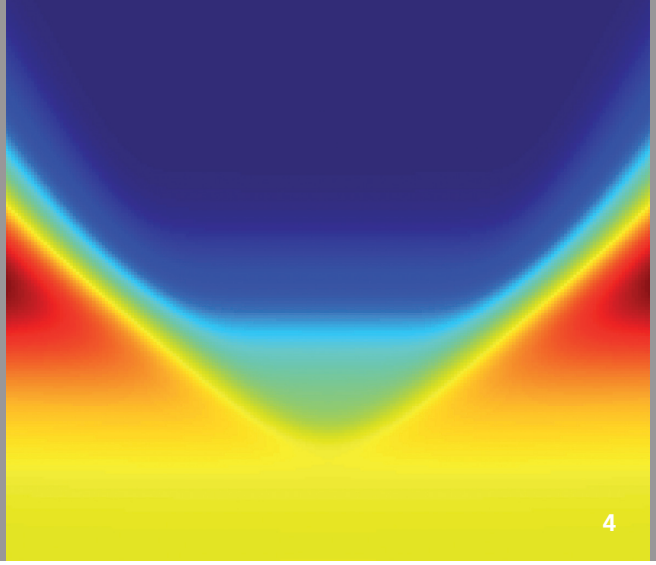


MODELLING QUASI-THREE-LEVEL LASER CRYSTALS

Task

Pulsed, resonantly pumped quasi-three-level lasers in the nanosecond range have many fields of application: materials processing, remote sensing, as well as in science and the military. With such laser media, the pump light absorption is dependent upon the intensity and a redistribution of the excitation occurs due to the laser emission. Due to this increased dependency, it is hardly possible to optimize these laser types with analytical or one-dimensional numerical models.

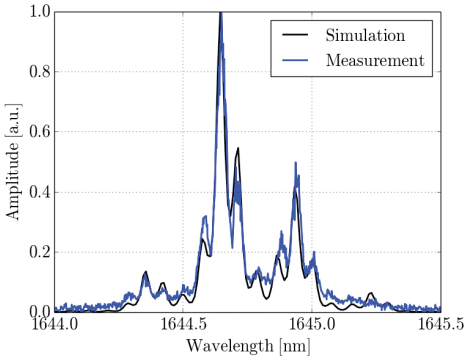
Method

The characteristics of relevant quasi-three-level laser media are replicated in a simulation. For this, the rate equations in the laser medium are solved numerically for pulsed operation in one temporal and three spatial dimensions; a spectral dimension is optional. In addition to material parameters of the crystals, their temperature as well as resonator parameters can also be set. With respect to the distribution of pump and laser radiation, several parameters – such as doping, crystal dimensions, host crystal and resonator design – can be optimized.

Result

The model implemented here was used within the scope of a project with the German Aerospace Center (DLR) to explain spectral characteristics of an Er:YAG laser (see graphics) and to optimize its design. To develop a MOPA system to detect carbon dioxide in projects with the DLR and the European Space Agency, different holmium- or erbium-doped crystal systems were simulated in order to find the optimal amplifying medium for the application in question. Data from literature could be reproduced and the system is now set up experimentally. In addition, different methods to generate pulse sequences were compared and improved.

Comparison of a measured laser spectrum with the simulation.



Applications

In addition to aiding in the design of new beam sources, the comparison can also be used to analyze, better understand and optimize experimental measurement values.

Contact

M.Sc. Philipp Kucirek
Telephone +49 241 8906-8108
philipp.kucirek@ilt.fraunhofer.de

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

3 Pumped Er:YAG crystal in a heat sink.
4 False color image of the excitation in a Ho:YLF crystal after a laser pulse.