Spatio-temporal characterization of high-power few-cycle pulses by SEA-F-SPIDER and time-domain ptychography.

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In recent years OPCPA and NOPCPA laser systems have shown the potential to supersede Ti:Sapphire plus non-linear post-compression based laser systems to drive next generation attosecond light sources via direct amplification of few-cycle pulses to high pulse energies at high repetition rates. With the advent of these laser systems comes a need for improved pulse characterization technology. Due to the non-collinear interaction in NOPA based laser systems the amplified few-cycle pulses can suffer from spatio-temporal couplings. Most spatio-temporal pulse characterization techniques are based on separating spatial and temporal measurements in a test- plus reference-pulse scheme. Here we review two self-referencing techniques that are able to perform spatio-temporal pulse characterization of few-cycle pulses.

In this work we measure pulses from two NOPA based OPCPA systems. One system provides sub-7 fs pulses at 400 kHz repetition rate with an average power of 4.2 W [1], and one system provides sub-7 fs pulses at 100 kHz repetition rate with an average power of up to 24 W [2]. We send the amplified beam to two dispersion balanced

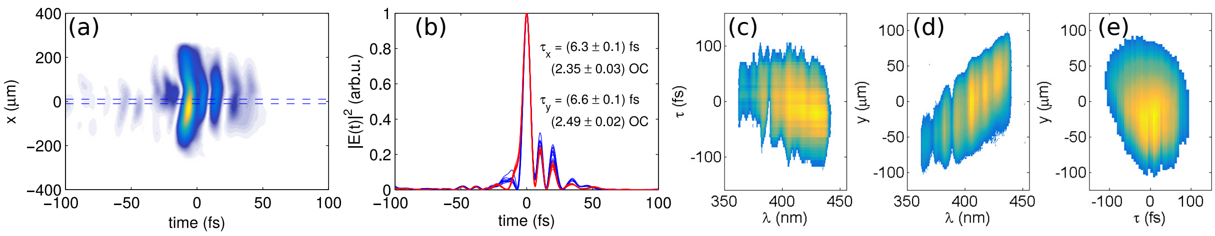

Figure 1. Spatio-temporal pulse characterization of a 100 kHz, 24 W NOPA laser system.

setups for spatio-temporal pulse characterization: a SEA-F-SPIDER (spatially-encoded arrangement filter-based spectral phase interferometry for direct electric field reconstruction) device [3] and a setup for spatially multiplexed time-domain ptychography – an extension of time-domain ptychography [4]. In Fig. 1(a) and (b) we show spatio-temporal measurements of the 24 W NOPA system for compressed pulses. The spatio-temporal intensity distribution shown in (a) is in the horizontal beam plane. The 1d-lineouts in (b) show the temporal intensity $|E(x_0,t)|^2$, and $|E(y_0,t)|^2$ for the horizontal and vertical planes. The time-domain ptychography measurements shown in Fig. 1(c),(d),(e) have been taken for a pulse with spectral chirp, spatial chirp, and pulse-front tilt. (c),(d),(e) are projections of the datacube $S(x,\omega,\tau)$ along the three dimensions. From this cube the full spatio-temporal field $E(x,t)$ can be reconstructed in amplitude and phase.

References

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