

(eo211) 4. Spatial Filters

Translation by J D White,

1. Purpose

Laser beams, due to scattering by particles in the air or imperfections in the laser beam itself, results in a less than perfect laser spot. This deviation from a perfect spot is denoted as spatial noise. Spatial filter can remove these disturbances. The purpose of this experiment is to understand the principles of spatial filtering and its effects on the beam.

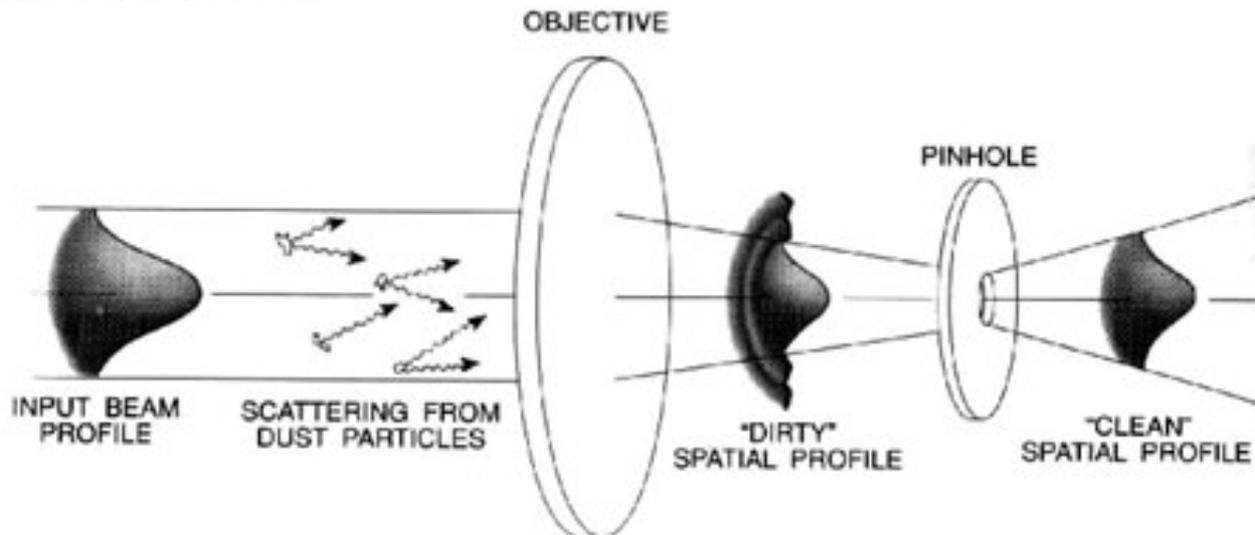
2. Basic Theory

Spatial filter is composed of a confocal lens group with a pinhole (diameter $10 \sim 25\mu\text{m}$) placed at the focal point as shown in the figure. The coherent parallel beam is focused by convex lens to a small point where the pinhole is located. This pinhole can almost completely block light scattered or diffracted by previous mirror or lens surface scratches, dust, or grease.

To achieve the optimum spatial filtering effect, we must choose the appropriate spatial filter specifications, namely the focal length of the lens, the laser wavelength and the laser beam diameter. The relationship for the minimum size of the ideal pinhole is as follows:

$$D_{p(\text{min})} = 2f\lambda/D_L$$

where f is the focal length of the microscope objective lens, λ is the laser wavelength and D_L is the diameter of the laser beam.



3. Summary of Experiment

1. Experiment using optical component assembly equipment.
2. Become familiar with the way the light collimation.
3. Become familiar with setting up and the function of the spatial filter

4. Equipment

1. Optical Rail and Laser with 45 degree mirror,
2. Two (2) apertures (with supporting hardware),
3. Spatial filter assembly (pin hole, microscope objective lens)

5. Procedure

- a. Align laser beam horizontal to table along the rail using 2 fixed apertures
- b. Adjust Spatial Filter

6. Questions

6.1 Lesson Topic:

- a. Given a 10X objective lens whose EFL (effective focal length) is 16.6mm, a laser wavelength of 632.8nm, Estimate the minimum size of a desired pinhole?

6.2 After-school topics:

- a. If laser beam is not indeed completed collimator, what impact will this experiment?