

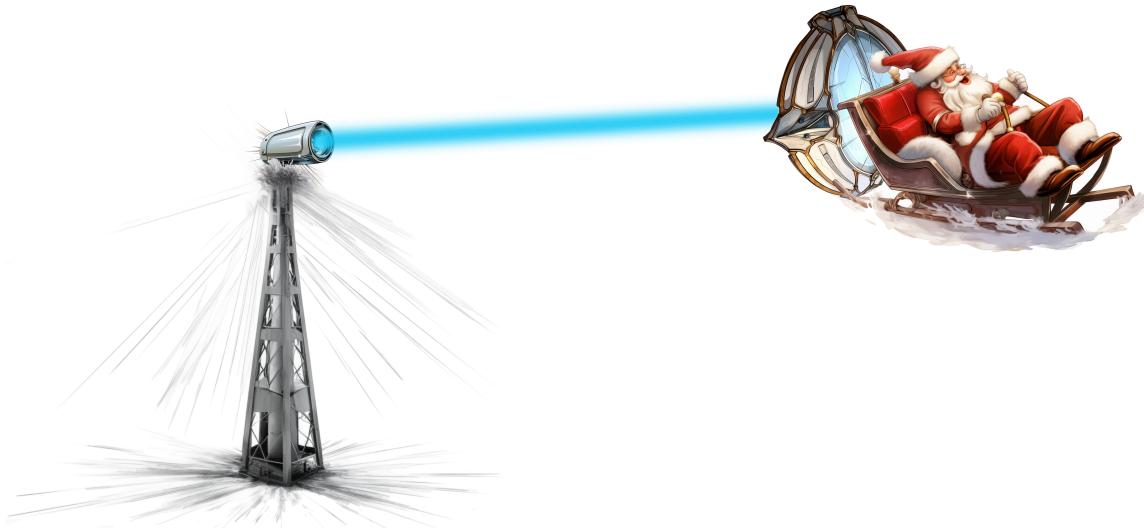
# New Santa's Sleigh

Enigma n°7

14<sup>th</sup> 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  $D$  is 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 too 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  $V = \frac{\beta}{D}$ , with  $\beta = 4\ 000\ 000\text{s}^{-1}$ .
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  $t = 0\text{s}$ ).
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?**

---

<sup>1</sup>With  $V$  in m/s and  $D$  in m (meters).