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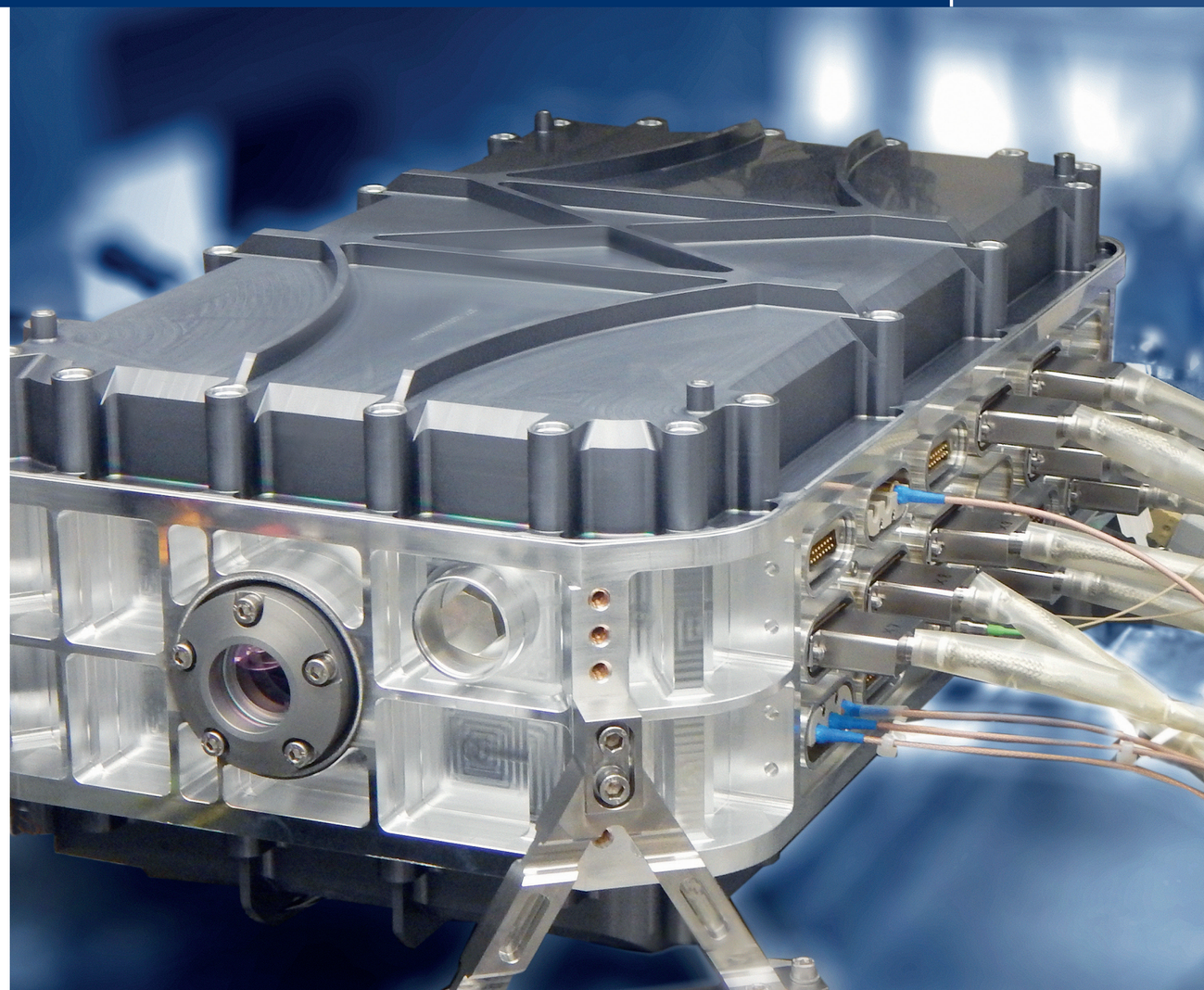
FRAUNHOFER INSTITUTE FOR LASER TECHNOLOGY ILT

SOLID STATE LASERS



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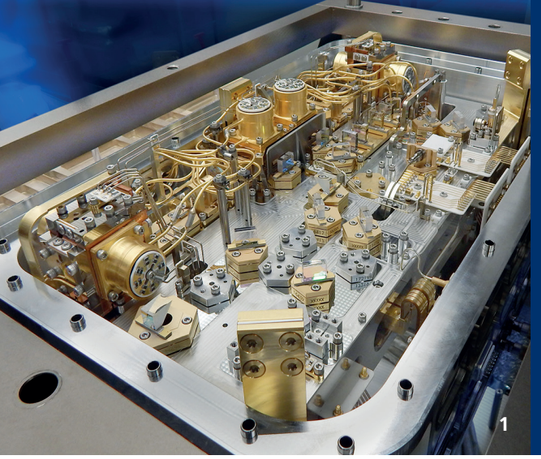
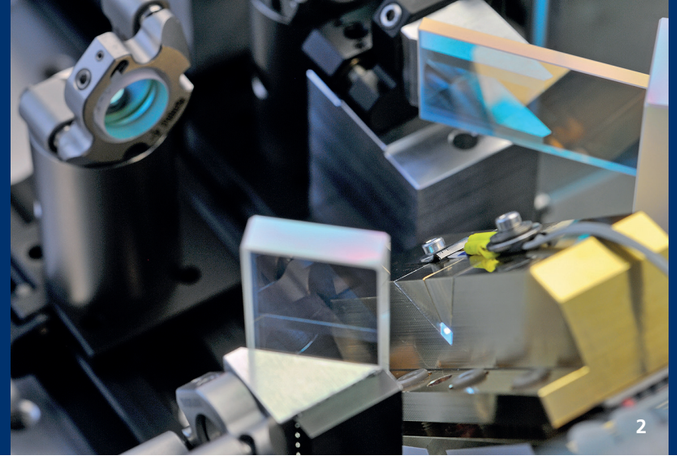
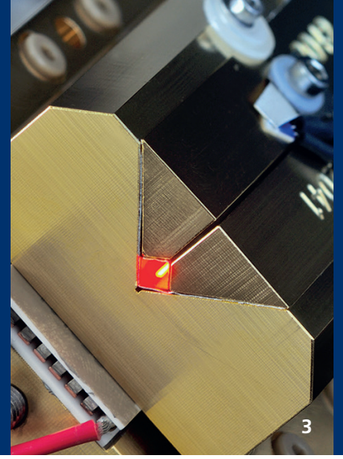
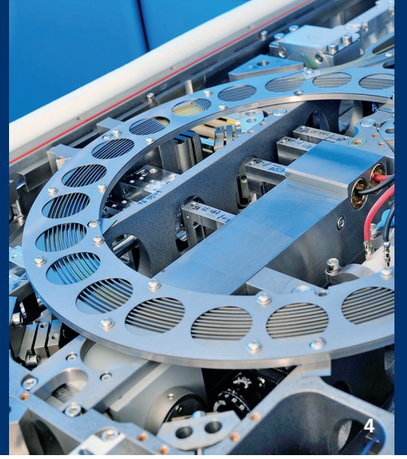
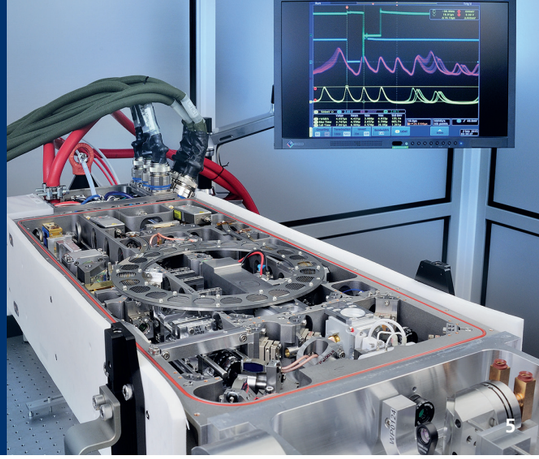
Fraunhofer Institute for Laser Technology ILT

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

SOLID STATE LASERS

Solid state lasers have opened a wide range of applications in industry and research. These beam sources have particular advantages because they can be adapted to a multitude of different applications. When laser materials as well as pump and resonator geometry are varied, laser oscillators and amplifiers can be designed having various output powers, pulse duration and wavelengths.

Services

At the Fraunhofer Institute for Laser Technology ILT, we assist our customers from industry and research in accomplishing their tasks and solving any issues regarding solid state lasers. The variety of R&D services we offer ranges from the design and simulation of customers' specific laser oscillators and amplifiers through experimental investigations on laboratory prototypes all the way to the development of industry-oriented, CE-certified prototypes. Here, we focus on optimizing the lasers' properties and expanding their parameter ranges.

By offering competent technology consultation, including market and feasibility studies, we advise our customers as to which product designs can be implemented successfully and how new products can be planned best. We deliver solutions to technically implement innovative ideas as well as to optimize efficiency and lower the costs of existing products.

Oscillators

When developing tailored laser oscillators, we draw on our experience with various active laser media. For this purpose, Nd-, Tm-, Ho-, Er- and Cr-doped crystals, among others, are used. Pump and resonator arrangements are optimized for crystals in slab, rod or disk geometry. Together with partners from research and industry, we also develop novel kinds of crystals in order to generate wavelengths adapted to an application in a direct and efficient manner.

We calculate and optimize efficiency, stability and beam quality of laser resonators by means of analytical and numerical analysis and simulation processes. When the resonator is Q-switched and the mode-coupled, laser pulses are generated whose duration, energy and repetition rate can be adapted within a wide range. The spectral bandwidth of laser pulses can be narrowed to the bandwidth limit by seeding the laser oscillator with a highly stable reference laser source. The laser frequency is stabilized by actively controlling the resonator length.

On this basis, we develop and build lasers for a wide range of applications, from materials processing to plasma generation all the way to the detection of trace gases.

Amplifiers

We develop and implement efficient amplifier systems for the power scaling of laser oscillators based on INNOSLAB or rod lasers. The laser sources we use here are either laser oscillators developed by Fraunhofer ILT or those supplied by our customers, such as diode lasers, rod lasers or fiber lasers. As a rule, the specific properties of the respective beam source – such as, for example, beam quality, spectral bandwidth and purity, pulse length and stability – during the power scaling should be maintained. By selecting the right conceptual design, we can cover a wide range of our customers' specific requirements thanks to modular platforms. Here, existing solutions based on Nd-, Tm-, Ho-, Er- and Cr-doped crystals can serve as the basis. Particularly noteworthy are the following amplifiers:

- INNOSLAB amplifier for pulsed laser sources with pulse lengths in the nano- and picosecond range, which also produces high average and peak pulse power
- Amplifiers for extremely narrow-band laser sources for scientific applications and aerospace applications
- Diode-seeded regenerative amplifiers with tunable pulse lengths

Prototype Development

In qualified teams, we develop tailor-made solutions for our customers' specific applications. At the same time, we assist our customers in developing the proper requirements for the laser. We consistently implement the resulting solutions right up to the finished prototype. These are already successfully being used in the industry, in scientific laboratories and in aerospace and serve as a basis for the product development of industrial laser manufacturers.

One example is the LIDAR laser for aerospace applications, where harsh environmental conditions place particularly high demands on the system's mechanical and thermal load-bearing capacity. For this extreme operating environment, we have placed great emphasis on robustness, compactness and efficiency in the laser design.

Simulations and Consulting

We gradually optimize every step in laser design and can optimize the most important influential parameters: beginning with the simulation of the pump distribution in the laser crystal and the resulting temperature and voltage distribution over the amplification properties of the pumped medium all the way to the resonator design of laser oscillators and amplifiers.

In this way we can forecast the spatial, temporal and energetic beam characteristics of the laser, while allowing for diffraction, amplification and polarization effects. Tolerance analyzes also help us to optimize the entire system while we take the given boundary conditions into account.

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Cover: FULAS – Future laser technology demonstrator (as part of the ESA project FULAS and the BMWi project Optomech II / III in cooperation with Airbus DS GmbH).
1 FULAS – interior view.
2 Tm: YLF oscillator - detail.
3 Pumped Ho: YLF crystal.
4 LIDAR laser – detail.
5 Pulsed single frequency LIDAR laser for helicopter use.