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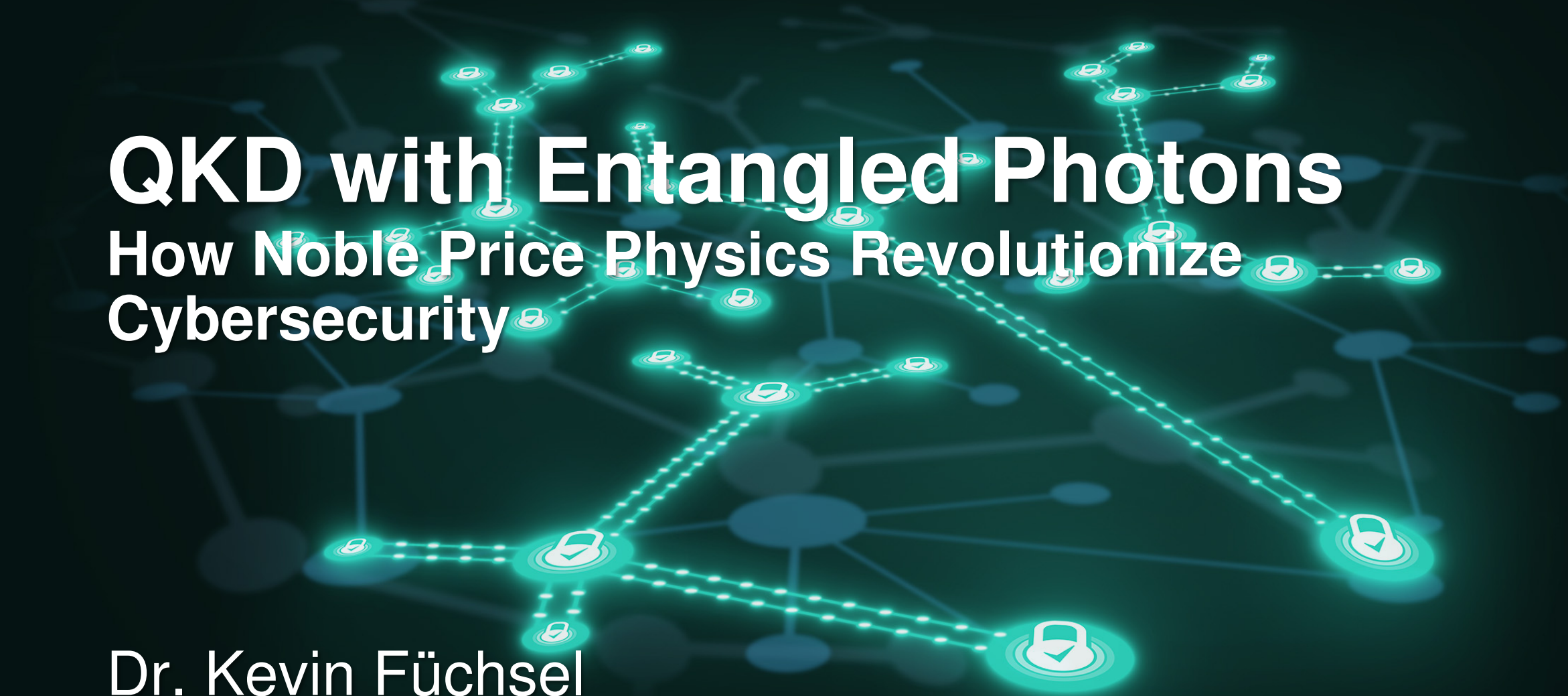
QKD with Entangled Photons

How Noble Price Physics Revolutionize Cybersecurity



Dr. Kevin Füchsel

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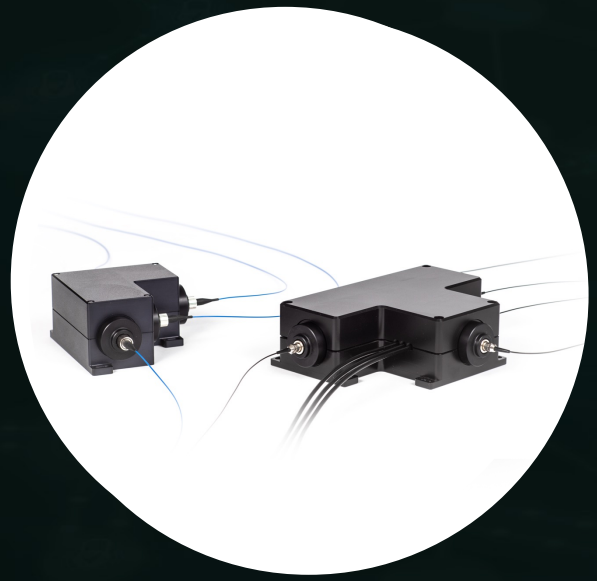
One-Stop Solution

Hardware, Software, & Service for post-quantum security

Entangled Photon Pair Sources

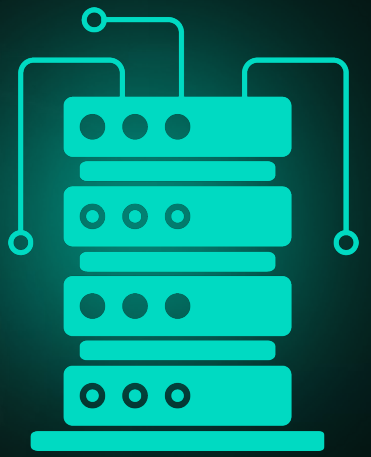
Quantum State Analyzers



Key Management System

Quantum Key Distribution Systems

Crypto Box / Network



Quantum Secure

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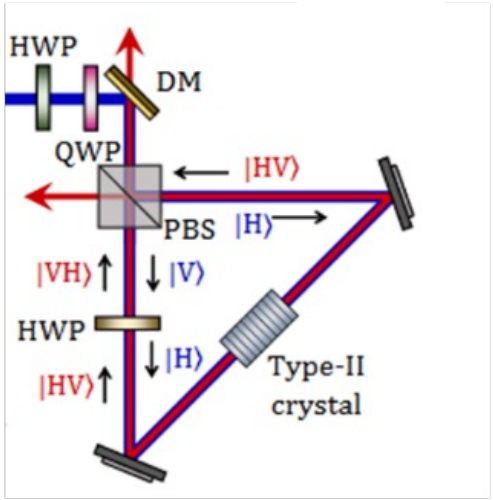
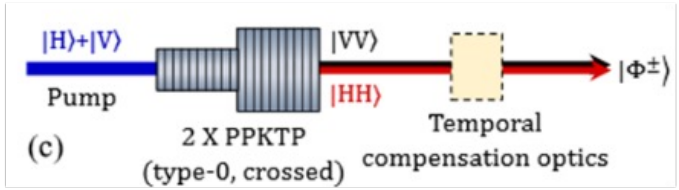
QKD with Entangled Photons

Entangled Photon Pair Source

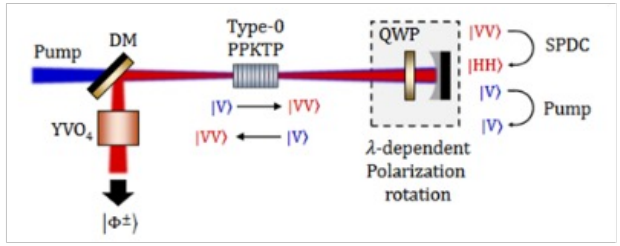
Sagnac-Cavity Configuration



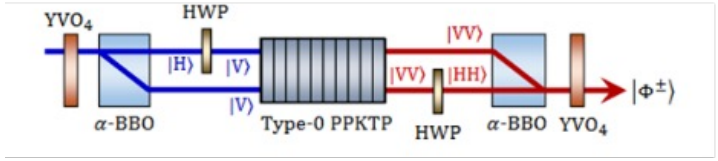
Crossed-Crystal Configuration



Douple-Pass Configuration



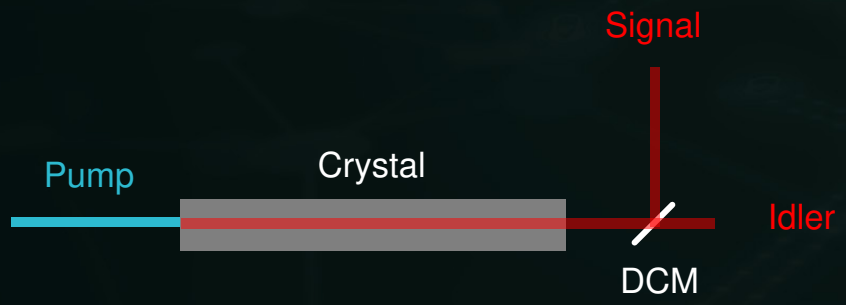
Parallel MZI Configuration

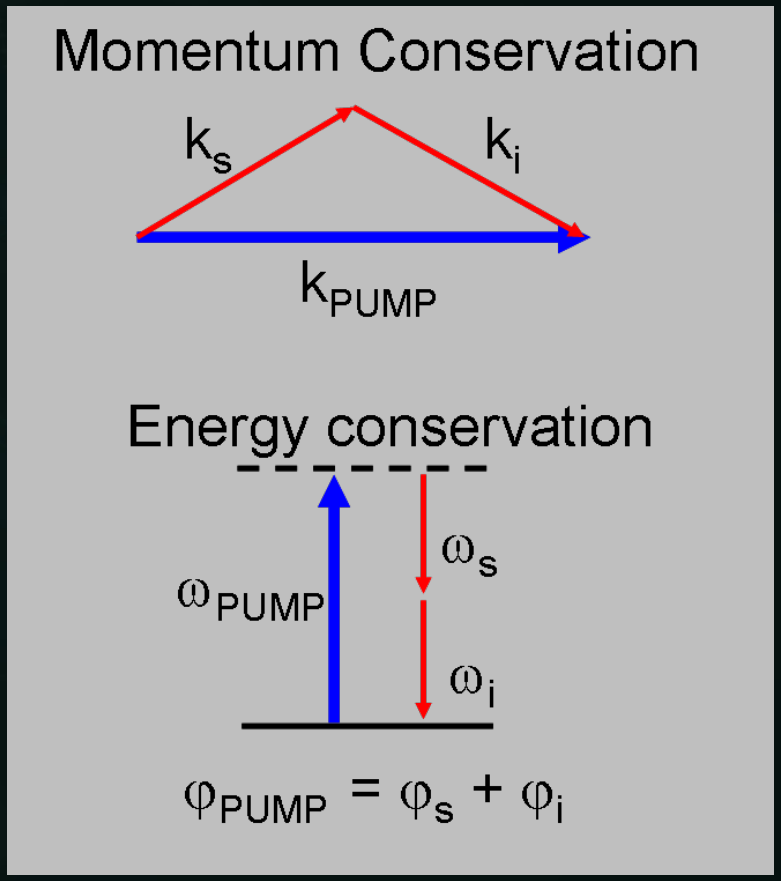


* A. Fedrizzi et al., „A wavelength-tunable fiber-coupled source of narrowband entangled photons," Optics Express 15(23), 15377-15386 (2007)
** F. Steinlechner et al., „A high-brightness source of polarization-entangled photons optimized for applications in free space," Optics Express 20(9), 9640-9649 (2012)
*** F. Steinlechner et al., „Phase-stable source of polarization-entangled photons in a linear double-pass configuration," Optics Express 21(10), 11943-11951 (2013)
**** R. Horn et al. ,"Auto-balancing and robust interferometer designs for polarization entangled photon sources," Optics Express 27(12), 17369-17376 (2019)

QKD-Systems with Entangled Photons

- SPDC (spontaneous parametric down conversion) process





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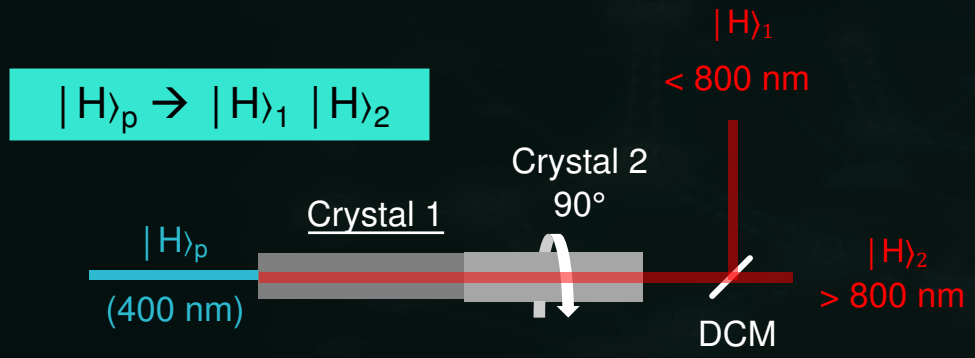
QKD-Systems with Entangled Photons



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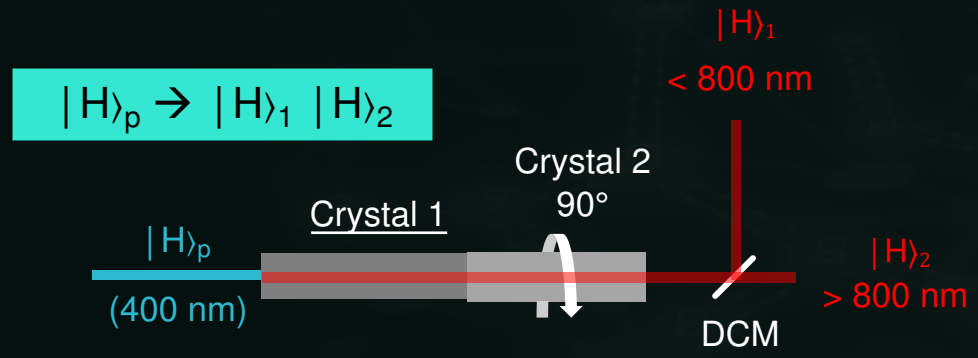
QKD-Systems with Entangled Photons



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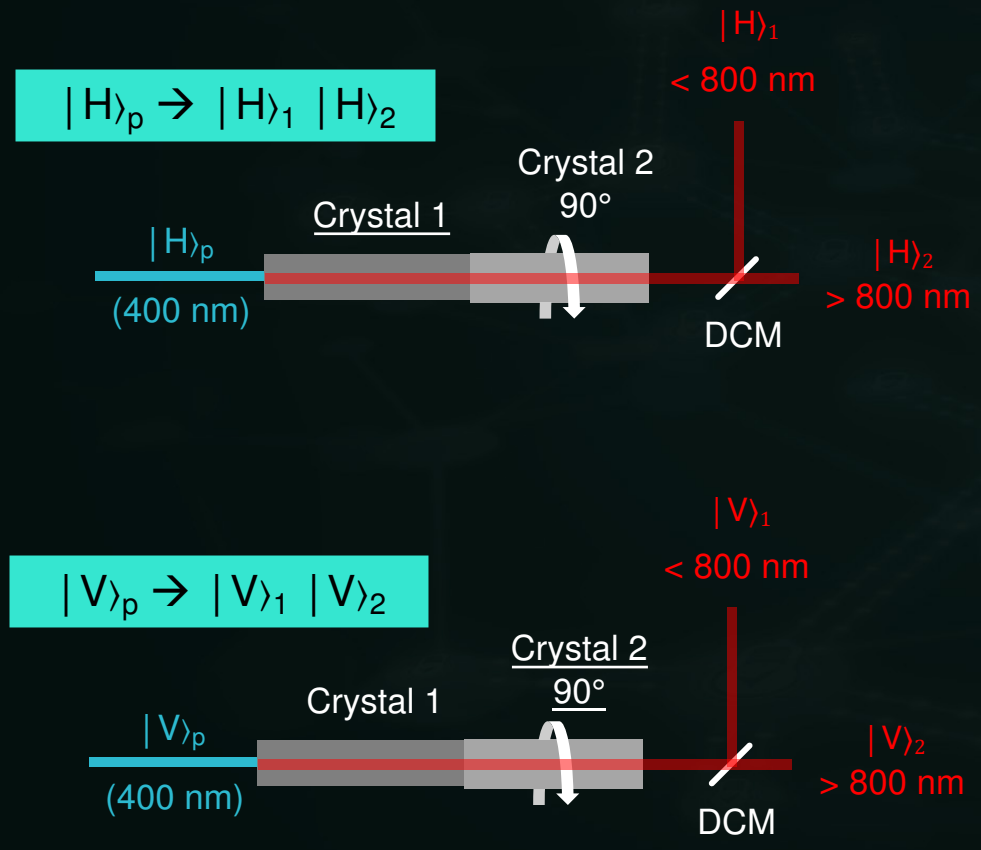
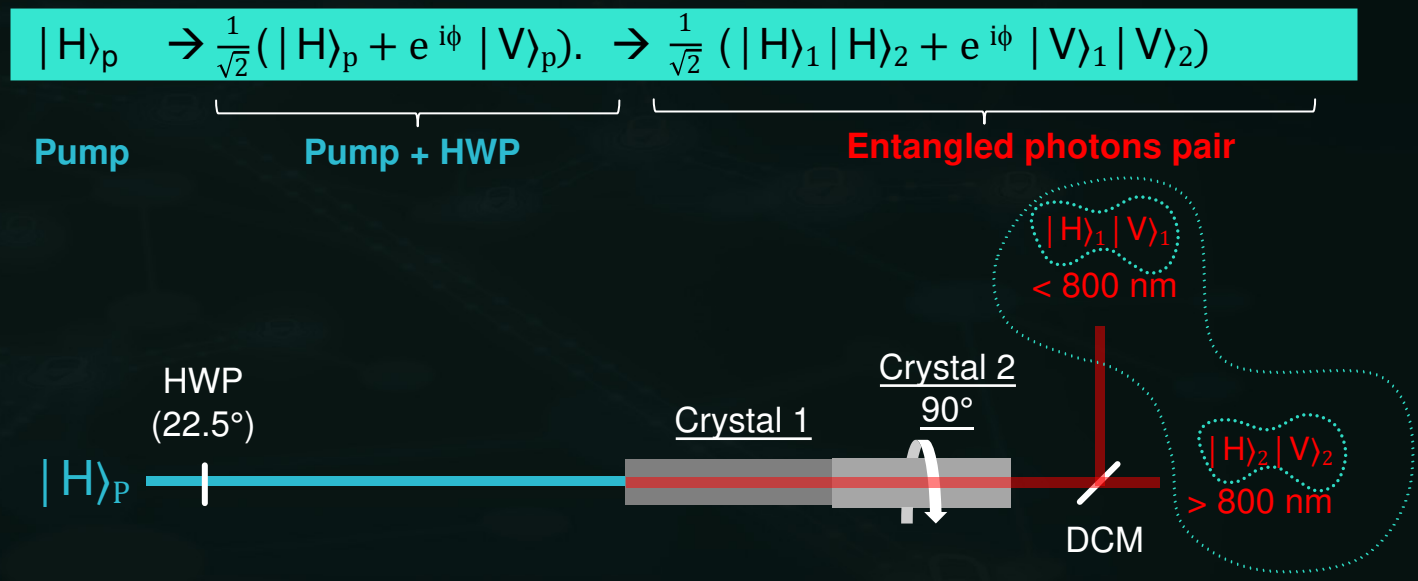
QKD-Systems with Entangled Photons





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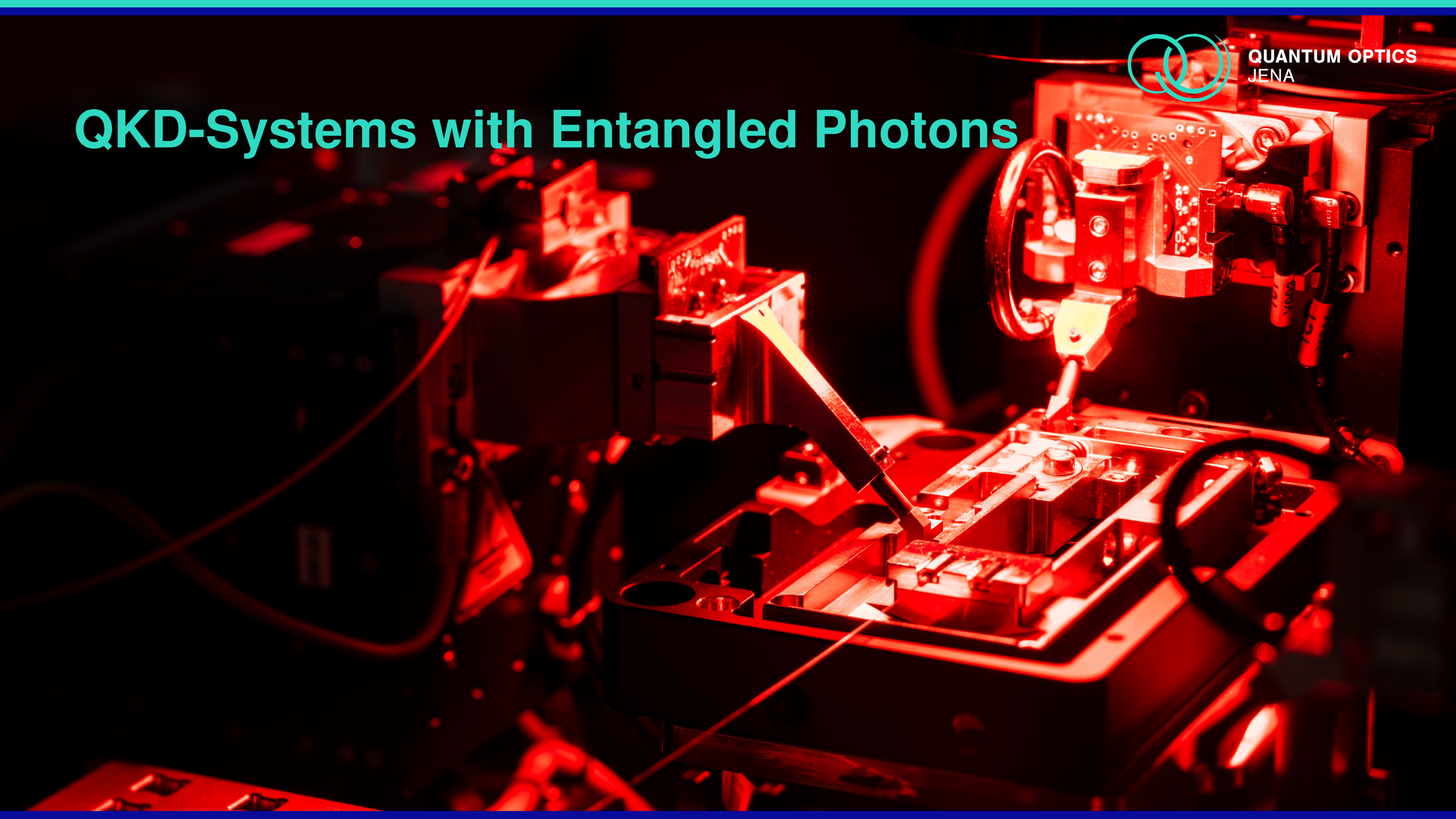
QKD-Systems with Entangled Photons



System Architecture

$$l \leq nq - n_x h_2(\delta_x) - n_z h_2(\delta_z) - leak_{EC} - log\frac{2}{\varepsilon_{cor}} - 2log\frac{1}{2\varepsilon_{sec}}$$

Secure Key Length ≤ Number of Photons Uncertainty − QBER − Public Information − Verify correctness & security

QBER ≤ 11%

Security of an entanglement-based QKD protocol without parameter estimation

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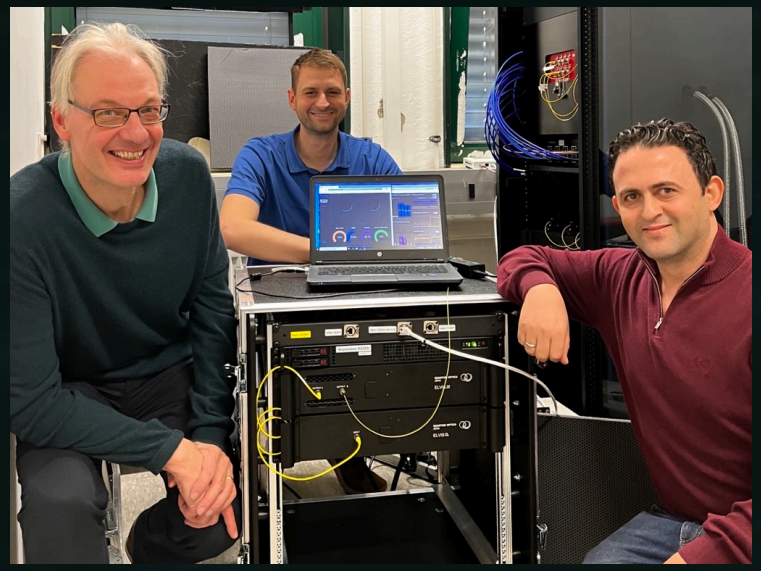
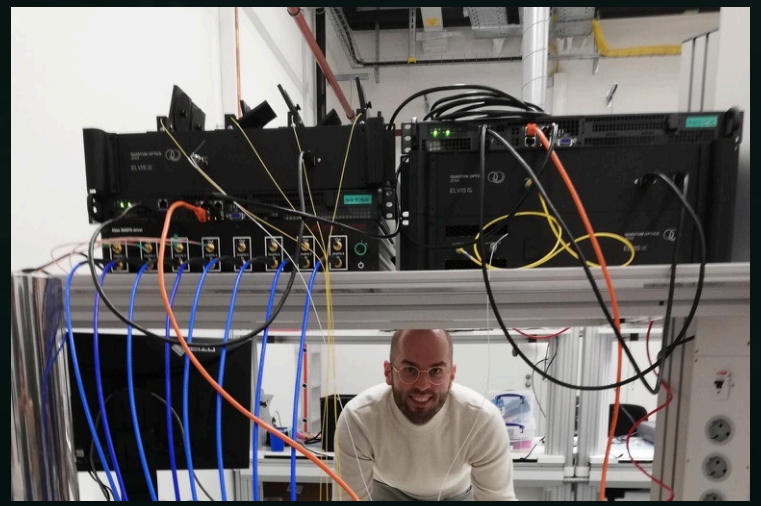
Demonstration





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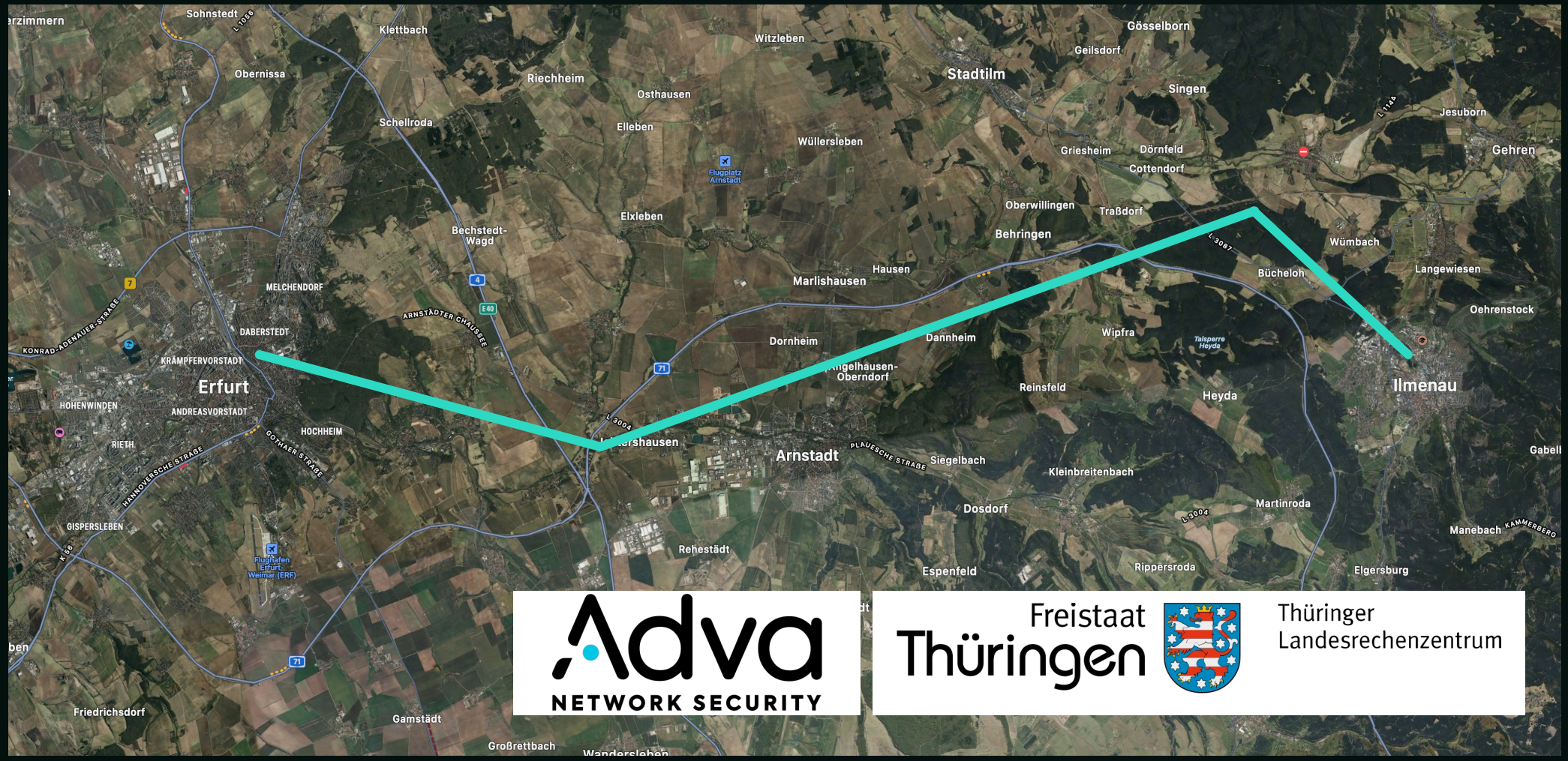
City Link Erfurt - Ilmenau

56 km, optical loss approx. 13 dB @ 1550 nm



Adva
NETWORK SECURITY

Freistaat Thüringen

Thüringer Landesrechenzentrum

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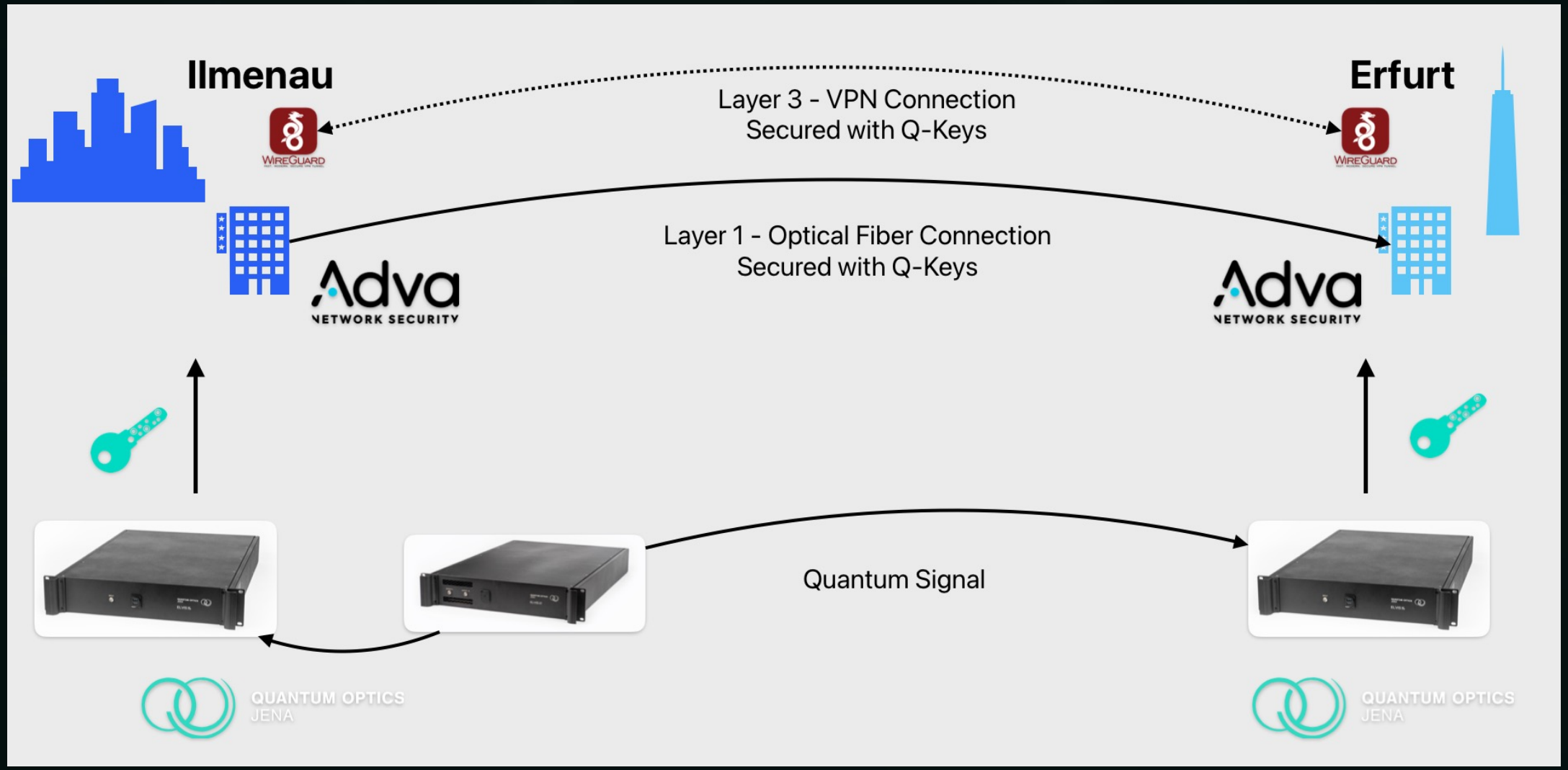

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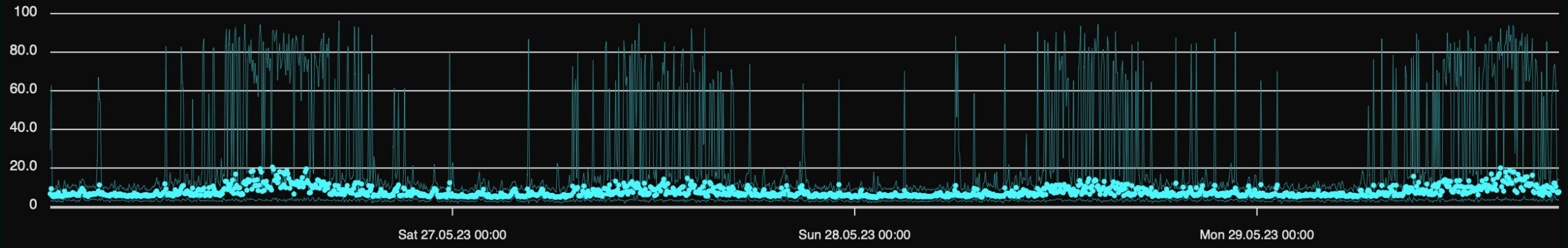
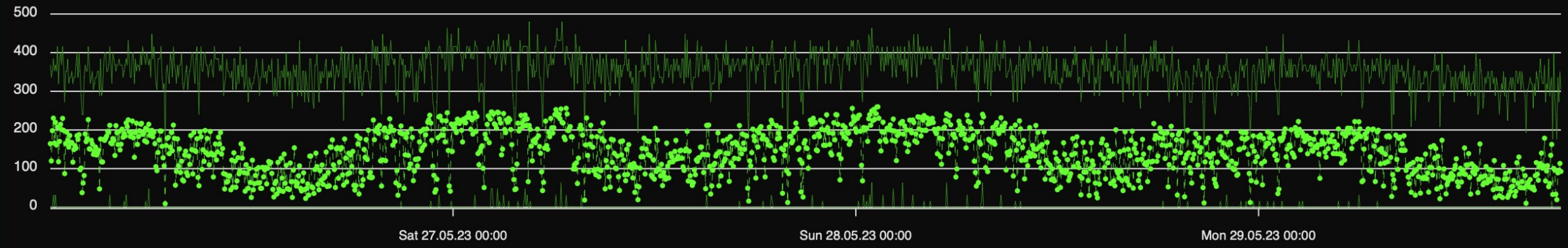
Average key-rate: 137 bit/s

Quantum bit error rate (QBER) in %



Secure key rate in bit/s



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Performance in 24h:

- 20 Bill. entangled photon-pairs sent
- 100 Mio. entangled photon-pairs measured
- 11.84 Mio. secure bits generated
- 46.260 x 256 bit keys established
- Average secure key rate 137 bit/s
- 1500 Keys (1x min) used – approx. 3% utilization

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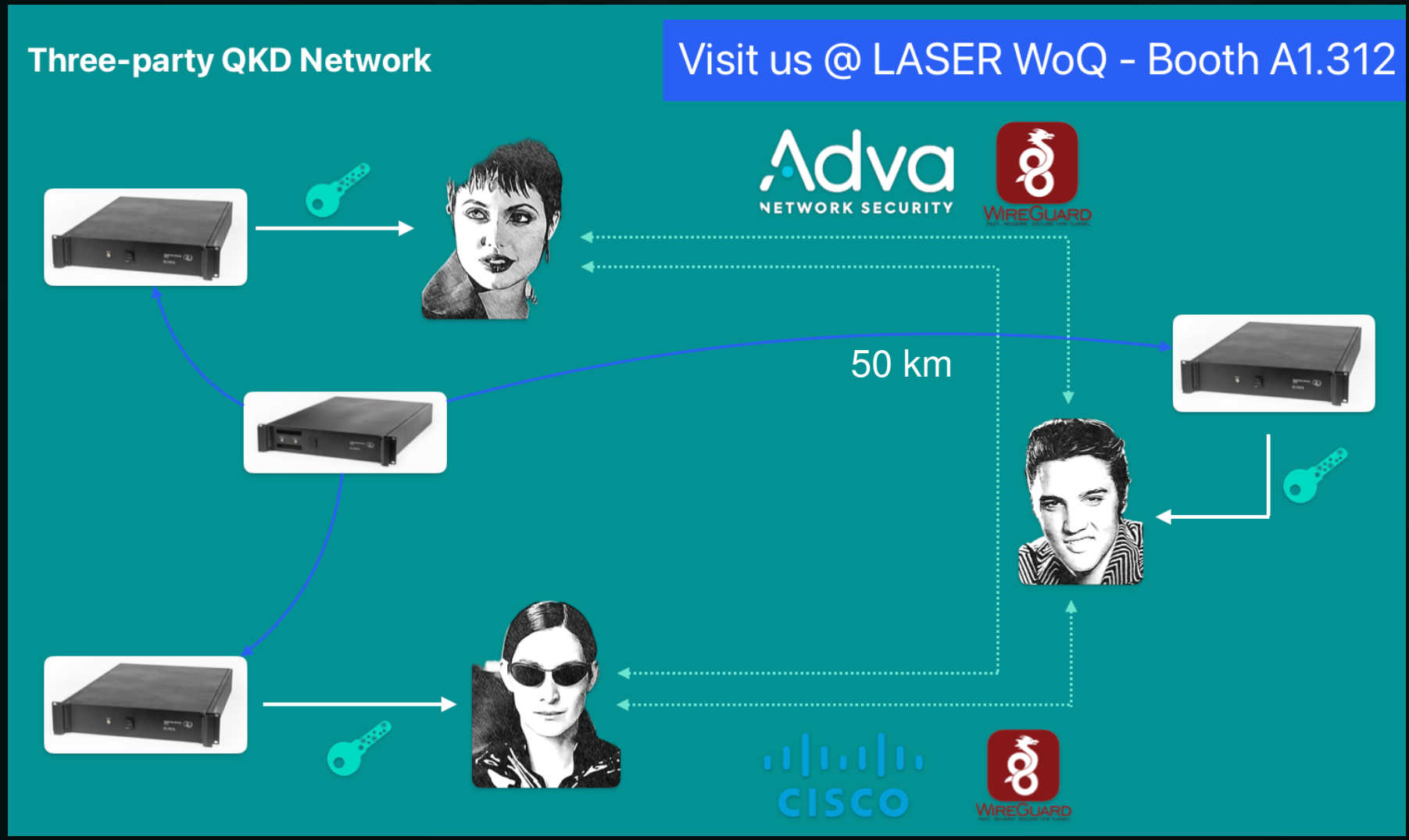
Multi-party QKD - ELVIS live on Stage



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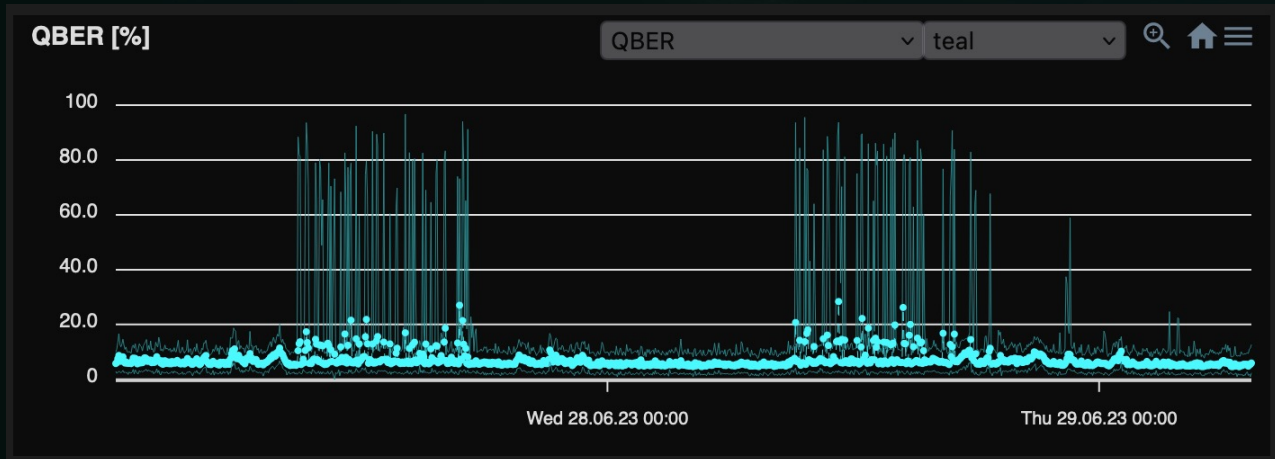
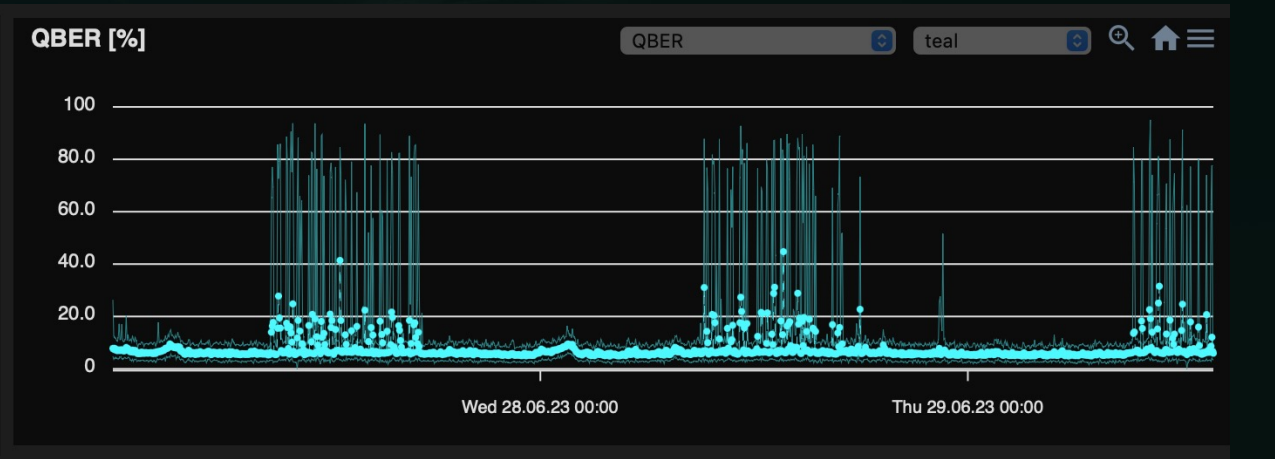
Multi-party QKD - ELVIS live on Stage





Link 1

Link 2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