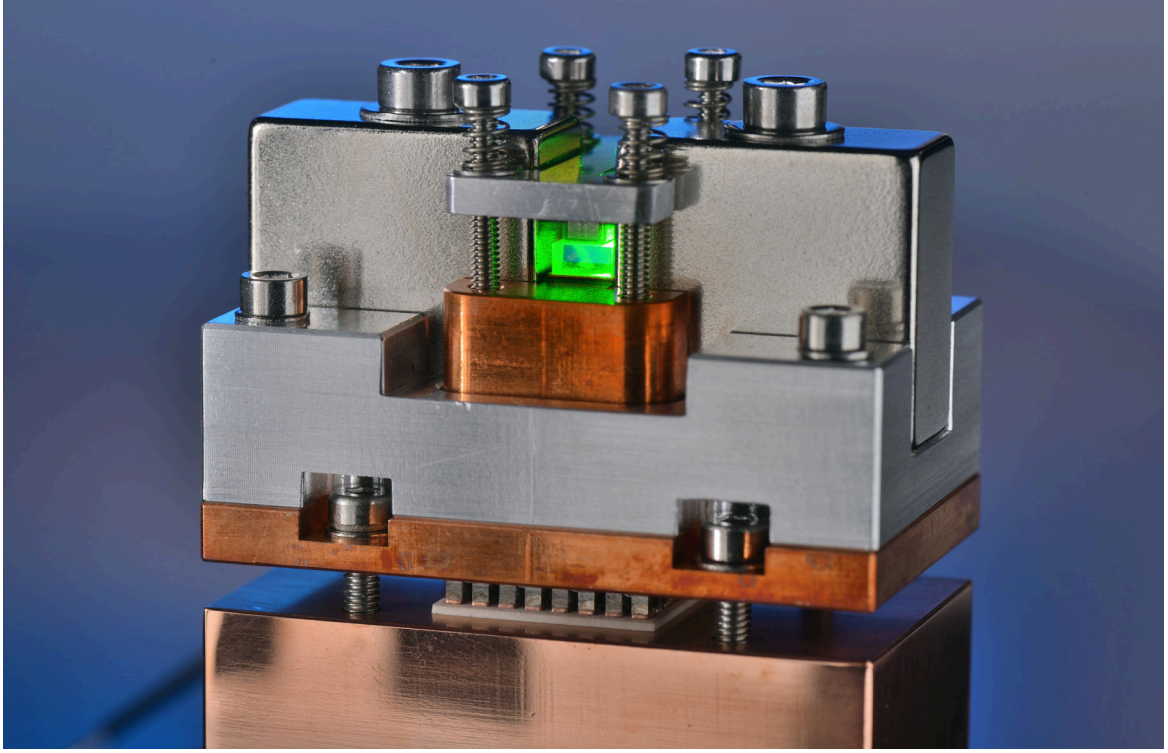

1 Laboratory demonstrator of a 2 µm NPRO.

Non planar ring oscillator at 2 µm wavelength

Third-generation gravitational wave detectors (GWD) have enormous potential to help scientists make new discoveries in astrophysics or cosmology. They require, however, highly stable laser systems in all parameters. In current laser systems for GWDs, non planar ring oscillators (NPRO) with an emission wavelength of 1064 nm are often used as seed lasers for a subsequent amplifier chain. As part of the Interreg project E-TEST, Fraunhofer ILT is developing an NPRO laser emitting at a wavelength of 2 µm, which serves as a highly stable seed laser for a power-stabilized fiber amplifier system. This wavelength can be used to extend the range of gravitational wave measurements in the lower frequency spectrum.

Monolithic laser with maximum stability

An NPRO is a monolithic laser oscillator in which the laser beam propagates in a ring using total internal reflection through the laser crystal. This field-tested system enables very high power and frequency stability. In order to achieve a wavelength of 2 µm, Fraunhofer ILT developed and built an NPRO based on an Ho:YAG laser medium. This is pumped through a multi-stage, highly stable thulium fiber laser developed at Fraunhofer ILT. Little heat is generated in the NPRO laser crystal thanks to the small wavelength difference between the two laser media.

Results and outlook

Two different NPRO systems have been built. The institute demonstrated that the first system reached an output power of up to 350 mW at a wavelength of 2120 nm in longitudinal single mode, and the second system up to 50 mW at a wavelength of 2090 nm. In both systems, an almost diffraction-limited beam quality was achieved, and both a relative power stability of 0.2 percent and a degree of polarization > 20 dB were demonstrated. The next step will be to amplify the NPRO at 2090 nm using a holmium fiber amplifier chain developed at Fraunhofer ILT. This system is to be frequency- and power-stabilized using active methods in order to meet the extreme requirements of future gravitational wave detectors. The work was funded by the European Regional Development Fund on behalf of the Ministry of Economic Affairs, Innovation, Digitization and Energy of the State of North Rhine-Westphalia

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