Pulse shaping for all-optical signal processing of ultra-high bit rate serial data signals - DTU Orbit (03/01/2019)

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The following thesis concerns pulse shaping and optical waveform manipulation for all-optical signal processing of ultra-high bit rate serial data signals, including generation of optical pulses in the femtosecond regime, serial-to-parallel conversion and terabaud coherent optical time division multiplexing (OTDM). Most of the thesis is focused on the utilization of spacetime dualities for temporal pulse shaping and Fourier transformation. The space-time duality led to the implementation of the optical Fourier transform (OFT) technique which was used as a crossing bridge between the temporal and spectral domain. By using the frequency-to-time OFT technique or optical temporal differentiators based on long-period gratings (LPGs), it was possible to generate narrow at-top pulses in the picosecond regime, and use them for mitigation of timing jitter or polarization dependence effects in OTDM demultiplexing experiments. The frequency-to-time technique was deployed also for implementing an alloptical synchronizer and re-timer. By using the specular phenomenon, time-to-frequency OFT, it was possible to develop a novel scheme for serial-to-parallel conversion, implemented via four-wave mixing (FWM) between dispersed OTDM data and linearly chirped pump pulses. This resulted in spectral compression, enabling the OTDM tributaries to be converted directly onto a dense wavelength division multiplexing (DWDM) grid. The serial-to-parallel conversion was successfully demonstrated for up to 640-GBd OTDM signals, reaching DWDM grids ranging from 100 GHz down to 25 GHz spacing, compliant with ITU-T specifications in terms of wavelength spacing and allocation. The final part of this thesis presents the latest results in OTDM transmission systems in combination with digital coherent detection, which enabled record-high serial data rates on a single-wavelength channel. The experimental results demonstrate 5.1- and 10.2-Tbit/s OTDM data signals achieved by 16-ary quadrature amplitude modulation (16-QAM), polarization multiplexing and symbol rates as high as 640 GBd and 1.28 Tb/s. These signals were transmitted with no penalty over 80- and 29-km dispersion-managed fiber (DMF).

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