

10 GHz ultra-low jitter optical pulse stream generated by optoelectronic delay oscillators with soliton compression

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Several applications in lightwave technology do require optical pulses with ultra-low time jitter, like in high speed optical sampling and LIDAR systems for example. Optoelectronic oscillators (OEOs) have recently been shown to be very attractive systems for the generation of such pulses [1].

OEOs are in fact known to provide microwaves with ultra-low levels of phase noise [2]. Beside the generation of ultra-pure microwaves in the radio-frequency range, OEO-like systems can also be used to generate ultra-short optical pulses in the optical frequency range. The advantage of OEOs in this case is that their intrinsically low phase noise is equivalent to extremely low time-jitter for the generated pulses.

We propose a new OEO architecture, able to generate at the same time ultra-low jitter optical pulses and ultra-low phase noise microwaves. This new system relies on the single-loop OEO, with two modulation branches: an intensity modulation for the formation of sinusoidal pre-pulses, and a phase modulation to chirp them. The train of chirped pre-pulses is then strongly amplified by an erbium-doped fiber amplifier and subsequently launched into a single-mode optical fiber. Owing to the combined effects of dispersion and self-phase modulation, the pre-pulses are optimally compressed with a compression factor which may be as high as 20, following a scenario referred to as time-lens soliton-assisted compression [3].

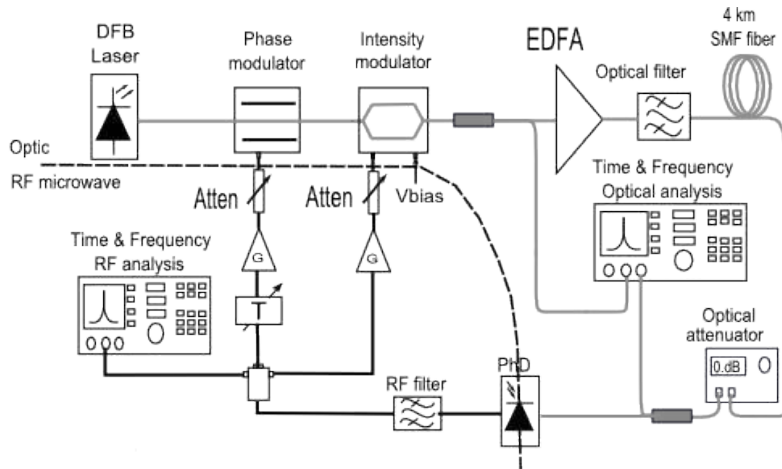


Fig. 1 The architecture of the OEO.

We provide a time-domain model for the slowly-varying amplitudes of the microwave and optical oscillation, and our analytical study is confirmed by numerical simulations and experimental measurements. We demonstrate the generation of 4.1 ps pulses with 2.7 fs jitter in the 10 Hz–100 kHz frequency band, along with a microwave whose phase noise is -140 dBc/Hz at 10 kHz from the 10 GHz carrier.

References

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