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40 GHz pulse train generation at 1.5 μm by pulse multiplication based on the temporal Talbot effect in a chirped Bragg grating

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Pulse train multiplication based on the temporal Talbot effect in a linearly-chirped fiber grating is demonstrated. A 40-GHz converted optical pulse train is obtained from a 2.5-GHz FM mode-locked Er-Yb laser at 1.5 μm.

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Techniques for multiplication of pulse trains repetition rate are of major importance for the development of future ultrahigh-speed optical transmission systems in the 1.5 μm wavelength region. A promising and simple method [1] is based on the linear propagation of the pulse train in a highly dispersive medium exploiting, in the time domain by multiple pulse interference, a condition analogous to that found in the fractional Talbot effect of diffractive optics [2]. Here we report on the first experimental demonstration of pulse train multiplication based on the temporal Talbot effect, using a suitably designed linearly-chirped fiber grating as a dispersive element. Although the technique is very general and any suitable pulsed source (including waveguide/fiber based) could be used, in our experiments the initial pulse train is generated by a 2.5 GHz repetition-rate FM mode-locked Er-Yb:glass laser, producing Gaussian pulses with durations tunable from ≅6 to ≅15 ps with 10 mW average power. A 100-µm thick intracavity BK7 etalon is used to finely tune the center wavelength of the mode-locked laser spectrum by few nanometers around 1533 nm. The linearly-chirped fiber grating is designed and fabricated to achieve a pulse multiplication factor M=16, with a nearly flat dispersion of ≅-1280 ps/nm within a spectral bandwidth (at –1 dB) $\Delta\lambda$≅6.5 nm around the central wavelength λ_0=1533.7 nm. The value of dispersion was chosen to satisfy the fractional Talbot condition $\ddot{\Theta} = 1/(2\pi M f^2)$, where f is the repetition rate of the mode-locked laser and $\ddot{\Theta}$ is the grating dispersion expressed in ps^2/rad. The mode-locked pulse train is sent to the fiber grating and the reflected optical signal is retrieved through an optical circulator. The converted optical pulse train is monitored by a PIN photodiode and a sampling oscilloscope (13 ps rise time) and characterized by background-free SHG autocorrelation measurements. Figure 1 shows a typical measured autocorrelation trace of the reflected optical field over the entire 400 ps periodicity of the original mode-locked pulse train. The resultant 40 GHz pulse train agrees well with that predicted by numerical simulations based on the measured characteristics of the fiber grating. For comparison, in the figure is also shown the autocorrelation trace of the 10-ps Gaussian pulses of the mode-locked laser. The pulse train deforms or disappears whenever the fractional Talbot condition is lost, requiring a fine tuning of the laser wavelength and/or of the modulation frequency. In this experiment the repetition rate of the converted optical pulses is limited by the duty cycle of the initial pulse train, but higher repetition rates may be achieved by using shorter pulse durations promising for the development of compact and reliable devices aimed at >100GHz pulse train generation.

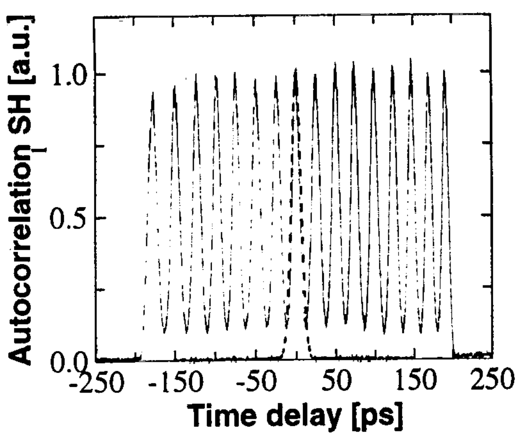

Fig.1 Noncollinear SHG autocorrelation of the multiplied pulse train at 40 GHz reflected by the chirped fiber grating. The dashed curve is the autocorrelation trace of the Gaussian mode-locked pulses incident to the fiber grating.

[1] I. Shake, H. Takara, S. Kawanishi, and M. Saruwatari, Electron. Lett. **34**, 792 (1998); J. Azaña and M.A. Muriel, Opt. Lett. **24**, 1672 (1999).
[2] M.V. Berry and S. Klein, J. Mod. Opt. **43**, 2139 (1996).