PRESS RELEASE

New generation of thulium fiber lasers achieves world record performance

Fraunhofer IOF researchers develop high-power fiber lasers

Jena

Researchers at the Fraunhofer Institute for Applied Optics and Precision Engineering IOF have developed powerful thulium fiber laser systems that almost double the previous performance world record. The technology lays the foundation for high-power lasers with even greater performance prospects.

High-power fiber lasers are a versatile tool for numerous technological applications, such as material processing or free space communication. The choice of the right spectral range plays a decisive role, especially over long distances — from earth to satellites, for example. The spectral region above 2030 nm is considered particularly suitable, as atmospheric losses are low there and the laser light is relatively eye-safe.

Researchers at Fraunhofer IOF have achieved a significant milestone in this area: they have developed a system comprising three high-power thulium fiber lasers that emits light in the spectral range of 2030-2050 nm and achieves an output power to 1.91 kW. Almost twice as much as conventional systems (~1.1kW) - a performance record.

Technological advances for sustainable scalability

The researchers in Jena are now building on their previous record and consistently developing the technology further. "Our goal is to optimize the technological basis so that we can reach the next level of performance with reliable individual sources," explains Dr. Till Walbaum, group leader for laser technology at Fraunhofer IOF.

The principle of spectral beam combining (SBC) is central to this. In this process, laser beams of different wavelengths are directed onto special optical reflection gratings at adapted angles. Diffraction combines the laser beams into a single beam. This not only increases the performance of the fiber laser system, but also preserves the beam quality and thus the good focusing ability of the laser beam.

Connection technology and unique gratings enable high performance

Previous systems reach their physical limits at high power levels, in particular due to overheating caused by low combination and laser efficiencies. The Fraunhofer IOF team has solved these challenges with new, more efficient individual sources and improved

Editorial team
Sina Seidenstücker | Fraunhofer Institute for Applied Optics and Precision Engineering IOF | Phone +49 3641 807-800 | Albert-Einstein-Straße 7 | 07745 Jena | www.iof.fraunhofer.de | sina.seidenstuecker@iof.fraunhofer.de

cooling systems. In particular, a special connection technique for fibers, known as "cold splicing", enables low-loss fiber-to-fiber coupling and effective temperature regulation.

Another key component is a specially developed diffraction grating with an efficiency of over 95 percent and excellent thermal performance. "The combination grating is the heart of our system," explains Friedrich Möller, scientist in the Laser Technology department at Fraunhofer IOF. "Up to now, optical combining elements such as gratings and dichroic mirrors for wavelengths around 2 µm were only available for laser powers of a few hundred watts. However, our colleagues at the institute have developed a special diffraction grating that also works excellently in the multi-kW region under challenging parameters. It enables a low-loss beam combination with overall efficiencies greater than 90 percent and is the baseline for our next leaps in performance," says Möller.

"We have created the technological prerequisites for realizing laser systems with even higher performance and reliability. The next big challenge is now to reach the 20-kW level," adds Till Walbaum on the future potential of the technology.

New possibilities for material processing, medicine and communication

The high-performance thulium fiber lasers that have been developed open a wide field of applications, including medical procedures, polymer processing and optical data transmission. An important advantage of the lasers: improved eye safety. Scattered light with a wavelength of 2 µm is absorbed by the cornea and does not reach the sensitive retina, which enables safer use in industrial and medical applications.

About the Fraunhofer IOF

The Fraunhofer Institute for Applied Optics and Precision Engineering IOF in Jena conducts applied research in the field of Photonics and develops innovative optical systems for the control of light - from its generation and manipulation to its application. The institute's range of services covers the entire Photonics process chain from opto-mechanical and opto-electronic system design to the production of customer-specific solutions and prototypes. Around 500 employees at the Fraunhofer IOF work on the annual research volume of 40 million euros.

Further information about the Fraunhofer IOF can be found at:
https://www.iof.fraunhofer.de/en.html

Scientific contact

Dr. Till Walbaum
Fraunhofer IOF
Department Laser and Fiber Technology | Group leader Laser

Phone: +49 (0) 3641 807- 604
Mail: till.walbaum@iof.fraunhofer.de

Friedrich Möller
Fraunhofer IOF
Department Laser and Fiber Technology | Group Laser Technology

Phone: +49 (0) 3641 807- 365
Mail: friedrich.moeller@iof.fraunhofer.de

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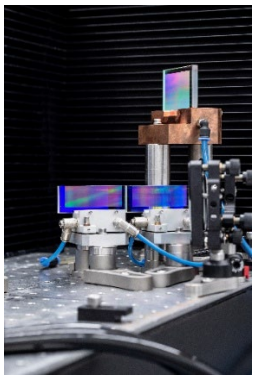
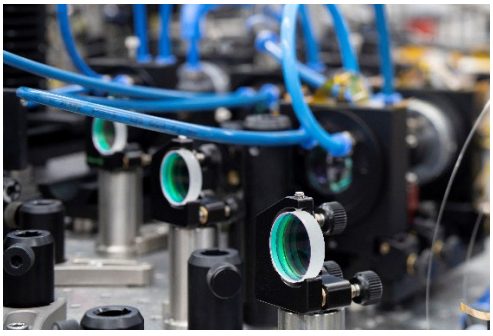
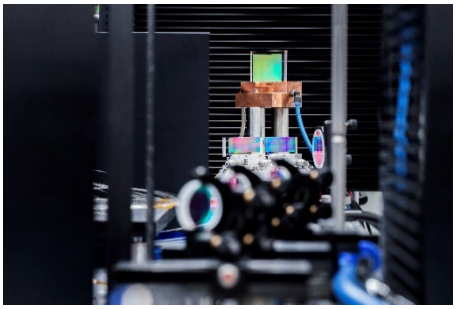


In-house manufactured optical reflection gratings for multi-kW beam combination at wavelengths of 2µm. © Fraunhofer IOF



Laser output and mirror for beam guidance of three high-power laser beams. © Fraunhofer IOF



Three parallel individual beams are combined into a laser beam with a record output of 1.91 kW by means of height-shifted reflection gratings. © Fraunhofer IOF

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