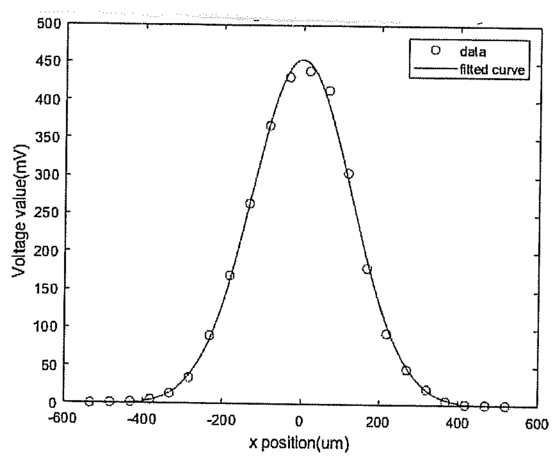
EC591 Lab 4 Report Notes

4.1 A) A representative plot of measured signal versus lateral position (after background subtraction) is shown in the figure below. The circles show the measured data and the solid line is a fit to a Gaussian curve. From the fit you can determine $W(z_1)$ (the half width at $1/e^2$ maximum of the peak).



The larger pinhole (100-μm diameter) allows for more light to be transmitted and therefore results in a larger signal-to-noise ratio for the measured data. The pinhole diameter limits the measurement spatial resolution. Therefore, the smaller pinhole (25-μm diameter) allows for higher resolution. However, since the full width of all measured peaks is larger than a few 100 μm, using the larger pinhole is appropriate for these measurements.

4.1 B | $W(z_2)$ is the half width at $1/e^2$ maximum of the intensity profile measured at $z_2 = z_1 + 400$ mm

4.1 C | From the lecture notes: $\begin{cases} W(z) = W_0 \sqrt{1 + \left(\frac{z}{z_0}\right)^2} \\ W_0 = \sqrt{\frac{\lambda z_0}{\pi}} \end{cases}$ where z is measured from the beam waist

$$\Rightarrow \begin{cases} W(z_1) = \sqrt{\frac{\lambda z_0}{\pi}} \sqrt{1 + \left(\frac{z_1}{z_0}\right)^2} \\ W(z_2) = \sqrt{\frac{\lambda z_0}{\pi}} \sqrt{1 + \left(\frac{z_1 + d}{z_0}\right)^2} \end{cases}$$

: two equations in two unknowns (z_1 and z_0)

with $\lambda = 632.8$ nm, $d = 400$mm

After solving this system of equations for z_0 and z_1, you can calculate $z_2 = z_1 + d$, $W_0 = \sqrt{\frac{\lambda z_0}{\pi}}$, $\theta_0 = \frac{W_0}{z_0}$

The solutions for W_0 and θ_0 should be close to the specified values of 0.4 mm and 0.0005 rad, respectively (although the exact values are different for different lasers in the lab).

The Rayleigh range z_0 should be on the order of several 100 mm.

The solution for z_1 should be such that the waist of the Gaussian beam is somewhere near the center of the laser cavity.

4.1 D

The beam radius at the focal point W_0 can be computed from:

$$W(z_2) = W_0 \sqrt{1 + z_2^2 \left(\frac{\lambda}{\pi W_0^2}\right)^2}$$

the solution for W_0 should be smaller than in 4.1C

$W(z_2)$: half width at $1/e^2$ maximum of intensity profile measured at z_2

z_2: distance from the focal point, which can be assumed to occur at the beam waist

4.2

The angle of the shear plate α is related to the fringe spacing d as follows: $d = \dfrac{\lambda}{2n\alpha}$, where $n \approx 1.5$ is the refractive index of the plate.

Typical wedge angles for the shear plates in the lab are on the order of a few 10 arcsec ($\sim 10^{-4}$ rad), producing fringe spacings of a few mm