10 GHz bandwidth nonlinear delay electro-optic phase dynamics for ultra-fast nonlinear transient computing

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Nonlinear delay dynamical systems have found several fundamental and applied issues in Optics [1], since delays from time of flight of the light becomes easily important, even with a few cm of fibers, compared to fast or even ultra-fast photonic response times. Fiber pigtailed modern Telecom devices can thus provide easy system design strategies to build well-controlled high complexity nonlinear delay dynamics. Recently in that context, electro-optic phase modulation, combined with an imbalanced Mach-Zehnder DPSK demodulator providing a temporally nonlocal nonlinear phase-to-intensity conversion, together with a delayed optoelectronic feedback loop (see Fig.1), was proposed as an efficient optical chaos generator for demonstrating 10 Gb/s optical chaos communications [2].

Such a Telecom bandwidth well-controlled chaos generator is here investigated for its intrinsic dynamical complexity, which dimensionality scales as the ratio between the time delay and the optoelectronic and electro-optic response time (up to several thousands). This motion complexity is used for the implementation of a novel brain inspired computational paradigm, nonlinear transient computing (NTC), also referred as to *Echo State Network* (ESN[3]), or *Liquid State Machine* (LSM[4]) and *Reservoir Computing* (RC[5]) in the early literature. Following recent successful experimental demonstrations of the concept [6-9], we have investigated the potential of the electro-optic phase nonlinear delay dynamics for ultra-fast NTC.

We will report on the design and characterization of this fast neuromorphic computing unit, and we will present the first results on standard academic benchmark tests, such as speech recognition and time series prediction.

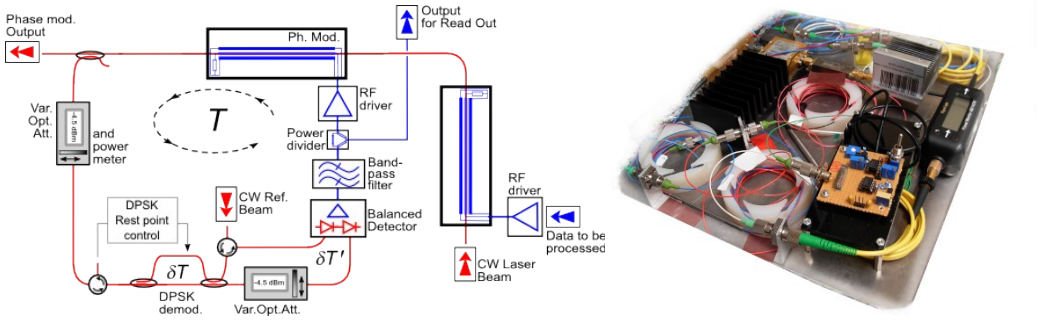

Fig. 1: Left, Schematic of the electro-optic phase nonlinear delay oscillator used as the dynamics aimed to provide the computational power through phase space complexity. Right: picture of the setup.

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