

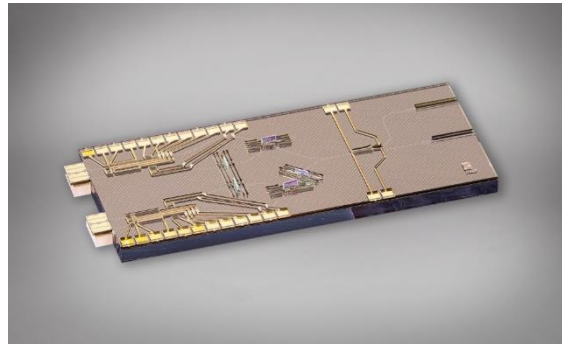
# QKD SYSTEMS AND COMPONENTS

## EPIC Online Technology Meeting on Quantum Communication

Dominic Schulz – Fraunhofer HHI



Photonic components for quantum communication



Hybrid PICs for quantum technologies



Quantum communication systems



# Facts and Figures

## Fraunhofer Heinrich Hertz Institute, HHI

### Staff\*

Permanent Staff

Students



467

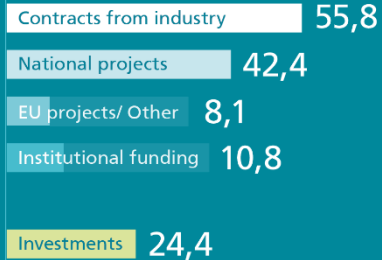


353

\*Per headcount 2023

### Total Budget

117,1



### Scientific Excellence\*

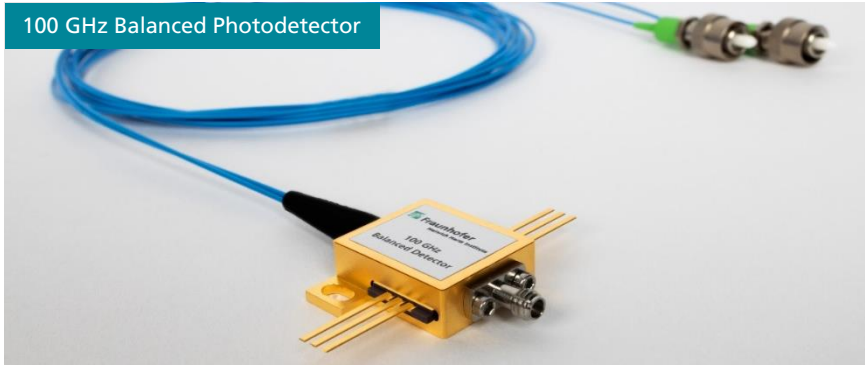


\* Year 2022

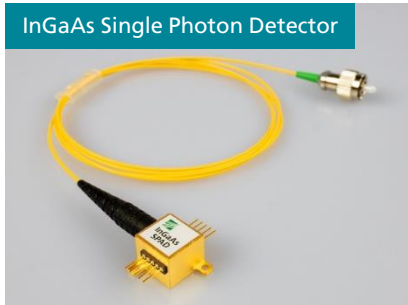
# SWIR Photodetectors by High Performance InP Chips

## Field of Research: Telecom, Datacom, Quantum Communication, Sensing

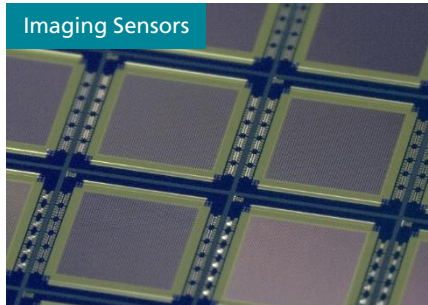
100 GHz Balanced Photodetector



InGaAs Single Photon Detector



Imaging Sensors



### Application

- High speed test & measurement e.g. for 5G / 6G, quantum communication and sensing

### Technology

- InGaAs photodiodes on InP substrates for 850 nm to 1650 nm

### USP/Benefits

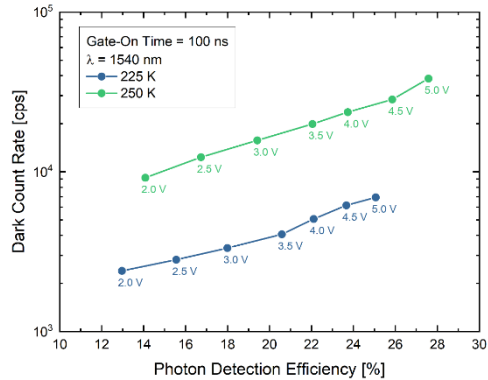
- World record performance, in-house small/mediate volume production

### Our Competencies

Packaging of active opto-electronic InP chips for optimized device performance

# InGaAs Single Photon Avalanche Diode for SWIR

## Packaged chips for optimum performance in application environment

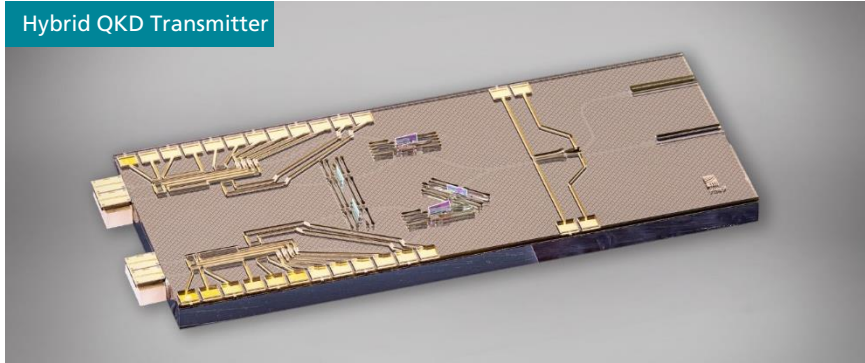


- Only supplier of InGaAs SPADs in Europe (design and fabrication)
- Drop-in compatible to existing SPAD modules from Asia
- SPAD modules commercially available by Q3 2024

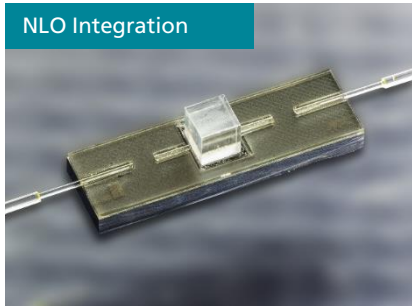
# Quantum Technology PICs by Hybrid Photonic Integration

## Field of Research: Quantum Communications, Sensing, Computing

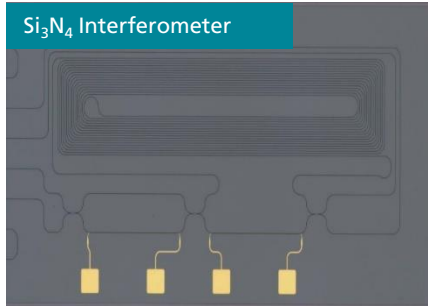
Hybrid QKD Transmitter



NLO Integration



Si<sub>3</sub>N<sub>4</sub> Interferometer



### Application

- Chip-based generation, manipulation and detection of photonic qubit states from VIS to NIR

### Technology

- Hybrid Photonic Integrated Circuits (PIC) based on polymers and Si<sub>3</sub>N<sub>4</sub> platform

### USP/Benefits

- Highly efficient thin-film filters and on-chip integration of isolators and NLO

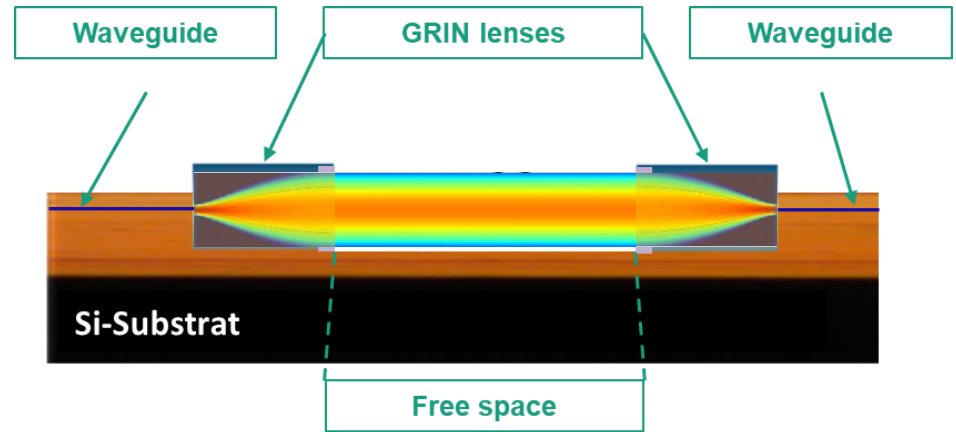
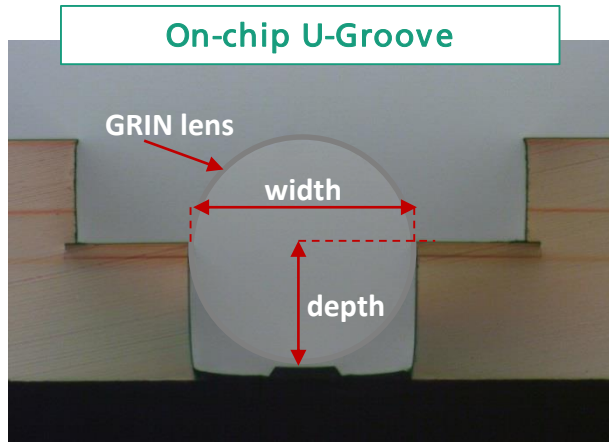
### Our Competencies

Hybrid Integration of Polymer, SiN, TFLN waveguides with InP, GaAs, GaN elements

# Micro-Optical Bench

## On-chip free-space sections

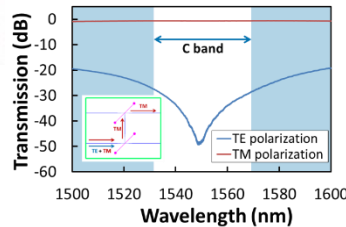
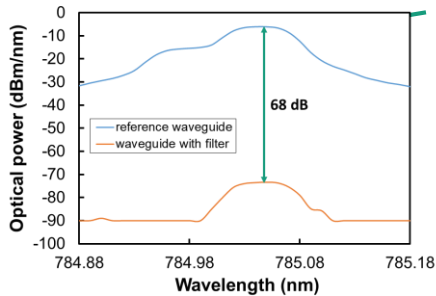
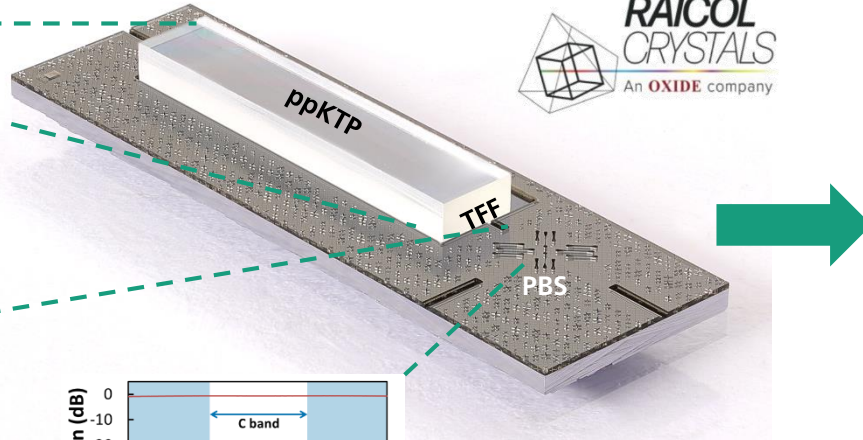
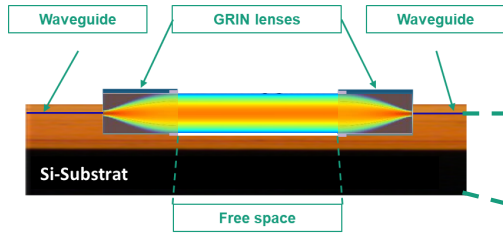
### Beam collimation with GRIN lenses in on-chip U groove



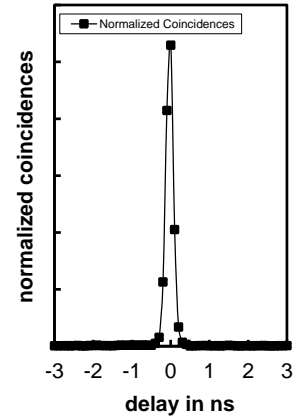
Free-space sections with lengths up to 5 mm  
→ insertion of non-linear + non-reciprocal crystals

# Integrated 1550 nm photon pair source

## Enabled by micro-optical bench and hybrid integration



Photon pairs  
→ bunching





# Sensitive data transmission by Quantum Key Distribution (QKD)

## Field of Research: Quantum Communications

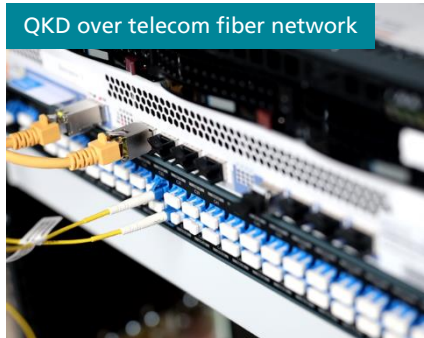
HHI QKD System



Time to digital converter



QKD over telecom fiber network



### Application

- Future-proof long-term protection of sensitive data transmission and critical communication applications

### Technology

- Certifiable QKD systems with BB84 QKD protocol and high secret key rates

### USP/Benefits

- Information security by fundamental quantum-physical principles

### Our Competencies

Concept development, system integration and application labs for quantum communication

# 625 MHz Time-Bin encoded BB84 QKD System

## Demonstrated in complicated environments



- Automatic startup and continuous operation under varying conditions
- Interoperability with central key management system and industrial encryptors
- Operation over telecom fiber and FSO-links
- Single-fiber operation with conventional channels
- QKD-secured video-conferencing for government



# Fraunhofer-Institut für Nachrichtentechnik, Heinrich-Hertz-Institut, HHI

**WE PUT SCIENCE  
INTO ACTION.**

Contact:

Dr.-Ing. Dominic Schulz, MBA  
dominic.schulz@hhi.fraunhofer.de  
+49 30 31002 694 | +49 160 4339057

Einsteinufer 37  
10587 Berlin

