Continuous Variable quantum optics on-chip

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Integrated quantum photonics has emerged as the ideal platform for the implementation of optical quantum technology [1]. Confining light inside miniaturized waveguide circuits enables the generation, manipulation, and detection of quantum photonics states in a scalable way [2]. While implementations of these three key operations exist separately, a single chip has yet to demonstrate all capabilities. Here we show the generation, manipulation, and the interferometric stage of homodyne detection of non-classical light on a single device, a key step towards a fully integrated approach to optical quantum technology with continuous variables. Our device is made of a reconfigurable lithium niobate waveguide network (see Fig. 1): two nonlinear periodically poled waveguides are pumped by a 777 nm laser, generating photons at 1554 nm through spontaneous parametric down conversion, and the two modes interfere in an electro-optically reconfigurable directional coupler. Two integrated frequency filters separate the pump from the signal while the output modes are characterized by two integrated homodyne detectors where signal and local oscillator (LO) are mixed and the phase of the LOs are scanned. Free space photodiodes are used for the measurements since they provide a detection efficiency >99%. This devices is capable of generating and characterizing squeezed vacuum and two-mode entangled states, essential resources for several optical quantum computation and communication protocols. We measure a squeezing level of -1.38±0.04 dB and demonstrate two-mode entanglement from quadrature correlations and by verifying an inseparability criterion I=0.77±0.02<1 [3]. Our platform can implement all the processes required for optical quantum technology and its high nonlinearity and fast reconfigurability makes it ideal for the realization of quantum computation with time encoded continuous variable cluster states [4]. Future development of this technology will enable the integration of several quantum photonic applications, including fast photon routing and frequency conversion for hybrid quantum networks.

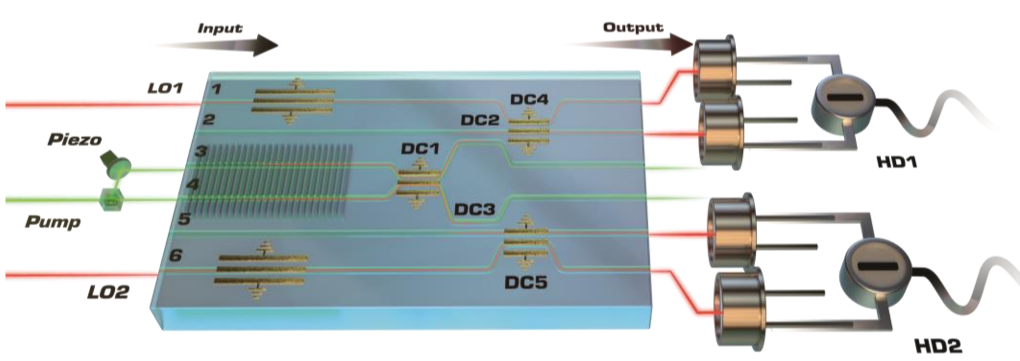

Figure 1: Schematic of the chip for the generation and manipulation of CV quantum states.

References

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