

Lab 7 : Detection of Light

I. Objective

The purpose of this experiment is the following:

1. to introduce to the student a method of quantitatively measuring light from a Helium- Neon (He-Ne) laser
2. to show how the light from a laser source can be directed by introducing various optical components into its pathlength.

II. Introduction

Various types of light sources are used extensively in today's research environments. However, the most sophisticated light source is of little use to any researcher or scientist if it cannot be measured or manipulated to suit the users needs. In this experiment, a Helium-Neon laser will be used as the light source. The student will become familiar with Neutral Density filters and how they can be used to alter the power of the light source. Finally, this lab will examine the method of quantitatively measuring the light from the He-Ne laser using a photo diode.

III. Procedure

The apparatus must be completely set up according to the attached schematic diagram in order to perform the following experiments.

A. Calibrate the Neutral Density Filters

1. Measure the power of the laser beam with no filters in place using the optical power meter.
2. Measure transmitted beam power for different neutral density filters. Only measure the 0.3 ND filter. If the optical power incident on the power meter is too low, you will not get an accurate reading. Compare the reduction in power with the label value. For any filters which you do not measure, you may assume their assigned value is correct.

B. Calibrate the Beamsplitter

1. Measure the power of the laser beam directly with the power meter, then direct the beam into the beamsplitter
2. Measure the power of each of the output beams (see Figure 1).
3. Is there a laser beam corresponding to the dashed line of the cubic beamsplitter of Figure 1? What is this beam due to?

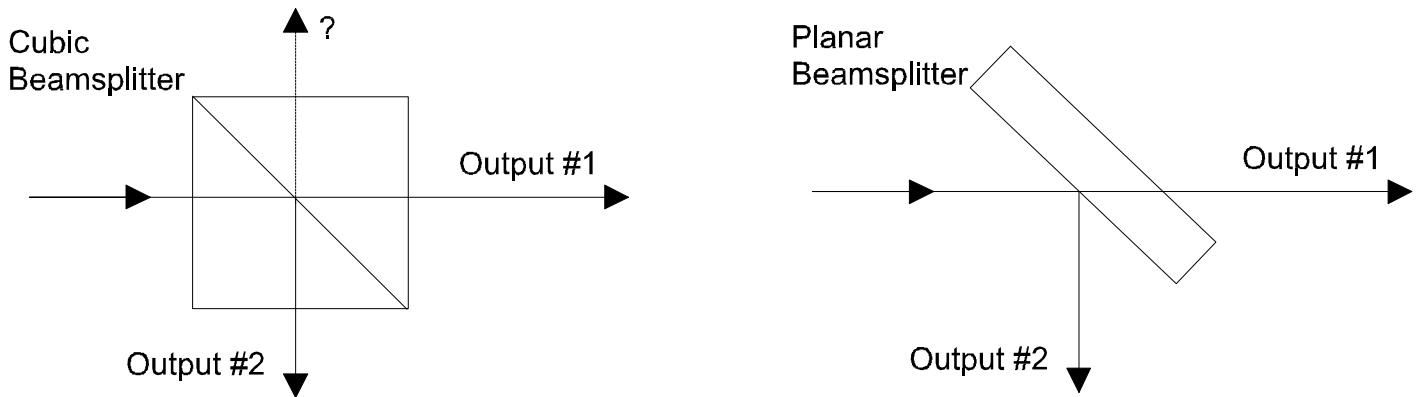
C. Measuring photo diode voltage using an oscilloscope. Does Background light affect the measurement?

1. Place the photo diode on the table with the diode facing the lights on the ceiling. Trigger the scope on auto with a line base of roughly 20 msec/division. Make sure to DC couple the input. You should observe a small DC signal. If you do not observe any detectable signal, please ask for help.
2. Cover the photo diode with your hand and observe any changes. What is the observed change in the detected signal due to?
3. Place the photodiode on the table in an x-y-z mount. Increase the sensitivity of the oscilloscope if necessary (DC coupled). Can you still observe the DC signal observed in III C1?

D. Determine the Linearity of the Diode

1. At this point, you can use your calibrations from IIIA and IIIB to determine the optical power on the photodiode. The diode should be mounted in an x-y-z translation mount. Before **EACH** measurement with the diode, you should adjust the mount to **maximize** the signal. This optimization of the diode position is necessary because any small deviation of the laser beam will change the apparent reading from the photo diode.

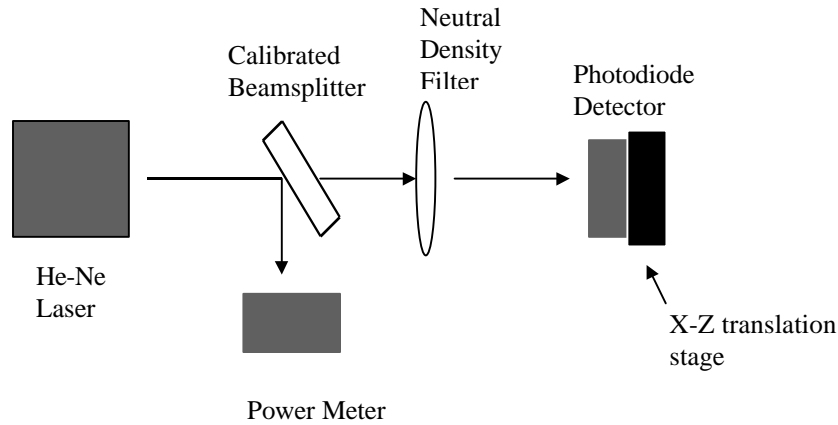
Figure 1: Propagation of light in a Beamsplitter



2. It is most likely that the direct light from the laser will saturate the diode (i.e. max out the diode). However, it may not. The result of saturating a diode is that it does not operate in a linear fashion. i.e. The voltage produced by the detector is not proportional to the power of incident light. Therefore it is necessary to determine what Neutral Density (ND) filter (if any) should be placed before the photodiode so that the detector responds linearly to detected light. You can quickly determine if the detector is linear by placing a 0.3 ND filter between the beamsplitter and diode, the output signal from the diode should drop by 50% (not 10%, 20% etc.). With no ND filters in the laser path, determine using the 0.3 ND filter if the detector is linear. Is it linear? Why or Why not?
3. Choose an arbitrary assortment of ND filters (minimum of 4) to use in the calibration of the diode. Be sure to include the 3.0 ND filter. You should also make a measurement by blocking the laser light completely. The voltage from the diode should be measured with an oscilloscope. Develop a calibration curve for the output voltage of the photo diode as a function of watts in the following manner:

Place a ND filter between the beamsplitter and the diode. Record the signal from the light that has passed through the ND filter using a photo diode (volts). Now, place that same ND filter in the path of light that goes to the power meter. Record the measurement (watts). Repeat this procedure for a variety of ND filters to develop the calibration curve for the photo diode. From your calibrations of IIIA and IIIB, you should make a plot of photo diode voltage versus power (mW) incident on the photo diode.

Figure 2- Linearity of Diode



IV. Summary of Results

1. Determine the ratio in which the beamsplitter splits the light from the laser. State explicitly the percentage of light in each direction.
2. Determine if a ND filter is required to enable the photo diode to operate linearly. If a filter is required, state which filter was used and why.
3. Develop a calibration curve for the photo diode(volts) as a function of Power (milliwatts).
4. Below what power level is the photo diode linear?
5. Does room light generally affect your measurement of the photodiode calibrate curve? Why?
6. Does room light affect the calibration point for the 3.0 ND filter? Why?
7. Assuming that a 1.0 ND filter is required to make the photo diode linear, where, relative to the photo diode, should the filter be optimally placed. Why?