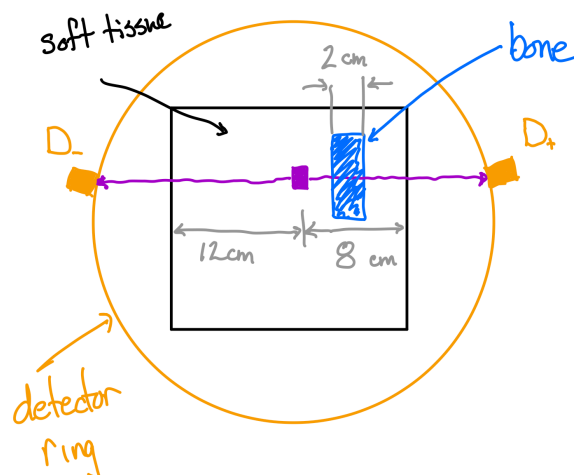


BME 4400 Fall 2022

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. 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 $^{99\text{m}}\text{Tc}$ 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 $^{99\text{m}}\text{Tc}$ 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}F 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.

hydrogen 1 H 1.0079																	helium 2 He 4.0026	
lithium 3 Li 6.941	beryllium 4 Be 9.0122																	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305																	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80	
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29	
cesium 55 Cs 132.91	barium 56 Ba 137.33	57-70	lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04		
francium 87 Fr [223]	radium 88 Ra [226]	89-102	actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	astatine 99 At [252]	tennessine 100 Ts [257]	meitnerium 101 Mt [258]	nobelium 102 No [259]		
		57-70		lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]	
		89-102		lawrencium 103 Lr [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	unnilium 110 Uun [271]	unnilium 111 Uuu [272]	ununium 112 Uub [277]	ununium 114 Uuq [289]				

* Lanthanide series

** Actinide series

lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
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