

Quantum key distribution based on single photons from a telecom quantum dot source

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Quantum cryptography is arguably the fastest-growing area of quantum information science. The most developed branch of quantum cryptography is quantum key distribution (QKD), which has led to major scientific and technological advances in information-theoretic secure communication worldwide. Telecom quantum dots (QDs) are a promising source of non-classical light with unique advantages over quantum communication using weak coherent states. They achieve a higher secure key rate and enable large-scale entanglement distribution.

Here we present our recent work on various QKD schemes and related technique based on a telecom C-band QD source. As shown in the figure, employing an InAs/InGaAs/GaAs QD embedded in a circular Bragg grating as the single-photon source enabled the first intercity QKD experiment to be demonstrated over a 79 km quantum link between Leibniz University Hannover and the Physikalisch-Technische Bundesanstalt [1]. A secure key rate of 10.93 kbits/s was obtained in the asymptotic regime. To counteract fluctuations in quantum channels affecting photonic polarisation states, we then demonstrate time-bin encoded QKD for the first time using a telecom QD [2]. This achieves the highest secure key rates of single-photon source-based time-bin QKDs. A positive secure key rate was identified with a maximum tolerable distance up to 127 km. Additionally, an ultra-stable, low-error encoder developed for the dynamic polarisation modulation of single photons is presented [3]. A quantum bit error rate of 0.69(2)% is achieved, marking the lowest error rate reported to date for the high-speed encoding of information on single photons. Our work signifies a substantial advancement in establishing robust, scalable quantum communication in real-world scenarios based on telecom QD emitters.

[1] J. Yang. et al., *Light: Sci & Appl.* **13**, 150 (2024). <https://doi.org/10.1038/s41377-024-01488-0>

[2] J.P. Wang. et al., *Light: Sci & Appl.* Accepted for publication (2026). <https://doi.org/10.48550/arXiv.2506.15520>

[3] J. Hanel. et al., arXiv:2507.16578 (2025)

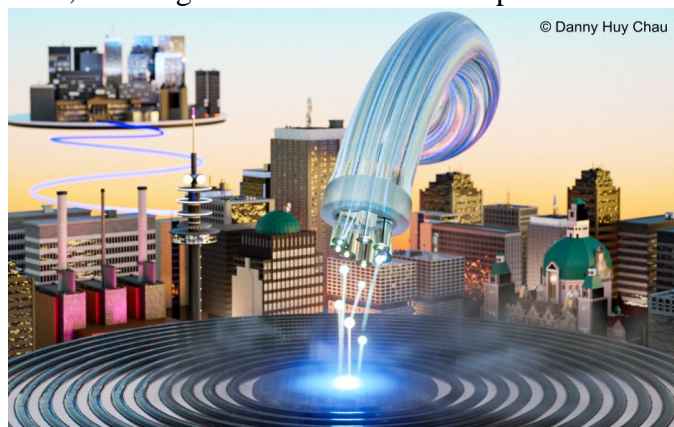


Figure: Intercity QKD between Hannover and Braunschweig using a telecom QD based single-photon device fabricated by University of Stuttgart.