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REPORT ON THE FIRST HUNGARIAN SHORT RANGE FREE SPACE QKD LINK

Abstract

Quantum communication is at the cutting edge of satellite communication technology that still requires further research. It is a promising emergent field since quantum communication using terrestrial networks is limited by channel loss, but free space channels can bridge much greater distances. Our group is pursuing this research topic and has hopes to establish a connection with the planned Eagle 1 quantum satellite. Here we report on the development of our short-range free space quantum communication system. It is designed to transmit one half of an entangled photon-pair between two optical ground stations while the other photon is measured locally. Our goal is to use this setup as a technological test bed for future ground stations communicating with a satellite and develop competences. We have built an entangled photon source, which produces photon pairs at 805 nm, using a BBO crystal. Our source is based on

wavefront splitting interference, which can produce entangled photon pairs with a single BBO crystal at type I phase matching. The entangled photons are coupled into single mode fiber optic cables and guided to the local measurement and transmitter optics. This allows for a more flexible setup, although stress-induced birefringence can alter polarization. We examined this problem and developed possible polarization correction procedures. We used commercially available fiber coupling ports to create a few meters long free space channel in a lab, and worked on integrating telescopes with our system to achieve longer channels. At the receiver side we used no adaptive optics, which was still possible due to the short distance in our experiments. However, it proved problematic at longer distances, and when we attempted to integrate telescopes at the receiver end. To identify corresponding photons on the transmitter and receiver sides, we have tested multiple time synchronization and correlation peak search methods. We found that Fourier transform based correlation search–although works well in theory–has trouble finding overlap in case of low signal to noise ratio. Start-stop histograms proved feasible under realistic channel conditions, yet require longer data collection, and perform best with a reasonable guess at the propagation delay and time synchronization offset. Integrated oscillators of time tagging cards proved too imprecise to identify photon pairs. We tested GPS disciplined oscillators and optically transmitted clock signals, both of which were successful in identifying photon pairs. We used a Bell-test experiment to verify that the transmission is suitable for quantum cryptography.