Validation of Goudsmit-Saunderson Msc model (Geant4.9.3-ref05)

Omrane KADRI
(National Center for Nuclear Sciences and Technologies –Tunisia)

Supervised by:
Prof. Vladimir IVANCHENKO
CERN

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Outline

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- Benchmarks
- Improvement of XSection in G4WentzelVI
- Conclusions

Introduction

Multiple scattering « process » of e-/e+ through matter is mainly described with a group of theoritical models of :
-Angular distribution
-Displacement sampling
-Path length limitation

The G4GoudsmitSaunderson model use:
-Goudsmit-Saunderson ➔ Angular distribution
-Lewis moments ➔ Displacement sampling
-L. Urban ➔ Path length limitation

Main modifications (G4-9-3-ref05):
- Some PDF's in DB (for small lambda & large angle) ➔ corrected
- Displacement coordinates ➔ Exact first Lewis moment (not Kawrakow's method)
- Some other precision limits used for finding roots ➔ High precision

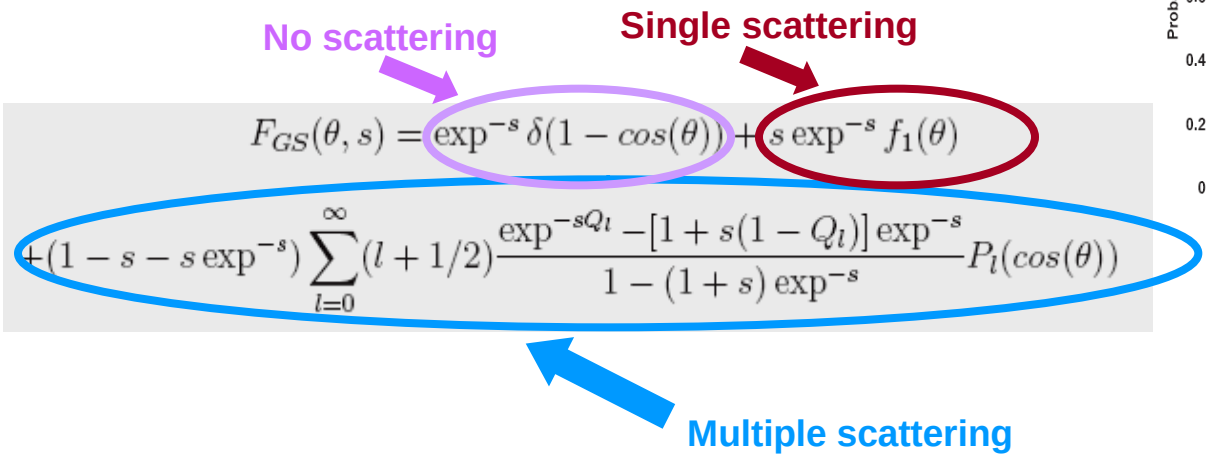
Overview of current model

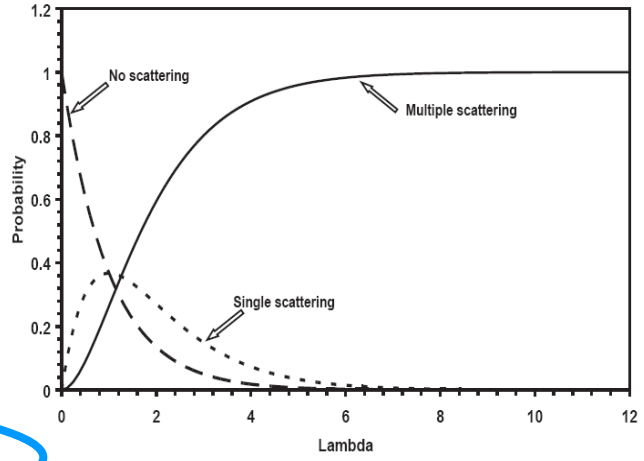
GS PDF (probability density function) ➔ $F_{GS}(\theta, s) = \sum_{l=0}^{\infty} (l + 1/2)\, e^{-sQ_l}\, P_l(cos(\theta))$

$$Q_l = 1 - yK_1(y)\left\{1 + 0.5y^2\left\{1 + \frac{1}{2} + \ldots + \frac{1}{l} - 0.5\ln(l(l+1)) - 0.5772\right\}\right\} \qquad y = 2\sqrt{l(l+1)A}$$

A:screening parameter

s/Lambda : path length in terms of mean free path





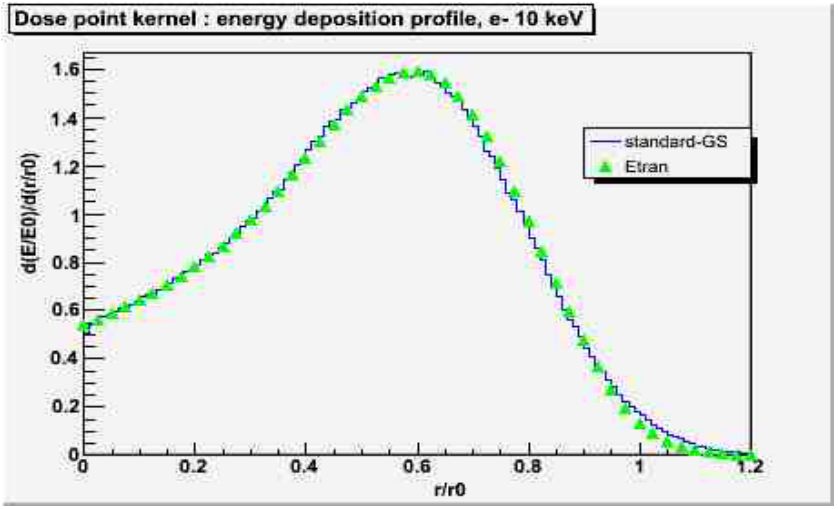
Benchmarks

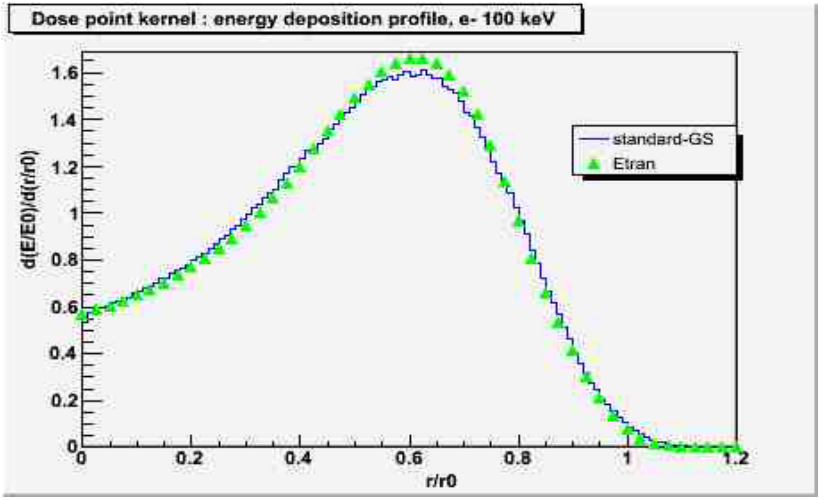
Mainly based on Test37 & TestEm 5, 11, 12 & medical of the extended/electromagnetic examples of Geant4 :

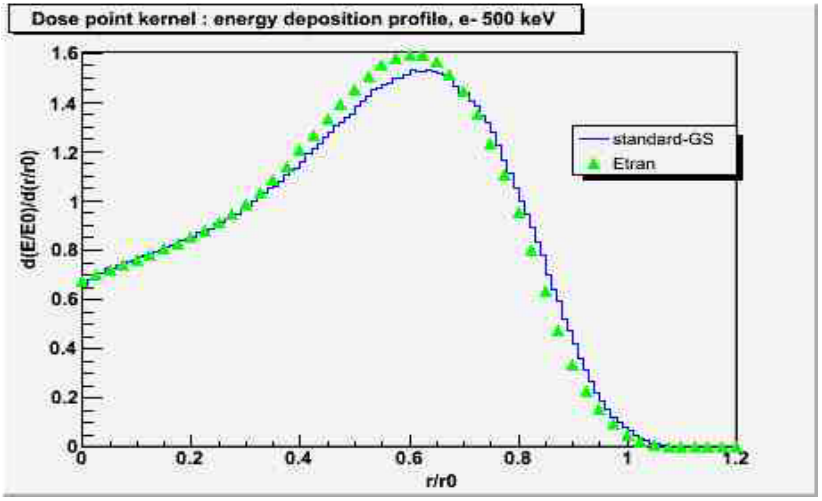
Test	Example	Reference
1. Dose Point Kernel	TestEm12	L. Ferrer, 2007. CBR, vol 22 (1), p. 125
2. Sandia	Test37	G.L. Lockwood, 1987. SAND79-0414
3. Hanson	TestEm5	A.O.Hanson, 1951. Phys. Rev 84, p. 634
4. Sempau	TestEm11	J.Sempau, 2000. Phys.Med.B.45,p. 2263
5. Electron Scattering	Medical	O'Shea, 2009. Med.Phys. 36, p. 2703
6. FanoCavity (&2)	Medical	Theoretical Theorem
7. Werner	TestEm11	Werner, 1988. J. Phys.D: Appl. Phys.21 p. 116.

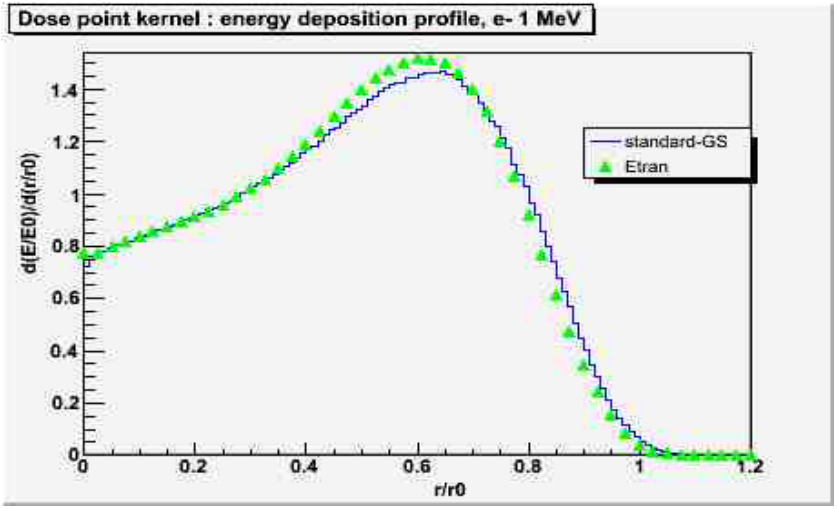
Benchmarks

1. <u>Dose point kernel:</u> 40.000 e- shooted at the center of 3 cm of a water sphere



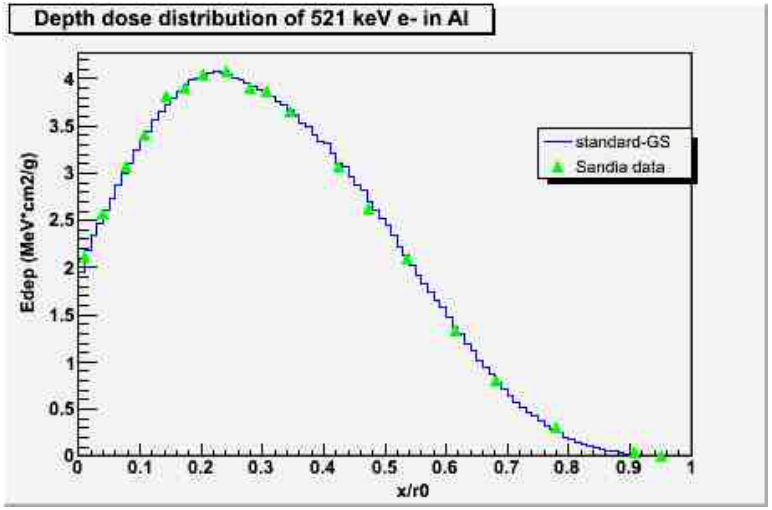


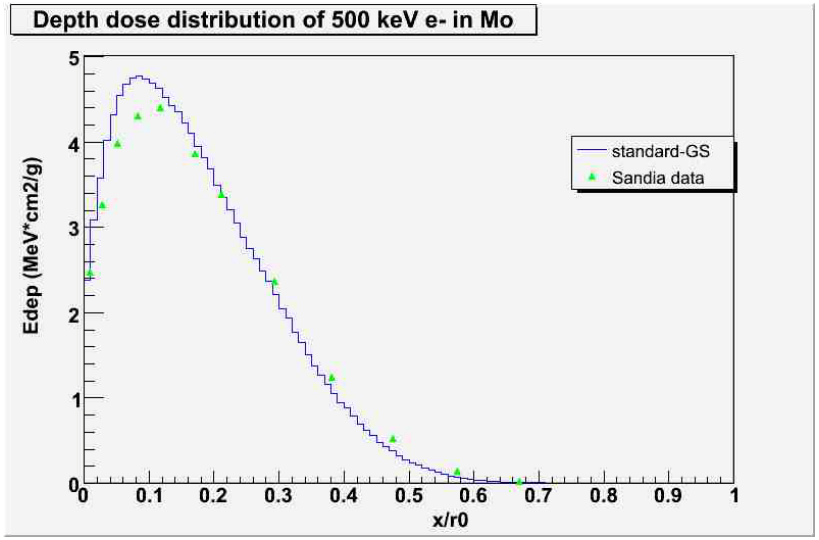


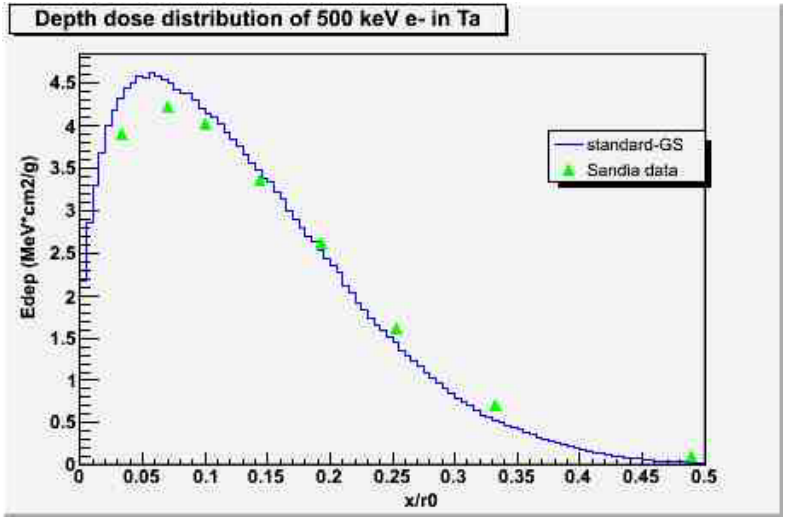


Benchmarks

2. Sandia: 100.000 e- hits, perpendicularly, a thin layer of a given material



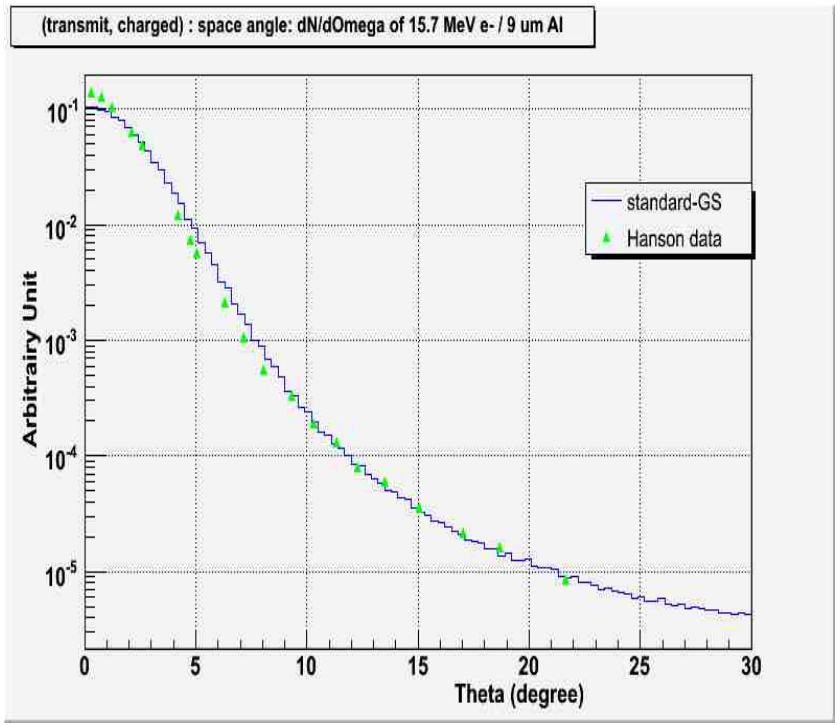


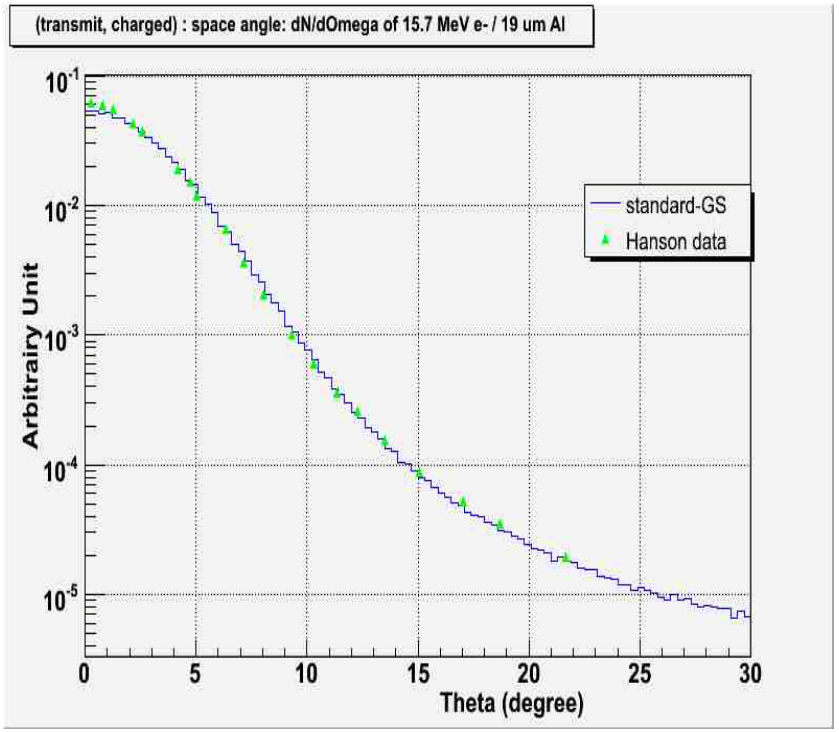


Benchmarks

3. Hanson: 1.000.000 e- of 15.7 MeV hits, perpendicularly, thin layers (9, 19 µm) of a gold

➔ distribution of transmitted electrons (GS against data)

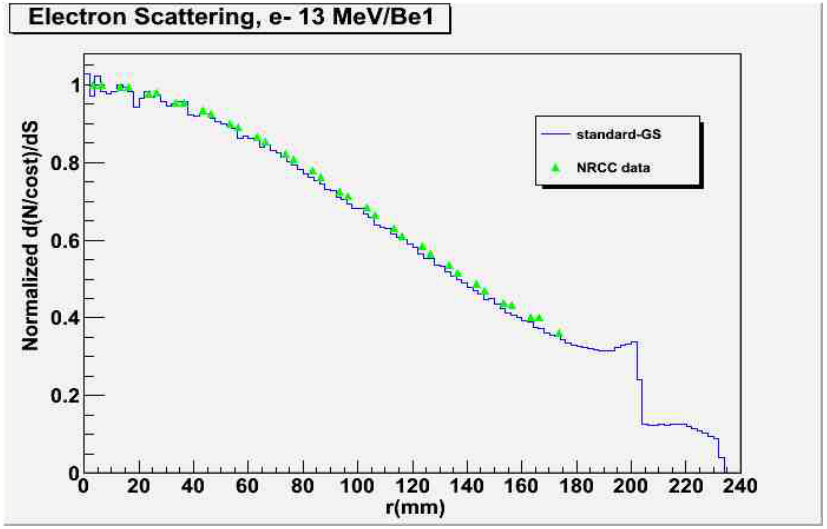




Benchmarks

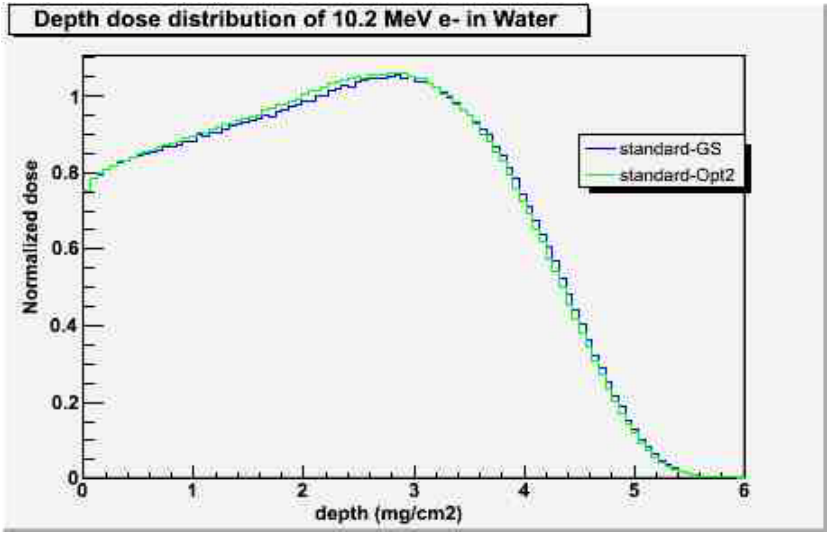
4. Electron scattering: 4.000.000 e- hits, perpendicularly, a thin layer of Be, for a given experimental setup

➔ normalized fluence at a scoring plane



5. Sempau: 100.000 e- hits, perpendicularly, a water box

➔ depth dose profile



Benchmarks

6. a. FanoCavity:

The run consists of 20000 gamma of 1.250 MeV through 2*5.000 mm of Water

(density: 1.000 g/cm3)

the cavity is 2.000 mm of Water_vapor (density: 1.000 mg/cm3);

(Dose/EnergyFluence)/Mass_energy_transfer = **0.99954** **0.01430**

6. b. FanoCavity2:

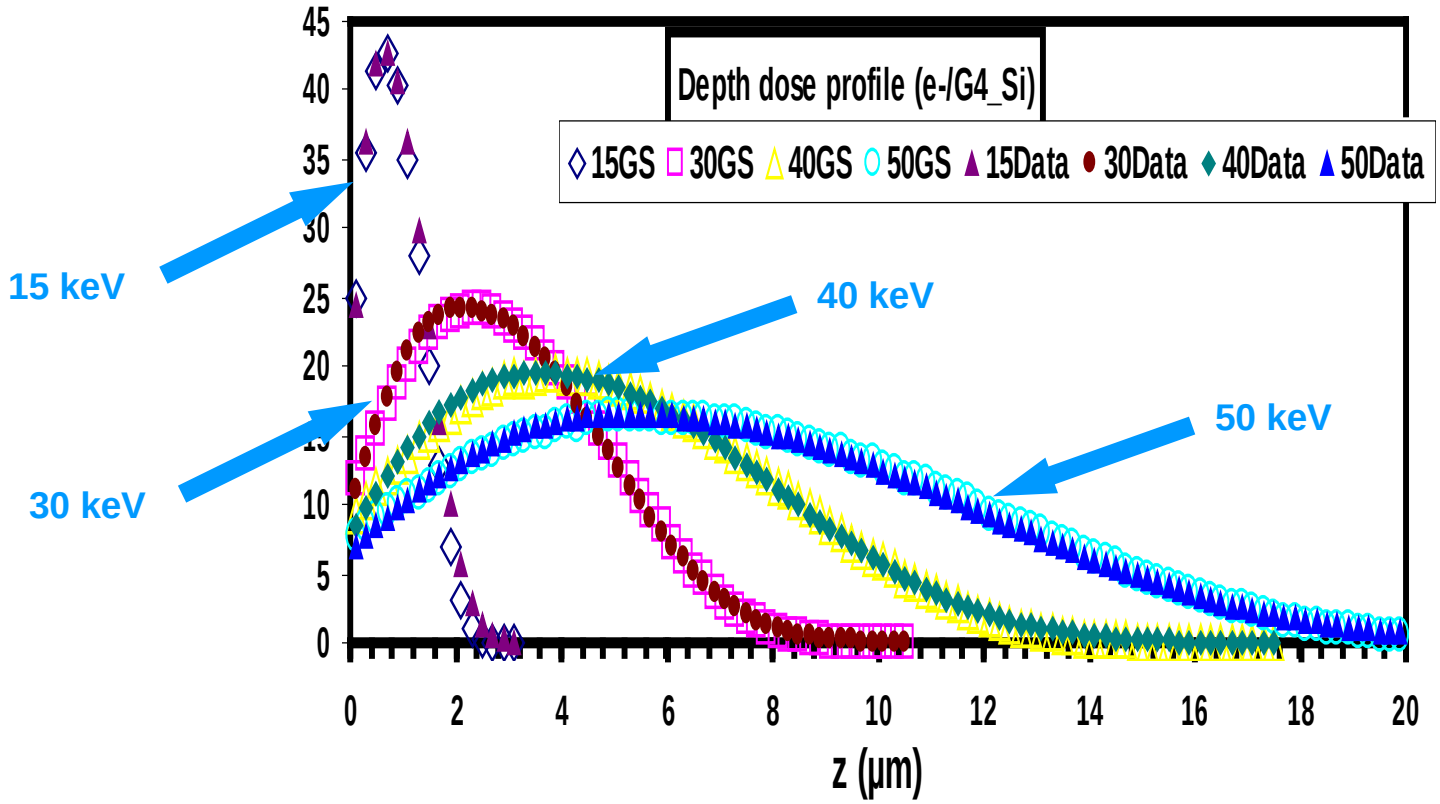
The run will be 400000 e- of 1.000 MeV through 2*5.246 mm of Water (density:1.000 g/cm3); Mass/cm2 = 1.049 g ; csdaRange: 4.371 mm

the cavity is 2.000 mm of Water_gas (density: 1.000 mg/cm3); Mass/cm2 = 0.200 mg --> massRatio = 0.000191; World radius: 10.000 m ; range in cavity: 4.371 m

DoseCavity/EnergyFluence = **1.00978** **0.01417**

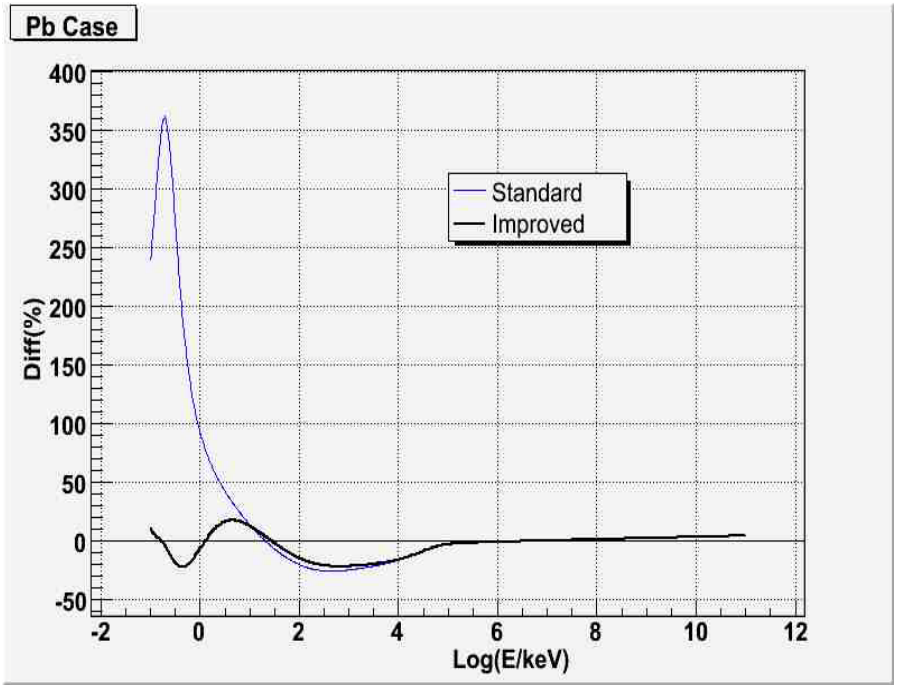
Benchmarks

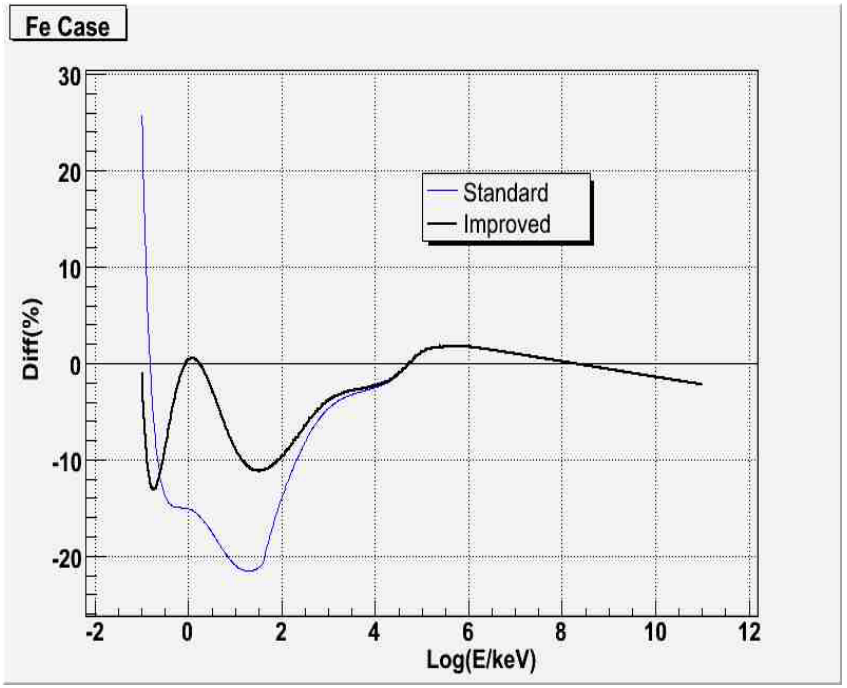
Werner: 100.000 e- hits, perpendicularly, a thin layer of Si
➔ normalized depth dose profile



Improvement of XSection in G4WentzelVI

➔ Adjustement of the screening parameter





Conclusion

During one month stay at CERN :

1. We can say that we have a more stable version of the GS model
2. Contibute to the tuning of G4WentzelVI model (concerning XSections computation)

➔So, Many thanks, especially, for:

i) Prof. Vladimir IVANCHENKO
ii) Prof. John APOSTOLAKIS
iii) Houm I forget

THANK YOU