Fiber Optics

Physics 150/126L Spring 2025

See course web page for information about due dates

Introduction

In this lab we will couple laser light into a single-mode optical fiber, characterize the laser focus by adjusting the position of the fiber tip, and measure the angular intensity profile of the optical mode emerging from the opposite end of the fiber.

The core of a single-mode fiber is small enough that at the design wavelength, only one propagating solution of the wave equation is possible. No other optical modes can travel through the fiber, so the amount of light transmitted depends only on the overlap integral between the input light and the allowed mode. Presuming the ends are clean and undamaged, a single-mode fiber therefore acts as a perfect spatial filter, rejecting all misdirected input light and emitting only a pure near-Gaussian output beam.

Assembling the fiber launch system

Assemble your fiber launch system as described by the instructors. The input light from the collimated laser is focused by a microscope objective onto the fiber tip, which can be moved independently in three orthogonal directions using a flexure stage with differential micrometers.

Aligning the light into the fiber

Begin continuous video monitoring and Focus the Raspberry Pi camera on the fiber output tip. Iteratively adjust the position of the fiber input tip in all three directions to maximize the intensity of the camera image. Think carefully about the shape of the laser focus so that you understand what you are seeing as you make adjustments. As you approach the optimal position, make sure the fiber tip remains centered in both directions perpendicular to the light propagation, then adjust position parallel to the beam to find the focus.

When you have optimized the coupling, you should see a bright red dot on the order of a centimeter in diameter if you put a screen near the output tip. Small movements (a few microns) of the stage in each of the two directions perpendicular to the beam should have a large effect on output brightness.

Measurements

1. By adjusting software settings and using neutral density filters, make irradiance measurements with the camera to confirm linearity.
2. Focus the laser into the fiber and maximize the output.
3. Plot the fiber output irradiance as a function of x, y, and z adjustments at the input.
4. Using a rotation stage, measure irradiance as a function of angle in the horizontal plane for light coming out of the fiber tip.
5. Partially obstruct the beam on the input side of the fiber and measure irradiance vs. angle again.