TU Berlin Quantum Communication Testbed

This lab at Technical University of Berlin focuses on the experimental implementation of single-photon based quantum cryptographic protocols. The utilized light sources are based on semiconductor materials, namely epitaxial quantum dots (QDs) or two-dimensional materials such as hexagonal boron nitride (hBN) or transition metal dichalcogenides (TMDCs). This results in a broad examined wavelength range from around 700-800nm (TMDCs, hBN, QDs), over 900-950nm (QDs) up to the telecommunication O- and C- Band (QDs). Two optical links between buildings at campus Charlottenburg of TU Berlin can serve as quantum channels, a free-space optical link (FSO) via telescopes for short wavelengths and a dark fiber optical link for telecom wavelengths.

A: Brief Information

Testbed Title	TU Berlin Quantum Communication Testbed
Start Point	Eugene Wiegner Gebäude, TU Berlin
End point	TU Berlin-Hauptgebäude 52°30'43.7"N 13°19'32.8"E for fiber link 52°30'42.9"N 13°19'37.0"E for free space optical (FSO) link
Institution/Organization	Technical University (TU) of Berlin and University of Münster
Contact	Tobias Heindel: tobias.heindel@uni-muenster.de
Status	active

B: Technical Information

Type of Transmission	fiber + FSO
Length [km]	3.9 for fiber 0.4 for FSO
Losses [dB]	0.8 – 1.5 for fiber ~1.5 for FSO
Supported Wavelengths [nm]	O-band (1310 nm) to C-band (1550 nm) for fiber 780 to 950 nm for FSO
Type of Fiber	single mode
Type of Deployment	underground for fiber
Polarization Stabilization	-
Fiber Link infrastructure	Dedicated Server-Rack (22 HE) Fiber Splice-Box (4x E2000 connectors, 1x Duplex)
FSO-Link infrastructure	• ø 50 mm clear aperture, ø beam 25mm • Active laser beam tracking system (MRC systems) • Actively controlled relay mirror

Quantum Communication Infrastructure	Components:
Quantum light sources	• single-photon sources based on epitaxial quantum dots and 2D-TMDCs
Detection systems	• 12-channel superconducting single-photon detection system, 4x 780 nm, 4x 850 nm, 4x O-/C-band • 4-channel SPCMs, 400-1000nm
QKD Detection modules	Passive choice polarization detection modules (BOB): • Multimode: 700-800nm • Singlemode: 850-950nm, 1550nm
QKD Sender modules	Electrooptical modulators (EOMs) for active state preparation (ALICE): 700nm, 780nm, 900nm, 1300nm, 1550nm with up to GHz driving electronics
Cryostat	Mobile cryostat systems with base temperatures of 2.8 K (Attocube attoCMC) and 27 K (Stirling Cryocooler by CryoTel)
Available Infrastructure for external Parties	Access available upon request and after collaboration agreement

C: Additional Information

Linked Projects	• TubLAN Q.0: https://www.forschung-it-sicherheit-kommunikationssysteme.de/projekte/tublan-q.0 • COMPHORT: https://www.forschung-it-sicherheit-kommunikationssysteme.de/projekte/comphort
Press Release and Publications	• Abhörsicheres Quantennetzwerk an der TU Berlin • Berlin erhält ein abhörsicheres Quantennetzwerk, 2023
Demonstrated Milestone	• Stable operation of FSO-link with ~70% avg. transmission • Mobile operation of fiber-pigtailed QD-sample with high multi-photon-suppression <1%
Outlook	• trusted multi-node QKD network based on deterministic (sub-Poissonian statistics) quantum light sources, • BB84-/MDI-QKD links
Suggested Use Cases	• field-experiments of quantum key distribution (QKD and beyond) • benchmarking of components for QKD
Other Comments/ Information	

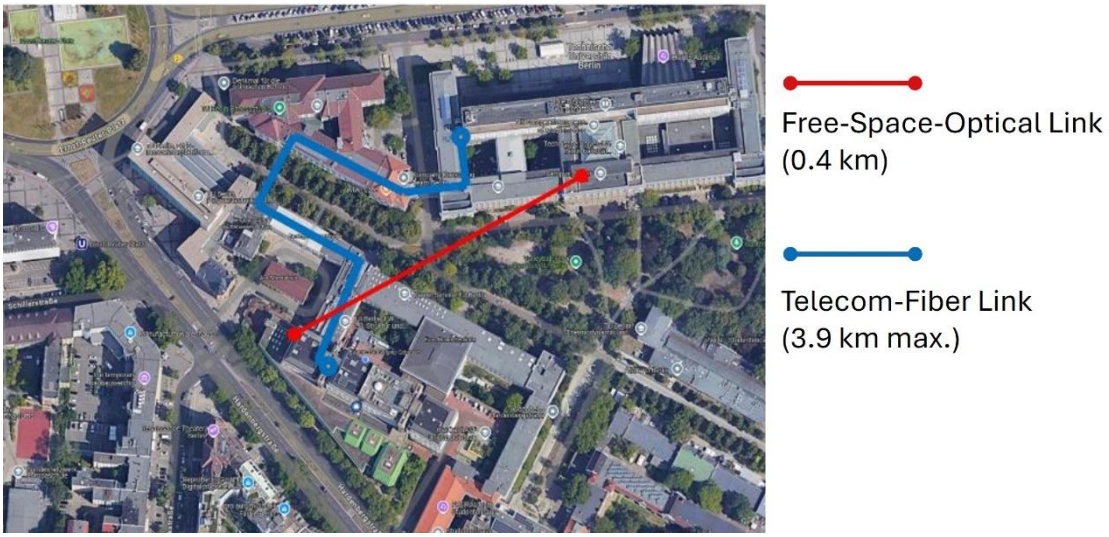

Fig.1: Link locations on campus Charlottenburg of TU Berlin

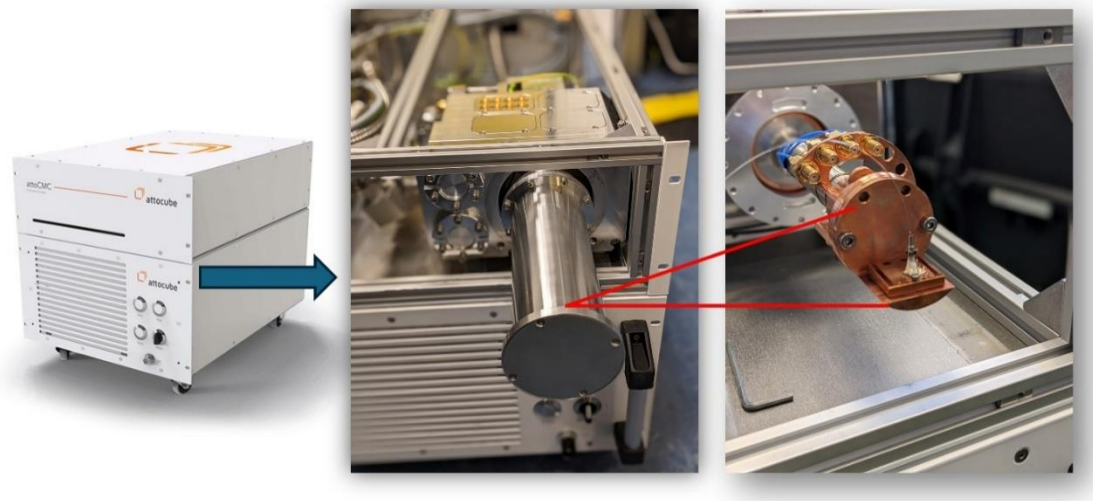

Fig. 2: Mobile 4K-cryostat AttocubeCMC with mounted fiber-pigtailed QD-sample

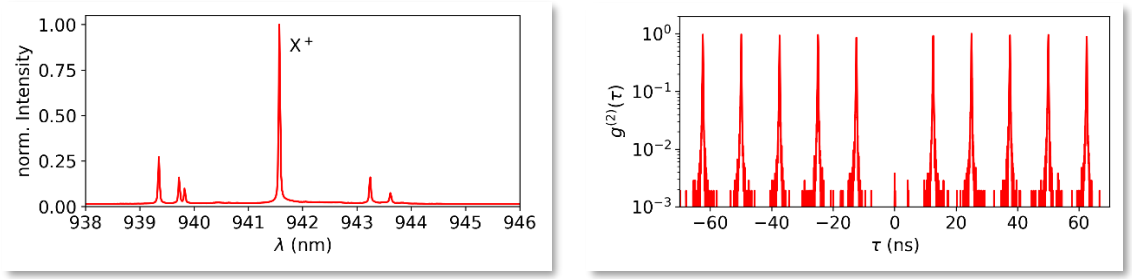

Fig. 3: Spectrum under pulsed excitation and second order autocorrelation of the device shown in Fig.2, with an excellent multi-photon suppression of $g^{(2)}(0) = 0.51\%$

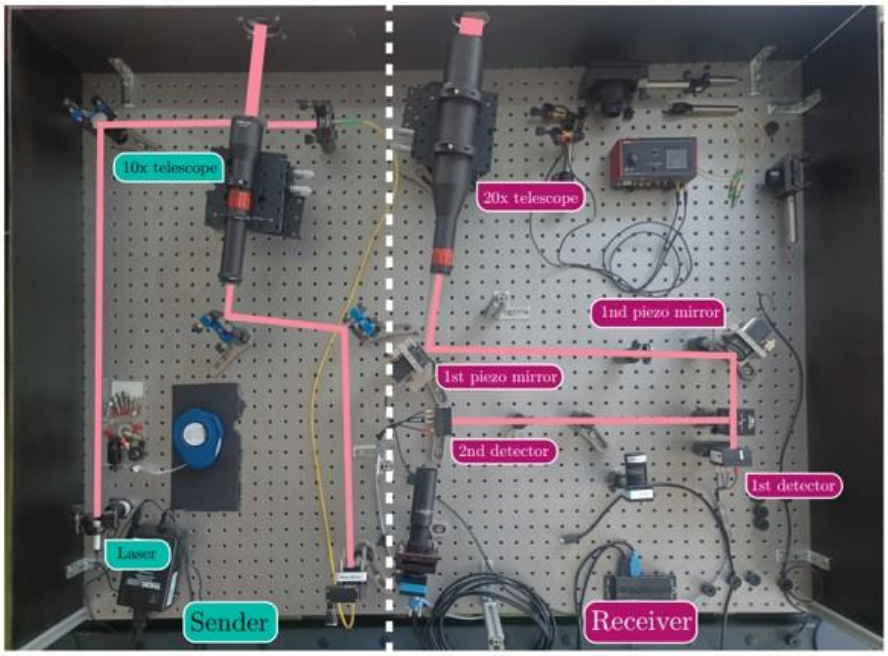

Fig. 4: Optical setup for the stabilization of the FSO link

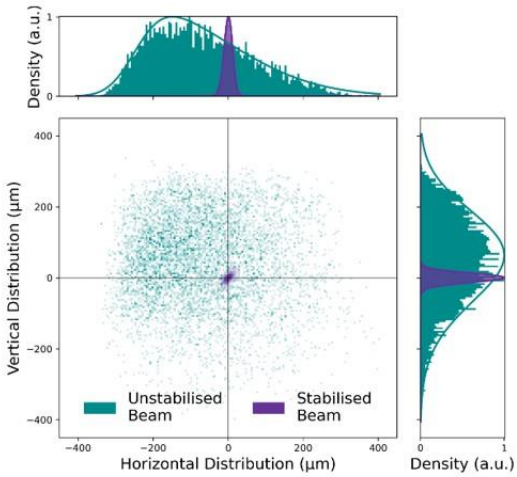

Fig. 5: positional data of beacon laser with and without active stabilization