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Dispersion Control of Femtosecond Laser Pulses In- and Outside the Laser Cavity

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Abstract. Progress in ultrafast optics relies extensively on the development of ways to characterize and control the dispersion. In the first part of this work we report an extensive study of the influence of the additional second- and third-order dispersion introduced in a femtosecond laser cavity by varying the beam's penetration into a prism of the double-pass intracavity prism compressor on the output pulse duration (see Figure 1), as well as on the emission spectral bandwidth and its central wavelength. The theoretically calculated pulse durations are found to be in a good agreement with the respective experimental data from frequency-resolved optical gating and interferometric autocorrelation measurements. In this way we were able to tune the output pulse duration from 24 fs to 120 fs. Further, we report results on the influence of the additional second-order dispersion introduced in sub-45 femtosecond laser pulses by intentional misalignment in a folded 4-f otherwise dispersionless system. In two sets of measurements we varied (1) the position of the lens only (see Figure 2), and (2) simultaneously the lens and folding mirror positions keeping the lens-to-mirror distance unchanged. The pulse durations are measured by a frequency-resolved optical gating device. We developed a theoretical model for the behavior of the 4-f

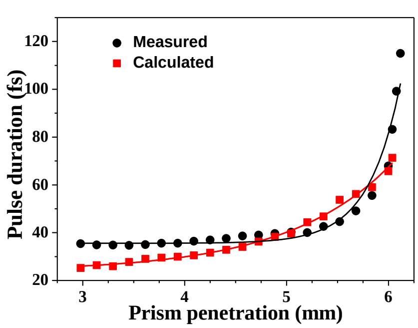

Figure 1: Output pulse duration vs. prism penetration depth inside the cavity.

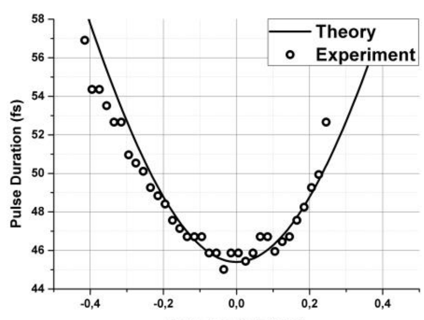

Figure 2: Output pulse duration at the exit of the misaligned 4-f system vs. lens position.

system using the 4×4 matrix formalism. In this way we calculated the second order dispersion (SOD) accumulated at different misalignments of the system. The particular net SOD allowed us to predict the femtosecond pulse time duration at the exit of the system (see Figure 2). This approach allowed us to tune the output pulse duration from 45 fs to 60 fs.

The theoretically calculated pulse durations in both cases are in a good agreement with the experimental data.

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