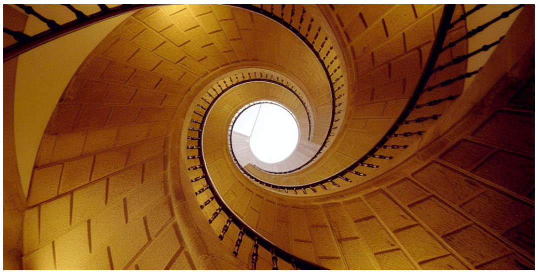

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A Fast QKD Prototype Based on Photonic Integrated Circuits

Tuesday, May 30, 2023 3:10 PM (20 minutes)

Quantum Key Distribution (QKD) has the potential to play a significant role in improving security in communication networks in the near future. Since the first experimental demonstration [1], multiple QKD experiments have been carried out, the majority of which were proof-of-concept demonstrations that continually broke new records in terms of transmission distance, in both fibre [2,3] and free space [4], and secret key rate (SKR) [5]. However, for large-scale applications of this technology in communication networks, compact, scalable and robust integrated receivers and transmitters are needed. To pursue this effort, we developed a compact, portable, ready-to-use high-speed (1.25 GHz) QKD platform based on Photonic Integrated Circuits (PIC), for both the transmitter and the receiver unit. Our practical integrated QKD system can generate secret keys at high speeds and with low Quantum Bit Error Rates (QBER) implementing the 3-state, one-decoy BB84 protocol with time-bin encoding [6,7].
Regarding the transmitter unit, a silicon-based Photonic Integrated Circuit (PIC) is responsible for producing the three states needed for the protocol [8]. A distributed feedback laser, which is external to the chip, generates phase-randomised laser pulses. An in-house-made PCB that actively controls all the previously mentioned components. The experimental setup is further supported by a field programmable gate array (FPGA). The totality of the transmitter unit is placed inside a 1U 19"frame.
The receiver's PIC is based on silica, features low loss and is polarization-insensitive [8,9]. The receiver's unit comprises two Negative-Feedback Single-Photon Detectors (NFADs), a PCB and an FPGA. The NFADs are integrated into a compact package resulting in a total volume of 125 cm3 per detection unit. The NFADs are cooled to -50ºC, with a standard Peltier, and achieve timing jitters smaller than 120ps, dark count rates below 600cps and afterpulsing probabilities of 3% at a detection efficiency of 25%. The totality of the transmitter unit is placed inside a 2U 19"frame.
As preliminary results, we obtained a QBERZ = 1.8% and QBERX= 3%. These were obtained with a receiver PIC that was not optimized for this application, therefore, we expect significant improvement in QBERX once a fitting receiver is assembled. With such low QBERs, we expect to obtain SKRs of more than 1 kbps, over 100km of fibre, and we look forward to presenting our newest results at the conference.

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