Case Study Laser

Exact cuts with a laser: recognizing and compensating for thermal focus shift

Messer Cutting Systems uses Ophir BeamWatch for non-contact measurement of the laser beam

Precise cuts, sophisticated component geometries, limited material melt – the advantages of laser cutting are numerous. And due to the steady increases in laser power, these advantages can now benefit a range of new applications: fusion cutting is more attractive for structural steel, and thinner materials can be cut significantly faster and more efficiently than ever. These advancements are also reflected in the Messer Cutting Systems portfolio. As a global provider of products and services for the metalworking industry, the company increasingly relies on high-performance fiber lasers for its cutting systems.

That's why it's crucial for the development team at Messer Cutting Systems to know the exact behavior and parameters of the laser beam. Since for this purpose the company uses Ophir BeamWatch, a non-contact measuring system, there are no limitations on the laser power that one can measure. For the first time, measurements taken at video frame rates allow the focus shift to be temporally resolved and displayed in near-real time. This is precisely the point that most interests the developers at Messer Cutting Systems: With their "Focus Shift Compensation," they've developed an algorithm to minimize the thermal focus shift in the switch-on process, which optimizes the quality of the laser cut.

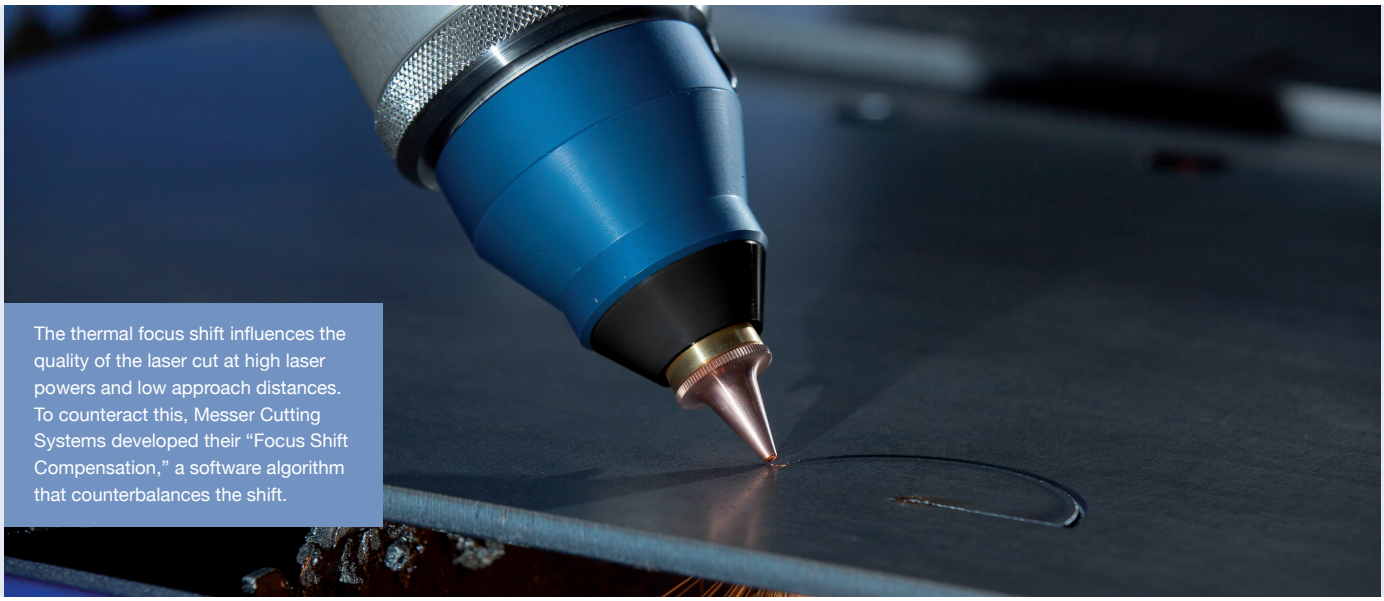
Product:
- Ophir BeamWatch

Field of use:
- Research & development

Application areas:
- Testing new cutting heads
- Measuring thermal focus shift
- Determining the basic parameters for the "Focus Shift Compensation" algorithm

Advantages:
- Non-contact measurement of the laser beam
- Compact, mobile device
- Measurements taken at video frame rates allow the focus shift to be temporally resolved

MESSER
Cutting Systems



The thermal focus shift influences the quality of the laser cut at high laser powers and low approach distances. To counteract this, Messer Cutting Systems developed their “Focus Shift Compensation,” a software algorithm that counterbalances the shift.

Thomas Dünzkofer

Project manager in development at Messer Cutting Systems

A long history of competence

Messer Cutting Systems is a global supplier of products and services for the metal processing industry. The company employs more than 800 people at its five main production sites. The product portfolio includes oxyacetylene-, plasma- and laser-cutting systems ranging from hand-held devices to special machinery for shipbuilding, as well as equipment and systems for oxyacetylene welding, cutting, soldering and warming. Proprietary software solutions optimize the production and business processes. Considered a pioneer in the industry, the mechanical engineering firm stands for continuous innovation, and its corporate R&D department, based in Rödermark, Hesse, makes significant contributions to that reputation. This is where the company carries out basic development projects on individual assemblies, software or sensor technology that are important to locations worldwide. Then, custom and market-specific development of the machines is continued at the respective locations.

Research needs measurement

Especially when it comes to the development of new cutting systems, measurement technology plays a decisive role. So when Thomas Dünzkofer, project manager in development at Messer Cutting Systems, read about the non-contact measuring method for determining thermal focus shift, he was immediately interested: “Determining the focus shift in particular had, until then, been very time-consuming for us, and it posed some risk when the lasers were of higher power. At the same time, we really needed those measurement results! Our first demo of the Ophir BeamWatch system was quite an eye-opener for us.” And the timing was right: Shortly before, the research team had developed a new software algorithm that could be used to minimize the focus shift in Messer’s laser-cutting systems. It’s based on time-resolved measurements specific to each type of cutting head. Simple and fast measuring, like that offered by Ophir BeamWatch, was just what the development team wanted.

Non-contact measurement as a starting point

The BeamWatch system is based on Rayleigh radiation. This refers to the scattering of electromagnetic waves off of particles smaller than the radiation‘s wavelength, such as oxygen or nitrogen molecules in the air. The electric field of the laser radiation induces an oscillation in the dipole molecule at the laser‘s frequency, thus leading to elastic scattering at that same frequency. The laser beam passes through an opening into the interior of the BeamWatch system and exits the other side – without experiencing any impact along the way.

Inside the instrument, the scattered laser light is imaged from the side using a telecentric lens assembly on a CCD or CMOS camera. Each individual pixel in a single line of the CCD camera detects the scattered light as a measuring point of intensity in the beam profile. Thus, typical CCD or CMOS cameras with 1090 x 2048 pixels will measure 2048 individual profiles simultaneously. From these measurements, the beam and beam-quality parameters can be calculated according to ISO-13694 and ISO-11146 standards. Taking measurements at video frame rates makes it possible to see – for the first time – any shift in focus, which is especially liable to occur right after the laser is turned on. Thomas Dünzkofer explains: “When cutting with lasers of high power and short approach paths, a shift in focus can definitely affect the cutting process.” This is why the research team at Messer Cutting Systems developed a software component for use with the company’s laser-cutting instruments. Users of the system now benefit from the new development without incurring additional costs.

Measurement technology with a future

Thomas Dünzkofer is convinced that measurement technology for lasers will increasingly gain in importance, especially for new types of cutting heads. More and more, cutting heads are being used for which one can set the focus position and focus diameter independently. The difference in focal length changes both the cut width and the Rayleigh length. Especially at higher powers, it is necessary to determine the thermal focus shift in relation to the focal length. With the BeamWatch system, the R&D team at Messer Cutting Systems can measure these parameters quickly and easily. Different cutting heads can thus be optimally selected for the respective application. And from Thomas Dünzkofer‘s point of view, nothing stands in the way of using the tool in production or even service. “The power meter is lightweight, compact, easy to transport and easy to operate. Because the beam simply passes through the instrument without being touched, neither the beam itself nor the gauge‘s reliability is affected. And you don‘t have to worry about power limitations.” In sum, BeamWatch is the ideal complement to his measurement portfolio.

Text: Dagmar Ecker, Dipl.- Wirt. Ing. (FH)
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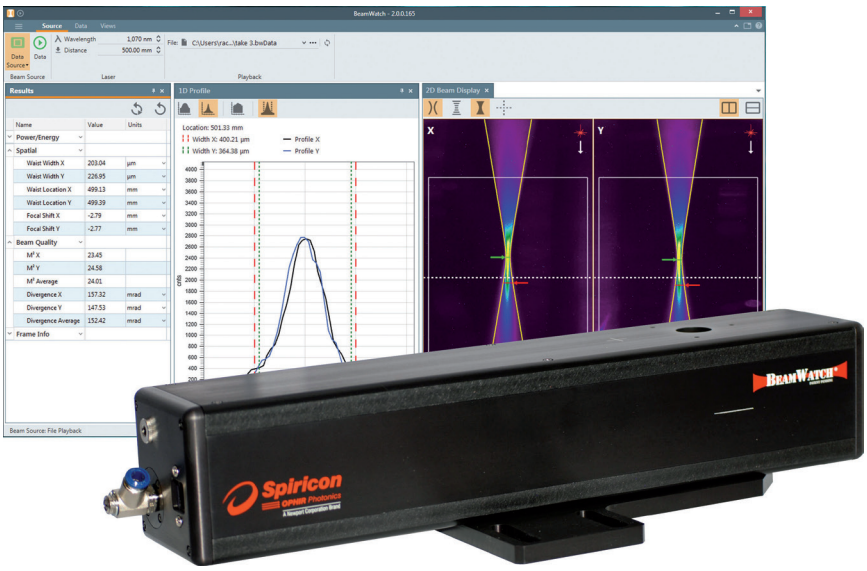

BeamWatch for 980-1080 nm

The patented BeamWatch non-contact profiling system accurately captures and analyzes industrial multi-kilowatt lasers wavelengths from 980nm - 1080nm by measuring Rayleigh Scattering. It features a complete passthrough beam measurement technique, no moving parts, and a lightweight compact design which makes it ideal for comprehensive analysis of industrial multi-kilowatt lasers.

- Beam waist sizes down to 55um
- From 400W and up – no upper limit (so far we‘ve measured up to 100kW)
- GigE Ethernet Interface
- BeamWatch End User or Technician Analysis software included

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