Fraunhofer ILT

Fraunhofer Institute for Laser Technology ILT

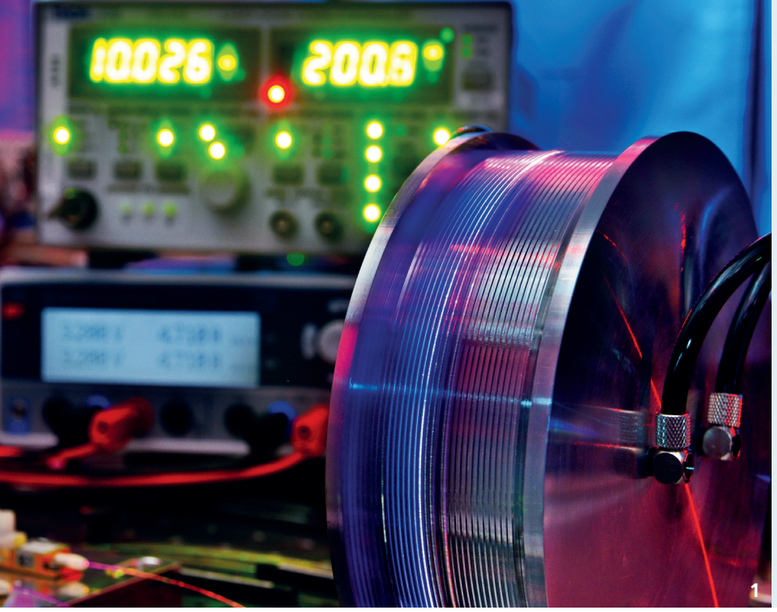
Fiber Lasers

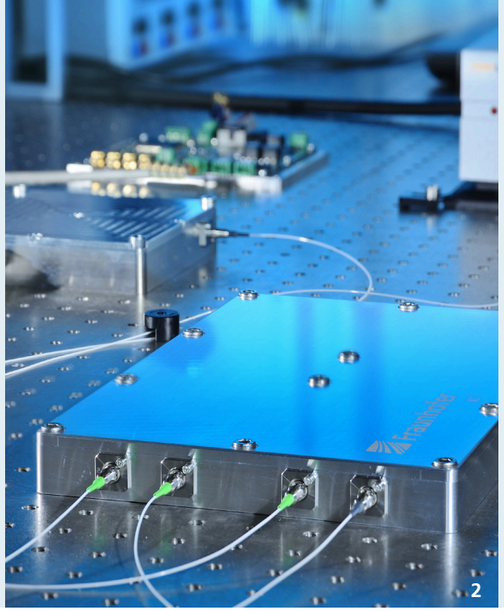
The Fraunhofer Institute for Laser Technology ILT develops adapted fiber-based beam sources for pulsed and continuous wave operation and offers its customers broad know-how in the fields of ultra-high stability fiber lasers, high power fiber lasers, simulation, packaging and splicing technology as well as laser components. In addition it places with a special focus on industrially feasible solutions.

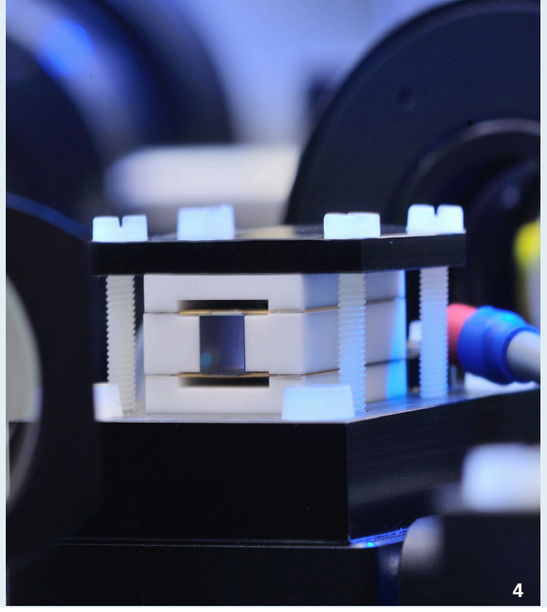
Fiber Lasers

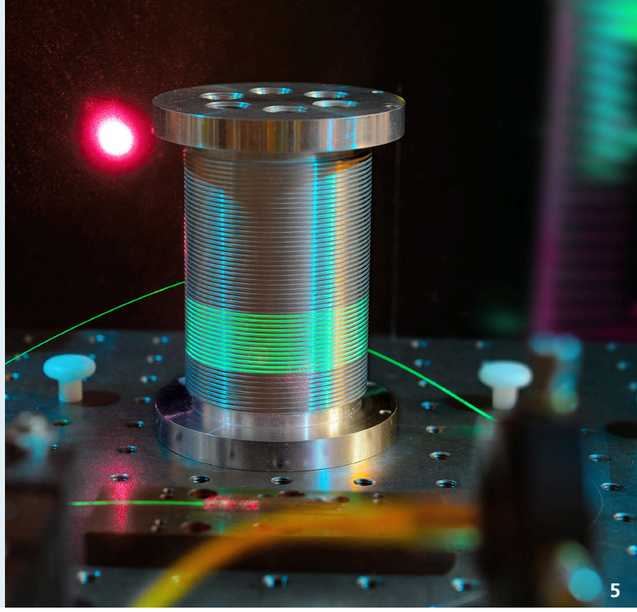
Fiber lasers combine highest beam quality and efficiency, both in continuous and pulsed operation. These lasers have established themselves in industrial applications alongside gas and solid-state lasers and have partially replaced them since they can be designed monolithically and, therefore, very robustly without needing free-space components. Thanks to its high flexibility of output parameters, such as power, wavelength or pulse shape, fiber lasers can be used for a wide range of applications: in material processing, e. g. for ablation and welding, interferometry in metrology, or in medical technology.

Q-switched high-power fiber laser.









Fiber Lasers

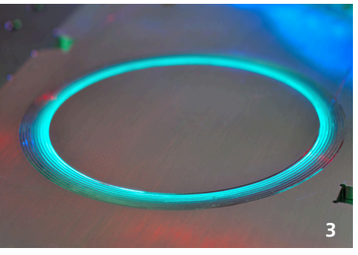
High-power fiber lasers for industrial applications

In various R&D projects, Fraunhofer ILT is developing and building lasers with output powers in the kilowatt range. By using fiber Bragg gratings and pump light couplers, it can develop fully fiber-integrated and, thus, particularly robust fiber lasers as resonators or amplifiers. The wavelength, pulse duration and polarization of the light can be adjusted to suit the application.

In cooperation with our customers we design and conceptualize adapted beam sources for various applications, such as:

- Ytterbium-doped fiber lasers (1000–1100 nm)
  - with up to 1 kW output power, linearly polarized, in single-mode operation
  - with up to 100 kW peak power, pulse duration range from pico- to microseconds
  - with up to 250 kW peak power, Q-switched, multi-mode fiber
- Thulium-doped fiber lasers (1900–2000 nm)
  - with up to multi-100 W peak power, QCW from µs to ms, in single-mode or multi-mode operation
  - with up to multi-10 W output power, in single-mode operation
- Holmium-doped fiber lasers (2000–2100 nm)
  - with up to 10 W output power, linearly polarized, in single-mode operation

Applications include (industrial) structuring of surfaces with pulsed radiation, adhesive surface preparation of composite components, medical technology, or cutting and welding.



1. Laboratory demonstrator of a highly stable thulium-doped fiber amplifier.
2. Prototype of a highly stable fiber laser for satellite use.
3. Active fiber in laser ground plane.

Highly stable fiber amplifiers for narrow band signals

To measure the gravitational field and gravitational waves, Fraunhofer ILT is developing narrowband, linearly polarized and ultra-high stability single-mode fiber amplifiers, e. g. with line widths < 10 kHz and an output power noise of less than 0.01 percent at a frequency of 100 Hz.

An ytterbium-doped fiber laser with up to 5 W output power is being developed as part of a preliminary study for the European Space Agency (ESA). The lasers will be exposed to different stresses such as shocks, vibrations, cosmic irradiation and vacuum in environmental test campaigns to determine if they are suitable for space applications.

Within the Interreg project ETEST, the institute is developing thulium- and holmium-doped fiber lasers with wavelengths around 2 µm and output powers of up to 10 W. The aim is to develop and demonstrate the technology required for a third generation gravitational wave detectors.

Simulation of optical components and fiber lasers

Various software tools are available at Fraunhofer ILT for the development and design of new beam sources. These tools are used to model both the thermo-mechanical properties using finite element methods (FEM) and the spectral and temporal properties of differently doped fiber lasers. Furthermore, they can simulate modal properties during propagation in arbitrary fiber geometries as well as mode coupling, e. g., in fiber Bragg gratings.

Fiber laser components, assembly and splicing technology

The design of our fiber lasers places the highest demands on the quality of the components. For this reason, the institute qualifies fiber-integrated and fiber-coupled components for the respective application in extensive tests in house. In addition, it continues to develop splice connections for power scaling. In many cases, commercial components are not available due to the special requirements and are, therefore, developed at Fraunhofer ILT according to needs, such as:

- Fiber Bragg gratings for multi-mode fibers
- Mode field adapters and mode strippers for space applications
- Isolators and Pockels cells, free of organic materials, for space applications as well as high power applications
- Pump and signal light couplers for adapted fiber geometries

4. Soldered Pockels cell as Q-switch.
5. Narrowband fiber laser for the investigation of stimulated Brillouin scattering.

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Fraunhofer Institute for Laser Technology ILT

The Fraunhofer Institute for Laser Technology ILT is one of the most important development and contract research institutes in laser development and application worldwide. Its activities encompass a wide range of areas such as developing new laser beam sources and components, laser-based metrology, testing technology and industrial laser processes. This includes laser cutting, ablation, drilling, welding and soldering as well as surface treatment, micro processing and additive manufacturing. Furthermore, Fraunhofer ILT develops photonic components and beam sources for quantum technology.

Overall, Fraunhofer ILT is active in the fields of laser plant technology, digitalization, process monitoring and control, simulation and modeling, AI in laser technology and in the entire system technology. We offer feasibility studies, process qualification and laser integration in customized manufacturing lines. The institute focuses on research and development for industrial and societal challenges in the areas of health, safety, communication, production, mobility, energy and environment. Fraunhofer ILT is integrated into the Fraunhofer Gesellschaft.

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Subject to alterations in specifications and other technical information.