Electron transport : recent results

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16th Geant4 Workshop, Slac (Californie)

19-23 September 2011

Electron transport : main ingredients

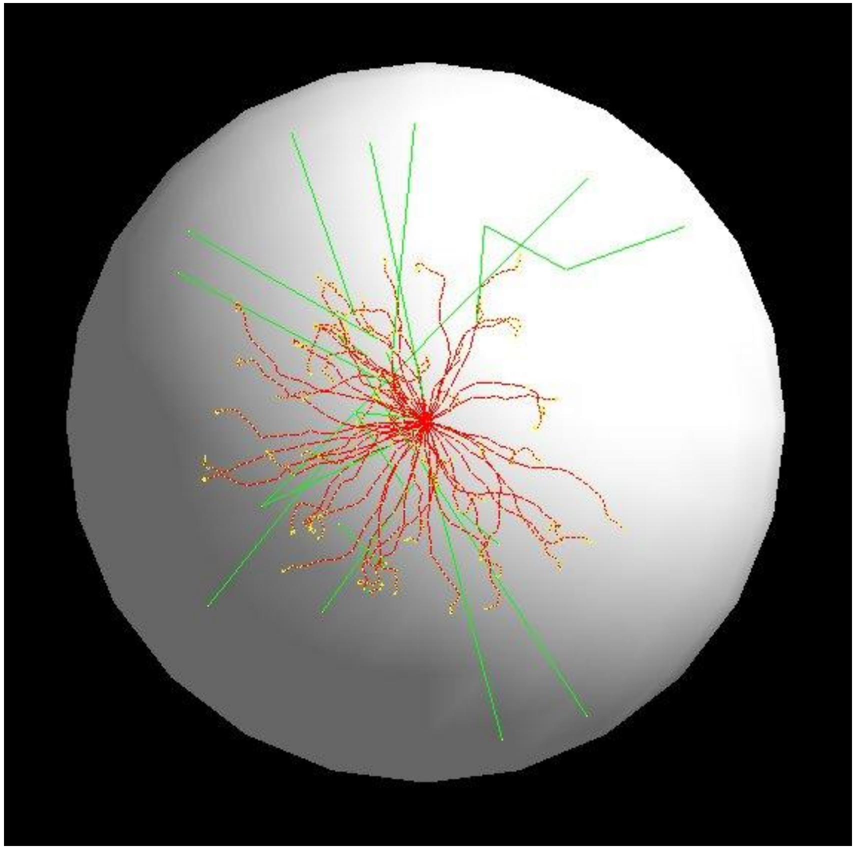
- Stopping power and range
- eLoss fluctuations
- Multiple Coulomb scattering
  - Angular distribution (opt 0)

    +
  - Boundary crossing algorithm (opt 3)

  → Urban93 → Urban95
- Delta-rays generation
- Bremsstrhalung generation

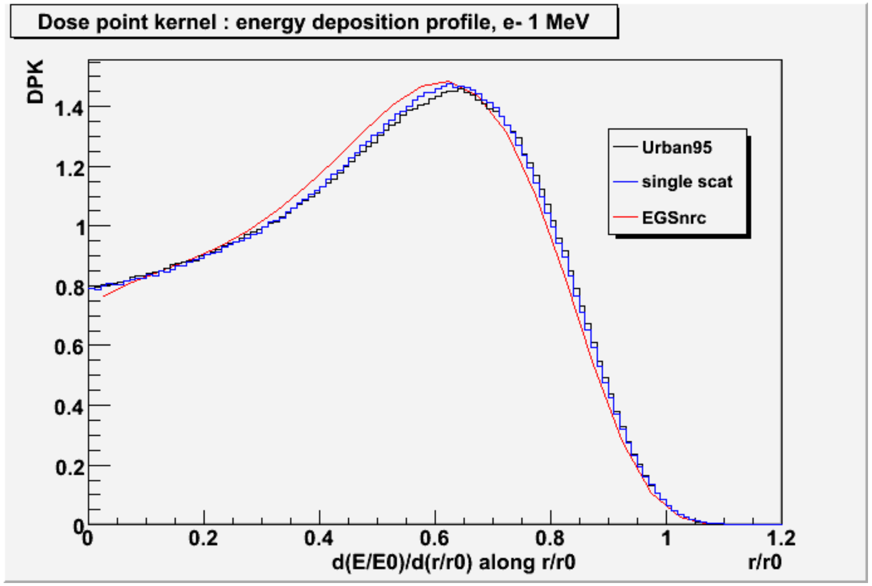
- TestEm12 : dose point kernel
- TestEm11 : pencil beam
- TestEm5   : thin target
- electronScattering
- FanoCavity &FanoCavity2

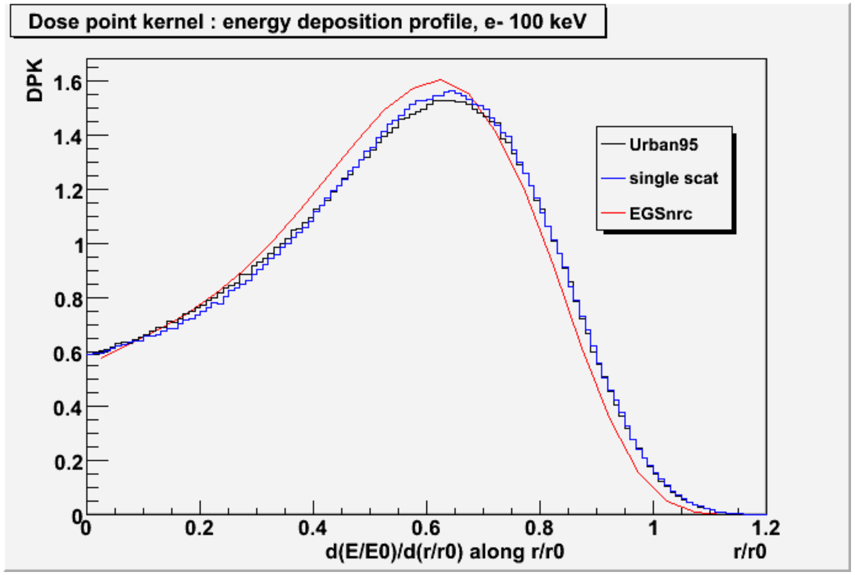
TestEm12 : Dose Point Kernel Distribution

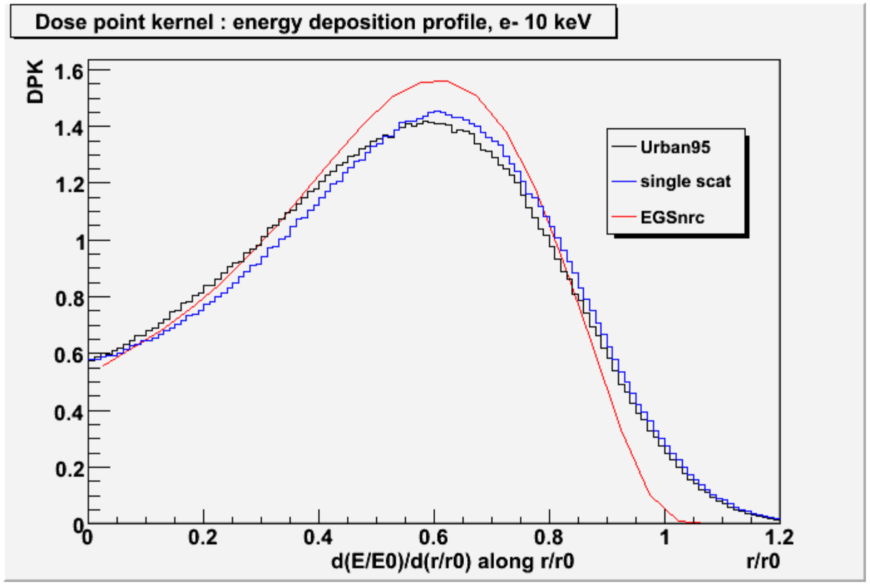


- Energy deposited in spherical shells
- Normalized distribution
- No data. EGSnrc comparison (perrot@clermont.in2p3.fr)

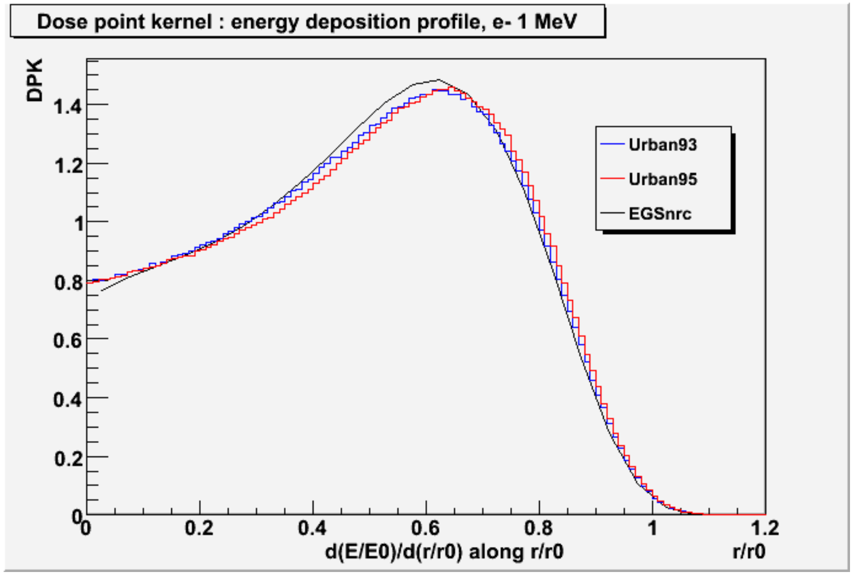
TestEm12 : Geant4 vs EGSnrc

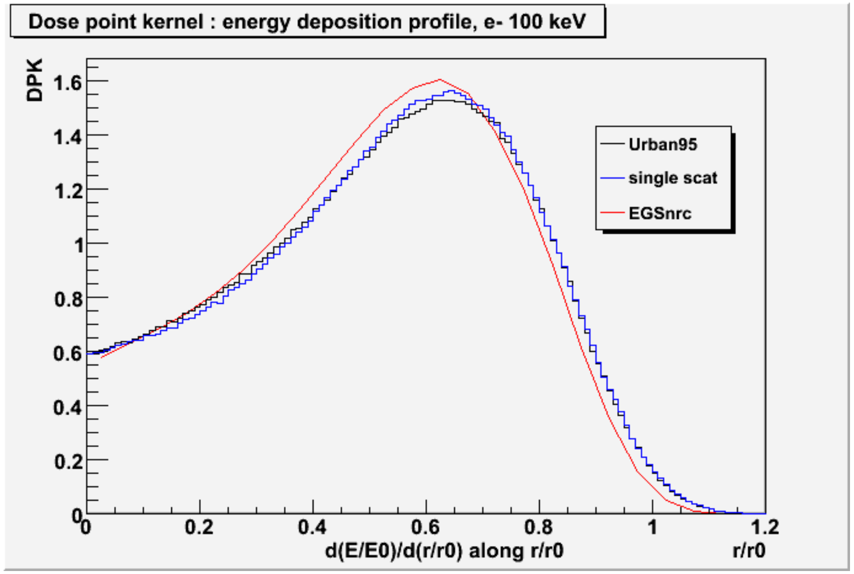


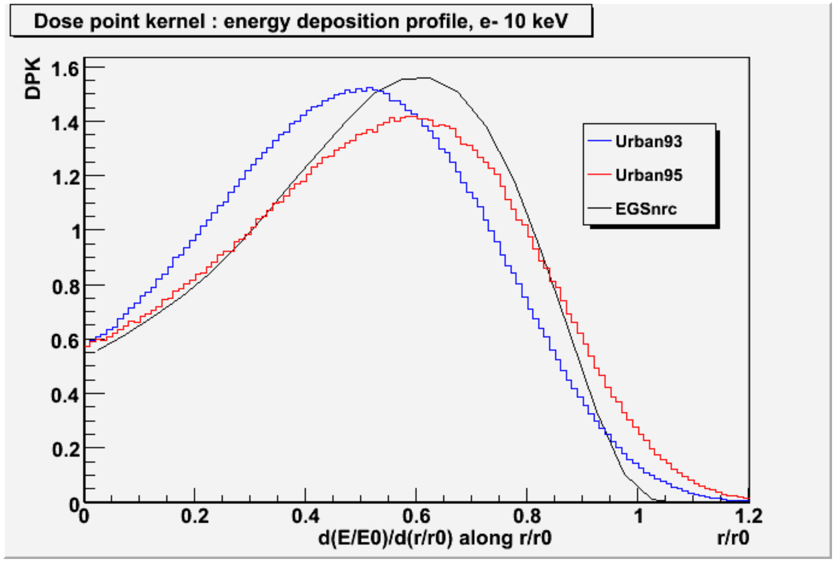




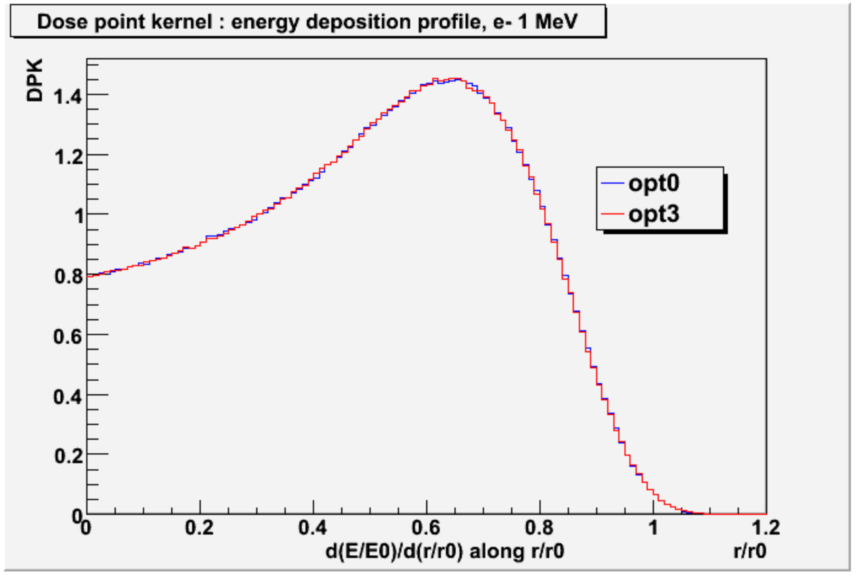
TestEm12 : Urban95 vs Urban93

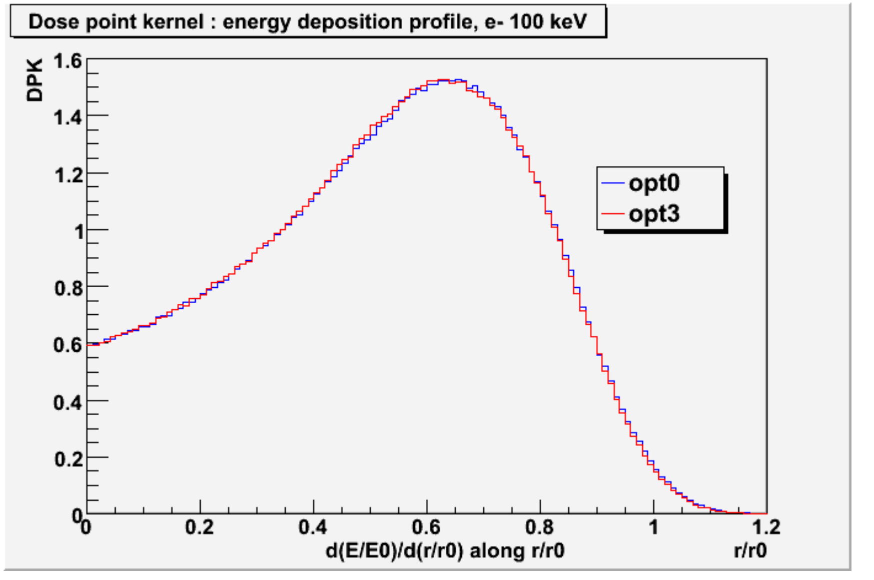


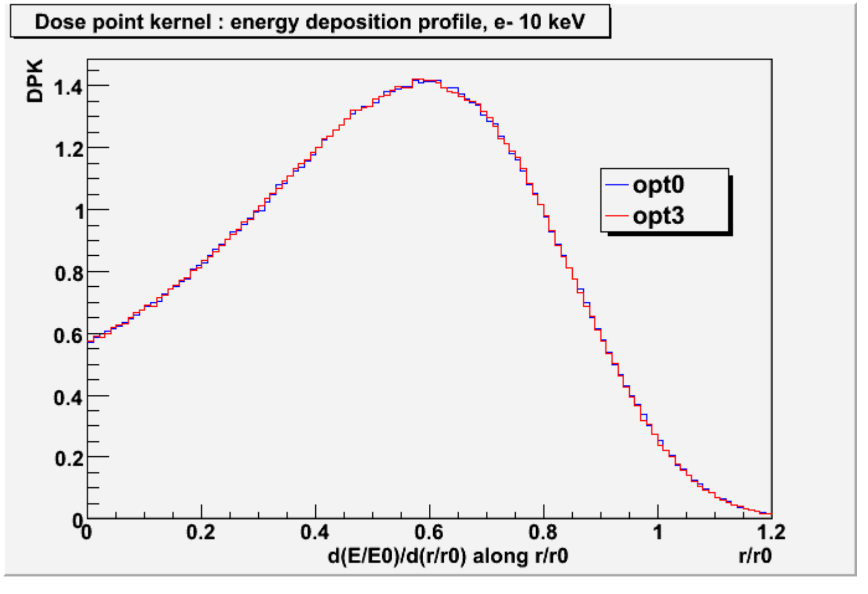




TestEm12 : option3 vs option0

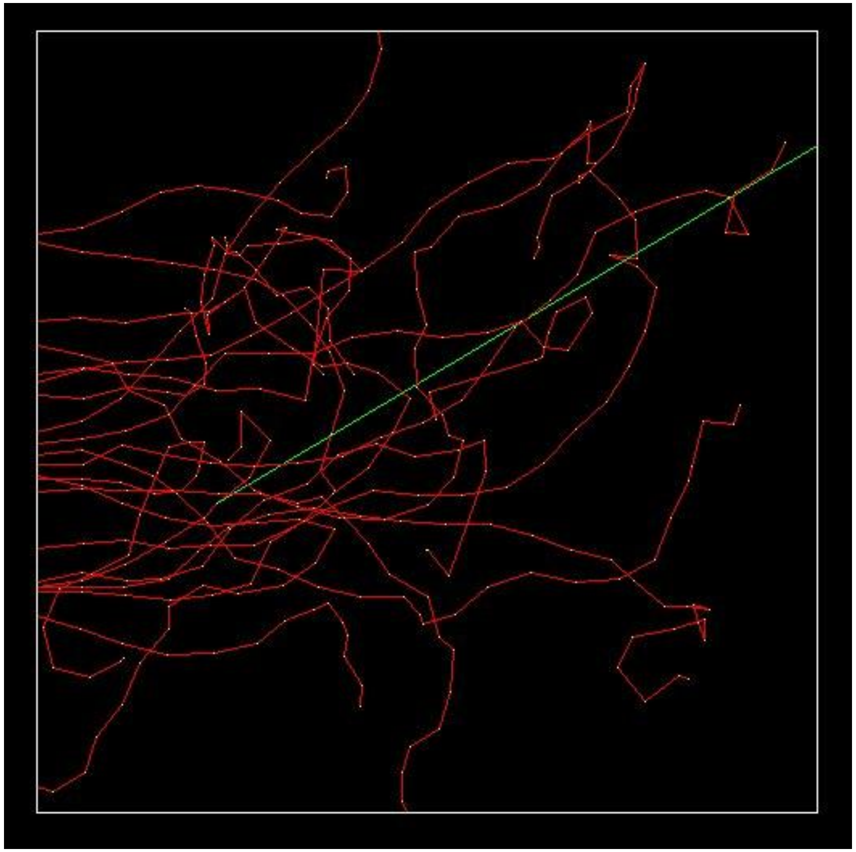






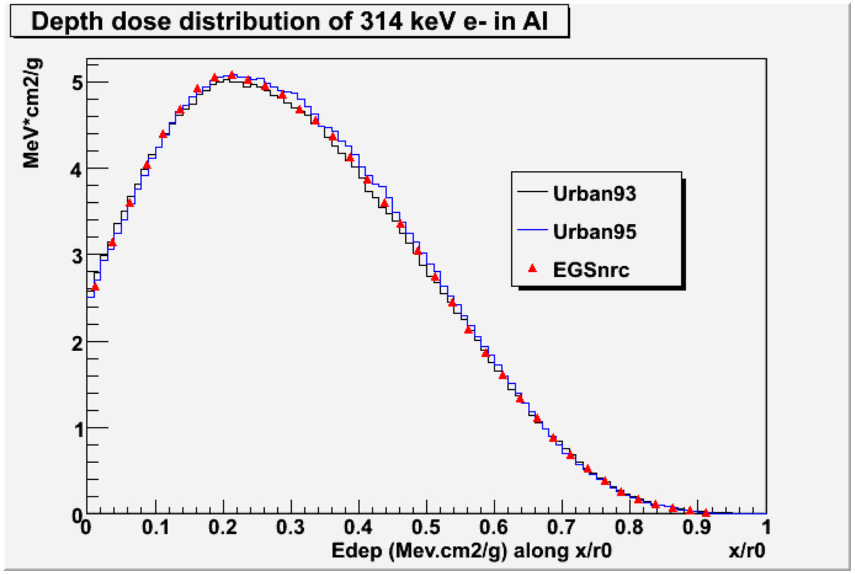
No boundary → no difference opt0 – opt3

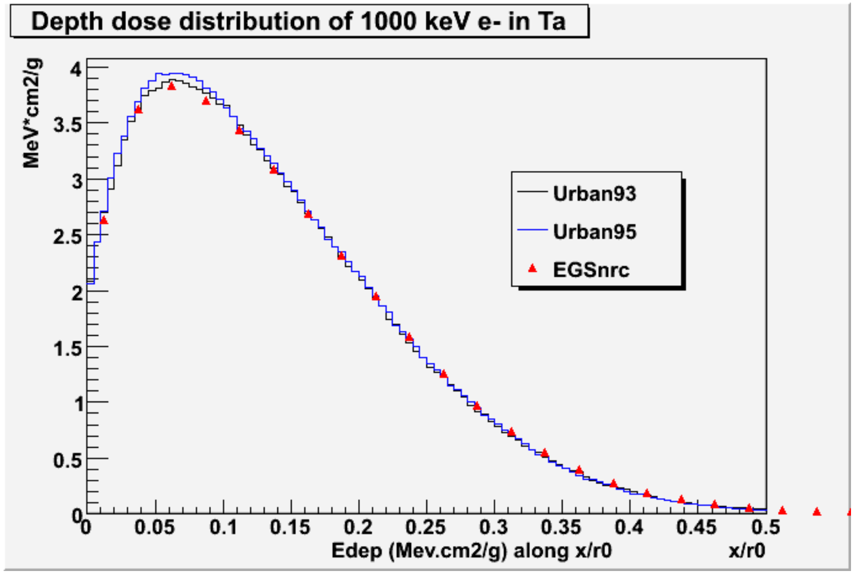
TestEm11 : Pencil Beam Distribution

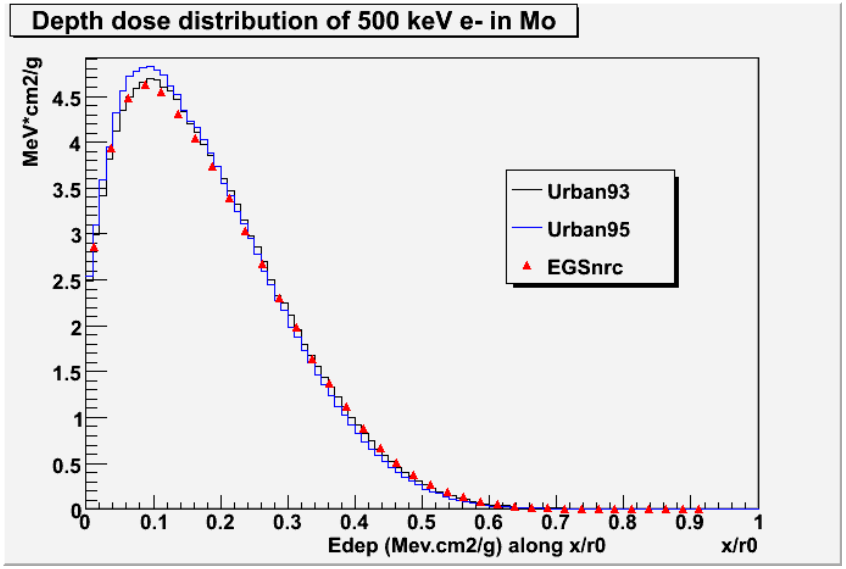


- Energy deposited in slices
- Normalized distribution
- Sandia data
- EGSnrc comparison (perrot@clermont.in2p3.fr)

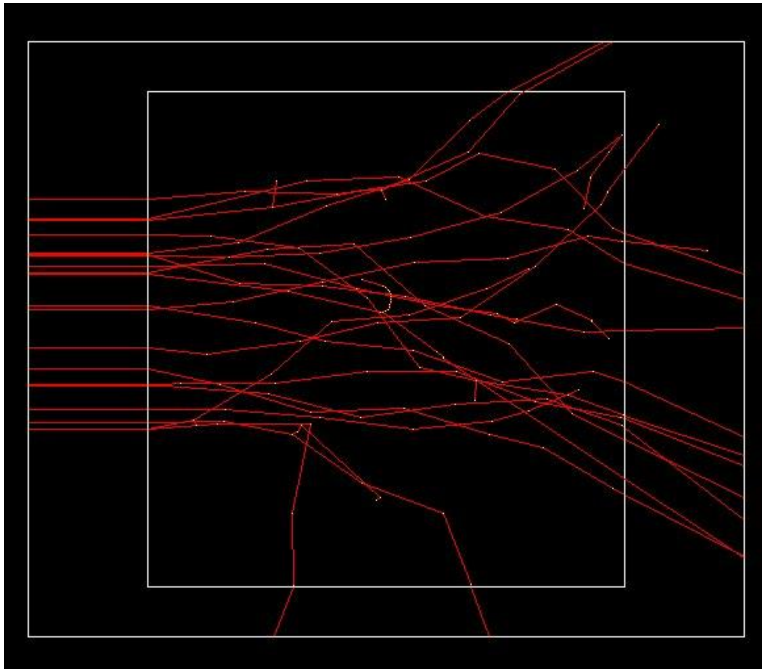
TestEm11 : Geant4 vs EGSnrc

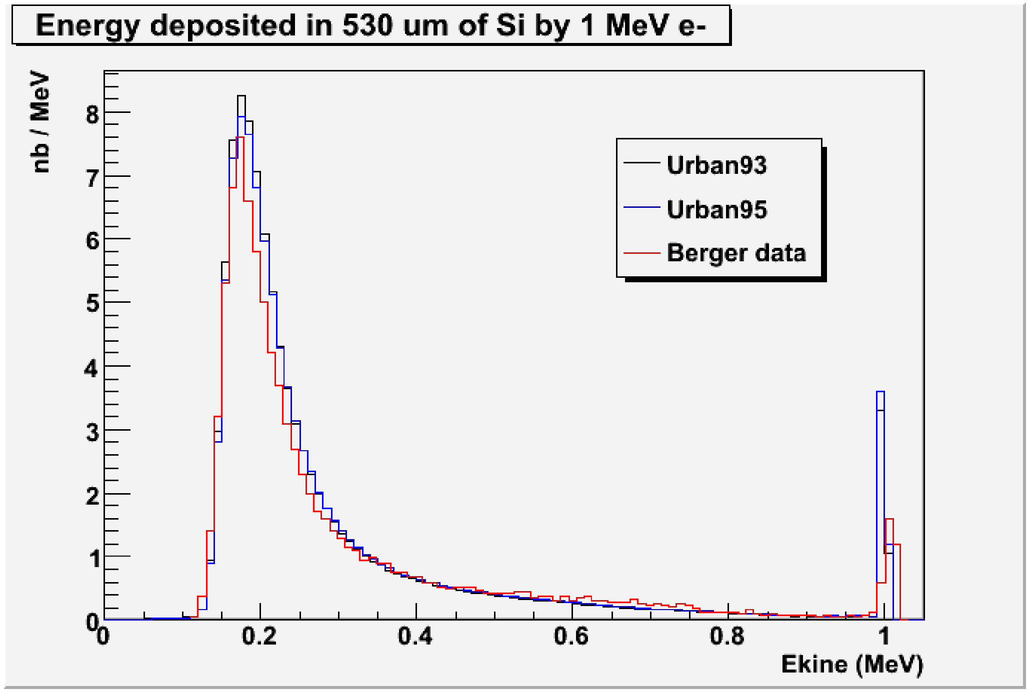






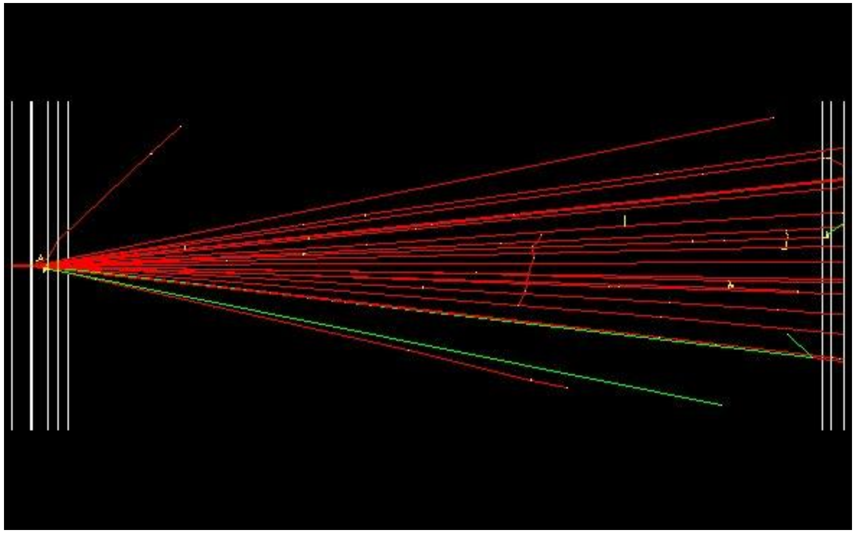
TestEm5 : Thin layer





- e- 1 MeV in 530 um Silicon
- Total energy deposit
- Berger data

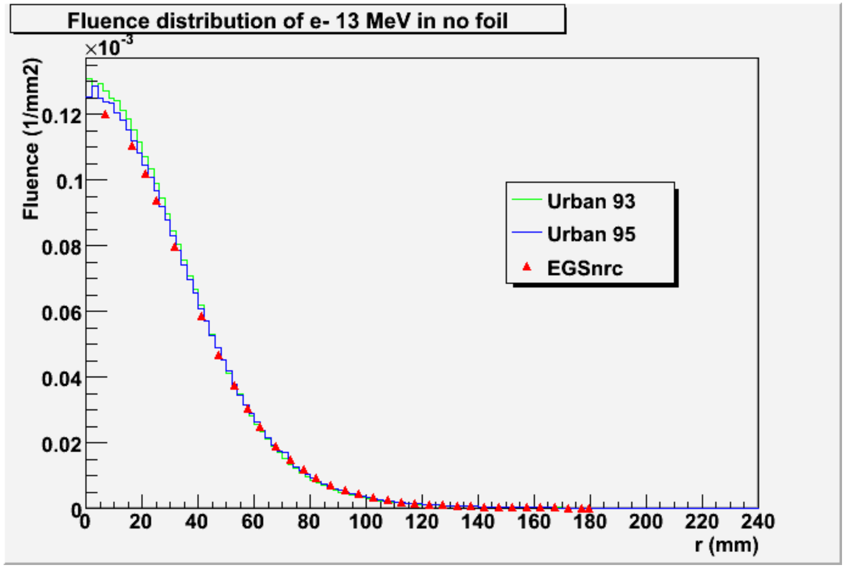
Electron Scattering experiment

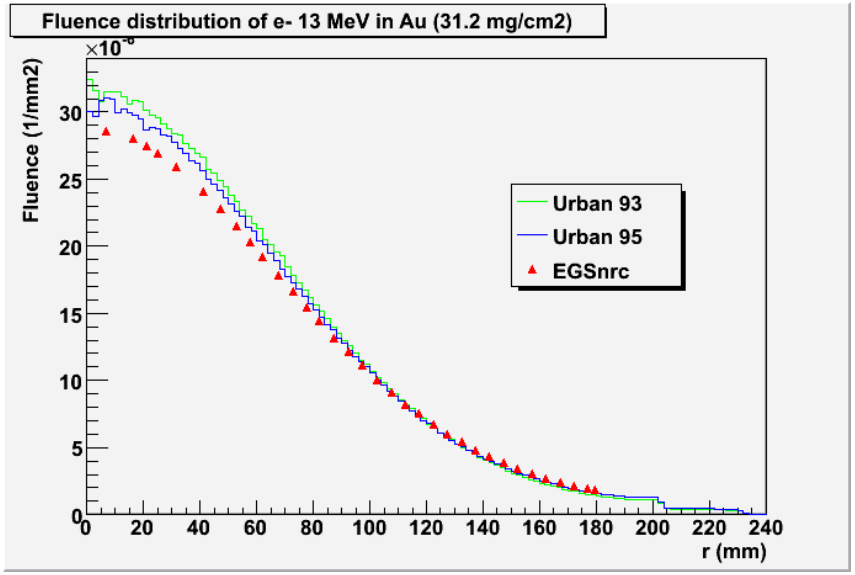


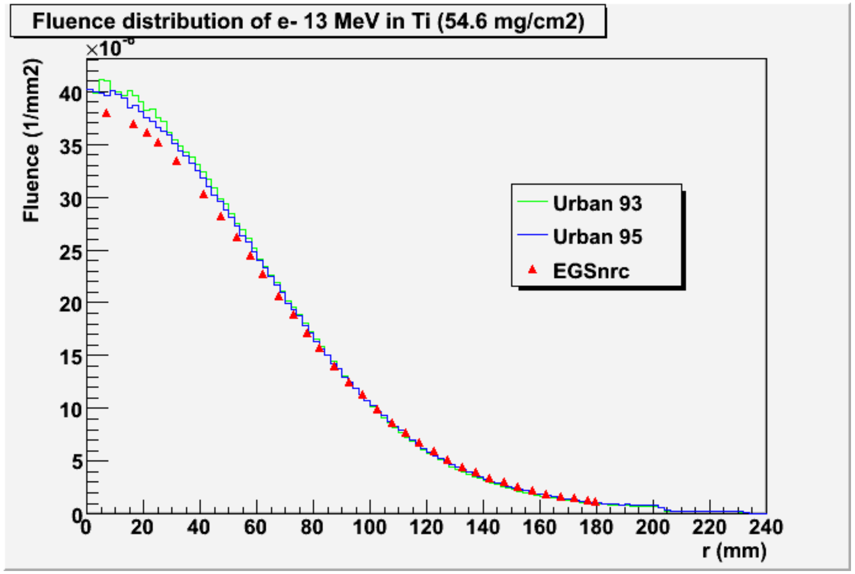
- Thin target
- electron distribution
- Data : Faddegon et al.
- EGSnrc comparison
  (perrot@clermont.in2p3.fr)

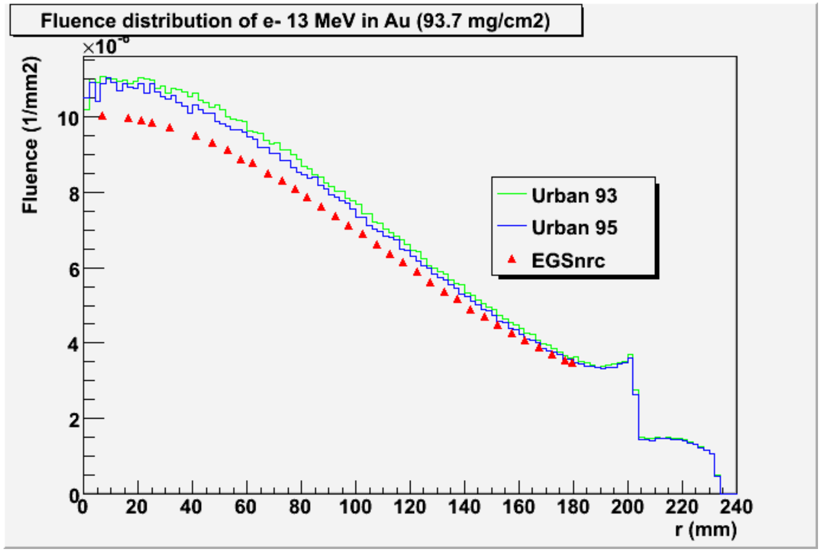
No foil		
Au 1	Z = 79	t = 16.2 um = 31.2 mg/cm2
Ti 4	Z = 22	t =123 um = 54.6 mg/cm2
Au 3	Z = 79	t = 48.5 um = 93.7 mg/cm2
Al 2	Z = 13	t = 518.5 um = 140 mg/cm2
C 1	Z = 6	t = 2.505 mm = 546 mg/cm2
Be 1	Z = 4	t = 5.005 mm = 926 mg/cm2

electronScattering : Geant4 vs EGSnrc

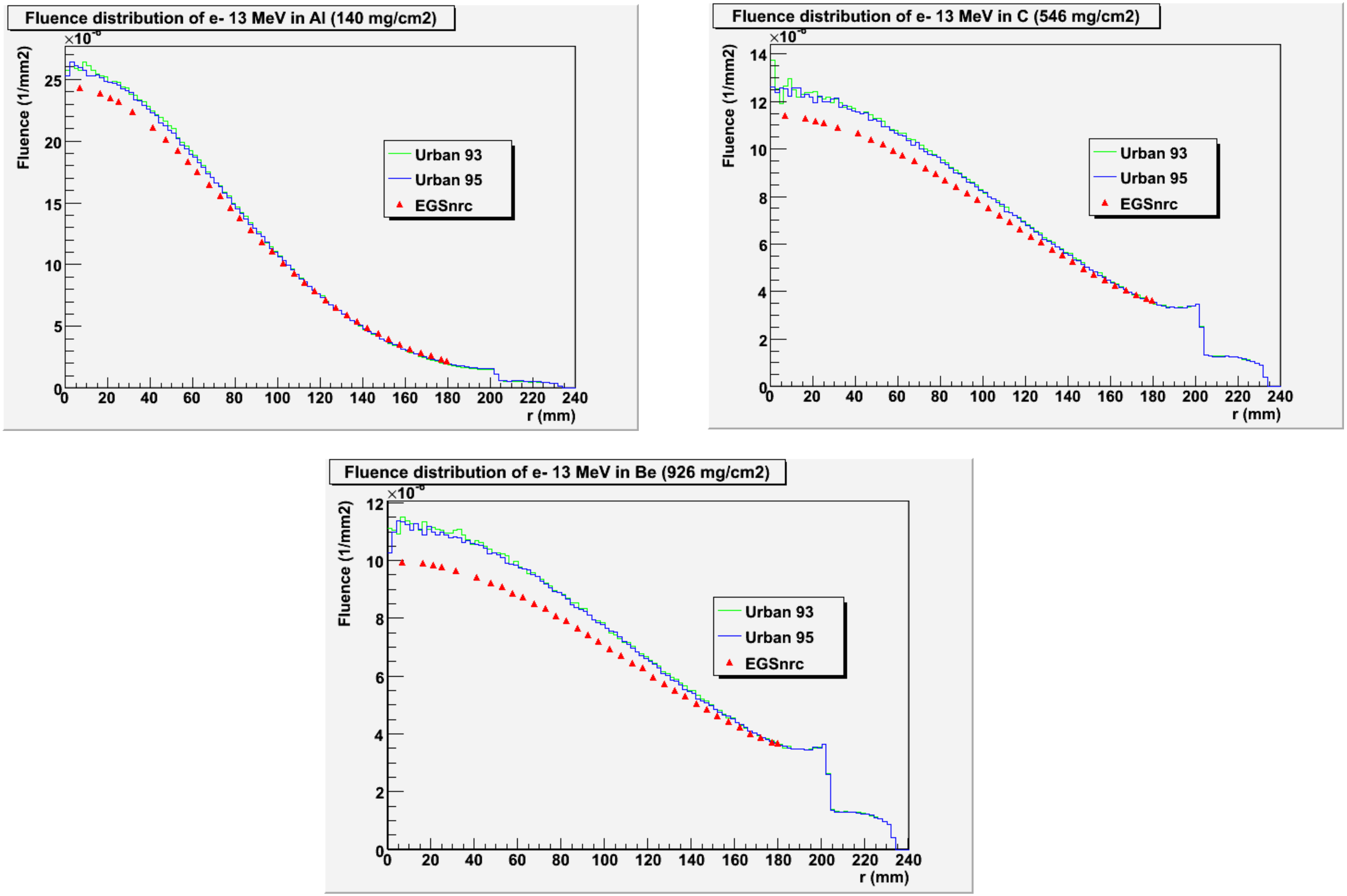




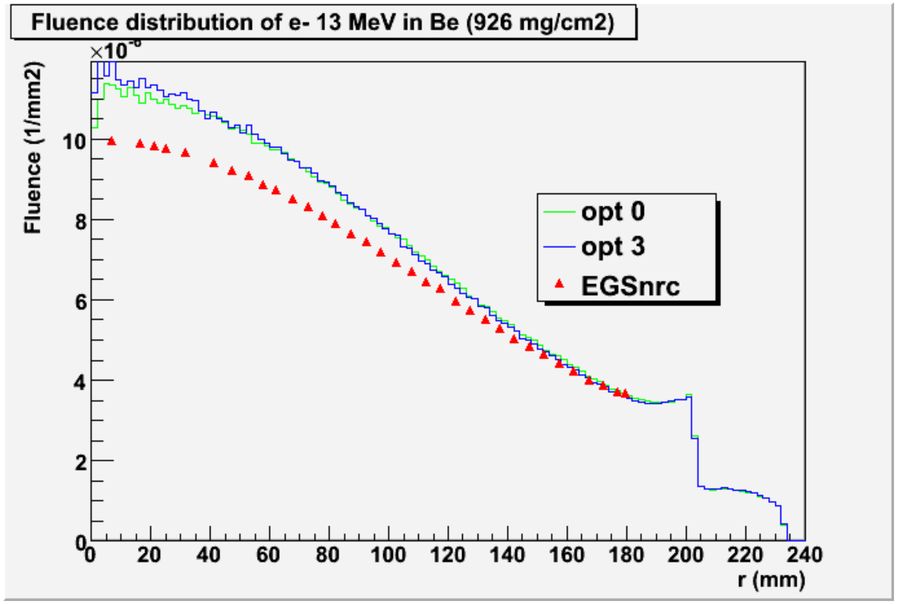


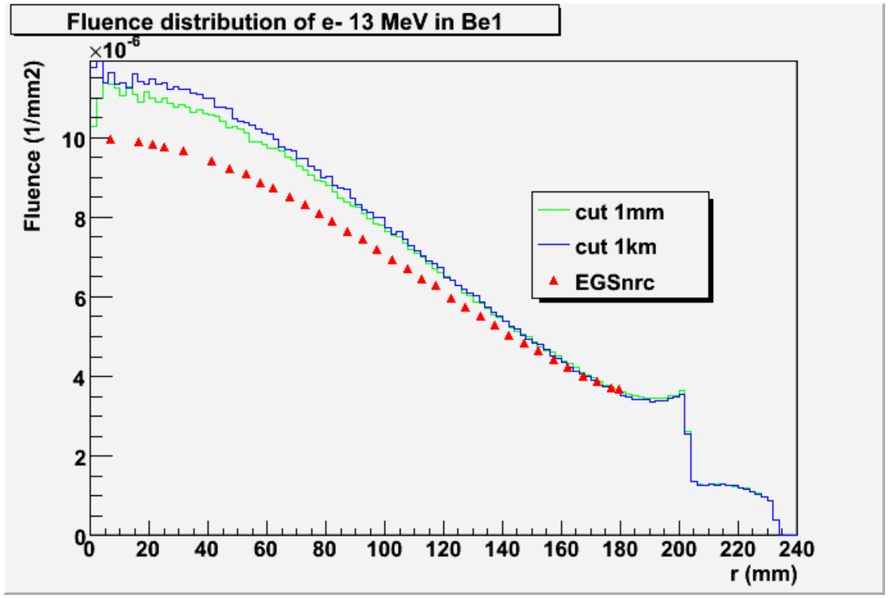


electronScattering : Geant4 vs EGSnrc

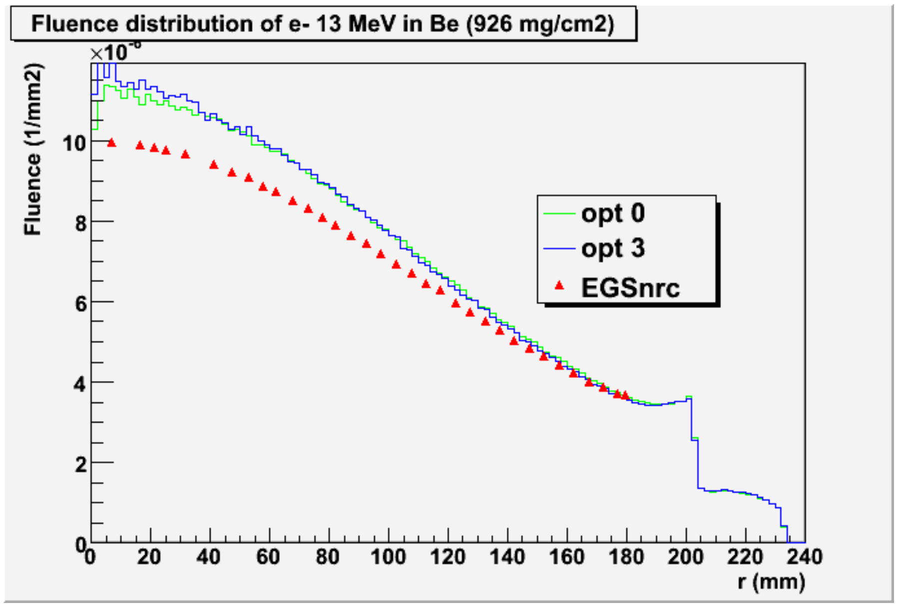


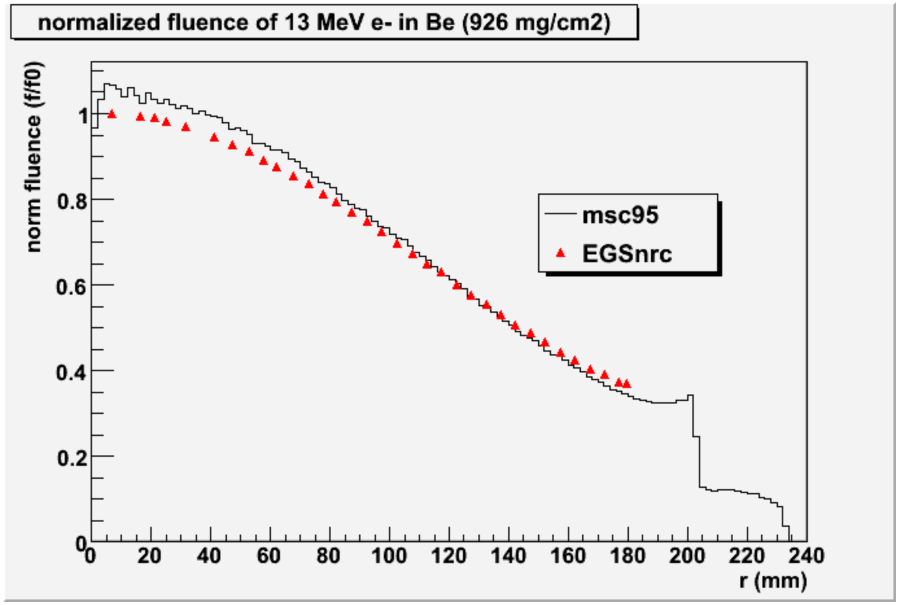
electronScattering : msc options ? Cuts ?

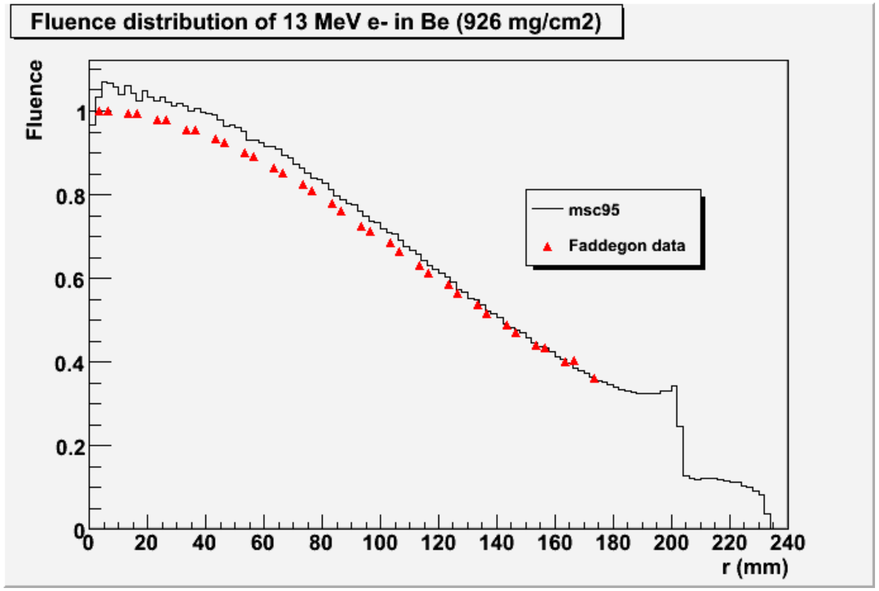




electronScattering : renormalisation

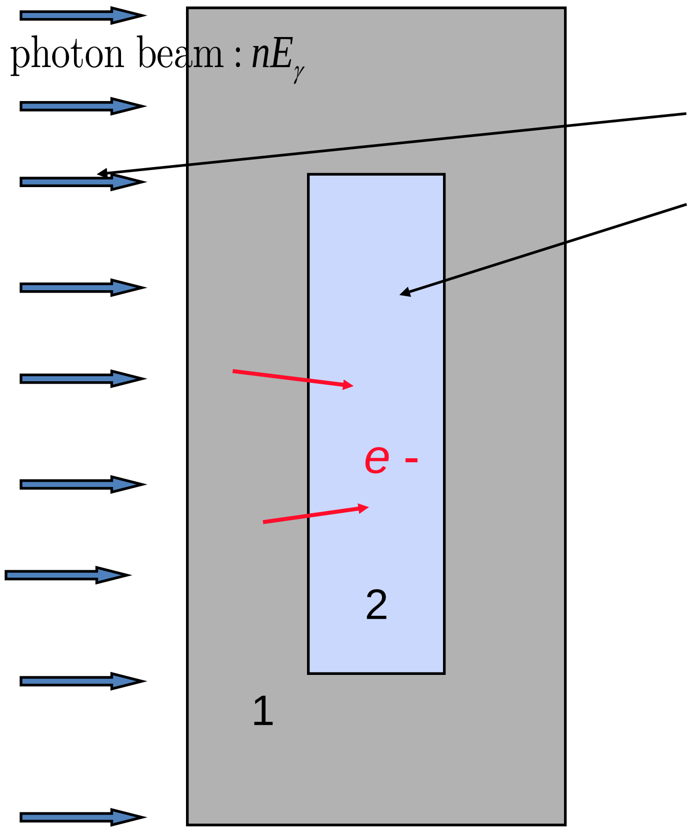






Fano Cavity Test

Materials 1 and 2 : same A, but different density ρ1 and ρ2 $\Rightarrow \left(\frac{1}{\rho}\frac{dE}{dx}\right)_1 = \left(\frac{1}{\rho}\frac{dE}{dx}\right)_2$



beam energy fluence : $\Phi = \frac{nE_\gamma}{S_1}$

dose in material 2 : D

energy transfert coefficient : $\mu_{tr}(E_\gamma) = \sigma_{tot}(E_\gamma)\frac{\langle T \rangle}{E_\gamma}$

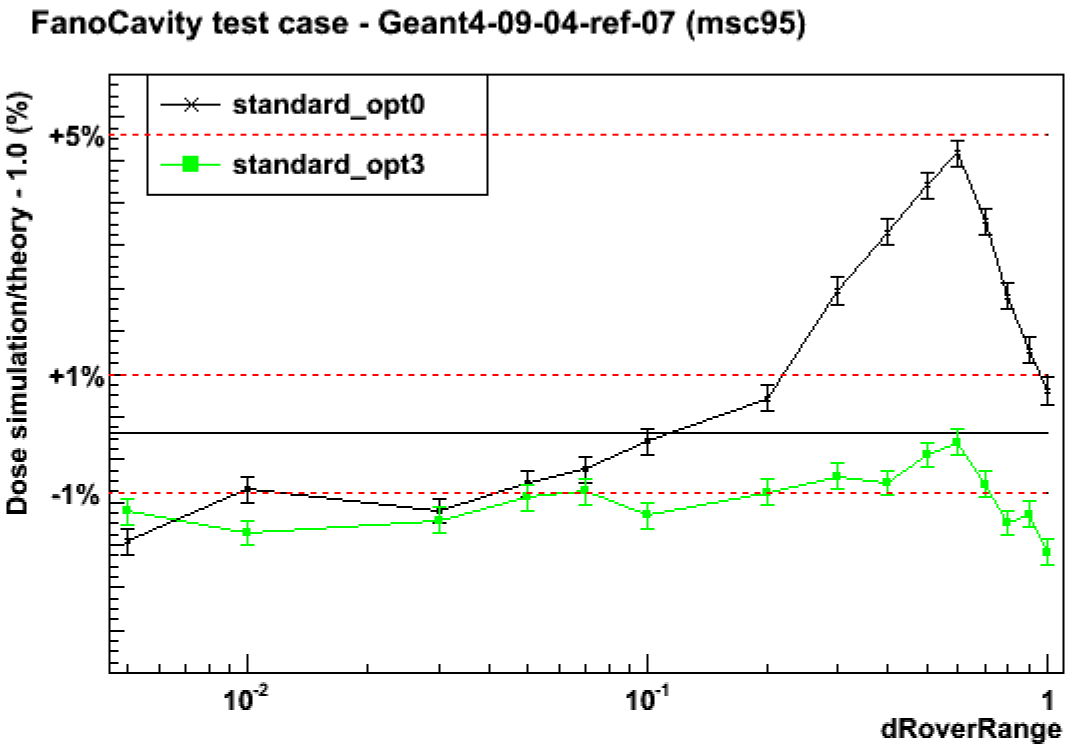
$\langle T \rangle$ is the mean kinetic energy of emited e^-

Under *charged particle equilibrium* condition :

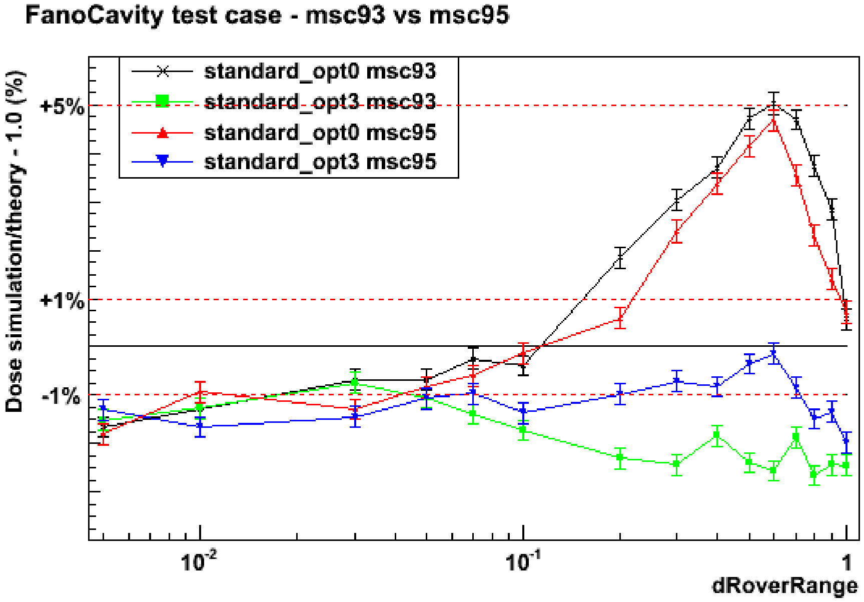
$$\frac{D}{\Phi(E_\gamma)} = \left(\frac{\mu_{tr}(E_\gamma)}{\rho}\right)_1 = \text{const}$$

i.e. independent of the tracking parameters of the simulation

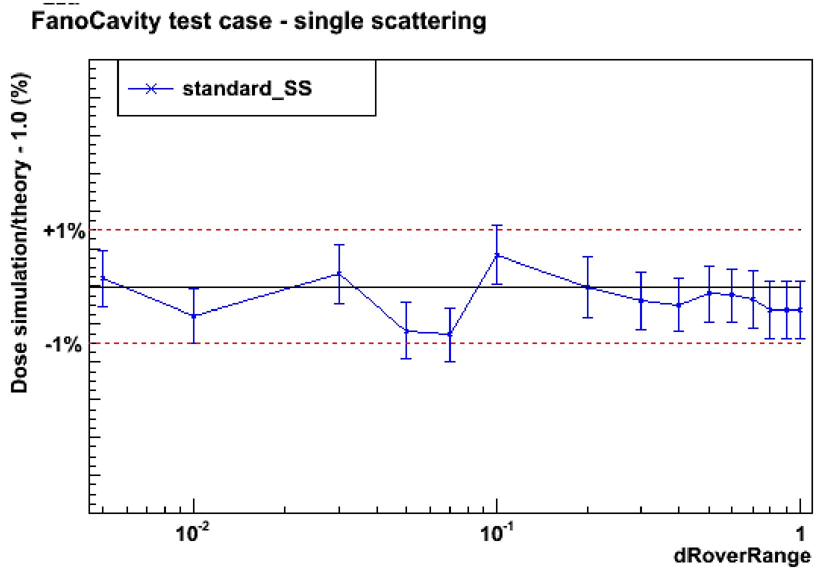
Fano cavity : 9.4-ref-08



Fano cavity



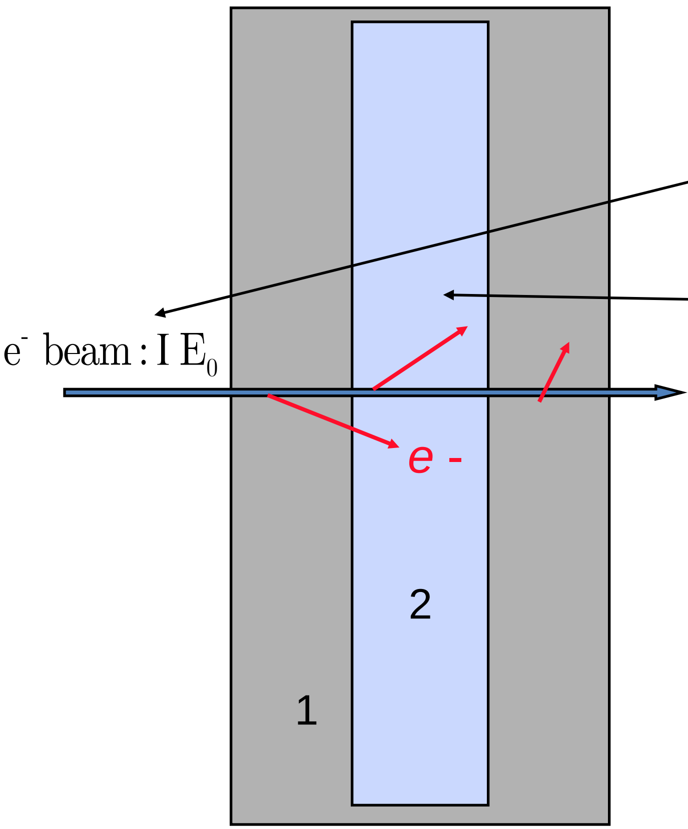
FanoCavity test case - msc93 vs msc95
standard_opt0 msc93
standard_opt3 msc93
standard_opt0 msc95
standard_opt3 msc95
+5%
+1%
-1%
Dose simulation/theory - 1.0 (%)
10^{-2}
10^{-1}
1
dRoverRange



FanoCavity test case - single scattering
standard_SS
+1%
-1%
Dose simulation/theory - 1.0 (%)
10^{-2}
10^{-1}
1
dRoverRange

Fano Cavity 2

Materials 1 and 2 : same A, but different density ρ1 and ρ2 $\Rightarrow \left(\frac{1}{\rho}\frac{dE}{dx}\right)_1 = \left(\frac{1}{\rho}\frac{dE}{dx}\right)_2$



lineic density $\mathrm{I} = \frac{n_1}{m_1} = \frac{n_2}{m_2}$

beam energy fluence : $\Phi = IE_0$

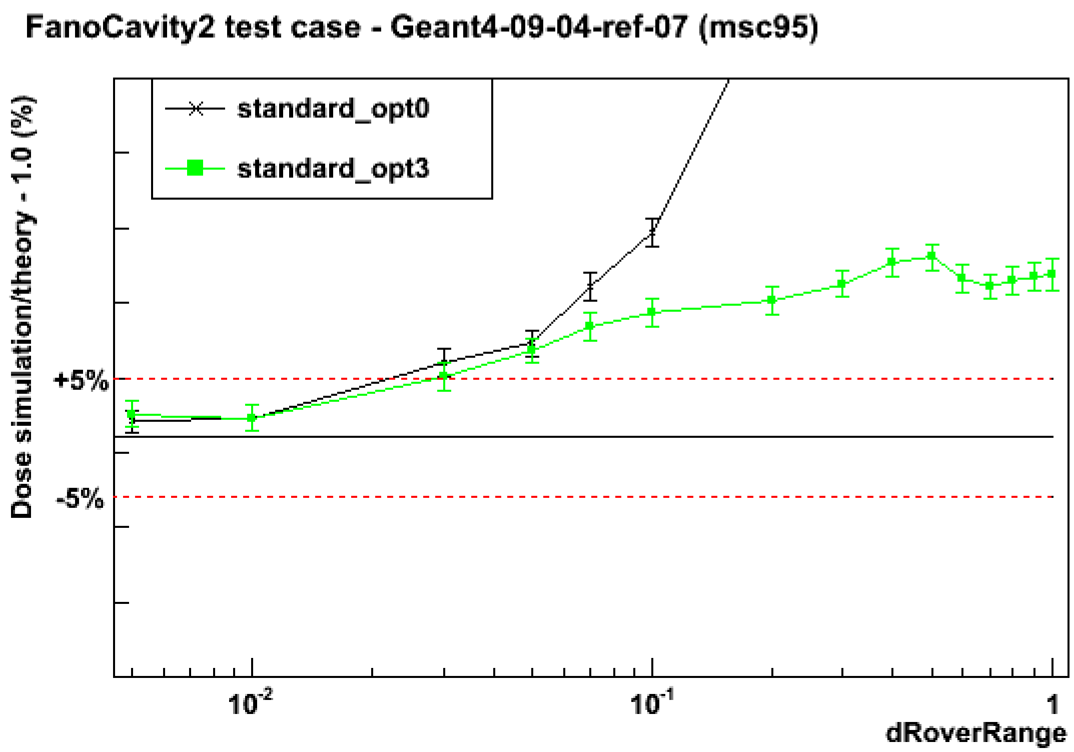
dose in material 2 : D

Under *charged particle equilibrium* condition :

$$\frac{D}{\Phi(E_0)} = 1$$

i.e. independent of the tracking parameters of the simulation

Fano cavity 2 : 9.4-ref-08



Fano cavity 2