PHGN 480 Laser Physics
Lab 4: HeNe lasing alignment

Do this by the end of the day Monday, 3 October. Turn in your write-up in class on Tuesday, 4 Oct.

For this lab, you finish the alignment process for building a HeNe laser. There are 5 laser tubes, but only 3 of these will have a high-reflector mirror bonded to one end of the tube. These 3 are much easier to align, so your team should pick one of them. We will work later on creating resonators from scratch with two independent mirrors.

The goals of this lab are to:
1. align the laser tube so that it is level to the table
2. install the output coupler and get the laser to lase. Use the power meter to optimize the output power.
3. Vary the current on the laser power supply and obtain a curve for output power vs. input current.

1. Alignment of the HeNe laser tubes:

Follow the procedure for Lab 3 to align the laser tube to the reference beam. A couple of notes:
a. Before installing the laser tube, verify that the beam is level to the table and straight to the table holes. If you are using one of the new rails, the reference beam should be aligned to be above a line that goes *between* the table holes, not directly above. Also, use a knife edge or the edge of a card to find the position of the focal point of the beam that will enter the tube.
b. Place the high reflector at a distance such that the beam focus is right at it. Align the front of the tube so that the entrance window is centered on the beam. Then align the back of the tube so that the return beam is centered on one of the input irises.
c. Put in the beamsplitter as in Lab 3, and use it to look at the quality of the return beam. You should be sure that there is no clipping on the return beam, and that it looks like a smooth Gaussian profile.

Now install the output coupler mirror:
a. As we will learn soon when we discuss resonators, the range for the separation between a flat mirror (the HR) and a curved mirror (the output coupler) is from R/2 to R, where R is the radius of curvature of the OC. Closer to R/2 should be easier to align. Be sure the curved surface is on the side of the laser tube.
b. After being sure that the alignment beam is visually centered on the OC, align the input beam so that the back reflection from the OC is directed back through one of your alignment irises. You should also see a bright back reflection from the beamsplitter. If you detune the OC reflected beam, you should be able to see a faint return beam from the HR. Inserting the OC may have deviated the beam to the HR, so you may need to return to an adjustment of the tube to get a clean return from the HR. Then align the OC so that its reflection is directly on top of it.

c. Turn on the laser tube, and hope it lases. If it does, go to step d. If it doesn't, try a small tweak back and forth on the OC angles, to see if you can see the laser flash. If that doesn't work, you can try detuning the OC in one direction, then moving the other adjuster back and forth (around +/- one turn). Then increment the first adjuster by a bit (about $1/10^{th}$ of a turn), then try again.

After you get it to lase, then put the power meter on the output beam (no beamsplitter), and optimize the output power with the OC angles. Note the sensitivity range of those adjustments.

If you have time, try adjusting the current level to see how the output power depends on input current. There is no indicator for the screw, so perhaps you could record the output power every 1/8 turn or ¼ turn increments.

In your write up, describe the procedure for doing the alignment, HR-OC distance, your measured output power, and the output power vs input current curve. Be sure to include which tube you are working with. Make a note of any questions or difficulties you had.