Novel hybrid ultrafast laser sources in the midIR

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Our research project focuses on the development of laser sources emitting in the 2-micrometer range, an area of significant importance due to its wide range of applications in various fields including surgical procedures, material processing, laser sensing, spectroscopy, secure short-range communication networks, as well as pump sources for parametric systems emitting at longer wavelengths in the mid-infrared.

We have developed two unique tunable continuous wave (CW) fiber lasers. The first is a Thulium (Tm)-doped laser, tunable from 1880 nm to 2010 nm, and the second is a Tm-Holmium (Ho) co-doped laser, tunable from 1980 nm to 2100 nm. These lasers, which were built in-house, cover the absorption and emission domains of Ho-doped ceramics and crystals. They have been designed to test and characterize novel crystals and ceramics manufactured by our partners in Limoges.

In parallel, we are developing a Chirped Pulse Amplification (CPA) system that uniquely combines fiber and solid-state technologies, which represents a novel approach in the field. Our goal is to develop a high-energy and high-power, high-repetition-rate, picosecond-scale, 2.05 µm laser system capable of producing ~10 mJ of pulse energy at a 1 kHz pulse rate. The pulses are generated, stretched, and pre-amplified in the fiber part of the system, and then further amplified in a multi-pass amplifier using a Ho:Yttrium Lithium Fluoride (YLF) crystal in the solid-state part.

Figure 1: Ho:YLF rod crystal used in the solid-state amplifier

In the solid-state part of the system, a two-dimensional rotational symmetric amplifier model was developed to simulate the laser dynamics (absorption, population inversion, gain, losses, …) and help us study different pumping-seeding configurations and the optimal geometry of the crystal to achieve maximum gain. The output of this system will be used as a pump source for an Optical Parametric Amplifier (OPA) system to generate ultrashort pulses in the mid-Infrared (midIR) region.