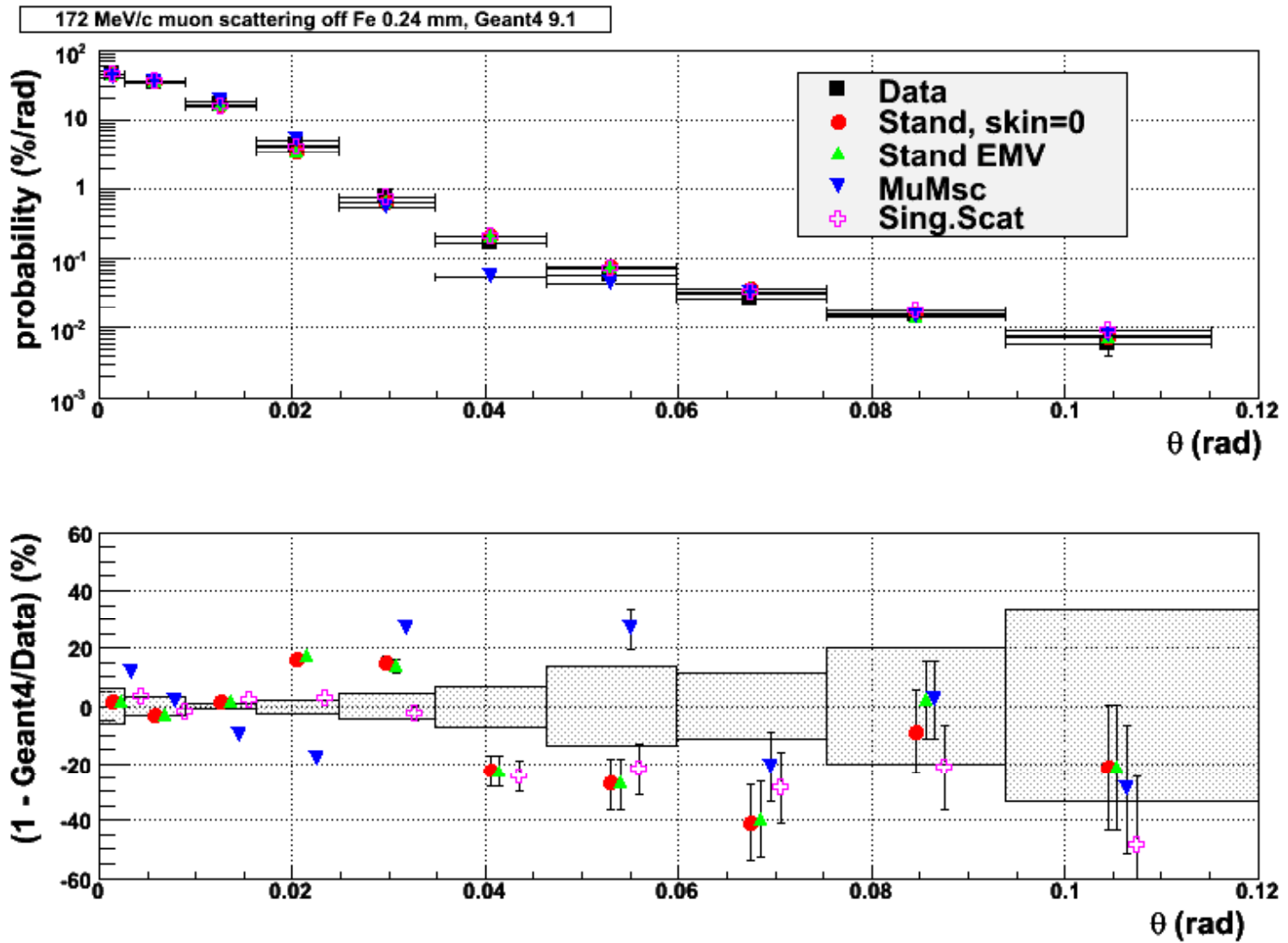
e^- 0.5 MeV in Ta, Geant4 9.1



e^- 0.521 MeV in TaAl, Geant4 9.1



Test41



Testing suite status

- Msc:
 - Test41 – MuScat data
 - Much more needed for different particles (data used by Laszlo should be formalized as tests)
 - Gottschalk 160 MeV proton experiment
 - Shen experiment for highest energies
 - ?
- Fluctuations of energy loss
 - Silicon data exist and the test is a high priority for LHC
 - There are a lot of data for low-energy ions
- Bragg peak
- Bremsstrahlung
 - Double differential cross sections
 - LPM effect

Plan for 2008

- Validation and verification of EM physics:
 - adding multiple scattering comparisons into the testing suite;
 - adding Bragg peak comparisons to the testing suite;
 - precise test on vertex detector simulation;
 - extend tests for medical applications;
 - regular execution of the testing suite.

Plan for 2008

- Further update of ionization processes:
 - review of density effect parameterisation;
 - include ICRU'73 data for ion ionisation;
 - simulation of fluctuations per particle type;
 - analysis and testing of Geant4 ionisation processes in ALICE TPC detector (in collaboration with ALICE experiment);
 - providing class for simulation of Birks effects in different media;
 - providing class for simulation of drift electrons in gaseous detectors.

Plan for 2008

- Further development of the processes of multiple and single scattering:
 - muon multiple scattering model development;
 - hadron multiple scattering coherent with hadron diffuse model;
 - ion scattering model from Vanderbilt University integration

Plan for 2008

- Infrastructure update
 - introduce process sub-type;
 - introduce cut in range for recoil;
 - introduce an option to use spline for Physics Vectors;
 - introduce variable density (medical applications);
 - development on a variant of cross section biasing;
 - design on EM model configurator.

Plan for 2008

- Further development of the polarized processes
 - implementation spin precession in magnetic field (using Stokes vectors representation)
 - continue validation of polarized processes
 - extend list of examples

Plan for 2008

- Further development of optical photon physics
 - analysis and testing of Geant4 optical processes in PbWO4 crystals (in collaboration with CMS and ALICE experiments);
 - analysis and testing of Geant4 optical processes in ALICE RICH detector (in collaboration with ALICE experiment);
 - include Mie scattering as a new optical photon physics process;
 - a new extended/optical example to exhibit transmission properties of optical fibers with circular and elliptical cross section;
 - implement extension to the UNIFIED surface model to have both specular and diffuse components for the transmitted photon;
 - implement a more flexible micro facet sampling method for optical surfaces;
 - model the optical transport in a volume that has different optical treatments on different sides.

Plan for 2008

- Cerenkov process: - limit the step in G4Cerenkov when the particle drops below the Cerenkov threshold.
- Introduce K-L shell X-rays in the photoelectric process.
- Review of the bremsstrahlung models including LPM effect.
- Development of the bremsstrahlung and e+e- pair production processes and models for pions and protons.
- Extend e+ annihilation to hadrons : add 3pi and K+K- production.