Ultra-short Pulse Diagnostic with Spectral Phase Interferometry

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Application Note

Introduction

SPIDER (Spectral Phase Interferometry for direct Electric Field reconstruction) is an essential tool used for the characterization of ultrashort pulses (Fig. 1) [1, 2]. We use this diagnostic tool for the development of a multi-mJ high repetition rate optical parametric chirped pulse amplifier systems which will be used to generate the XUV seed for a free electron laser at the FLASH-FEL facility in Hamburg (DESY). A lower ionization fraction is obtained with ultra-short pulse (sub-10 fs, e.g. Fig. 2) compared to longer pulses with the same focusing geometry in a gas-jet for higher order harmonic generation. This allows to use higher focal intensities with sub-10 fs pulse, thus increasing the harmonic cut-off frequency.

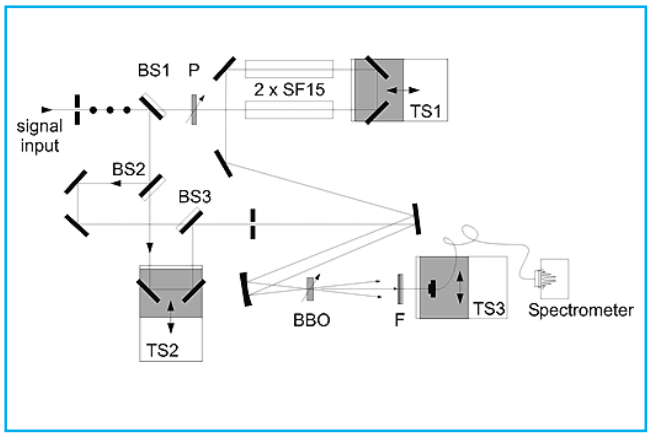

Fig.1 SPIDER setup for ultra-short pulse characterization.

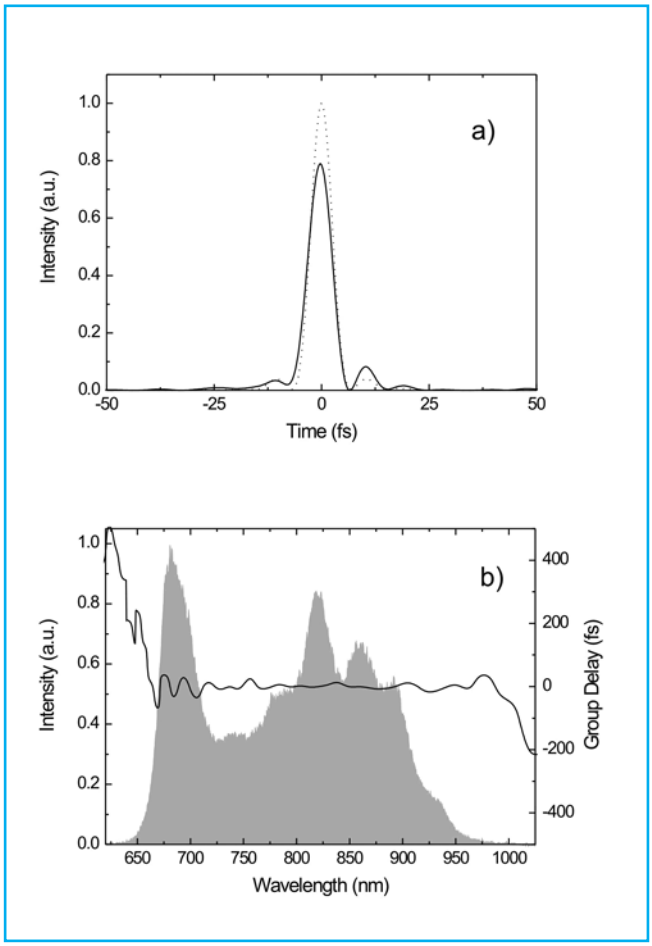

Fig. 2 a) Measured pulse shape with SPIDER technique (solid line) and Fourier-limited pulse duration (dotted line); b) pulse spectrum and reconstructed spectral phase.

Detector for spectral phase interferometry

We've decided for a Shamrock SR-303i spectrometer in combination with an iDus CCD-detector DV420A-OE. The advantages of high detector sensitivity and the negligible dark current at low operation temperature are important for the acquisition of SPIDER signals to resolve the fringes with high accuracy even at very low input signal. The possibility to tune the spectrometer within a large spectral acquisition range (turret with 3 gratings) is an additional very valuable feature of the Andor spectrometer series.

References

[1] C. Iaconis, V. Wong, and I. A. Walmsley, "Direct Interferometric Techniques Characterizing Ultrashort Optical Pulses", IEEE J. Sel. Top. Quantum Electron. 285-294 (1998).

[2] C. Iaconis and I. A. Walmsley, "Spectral phase interferometry for direct electric-reconstruction of ultrashort optical pulses", Opt. Lett. 23, 792-794 (1998).

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