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ADVANCED QUBIT GENERATOR AND SYNCH FOSTERING QUANTUM COMMUNICATIONS IN SPACE

Abstract

As of today, quantum-key-distribution QKD is among the most mature quantum technologies, and major European projects are supporting QKD testbeds and the development of a network across Europe in Space and on ground, as this is ongoing in other continents as well.
The implementation of QKD in Space demands that advanced technology solutions are realizing the protocols as functional and efficient payloads. This is the case for photonics solution aimed to achieve high key-rate, the all-day availability and the long service time of operation are asked for the secure communications payloads.
The Quantum-Bit-Error-Rate, or QBER, is a crucial QKD parameter, as the secure key that can be extracted from the available raw-key is strongly reduced as QBER increase above a value of a few percent. Therefore, the request for a qubit generation, the hearth of the QKD transmitter, which may minimize the QBER at the source is of paramount importance. In addition, due to the harsh condition of the transmitter in orbit, the qubit generator is also asked to operate in a reliable and stable regime, despite temperature variations, vibrations and the vacuum condition.
In this work, the solution to these requests are presented with the I-POGNAC qubit generator, providing a stable, low-error, and calibration-free polarization encoder for free-space quantum communication [1]. Moreover, the output polarization is fixed and the level of QBER demonstrated in field trials is well under the percent [2-3].
For the QKD terminals synchronization, here is also presented a correlation method named Qubit4Sync, based directly on the qubit exchange from the satellite [4], providing an effective solution that avoid dedicated hardware for this important operation.
1 M.-Avesani et al., “Stable, Low-Error, and Calibration-Free Polarization Encoder for Free-Space Quan-

tum Communication." Optics-Letters 45 (2020).
2 C.-Agnesi et al., "Simple quantum key distribution with qubit-based synchronization and a self-compensating polarization encoder," Optica 7 284 (2020).
3 M.-Avesani et-al., "Resource-Effective Quantum Key Distribution: A Field Trial in Padua City Center." Optics-Letters 46 2848 (2021).
4 L.-Calderaro et al., "Fast and Simple Qubit-Based Synchronization for Quantum Key Distribution." Physical-Review-Applied 13 1 (2020).