Entanglement Distribution Over a 29 km Actively Polarization-Stabilized Metropolitan Fiber Link

Akriti Raj[1], Tobias Bauer[1], Christian Haen[1], David Lindler[1], Vivienne Leidel[2], Quankui Yang[2], Thorsten Passow[2], Marko Haertelt[2], Jürgen Eschner[1], Christoph Becher[1]

[1]Universität des Saarlandes, FR Physik, Campus E2.6, 66123 Saarbrücken, Germany

[2]Fraunhofer-Institut für Angewandte Festkörperphysik IAF, Tullastr. 72, 79108 Freiburg, Germany

Entangled photon pair sources are crucial for the efficient implementation of quantum communication protocols. These sources can be realized using AlGaAs Bragg reflection waveguides because these have a high nonlinear coefficient, operate at room temperature and are non-birefringent [1]. Here, we present the generation and distribution of polarization-entangled photons over a 29 km dark fiber link. This link uses commercial fibre deployed both underground and overhead, with several patch stations and has a transmission loss of ~19 dB. The source produces a state with 95.7 % fidelity and 92.4 % purity with respect to the $|\Psi^+\rangle$ Bell state. After transmission over the actively stabilized [2] fiber link, the fidelity reduces to 87.9 % whereas the purity remains unchanged (92 %). The reduced fidelity is due to a significantly lower signal-to-noise ratio on the fiber track, residual uncompensated polarization rotation and a bandwidth mismatch between the reference laser used for polarization stabilization and the source. The reconstructed biphoton density matrices for both the measurements are shown in Fig.1. In summary, we demonstrate a room-temperature entangled photon pair source at telecom wavelength, suitable for real world quantum applications.

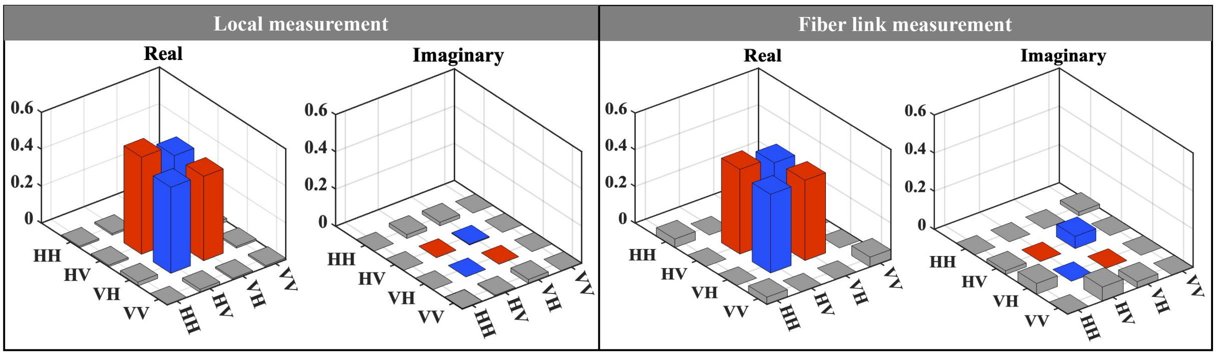

Fig. 1: *Reconstructed biphoton density matrix for local and fiber link measurement.*

Funding acknowledgement

We acknowledge funding by the German Federal Ministry for Research, Technology and Space (BMFTR) within the project VOMBAT (Grant number: B410130213, 16KIS1765K).

Reference

[1] F. Appas et al., J. Light. Technol. 40 (2022).

[2] S. Kucera et al., npj Quantum Inf. 10, 88 (2024).