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Analytical Reconstruction of Two Different Pulses from Non-Interferometric Double Spectrograms Alone

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In this work a fully analytical 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) [1].

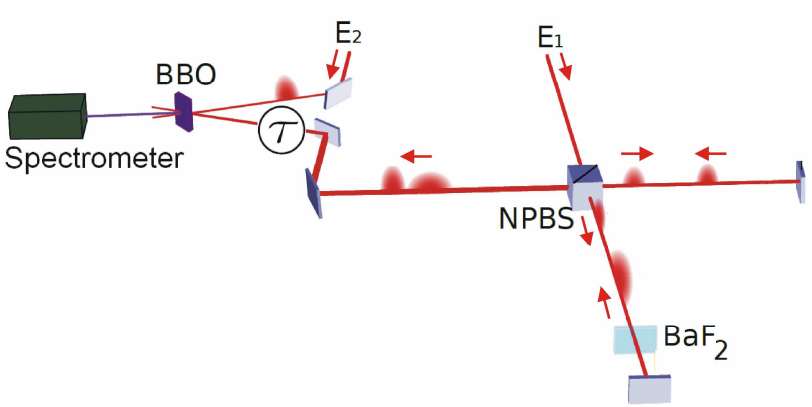

Figure 1. Experimental setup

By using a dispersive element within the VAMPIRE setup, as shown in Fig. 1, which exhibits close to quadratic dispersion over a wide spectral range a mathematical approach can be borrowed from tomographic pulse reconstruction methods [2] 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 [3]. Thus, the uniqueness conditions of the reconstructions can be discussed and justified mathematically. From our results we can demonstrate an analytic, fast, and simplified spectrographic pulse reconstruction method.

1. B. Seifert and H. Stolz, "A method for unique phase retrieval of ultrafast optical fields," *Meas. Sci. Technol.*, **20**, 2009, 015303, doi: 10.1088/0957-0233/20/1/015303.

2. C. Dorrer and I. Kang, "Complete temporal characterization of short optical pulses by simplified chronocyclic tomography," *Opt. Lett.*, **28**, 2003, pp. 1481-1483, doi: 10.1364/OL.28.001481.

3. B. Seifert, R.A. Wheatley, R. Rojas-Aedo, S. Wallentowitz, U. Volkmann, K. Sperlich, H. Stolz, "Unambiguous ultrashort pulse reconstruction from double spectrograms alone," *J. Opt.*, **18**, 10, 2016, 105502, doi: 10.1088/2040-8978/18/10/105502.