

Saarbrücken Quantum Communication Fiber Testbed

The Saarbrücken Quantum Communication Fiber Testbed is a 14.4 km urban dark fiber link between the Universität des Saarlandes (UdS) and the Hochschule für Technik und Wirtschaft des Saarlandes (HTW Saar), established as an open testbed for research on distributed quantum networks. Planned activities include the demonstration of fundamental quantum repeater building blocks, such as entanglement distribution between remote nodes, fiber-coupled quantum nodes in two- and three-party configurations, and the investigation of hybrid quantum nodes based on different hardware platforms. A central goal of the testbed is the experimental demonstration of quantum repeater concepts under realistic urban fiber network conditions. This infrastructure provides a practical environment for quantum communication experiments and enables comprehensive validation studies as well as investigations of system interoperability.

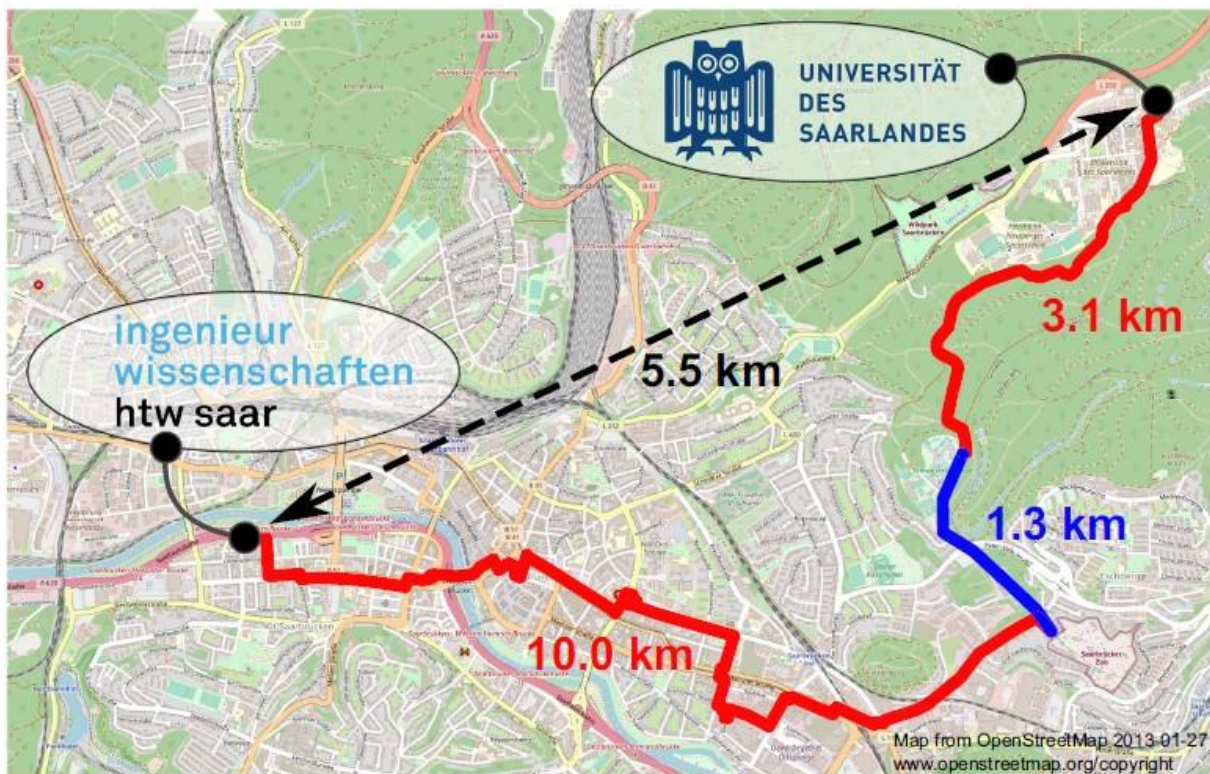


Fig. 1 Map of the fiber link. The approximate course of the 14350 m long fiber link extending from the labs at the UdS to the HTW is displayed; underground sections are in red, and overhead sections in blue. Map data from [OpenStreetMap](https://www.openstreetmap.org/). (Source reference: [Kucera, S., Haen, et al. Demonstration of quantum network protocols over a 14-km urban fiber link. npj Quantum Inf 10, 88 \(2024\)](#)).

A: Brief Information

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|----------------------|----------------------------------------------------------|
| Testbed Title | Saarbrücken Quantum Communication Fiber Testbed |
| Start Point | Universität des Saarlandes (UdS), Saarbrücken |
| End point | Hochschule für Technik und Wirtschaft (HTW), Saarbrücken |

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|---------------------------------|---------------------------------------------------------------------|
| Institution/Organization | UdS with VSE NET GmbH |
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| | Prof. Dr. Christoph Becher, christoph.becher@physik.uni-saarland.de |
| Status | active |

B: Technical Information

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|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Type of Transmission | Dark fiber |
| Length [km] | 14 |
| Losses [dB] | 11 |
| Supported Wavelengths [nm] | O-band (1310 nm) to C-band (1550 nm) |
| Type of Fiber | Single mode |
| Type of Deployment | Combined |
| Polarization Stabilization | Yes (Home-built @ UdS) |
| Quantum Communication Infrastructure | entangled photon source @ 854 nm; source of ion-entangled single photons @ 854 nm; quantum frequency conversion to 1550 nm; single photon detectors @ 1550 nm; access to experiments on quantum nodes based on trapped Ca ions and SnV centers in diamond |
| Available Infrastructure for external Parties | access upon request and agreement; available infrastructure: access to entangled photon source, single photon detectors, internet |

C: Additional Information

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|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Linked Projects | <ul style="list-style-type: none"> • Technologien und Demonstratoren für Quantenrepeater, TD.QR (11/2025–12/2026): https://www.hu-berlin.de/forschung-lehre/forschungsinformationssystem/projekt-details/technologien-und-demonstratoren-fuer-quantenrepeater-tdqr-teilprojekt-3-knoten-verschraenkung-von-quanten-speichern-ueber-eine-52km-telekomfaserverbindung-1?lang=de_DE • Quantenrepeater.Net, QR.N (01/2025–12/2027): https://quantenrepeater.net/en/ • Quantum Hifi (07/2022–06/2025): https://www.forschung-it-sicherheit-kommunikationssysteme.de/projekte/quantum-hifi • QSync (09/2021–09/2023): https://www.forschung-it-sicherheit-kommunikationssysteme.de/projekte/qsync • Quantenrepeater.Link, QR.X (08/2021–07/2024): https://www.forschung-it-sicherheit-kommunikationssysteme.de/projekte/qr.x |
| Press Release and Publications | https://www.nature.com/articles/s41534-024-00886-x |

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|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Demonstrated Milestone | <ul style="list-style-type: none">• photonic entanglement distribution over 14 km of deployed fiber including quantum frequency conversion• atom-photon entanglement across fiber• teleportation over fiber from ion qubit at UdS to photonic qubit at HTW |
| Outlook | <ul style="list-style-type: none">• demonstration of fundamental quantum repeater building blocks, i.e. entanglement distribution between remote nodes• fiber-coupled quantum nodes (2-party direct link, 3-party link through central node etc.)• hybrid quantum nodes based on different platforms |
| Suggested Use Cases | Quantum repeater demonstration experiments |
| Other Comments/ Information | Photo sources: https://www.nature.com/articles/s41534-024-00886-x and Universität des Saarlandes / Oliver Dietze |

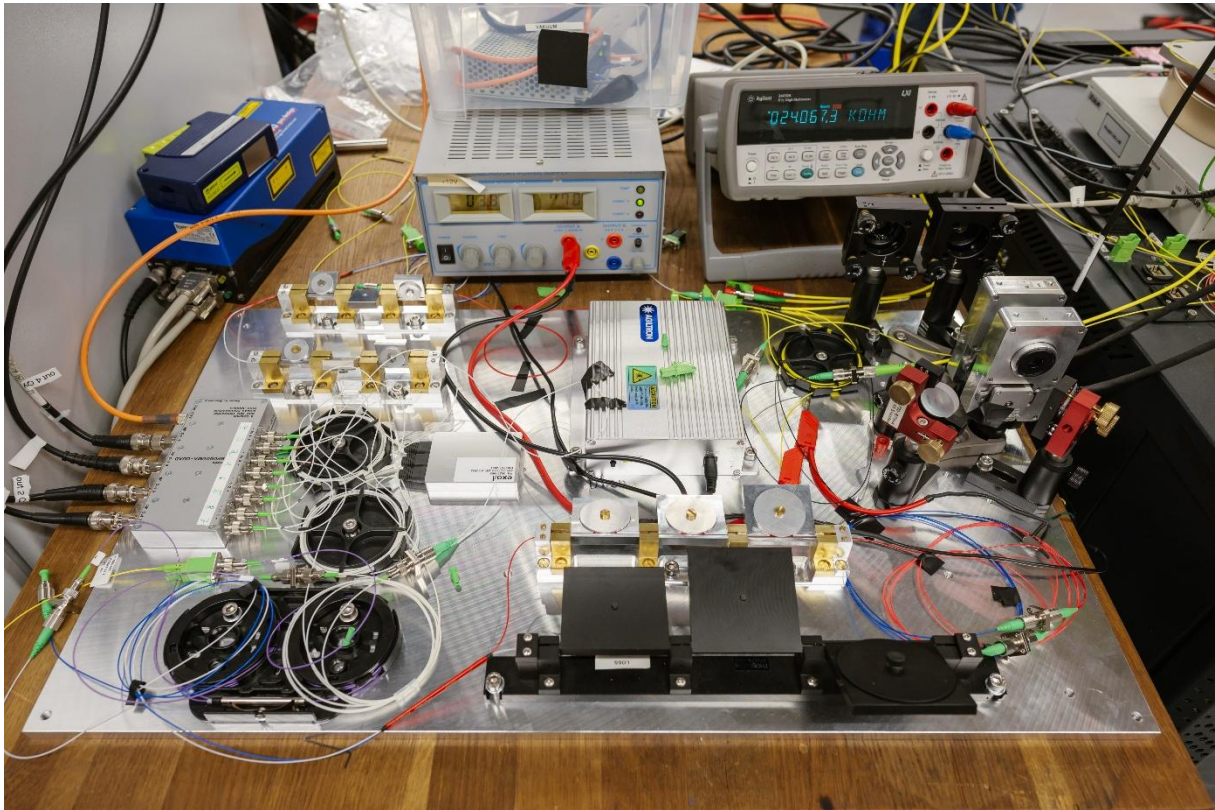


Fig. 2 Fiber track stabilization set-up at the UdS (© Oliver Dietze).



Fig. 3 Server rack at the HTW.