GATE/G4 simulations of ^{125}I brachytherapy sources

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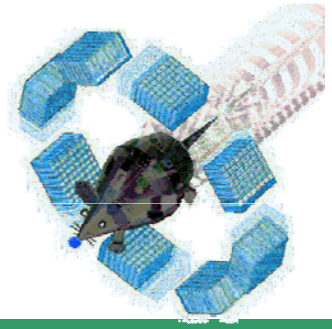

Content

Plateforme de Calcul pour les Sciences du Vivant

- **Specification of 125iodine (low-energy photon emitter)**
- **Treatments for some ocular and prostatic tumors using low-dose rate brachytherapy**
- **Dosimetric calculations using GATE for 3 types of sources using 125iodine**
  - Radial dose functions
  - Anisotropy functions
  - Comparisons with experimental measurements and other MC codes

Treatments using iodine 125

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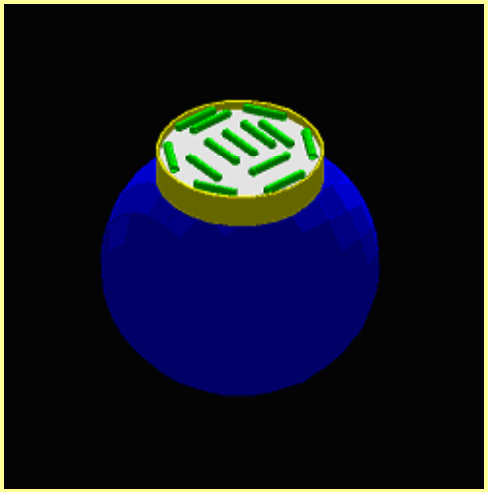

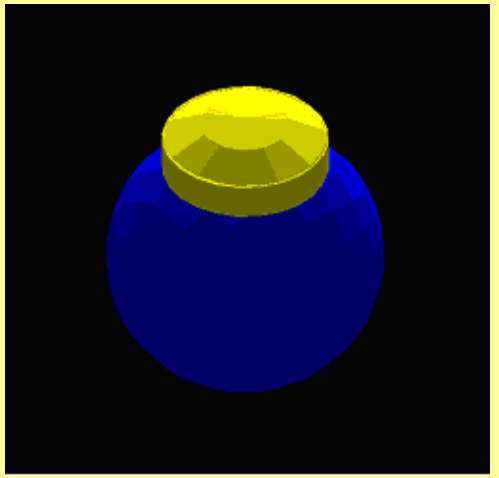

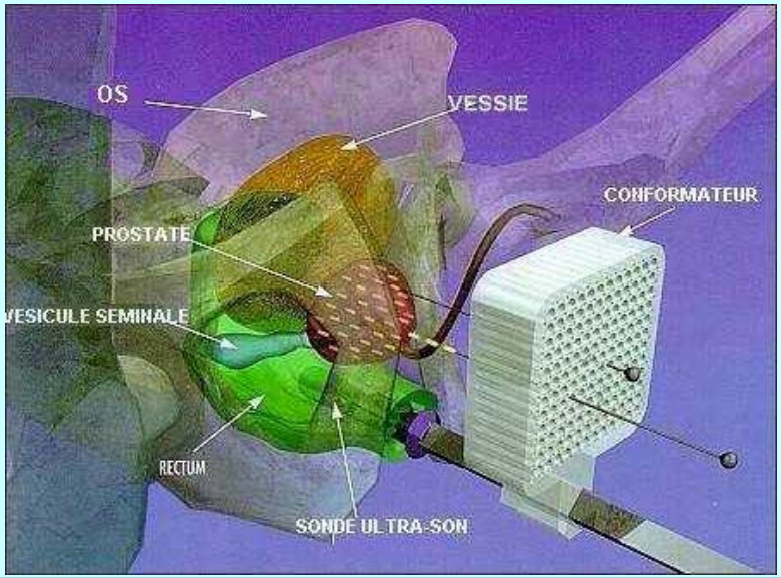

Iodine 125 specifications

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- **100% disintegration by electron capture**

$$^{125}_{53}I + e^- \Rightarrow {}^{125}_{52}Te + \nu$$

$$p + e^- \Rightarrow n + \nu$$

- **X-ray emission (between 27 et 31 keV) and AUGER electrons (3 – 4 keV)**
- **Gamma emission (~ 36 keV)**
- **Photoelectric effect => main interactions => Dose deposited by photoelectrons**

Energy keV	Number of photons by e- capture
27,202	0,406
27,472	0,757
30,98	0,202
31,71	0,0439
35,492	0,0668

Design of sources

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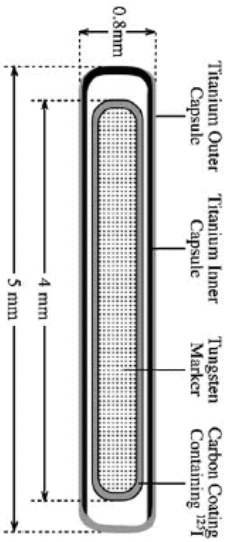
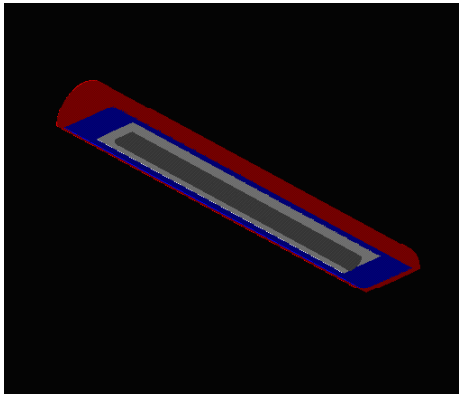
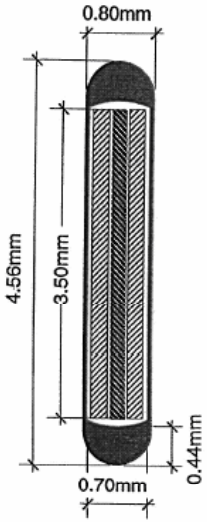
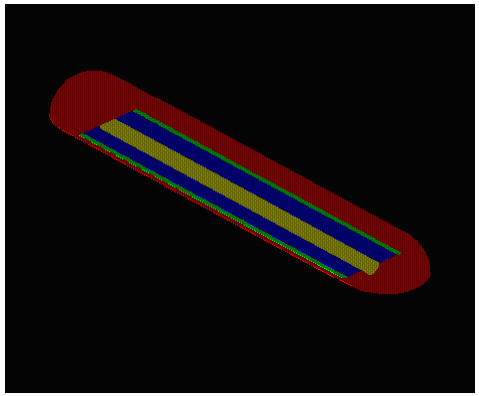


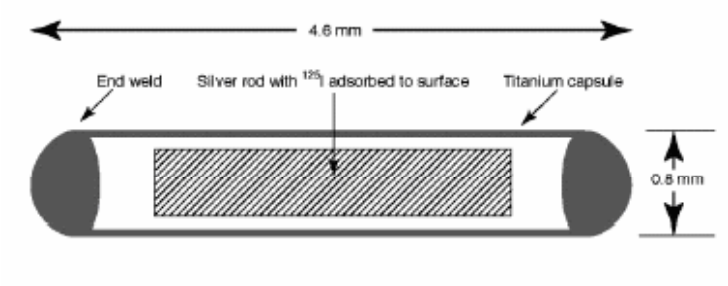


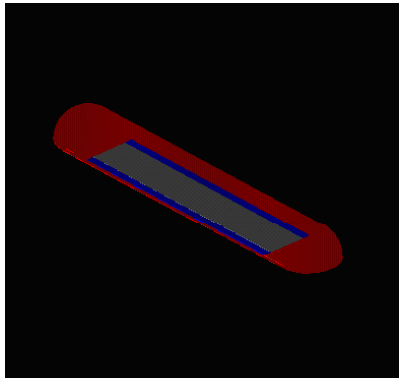
B.M.I. model 2301





Symmetra model UroMed/Bebig





6711 model Amersham

G4 Low Energy package

Xray cut 5 keV
Electron cut 0.01 mm
Delta ray 1 keV

^{125}I brachytherapy source study

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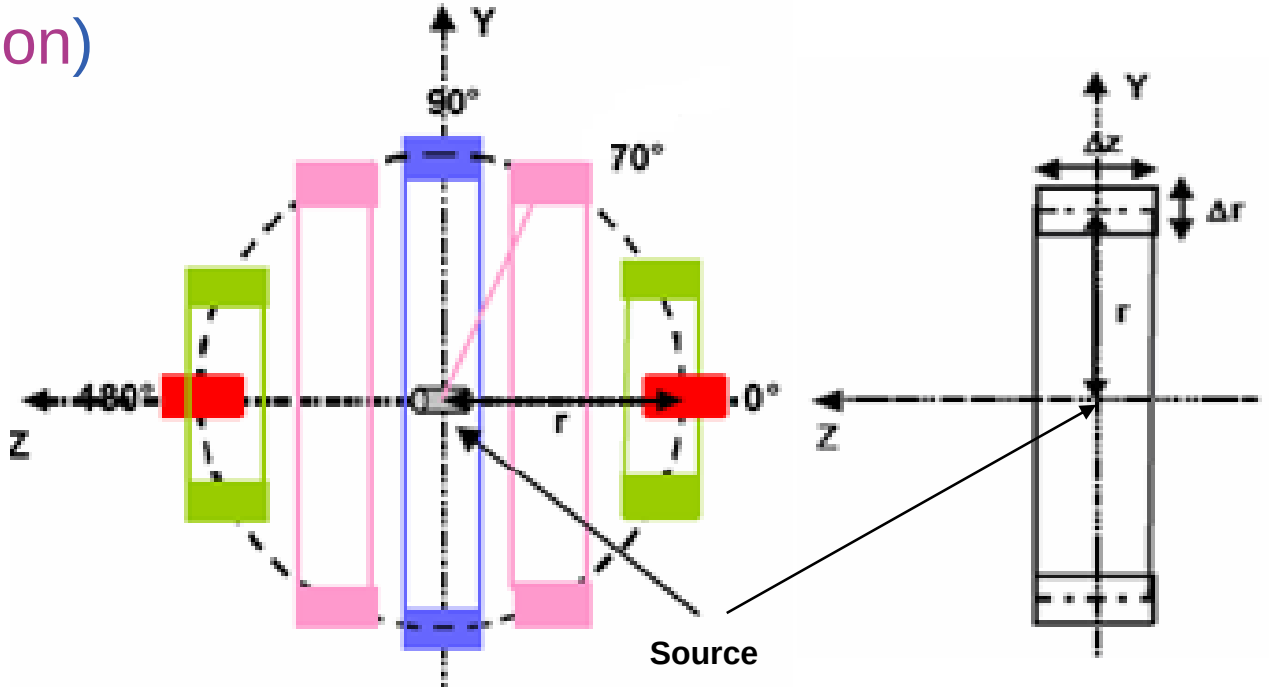
Doses calculation method is based on the AAPM radiation therapy committee TG-43 (March 2004)

(radial dose function, dose rate constant and anisotropy function)



$$g(r) = \frac{[D(r, \pi/2)/G(r, \pi/2)]}{[D(r_0, \pi/2)/G(r_0, \pi/2)]}$$

$$F(r, \theta) = \frac{[D(r, \theta)/G(r, \theta)]}{[D(r, \pi/2)/G(r, \pi/2)]}$$

Comparisons between G4 versions

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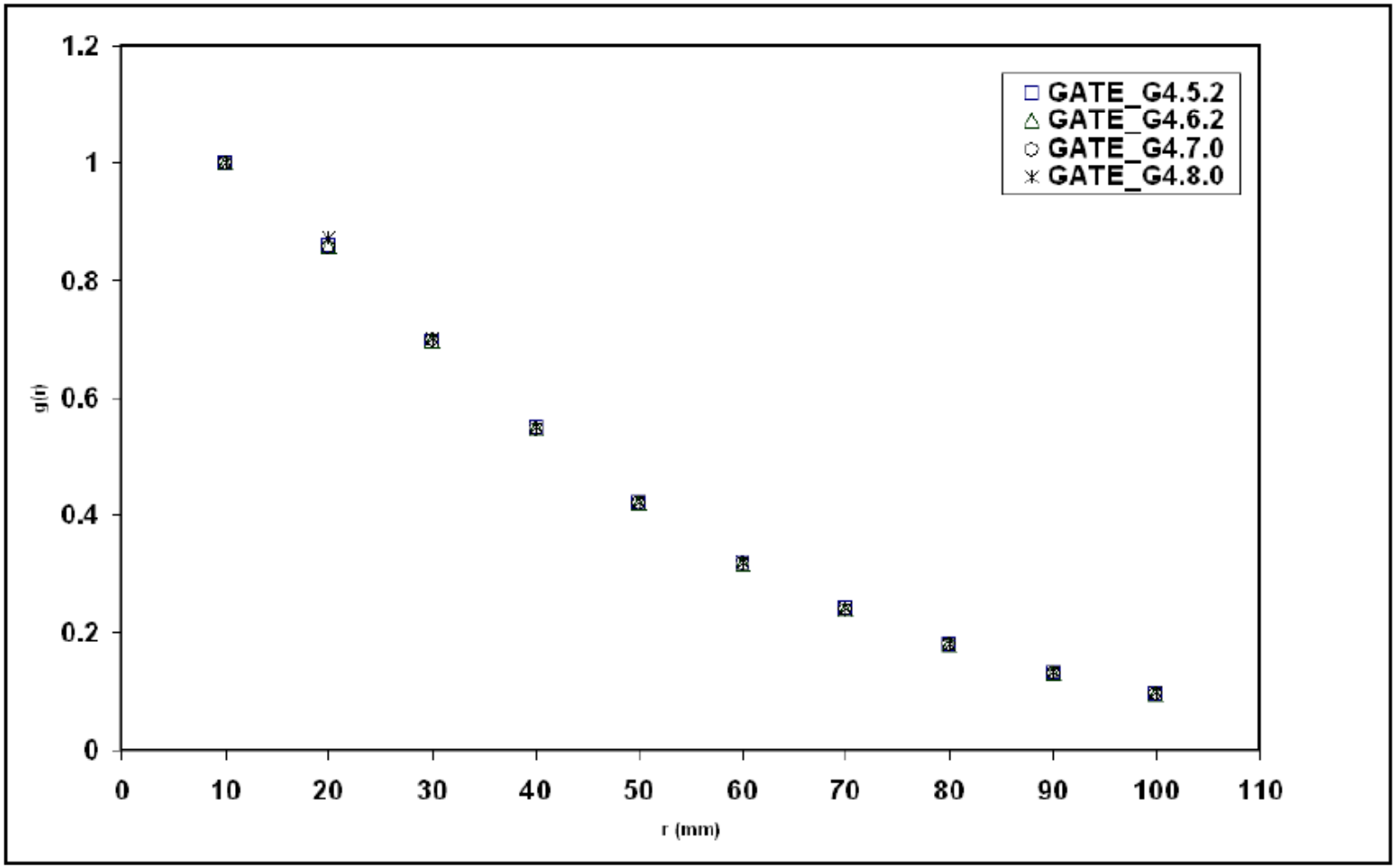

FIG. 3.30: Fonction de dose radiale g(r) pour le modèle Symmetra de "UroMed/Bebig" : Comparaison entre différentes versions de GATE/GEANT4

Results for the Symmetra model

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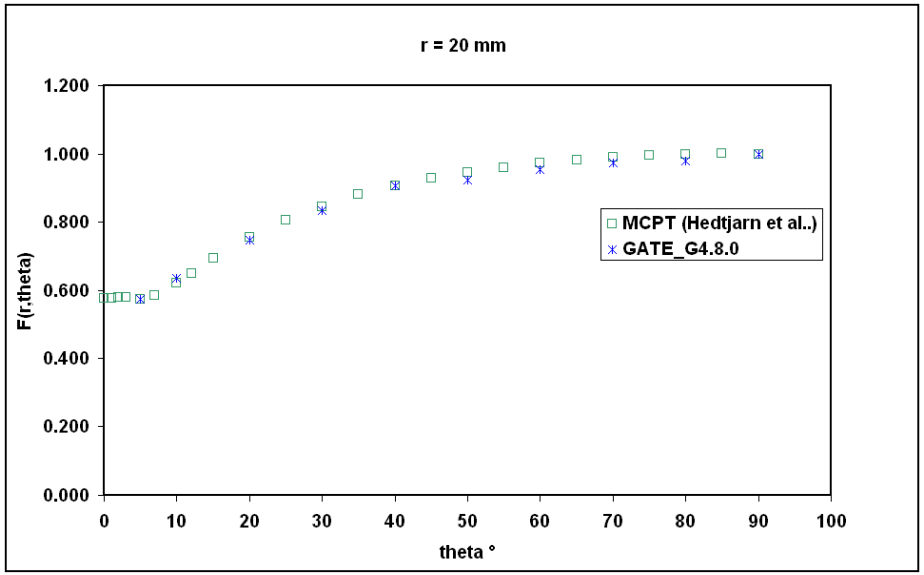
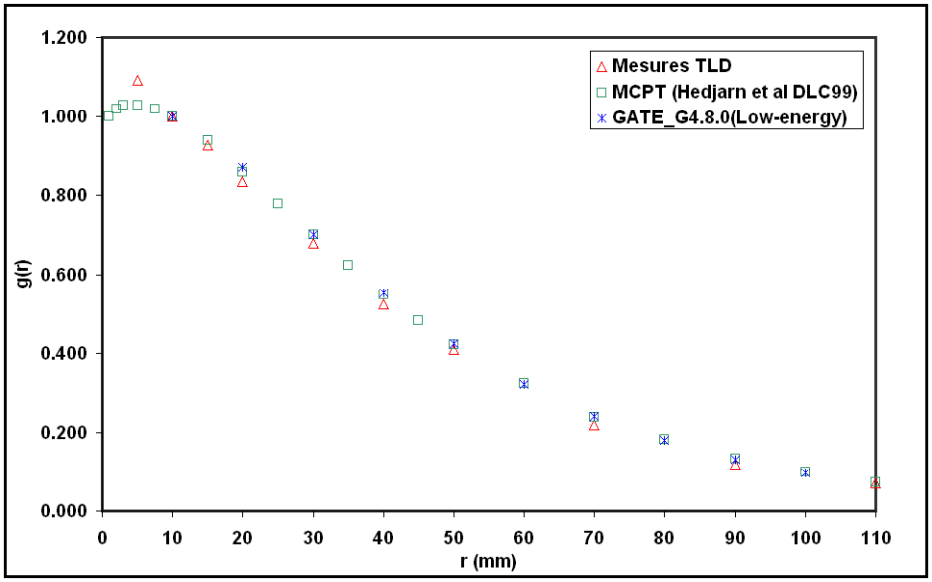
Radial dose function (accounts for the effects of absorption and scatter in the medium along the transverse axis of the source)

Comparisons between G4 versions: relatives variations < 0.5%





Results for 2301 BMI model

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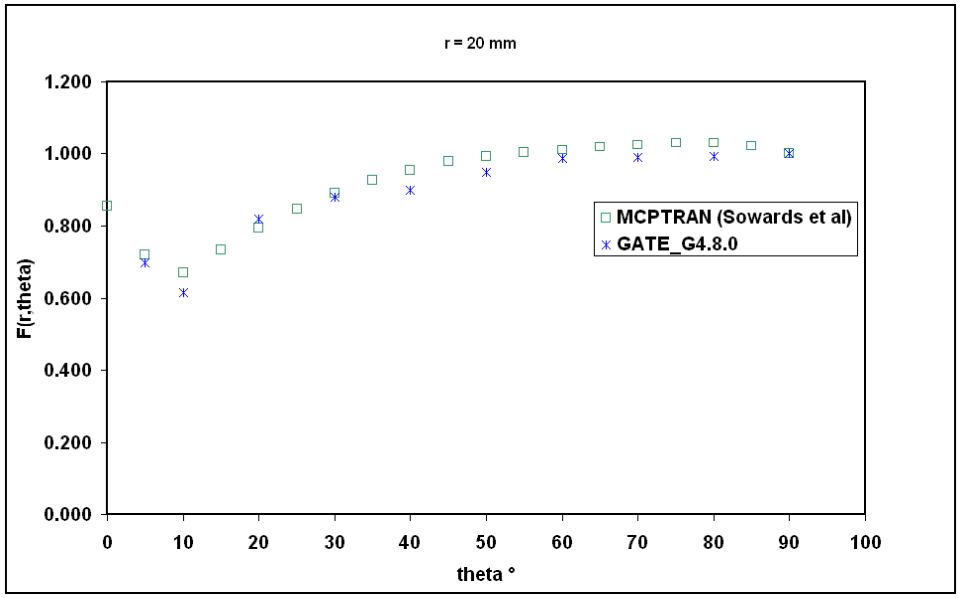

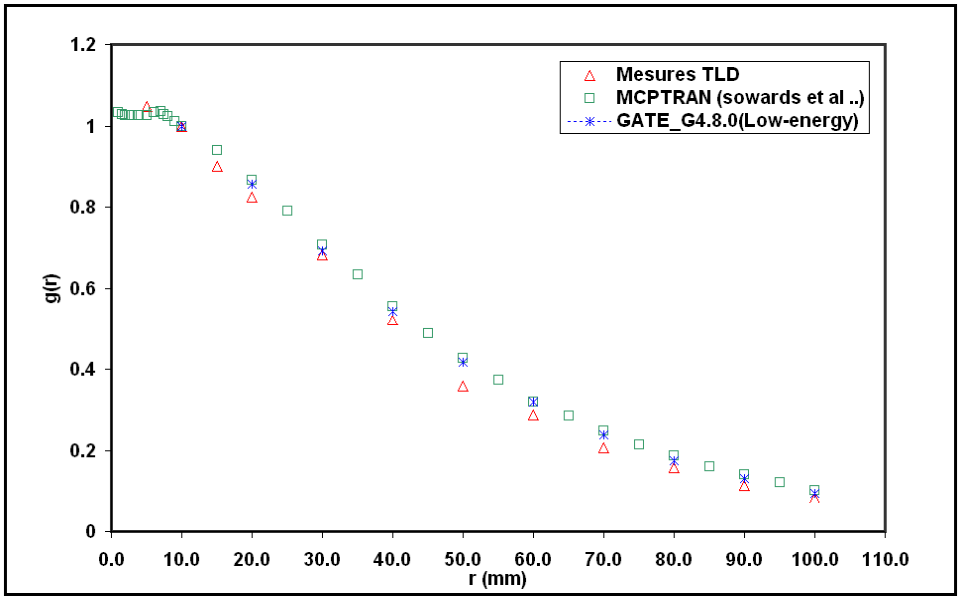

Results for 6711 model

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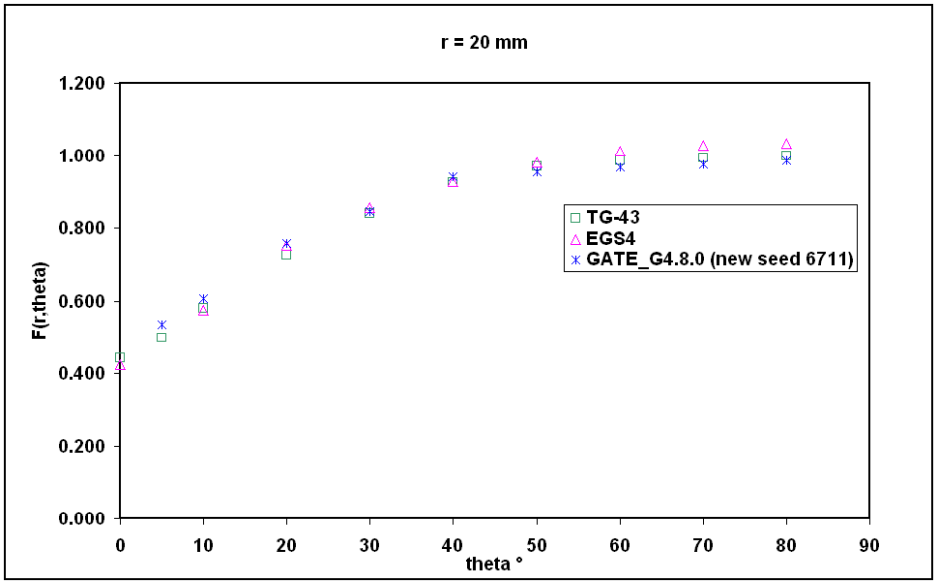

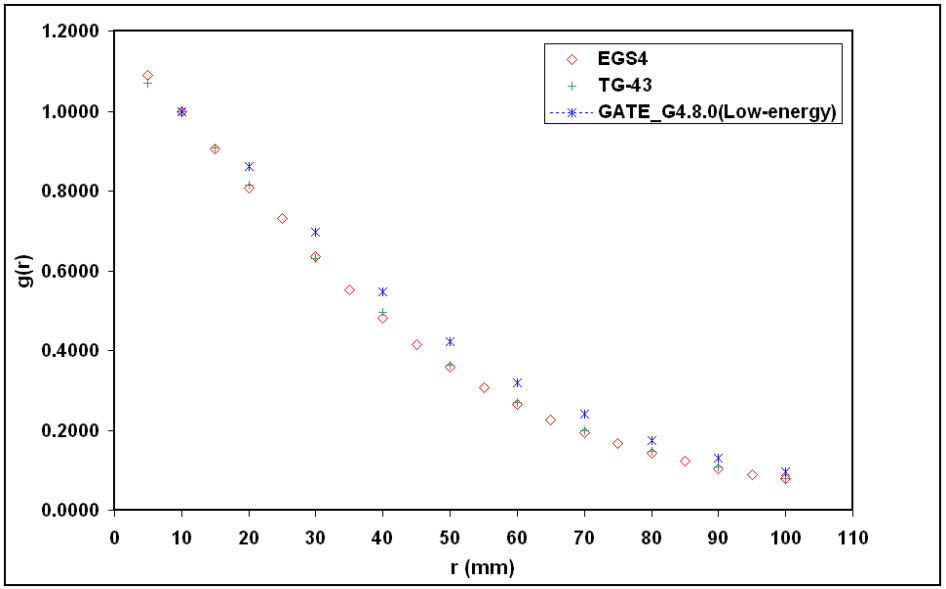

Discussion and conclusion

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Relatives variations between Geant4.8.0, MCPT and TLD Measures

Average relative variation %		
MC Comparisons	g(r)	F(r, theta)
G4.8(low-energy)/MCPT	0.1	2
G4.8(low-energy)/TLD Mesures	3	3.5
G4.8(Low-energy/Standard)	7	-

- Little discrepancies between Geant4 Standard and Low-energy packages (7%)
- Good agreement between G4 versions
- Good agreement with other MC and measurements