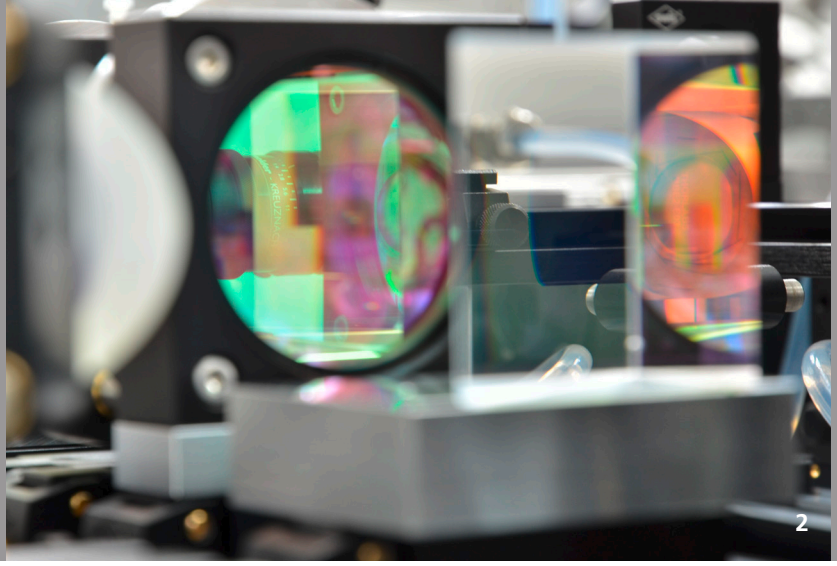

NONLINEAR PULSE COMPRESSION IN A MULTI-PASS CELL

Task

The pulses of Yb-based high-power ultrafast lasers (pulse durations ~ 200 fs - 1 ps) shall be shortened with an additional passive compression stage. Existing high-power schemes for compressing sub-ps laser pulses are based on nonlinear spectral broadening in a waveguide. These schemes are, however, limited in average power scalability, efficiency (typically < 80 percent) and addressable pulse energy ranges (< 5 µJ for glass fibers, > 200 µJ for gas-filled capillaries). Fraunhofer ILT shall develop an efficient method that allows pulse compression in the pulse energy range of ~ 5 - 200 µJ, which currently cannot be addressed with existing schemes. The process should be suitable for average power up to the kW range.

Method

Instead of a classical waveguide, a multi-pass cell is used in which the pulses to be compressed pass through a thin nonlinear medium (e.g. fused silica) many times. In between these passages lies a long propagation without nonlinearity. This way, the limitations of existing waveguide-based methods are circumvented with respect to efficiency, power scalability and pulse energy range.

Results

With the method described here, the pulses of an Yb:YAG INNOSLAB laser system were compressed from an 880 fs pulse duration to < 170 fs. A compressed average output power of 375 W was achieved at a pulse energy of 37.5 µJ. The efficiency of the compression setup was 91 percent.

Applications

The demonstrated combination of pulse duration, pulse energy and output power is relevant both for applications in ultrafast material processing, which are based on nonlinear processes (multi-photon absorption, filamentation), as well as for the generation of coherent EUV radiation by cavity-enhanced high harmonic generation.

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Contact

Jan Schulte M.Sc.
Telephone +49 241 8906-371
jan.schulte@ilt.fraunhofer.de

Dr. Peter Rußbüldt
Telephone +49 241 8906-303
peter.russbueldt@ilt.fraunhofer.de

2 Setup for nonlinear pulse compression in a multi-pass cell.