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ENHANCING RESILIENCE AND ADAPTABILITY IN FREE SPACE TIME-BIN ENCODING QUANTUM KEY DISTRIBUTION

Abstract

A more resilient and adaptable system to address turbulence channels presents the most significant challenge for free-space optical (FSO) quantum communications. In this study, we demonstrate the feasibility of the time-bin encoding Quantum Key Distribution (QKD) protocol through a free-space channel, offering a dual solution for turbulence attenuation. First, we show new methods of fine correction closed-loop constructed upon a tip/tilt fast steering mirror (FSM) and a four quadrant detector (QD). The aim of the latter is to optimize the coupling ratio between the free space and fiber of the detection apparatus. We explore different feedback algorithms going from most standard approaches to artificial intelligence (AI). Second, we use of integrated photonics in the quantum detection scheme to enhance the interferometer's visibility stability over extended acquisition periods. This integration, coupled with the superconducting nano-wire single photon detectors, guarantees long-term stability under varying environmental conditions. Given the simplicity of the scheme, the high-rate qubit delivery rate, the stability of the quantum detection, and the versatility of the C band and the time-bin encoding, our setup is a good candidate for future communications in the free space optical links scenarios. The detection scheme and the tip/tilt adaptive system encourage us to reach longer and longer communication distances soon with time-bin encoded qubits in the third telecommunication windows.