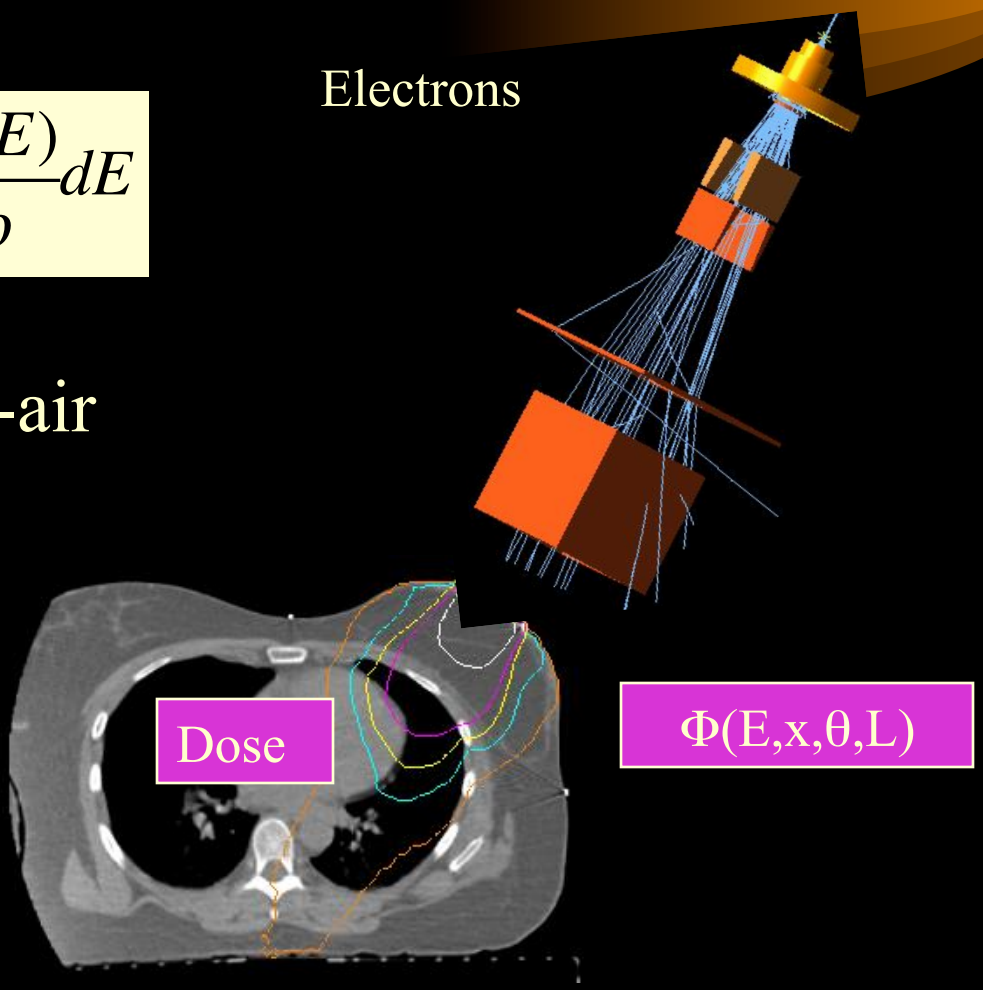
Electron scattering from foils at 13-20 MeV

Bruce Faddegon and José Ramos-Méndez
University of California San Francisco

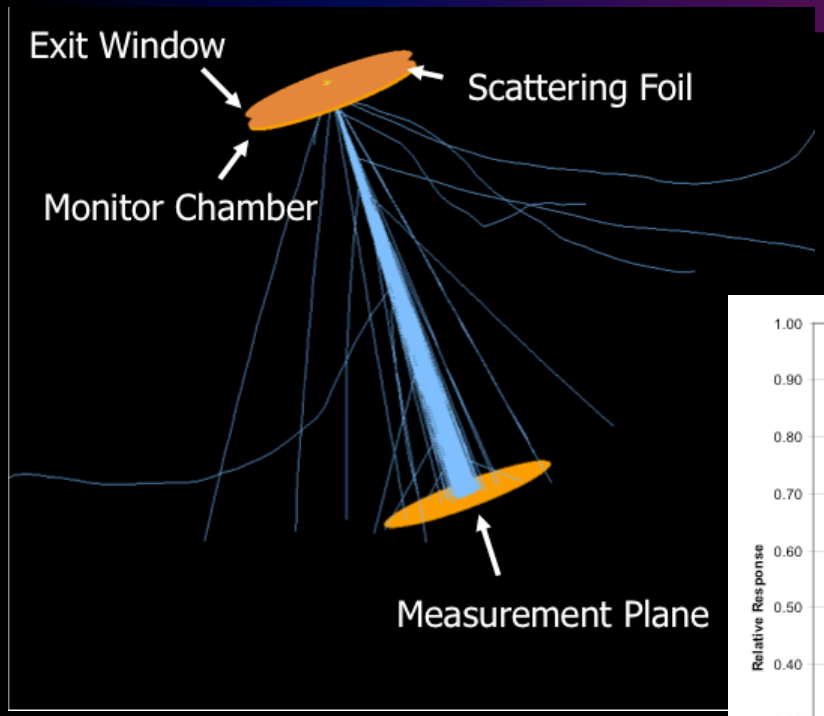
Electron benchmark

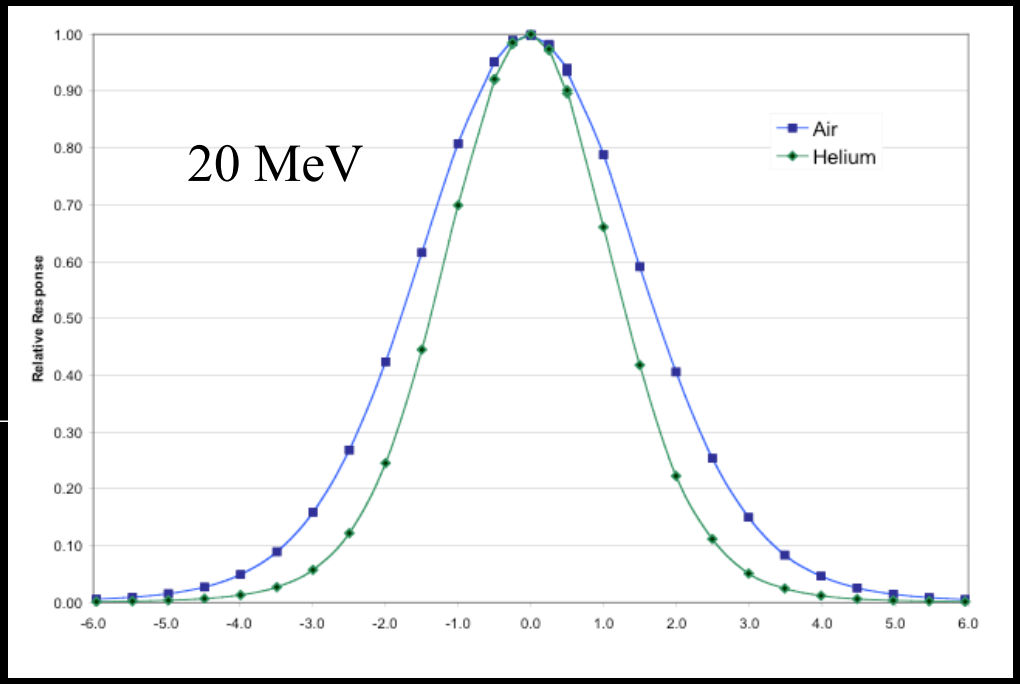
$$D(\theta) = \int \Phi(\theta, E) \frac{L(E)}{\rho} dE$$

Benchmark electron in-air fluence profiles from scattering foils used in radiotherapy

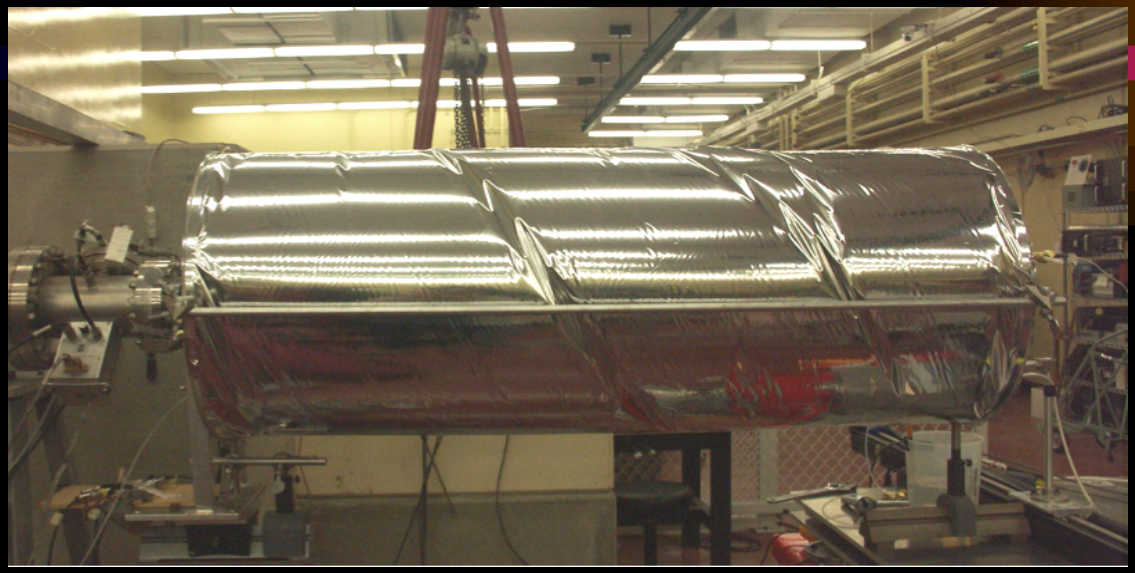


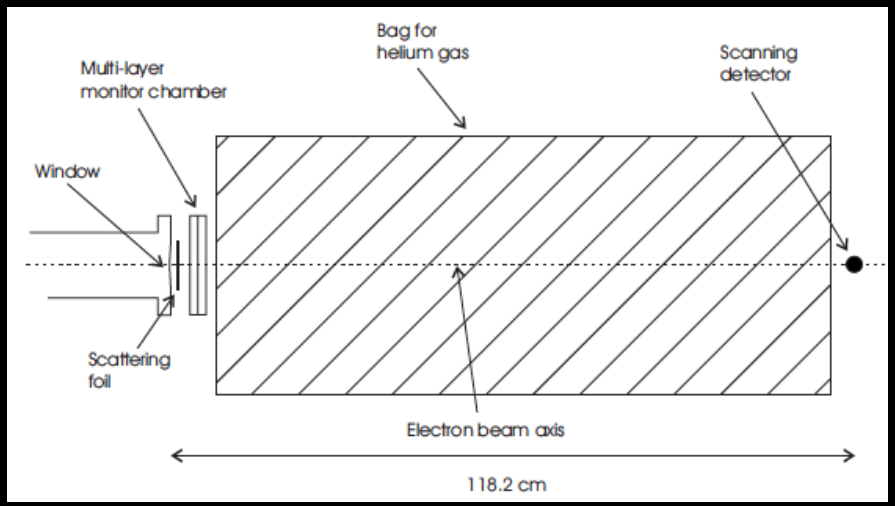
Benchmark set-up





Electron scatter measurement



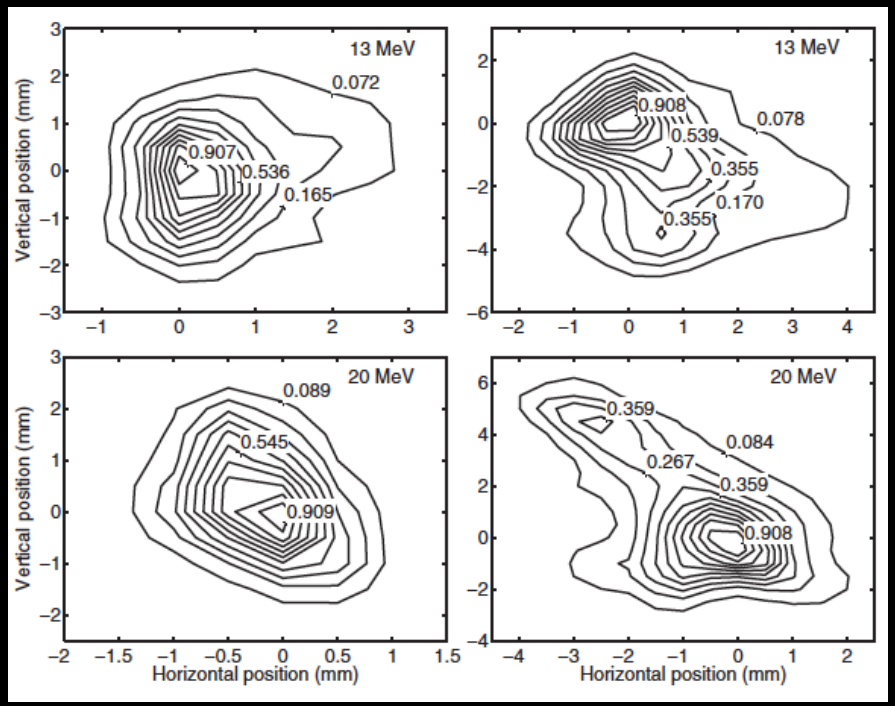


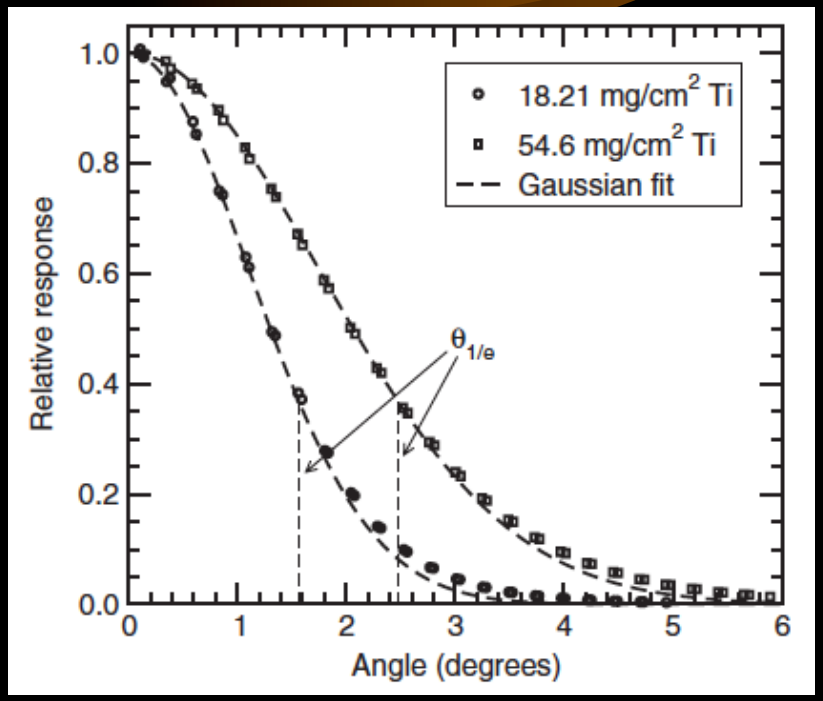
C Ross, M McEwen , A McDonald , C Cojocaru , B Faddegon, "Measurement of multiple scattering of 13 and 20 MeV electrons by thin foils, " Med. Phys. 35(9): 4121-4131, 2008

Electron scatter measurement

At window

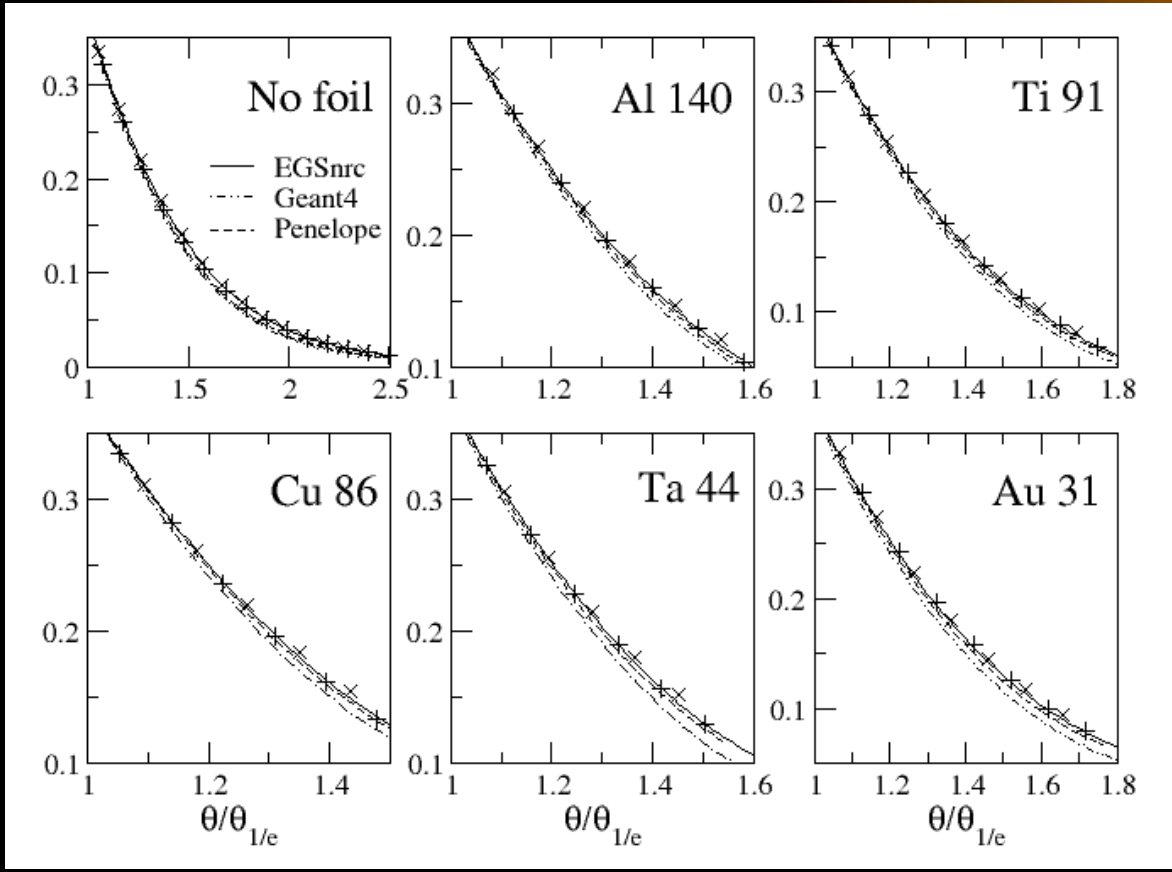
Window+1m





Published benchmarks - 2009

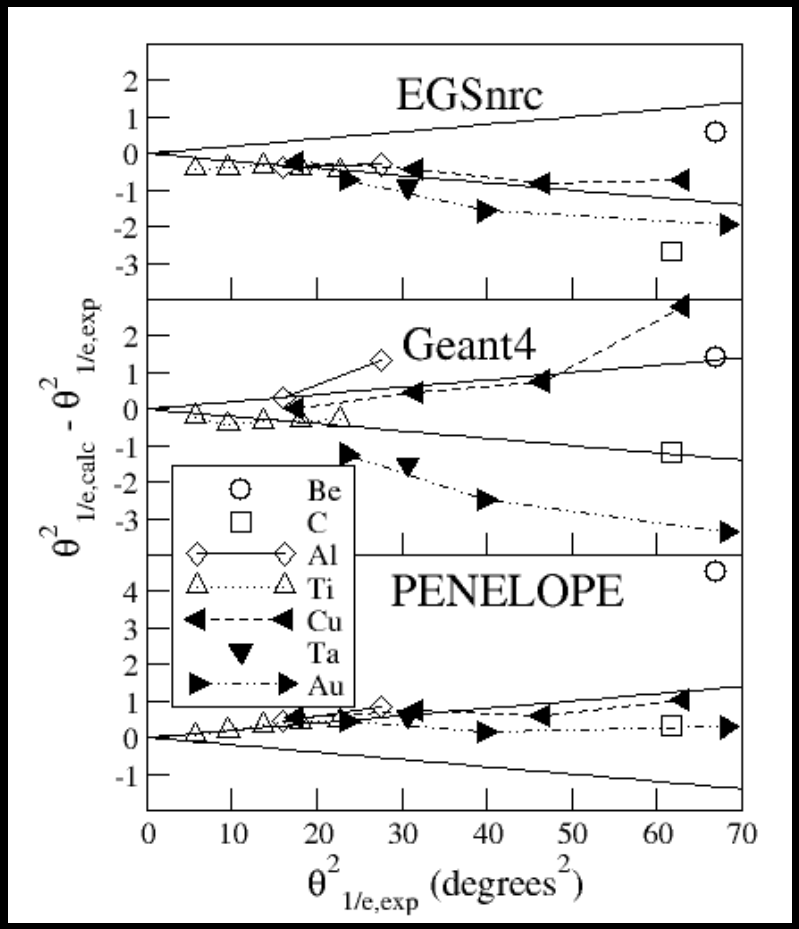
13 MeV



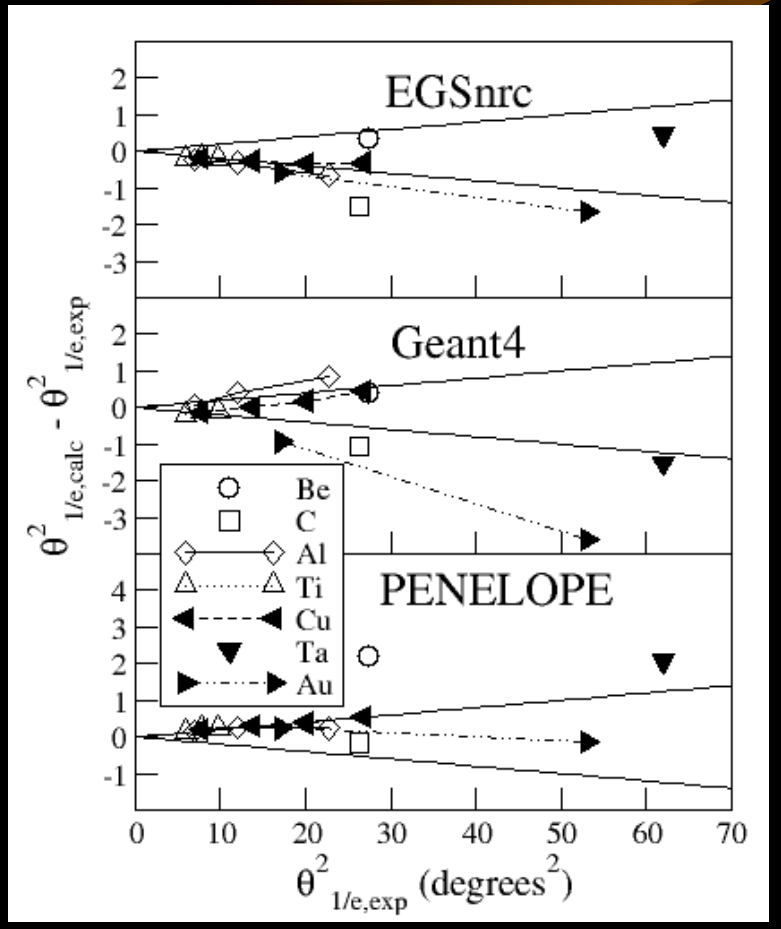
BA Faddegon, I Kawrakow, Y Kubyshin, J Perl, J Sempau, L Urban, "Accuracy of EGSnrc, Geant4 and PENELOPE Monte Carlo systems for simulation of electron scatter in external beam radiotherapy," Phys. Med. Biol. 54:6151-6163, 2009

Published benchmarks - 2009

13 MeV

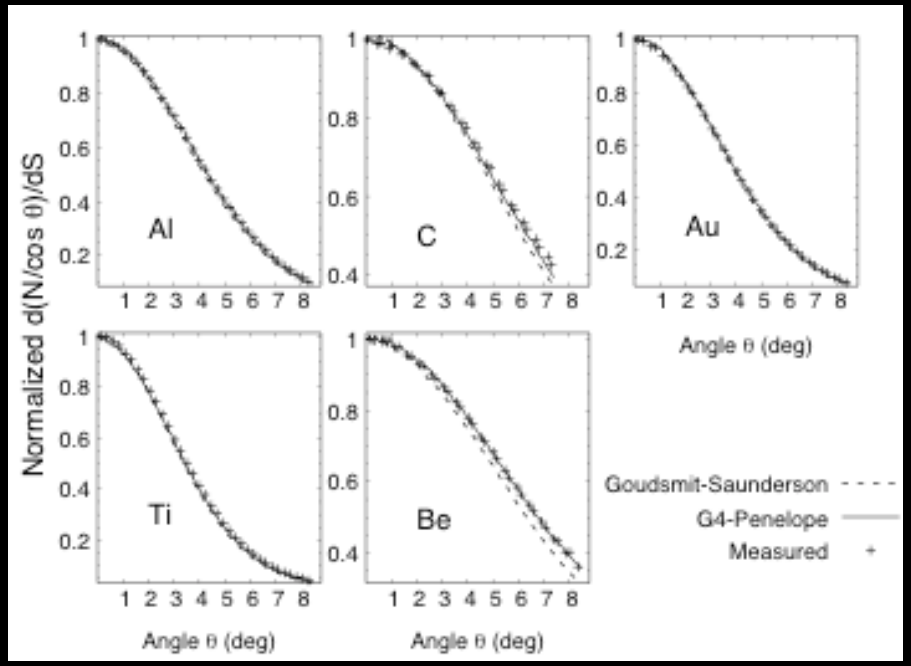


20 MeV

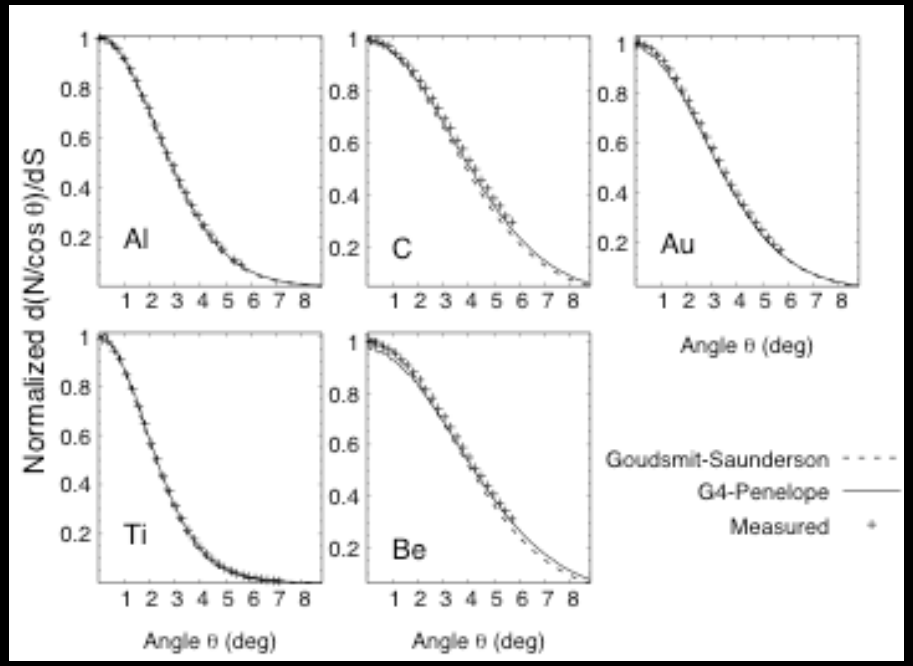


Latest results: Geant4 version 10.3.b0
Fluence Profiles

13 MeV

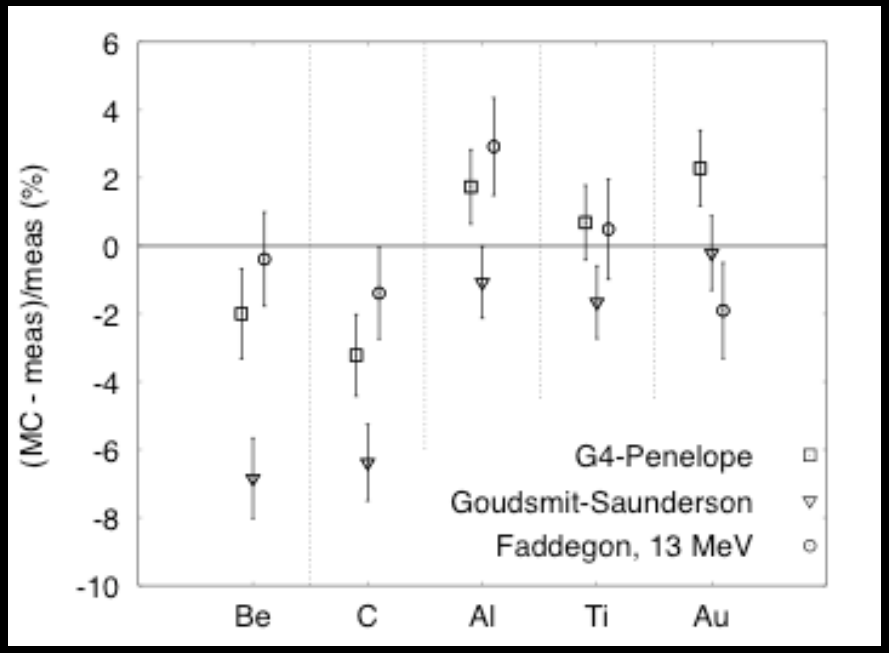


20 MeV

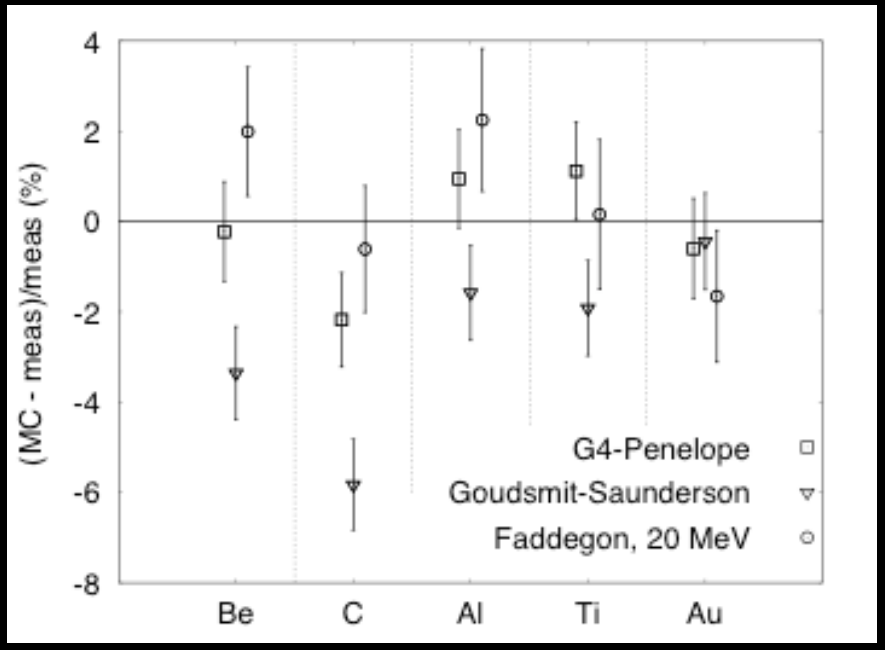


Latest results: Geant4 version 10.3.b0
Characteristic angle

13 MeV



20 MeV



Faddegon result is previously published benchmark (2009) for Geant4 v.9.2

Discussion

- The Beryllium and Carbon materials require further tuning in the electromagnetic options of the Goudsmit-Saunderson model with the current Geant4.10.3.b01.
- The Penelope physics allowed obtain differences in the characteristic angle with respect to the measured data within 2% one standard deviation.

Conclusions

- Choice of benchmarks from measured set:
  - All target materials (Be, C, Al, Ti, Cu, Ta, Au)
  - Foil thickness with characteristic angle ~5 degrees
  - 13 MeV and 20 MeV
- Regression testing tolerance: Verify calculation with new versions of Geant4 has same accuracy within 2 standard deviations calculation precision or higher accuracy (matches measurement better)