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HIGH DIMENSIONAL FREQUENCY-BIN ENTANGLEMENT FOR 1550NM HIGH SECURE KEY RATES QKD SATELLITE-BASED COMMUNICATIONS

Steven Colle/Speaker^{1,2}, Sacha GRESSANI^{1,2}, Frederic PATOIS¹, Johann CUSSEY¹
Luca Furfaro² and Jean-Marc MEROLLA²

¹Research and Development, AUREA Technology, Besançon, France

²Optical Department, FEMTO-ST, Besançon, France

steven.colle@aureatechnology.com, webpage of the institution (presenting author)

Abstract: In the race of Quantum Internet Network (QIN) development, satellite-to-ground nodes are a key-enabler of large-scale quantum communication. In the context of Quantum Key Distribution (QKD), such node has already been demonstrated as a promising method to overcome distance limitations of fiber and free-space links on ground. In the frame of ESA ARTES 4.0 program, AUREA Technology has implemented high performances compact entangled photon source (HP-EPS) operating in the telecom wavelength window designed for satellite-based Time-Binning QKD^[1]. We investigated the use of high-dimensional Frequency-Bin entanglement encoding, compliant with the source designed by AUREA Technology, to implement a robust and high bit rate QKD system. High-dimensional entanglement has several advantages in the field of quantum communication primarily due to the higher information capacity and noise tolerance^[2,3] it offers. Frequency-Bin entanglement^[4,5] is based on electro-optic phase modulation which naturally enables encoding up to 8-bits-word per detected signal. Contrary to Time-Bin or Time-Binning encoding, this method is resilient to environmental fluctuations due to the use of integrated electro-optic phase modulators. The performances of the Frequency-Bin entanglement method have been estimated using both Single Photon Avalanche Photodiode (SPAD) and low noise Superconducting Single Photon Detectors (SSPDs). The later exhibiting an efficiency of 70%, a time jitter of 15 ps and a noise lower than 20 counts/s. Using a pulsed entangled photon source combined with a 12.5 GHz phase modulation, we have implemented a fiber-based QKD protocol operating up to 65 dB transmission loss budget (both downlinks combined).

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