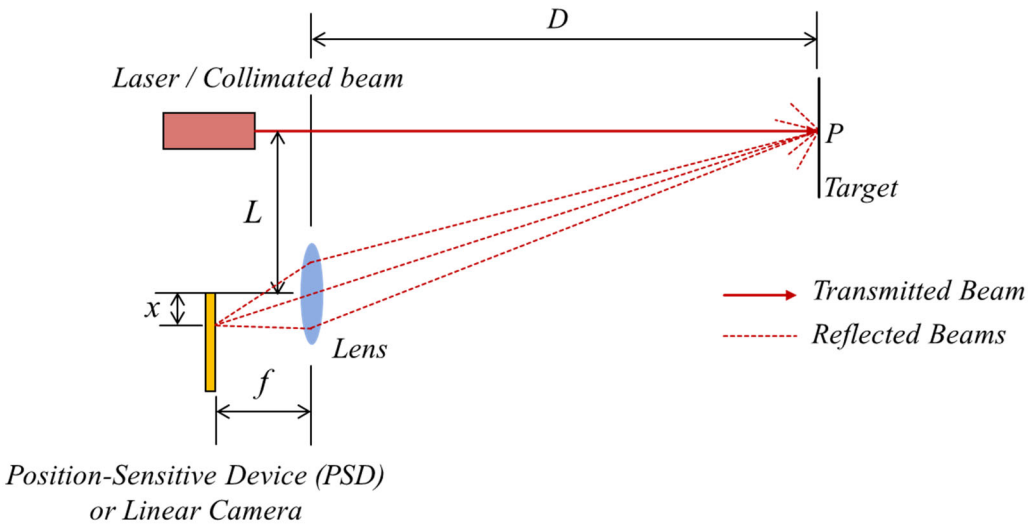
Exercise 3 – Triangulation Sensor



Imagine the laser triangulation sensor sketched above. A laser beam is pointed against the target and diffusely reflected through the Lens on the Position Sensitive Device (PSD).

Q1: Measurement model

a) Please find the measurement equation $D = g(x, L, f)$, using the focal length f, the distance between the laser beam and the center of the lens L and the measured value x.
b) Sketch this relation in a diagram with D on the horizontal and x on the vertical axis.
c) What does this equation tell you about the measurement quality (resolution, noisiness, …) for targets that are far away?

Q2: Measurement Model considering uncertainties

Assume that the measurement x is error prone and can be described by a Gaussian with the mean μ_x and standard deviation σ_x.

a) Calculate the standard deviation σ_D of the measured distance D as a function of σ_x
b) Sketch σ_D against the measured distance D with D on the horizontal and σ_D on the vertical axis.
c) What does this equation tell you about the uncertainty for targets that are far away?

Hint: *Recall that for normal distributions, we can use the error propagation law* $C_Y = H_X C_X H_X^T$ *where* Y *is the output (distance D).*