TECHNICAL NOTE

INSTANT M^2 MEASUREMENTS WITH THE BEAMAGE-M2

For the major part of scientific and industrial laser applications, measurement and numerical analysis of Gaussian beams waist, divergence, astigmatism, Rayleigh length and M^2 factor provides valuable information regarding the most efficient use of lasers in optical systems. Recently, a notable progress was achieved in the field of beam measurement technologies. Laser users will now have the opportunity to upgrade their laser measurement capabilities to have more stable and reliable optical processes as well as better laser quality control and easier troubleshooting.

PROBLEMS FACED BY LASER USERS

For the largest part of laser based applications, specific types of lasers and adapted optical components, like convergent lenses, are selected for their ability to achieve a particular task. Since laser systems are made of matter, they degrade over time. Also, optical components can fail unpredictably. With these conditions, a laser may not do its work efficiently. For example, if at any point during a process, material fragments come in contact with the lens and damage it, the wave front of the laser can be affected. This causes the M^2 factor of the system, which quantifies the beam quality and thus the quality of the work accomplished, to be affected as well.

Currently, measurement and numerical analysis of beam parameters can either be done with beam waist analyzing devices, that use moving or spinning components to achieve measurements or with customized and bulky systems, that are designed for the needs of special setups. These systems are very expensive and are individually suitable for a single situation. In both cases, real time measurement of the M^2 factor is not possible for online applications.

For situations of fine alignment or in cases where the optical setup has to be changed several times, systems that are not quickly installed and that do not provide rapid analysis of the beam are not appropriate instruments for accurate and fast troubleshooting as well as for reliable quality control.

T 418.651.8003 1888 5GENTEC F 418.651.1174 www.gentec-eo.com info@gentec-eo.com

TECHNICAL NOTE

THE BEAMAGE-M2 - M^2 MODULE AND PC-BEAMAGE-3.0 SOFTWARE

AN INNOVATIVE SOLUTION IN THE WORLD OF LASER BEAM DIAGNOSTICS: REAL TIME MEASUREMENT AND MONITORING OF BEAM QUALITY.

Unlike other beam profiling devices, the Beamage-M2 module, when added to the Beamage-3.0 camera, can measure the waist of a laser beam without the need of any moving parts and external power supply, providing instantaneous measurement and analysis of the beam parameters. By establishing limit values and monitoring the M^2 factor of a process to keep it within acceptable range, localization of poorly performing elements helps keeping the laser in good shape and maintains the quality control and reliability of a process. This versatile device, which can be placed after the focusing lens of the system under evaluation, can be configured for a wide range of applications for almost all laser wavelengths and laser powers. Its modular design allows users, who want to measure only the intensity or energy profile, to remove the beam profiler Beamage-3.0, which contains the CMOS sensor, from the M^2 module, and thus use the camera separately.

AN INNOVATIVE TECHNOLOGY

THE FABRY-PEROT INTERFEROMETER

Within the system, the very fast measurements are done with the use of a completely passive optical approach. Inside the device, a pair of Fabry-Perot etalons (Figure 1), which constitute an interferometer made of a pair of partially reflective glasses, is positioned in front of the CMOS sensor of the camera at a convenient angle for the light to oscillate. Each round trip of the focused laser beam creates a time delay and spatial offset of the light.

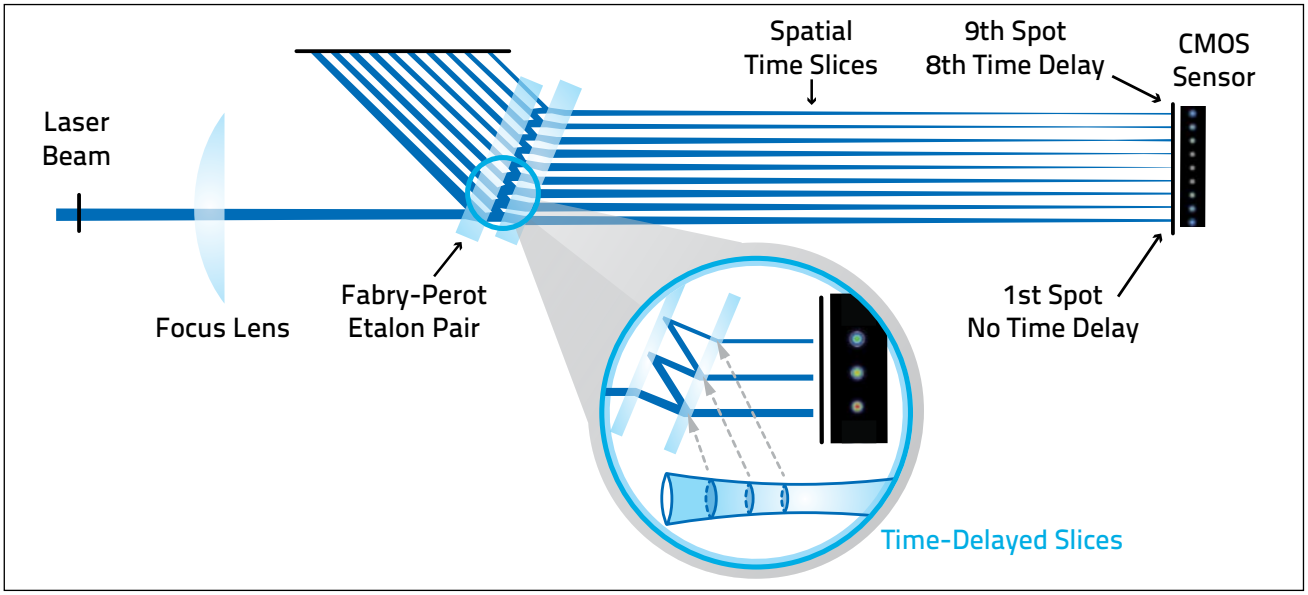

Figure 1: Basic optical configuration

The adjustable distance between the Fabry-Perot pair allows the measurement of beam waists for a large range of Rayleigh lengths. Measurement is possible for any system that uses a lens of focal length equal to or higher than 110 mm. For shorter focal lengths, a focusing adapter is required. It can be mounted onto the entrance port of the system.

TECHNICAL NOTE

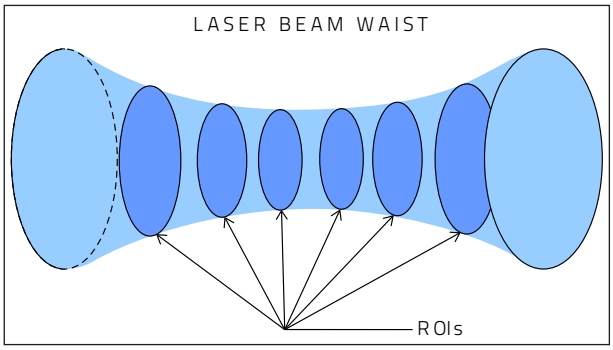

Figure 1: Basic optical configuration

After the multiple time delayed slices of the beam (Figure 2) have landed on the CMOS sensor, each one a spatial cross-section along the waist which is evaluated as a region of interest (ROI), the software simultaneously analyzes and images them, giving an almost instantaneous measurement of the M^2 value. When used at its highest resolution, the Beamage-M2 works at 3 frames per second. This results in a measurement of the M^2 factor, among others, in about 333 milliseconds. Adjustments can be made for the exact beam waist to be contained within the multiple regions of interest generated by the camera and software. In the software, the smallest slice should be located in the primary region of interest, midway in the series of slices. For all systems to be appropriately optimized, the separation between each region of interest is uniform and dynamically adjustable.

REAL-TIME MONITORING

The most important feature offered by this technology is the real-time monitoring and tracking of measurements. With the software, it is possible to set upper and lower limit values for parameters. If any of them falls out of the selected range, it triggers the parameter highlight to change from green to red. An optional USB port output can be connected to an interlock system that will turn off the process in which the laser is involved when the controlled value goes out of range. This is especially valuable for critical manufacturing processes where the performance of the laser or optics must be held to a tight tolerance to avoid problems like the destruction of a component under a very high power.

A LEADING AND ADVANTAGEOUS SOLUTION

HERE IS AN OVERVIEW OF THE ADVANTAGES OF THE BEAMAGE-M2 SYSTEM:

- Real-time measurement of the M^2 parameter.
- ISO 11146 and ISO 13694 compliance.
- Easy-to-use software with an array of useful tools.
- Compact assembly that allows the system to be inserted at any location in optical setups.
- Modular design that allows using the beam profiling camera separately from the M^2 module.
- Working with low power lasers as well as high power lasers, even in the kilowatts (attenuation modules available).
- Working with CW lasers as well as pulsed laser sources.
- Measurement of the beam waist of any system that uses a lens of focal length higher than 110 mm without the need of any adapter.
- All in one product for multiple needs (M^2 measurement, quality control, troubleshooting, etc).

THE IDEAL SYSTEM FOR BEAM ANALYSIS

For present and future needs of scientific and industrial laser applications, monitoring of the M^2 factor will give early warnings of problems related with the laser or optical system. This will allow an increased quality control and better process reliability. Whether it is to ensure that a laser performs the same as during an application development or behaves the same as before it was delivered, to have a real-time quality control of a critical material processing in production, or to achieve fast troubleshooting of an optical system, the Beamage-M2 system, with its compact design, easy-to-use software and real-time performance, is the best solution.
For more information, please contact your local Gentec-EO representative.

T 418.651.8003 1888 5GENTEC F 418.651.1174 www.gentec-eo.com info@gentec-eo.com