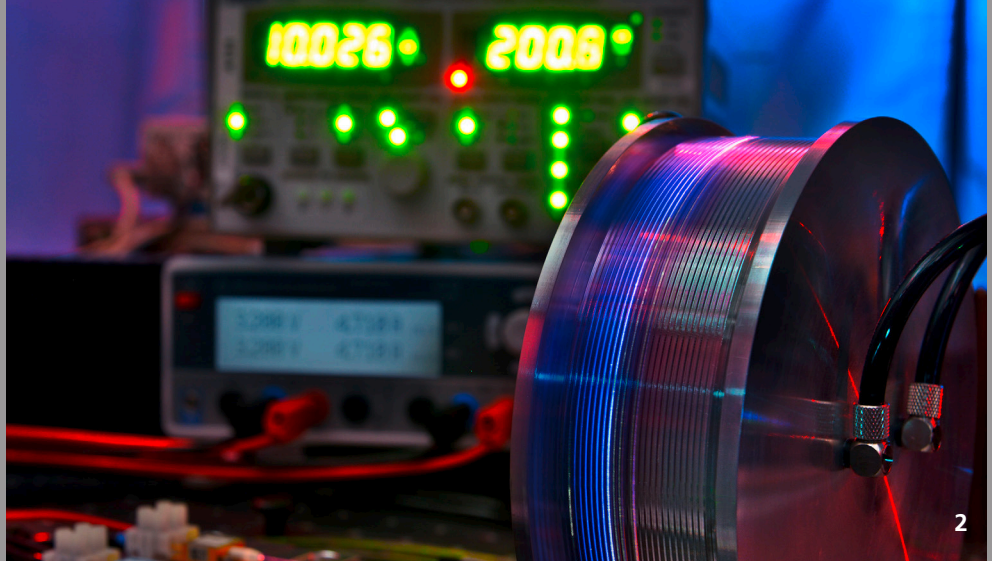

LASER BEAM SOURCES WITH A WAVELENGTH OF 2 µm FOR GRAVITATIONAL WAVE DETECTION

Task

Gravitational wave detectors provide an alternative view into interstellar processes such as the collision of stars and black holes, which can be detected by specific signatures in the form of gravitational waves. These detectors, thus, complement other established observational methods in the exploration of the universe. In the E-TEST project, key technologies are being developed for a third-generation gravitational wave detector, also known as an Einstein telescope. To this end, Fraunhofer ILT is developing a highly stable laser with a wavelength of about 2 µm and a spectral linewidth of less than 10 kHz, which could be used within an interferometer to detect minute changes in length induced by gravitational waves.

Method

To generate radiation with a narrow linewidth at a wavelength of about 2090 nm, the institute is investigating different solid-state laser concepts. As a first approach, it will develop a unidirectional ring oscillator based on Ho:YAG crystals and – using the knowledge gained from this – a non-planar ring oscillator, which is particularly suitable for generating radiation with a low linewidth. A multistage fiber laser concept based on holmium-doped fibers will be developed to amplify the generated radiation. The extremely high stability requirements are to be met by actively controlling different actuators. Furthermore, the institute is developing highly stable thulium-doped fiber lasers at a wavelength of about 1950 nm to pump the fiber laser.

Results

After the concept was developed, the first stage of the fiber laser for amplifying radiation around 2090 nm was designed and tested experimentally. The next steps will be to actively stabilize the output power and investigate the solid-state laser experimentally.

Applications

Beam sources with wavelengths around 2 µm have other applications besides gravitational wave detectors, including those in quantum technology, medical technology and materials processing. While an improved signal-to-noise ratio of the gravitational wave detector is targeted in interferometry, in medical technology and material processing the improved absorption of the 2 µm radiation is relevant.

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2 Thulium-doped fiber amplifier for E-TEST.