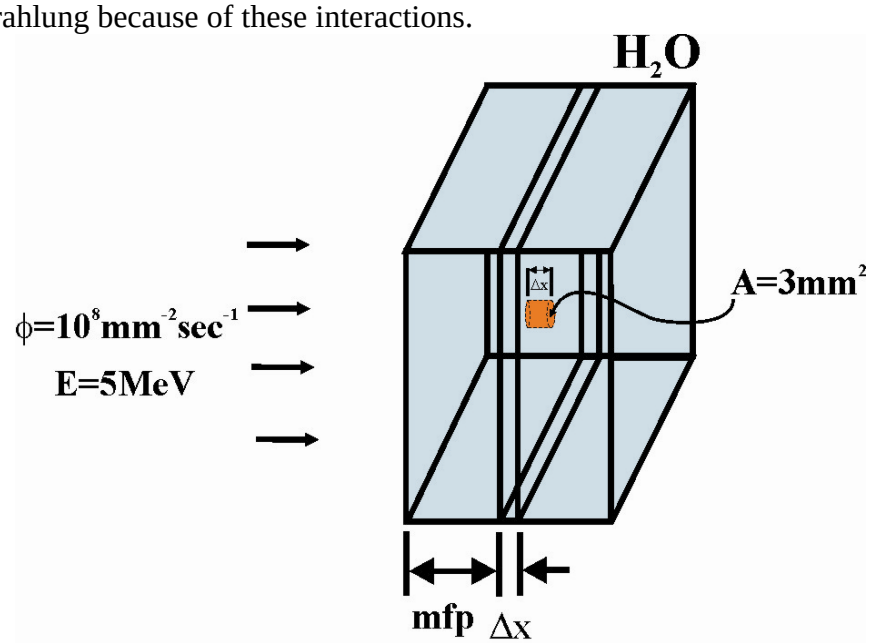
2. Consider a beam of monoenergetic photons incident on a slab of water as depicted below. The energy per photon is 5 MeV and the indicent photon fluence rate is $\phi = 10^8$ mm^{-2} sec^{-1}. At a depth of one mean free path (mfp) determine the rate of Compton interactions, photoelectric absorption interactions, coherent scatter interactions and pair production interactions in the pill box shaped volume (orange in figure below) of cross sectional area A=3 mm^2 and thickness Δx=1cm. Estimate the power (watts) that is generated as bremsstrahlung because of these interactions.



3. A ^{60}Co radiation therapy unit is equipped with a 1000 Ci source. The source to skin distance is 100 cm. Estimate how many photons per second are incident on a 1 mm x 1 mm area of the skin of a patient. Neglect air attenuation.

4. A fission reactor accident evaporates 5 x 10^6 Ci of ^{90}Sr ($T_{1/2}$ = 27.7 yr) into the air. The ^{90}Sr falls out uniformly over an area of 10^4 km^2. How long will it take the activity of the ^{90}Sr to reach the agriculturally "safe" level of 2 μCi/m^2?

5. Calculate the energy of the Compton scattered photon at $\theta=90^o$ for incident photons of energies 100 keV and 5 MeV.

7. A sample of a radioactive isotope is found to have an activity of 115 Bq immediately after it is pulled from the reactor that formed it. Its activity 2 hours and 15 min later is measured to be 85.2 Bq. (a) Calculate the decay constant and the half-life of the sample. (b) How many radioactive nuclei were there in the sample initially?

Supplementary Material

WATER	Density kg/m^3	# of atoms /kg	Av. Atomic wt. (amu)	Av. Atomic Z	# of elect per kg
	9.9820E-01	1.0028E+26	6.0053E+00	3.3333E+00	3.3426E+26

Energy	σ (x 10^{-28} m^2/atom)				μ / ρ	μ_{tr} /ρ	μ_{ab} /ρ	average E_{tr}	average E_{ab}
(MeV)	Coherent	Incoherent	Phot. Elec.	Pair Prod.	(cm^2/g)	(cm^2/g)	(cm^2/g)	(MeV)	(MeV)
5.000E+00	2.254E-05	2.769E-01	2.588E-06	2.550E-02	3.033E-02	1.947E-02	1.921E-02	3.210E+00	3.168E+00

Reference: E. F. Plechaty, D. E. Cullen, and R. J. Howerton, "Tables and graphs of photon interaction cross sections from 1.0 keV to 100 MeV derived from the LLL evaluated nuclear data library," UCRL-50400, Lawrence Livermore Laboratory **6**, Revision 1 (1975)

Rest mass energy of an electron = 0.511 MeV
1 Ci = 3.7 ×10^{10} Bq
1 eV = 1.602 ×10^{-19} J
1 watt = 1 J/sec
1 amu = 931.5 MeV/c^2

Z	A	Mass (u)	Abundance	Mode
Neutron (n)				
0	1	1.008665	10.4 m	β^-
Hydrogen (H)				
1	1	1.007825	99.985%	
1	2	2.014102	0.015%	
1	3	3.016049	12.33 y	β^-
Helium (He)				
2	3	3.016029	0.000137%	
2	4	4.002603	99.999863%	
2	5	5.012220	0.60 MeV	α, n
2	6	6.018888	806.7 ms	β^-
2	7	7.028030	160 keV	n
2	8	8.033922	119.0 ms	β^-, $\beta^- n$