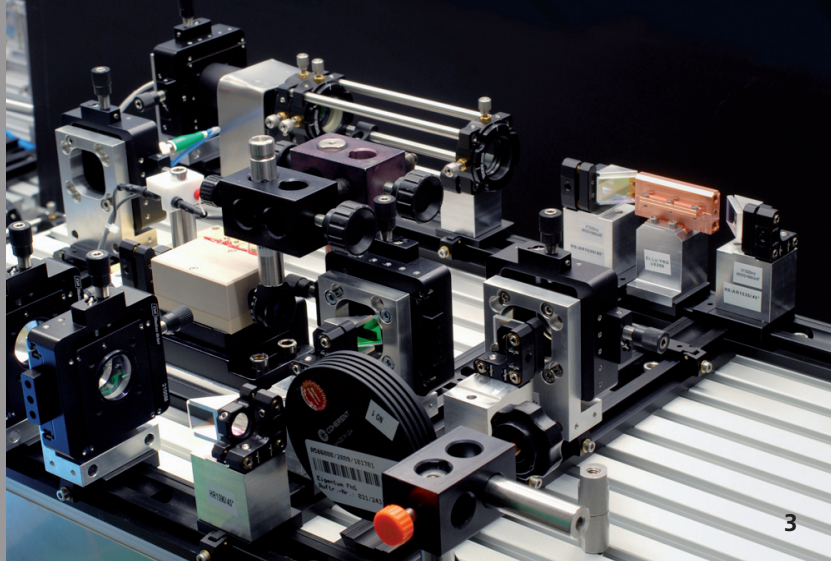
2


3

SINGLE-FREQUENCY ER:YLUAG LASER AT 1645 NM FOR A METHANE LIDAR

Task

The distribution and quantity of the greenhouse gases CO_2 and CH_4 in the atmosphere influence the climate, which is why they are the subject of research. Absorption lines of molecules in the 1.6 µm range can be used to measure these gases with LIDAR techniques. These techniques require narrowband (single frequency) laser radiation with a line width under 20 MHz; to date, this has been implemented using nonlinear conversion stages (OPO/OPA). Directly generating this kind of laser radiation in solid state lasers based on erbium-doped crystals dispenses with additional nonlinear processes and promises superior efficiency and robustness. Both are important factors for subsequent use on satellites.

Method

A solid state laser with an erbium-doped laser crystal is set up, and pumped with fiber lasers at a wavelength of 1532 nm. The Er:YLuAG laser crystal has a specifically optimized composition whereby the maximum emission cross-section in the erbium ion occurs at the envisaged emission wavelength. The laser oscillator is Q-switched at a repetition rate of 100 Hz and runs in longitudinal single mode ("single-frequency") with active resonator length control.

Result

For the first time a pulsed laser was set up with this laser material; it currently achieves a pulse energy of 2.3 mJ with approx. 3 percent optical efficiency and $M^2 = 1$ in single-frequency mode. The pulse duration is 90 ns. For the first time the methane absorption line at 1645.1 nm (in air) together with its substructure was successfully measured in a methane reference cell in the laboratory without the use of nonlinear converter stages.

At present, the pulse energy is limited by the available pump power. Based on the results obtained to date, further research aims to achieve a minimum two-fold efficiency increase from improved crystal cooling and an optimized design of the laser resonator.

Applications

Laser radiation with wavelengths around 1.6 µm also has uses in medical technology. Another potential application is in laser material processing for materials that are transparent at visible wavelengths.

This research was funded by Germany's Federal Ministry of Education and Research (BMBF) under reference number 01 LK 0905 B.

Contacts

Dipl.-Phys. Ansgar Meissner
Phone +49 241 8906-132
ansgar.meissner@ilt.fraunhofer.de

Dipl.-Phys. Marco Hoefer
Phone +49 241 8906-128
marco.hoefer@ilt.fraunhofer.de

2 Er:YLuAG laser crystal.

3 Single-frequency laser with Er:YLuAG crystal.