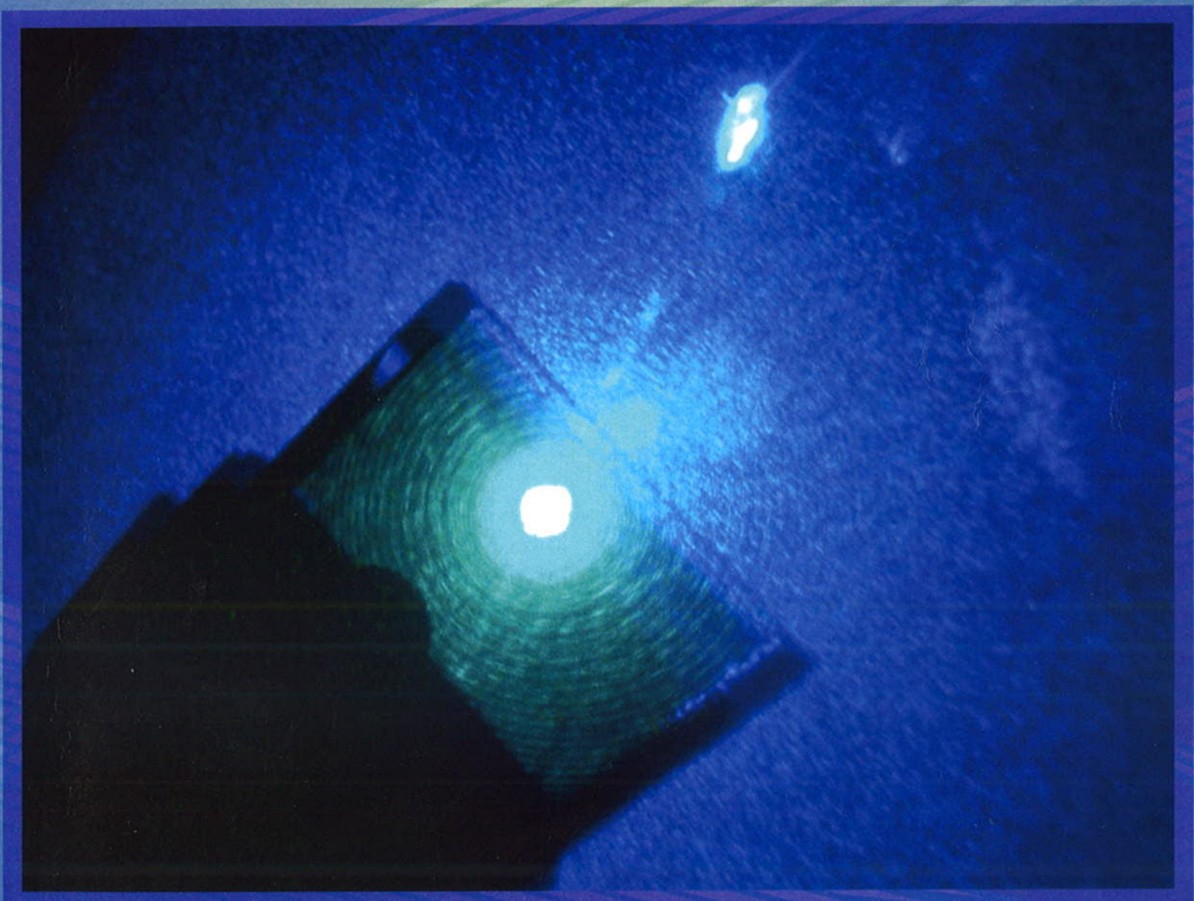
Program and Book of Abstracts



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12.5-mJ CEP-stable OPCPA at 1.5 μm

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The current quest for generating multimillijoule few-cycle IR pulses has been fuelled by intriguing applications in attosecond physics and high-field science. Optical Parametric Amplification (OPA) and Optical Parametric Chirped-Pulse Amplification (OPCPA) have emerged as promising candidates for this task because of their unique optical properties including ultrabroadband gain and absence of thermal load problems. We report on generation of carrier-envelope phase (CEP)-stable few-cycle pulses at 1,5 μm. Seed pulses were formed my means of difference-frequency generation.. In general, in a more narrowband parametric amplifier, uniform gain saturation across the pulse spectrum can more easily be achieved, thus avoiding back-conversion into the pump. The resulting parametrically amplified spectra, however, exhibit steep slopes leading to a poor quality of the compressed pulses in the time domain. Subsequent spectral broadening in a gas filament provides low-intensity broad spectral wings essential for few-cycle pulse formation.

Recently, we have reported on multimillijoule optically synchronized and passively CEP-stable OPCPA at 1.5 μm [1]. Our 4-stage IR OPCPA system is based on a diode-pumped solid-state Yb-MOPA driven CEP-stable front-end [2] and two successive power-amplification stages pumped by a flash-lamp-pumped Nd:YAG amplifier (Ekspla Ltd.). We employ nearly collinear type-II phase matching in KTP in 2-4 amplification stages reaching pulse energies up to 12.5 mJ at a 20-Hz repetition rate before grating compressor.

The CEP-stable 1,5-μm pulses from the front-end [2] The CEP-stable 1.5-μm pulses from the front-end [2] are stretched to ~40 ps using a grating-based stretcher (500 grooves/mm plane ruled 96%-efficient gold reflection grating, blazed for 1.37 μm with nominal blaze angle of 20°) and an IR high-resolution acousto-optic programmable dispersive filter (DAZZLER) in order to match the 60-ps duration of the Nd:YAG pump pulses. To obtain a homogeneous pump profile without "hot spots", we reimage the Nd:YAG rod in the power amplifier onto the type II KTP crystals in 3rd and 4th stages (10 mm long). From the measured surface damage threshold of KTP for our pump pulses (21 GW/cm2), we keep a pump diameter of 2 mm for the 3rd stage and 3.1 mm for the 4th stage. Relay-imaging is then achieved with three lenses of focal lengths f = 75 cm, f = 10 cm, and f = 35 cm. Because of the larger pump intensities in the 4th stage, the focal plane has to be placed inside a vacuum cell to avoid breakthrough in air. With this pumping geometry and 90 mJ pump pulses, we can achieve up to 12.5 mJ output at 1.55 μm. In order to avoid damage to the gold gratings in the OPCPA compressor (identical to grating in stretcher), we expand the $1/e^2$-beam diameter of the 4th stage output by a factor of 5 to 9,5 mm by means of a Galilean beam expander. Fig. 2 shows SHG-FROG characterization data of the 20-Hz output from our 4-stage OPCPA system.

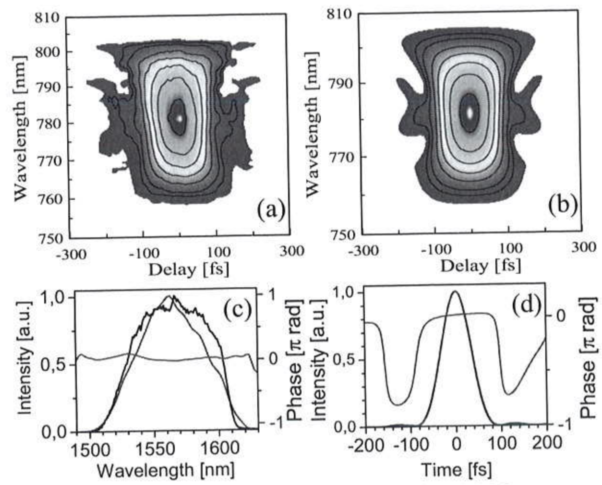

Fig. 1. SHG-FROG characterization of the 20-Hz output from the 4th OPCPA stage: (a) measured and (b) retrieved FROG traces. (c) measured spectrum (black curve), retrieved spectral intensity (blue) and phase (red). (d) Retrieved temporal intensity (blue) and phase (red) profile exhibiting a FWHM 74.4 fs pulse duration. The transform-limited intensity profile (dashed) corresponds to a 72.6 fs duration.

References:

[1] O. D. Mücke, D. Sidorov, P. Dombi, A. Pugžlys, S. Ališauskas, N. Forget, J. Pocius, L. Giniūnas, R. Danielius, and A. Baltuška, in *Ultrafast Phenomena XVI*, P. Corkum, K. Nelson, E. Riedle, R. Schoenlein, S. De Silvestri (Eds.) (Springer, Berlin, 2009), in press.

[2] O. D. Mücke, D. Sidorov, P. Dombi, A. Pugžlys, A. Baltuška, S. Ališauskas, V. Smilgevičius, J. Pocius, L.Giniūnas, R. Danielius and N. Forget., Opt. Lett. **34**, 118 (2009).