Tutorial 2

OMA School, Pavia,

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1 Simulations

1. Which of the following statements are NOT true of simulation?

   a) Simulation models the behaviour of a system.
   b) A simulation model cannot prescribe what should be done about a problem.
   c) Simulation models can be used to study alternative solutions to a problem.
   d) The equations describing the operating characteristics of the system are known.

2. Which of the following statistical methods are commonly used to analyze simulation results?

   a) Regression analysis.
   b) Analysis of variance.
   c) t-tests.
   d) All of the above.

3. Simulation models can be used to obtain operating characteristic estimates in less time than with the real system using a feature of simulation called:

   a) Warp speed.
   b) Microseconds.
   c) Time compression.
   d) None of the above.

2 Medical accelerators I (multiple choice questions)

1. In a medical linear accelerator:

   a) Magnetron is a generator of microwaves.
   b) Klystron is an amplifier of microwave power.
   c) Circulator protects the microwave power source from reflected microwaves.
   d) Bending magnets bend the X-ray beam through 90^o to 270^o depending on the gantry angle.

2. What of the following is (are) true for medical electron linear accelerators:

   a) Electrons are accelerated toward an anode biased from 4 to 25 MeV.
   b) Microwave amplification occurs with either klystrons (for low energy systems) or magnetrons (for high-energy systems).
   c) For the same maximum acceleration, side-coupled standing wave accelerator structures are shorter that traveling wave designs.
   d) High microwave frequencies of approximately 3 GHz are used within the acceleration structure.
   e) None of the above.

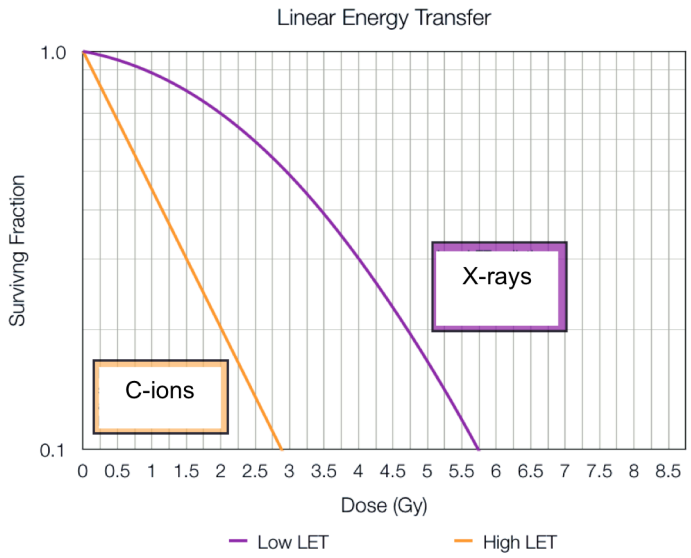
3. What is the approximate microwave pulse frequency in a medical linear accelerator?

   a) 100 MHz
   b) 300 MHz
   c) 1000 MHz
   d) 3000 MHz

3 Medical accelerators II

Compare advantages and disadvantages of cyclotrons with respect to synchrotrons for hadrontherapy. Make a comparison list.

4 Given the following plot, calculate RBE30 and RBE70



5 LET and RBE (multiple choice question)

Radiation with a LET of 100 keV/μm has the greatest RBE for cell killing, mutagenesis, or oncogenic transformation because:

a) The average separation between ionizing events coincides with the diameter of the DNA double helix.

b) The average separation between ionizing events coincides with the diameter of the cell nucleus.

c) The average separation between ionizing events coincides with the diameter of the cell.

6 RBE (multiple choice question)

RBE depends on the following:

a) Radiation quality (LET).

b) Radiation dose.

c) Dose rate.

d) Biologic system.

e) Endpoint.

f) All of the above.

7 Dosimetry

1. The film for and SSD treatment on a linear accelerator is taken at 133 cm. What is the magnification factor?

   a) 1.33 cm

   b) 1.53 cm

2. A patient is simulated to receive a treatment to cover a tumor volume plus 1 cm on each side. The tumor is 3.5 cm wide and the depth of 4 cm. What will be the necessary field width at the skin surface, using a linear accelerator with the isocentric setup?

   a) 5.28 cm

   b) 6.31 cm

   c) 4.45 cm

   d) 6.67 cm

   e) 8.0 cm

3. What is the field size on a film if the collimator setting is 7×19 cm, and the magnification factor is $1.33\times$? Choose closest answer.

   a) 8×15 cm

   b) 10×10 cm

   c) 9×25 cm

   d) 11×25 cm

   e) 8.99×26 cm

4. A patient is treated with parallel opposed portal. The isocenter is in the midline. The fields are equally weighted. The total dose is 5760 cGy, and the daily dose per port is 90 cGy. How many daily treatments will the patient receive?

Bonus!

8 Speed of a raster system

A scanning magnet is positioned $d = 7$ m from the iso-centre of a therapy room. Its maximum field strength is $B = 0.38$ T, reached at a current of $I = 400$ A. Assume B and I to be proportional. The effective length of the magnetic field is $L = 1209$ mm. The power supply of this magnet is able to raise the current by $\mathrm{d}I/\mathrm{d}t = 40$ kA/s.

1. For a $^{12}C^{6+}$ beam of $E = 363$ MeV/u and a magnetic rigidity of $B\rho = 6$ Tm, what is the scan speed of the beam in the iso-centre?

2. For the same beam, if you assume a delay of $50\,\mu$s until the power supply reacts, what is the time to traverse a typical scan distance of 2 mm? What is the corresponding effective scan speed?

3. For the same parameters as in b), assume that you want to deliver a plan consisting of spots with 10^4 particles each. What is the maximum usable beam fluence if particles delivered between 2 spots should be limited to 5% of the nominal particle number? For all calculations, use linear approximations e.g. for small angles!

Hint: For all calculations, use linear approximations, e.g. for small angles!