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Unambiguous ultrashort pulse reconstruction from double spectrograms alone

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In this work a fully analytic ultrashort pulse reconstruction technique which can be used to characterize two different ultrashort pulses of different center wavelengths and spectral ranges is presented. The proposed non-interferometric spectrographic reconstruction method is not based on an iterative Fourier transform algorithm or an ill-posed inversion problem in general, and the experimental setup is a simplified version of a dual spectrogram method known as ‘very advanced method for phase and intensity retrieval of e-fields’ (VAMPIRE). By using a dispersive element within the VAMPIRE setup, as shown in figure 1, which exhibits close to quadratic dispersion over a wide spectral range a mathematical approach can be borrowed from tomographic pulse reconstruction methods and used to reconstruct pulses from spectrographic information. The particular dispersive element used is BaF₂ which exhibits a near quadratic spectral dispersion over the spectral range 200 to 1200 nm. Where the spectral dispersion is near quadratic the conditions for a tomographic approach to reconstruction are satisfied. Both spectrograms are thus related mathematically by the well-defined dispersive properties of BaF₂. Wigner-Ville function projections are used to extract spectral phase information present in both spectrograms. Thus, the uniqueness conditions of the reconstructions can be discussed and justified mathematically. This is an important feature of the here proposed method, compared to previous versions of VAMPIRE. From our results we can demonstrate an analytic, fast, and simplified spectrographic pulse reconstruction method.

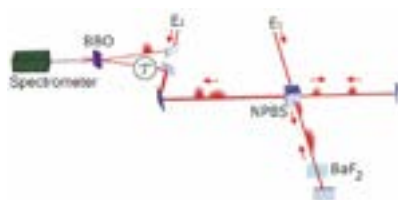


Figure 1. Experimental setup

Recent Publications

1. Seifert B and Stolz H (2009) A method for unique phase retrieval of ultrafast optical fields. Measurement Science and Technology 20:015303.
2. Dorrer C and Kang I (2003) Complete temporal characterization of short optical pulses by simplified chronocyclic tomography. Optics Letters 28:1481-1483.
3. Seifert B, Wheatley R A, Rojas Aedo R, Wallentowitz S, Volkmann U, Sperlich K and Stolz H (2016) Unambiguous ultrashort pulse reconstruction from double spectrograms alone. Journal of Optics 18:105502.
4. Seifert B, Wallentowitz S, Volkmann U, Hause A, Sperlich K and Stolz H (2014) Spectrographic phase-retrieval algorithm for femtosecond and attosecond pulses with frequency gaps. Optics Communications 329:69-75.
5. Seifert B, Hause A and Mitschke F (2010) A fiber Mach-Zehnder interferometer for the unique phase retrieval of ultrafast pulses with a 1 THz gap. Applied Physics B: Lasers and Optics 99:423-426.

Biography

Birger Seifert is an expert in the field of ultrashort light pulse characterization and his Doctor thesis was focused on this topic. He has in depth knowledge of the state of the art optical methods for the characterization of ultrashort light pulses, and the precluding background to the present status. In 2006 he invented and patented the dual spectrogram method known as very advanced method for phase and intensity retrieval of e-fields (VAMPIRE). He also works in quantum optics generating squeezed light, exploring quantum-well structures and quantum dots and measuring the coherent secondary emission from excitons bringing new insight about the decoherence processes in semiconductors.

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