PHGN 480 Laser Physics
Lab 3: HeNe gain measurement

Do this by the end of the day Monday, 26 September. Turn in your write-up in class on Tuesday, 27 Sept.

For this lab, you will begin the alignment process for building your HeNe laser. There are 5 laser tubes, and you should work in teams of 3 (there may be one or two teams of 2). Each team will work with a different tube, and you'll use the same tube in Lab 4 to get it lasing.

The goals of this lab are to:
1. align the laser tube so that it is level to the table
2. set up a system to measure the double-pass gain at three different wavelengths.

The first step can be done in parallel with multiple groups working at the same time. The second step requires the use of a couple of HeNe laser that we have that run on different wavelengths, and we only have one of each of those.

1. Alignment of the HeNe laser tubes:

Everything in a laser cavity must be centered along a line. Our HeNe tubes are mounted for safety in a polycarbonate tube, which holds the laser tube with two pairs of three nylon screws. These screws will need to be adjusted to level the laser tubes.

Construction of the laser tube on the rail: Attach the post holders for the laser tubes to one of the extruded aluminum bars. If you are using a laser tube with a mirror bonded to one end, you can mount the laser tube at the far end of the rail. If you are using a tube with two Brewster windows, you will need to leave room at one end for a mirror mount. For this type of tube, you need to mount a flat high reflector (a small dielectric mirror) in a mirror mount on a post. Use a level to get the polycarbonate tube level to the table.

Set up the reference laser beam: Use the good HeNe laser (long black round tube), a pair of mirrors, and a pair of irises to get the final beam level to the table and straight to the table holes, as you did in the first lab.

- To get the right height, you can set an iris to be visually at the same height at the laser tube, or measure with a ruler. Later, you can adjust the tube to this height.
- For the lateral position, make sure that when you clamp the laser rail to the table, the beam will run close to the center of the tube.
- Install a lens in the beam so that it is centered on the beam. It may be helpful to use a third iris. Choose a moderate focal length ~300-500mm so that the focal point is somewhere over the table. Use the knife-edge technique to find the focal point of the lens.

Align the tube to the laser beam: Slide the laser tube into the beam so that it goes straight down the bore of the laser. This will take some iteration since the adjustments are not very easy. Clamp the laser rail to the table so that the rail is straight along the holes of the table. Loosen the top nylon screws of each end, then adjust the position of the entrance

window then the other end so that the beam is centered on the tube. If you are using a tube with an HR at the end, try to point the beam back through one of your alignment irises. If you are using a double-Brewster tube, get the tube centered on the beam, then install the HR mirror and use it to direct the beam backwards. The beam should go through the tube without any clipping. Tighten the top nylon screws to lock down the laser tube position.

2. Double-pass gain measurement:

Install a beamsplitter into the beam path before the laser tube. You should be able to do this without introducing clipping on the laser tube. The beamsplitter will allow you detect the return beam with a power meter. Set up a power meter head on a post, and center the return beam on the sensor. Measure and record the initial power, then power on the test laser tube and measure the output power. You should see roughly a 10% increase for the 632.8nm light.

Adjusting the current level for optimum gain: Inside the power supply box, there is a flat head screw for controlling the current in the HeNe discharge. Because of the increased collisions at higher current, more current does not necessarily mean more gain. Turn off the test laser tube and unplug the power supply. Unscrew the top of the case (don't lose the screws) to get access to the current adjustment. Turn the power back on, and adjust the current for maximum gain. Record that gain, and make a note of roughly where the screw position is. (For the one supply that I tested, maximum current did give maximum gain, but this may not be true for other tubes.)

Test gain for other wavelengths: We have two other lasers that are aligned for lasing on other wavelengths, in the orange and the yellow. Use your mirrors to align the other test laser beam through the irises. Measure the gain for those wavelengths at the same current setting that optimized the gain for the red. Check to see if the optimum current setting is different for the other wavelengths.

In a later lab, we may pick one of the laser tubes to try to make it lase on other laser lines, and we want to know which tube has the highest gain.

In your write up, describe the procedure for measuring gain, and make a table of the gain values you measure. Be sure to include which tube you are working with. Make a note of any questions or difficulties you had.