Status of MC Validation with HEC Testbeam Data

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- Collaboration between MPI and Kosice
- Status of validation of GEANT4 version 8.0
- Other MC validation tasks

Validation of GEANT4 version 8.0

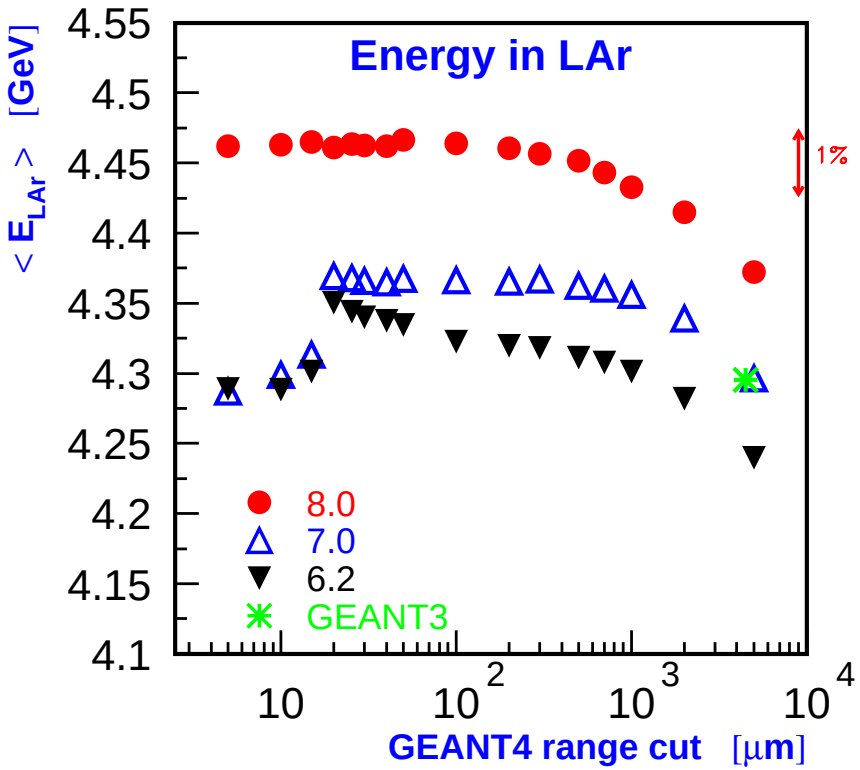
- Beam tests of HEC serial modules
- Stand-alone simulation codes
- New round of GEANT4 simulations:
  version **8.0** + patch-**01**
- Simulated/analysed samples:
  - scan over the GEANT4 range cut with electrons
  - electron energy scans (to be analysed)
  - pion energy scans (to be analysed)

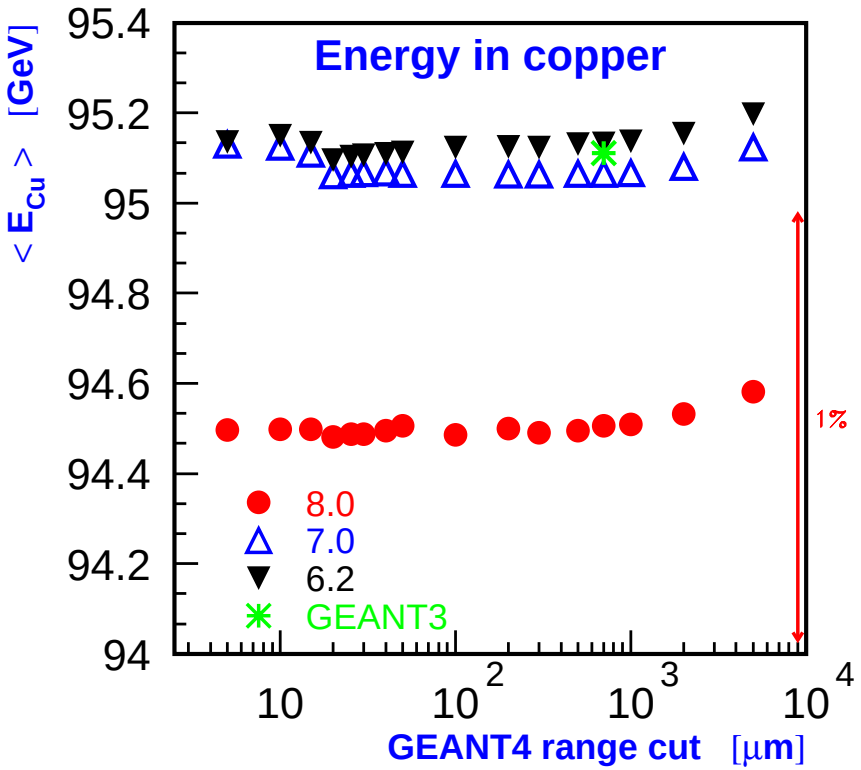
Simulation packages

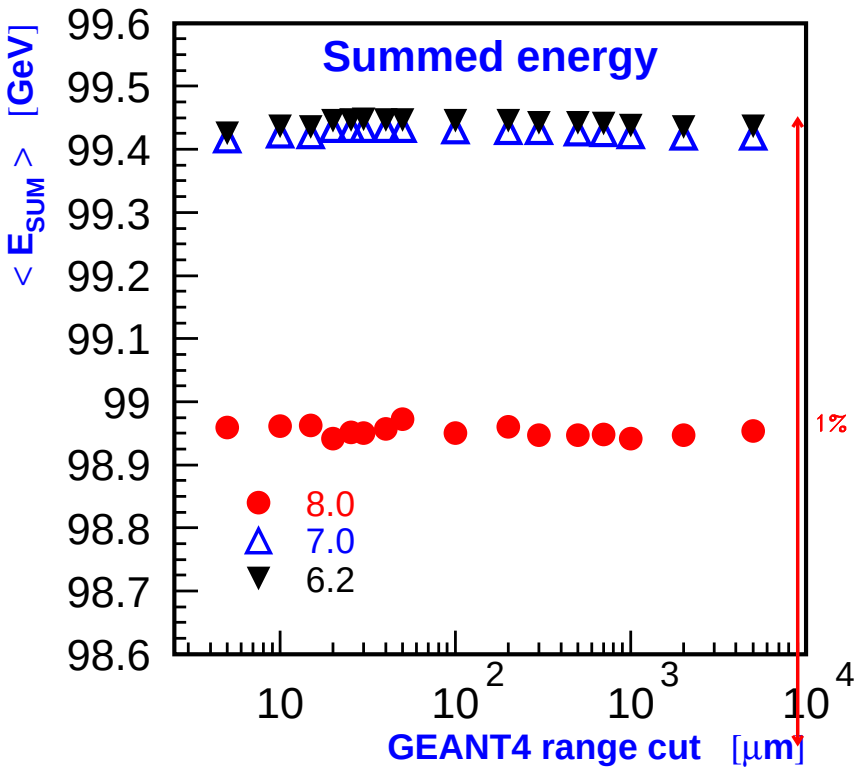
- GEANT4
  - Version **6.2p02**
  - October 2004
  - LHEP 3.7
  - PACK 2.4
  - Version **7.0p01**
  - February 2005
  - LHEP 3.7
  - PACK 2.4
  - Version **8.0p01**
  - February 2006
  - LHEP 4.0
  - PACK 5.0
- GEANT3
  - Version 3.21
  - G-CALOR (hadronic shower code)
  - 100 keV transport cuts and 1 MeV process cuts
- HEC geometry: the same in GEANT4 and very similar in GEANT3

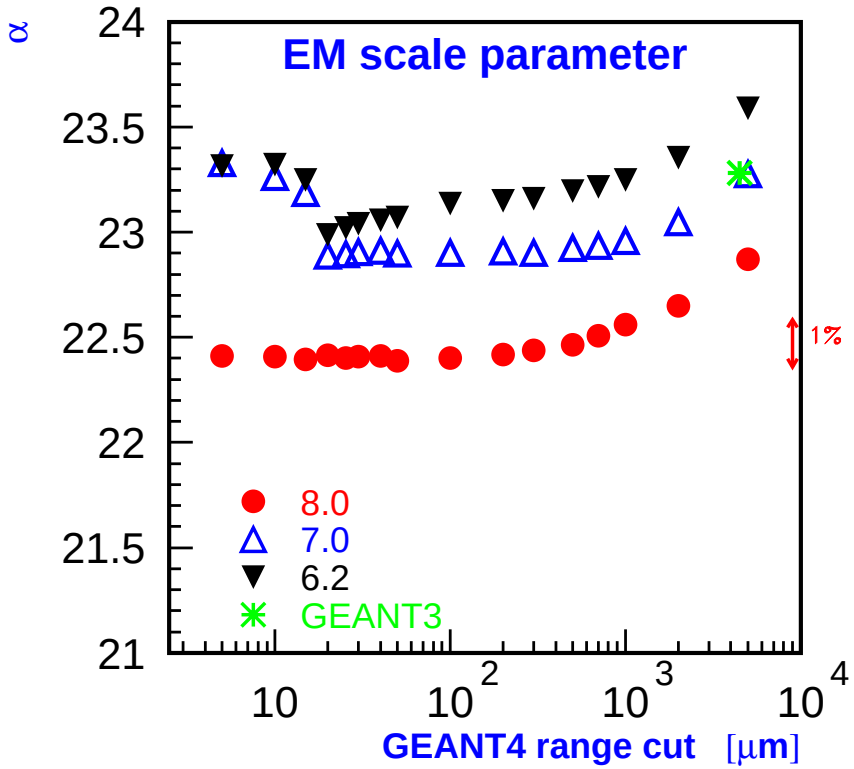
Electrons: Scan over the range cut

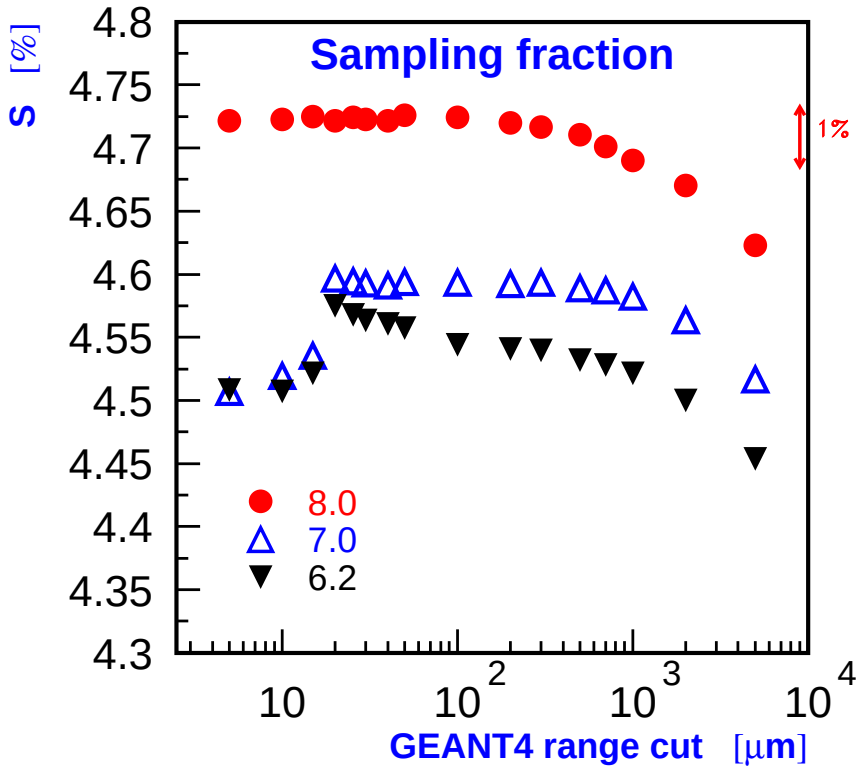
- 100 GeV electrons
- GEANT4 range cut: 5 μm - 5 mm
- 5000 events per cut
- Variables:
  - visible energy in LAr gaps E_{LAr}
  - energy deposited in copper plates E_{Cu}
  - their sum E_{SUM}
  - EM-scale parameter $\alpha = E_{BEAM} / < E_{LAr} >$
  - sampling fraction $S = < E_{LAr} > / < E_{Cu} >$


Energy in LAr
< E_LAr > [GeV]
4.55
4.5
4.45
4.4
4.35
4.3
4.25
4.2
4.15
4.1
1%
8.0
7.0
6.2
GEANT3
10
10^2
10^3
10^4
GEANT4 range cut [μm]


Energy in copper
< E_Cu > [GeV]
95.4
95.2
95
94.8
94.6
94.4
94.2
94
1%
8.0
7.0
6.2
GEANT3
10
10^2
10^3
10^4
GEANT4 range cut [μm]

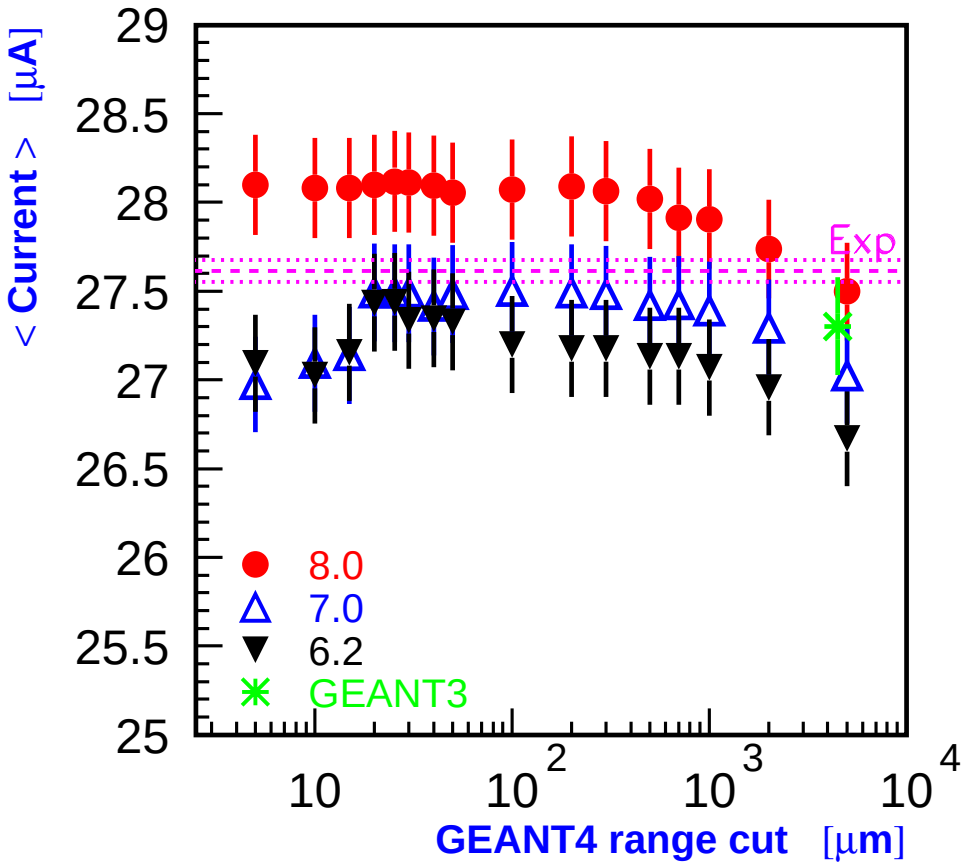

Summed energy
< E_SUM > [GeV]
99.6
99.5
99.4
99.3
99.2
99.1
99
98.9
98.8
98.7
98.6
1%
8.0
7.0
6.2
10
10^2
10^3
10^4
GEANT4 range cut [μm]


EM scale parameter
α
24
23.5
23
22.5
22
21.5
21
1%
8.0
7.0
6.2
GEANT3
10
10^2
10^3
10^4
GEANT4 range cut [μm]

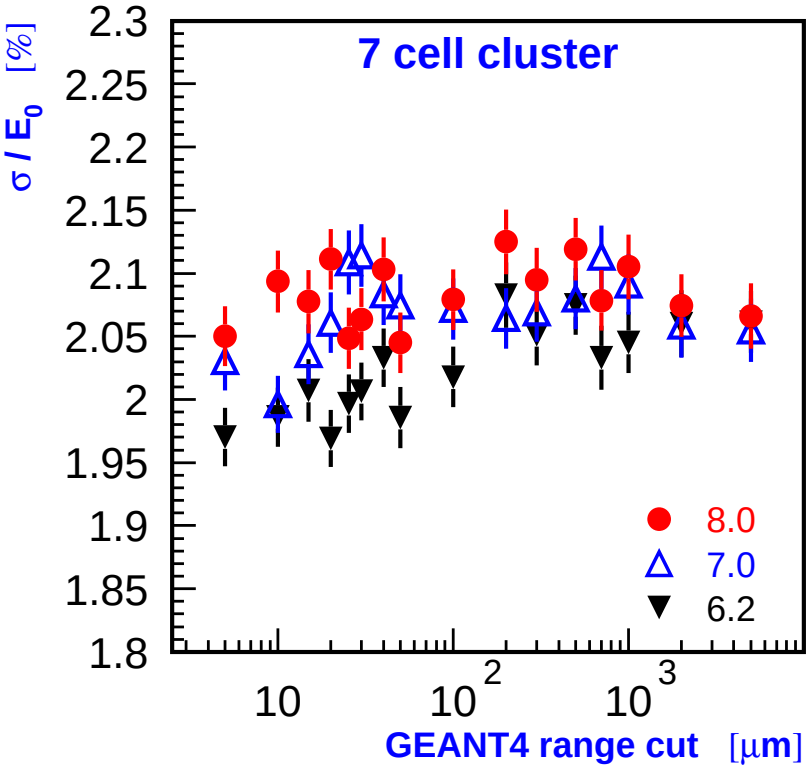

Sampling fraction
s [%]
4.8
4.75
4.7
4.65
4.6
4.55
4.5
4.45
4.4
4.35
4.3
1%
8.0
7.0
6.2
10
10^2
10^3
10^4
GEANT4 range cut [μm]

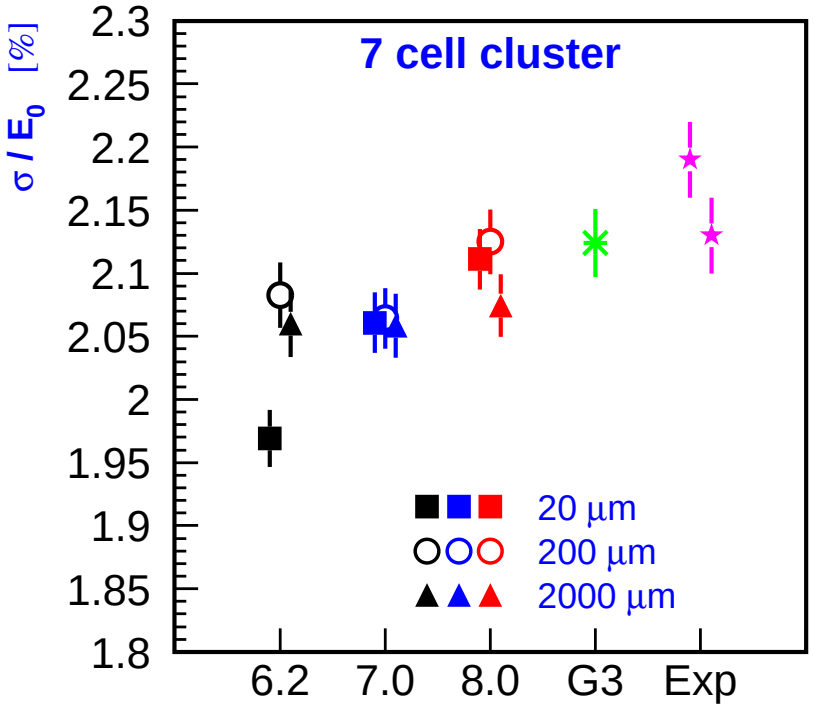
Comparison with experiment: Signal in one cell

- Cell with the maximal average signal
- Visible energy $\Rightarrow$ Current
- Conversion factor
  (from detailed modeling of the HEC electronic chain):
  7.135 μA/GeV
  with an uncertainty of ± 1 %



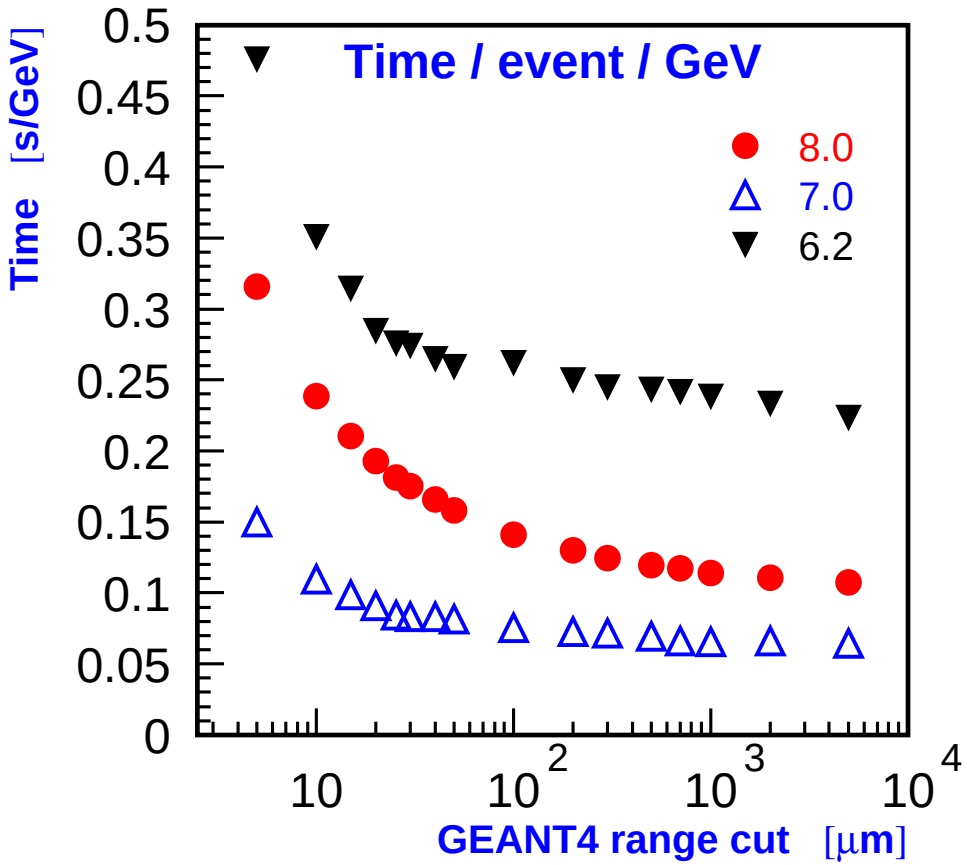
Comparison with experiment: Energy resolution

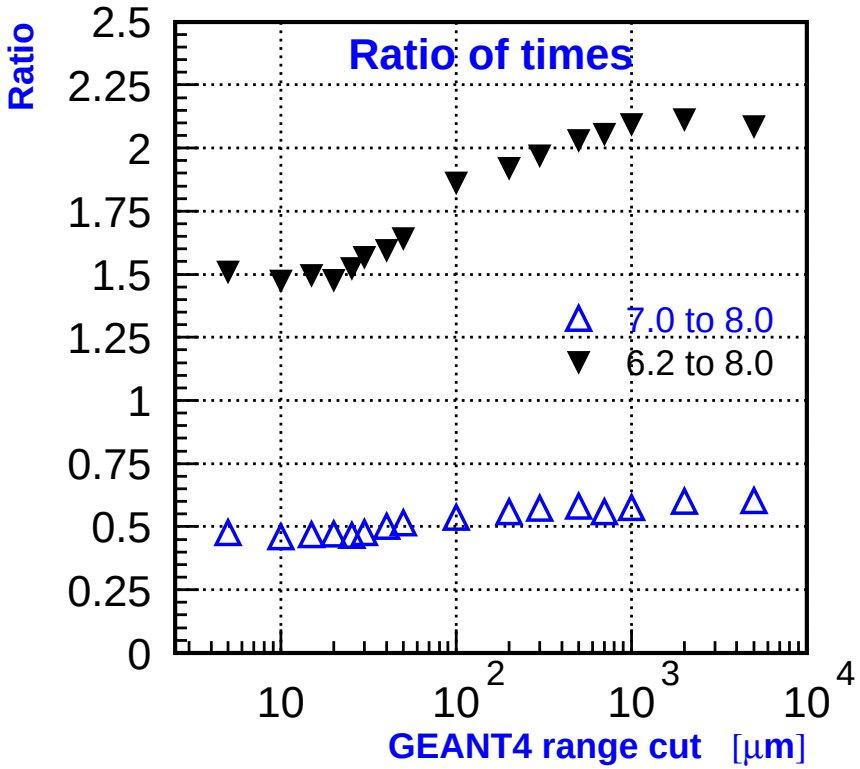


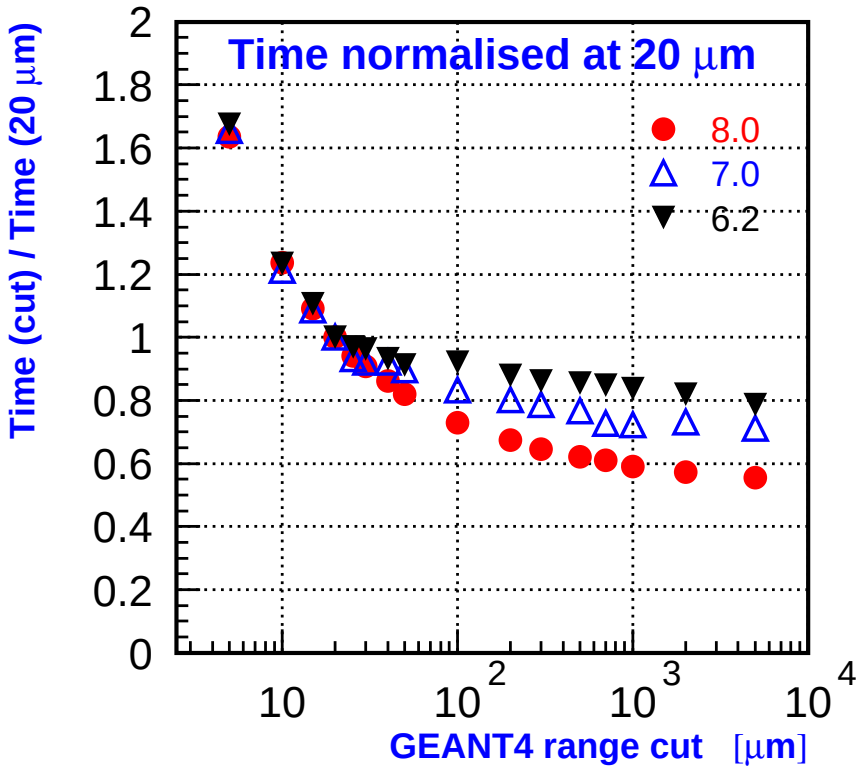


Time of simulations

- Batch farm at MPI
- 2 processor computers
- 1533 MHz




Ratio of times
Ratio
GEANT4 range cut [μm]
7.0 to 8.0
6.2 to 8.0


Time normalised at 20 μm
Time (cut) / Time (20 μm)
GEANT4 range cut [μm]
8.0
7.0
6.2

GEANT4 version 8.0: Some conclusions

New round of GEANT4 based simulations with version **8.0p01** was carried out for the HEC stand-alone testbeam. Analysis of the range cut scan for electrons is done. Comparison with experimental results and results of previous simulations (GEANT4 versions **7.0p01** and **6.2p02**, GEANT3) is fulfilled.

- Certain changes are observed in the new version:
  - broader plateau of the visible energy in LAr as a function of the range cut between 5 and 500 μm
  - increase of the visible energy (2-4 %)
  - decrease of the total deposited energy (0.5 %)
  - increase of the simulation time by factor $\sim$2 (w.r.t. version 7.0)
- Obtained results are to be discussed with GEANT4 experts
- Analysis of energy scans with electrons and charged pions is going on

Other MC validation issues

- Description of the HEC geometry for ATLAS (more realistic than the present one)
- Validation of the simulation and reconstruction software for the combined EMEC/HEC/FCal testbeam
  - Athena framework
  - on-going work
- GEANT4 physics evaluation with combined EMEC/HEC testbeam data
  - stand-alone codes for simulation and reconstruction
  - no progress for a while
- Participation in the validation of the Athena based software for the combined EMEC/HEC testbeam (in the long-term perspective)