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Review of the dispersion-scan technique

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The dispersion scan technique, short d-scan, for the characterization of ultrashort laser pulses was introduced little more than five years ago [1]. The underlying idea is that the spectral phase of a short laser pulse will impact nonlinear interactions driven by that pulse. A d-scan trace is obtained, when the output of a nonlinear interaction is recorded while the spectral phase of the pulses is varied in a controlled way. Most commonly the SHG spectrum is recorded, while the dispersion is scanned with a pair of glass wedges, thus the name dispersion-scan. If an accurate model for the nonlinear interaction exists, the spectral phase of the pulses can be found by numerically minimizing the error between a measured and a simulated d-scan trace. Over the years, many different nonlinear effects, such as transient grating or cross-polarized wave generation, have been employed to perform d-scans. Furthermore, the dispersion may be scanned differently, e.g. by grating or prims arrangements, or active devices like spectral phase shapers. Dispersion-scan traces are formally very similar to those obtained from MIIPS and chirp scan [2,3], and the approach to phase retrieval is similar to other tomographic techniques like FROG [4].

In our talk, we will generally review the d-scan technique, discuss its advantages and highlight recent developments. In particular, we have demonstrated a very compact implementation of a single-shot d-scan apparatus for few- to single-cycle pulses [5] and we have suggested a new retrieval algorithm [6], which performs much faster than the general minimization approaches of early d-scan retrievals. Both developments aim at establishing the d-scan as a real-time, online monitoring tool for laser laboratories.

In our own laboratory, the d-scan technique became crucial for generating, characterizing and manipulating few-cycle laser pulses. Furthermore, we have suggested a technique combining the d-scan and Fourier transform spectrometry to completely characterize few-cycle pulses in the spatio-temporal domain [7], giving direct access to phenomena, like spatio-temporal couplings, which cannot be observed, if the spatial and the temporal domain are investigated individually. This has proven very powerful for minimizing angular and spatial chirp from noncollinear optical parametric amplifiers [8].

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