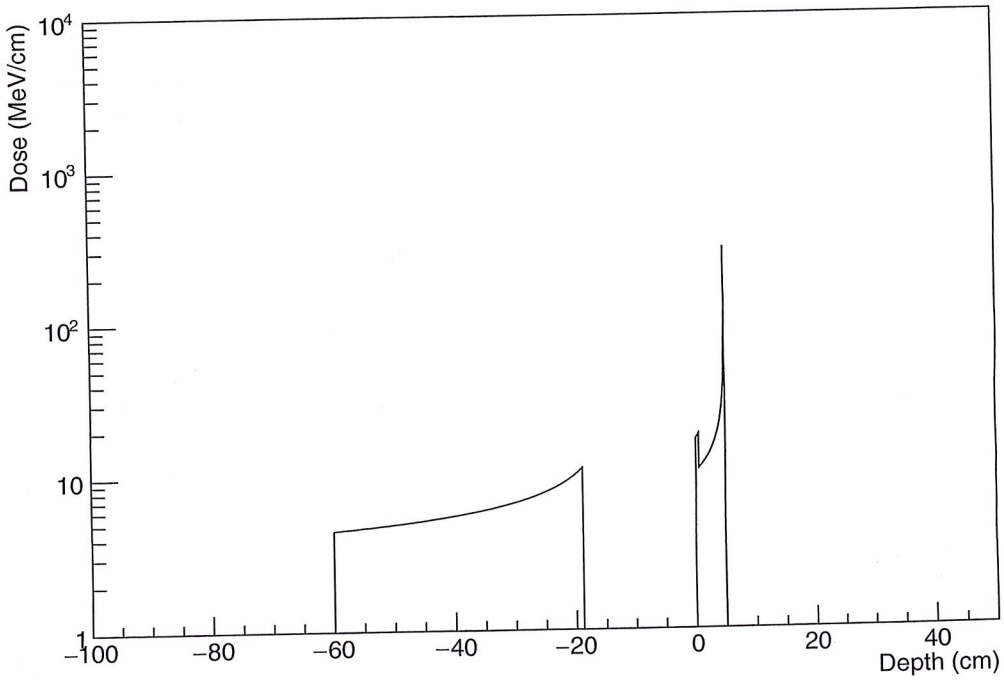
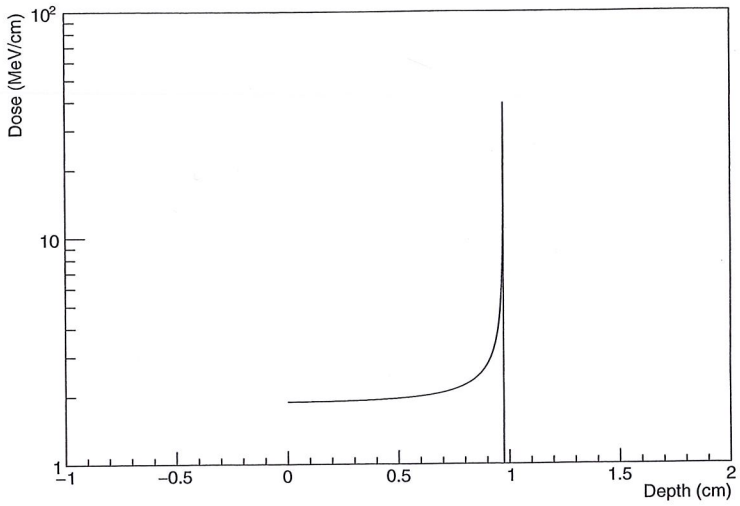
Phys 564 Assignment #4

1. The acrylic layer degrades the energy of the proton beam. The thickness is tuned so that the protons stop at exactly a depth of 5 cm. This thickness is approximately 41.15 cm.

This plot shows the dose as a function of depth through the material where it can be seen that the maximal dose is at the depth of 5 cm.



2. (a) The dEdX.C program was modified by changing the mass of the beam particle to 0.5M MeV and the initial kinetic energy to 2.137 MeV. The maximum depth in water was then found to be 0.975 cm.



(b) The number of photons emitted per unit path length per unit wavelength is

$$\frac{dN}{dx\,d\lambda} = \frac{2\pi\alpha}{\lambda^2}\left(1 - \frac{1}{\beta^2 n^2}\right).$$

For a given β, the number of photons emitted with $\lambda_{min} < \lambda < \lambda_{max}$ is

$$\frac{dN}{dx} = \int_{\lambda_{min}}^{\lambda_{max}} \frac{dN}{dx\,d\lambda}\,d\lambda = -\frac{2\pi\alpha}{\lambda}\left(1 - \frac{1}{\beta^2 n^2}\right)\Bigg|_{\lambda_{min}}^{\lambda_{max}}$$

$$= 2\pi\alpha\left(1 - \frac{1}{\beta^2 n^2}\right)\left(\frac{1}{\lambda_{min}} - \frac{1}{\lambda_{max}}\right)$$

However β is a function of depth because the electron slows down as it loses energy.

Numerical integration gives $N = 185$.

The numerical integration shows how the electron slows down as it moves through the water and as a consequence, dN/dx decreases.