Dispersion-scan measurements of few-cycle pulses compressed with the multiplate continuum process

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Multiplate continuum [1] (MPC) is a recent supercontinuum generation (SCG) technique for spectral broadening of ultrashort laser pulses. Compared to the well-established SCG of mJ-level pulses by self-phase modulation in gas-filled hollow-core fibers (HCFs) [2,3], the MPC uses solid-state media (a set of thin glass plates) and has more relaxed beam alignment and stability requirements. An important advantage of MPC is that it effectively circumvents the limited input peak power of traditional SCG in bulk media, showing great promise for scaling to higher pulse energies and peak power compared to HCF-based compression.

In this work, we report on the complete (amplitude and phase) temporal characterization of ultrashort laser pulses post-compressed by the MPC process, without any further pulse manipulation besides dispersion compensation, using the single-beam and fully inline dispersion scan (d-scan) technique [4] to simultaneously measure and compress the pulses. The MPC setup is much simpler than SCG in gases, i.e., it obviates the need of vacuum and gas handling equipment as required by HCF compression. Furthermore, it does not require a feedback system to maintain long-term alignment. We focused ~30-fs, 140 μJ pulses from a CPA Ti:Sapphire amplifier (Femtopower Compact Pro CE-Phase) with a 1-meter focal length lens into a set of six unevenly spaced thin (100 μm) fused silica slides placed at Brewster's angle. The output beam was collimated and sent into a d-scan system comprising a set of dispersion-compensation mirrors (DCMs) and a glass wedge pair. Second-harmonic generation (SHG) d-scan traces of the pulses were obtained by measuring the spectrum of the SHG produced in a 5 μm BBO crystal as a function of dispersion around the point of maximum compression. The spectral phase of the pulses was then obtained by applying the d-scan algorithm to the measured d-scan traces and linear spectrum of the pulses. Figure 1b shows the measured temporal intensity of the compressed pulses as well as the transform-limited pulse (for reference). The corresponding spectrum and spectral phase are shown in Fig. 1c.

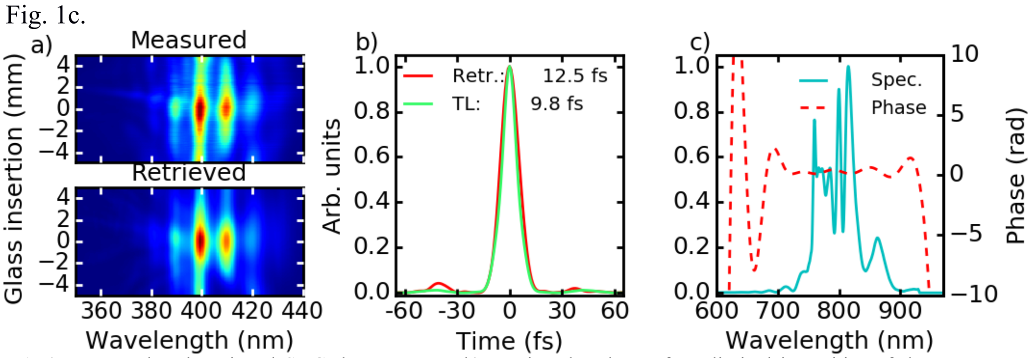

Fig. 1 a) Measured and retrieved SHG d-scan traces. b) Retrieved and transform-limited intensities of the compressed pulses; c) Spectrum and spectral phase.

We obtain compressed pulses with a full-width-at-half-maximum (FWHM) duration of 12.5 fs, which is relatively close to the transform-limited duration of 9.8 fs. The output efficiency of the MPC process is roughly 50% and the beam spatial profile is very homogeneous. Broader spectra and shorter pulses should be achievable by optimizing the number of plates and their relative distance. The simplicity and compactness of MPC combined with the single-beam and robust d-scan technique for measuring and compressing few-cycle pulses makes this method and system very appealing for novel applications of MPC, such as high-harmonic generation [5].

References

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