(16.6) In a linear accelerator for protons the first drift tube is 1 cm long and the accelerating potential is 25 kV. (a) Since the speed of light is not approached in the first drift tube, how long should the second and third drift tubes be? (b) What should the full-wave frequency of acceleration be?

Firs definitions of units etc.

$c_{light} := 299792458 \cdot m \cdot sec^{-1}$ $\quad q_e := 1.66021773 \cdot 10^{-19} \cdot coul$ $\quad m_{0p} := 1.672623 \cdot 10^{-27} \cdot kg$

$MeV := 1.66021773 \cdot 10^{-13} \cdot joule$

Then use eqn. (16.1) to compute the proton energy.

$z := 1$ $\quad V_{acc} := 25 \cdot KV$

$E_{p1} := 1 \cdot z \cdot q_e \cdot V_{acc}$ $\quad E_{p1} = 4.151 \cdot 10^{-15} \cdot kg \cdot m^2 \cdot sec^{-2}$ $\quad E_{p1} = 0.025 \cdot MeV$

Because this energy is low, we can negelect relativistic effects when computing the velocity from the kinetic energy.

$v_{p1} := \sqrt{2 \cdot \frac{E_{p1}}{m_{0p}}}$ $\quad v_{p1} = 2.228 \cdot 10^{6} \cdot m \cdot sec^{-1}$ $\quad \frac{v_{p1}}{c_{light}} = 0.007$

$l_1 := 1 \cdot cm$ $\quad t_1 := \frac{l_1}{v_{p1}}$ $\quad t_1 = 4.489 \cdot 10^{-9} \cdot sec$

$f_{acc} := \frac{\frac{1}{2}}{t_1}$ $\quad f_{acc} = 111.388 \cdot MHz$ $\quad \lambda := \frac{c_{light}}{f_{acc}}$ $\quad \lambda = 2.691 \cdot m$

Use eqns. (16.6) and (16.7) for the first three stages.

$n := 1 .. 3$

$k := q_e \cdot \frac{z \cdot V_{acc}}{m_{0p} \cdot c_{light}^{2}}$ $\quad L_n := \frac{\lambda}{2} \cdot \sqrt{1 - (n \cdot k + 1)^{-2}}$

n	L_n
1	0.0100·m
2	0.0141·m
3	0.0173·m