# Mandatory exercise FYSKJM4710 -Monte Carlo simulations of radiation transport

Activate program "egs\_inprz". Use Excel to evaluate output files (\*.egsgph and \*.egslst) -> open file in excel, use "fixed width", select data to be extracted.

## 1. 'Watch' electron and photon interactions

Use parallel beam, radius 3 cm. Medium is water. 1 slab of thickness 10 cm and radius 10 cm. 10 histories. IWATCH=graph. Extract the path of primary particles only. Plot trajectory in yz-plane.

- a) 0.1 MeV photons.
- b) 5 MeV electrons.

Discuss differences between electrons and photons.

IWATCH=off in the following. Normalize all plots to maximum value.

## 2. Narrow photon beam attenuation

Simulate narrow beam attenuation. Use parallel beam, radius 1 cm. Use copper as absorber. At 1 m from the absorber, place a water filled detector with 0.5 cm radius. Use air in between. Vary the thickness of copper.

- a) 250 keV monoenergetic photons. Plot dose in the detector as a function of copper thickness (semilogarithmic). Determine HVL and  $\mu$  from the slope. Use tables in Attix to find the equivalent photon energy.
- b) 250 kV spectrum ("250.spectrum"). Plot dose in the detector as a function of copper thickness Determine HVL and  $\mu$  from the slope. Use tables in Attix to find the equivalent photon energy.

Discuss differences between a and b.

## 3. Longitudinal and lateral dose deposition characteristics

Use parallel beam, radius 3 cm. Medium is water.

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| Geometry (continue<br>list with radius 10<br>and 15 cm): | C individual   C cavity description   Planes information   # slabs thickness [cm]   1 25 0.25   2 25 1   2 25 1   3 5 6   6 4   7 5   8 9   9 7   10 11   12 4  | description by     planes     •       medium     start 2 stop 2 start     stop F       1     H2O521ICRU     1     50     1     13       2     3     -     -     6     -     -       3     -     -     6     -     -     -     -       6     -     -     -     6     - |
|  | Execute PreviewRZ Print Compile   | Save Exit Help About  |

- a) 0.1, 1 and 10 MeV photons. Use 5000000, 4000000 and 3000000 histories, respectively. Extract central, longitudinal dose profile ('depth dose'). Extract lateral dose profile at 5 cm depth.
- b) 5, 10 and 20 MeV electrons. Use 2000000, 1500000 and 1000000 histories, respectively. Extract central, longitudinal dose profile ('depth dose'). Extract lateral dose profile at 2 cm depth.

Discuss differences between the dose deposition characteristics of photons and electrons. Discuss the dependence of photon or electron energy on the dose deposition characteristics.

## 4. Air cavity

Place an air cavity in the central part of the phantom at 2 cm depth. Calculate the dose to the air cavity.

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| Ĵ  | input method Z of front face: 0. Media input<br>c groups<br>c individual<br>c cavity description<br>description by planes |
| Geometry the same<br>as above, except air<br>cavity: | medium start 2 stop 7   1 25 0.25   2 25   3 -   4 -   5 -   6 -   7 -   8 6   9 -   10 -   11 -   12 -                   |
|  | Execute     PreviewRZ     Print     Compile   |

a) 1 MeV photons. 10000000 histories. Calculate  $D_{water}/D_{air}$  (take former from problem 3 above). Compare to CPE-theory, where tables from Attix may be used.

b) 10 MeV electrons. 1500000 histories. Calculate  $D_{water}/D_{air}$  (take former from problem 3 above). Compare to Bragg-Gray-theory, where tables from Attix may be used.

Discuss.

## 5. Own simulation

Simulate a problem of relevance for the course!