SRT

1) $t' = t \cdot \gamma = 2{,}603 \cdot 10^{-8}\,s \cdot \frac{1}{\sqrt{1 - 0{,}99938^2}} = 2{,}341 \cdot 10^{-7}\,m/s$

2) $t = 2{,}19703\ ms$

a) $\frac{t'}{t} = \gamma = \frac{1}{\sqrt{1-\left(\frac{v}{c}\right)^2}}$ $\qquad \left(\frac{v}{c}\right)^2 = 1 - \left(\frac{t}{t'}\right)^2$

$\rightarrow \quad v = c\sqrt{1-\left(\frac{t}{t'}\right)^2} = 3 \cdot 10^8\,\frac{m}{s}\sqrt{1-\left(\frac{1}{5{,}3}\right)^2} = 2{,}946 \cdot 10^8\,\frac{m}{s}$

b) $\Delta s = v \cdot t' = v \cdot t \cdot \frac{1}{\sqrt{1-\left(\frac{v}{c}\right)^2}} = \frac{0{,}99973\,c \cdot 2{,}19703 \cdot 10^{-6}\,s}{\sqrt{1-(0{,}99973)^2}} = 28{,}357\ km$

[mit $2{,}19703\ ms \longrightarrow 28{,}357 \cdot 10^6\ m$]

3) $l' = l/\gamma = l \cdot \sqrt{1-\left(\frac{v}{c}\right)^2}$

$\Rightarrow \quad l - l' = \Delta l = l\left(1 - \sqrt{1-\left(\frac{v}{c}\right)^2}\right) = l\left(1 - \left(1-\left(\frac{v}{c}\right)^2\right)^{1/2}\right) \cong$

$\simeq l\left(1 - \left[1 - \frac{1}{2}\left(\frac{v}{c}\right)^2\right]\right) = \frac{l v^2}{2c^2} = \frac{6{,}7\,km \cdot (290/3{,}6\ m/s)^2}{2 \cdot (3 \cdot 10^8\ m/s)^2} = 0{,}24\ nm$

mit $(1-x)^\alpha \sim 1 - \alpha x$ für $x \ll 1$ (Taylorentwicklung)

$\left(1-\left(\frac{v}{c}\right)^2\right)^{1/2} \sim 1 - \frac{1}{2}\left(\frac{v}{c}\right)^2$

4) weglassen da 6 GeV relativistisch in v umgeformt werden müssen $\rightarrow$ noch nicht gemacht.

5) $t' = t \cdot \gamma = \frac{t}{\sqrt{1-\left(\frac{v}{c}\right)^2}} \cong \frac{t}{1-\frac{1}{2}\left(\frac{v}{c}\right)^2} = \frac{24\,h}{1 - \frac{1}{2}\cdot\left(\frac{300\ m/s}{3{,}6\,c}\right)^2}$

$\Delta t = 24 \cdot 3600\,s\left(\frac{1}{1-\frac{1}{2}\left(\frac{300\ m/s}{3{,}6 \cdot c}\right)^2} - 1\right) = \underline{\underline{3{,}3\ ns}}$ länger

6) a) $l_A = l_B \sqrt{1-\left(\frac{v}{c}\right)^2} = 300m \sqrt{1-0{,}6^2} = 240m$

b) $t_B = \frac{2D}{c} = \frac{2 \cdot 300m}{3 \cdot 10^8 m/s} = 2{,}0\ \mu s$

$t_A = \frac{t_A}{\sqrt{1-\left(\frac{v}{c}\right)^2}} = \frac{2D}{c\sqrt{1-(0{,}6)^2}} = \frac{2 \cdot 300\,m}{3 \cdot 10^8 m/s \sqrt{1-0{,}36}} = 2{,}5\ \mu s$

c) optischer Dopplereffekt: $t_A = t_B \sqrt{\frac{1-v/c}{1+v/c}} = 2\mu s \cdot 0{,}5 = 1\ \mu s$

d) Reflexion ist immer in der Mitte:

Für B: $\frac{2{,}0\mu s}{2} = 1\mu s$

A: $\frac{1\mu s}{2} = 0{,}5\ \mu s$

7) Addition: $u = u' \oplus v = \frac{u'+v}{1+\frac{u'v}{c^2}} = \frac{0{,}9c + 0{,}9c}{1+\frac{0{,}9c \cdot 0{,}9c}{c^2}} = 0{,}9945c$