Measuring Laser Output Flux

Using an integrating sphere for measuring the output flux of a laser can solve three problems concurrently:

- *saturation*
- *alignment*
- *simultaneous spectral measurement*

Design

The sphere is designed to measure flux introduced onto the sphere wall and to respond equally to flux directed anywhere over a wide area of the sphere surface.

To avoid saturation, flux in integrating spheres can be designed to be as low as desired.

Calibration

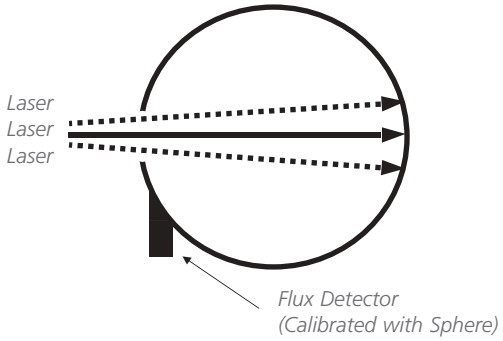
The detector and sphere are calibrated as a unit, using a source of known flux. This is usually achieved by a lamp standard of spectral irradiance at a precisely measured distance, through a precision aperture of known area. This provides a known quantity of flux into the sphere. The detector signal is scaled to this calibrating flux. For a sphere used to measure a narrowband source, such as a laser, the calibration source is generally filtered to provide flux over a similar narrow band, in order to account for the spectral dependence of the sphere-detector combination. In the case of a sphere used to measure the flux from lasers of very different spectral ranges, more than one calibration may be required.

Saturation

Often, the power density of a laser is high enough to saturate a directly illuminated detector. In an integrating sphere, the flux to the detector is typically no higher than about 5% of the flux entering the sphere, and can be designed to be as low as desired. Attenuations as great as -40dB (.01%) and greater are easily achieved in a sphere while maintaining a stable, accurate response.

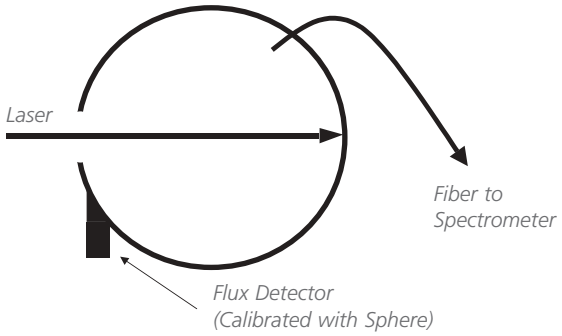
Alignment

Measuring the output flux of a laser with a simple detector can present serious alignment problems. A small detector may be difficult to hit at all; a larger detector may have non-uniform responsivity across its face. A properly designed and calibrated integrating sphere-detector combination measures flux, and is extremely insensitive to alignment. Furthermore, the entire face of the detector is illuminated, eliminating problems with detector non-uniformity. In the figure below, the detector signal is the same for all three alignments shown.



Simultaneous Spectral Measurement

In addition to measuring flux, a second detector can be added to the sphere to simultaneously view the spectrum. Since this spectral detector need not be calibrated for flux, it can be positioned nearly anywhere in the sphere, as shown in the figure below.



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