41. (a) We use the relativistic relationship between speed and momentum:

$$p = \gamma m v = \frac{mv}{\sqrt{1-(v/c)^2}} \ ,$$

which we solve for the speed v:

$$\frac{v}{c} = \sqrt{1 - \frac{1}{\left(\frac{pc}{mc^2}\right)^2 + 1}} \ .$$

For an antiproton $mc^2 = 938.3\,\text{MeV}$ and $pc = 1.19\,\text{GeV} = 1190\,\text{MeV}$, so

$$v = c\sqrt{1 - \frac{1}{(1190\,\text{MeV}/938.3\,\text{MeV})^2 + 1}} = 0.785c \ .$$

For the negative pion $mc^2 = 193.6\,\text{MeV}$, and pc is the same. Therefore,

$$v = c\sqrt{1 - \frac{1}{(1190\,\text{MeV}/193.6\,\text{MeV})^2 + 1}} = 0.993c \ .$$

(b) See part (a).

(c) Since the speed of the antiprotons is about $0.78c$ but not over $0.79c$, an antiproton will trigger C1.

(d) Since the speed of the negative pions exceeds $0.79c$, a negative pion will trigger C2.

(e) and (f) We use $\Delta t = d/v$, where $d = 12\,\text{m}$. For an antiproton

$$\Delta t = \frac{12\,\text{m}}{0.785(2.998\times 10^8\,\text{m/s})} = 5.1\times 10^{-8}\,\text{s} = 51 \text{ ns} \ ,$$

and for a negative pion

$$\Delta t = \frac{12\,\text{m}}{0.993(2.998\times 10^8\,\text{m/s})} = 4.0\times 10^{-8}\,\text{s} = 40 \text{ ns} \ .$$