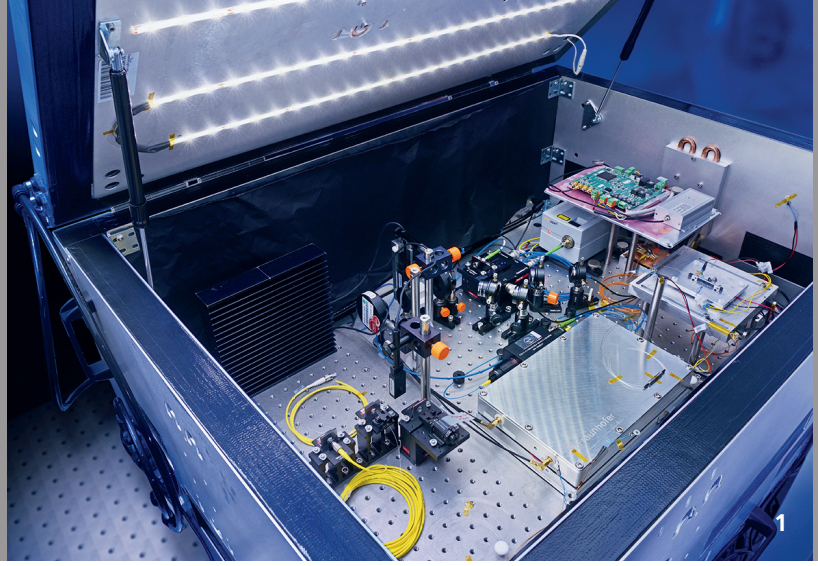

LISA – HIGHLY STABLE FIBER AMPLIFIER FOR GRAVITATIONAL WAVE DETECTION

Task

The future space-based gravitational wave detector LISA (Laser Interferometer Space Antenna) requires a narrow-band, linearly polarized and highly stable single-mode laser with an output power of greater than 2 W and phase modulation at ± 2.4 GHz around the central wavelength of 1064 nm. Within a project for the European Space Agency ESA as a study for the LISA mission, Fraunhofer ILT and its partners have initially developed and built a power-stabilized fiber amplifier with an output power greater than 2 W. Currently, the amplifier is to be revised and optimized with regard to power stability in the low frequency range, and the components installed are to be tested and qualified for use in a satellite.

Method

To minimize the amplified spontaneous emission (ASE) and its influence on the power stability of the system, Fraunhofer ILT redesigned the laser and built a two-stage fiber amplifier. Furthermore, it investigated in detail the laser's relative intensity noise (RIN) in the frequency range from 10^{-5} Hz to 10^{5} Hz and the necessary modulation of the sidebands. Due to the extremely high stability requirements, all thermal influences had to be minimized as far as possible during setup in the laboratory, making the thermal enclosure of both the laser itself and the measurement setup necessary.

1 Thermal enclosure of the fiber amplifier and the measurement setup for stabilization.

Results

The highly stable fiber amplifier built at Fraunhofer ILT with a spectral linewidth below 10 kHz at 1064 nm generates an output power of more than 2 W. The power fraction based on nonlinear effects, especially stimulated Brillouin scattering (SBS) and ASE, has been minimized. In addition, a polarization extinction ratio of 25 dB and a very good beam quality M^2 of 1.1 have been achieved. In the entire frequency range, the amplifier fulfills the RIN requirement so that all required specifications could be demonstrated except for the phase sideband fidelity, which is still to be demonstrated in current investigations.

Applications

The highly stable and narrow-band fiber amplifier can be used for satellite-based gravitational field measurement, atom cooling and trapping, and communications applications, in addition to its use in space-based and earth-based gravitational wave detectors.

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