

1 a) $N = 16\phi_0 \times 10^{-12} \frac{\text{Coul}}{\text{pulse}} / 1.602 \times 10^{-19} \frac{\text{Coul}}{\text{proton}} = 1.0\phi\phi \times 10^{+9}$

b) Int. Power = $23\phi \frac{\text{MeV}}{\text{proton}} \times \phi.16\phi \text{ nC} \times 10^{-3} \frac{\mu\text{C}}{\text{nC}} / 2\phi \times 10^{-6} \text{ s}$
 $= 1.84 \times 10^9 \text{ W} \quad (\text{MeV} \times \mu\text{C} / \text{s}) = (\text{MeV} \times \mu\text{A}) = \text{W}$

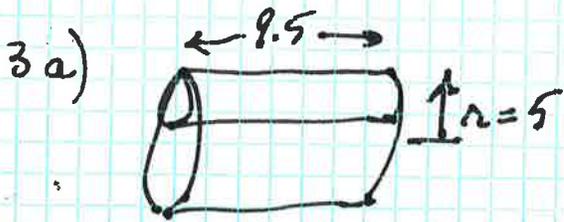
c) $\text{Gray} = \frac{\text{Joule}}{\text{kg}} = 4 \frac{\mu\text{A}}{\text{s cm}^3} \times 2\phi \times 10^{-6} \text{ s} \times \frac{1 \text{ cm}^3}{1 \text{ g water}} \times \frac{10^3 \text{ g}}{\text{kg}}$
 $= 8 \times 10^{-2} \text{ Gray}$

Other approach gives different value.
 $\text{Gray} = \frac{E}{\text{kg}} = 23\phi \frac{\text{MeV}}{\text{proton}} \times 10^9 \frac{\text{proton}}{\text{pulse}} \times \frac{1}{\phi.0\phi1 \text{ kg}} = 2.3 \times 10^9 \frac{\text{eV}}{\text{kg}} \times 1.6 \times 10^{-19} \frac{\text{J}}{\text{eV}} = 37 \text{ Gray}$

2 a) $\text{Photons/MeV} = 87.0\phi\phi \quad E_\gamma = 0.662 \text{ MeV} \rightarrow N_{\text{photons}} = 5.76 \times 10^4$

$R = 2.355 \sigma = 2.355 \sqrt{\frac{1}{N_{\text{photon}}}} = 9.81 \times 10^{-3} \approx 1\%$
 $\rightarrow \text{NO!}$

b) The ~~one~~ decay time for $\text{Ba}_{135}\text{Cs}_{137}$ is very long and probably would not be acceptable ↗ IB-2571



1φ

Table

$$V_{\text{cyl}} = \pi (5)^2 \times 9.5 \text{ mm}^3$$

$$V_{\text{cyl}} = 746. \text{ mm}^3 = 0.746 \text{ cm}^3$$

$$\text{mass} = \rho \times V = 1.032 \text{ g} \times 0.746 \text{ cm}^3$$

$$\text{mass} = 0.77 \text{ g} \quad \frac{\text{cm}^3}{\text{cm}^3}$$

$$\text{Want } 10^{12} \frac{\text{MeV}}{\text{g}} = N \times 10^6 \frac{\text{MeV}}{\text{A}} \times 4\phi / 0.77 \text{ g}$$

$$\frac{0.77 \times 10^{12}}{4\phi\phi\phi} = N$$

$$1.92 \times 10^8 = N$$

b) No, the beam would deliver the energy according to the dE/dx function and have a peak near the end of the range - Bragg Curve -

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4 a)

$$R_{\text{TRUE}} = R_{\text{OBS}} / (1 - R_{\text{OBS}} \epsilon) = \frac{3 \times 10^4 / \Delta}{1 - 3 \times 10^4 / \rho \times 10^6 / \Delta}$$

$$= \frac{3 \times 10^4}{1 - 0.3}$$

$$= 4.3 \times 10^4 / \Delta$$

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$$4 b) \quad A = A_{TRUE} \times W(\theta, \phi) \times \epsilon_{INT} \times \epsilon_{GEO} \times BR$$

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(Note we already calculated the effect of dead time on the ϵ_{ELEC}).

$$W(\theta, \phi) = 1 \quad [\text{one } \delta \text{ ray}]$$

$$\text{Branching Ratio} = 0.1044 \quad [\text{from Figure}]$$

$$\epsilon_{INT} = 0.5 \quad [\text{given}]$$

$$\epsilon_{GEO} \approx \frac{\pi(5/2)^2}{4\pi(1\phi)^2} = 1.56 \times 1\phi^{-2}$$

$$A_{TRUE} = \frac{A}{\epsilon_{INT} \epsilon_{GEO} BR} = \frac{4.3 \times 1\phi^4 / s}{0.5 (1.56 \times 1\phi^{-2}) 0.1044} = 5.3 \times 1\phi^7 / s$$

$$= 5.3 \times 1\phi^7 / s \Rightarrow Bq$$

5a) Radiation damage of fill gas by heavy charged particles

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b) neutrons do not scatter effectively in crystals with heavy nuclei compared to organics with hydrogen atoms

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c) positive (heavy) molecular ions do not gain enough energy in one MFP to create ions with attainable electric fields

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d) Pirani gauges work by heat conduction ^{by the gas} from a wire and at low pressure thermal radiation dominates the heat transfer compared to gas-cooling

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e) the oil will be sucked up into the chamber because these pumps are "open" to ATM pressure on the exit side

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