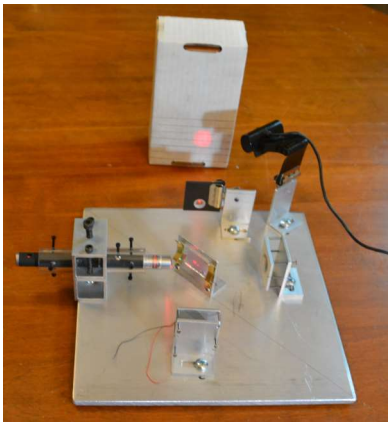
Michelson Interferometer Assembly and Instructions

Safety Warnings

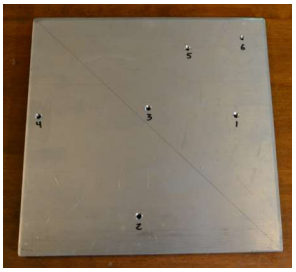


Assembled Interferometer

The laser shipped with this kit is a class IIIA laser rated at less than 5mw. Although no permanent damage should occur to one's eyesight if the beam is accidentally and momentarily shined into one's eye, one should never intentionally look into the beam. Some schools and organizations do not allow lasers with powers greater than 1mw. Do not use this laser pointer if its use is restricted in your organization.

Never shrink the beam to a smaller size using optics elements as this could intensify the beams power per unit area rendering it more hazardous. To avoid this issue this kit uses a single concave mirror that can only expand the beam. Do not use a convex lens or other lens arrangement that could focus the beam to a smaller cross section than exits the pointer.

Assembly Instructions

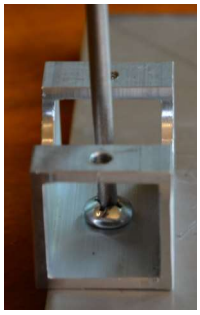


1. Use the parts list at the end of this document to verify you have all the parts.
2. Orient the base plate with the hole labeled “2” nearest to you and hole “4” on the left.

3. Flip the base plate upside down so hole “4” is on the right. Attach a rubber foot at the three locations shown. Positioning is not critical.

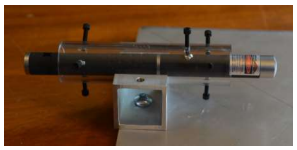
4. Flip the base back over and orient with hole “4” on the left as in step 2.
5. Use a straight edge and draw a line from the top left corner to the bottom right corner. You will use this line to align the beam splitter in a later step.

6. Using a 1/4-20 phillips screw, attach the bottom of the laser tube holder mount to the base at hole number 4. The edge of the mount should be parallel to the edge of the base plate.



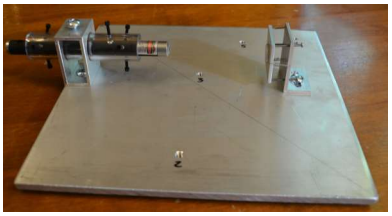
7. Make sure all 7 4-40 plastc screws are located in their holes in the polycarbonate tube. Insert them just far enough for them to stay in the tube without falling out. Place the laser in the tube. If your laser pointer has a push button on the side, place the push button under the “on-off” screw. If your laser has a switch on the end of the tube you do not need the on-off screw but you might leave the screw in the tube in case you should change the laser pointer in the future. Adjust and tighten the positioning screws so the laser pointer is approximately centered in the tube at both ends.

8. Place the polycarbonate tube on the lower mounting base with the screw for the on-off button on top. If used, the screw for the on-off button should be on the inboard side of the mount with the screw approximately 1/2” away from the mounting bracket. Do not screw in the on-off screw at this time.



9. Screw the top onto the laser mount using two 10-32 allen head screws. Then put a 1/2” long, 1/4-20 screw into the top hole. Tighten the 1/4-20 screw until the polycarbonate screw is snug in the bracket and does not wiggle. Do not over tighten.

10. Using a 3/8” long 1/4-20 phillips head screw, mount the mirror assembly to hole number 1. The base of the mirror assembly should be parallel to the side of the base plate.

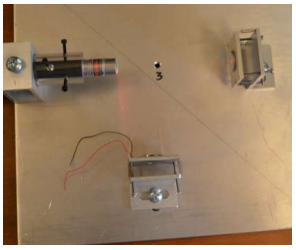


11. Now screw in the on-off screw to turn the laser on. Turn just far enough to turn the laser on. If you turn the screw too far you may push the button into the body of the laser pointer making the pointer inoperable. (If your laser has an on-off switch on the end of the laser then you do not need to use the on-off screw).

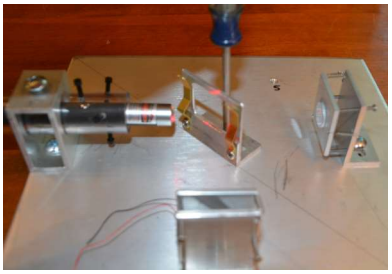
12. With the laser on, adjust the six screws in the clear polycarbonate tube to raise/lower the pointer so the beam strikes the approximate middle of the mirror.

13. With the beam striking the middle of the mirror, adjust the mirror so the beam reflects back to the pointer. The beam should not go directly into the laser but should hit the laser pointer housing just to the left or right of the hole where the beam exits.

14. Turn the laser pointer off. Using a 3/8” long 1/4-20 phillips head screw, attach the piezo disk assembly to hole number 2. The side of the bracket should line up with the side of the base plate.



15. Using a 3/8” long 1/4-20 phillips head screw, attach the beam splitter assembly (without the beam splitter) to hole number 3. Wait until you have completed assembling the interferometer to put the beam splitter in its mount. The base of the beam splitter bracket should be parallel to the 45 degree line you drew previously.



16. Using a 3/8” long 1/4-20 phillips head screw, attach the lens holder bracket to hole number 5. Do not insert the lens yet.

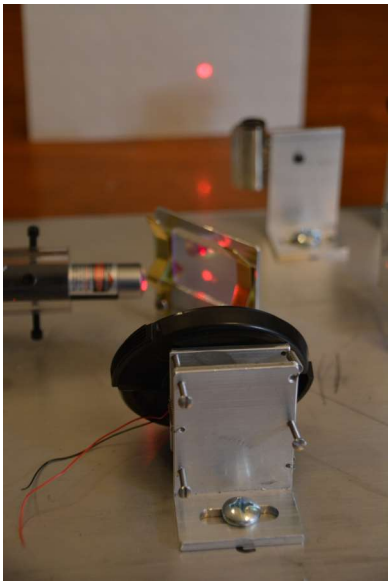
17. If you are going to use a camera, using a 3/8” long 1/4-20 phillips head screw, attach the camera mount to hole number 6.

18. Now grasp the beam splitter by its edges. Insert the beam splitter into its brackets. Using two fingers of one hand, gently pull the prongs out and slide the beam splitter into its holder.

    Using an opaque, non-reflective object, block the mirror on the piezo disk. Verify the beam is still striking the mirror in its approximate center. Adjust the pointer's position if needed to recenter the beam.

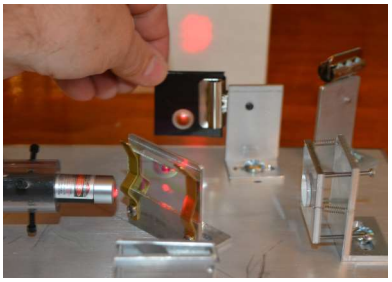
    Also verify the reflected beam still strikes the end of the laser pointer just to either side of the hole the beam exits from on the pointer.

19. Place a small index card sized white screen about six inches away from the interferometer to display the laser beam from the mirror assembly.

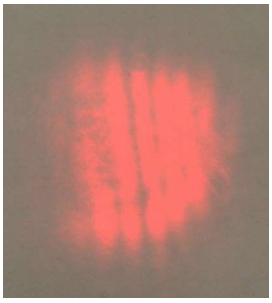


20. Remove the object blocking the beam from the piezo disk. Adjust the piezo disk mirror so the beam lands on the screen. Continue adjusting the piezo disk mirror until the piezo disk beam falls directly on top of the beam from the mirror assembly.

21. Place the lens plate into the bulldog clip and orient/adjust until the beam travels through the approximate center of the lens. Position the lens so you can easily see the two beam patterns in the screen. Gently tweak the screws on the piezo disk until you see fringes. If you are not sure whether you are seeing fringes or just the two beams gently press down on the base plate just behind the piezo disk assembly. If you have fringes there will be clear movement of the fringes.

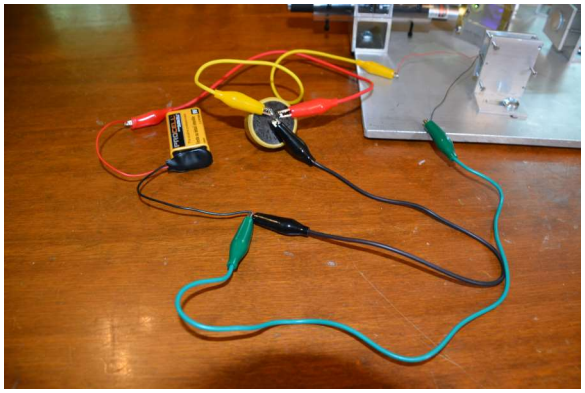


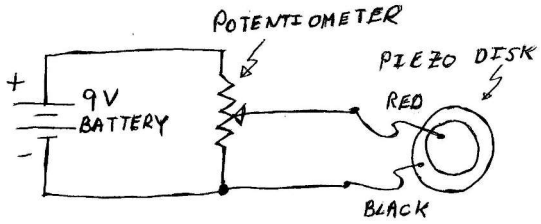
Here is a picture showing a vertically oriented fringe pattern. Depending on your laser pointer and the relative beam positions the fringe pattern you see may be quite different.



Piezo Disk Wiring

The piezo disk is a very low current, high impedance voltage controlled device. It will withstand approximately 30 V. We use a 9V battery and a potentiometer as a voltage divider to power it. The schematic and wiring diagram are shown here.





Activities

<u>Measuring the Piezo Disk Displacement</u>

With the circuit wired and connected as shown, rotate the potentiometer all the way counter clockwise. Adjust the piezodisk mirror to obtain interference fringes that are two to three millimeters apart on the screen. Place a small dot on of the the fringes to identify its original location. Slowly turn the potentiometer while observing the fringe that was marked. Rotate the potentiometer until the next fringe lies over the dot just made. The piezodisk mirror has now moved one wavelength. Continue rotating the potentiometer while counting the number of fringes passing the dot. The total distance is the number of fringes that pass the dot times the wavelength of the laser in nm. For example, if 3 fringes cross the dot and your laser has a wavelength of 650nm, then the disk has moved 3 x 650n =

1950 nm.

You can also determine the displacement versus voltage by knowing the total change in voltage is 9V. In this example the displacement is 1950nm for a 9V change so the displacement/volt is 1950/9 = 217nm/volt.

If you have a voltmeter you can get a more accurate reading of the piezo disk voltage.

It is difficult to keep track of the fringes. Most data acquisition programs can now incorporate videos. By making a video while recording voltages one can improve the analysis.

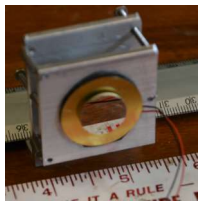
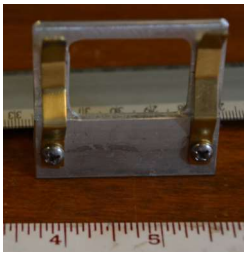
Measuring the movement of a wall.

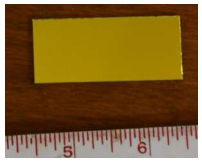
Place the interferometer on a table or stool very close to a wall. Fabricate a holder to attach the mirror assembly to the wall. Set up the interferometer so you see fringes. Push on the wall. You should be able to see the fringes move. In order to keep both legs of the interferometer about the same length place the intererometer as close to the wall as possible without it actually touching the wall. This demo may be a little challenging as the apparatus needs to be extremely stable. Otherwise shaking of the apparatus my obscure the motion of the fringes. You can use a web camera to make the fringe motion observable if you have a lot of students.

Parts List

Item No.	Qty	Item	Description
		Base plate Assembly	
1	1	Base plate	
2	2	Rubber Feet	
		Laser Mount Assembly	

3	1	Laser Tube Mount	
4	1	Clamping Screw[1]	1/4-20, 3/4” long, phillips or allen head
5		Top/bottom clamping screw	10-32 X 1-3/8” long, allen head or phillips
6	1	Clear polycarbonate laser Tube with qty 7 Allen Hd Screws, 4-40 x 1/2” lg, nylon	
7	1	Mounting Screw: 1/4-20, 3/8” lg, phillips head	
8	1	Laser Pointer	Red Laser Pointer Class IIIA, <5mw
		Mirror Assembly	
9	1	Mirror Mount Bracket	Aluminum angle, 1: x 2: x 1.25”, 1.5” wide.
10	1	Mirror Plate	Square aluminum plate, 1.5” x 1.5” x 0.125”
11	3	Extension Spring	
12	3	Adjusting Screw	2-56 thd, ~1” long
13	1	Mounting Screw: 1/4-20, 3/8” lg, phillips head	
14	1	Mirror Mounting Tape	3M vhb tape, 1.5 cm (nominal) dia x 0.065 th

15	1	Mirror	Mirror, BK7 glass, 1.0 cm (nominal) dia. X 1 cm thick, 1/10λ.
		Piezo Disk Assembly	
16	1	Mirror Mount	Aluminum angle, 1: x 2: x 1.25”, 1.5” wide.
17	1	Piezo Disk Plate	Square aluminum plate, 1.5” x 1.5” x 0.125”
18	3	Extension Spring	
19	3	Adjusting Screw	2-56 thd, ~1” long
20	1	Mounting Screw: 1/4-20, 3/8” lg, phillips head	
21	1	Piezo Disk	
22		Mirror	
23		Piezo Disk Mounting Tape	3M vhb tape, 1.0” OD x 0.75” (nominal) x 0.065 th
24		Mirror mounting tape	3M vhb tape, 1.5 cm (nominal) od dia, x 0.065 th
	1	**Beam Splitter Assembly**	
25	1	Beam Splitter Mount	
26	2	Prongs	
27	2	Prong Mounting Screw	10-32 x 3/16” long, phillips head
28	1	Beam splitter mounting bolt	1/4-20 x 3/8” long, phillips head

29	1	Beam Splitter	
	1	**Lens Holder Assembly**	
30	1	Lens Holder Mount	
31	1	Bulldog Clamp	
32	1	Clamp Mounting Screw	Machine Screw, 8-32, 3/16” long, phillips head
33		Mounting Screw: 1/4-20, 3/8” lg, phillips head	
		Lens Assembly	
32		Lens Mounting Plate	
33		Lens	Concave lens, nominal 12 – 16 mm focal length. Diameter may vary

		Camera Mount	
34		Camera Mount Bracket	
35		Bulldog Clamp	
36		Mounting Screw: 1/4-20, 3/8” lg, phillips head	
37		Mounting Screw	10-32 x 3/16” long, phillips head
		Electrical	
38	1	9V Battery Clip	
39	1	Potentiometer	Size, type and resistance may vary. Typically 10k ohms, ½ Watt
40	4	Alligator Clip Leads	
41	1	9V Battery	
		Tools and Miscellaneous	
42		Instructions	
43		Phillips Screwdriver	No. 1 phillips screwdriver
44		Polarizer Sheet	Polarizer sheet, 1” x 1” (nominal)