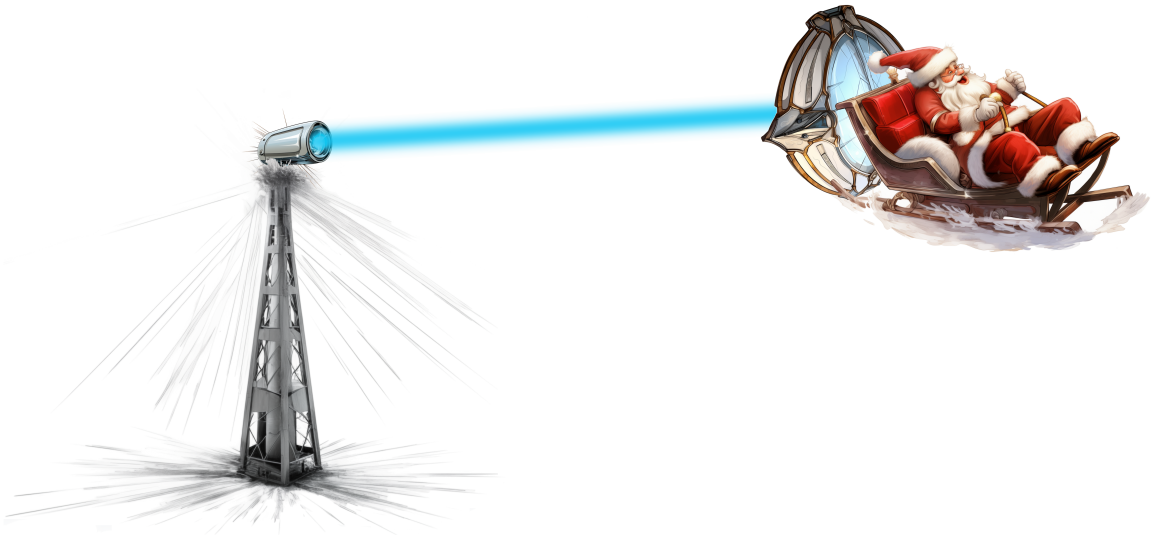
New Santa's Sleigh

Enigma n°7

14th December 2023

Santa's magical reindeer are getting old. In order to have no disruption in the distribution of presents when the reindeer can no longer fly, Santa is testing a new model of sleigh from the future: a laser-powered sleigh.

The concept is simple: Santa Clause needs to ask the elves to construct towers at regular intervals. They will take it in turns to propel the sleigh via ultra-powerful lasers. To prevent the sled from disintegrating, it is fitted with a shield at the rear.



Santa Clause trying his new high-tech sleigh.

If D id the distance between the sleigh and the tower, the energy transmitted by the tower is proportional to $1/D$ (due to interaction of the laser with the atmosphere). The velocity V of the sleigh is proportional to the energy it receives from the tower (1). Despite the shield, being to close to the tower is dangerous (2). The sleigh is launched via a big spring canon, configured so that the sleigh arrives at flying altitude at the beginning of the safe range of the first tower (3). There is a minimum speed, below that speed, the sleigh cannot fly properly (4).

1. We have $V = \frac{\beta}{D}$[1], with $\beta = 2\,000\,000\text{s}^{-1}$.
2. The sleigh must be at least 8km away from the tower (when receiving energy from the tower).
3. The canon is configured so that the sleigh arrives with a speed of 900km/h (250m/s) at 8km from the first tower (at $t = 0$s).
4. The sleigh can not fly at a speed below 144km/h (40m/s).

What is the maximal possible distance (in meters) between two towers?

[1] With V in m/s and D in m (meters).