How to easily speed up end-of-line quality testing for lasers

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The laser is a very powerful and universal tool. It has found its way into many processes across all industries, including medical applications where the number of use cases continues to grow. Reliability and safety demands are placing high levels of responsibility on manufacturers of laser systems. To ensure the high quality of each laser system, thorough end-of-line testing is mandatory before a laser system is delivered. Nevertheless, as with many industries today, competition is high and manufacturers are seeking to more cost-effectively produce while meeting high-quality standards. Using the Ophir® BeamSquared® system, end-of-line-testing for laser systems can be performed much faster and the process can be optimized.

M2 and the quality of a laser

When it comes to determining the quality of a laser, the key parameter is the beam propagation ratio or M^2 (M-Squared). Its value indicates how close the laser beam comes to be a single mode TEM00 beam, which in turn determines how small a beam waist can be focused. For the perfect Gaussian TEM00 condition, M^2 equals 1. While M-Squared is a key parameter for laser manufacturers, it usually requires some measurement efforts: To determine the beam propagation ratio, as described in the ISO/DIS 11146 standard, a series of measurements are mandatory. M^2 is measured on real beams by focusing the beam with a fixed position lens of known focal length, and then measuring the characteristics of the artificially created beam waist and divergence.

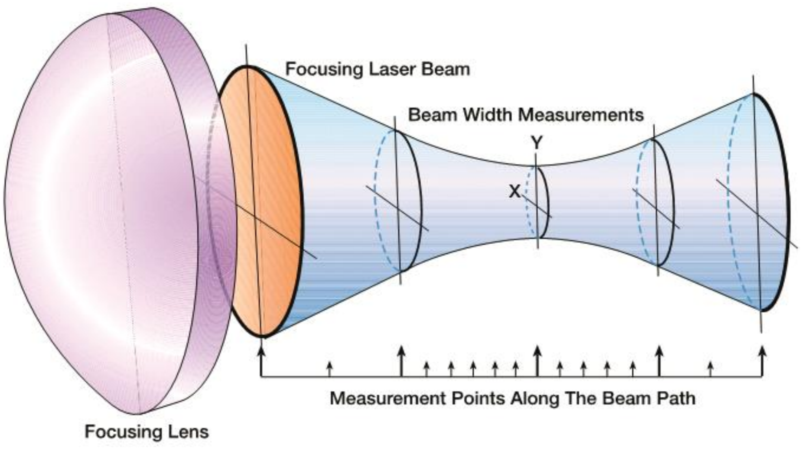

Figure 1: Beam width measurements of a focused beam.

To provide an accurate calculation of M^2, it is essential to make at least five measurements in the focused beam waist region and at least five measurements in the far field, two Rayleigh ranges away from the waist area. The multiple measurements ensure that the minimum beam width is found. In addition, multiple measurements enable a “curve fit” that improves the accuracy of the calculation by minimizing measurement error at any single point. An accurate calculation of M^2 is made by using the data from the multiple beam width measurements at known distances from a lens, coupled with the known characteristics of the focusing lens.

Measurements in less than 1 minute

Having discussed the importance and complexity of the M^2 measurement, it becomes apparent that optimizing its measurement within the end-of-one line testing is a decisive factor in terms of time savings and general process optimization. To facilitate the process and accurately deliver M^2, MKS offers the Ophir BeamSquared beam profiler. This compact tool measures the propagation characteristics of CW and pulsed laser systems from the UV to NIR to Telecom wavelengths, fully automated. Additionally, wavelengths above 1.8 microns, including CO_2 and terahertz, can be measured in manual mode (a bench set-up; without the automated optical train) with a Pyrocam IV or IIIHR.

The main advantage of Ophir BeamSquared is that it delivers the quality parameter of the laser beam in less than a minute. Compared to its predecessor, the widely used Ophir M2-200, which has been the industry standard for years, the system is 10 to 20 times faster. The beam enters the measurement device and by using several mirrors inside of it, a long beam path is created along which the beam profile can be measured almost in real time. In combination with the patented Ultracal™ Calibration algorithm, Ophir BeamSquared delivers fast and highly accurate ISO 11146 compliant beam propagation characteristics in both the X and Y axes for display parameters such as:

- Waist diameters
- Full angle divergences
- Waist locations
- Rayleigh lengths
- M2 or K and BPP factors
- Astigmatism
- Asymmetry

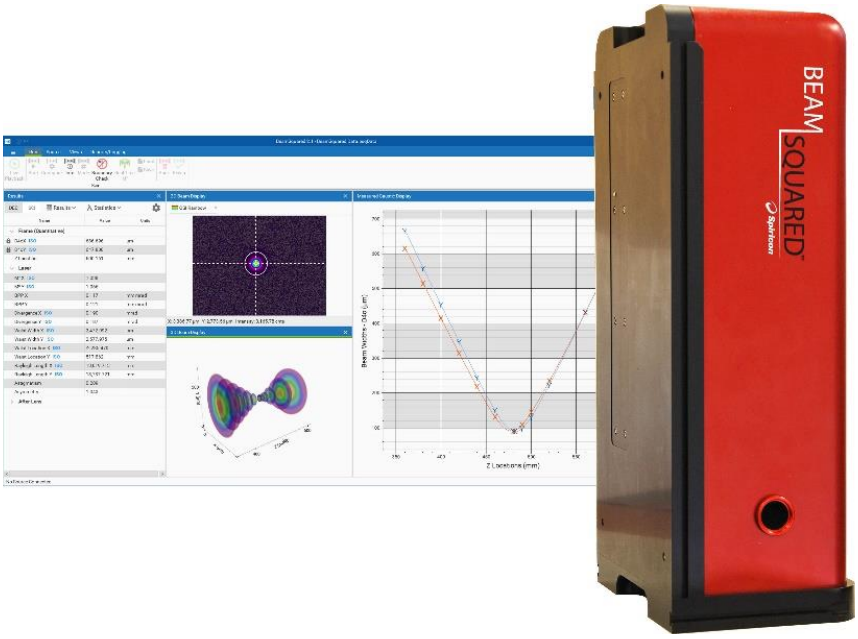

Figure 2: Ophir BeamSquared can be used in an upright position.

Easy integration in testing benches

In addition to the limited time available in end-of-line testing, there are often space constraints that need to be considered. Here, the flexibility and robustness of the measurement device pays off. The Ophir BeamSquared can be used in both directions, horizontally and in an upright position. Especially in integrated environments, this option is extremely helpful for optimizing the use of limited bench space. Similarly with the acoustic noise level during operations, all measurements are performed quickly and silently, which is especially appreciated in production areas where many systems are working in parallel. Apart from its hardware features, the Ophir BeamSquared software includes a 3D slice display and the ability to add 3D displays to reports. Reports can be defined to include a beam caustic chart, in addition to setup information, laser measurements, and a variety of statistics. An automation interface via .Net components allows users to build custom applications that incorporate the laser beam analysis and processing power of BeamSquared.