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High-Energy Sub-Cycle Waveform Synthesis and Characterization

FRANZ KÄRTNER, Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology

The control of atomic scale electronic motion by ultrafast optical electric field waveforms strong enough to mitigate the atomic Coulomb potential has broken tremendous new ground with the advent of phase controlled high-energy few-cycle pulse sources. Currently, such sources are based on Ti:sapphire amplifiers and hollow-core fiber post-compression or optical parametric chirped pulse amplification, together with optical gating techniques. Significant control of the waveform on sub-cycle time scales, however, requires a fully phase-controlled multiple-octave-spanning spectrum. Here, we present a first fully phase-controlled multi-octave-spanning source that supports gigawatt-peak-power isolated single-cycle waveforms based on pulse synthesis of two carrier-envelope phase (CEP) stable OPCPA systems. It is especially a challenge to fully characterize such ultrawide band waveforms. We apply two-dimensional spectral shearing interferometry (2DSI), which can measure the group delay between all spectral components of the synthesized pulse.