Experimental DPTS protocol over 170 km fiber-based link.

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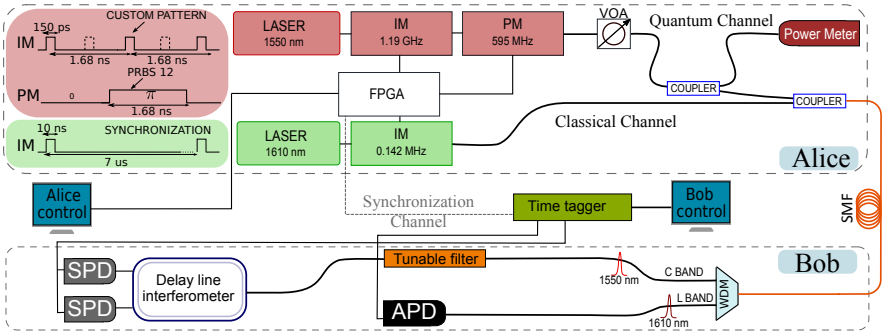
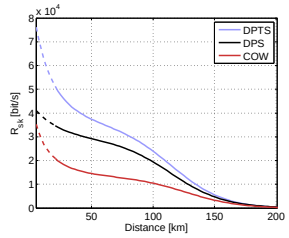
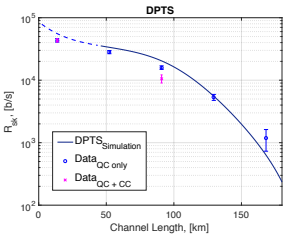
Encryption of public and personal data is becoming increasingly important. However classical cryptography, based on the mathematical assumptions relative to the complexity of the encryption algorithm, cannot guarantee data security of the current century. Quantum cryptography, on the other hand, allows unconditional security based on fundamental physics laws [1]. Despite commercial QKD systems are available today, a complete deployment of this technology is far from being achieved. Limitations in terms of distance, secret key rate and tolerable bit error rate, are essential factors which restrict the deployment of the quantum communication systems. By increasing the modulation dimensionality for QKD systems is possible to enhance the final secure key rates with a better resistance to noise level [2]. Here, we introduce and experimentally realize a new two-dimensional differential phase-time shifting (DPTS) QKD protocol, in which the information is encoded in the time and relative phase of weak coherent pulses [2] (see Fig. 1(a)). Comparison with state-of-the art experiments shows better performance in terms of secret key rate under the assumption of practical security in a local area network (LAN) [3–5]. Theoretical secret key rate as a function of the distance, under the assumption of beam splitting attack, is reported in Fig. 1(b). We demonstrate the robustness of this scheme by transmitting the quantum signal (QC) over 170 km single-mode fiber with tolerable QBER, and also show that a classical channel (CC) (carrying synchronization information) can be transmitted simultaneously through the same fiber up to 90 km. In particular, low and stable QBER (below 5%) was achieved even for a transmission length of 170 km. In Fig.1(c), the experimental secret key rate matches the simulated one (solid blue line). A positive key rate of 10 kbit/s was extracted after 90 km of fiber transmission (20 dB losses), in the case of combined signals, and a key rate of 1 kbit/s is maintained out to 170 km transmission for the QC alone. Note that in this demonstration we only used off-the-shelf equipments, thus showing how the proposed protocol is highly practical and simple in its implementation (See Fig. 1(a) for the experimental setup). Thanks to the minimum requirements in terms of electrical and optical components, future directions will include integrated quantum devices for fiber based DPTS-QKD system.



(a) Experimental setup



(b) Theor. R_{sk}



(c) Exper. R_{sk}

Fig. 1 The setup used in the DPTS experiment in (a). In (b) theoretical simulation of different protocols of the DPR family. In (c) experimental data of the secret key rate as a function of distance.

References

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