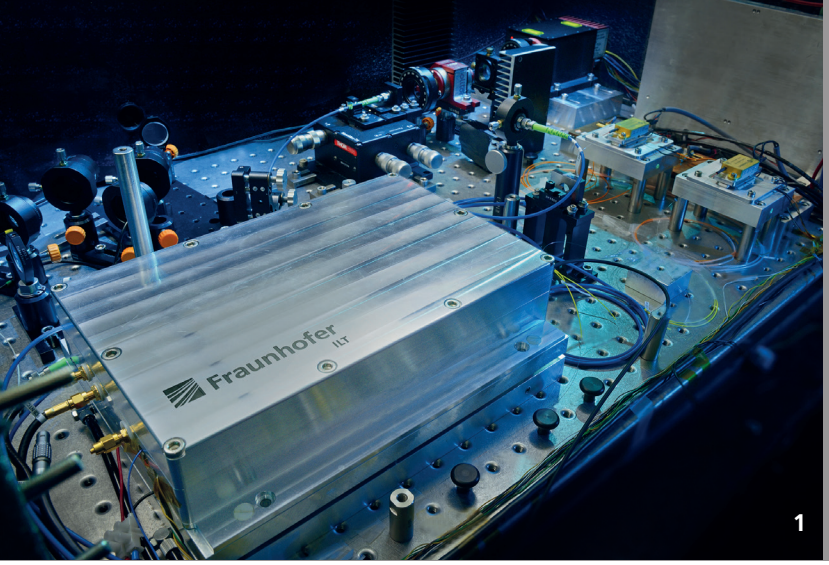

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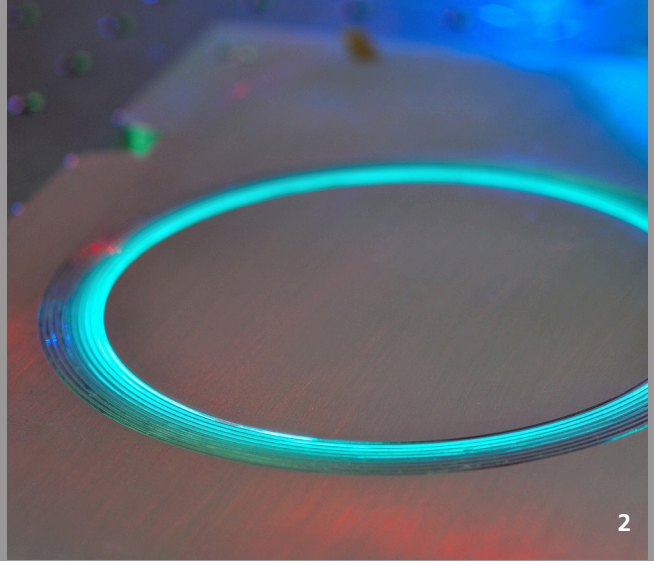
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Subject to alterations in specifications and other technical information. 06/2022.

HIGHLY STABLE FIBER AMPLIFIERS FOR SATELLITE-BASED GRAVITATIONAL WAVE DETECTION

Task

Within a project of the European Space Agency ESA, Fraunhofer ILT has developed and built a power-stabilized, spectrally narrowband fiber amplifier with 10 W output power as a study for the future space-based gravitational wave detector LISA (Laser Interferometer Space Antenna). Since the requirements for the engineering model (EM) have become stricter, the institute is continuing to develop and investigate the amplifier, including stability requirements for power and phase; the EM is being implemented at a project partner in the current project phase. Furthermore, since the Technology Readiness Level (TRL) of the components has to be confirmed for the EM, Fraunhofer ILT is conducting long-term tests of the components in a vacuum.

Method

In order to meet the extreme stability requirements for the EM as well, the institute is designing and experimentally comparing different fiber amplifier concepts. One question here is whether the particularly strict requirements are technically feasible. Special measuring stations are used to measure the power stability and the phase noise. For the operational thermal-vacuum component tests, Fraunhofer ILT is developing a fiber amplifier based on the technology established for the LISA.

1 Breadboard setup of the highly stable fiber amplifier of the LISA preliminary study.

2 Active fiber of the amplifier in fiber spiral.

Results

An output power of 10 W with a spectral linewidth of < 10 kHz at a wavelength of 1064 nm could be demonstrated for the fiber amplifier concepts investigated. To the best of our knowledge, the high power stability requirements of the LISA mission could be met for the first time worldwide at Fraunhofer ILT over the entire frequency range, especially in the technically challenging low frequency range from 10^{-5} to 1 Hz. The institute also investigated the physical feasibility of the phase noise requirements, which were fulfilled for 1 W output power.

Applications

In addition to their use in gravitational wave detectors, highly stable narrowband fiber amplifiers can be used for quantum technology, satellite-based gravitational field measurement and in communications applications.

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