

OPTICS DESIGN AND DIODE LASERS

Lasers and Laser Optics

- Optics Design & Diode Lasers
- Solid State Lasers
- Ultrafast Lasers
- Fiber Lasers
- Nonlinear Optics
& Tunable Lasers
- Packaging



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**Fraunhofer Institute
for Laser Technology ILT**

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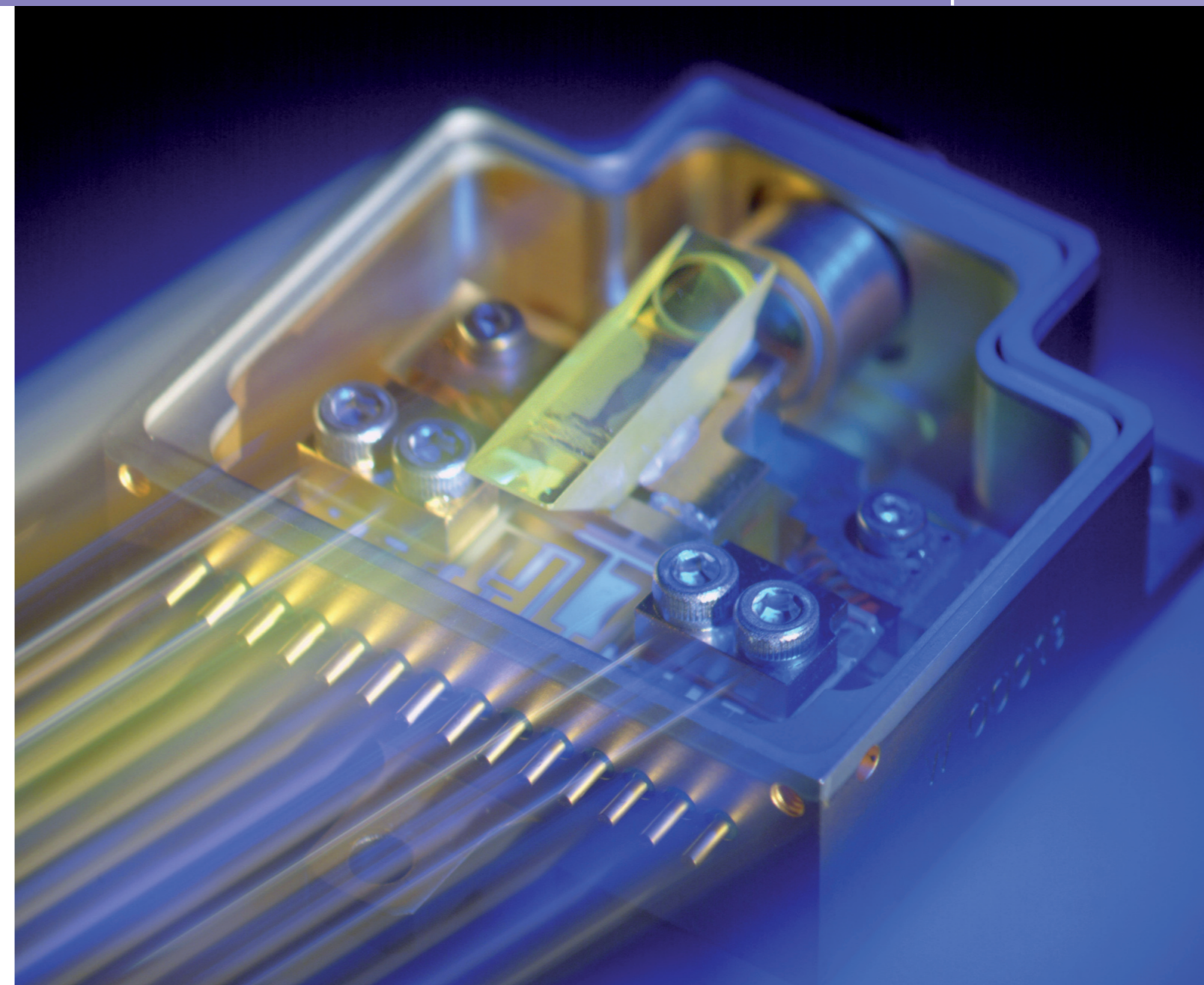
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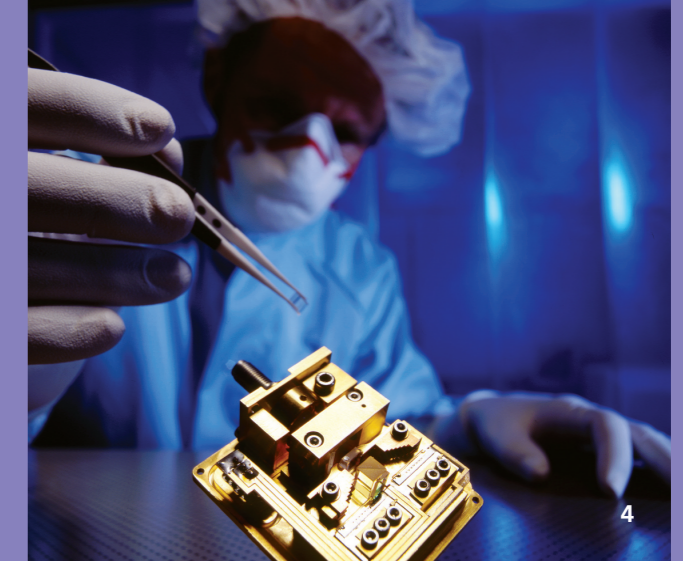
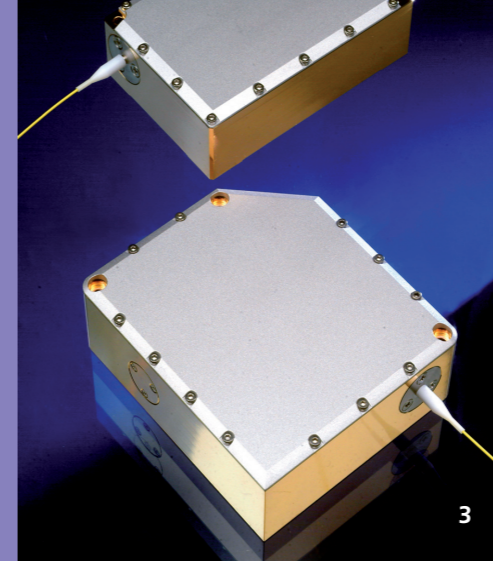
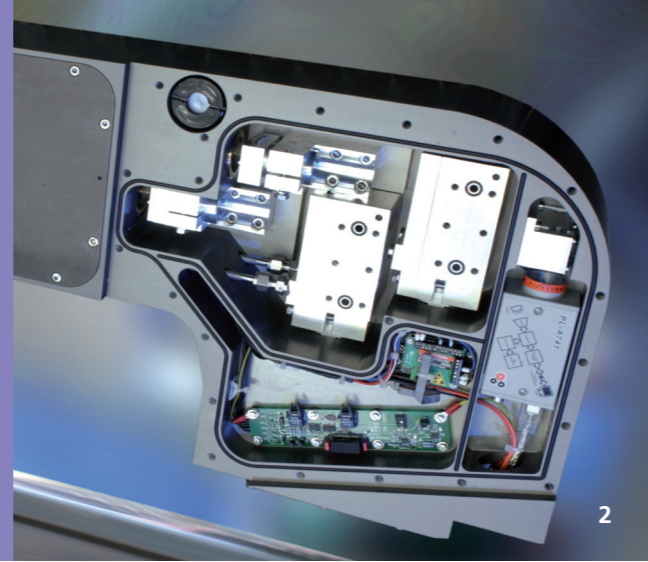
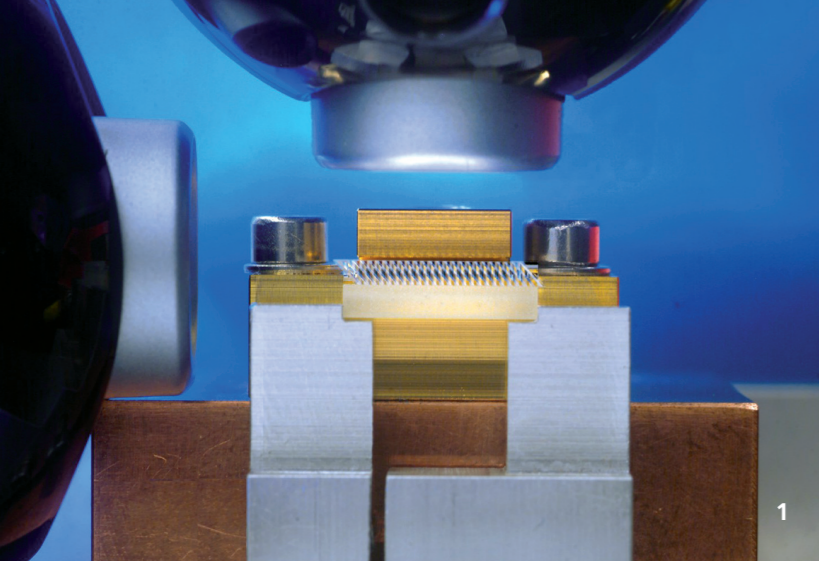
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Fraunhofer Institute for Laser Technology ILT

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.





OPTICS DESIGN AND DIODE LASERS

At the Fraunhofer Institute for Laser Technology ILT, we support our customers from industry and research to accomplish their tasks and answer their questions regarding optics design and the development of diode lasers. We will help you implement product strategies or plan new products by competently consulting you as well as performing market and feasibility studies. Our R&D services range from design and simulation to experimental investigations on prototypes, all the way to the development of industry-oriented, CE-certified prototypes.

Diode Laser Modules

Diode laser modules are used as pump sources for solid-state and fiber lasers, to amplify signals in telecommunications as well as in direct materials processing (e.g. plastics welding). The main advantages of diode laser modules are their high electro-optical efficiency, compact size and cost-efficiency.

At the Fraunhofer ILT, diode laser modules are designed and built according to our customer's specific requirements. Among these count fiber coupling concepts for multimode or single mode radiation as well as frequency stabilization and incoherent spectral scaling of output power (Dense Wavelength Multiplexing). In addition to optics design, including tolerance analysis, we emphasize thermal and mechanical design as well as assembly engineering all the way to fully automatic adjustment of optical components.

Characterization

By means of various measuring and testing procedures, we investigate assembled high-performance diode laser bars on their electro-optical properties and identify how the structural design engineering influences their efficiency:

- Electro-optical characterization: The relevant characteristic data of the diode laser are recorded in dependence upon the operating current. From these measurements further data are derived, for example, the thermal resistance of the diode laser.
- Space-resolved characterization: Individual emitters of the diode laser bar can be characterized regarding power density, wavelength and polarization. These results enable conclusions to be made on the thermal and thermo-mechanical influence of the structural design engineering.
- Measurement of the spatial power density distribution: Beam profiles can be determined by using a fiber sensor (NFSM). The measurement can also be conducted for extended distributions and maximum output power.
- Measurement of the angular power density distribution: The power density distribution of diode laser bars is determined in dependency upon the radiation angle.
- Determination of the diode laser smile: The deformation of the diode laser is determined with a resolution in the range of sub micrometers. The results enable an evaluation to be made of the structural design engineering as well as of the quality of the microscopic components used.

Process-adapted Power Density Distributions

In addition to the classical requirements upon the design of optical systems, such as diffraction-limited imaging and focussing, the generation of process-adapted power density distributions is gaining significance. Intelligent optical systems can be generated by connecting conventional optics with innovative beam forming elements and open up a wide range of applications. The implementation of these designs in robust and industry-ready prototypes rounds off the development of optical systems.

On the basis of long-term experience, we develop for our customers tailor-made optical systems that can be applied in materials processing, illumination and as pump sources for solid-state lasers. To realize these systems, our highly qualified employees have a comprehensive technical infrastructure at their disposal.

Freeform Optics for LED Illumination Applications

Freeform optics pass beyond the limits of classical optics and set a new trend in the sector of optics design. They cannot be described analytically, but rather can only be defined by the local interpolation of control points. In particular, in the sector of LED illumination applications, this technology has found great interest. Numerically complex optimization algorithms are at the center of this development at the Fraunhofer ILT. Moreover, we also utilize freeform surfaces in laser systems.

Optics Design

We offer a comprehensive package to develop customer-specific prototypes ready for series production:

- Dimensioning of classical optical systems using sequential ray tracing
- Non-sequential ray tracing and tolerance analysis of high-performance diode lasers, based on measuring farfield distributions
- New concepts to symmetrize the beam parameter products by using beam transformation
- One and two-dimensional homogenization of high-performance laser emission
- Micro optics for beam forming
- Frequency stabilization and spectral superposition
- Error and risk analysis including CE certification of developed prototypes

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- 1 Automated adjustment and assembly of micro-optical components.
- 2 Robust beam transformation system for fiber-coupled multi-kW lasers.
- 3 Fiber laser pump module.
- 4 Diode laser module for use in outer space.