SPECIAL focus

How to choose a suitable beam profiler

In Profile

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Every laser process is highly dependent on the spatial energy distribution of the laser beam. Many processes depend on the irradiance squared or cubed; even subtle variations in the spatial profile can significantly affect the experiment. Electronic laser beam diagnostics equipment provides the best way to determine the spatial energy distribution of a system because even the most basic instrument is many times more sensitive than visual observation. Such instruments provide quantitative and reproducible data presented in an intuitive format.

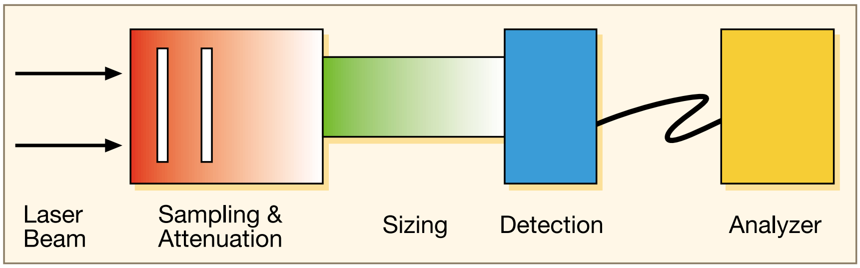
Even the most modern photonics lab depends on a beam profiler, because undesired structure in the beam profile provides the primary indicator of an improperly adjusted laser. To get the most out of a profiler, you need the right tool for the job. With the dizzying array of instrumentation available, how do you make the best selection?

Fortunately, narrowing the field requires answering only a few basic questions. The fundamental elements of any laser beam diagnostic system consist of a beam-sampling system to attenuate the laser energy, a beamwidth-sizing device to reduce or enlarge the beam, a detection device to image the spatial energy profile, and software to provide quantitative analysis and display the beam profiles (see figure).

The information you need to streamline your decision-making process includes the average power of the laser (to determine whether you need a beamsplitter or just neutral-density filters), the wavelength (to determine detector type), the beamwidth (to determine detector diameter), and the laser type (pulsed or continuous wave (CW); some profilers work only with CW beams while others work with both). Above all, of course, you need to know the quantitative information you seek, such as beamwidth, shape, position, pointing stability, and so on.

Armed with the answers to these questions, you can now determine which class of instrumentation to investigate. Generally, profilers leverage either focal-plane-array (FPA) detectors or single-element detectors with rotating pinholes or slits. Each has its advantages and shortcomings, and the best way to determine which is best for your application is to ask the major vendors supplying each technology. In general, single-element detectors with mechanical spinning slits or pinholes are better for CW lasers with focused beamwidths smaller than 0.1 mm and display a composite image taken over many seconds, with some exceptions. FPA detectors can display the entire beam profile many times per second, and work with both pulsed and CW lasers.

Pay particular attention to the wavelength of the laser, since FPAs and single-element detectors are often sensitive over a narrow spectral band. Generally, fluorescent plates with CCD cameras and imaging lenses are used for UV lasers, CCD cameras for visible and near-IR lasers, indium-gallium-arsenide or lead-selenide FPA cameras for laser wavelengths to 2 µm, and pyroelectric cameras for lasers from 1 µm to 1000 µm, including the new terahertz lasers.



A laser-beam diagnostic profiling system consists of a beam sampling system, a beamwidth-sizing device, a detector, and software.

Once the beam is attenuated and properly sized for the detector, the software package is the next critical element. Does it offer a clearly illuminating real-time display as well as quantitative calculations? Does the package include all the necessary calculations? Do the calculations follow ISO 9000 (11146) methods?

Once these questions have been answered, you can survey the industry for the best solution to the problem at hand, and also be confident that the instrumentation can be used for new experiments in the future. **oe**

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