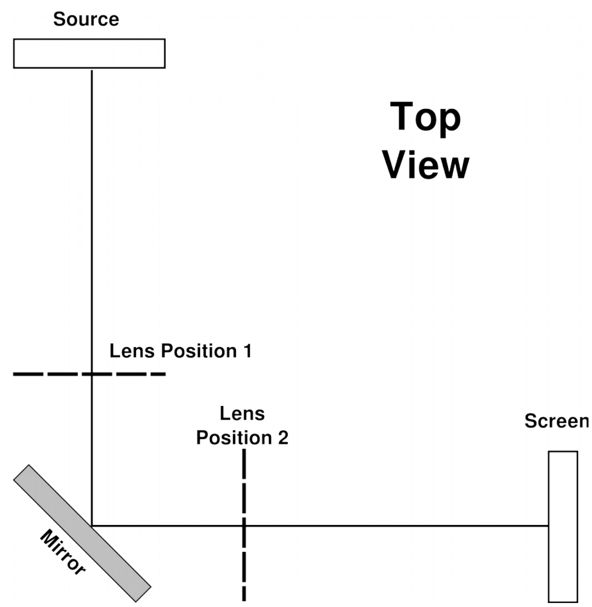
INTRODUCTION

The purpose of this portion of the lab is to familiarize you with positioning images and beams of light. You will be learning how mirrors affect images. You will also learn to position a laser beam. These are common skills needed when working with optics and lasers. Because you are going to be working with at least two dimensional setups, you will for the first time be using the optical table as a two dimensional surface. As usual, care is necessary when setting up the optics. You will also be using research quality mirrors and mirror mounts. Familiarize yourself with how the mirror mounts work and **never** set a bare mirrors face down on a surface. (If they have recessed mounts you may carefully set them facing downward.)

1 – TEST PRE-LAB EXPERIMENT

Set up the situations from the pre-lab and test your predictions. Describe your results and reconcile your prediction with your observations. The top view is shown in the figure.



Lens Position 1

Set up the lens before the mirror and locate the image on the screen. Compare with your prediction, both the distance and orientation of the image.

Lens Position 2

Repeat the above with the lens after the mirror. Comment.

2 – IMAGE IN MIRROR WITH WEBCAM IMAGE FINDER

Remove the lens from the system you set up in Part 1). Predict where the image of the source will appear when looking in the mirror. Draw what you think you will see on a piece of paper, and actually place it on the optical table where it will appear.

Use the lensless webcam to locate the image in the mirror. Compare your predictions with your results and reconcile any differences.

3 – A COLLIMATED BEAM

You often want to transmit an image or light over distances without changing them. In this section you will do this by collimated beams or images.

1) Collimated images are easy to see with your eyes. The image is located at infinity, (Why?) so you can find and look back along the beam to help steer it. As you work with collimated images over the next sections, you can use your eyes to help with alignment. **Caution**: Never look directly at a laser beam! These collimated beam are safe because the light intensity is about the same as looking directly at the source.
2) Set up the source with a +150mm lens exactly one focal length away by auto-collimating it using a mirror, then remove the mirror. Examine the collimated image using a screen and your eyes. Once you get the source and collimating lens in position, clamp both down to the optical table.
3) Look into the beam and describe what you see.
4) Explore using a +200mm lens to form an image from the collimated beam at different distances. Make sure you note the size and orientation of the image.
5) Repeat using a +100 mm lens.
6) Summarize what you found about collimated beams.

4 – COLLIMATED BEAM WITH ONE REFLECTION

Consider a configuration like in the first section but with a collimating lens **before** the mirror, and an **imaging** lens after the mirror.

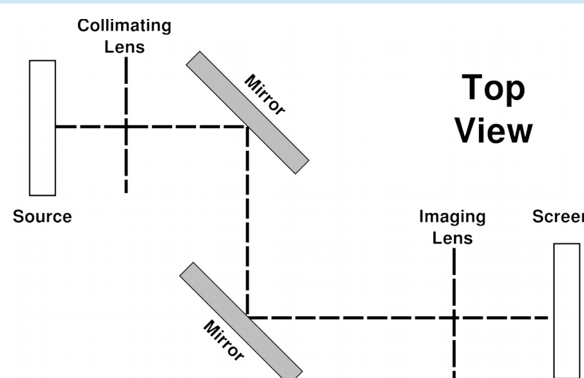
1) Predict the size and orientation of the image.

2) Set this up and compare your predictions with your observations. Comment on how they compared.

5 – IMAGES WITH TWO REFLECTIONS

Consider a system with two 90º reflections being careful to keep the beam at the same vertical height above the table.

1) Predict the size and orientation of the image.



2) Set this system up reconcile your predictions with your observations. You may use your eye and the imaging lens-screen to set up and observe.

3) Now predict what will happen if you tilt the first mirror up and then adjust the second mirror so that the collimated beam is about 5cm higher, but still parallel to the table.

4) Adjust your system and do the usual reconciliation.

5) Return the beam to the same height as it was initially. Predict what the image will be if you flip the second mirror so the final beam anti-parallel with the initial beam.

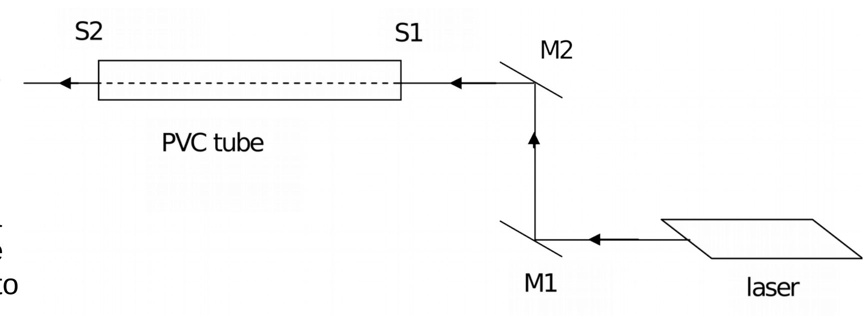
6) Adjust your system and do the usual reconciliation.

TASK 1 – ROTATE AN IMAGE 90º

Occasionally it is necessary to rotate an image through 90 (or 270) degrees. This section requires that you figure out how to do this. How would it be possible to rotate an image by 90 (or 270)? Hint: Think 3 dimensionally. Design a system to do this and show it to your instructor before proceeding.

Make the system. Correct it if necessary. Reconcile your initial design with your final design.

TASK 2 – LASER ALIGNMENT



In this section you will be working with lasers. You must always terminate the beam with some sort of beam stop. In this part of the lab, each of you should be setting up a laser individually so that you all get the "feel" of how to position the beam.

It is almost always preferable to position a laser beam using at least two mirrors. The reason for this is that it makes it possible to redirect the laser beam so that it can always be parallel to the working (table) surface. The two mirrors allow you to change horizontal and vertical positioning accurately.

Task 2a:

You have to get the laser through a 30 cm long, 1.3 cm diameter pipe. This pipe represents some sort of oven through which the laser beam must travel. Using two mirrors and the laser, direct the beam through the pipe without hitting the sides of the pipe.

The easiest way to perform the adjustments is through an iterative approach. Since you have two mirrors and two locations through which the light beam must pass you have to determine which mirror to adjust. Consider the drawing shown below. The best approach would be to adjust mirror M1 for the laser beam's location at S1 and mirror M2 for the laser beam's location at S2. (Why?) Any other ordering of mirror adjustment will often result in an inability to get the beam to behave in a way that is reasonable.

Instructor's initials:

Task 2b:

Switch to a violet laser. You have to direct your laser beam through the apertures on sample that is not on the table.

Instructor's initials: