Frequency Dissemination and Quantum Key Distribution on the Niedersachsen Quantum Link Testbed

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We report on the modification and extension of the 73 km fiber link for time and frequency dissemination (TFD) between PTB in Braunschweig and Leibniz University in Hannover, Germany,[1] as a testbed for quantum key distribution (QKD) alongside TFD.

Commercial QKD systems predominantly utilize discrete variable (DV) QKD in the single-photon or near-single-photon regime, thus requiring a fully dark fiber for single photon transfer. Additional bandwidth for classical communication is needed to facilitate post-factum synchronization and classical post-processing. Operating DV-QKD alongside TFD systems is challenging for both applications, as QKD faces prohibitive crosstalk and Raman scattering of the TFD light when operated on a shared fiber, while TFD faces reliability degradation if operated on a single fiber without out-of-loop monitoring. To overcome this, we built a separable fiber configuration (Fig. 1), using a commercial QKD system (10 nm wide QKD passband) in combination with a phase-stabilized optical carrier (ITU 44) and ELSTAB[2] (ITU 42 - 43). During QKD operation, TFD is available via ELSTAB, while the fiber in TFD configuration allows ELSTAB and the phase-stabilized optical carrier to be used with out-of-loop monitoring. Optical communication, facilitating remote control and monitoring of the installed systems and providing the required classical communication for the QKD components, is available independent of the fiber configuration.

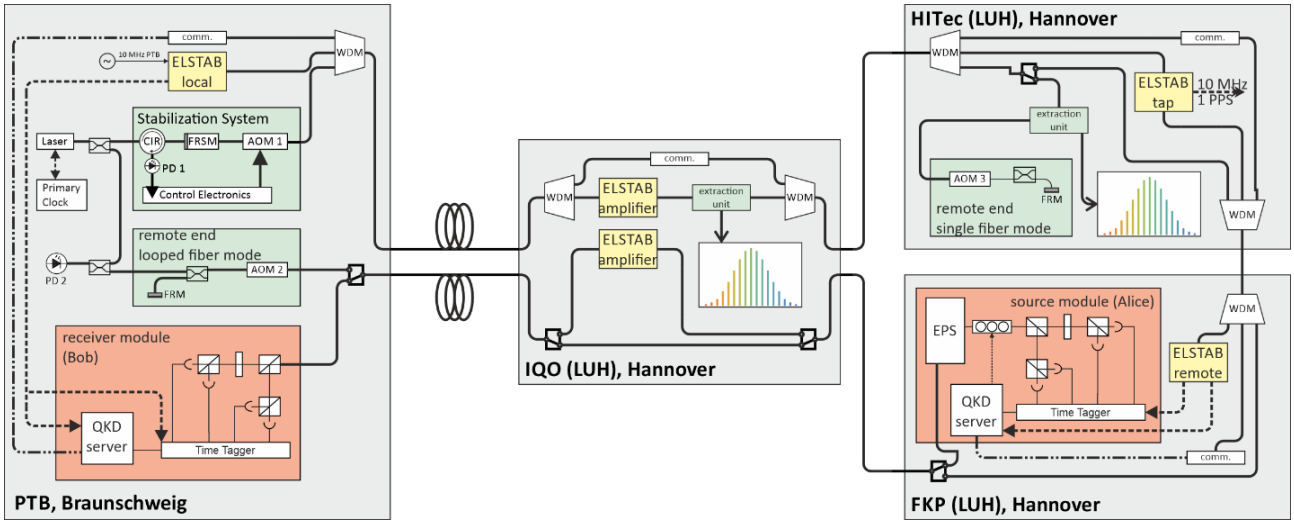

Fig. 1: Schematic of the Niedersachsen Quantum Link testbed for quantum key distribution (orange) and frequency dissemination techniques (green) in separable fiber configuration (here configured for QKD operation alongside ELSTAB (yellow)).

[1] G. Grosche et al., "Optical frequency transfer via 146 km fiber link with 10^{-19} relative accuracy," Opt. Lett., vol. 34, p. 2270-2272, 2009.

[2] P. Krehlik et al., "ELSTAB-Fiber-Optic Time and Frequency Distribution Technology: A General Characterization and Fundamental Limits," IEEE Trans. Ultrason. Ferroelectr. Freq. Control., vol. 63(7), p. 993-1004, 2016.