BME 4400 Fall 2022

Assignment #4

Due: October 20, 2022 9:00 PM

specific activity

1. A cyclotron provides ^{18}F with specific activity of 90,000 mCi/µg. From this, [^{18}F]-FDG will be produced and shipped to nearby PET imaging facilities. If a 440 MBq dose is to be given to a patient 8 hr after ^{18}F production from the cyclotron, what mass of [^{18}F]-FDG will be injected?

coincidence detections 2 positrons

2. Look at the figure at the bottom of the page, and look up appropriate material characteristics for cortical bone and soft tissue from the NIST site (https://www.nist.gov/pml/x-ray-mass-attenuation-coefficients, tables 2 and 4; use values tabulated at the nearest energy value). A positron emitter (assume ^{18}F) has accumulated in the purple region and is producing an activity of 0.25 MBq along the horizontal path leading to the D+ and D- detectors. Compute the number of coincidence detections expected over a 2 min acquisition.

detector

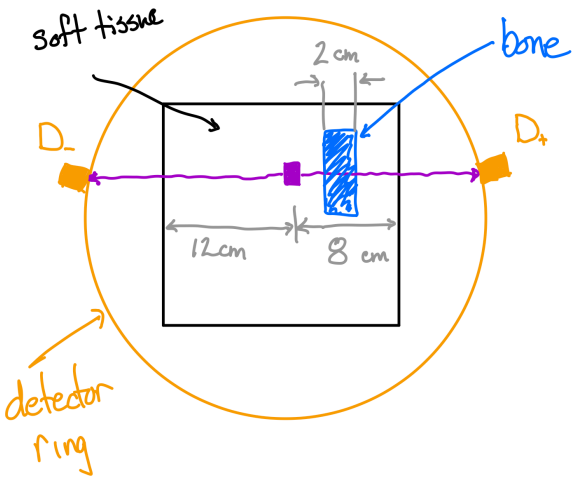
3. When imaging ^{99m}Tc with a NaI(Tl) scintillation screen with PMT array,
   a. what is a typical photon energy window used to accept detections?
   b. if a scintillation event results in a lower energy deposition that is below this window, why should you not count this event?
   c. if scintillation event results in a higher energy deposition that is above this window, why should you not count this event?

dose & adjacent

4. Compute the radiation dose to the liver for an injection of 100 MBq of ^{99m}Tc sulfur colloid. Assume that 60% of the activity is trapped in the liver, 30% is trapped in the spleen, and 10% in red bone marrow. Assume instantaneous uptake and no biological excretion.

resolution

5. In a ^{18}FDG abdominal scan made with a 90 cm diameter detector ring, how high a resolution are you likely to be able to get and why?



Gamma Emitters

Z	Nuclide	Half-life	Photon Energy (keV)
24	Chromium-51	28d	320
31	Gallium-67	79.2h	92, 184, 296
34	Selenium-75	120d	265
38	Strontium-87m	2.8h	388
43	Technetium-99m	6h	140
49	Indium-111	2.8d	173, 247
	Indium-113m	1.73h	393
53	Iodine-123	13.3h	159
	Iodine-125	60d	35, 27
	Iodine-131	8.04d	364
54	Xenon-133	5.3d	81
80	Mercury-197	2.7d	77
81	Thallium-201	73h	135, 167

Positron Emitters

Z	Nuclide	Half-life	Positron Energy (keV)
6	Carbon-11	20.3min	326
7	Nitrogen-13	10.0min	432
8	Oxygen-15	2.1min	696
9	Fluorine-18	110min	202
29	Copper-64	12.7h	656
31	Gallium-68	68min	1900
33	Arsenic-72	26h	3340
35	Bromine-76	16.1h	3600
37	Rubidium-82	1.3min	3150
53	Iodine-122	3.5min	3100

Source: Wolbarst, 1993.