A scalable quantum key distribution network based on time-bin entanglement

Erik Fitzke, Maximilian Tippmann, and Thomas Walther

TU Darmstadt, Institute for Applied Physics, Schlossgartenstr. 7, Darmstadt, Germany

In this talk, we report on our scalable network for pairwise quantum key distribution [1]. The central component is an all fiber photon source. It generates entangled photons via Spontaneous Parametric Downconversion (SPDC) in a type-0 PPLN crystal. The photons are distributed via an arrayed waveguide grating (AWG) or by a wavelength selective switch (WSS) to the respective parties. Currently, there are four parties connected to the source, but it can be easily scaled up to 100 parties.

The actual key distribution is based on time-bin entanglement requiring identically imbalanced interferometers at each party as well as the source. Due to the specific manufacturing process and precise temperature tuning we achieve low quantum bit error rates (QBER) even for larger distances between parties. In fact, the QBER provides feedback to precisely control the phases of our interferometers via temperature tuning.

We have performed a simultaneous quantum key exchange over various distances by placing fiber spools up to a length of 100 km between the source and the four parties. More over, one party was separated from the source by a 26-km field deployed fiber operated by the Deutsche Telekom. Raw key rates in excess of 40 bits/s limited by our detectors and QBER as low as 3% were found for a distance between parties of 60.55 km.

[1] Erik Fitzke, Lucas Bialowons, Till Dolejsky, Maximilian Tippmann, Oleg Nikiforov, Felix Wissel, Matthias Gunkel, Thomas Walther, A scalable network for simultaneous pairwise quantum key distribution via entanglement-based time-bin coding, PRX Quantum 3 (2022) 020341.