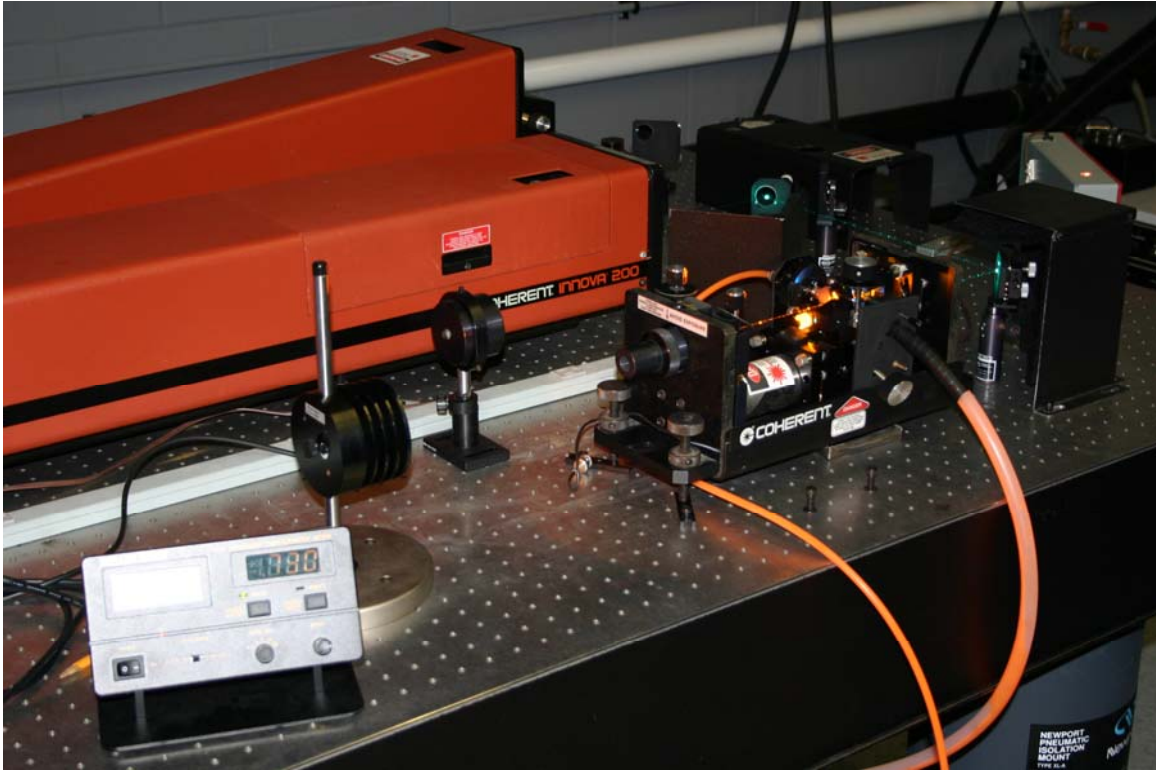


# Dye laser alignment Lab

Revision B – 2008/02/20 (First draft January 25, 2008)

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## In this Laboratory,

1. Following instructions from a laser manual, gain proficiency in laser alignment and tuning.
2. Care and handling of optics.
3. Safety concerns when aligning Class IV visible lasers.

## Reference:

1. Niagara College SOP, “ Standard Operating Procedure Coherent 599 Standing Wave Dye Laser ”. Note: SOP is for 599-01 laser. In this lab you will be using the 599-OEM laser a shorter cavity model in the 599 series of dye lasers.
2. Niagara College SOP, “Standard Operating Procedure Coherent Innova-200 Argon Laser”.
3. Coherent laser Manual, “599 Standing Wave Dye Laser”.

4. Coherent laser product brochure, "599 Standing Wave Dye Laser" (copy attached).

## **Safety:**

This laser is a Class IV laser and operators are expected to be familiar with proper safety precautions before operating this laser. The operator is directed to the laser manual for a complete description, "599 Standing Wave Dye Laser" and the Standard, "ANSI Z136.1 (2000) Safe Use of Lasers".

**Eyewear must be worn at all times** that protects the operator and anyone else in the nominal hazard zone against radiation in the 488-514 nm range from the argon pump laser. In this experiment the argon laser is pumping a dye laser with R6G dye, which operates in the range of 575-640 nm.

**Remove all rings and jewelry.** This is particularly important when using a pump laser such as the argon laser used in this experiment.

Addition Safety Notes for this experiment:

1. In this experiment you will be aligning a laser that operates in the 575-640 nm range (green/yellow to red), which is pumped by a multiline argon laser 488-514 nm (blue to green). Eye protection must be worn for the argon laser wavelengths at all times. The dye laser will not lase until the installation of the output coupler. Before installation of the output coupler a proper beam dump or suitable power meter must be installed to terminate the beam.
2. When tuning the dye laser, adjustments need to be made to the dye laser pump mirror. Only small adjustments should be made as the argon beam could be steered off of the dye jet with excessive adjustment. If lasing stops when making this adjustment, try and turn the knob back a bit to resume lasing. If you cannot restore lasing by turning the "knob back to where it was" insert a white card into the laser cavity. You should see two yellow fluorescent spots very close together. Turn the pump mirror knobs until these spots are aligned over top of each other. Upon removal of the card the laser should lase. If it still will not lase get your instructor to assist.
3. At several stages of this experiment the aperture on the argon laser needs to be opened and closed. Care must be taken to not lean over top of the dye laser when doing this. This is a very unsafe practice as reflections from the dye jet and birefringent filter (if installed) reflect upwards.
4. At the jet assembly, make sure the splash shield is over the dye stream whenever the argon laser is on to minimize the reflection from the dye.

## **Operation:**

**Emergency Shut Down: In case of dye leak,**

1. Argon laser must always be shut down first. The dye jet is essentially a beam dump for the argon laser. This can be done quickly by closing the argon laser shutter. Turn the switch on the dye laser module (below the table) from the Jet to the off position.

### Operation:

1. Make sure everyone within the nominal hazard zone is wearing protective goggles for argon laser wavelengths. Remove jewelry and watches.
2. The dye laser will be in working order and running (Argon laser set to 3W, aperture=9, ~34 Amps). If necessary tune the argon laser (see Innova-200 SOP) and then re-adjust current to give 3W output.



I-200 Control Module

3. Make small adjustments to the dye laser's output coupler and pump mirror knobs to optimize the laser power.

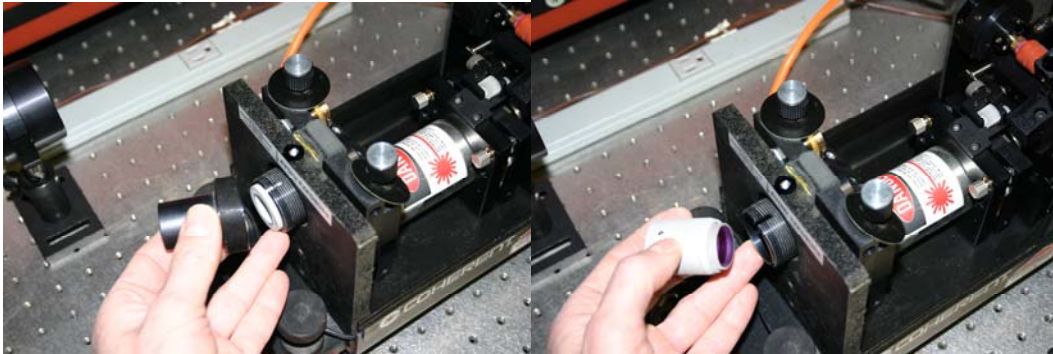
Power = \_\_\_\_\_ W

4. Close argon laser shutter, taking care to not lean over the dye laser when doing so.
5. Note: For the inexperienced, finger cots or gloves should be worn. However, wearing gloves does not mean the coated surface of an optic can be touched).

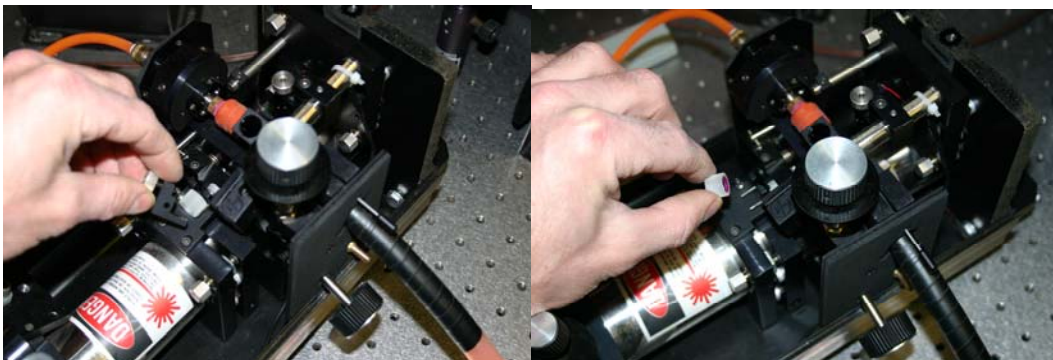
Remove the dye laser's output coupler bezel nut then the output coupler keeping it in its holder and place it off to the side where it cannot get damaged.

Remove the high reflector clamp. Carefully remove the high reflector taking care not to touch the coated surface of the optic. Place optic off to the side on a piece of lens paper with optic's coated side up.

Note: Replacement costs of these optics are \$ 600 each.

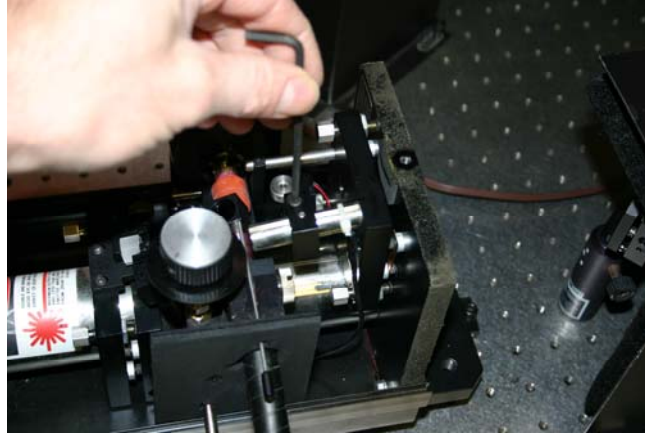


Output coupler removal



High reflector removal

6. Loosen the setscrew clamping the fold mirror mount onto the invar finger and slide the fold mirror mount forward. You do not need to remove the fold mirror from the mount for this lab.



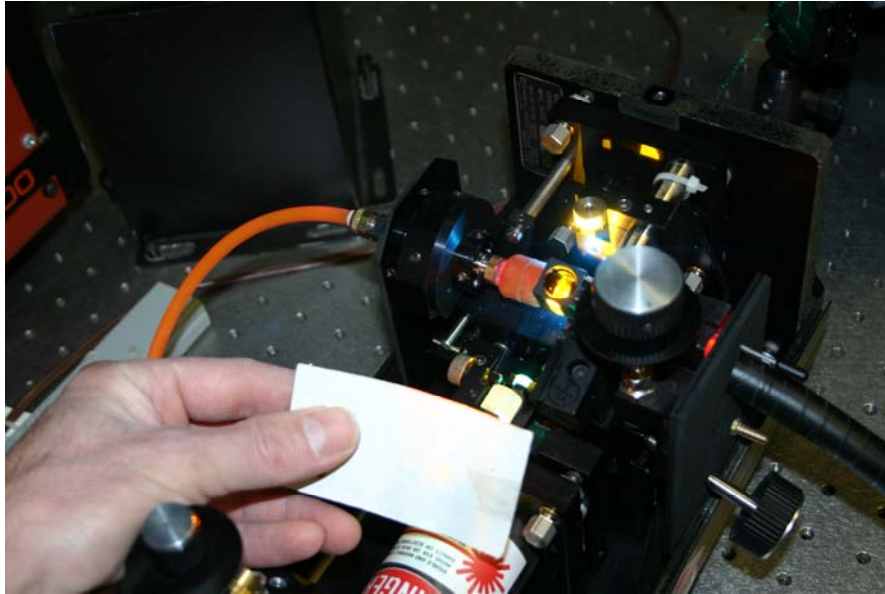
7. Follow the procedure outlined in the 599 laser manual, chapter three. Due to time considerations, the dye laser has been physically aligned to the argon laser and the pump mirror aligned to the dye jet. Start the alignment procedure from step 14 (note: fold mirror is already installed on mount).

The following notes are meant as a supplement to the procedure described in the manual. Be sure to **refer to the Coherent 599 manual (starting on step 14) for alignment instructions** now.

**Step 14.**

Slide the fold mirror mount  $\sim 1/2$  way along the invar finger. Measure 64 cm from the fold mirror (long radius) and mark this location with a piece of tape on the optical bench. This will be your focusing reference mark.

Confirm the argon laser is still set at the correct current. Open the argon laser shutter. If required tune argon laser to get 3W output. Searching in the dye laser cavity with a white business card, you should now be able to see a yellow fluorescent spot from the reflection from the fold mirror. While observing this spot at the 64cm mark outside the laser cavity, slide the fold mirror along the invar finger until spot is  $\sim 2$ mm in diameter (i.e. at best focus at the 64cm mark).



**Step 15.**

Taking care to not put your hand into the argon laser pump beam, turn the three screws on the fold mirror mount plate and steer the yellow fluorescent spot from the fold mirror out the output coupler hole and to a spot  $\sim 1.7$  cm above the reference spot at end of the optical bench (Note: a reference spot from the dye laser alignment with the argon laser has been placed on a board at the end of the bench).

Holding a business card at the 64 cm reference mark on the table, slide the fold mirror on the invar finger until this spot comes roughly into focus. Gently tighten the fold mirror set screw securing it to the invar finger. Adjust the fluorescent spot again, back onto reference mark if it has moved when tightening the setscrew.

**Step 16.**

Pump focus has been done do not adjust for this lab.

**Step 17.**

Final focusing can be made by turning all three screws on the mount in or out as required until focused at the 64 cm distance. Note the reference location of spot should be checked with each adjustment. Be careful to not accidentally put hand into argon beam.

Hint: to help determine focus at 64 cm mark take a white business card and start out at  $\sim 100$ cm where the fluorescent spot is observed as out of focus. Slowly pull the card towards the back of the laser and you will see where the spot comes into focus and then becomes over focused. After a couple of tries you will figure out the direction to move the fold mirror mount to get to a sharp focused spot at 64 cm (The spot looks like a teardrop).

At this point, you should have a focused spot at the 64cm mark and, when that alignment card is removed, the spot should be 1.7cm above the reference mark.

Step 18.

Turn the argon pump beam OFF first by closing the shutter.

It is very important to handle the high reflector by its edges only. Carefully inspect mirror for dirt or dust. At the high intracavity powers these mirrors experience, the heat produced from light absorption of a piece of dust can burn right through the coating. Clean if necessary (see instructor for proper instruction).

GENTLY tighten the mount for the mirror.

Step 19.

See notes for step 18 above.

Laser can lase at any time after the insertion of the output coupler. Proper beam stops must be in place. Close the argon laser shutter while inserting output coupler. Open shutter once installed.

Steps 20 and 21.

The 599 manual suggests looking for the reflection from the output coupler on the fold mirror aperture. This can be done but it is normally easier to see by inserting a white business card with a small hole into the cavity. When the Fold and HR mirror's fluorescent spots are aligned through the hole a back reflection from the OC should be seen (rocking the OC mount will help determine which spot is from OC). Align the OC spot slightly above the overlapped fold and HR spots and remove the business card. Make small OC adjustments right or left while rocking the OC mount in the vertical plane. At some point you should see a laser flash. Continue adjusting until constant lasing is observed. If you cannot get the laser to lase at this point you may need to go back and check fold mirror and high reflector focus and alignment above the reference spot. If you still have difficulties, see your instructor.

Step 22.

Disregard the step of centering the laser spot on HR mirror. If focusing was done correctly, making fine adjustment back and forth between the OC and pump mirror knobs should bring the laser up to a power close to or better than the initial power that you recorded before disassembly? (Note: double check that the argon laser power is still at 3W – tune if required).

Power = \_\_\_\_\_ W

Step 23 to 27.

Disregard these steps. This has already been aligned for you.

8. If time permits output power can be further optimized by fine tuning first the fold mirror then the high reflector.

Turn all three nuts on the fold mirror mount an equal amount in either direction (usually 1/6 turn on screw head). If all were adjusted the same amount laser should lase with a fine tweaking to these knobs. Adjust the three nuts to maximize laser output. Then make fine adjustments to the output coupler and pump mirror knobs. If final power is greater than starting power continue turning the screws in this direction. If power is less turn the screws in the opposite direction. Once maximum power has been reach repeat the procedure with the high reflector mount.

Final Power = \_\_\_\_\_ W

If interested, especially if there was a great improvement in output performing the above step, remove the output coupler and recheck the how the focused spots appear at the 64 cm mark compared to how you had initially focused them?