Introduction to Beam Analysis

It is becoming increasingly important to characterize laser beam parameters fully. The traditional ways of specifying laser beams are necessary, but not sufficient. It used to be that the measurement of wavelength, power, beam width, and mode structure were sufficient for most applications. But there is a significant trend in the photonics industry toward requiring diffraction-limited performance from lasers and optical systems in order to increase the precision and reproducibility with which beams propagate, interact, and can be focused on a target.

CVI Melles Griot provides a complete range of instrumentation to measure not only the traditional parameters, but also difficult-to-measure parameters such as beam profile, propagation factor (M^2), and beam spectral measurements in both wavelength and frequency space. Our instruments take full advantage of state-of-the-art transducers and the full computational and graphic-display capabilities of modern personal computers. Thus this range of instruments provides cost-effective solutions to many laser-beam measurement and characterization needs, both in research and development laboratories and in manufacturing quality-assurance test stations.

CVI Melles Griot instrumentation falls into four broad categories: power and energy measurement, beam-postion measurement, spectral analysis, and beam-intensity profiling.

POWER AND ENERGY MEASUREMENT

One of the most fundamental measurements for a laser is its output power and/or energy. CVI Melles Griot offers complete metering systems (detector head and control/display unit) featuring broadband thermopile and pyroelectric thermal detectors, with flat response from 200 nm to 20 μm, as well as several varieties of photodiode (quantum) power and energy detectors.

Power and Energy Meters

For observing modulated continuous wave (cw) beams, determining pulse shapes, and measuring high-speed noise, we offer a range of high-sensitivity silicon detectors and matching current amplifiers, together with a modular mounting system and a full range of accessories, including integrating spheres.

Photodiodes, Integrating Spheres, and Amplifiers

BEAM-POSITION MEASUREMENT

An unfortunate characteristic of a laser beam is that it changes position as a function of time, age, and atmospheric conditions. In most cases, the movement is only a fraction of a diameter, but in a long-path optical train, even this movement can cause problems. CVI Melles Griot offers

Beam Alignment and Positioning Measurement

four types of systems for measuring beam position and drift: a quadrant detector system for exact centering and alignment, a lateral-effects detector system for measuring larger-scale movement, a dual-detector alignment system that measures both beam position and angular deviation (critical for aligning long-path transfer systems and articulated arms), and a camera-based system for the simultaneous measurement of multiple beams.

SPECTRAL ANALYSIS

A fundamental property of a laser is its wavelength. For many lasers, particularly those operating on narrow atomic transitions, the wavelengths are well defined, at least down to a tenth of a nanometer or less (e.g., the red helium neon lasers output is always 632.8 nm). For broadband lasers, however, this is not the case. A typical dye or titanium-sapphire laser can be continuously tuned over 50 nm or more; the output of a semiconductor diode laser can drift over several nanometers as a function of temperature; some diode-pumped solid-state lasers can be tuned over many nanometers. To measure the fundamental wavelength of a laser, CVI Melles Griot now offers an inexpensive laboratory wavemeter with an accuracy of 0.5 nm. To measure the fine modal structure of the laser beam, we offer two confocal Fabry-Perot optical spectrum analyzers with free spectral ranges (FSRs) of 1.5 GHz and 300 MHz.

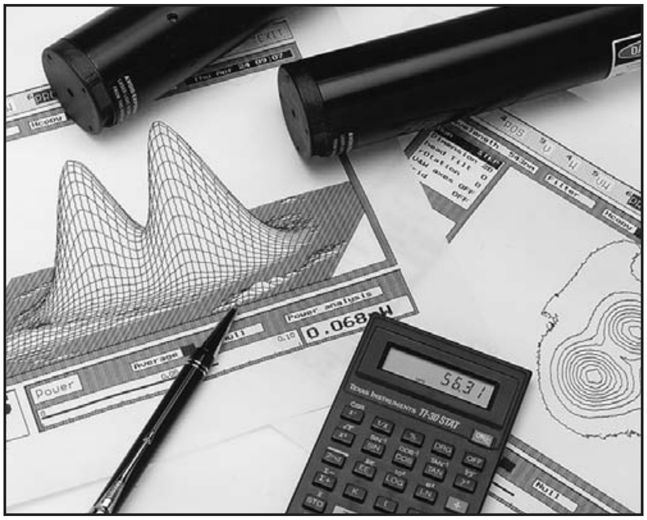
In addition to the instruments mentioned above, CVI Melles Griot now offers a variety of Czerny-Turner spectrometers and a spectrophotometer for measuring the spectral content of incoherent sources, as well as a line of spectral-line and illumination sources.

Spectral Analysis

BEAM INTENSITY PROFILERS

For a circular Gaussian beam, knowing the beam-waist diameter and the far-field divergence is sufficient to characterize completely the propagation of that beam through an optical system. Unfortunately, many real laser beams are neither circular nor near-Gaussian. There may be a contribution from higher-order transverse modes; there may be truncation (clipping) or other distortions introduced by lenses, apertures, or other system optics; and the beam itself may be rectangular, elliptical, or completely irregular. Even for a well-behaved near-Gaussian laser beam it is not safe to assume that the divergence and beam-diameter specification indicated on the specification sheet are sufficient to understand the propagation characteristics, since the beam waist is rarely located right at the laser, and, in the near field, divergence is much less than in the far field.

CVI Melles Griot offers the most complete line of beam-intensity profilers in the industry, including pinhole, slit, and knife-edge beam scanners, camera-based profilometers for measuring pulsed and cw sources, and M^2 meters for determining beam propagation characteristics.



Beam Intensity Profilers and M^2 Measurement