54. (a) The strategy is to find the γ factor from $E = 14.24 \times 10^{-9}$ J and $m_p c^2 = 1.5033 \times 10^{-10}$ J and from that find the contracted length. From the energy relation (Eq. 38-45), we obtain

$$\gamma = \frac{E}{mc^2} = 94.73 \ .$$

Consequently, Eq. 38-13 yields

$$L = \frac{L_0}{\gamma} = 0.222\,\text{cm} = 2.22 \times 10^{-3}\ \text{m} \ .$$

(b) and (c) From the γ factor, we find the speed:

$$v = c\sqrt{1 - \left(\frac{1}{\gamma}\right)^2} = 0.99994c \ .$$

Therefore, the trip (according to the proton) took $\Delta t_0 = 2.22 \times 10^{-3}/0.99994c = 7.40 \times 10^{-12}$ s. Finally, the time dilation formula (Eq. 38-7) leads to

$$\Delta t = \gamma \Delta t_0 = 7.01 \times 10^{-10}\ \text{s}$$

which can be checked using $\Delta t = L_0/v$ in our frame of reference.