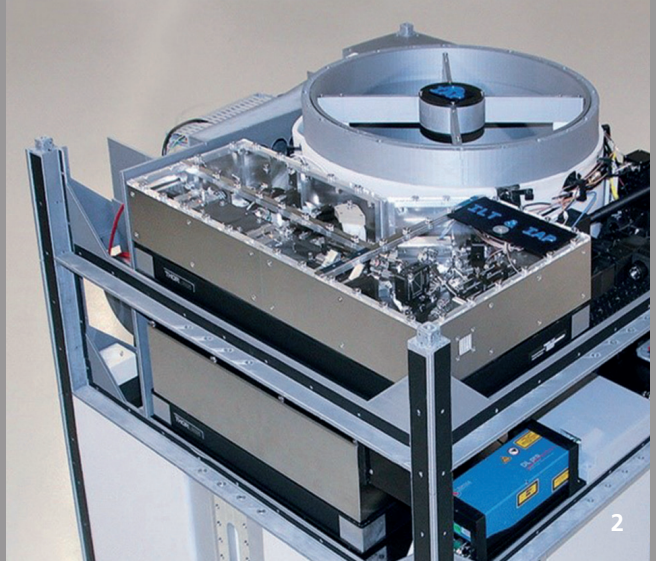

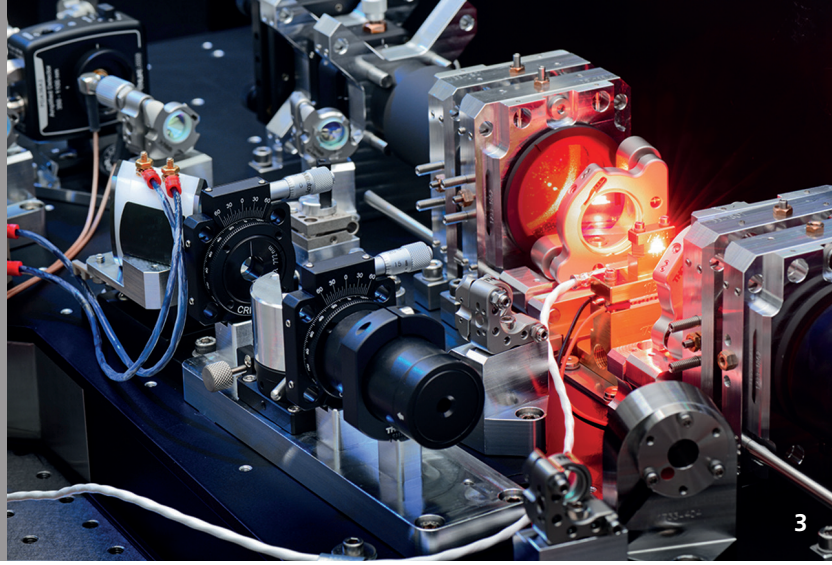

DIODE-PUMPED ALEXANDRITE LASER FOR A COMPACT LIDAR SYSTEM

Task

At the Leibniz Institute for Atmospheric Physics (IAP), mobile resonance LIDAR systems are being used to measure temperature profiles of the atmosphere at altitudes between 80 and 110 km. To accomplish this, the Doppler width of a metal resonance line is spectroscopically determined as a measure of temperature. The institute used flash lamp-pumped alexandrite ring lasers as laser emitters for a long time. The successful development of the first diode-pumped alexandrite laser significantly increased the efficiency and reduced the space requirements. On this basis, IAP and Fraunhofer ILT jointly developed a new type of compact LIDAR system (~ $1 m^3$) using innovative LIDAR technology, which can be used to measure the entire atmosphere from the troposphere to the lower thermosphere. For this purpose, Fraunhofer ILT developed an improved prototype of the laser and integrated it into a new LIDAR system.

Method

The prototype operates as a Q-switched alexandrite ring laser. The pump source is fiber-coupled, which increases flexibility and maintainability, and is based on two commercial diode laser modules, each emitting up to 40 W average power at 638 nm in continuous operation. Stable single-frequency operation is achieved by seeding with a narrow-band diode laser and by electronic control of the resonator length. The output wavelength of the alexandrite laser can also be continuously tuned in the potassium resonance range with the wavelength of the seeder. After completion in the laboratory, the laser was integrated into the system of IAP, which contains the laser's peripheral equipment as well as the entire LIDAR technology.

Results

In transverse fundamental mode operation ($M^2 < 1.1$), the laser emits pulses at a wavelength of 770 nm, an energy of 1.7 mJ and a repetition rate of 500 Hz. The pulse duration is 800 ns with a spectral bandwidth of less than 5 MHz. Thus, the total space requirements including the cooling technology as well as the energy consumption could be reduced by a factor of 100 compared to the previous LIDAR system, which used a flash lamp-pumped laser.

Applications

In the next step, several such systems will be built and combined to form a LIDAR array with spatial coverage over several 100 kilometers. In the ALISE research project (grant number 50RP1605) funded by the German Federal Ministry of Economics and Energy, Fraunhofer ILT and Leibniz IAP also investigated how the technology can be implemented for satellite-based atmospheric research.

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2 Alexandrite laser integrated in a LIDAR system, © Leibniz IAP, Kühlungsborn.
3 Diode-pumped alexandrite laser.