

Chip-based compact squeezing experiment at a telecom wavelength

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Abstract

We present a compact and easy-to-use set-up exploiting the association of commercial plug-and-play fibre components and integrated optics on lithium niobate for the generation and detection of squeezed light at a telecom wavelength. A squeezing level as high as -2.00 ± 0.05 dB in a single-pass configuration is measured.

Squeezed states of light exhibit a reduced noise level with respect to the classical quantum limit represented by the shot noise of a coherent state. These states are essential ingredients for a variety of quantum technologies [1]. Accordingly, in view of out-of-the-laboratory applications, we have been assisting to a growing interest towards compact, stable and versatile realisations, exploiting integrated optics to miniaturise important building blocks of the squeezing experiments [2, 3, 4]. In our work, we demonstrate that a full miniaturisation of continuous variable experiments can be achieved by associating integrated optics to mature classical guided-wave technologies [5]. Our scheme exploits a single photonic circuit for the squeezing generation and detection (see Fig. 1). Squeezed light at 1560.44 nm is generated via single pass spontaneous parametric down conversion in a periodically poled waveguide and detected, directly on chip, thanks to a homodyne detector whose interferometric part relies on an integrated optical coupler. Outside the chip, all the other experiment building blocks are realised thanks to off-the-shelf plug-and-play fibre components. The wedding between integrated optics and these technologies allows realising an extremely compact and easy-to-assemble experiment, where stability and spatial mode matching issues affecting bulk experiments are completely removed. For a CW pump power of 40 mW, we demonstrate a raw squeezing level of -2.00 ± 0.05 dB, corresponding to -3.00 ± 0.05 dB when corrected from avoidable losses [5]. This value represents, to our knowledge, the highest reported squeezing level in single pass configuration pumped in CW regime and it demonstrates the validity of our approach.

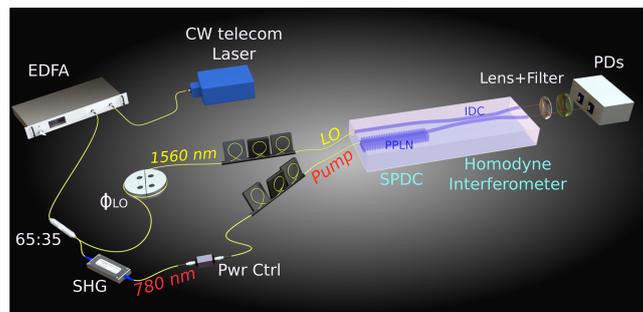


Figure 1: Experimental setup. A fibre coupled CW telecom laser at 1560.44 nm is amplified (EDFA) and split into two by means of a fibre beam splitter (f-BS). The less intense output serves as local oscillator (LO) while the brighter one is frequency doubled (SHG) in a periodically poled lithium niobate ridge waveguide and used to pump a on-chip squeezing generation stage (SPDC). Squeezed light at 1560.44 nm is optically mixed with the LO beam inside the same chip in an integrated directional coupler (IDC). At the chip output, light is sent to two InGaAs photodiodes (PDs). The LO phase is scanned thanks to a home-made fibre-stretcher.

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