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Integrated phase filters for dispersion-based optical signal processing

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Ultrafast photonic signal processing based on group-velocity dispersion has been extensively utilized for a multitude of applications such as for arbitrary repetition rate control of periodic pulse trains and frequency combs, passive (noiseless) amplification and retrieval of arbitrary waveforms buried in noise, real-time gapless spectogram, temporal imaging, etc. However, these functionalities usually require the use of a large amount of second-order dispersion (typically > 1,000 ps/nm) over a broad bandwidth. Linearly chirped waveguide Bragg gratings (LCWBGs) have been suggested as a potential solution for GVD compensation. Yet, cm-long LCWBGs provide limited second-order dispersion (< 200 ps/nm) over a narrow bandwidth (< 1 nm). On the other hand, by employing an equivalent discrete spectral phase filtering process, the original continuous quadratic spectral phase function of a dispersive line can be discretized and bounded in a modulo 2π basis. This technique avoids the spectral phase accumulation of an LCWBG, which translates to a significant reduction in the device length. In this talk, we will describe the WBG-based design framework proposed for the implementation of integrated phase filters. Limitations and capabilities of the proposed phase filtering process in emulating or compensating for large amounts of second-order and higher-order dispersion for broadband periodic waveforms will be discussed in detail. We will discuss proof-of-concept demonstration of the temporal Talbot effect based pulse repetition rate multiplication of a periodic pulse train using on-chip phase filters. Further, experimental results related to arbitrary dispersion compensation of periodic pulse trains using mm-long phase filters in a silicon-on-insulator platform will be communicated. Lastly, we will discuss the potential of the proposed phase filtering process in the dispersion compensation of aperiodic waveforms, such as random data signals used in a telecommunications fibre-optic link.