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Simultaneous measurement of sub-femtosecond timing jitter in two frequency channels by using time stretched self-coherent detection

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The timing information between the pulses of a pair of pulses has been utilized in many applications such as time of flight imaging, LIDAR and optical sensing. The timing jitter between the two pulses in the pulse pair determines the measurement precision [1]. Recently, we have demonstrated timing jitter measurement at attosecond level by using dispersive time stretched self-coherent detection (TSSCD) technique [2]. Attosecond-level measurement is made possible by using the phase information of the beating-frequency signal (BFS) of the chirped pulses and the low noise floor of the laser source used in the measurement. The measurement in [2] is carried out for a single frequency channel. For multi-objective synchronous measurement and quasi-distribution sensing, the number of signal channel is more than one. Thus, simultaneous measurements of the timing jitters in multiple signal channels have to be made. In this work, we demonstrate simultaneous characterization of the timing jitter in two signal channels by using TSSCD. The phase change of the light in each frequency channel induced by the corresponding timing jitter can be independently determined from the BFS of the TSSCD system.

Figure 1(a) shows the experimental setup of the dual-channel TSSDCD system. The output of the mode-locked laser is stretched and then injected into the dual-signal-channel interferometer. The timing jitter signals of the two channels under test are induced by two piezoelectric transducers (PZT 1 and PZT 2). PZT 1 and PZT 2 are driven by sinusoidal signals at frequencies 600 kHz and 500 kHz, respectively. Fig. 1(b) shows the BFS signal in a period of 50 μs. Figs. 1(c) and 1(d) show the measured timing jitter signals at 600 kHz and 500 kHz in Channel 1 and 2, respectively. The amplitudes of the measured timing jitters of Channel 1 and 2 are ~856 and ~1062 attoseconds, respectively. The power spectral densities (PSD) of two channels are shown in Figs. 1(e) and 1(f). The grey curves are the noise floors of the timing jitters when the driving voltages of the PZTs are set to zero. The narrow peak at 600 kHz of the black curve in Fig. 1(e) and that at 500 kHz of the red curve in Fig. 1(f) curve correspond to the timing jitters induced by the respective PZTs for the two frequency channels. The signal-to-noise ratio of the timing jitter signal are 43.0 dB and 45.7 dB, respectively. The results demonstrate simultaneous measurement of sub-femtosecond timing jitters in two frequency channels by dispersive time stretched self-coherent detection.

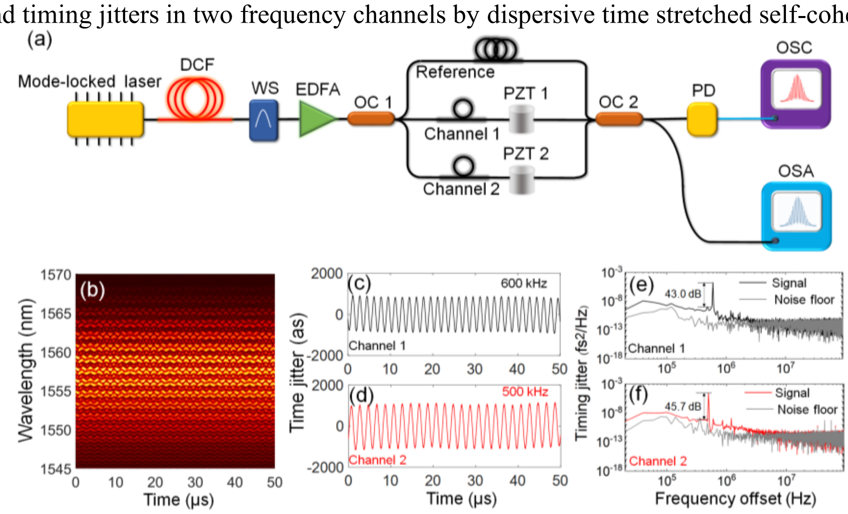

Fig. 1 (a) Experimental setup of the dual-channel TSSDCD system; (b) evolution of the BFS; (c) and (d) timing jitter signal at frequencies 600 kHz and 500 kHz, respectively; (e) and (f) the power spectral densities (PSDs) of the timing jitter signal at frequencies of 600 kHz and 500 kHz, respectively.

References

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Abstract:
We demonstrate simultaneous measurement of sub-femtosecond timing jitter in two frequency channels by time stretched self-coherent detection. The phase information of the beating-frequency signal of the chirped pulses is utilized to determine the timing jitter. **(35 words)**