LU4: LAB 1-4B: Optical Alignment Techniques

REFERENCES:

- *Fundamentals of Light & Lasers* (OPTEC), 3rd edition
- Module 4, Laboratory 1-4B, pages 48-49.
- http://optecvideo.opteccrm.org, Video 14: Read these instructions and watch the videos before doing the lab.
  - Course 1: Fundamentals of Light and Lasers
  - Lab Activity Video
  - Choose Video #

THEORY:

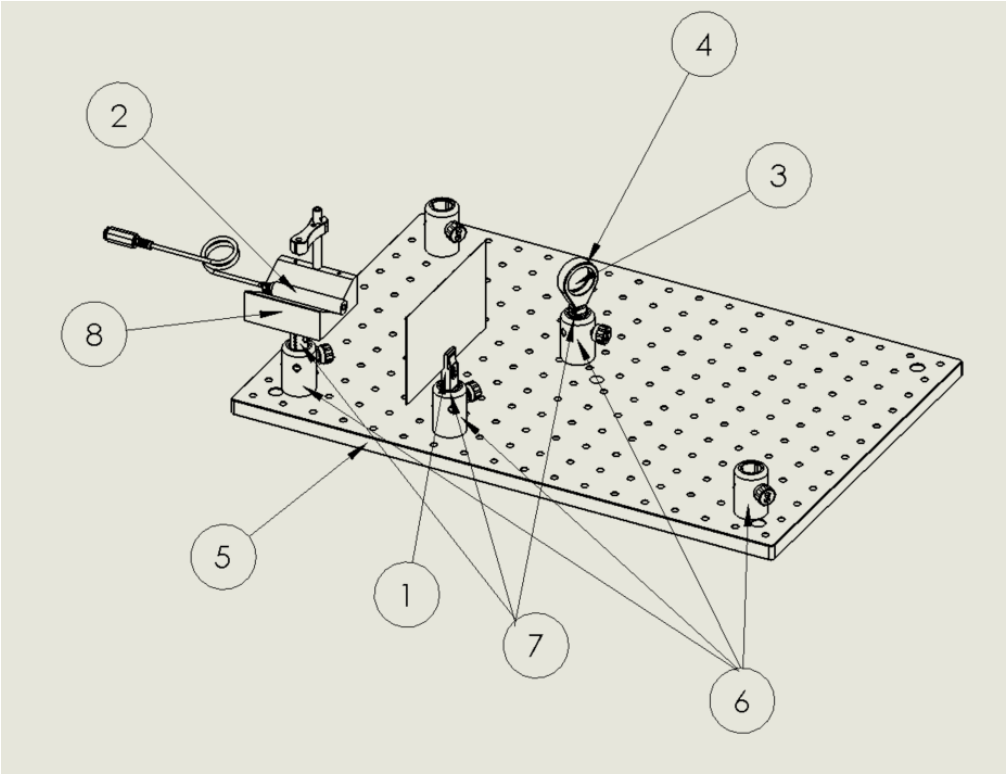
Many laser applications require very precise alignment of optical components. Lab exercises provide opportunities to practice alignment techniques used in laser and optics careers.

OBJECTIVE:

Practice basic optical alignment techniques using an optical breadboard.
To do a comprehensive and precise Lab Write-up.
Take appropriate pictures (5 or more) to prove/show lab work.

EQUIPMENT:

Dual Filter Holder (key 1)
Laser Diode Module (key 2)
Laser Diode Power Supply
Lens, Convex (key 3)
Lens Mount (key 4)
(2) Mirror with Mirror Mount
Optical Breadboard (key 5)
(5) Post Holder (key 6)
(5) Post (key 7)
V-Clamp (key 8)
Misc. Hardware
Index Card



SET-UP: Read the entire SET-UP and PROCEDURE before starting the lab.

1. Mount a post holder in the second row of holes from each edge at a corner at the left end of the breadboard.
2. Assemble a post to the center hole on the bottom of the V-Clamp and insert the assembly into the post holder.
3. Place a non-reflecting beam block at the end of the breadboard (long direction) opposite the V-Clamp.
4. Mount the laser diode in the V-Clamp and rotate the V-clamp so that the laser beam will be projected along the center of a row of holes the length of the breadboard.
5. Mount two post holders in the row of holes aligned with the laser beam. Mount one 4 or 5 holes from the laser aperture. Mount the other in the second row of holes at the other end of the board.
   a. **Important: Mount all post holder setscrews in the board first. Install each setscrew to assure that it does not project into the bottom of the holder**.
6. Mount an additional post holder on the same end of the board as the laser, in the corner across from the laser. Mount it in the second row of holes from each edge. Mount the setscrew in the board first as in step 5.
7. Remove the small extension from a post to shorten it and mount the filter holder on the post. Insert it in the post holder in line with the laser beam and closest to the laser.
8. Mount each mirror assembly (M1 and M2) on a post and lay them aside to be used later
9. Mount the lens holder on a post and mount the convex lens in the holder. Lay it aside for later use.
10. **Take a picture of this set-up and include in Lab Write-Up**.

PROCEDURE: Read this complete procedure before following it.

P1: Align the laser beam with the breadboard:

1. Accurately find the midpoint of an index card and place a thin, vertical line there.
2. Place the index card in the filter holder with post (target assembly), aligning the vertical line to the center of the filter holder clamp (in line with the post)
3. Position the post with the filter holder at the bottom of the $4^{th}/5^{th}$ hole post holder (don't tighten the post holder thumb screw).
4. Turn on the laser and adjust the position of the laser so that the beam is projected on to the vertical line on the index card.
5. Place a horizontal line on the card at the center of the laser beam to make a "cross hairs" target.
6. Move the filter holder assembly with the target to the holder at the far end of the board (do not move the card in the filter holder) and readjust the laser position if necessary.
7. Recheck the first position. Do this until you are certain the beam is centered to the cross hairs at BOTH positions.
    a. This process may take several attempts to achieve this:

8. The V-clamp arrangement is designed to hold the laser so that the beam is projected horizontally and directly above the mounting holes. If you are having trouble aligning the beam with the row of holes, check that the target is centered on the filter holder or that the laser diode is secure in the V-clamp.
9. **Take a picture of the lab set-up and the results and include in Lab Write-Up**.

P2: Retroreflection from a mirror:

1. Remove the target assembly from the beam path and place it in the holder at the LASER END of the board.
2. Place a mirror assembly (M1) in the post holder at the end of the board opposite the laser. Position the post at the bottom of the post holder. Turn M1 to reflect the beam back to the laser, then tighten the thumb screw.
3. Use the screws on back of M1 mount to adjust the mirror so that the beam is reflected directly back into the aperture of the laser.
4. Loosen the thumb screw and rotate the mirror so that the reflected beam is directed to the target in the holder at the opposite corner of the board. If the horizontal adjustment of the beam is accurate, the beam will strike the center of the target. Adjust to do so.
5. Remove the target assembly and replace it with the second mirror (M2) assembly.
6. Position M2 so that it reflects the beam directly back to M1 and directly back into the aperture of the laser.
7. Use the adjustment screws on M2 to do the final alignment into the laser aperture.
    a. This process, steps may take several attempts to achieve this:

8. **Take a picture of the lab set-up and the results and include in Lab Write-Up**.

P3: Retroreflection from a lens:

1. Remove M2 (mirror on the laser end of the board). Replace it with the target to block the reflected laser beam.
2. Place the lens assembly in a post holder but do not attach the post holder to the board.
3. Position the lens assembly in the beam path at the $4^{th}/5^{th}$ hole position, between the laser and M1.
4. Adjust the positon of the lens (vertically and horizontally) until the laser beam is reflected directly back into the laser output aperture.
        i. There will be 2 - reflections from the lens.
    b. The reflections must be coincident & concentric at the laser output aperture.
    c. Use an index card to look for the reflected beams. It may help to darken the room.
    d. If you are having trouble, try inserting the lens assembly in the post holder used for the initial target assembly. This should help center the lens in the beam.
5. When the lens is positioned to reflect the beam directly back into the laser output aperture, tighten the set screw to maintain the lens height and move the lens assembly into the beam reflected by the mirror (M1).
6. Move the lens so that its focal point is center on the target which has been placed in the M2 position.
7. Adjust the position of the lens assembly so that the reflections from the lens are directed back to the mirror and into the output aperture of the laser.
    a. If the laser beam horizontal adjustment is accurate, the lens should be at the correct vertical position.
    b. It may be necessary to dim the room light to see the retro-reflected beams.
8. **Take a picture of the lab set-up and the results and include in Lab Write-Up**.

DISCUSSION:

- The preferred method of aligning multiple components along an optical axis is to insert and align the component farthest from the laser first. This allows each component to be aligned to the beam using retroreflection.
- Laser technician careers including laser installation or maintenance will often include alignment of optical components.
- High power lasers or lasers with invisible beam wavelengths are sometimes aligned using a low-power alignment laser.