Temporal measurement of high-intensity laser pulses directly on target during laser-matter interactions

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In laser–matter interaction experiments, it is of paramount importance to characterize the laser pulse on target (*in situ*) and at full power. This allows pulse optimization and meaningful comparison with theory, and it can shed fundamental new light on pulse distortions occurring in or on the target, but it has proven very difficult to achieve. We present a new technique – THIS:d-scan – based on dispersion-scan [1,2] using the concurrent third-harmonic (TH) emission from the target that permits the full *in situ* characterization of ultrashort laser pulses in a gas or solid target over a very wide intensity range encompassing the 10^{13}–10^{15} Wcm^{-2} regime of high harmonic generation and other important strong-field phenomena, with possible extension to relativistic intensities well above 10^{20} Wcm^{-2} that are presently inaccessible to other diagnostics [3]. The setup for THIS:d-scan can be easily added to an existing beamline and provides a pulse characterization at the location of the sample, thus eliminating the need for the error-prone process of attempting to equalize optical path lengths, which is necessary with *ex situ* measurements. Furthermore, it provides an accurate measurement of the pulse directly on target, including any linear or nonlinear phase acquired within the beamline. The fact that the TH emission occurs in gases, solids, and plasmas over a broad range of target densities, pulse durations and laser intensities extending well into the relativistic regime, makes THIS:d-scan a very promising technique for the *in situ* measurement of ultrashort pulses during strong-field laser–matter interaction at the extreme conditions presently attainable with ultra-high power lasers [4].

References

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