Geant4 10.2 electromagnetic physics highlights

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for Geant4 Collaboration

9 December 2015

Summary of modifications in EM standard libraries

- G4EmParameter class is now the main user interface to change EM parameters
  - Several new UI commands are available
- New UI commands and c++ interface allowing to configure PAI, MicroElec, and DNA models on top of any EM physics list
- In all ionisation processes a lowest energy limit is introduced and corresponding UI commands and c++ interface are added
  - It is the result of the review of existing limits, which were hidden from users
- Corrected density effect parametrisation for low-density gases
- G4UrbanMscModel upgrade:
  - Added correction factor for e+.
  - Added new optional algorithm of sampling of the lateral displacement
- Implementation of the Goudsmit-Sounderson model was revised and completely rewritten
  - New physics constructor G4EmStandardPhysicsGS is added
- Hadrons/ions multiple scattering modifications
  - A combined approach is used by default WVI multiple scattering + single scattering model
  - By default the lateral displacement sampling is disabled
- A revised implementation of single scattering models for ions and for $e^{\pm}$ (with Mott corrections)
  - P.G.Rancoita & M.Tacconi
  - New physics constructor G4EmStandardPhysicsSS uses single scattering models
  - New UI command is added to enable the usage of the $e^{\pm}$ model with Mott corrections

Summary of modifications in EM low-energy libraries

- Ion/ion stopping power tables were updated using new computations of A.Schinner
- Polarized models are migrated to MT
- Introduced a new G4LowEPPolarizedComptonModel for simulation of linear polarized gamma scattering
  - developed in Monash University
- A new option to enable simulation of the full Auger atomic de-excitation cascade is available
  - Secondary vacances are taken into account
- Selection of Bearden data for more accurate fluorescence lines simulation
  - Developed in Geneva University for space spectroscopy

Summary of modifications for Geant4-DNA

- New electron elastic and inelastic models for liquid water
  - dielectric formalism
  - collaboration with Ioannina University, Greece
  - improved accuracy on electron transport at very low energy (for eg. DPK simulation)
  - see Med. Phys. 42 (2015) 3870-3876
- New model for simulation of scattering for light ions in liquid water
- New physics constructors G4EmDNAPhysics_optionX
  - X=1 - 7
  - included alternative models for elasic and inelastic interactions of electrons
- New extended examples: range, svalue, wvalue, clustering
- Coupling of Geant4-DNA physics to GATE simulation platform
  - see Nucl. Instrum. Meth. B 353 (2015) 46-55

Technical modifications for all EM physics libraries

- It is recommended to use G4EmParameters
  - Thread safe approach
  - Old G4EmProcessOptions is available but will be removed for the next releases
- List of new UI commands
  - /process/msc/MuHadLateralDisplacement true
  - /process/msc/RangeFactorMuHad 0.2
  - /process/msc/StepLimitMuHad UseSafety
  - /process/em/augerCascade true
  - /process/eLoss/UseMottCorrection true
  - /process/em/lowestElectronEnergy 20 eV
  - /process/em/lowestMuHadEnergy 100 keV
  - /process/em/AddPAIRegion all myregion
  - /process/em/AddMicroElecRegion myregion
  - /process/em/AddDNARegion myregion
- Added «lock» option applicable in custom Physics List – parameters of a model may be defined by usercode and ignore UI commands
- New G4LEDATA library G4EMLOW6.48 is needed

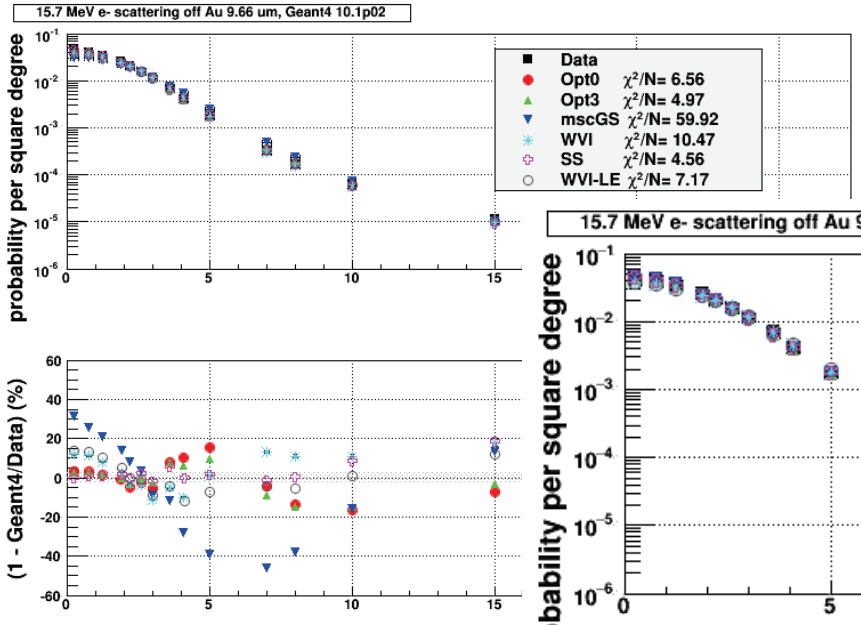
Selected validation results

In general EM physics results are stable

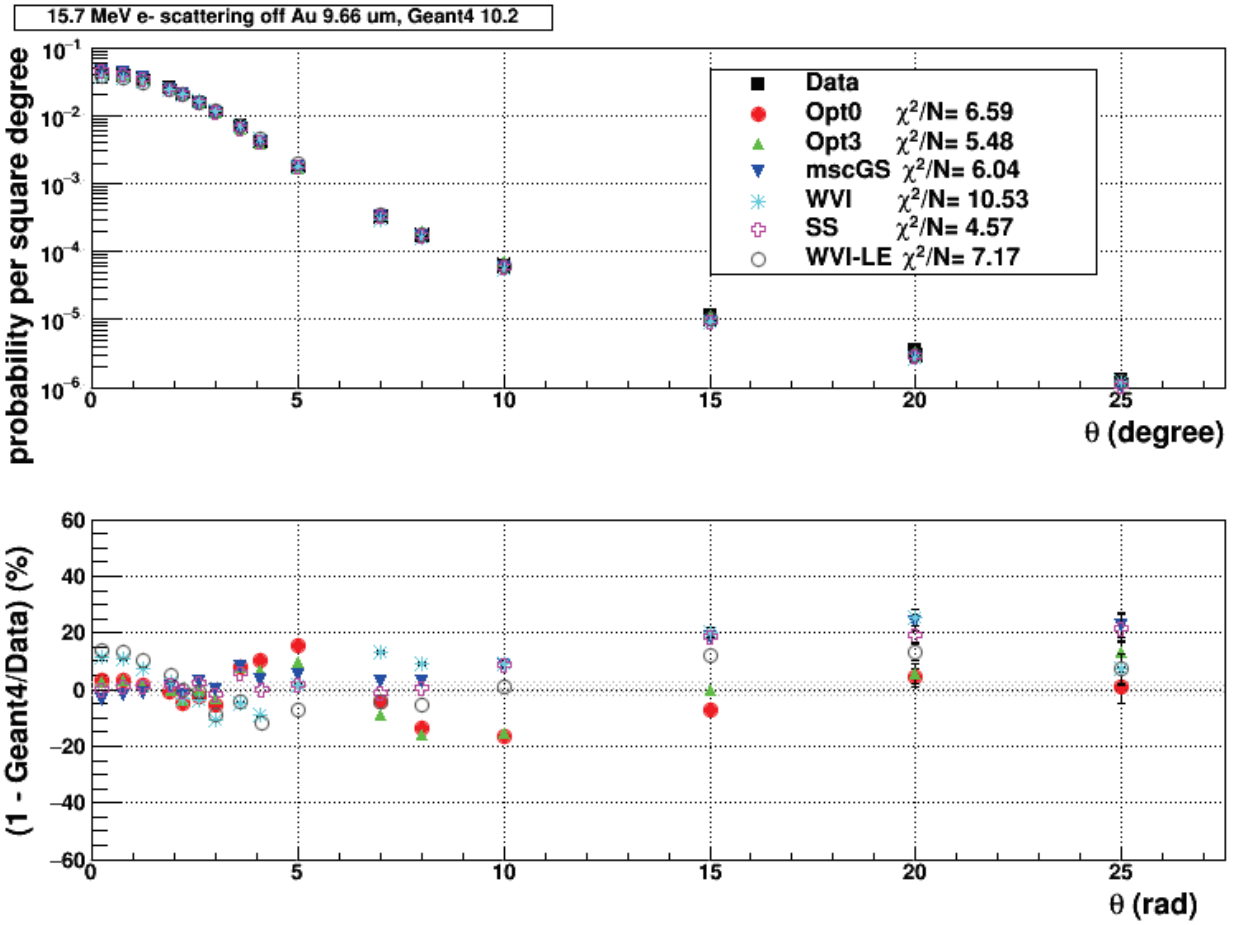
CPU performance is similar to the previous release 10.1

Hanson data for e- scattering off thin foil

Phys. Rev. 84, p. 634-637, 1951.

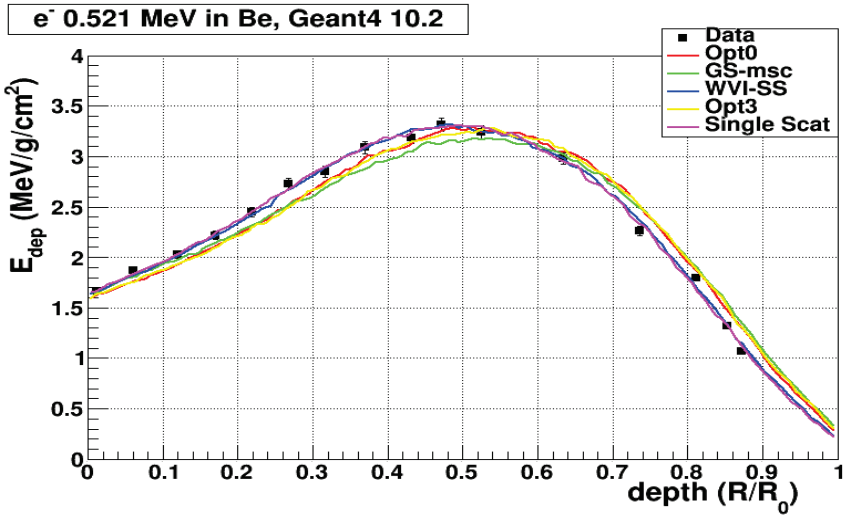


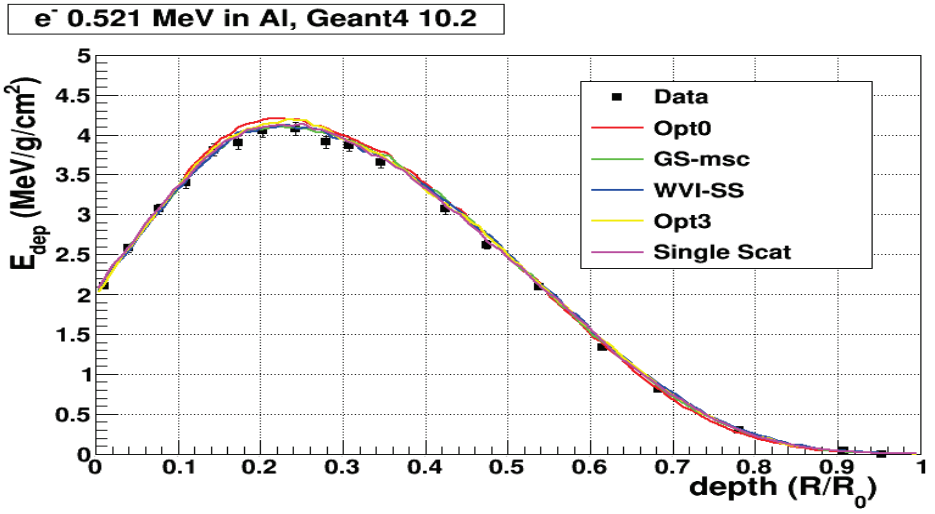
GS model has been significantly improved

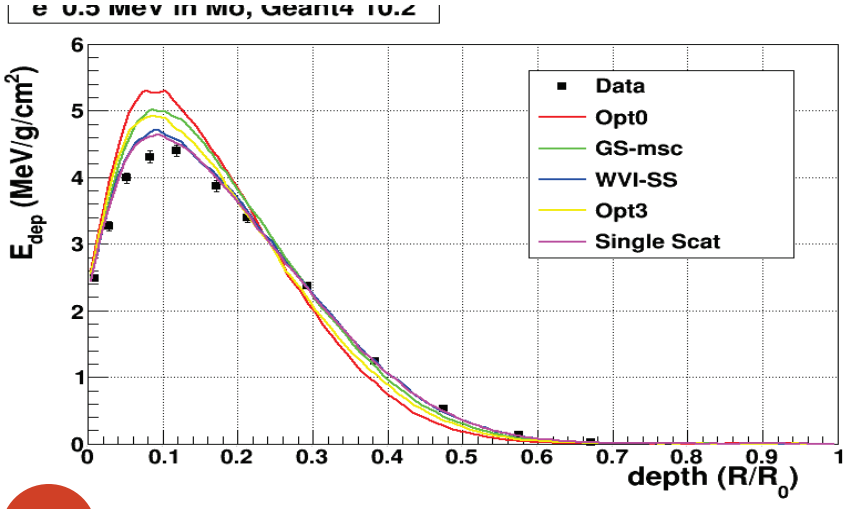


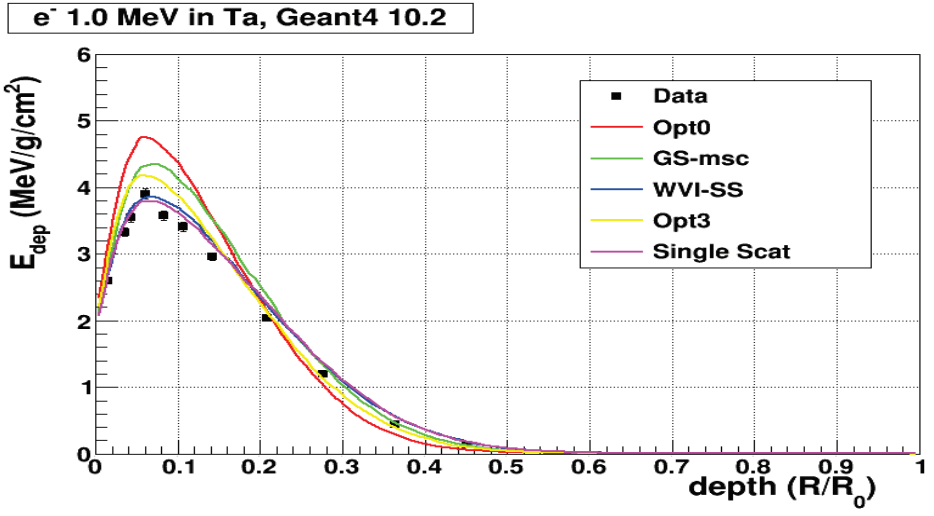
Sandia data – backscattering

NIM B 258 (2007) 381



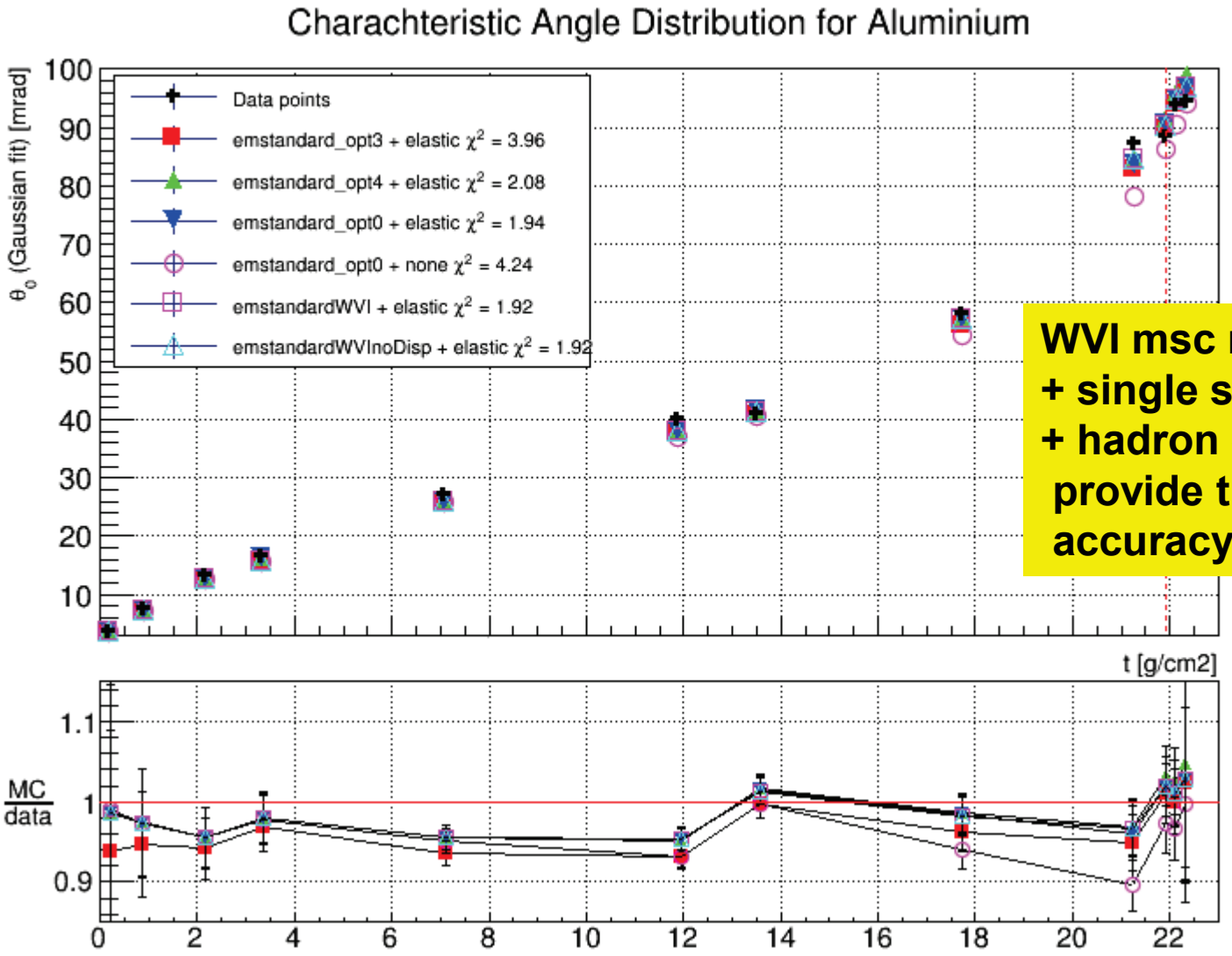






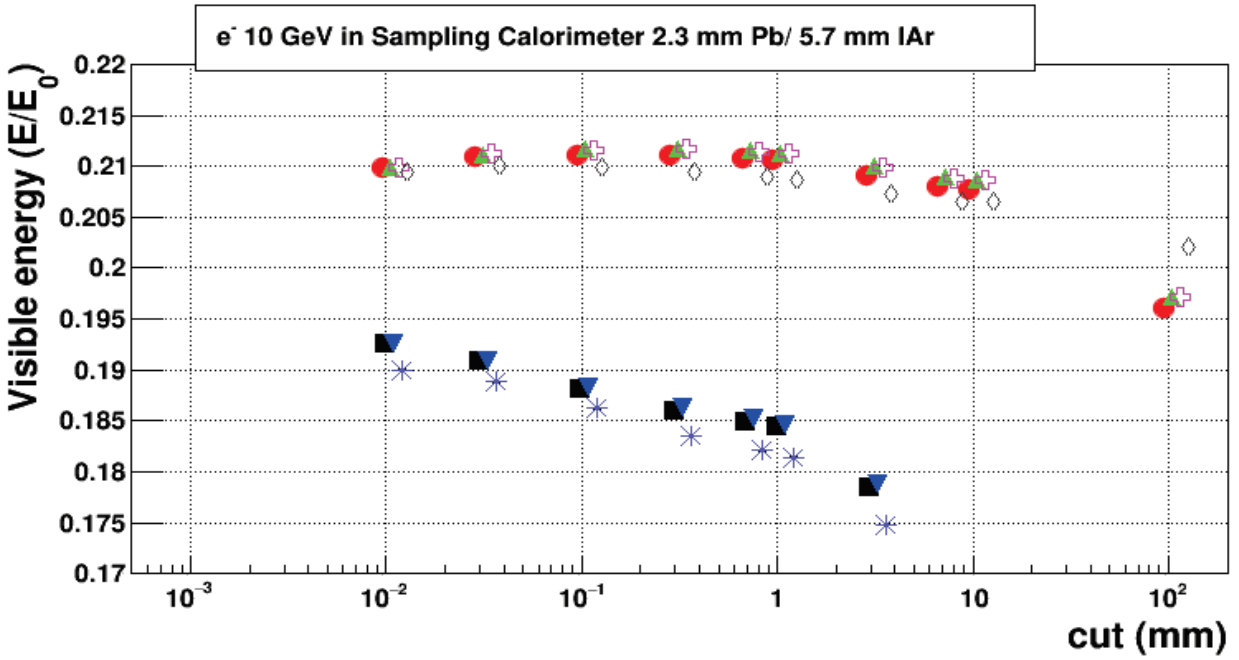
Proton scattering off thick Al target

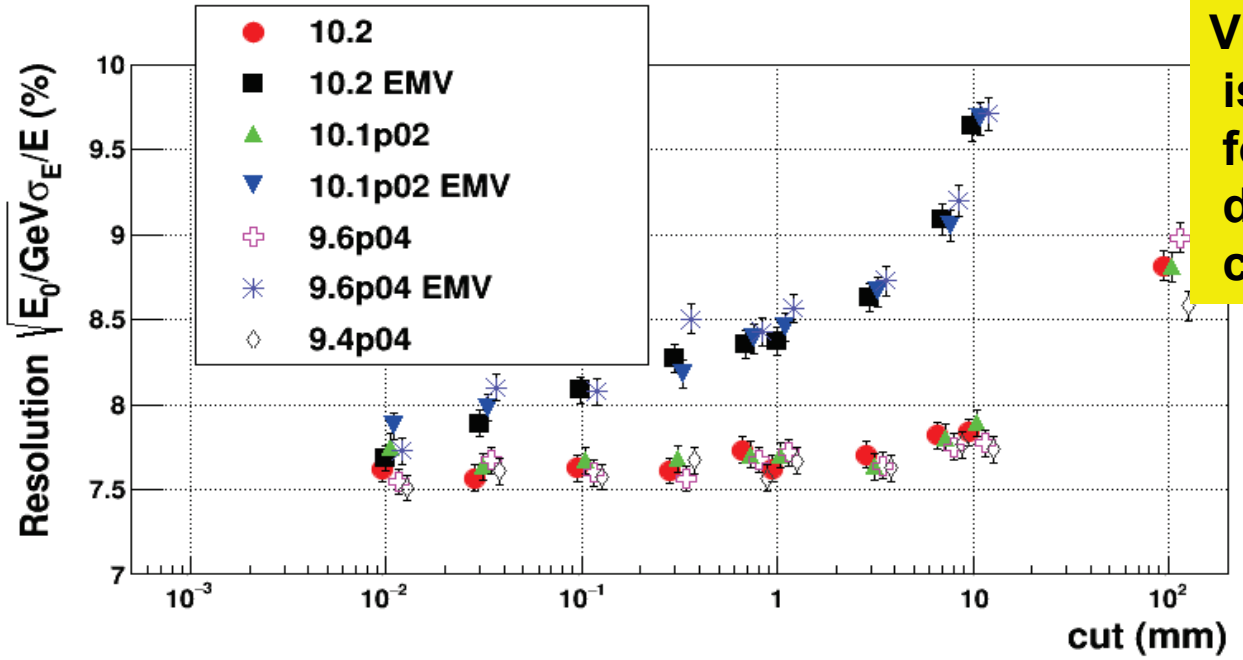
(B. Gottschalk et al., NIM B 74 (1993) 467)



WVI msc model + single scattering + hadron elastic provide the best accuracy

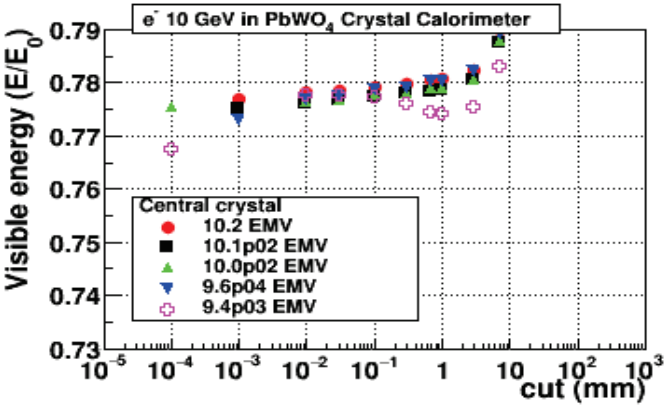
ATLAS barrel type simplified calorimeter results

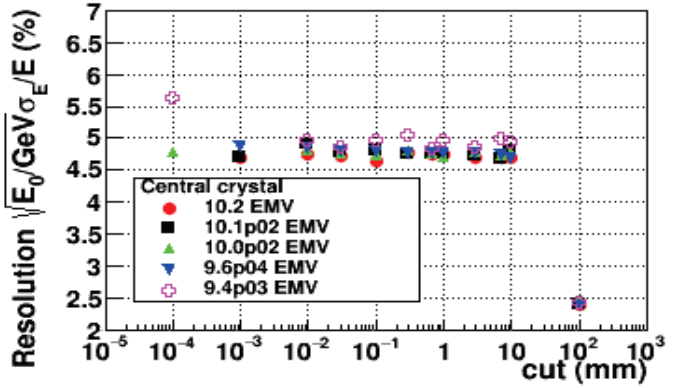


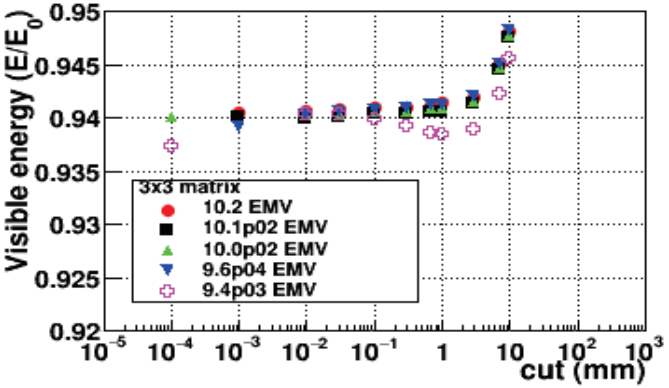


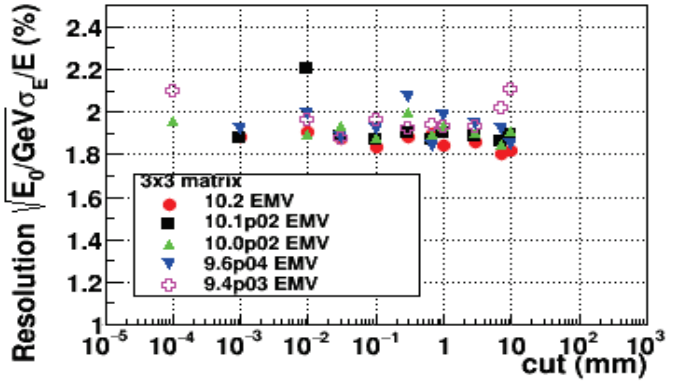
Visible energy is reduced for ~0.1% due to e+ correction

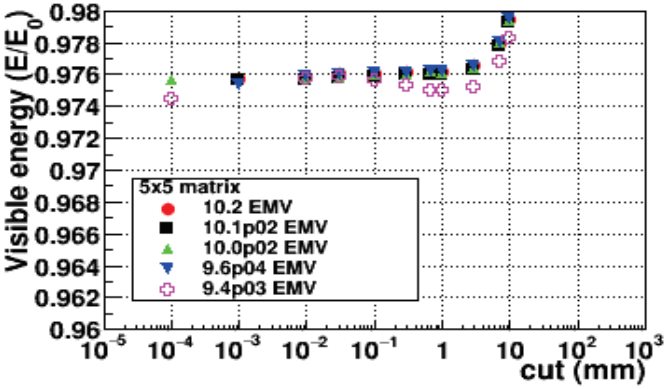
CMS type crystal calorimeter

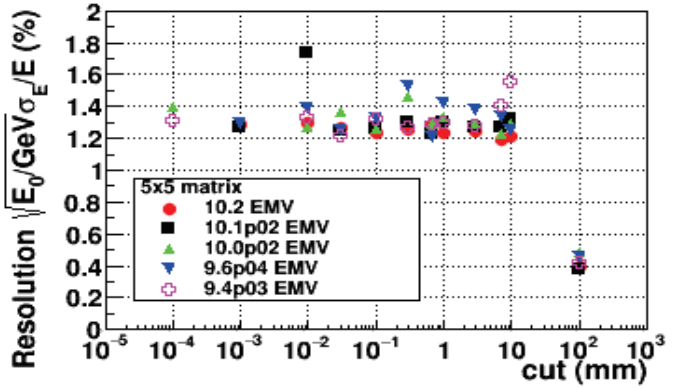




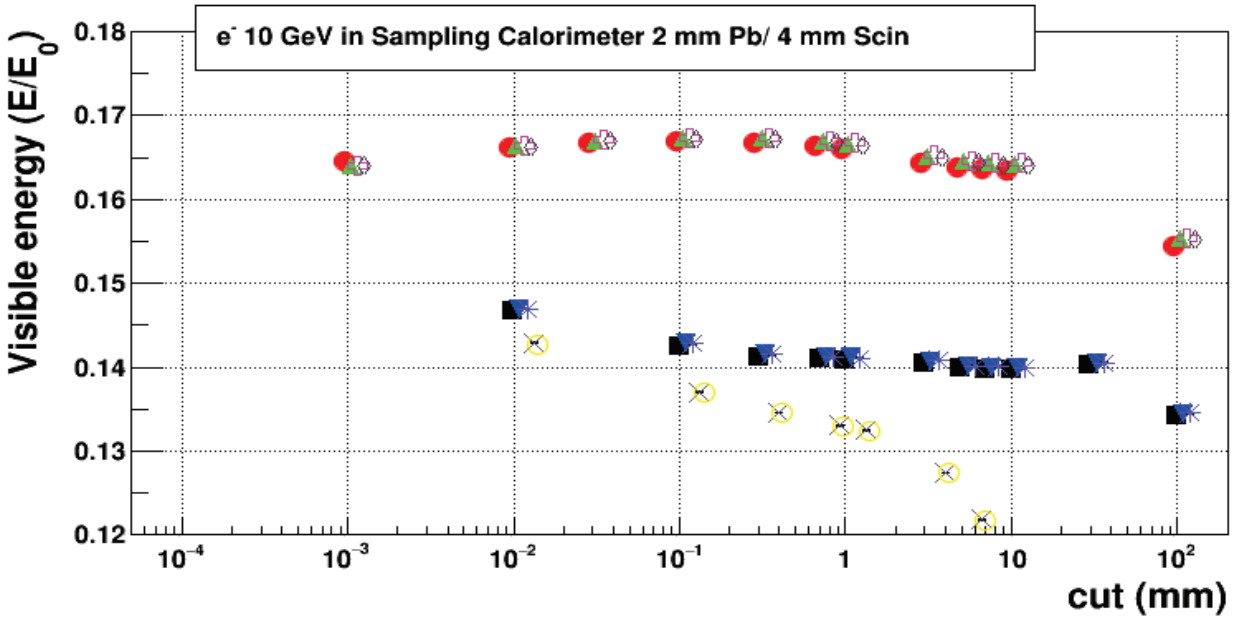


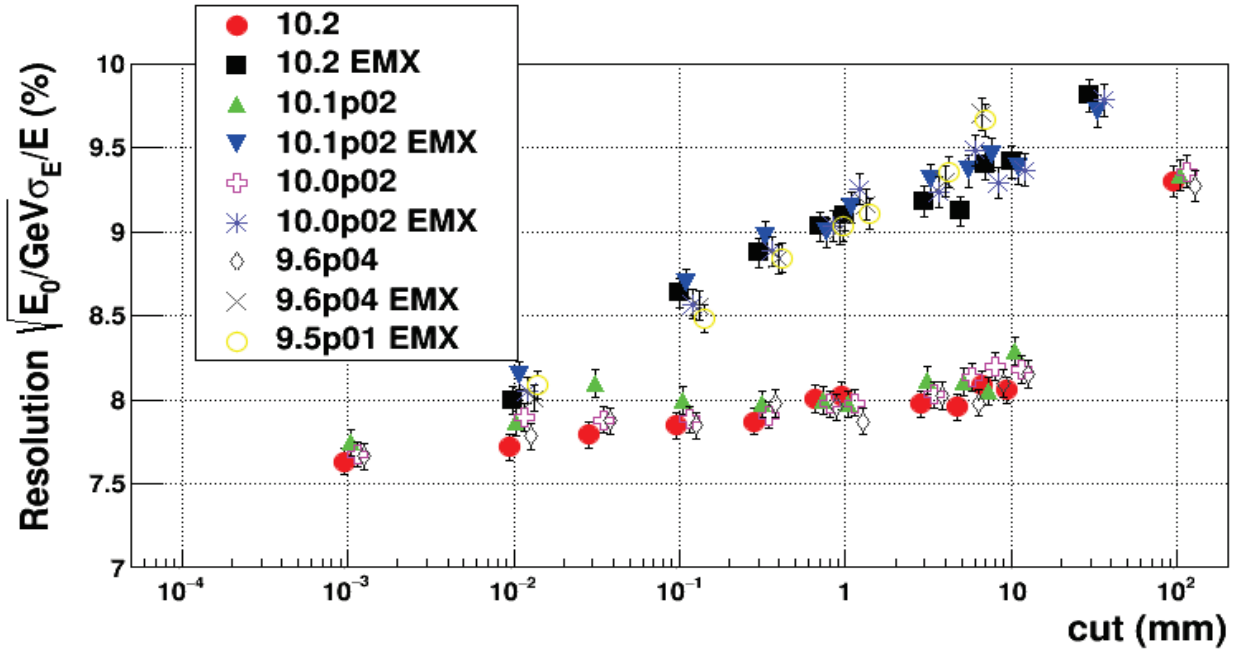






LHCb type simplified calorimeter





Resolution of simplified ATLAS HEC calorimeter versus test beam data