1. If $v = 0.95c$, the Lorentz factor is

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$= \frac{1}{\sqrt{1 - (0.95)^2}}$$

$$= 3.2$$

So, the rest-frame lifetime is $t = 2.6 \times 10^8$ s, and we must measure a decay time $t'$

$$t' = \gamma t = 3.2 \times 2.6 \times 10^{-8} s = 8.3 \times 10^{-8} s$$

$$\therefore t' = 8.3 \times 10^{-8} s$$

2. From above, cloth at bottom of tower runs more slowly by a factor $(1 + gh/c^2)$. So, when cloths are compared, the time difference will be

$$\Delta t = t (1 + gh/c^2) - t$$

$$= tgh/c^2$$

$$= \left(10 \times 365.25 \times 24 \times 60 \times 60 \right) \times \left(\frac{9.8 \times 541}{3 \times 10^3}\right) s$$

$$= 1.86 \times 10^{-5} s$$

$$\therefore$$ cloth on ground will have lost time (ie run slowly) by an amount $1.86 \times 10^{-5} s$ (18.6 μs)
3) The strong equivalence principle says that no experiment can differentiate between being in a free-falling frame (in absence of gravity) or an inertial frame very far from any gravitational object.

Suppose you are free floating in deep space. Clearly, if you have two objects at rest close by, they will stay at rest. By the S.E.P., this is equivalent to you and the objects being in a free-falling frame. So, for these pictures to correspond, you and both objects must accelerate/freefall at same rate irrespective of composition or mass.

4) Balloon moves forwards. By the S.E.P., the accelerating car is equivalent to a stationary car tipped up...

[Diagram showing a car with a balloon floating up and the driver being pulled back into the seat]
5) Event A: Back of car enters garage
   Event B: Front of car reaches front of garage &
             breaks are applied.

Think about these events in two frames:

(i) Frame of reference of house:
    garage normal size
    car contracted

B occurs before A

(ii) Frame of reference of car:
    garage contracted
    car normal size

A occurs before B.

So, order of A or B can be flipped
   \[ \Rightarrow \text{A or B can never be causally connected} \]

The "brake" signal would need to transmit through
the car faster than the speed of light.