PHGN 480 Laser Physics Lab 5: imaging

Do this by the end of the day Monday, 10 October. Turn in your write-up in class on Tuesday, 1 Oct.

This is a lab to give you experience in using lenses for imaging.

The goals of this lab are to:

Use the laser beam to ensure that lenses are centered along an optical axis. Make an image of an iris to a CCD camera two ways: with a single lens and with a 2-lens relay imaging setup. Explore the stability of the relay imaging to pointing fluctuations.
Use the imaging setup to measure the diameter of the HeNe discharge column.

1. Alignment of the imaging system:

Use two mirrors and two irises to get a beam from a laser level to the table and straight along one of the rows of holes. Place the first iris close to the second mirror.

a. Single lens image

Pick a single lens to make an image of the first iris. Close the iris on the beam a little to trim the edges, then use a card to locate the plane where the image plane is.

Place a CCD camera with the darker attenuating filter near the image plane.

- Ensure that the CCD is not saturated (you can turn the exposure time and other camera settings to limit the camera's sensitivity, or add another filter).
- Either by adjusting the iris size or the magnification of your image, be sure the illuminated circle of light fits on the sensor. Move the camera along the optical axis to see what the image looks like in and out of focus. *Describe what you see, especially near the edge of the iris hole.*
- Use calipers to measure the iris size and use the geometric magnification to determine the pixel size.

Make a sketch of your single lens setup, noting focal length and the iris-lens-camera distances and the magnification.

Open the iris: even without the iris in place, we are still making an image of the beam itself as it appears at the plane of the iris. Follow the beam on a card from the lens to the camera and *describe what the beam does along the way*.

b. Image relay with 2 lenses.

Pick two positive lenses with focal lengths f1 and f2. Set up an imaging system with spacing: f1 from iris to L1, f1+f2 to L2, f2 to image plane. What should the magnification be in this setup? *Make a sketch of your two lens setup, noting the focal lengths, distances and magnification.*

Place the CCD at the image plane. Again, measure the iris size and determine the image scale (mm at the iris to pixels on the camera). Use the calculated magnification to cross-check your pixel size measurement.

Open the iris – you are again making an image of the iris plane, but the behavior of the beam along the way to the camera is different. *Describe how the beam size varies through the system. Can you explain why this 4f arrangement is called an image relay?*

Try adjusting the pointing of the beam with the mirror next to the iris. You should see very little movement of the beam on the camera. *Why is this the case?*

2. Imaging the HeNe discharge.

Remove the iris and the mirror next to it. Place one of the HeNe tubes so that the end of the discharge column is near where the iris was. Turn the tube discharge on and see if you can make an image of the end of the discharge tube. Using your calibration from the previous part, *measure the diameter of the discharge*, so that later we can optimize the laser cavity mode size for optimum power.