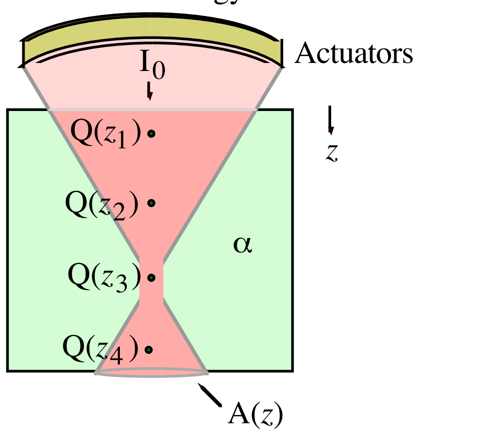
Ex: An ultrasound beam of intensity I_0 is created by actuators arranged in a crescent, as shown in the figure below. The beam travels through an object (shown in green) that absorbs the beam energy as it travels in the z direction.



The following equation, derived from physics, describes the intensity that sensors measure as a function of distance, z, into the medium.

$$Q(z) = I_0 \frac{\alpha e^{-2\alpha z}}{A(z)}$$

where

$z \equiv$ distance into object

$I_0 \equiv$ initial beam intensity

$Q(z) \equiv$ measured intensity at z

$A(z) \equiv$ beam area at z

$\alpha \equiv$ coefficient of absorption for object

The optimization problem is to derive a value for α from measured values of intensity, $Q(z_1)$, $Q(z_2)$, $Q(z_3)$, and $Q(z_4)$, versus distance z into the object. The beam area versus distance, z, is known from geometry (plus an approximation at z_3 where the beam is focused but must have an effective area greater than zero):

$$z_1 = 1, \quad z_2 = 2, \quad z_3 = 3, \quad z_4 = 4$$

$$A(z_1) = 8, \quad A(z_2) = 2, \quad A(z_3) = 1, \quad A(z_4) = 2$$

One approach is to find the α that minimizes the following squared error function:

$$E = \sum_{i=1}^{4} [Q(z_i) - Q(z)]^2$$