Motivation

Quantum-secured Networks

Motivation

- Exploit full potential of solid-state single-photon sources
- Improve performance of QKD systems
- QKD Testbed

Receiver Module "Bob"

- QKD-Microlens Single-Photon Source
- Polarizer (Pol)
- Beam Splitter (BS)
- Photodetector (PDB)

Receiver Module "Alice"

- Source with electrically triggered SPS
- Different network topologies

Real-Time Security Monitoring

- Proof-of-concept Real-Time Photon Statistics
- Temporal Filtering
- Quantum Bit Error Ratio
- Multi Photon Probability

Secret Key Rate (asymptotic) (0)

\[ S = \frac{b_{\text{link}}}{2} (1 - \epsilon)(1 - f_{\epsilon})b_{\text{sec}}(\epsilon) \]

Sifted Key Rate

\[ P_{\text{out}} = P_{\text{in}} \times P_{\text{secure}}(\epsilon) \]

2D Temporal Filtering

- Acceptance window: Width \( \Delta t \) and Center \( t_c \)

Temporal Filtering

- Measured photon arrival distributions

Photon statistics

- \( g^{(2)}(\tau) \) via HBT-measurement
- Channels of each bases combined
- Timestamp evaluation

Secret Key Rate

- \( g^{(2)}(\tau) \) via HBT-measurement
- Channels of each bases combined
- Timestamp evaluation

QKD Implementation

- Modulation of Signal with fast EOM
- Investigation of sender side Alice
- Full implementation in laboratory and in field

Outlook

BQN – The Berlin Quantum Network

Next Steps

- Single Photon Source
  - Telecom O-band CBG SPSs
  - Full implementation of Plug-and-Play SPS
  - Source with electrically triggered SPS

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BMBF-Program Photonic Research Germany

Federal Ministry of Education and Research (BMBF)

Dr. Tobias Heindel

BMBF Junior Research Group Leader

Tools for the Performance Optimization of Single-Photon Quantum Key Distribution

Timm Kupko¹,², Martin v. Helversen², Lucas Rickert², André Strittmatter¹,², Manuel Gschrey¹, Sven Rodt¹, Stephan Reitzenstein¹, and Tobias Heindel¹,²

¹Institute of Solid-State Physics, Technical University Berlin, Germany
²Present address: Institute of Physics, Otto-von-Guericke University Magdeburg, Germany

*E-Mail: tobias.heindel@tu-berlin.de, t.kupko@tu-berlin.de

QKD Testbed

QD-SPS

Alice

Bob

Real-Time Security Monitoring

- Integration time (s)
- Channel loss (dB)

Quantum Key Distribution

- Photonic Single-Photon Source
- Deterministically fabricated single-photon source [1]
- Static polarization preparation at "Alice"
- 4-state polarization analyzer for BB84 QKD: Standard optical components + Si-APDs + quTag (TDC electronics)

QKD Implementation

- Channel disturbance (e.g. Eve using coherent light source)
- Secret key rates \( S(\Delta t, t_c) \)
- Assuming \( g^{(2)}(0) = 0 \)
- Short vs. long pulse width
- High vs. low noise

Experimental data

- Trade-off between sifted key and QBER
- \( g^{(2)}(0) \) vs. HBT-measurement
- Channels of each bases combined
- Timestamp evaluation

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