Dominic Schulz – Fraunhofer HHI

Photonic Quantum Devices

EPIC Technology Meeting on PICs, 12. March 2025, Lausanne

Fraunhofer-Gesellschaft

Europe’s largest research organization

76
Institutes in Germany

Worldwide
research collaborations

More than
30.000
employees

3,4
Billion euros Budget

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Fraunhofer HHI

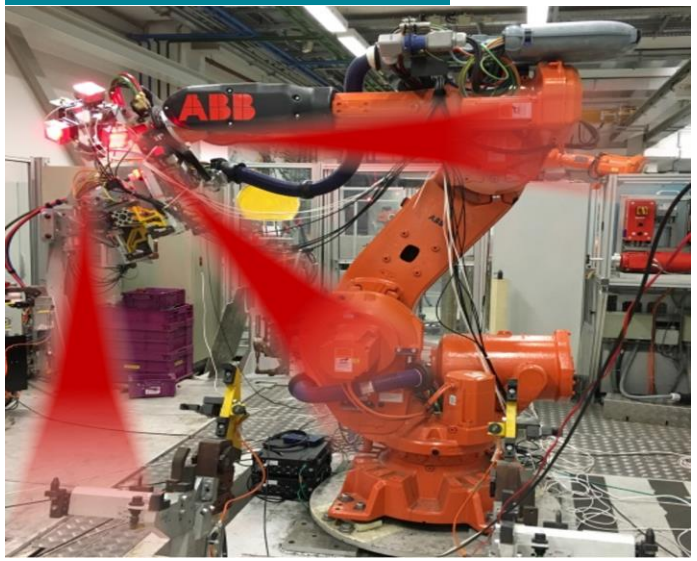
Fraunhofer HHI: Video, AI, Networks, and Photonics

100+ Mio € Budget, 800+ people, 80% self-financed

Video Compression and AI

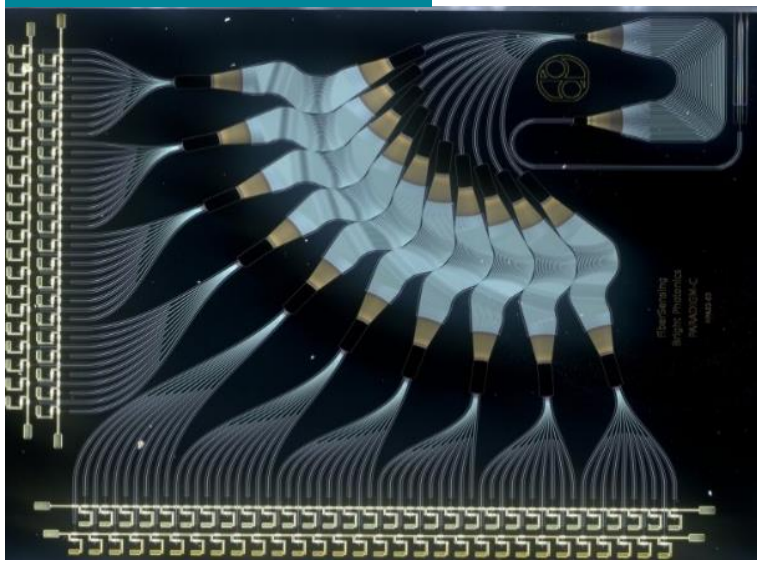
- H.265 / HEVC: 4th Emmy received
- ~10B devices

Photonic and 5G/6G Networks



- LiFi for mobile data in EMI environments
- Quantum Networks

Photonic Components & PICs



- Up to 145 GHz
- Terahertz sensing
- Quantum components & PICs

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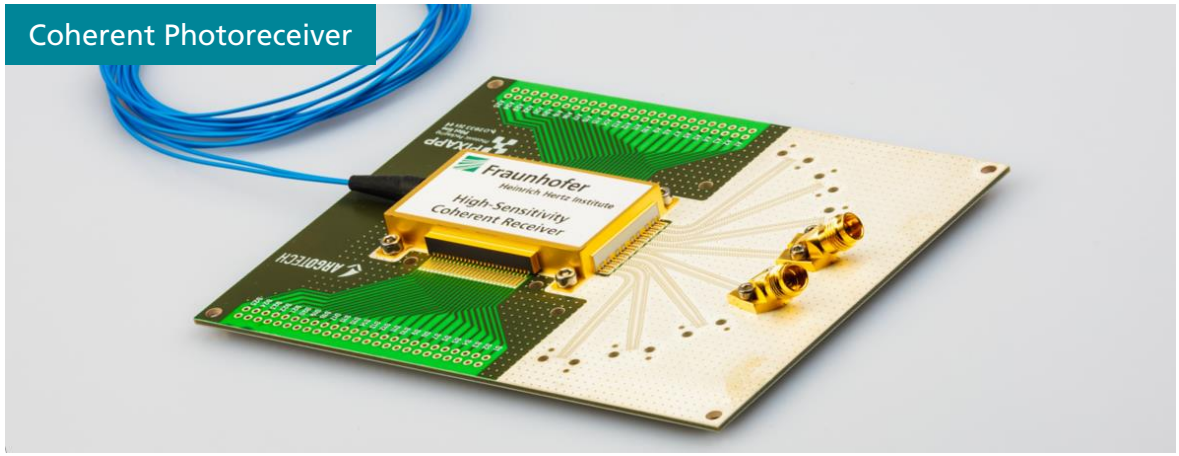
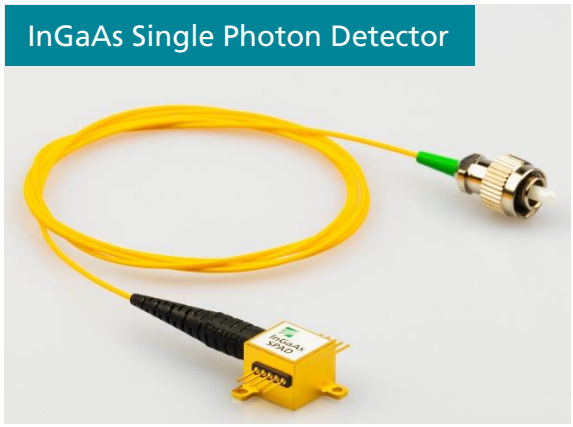
High Sensitivity and Low Noise SWIR Photodetectors

For Detection of Single and Few Photons

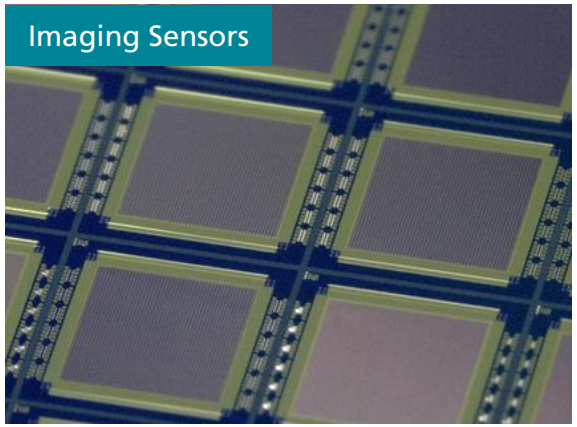
Coherent Photoreceiver



InGaAs Single Photon Detector



Imaging Sensors



Application

High quantum efficiency detectors are applied for quantum communication and sensing applications

Technology

InGaAs photodiodes on InP substrates allow for detection of light from 850 nm to 1650 nm

Our Offer

High-end in-house small and medium volume production with packaging of InP photodetector chips for optimized device performance

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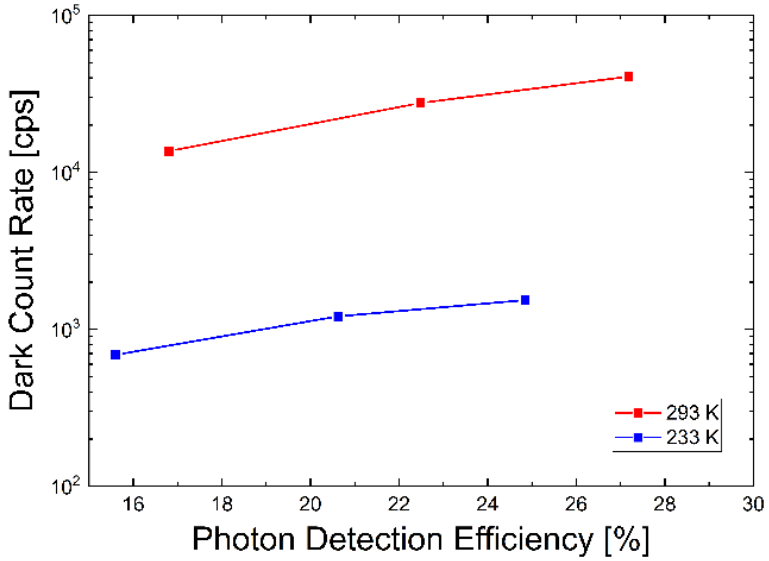
InGaAs Single Photon Avalanche Diode for SWIR

Packaged chips for optimum performance in application environment

SPAD Chip

SPAD Module



- Design and fabrication of InGaAs SPADs in Europe
- Drop-in compatible to existing SPAD modules from Asia
- SPAD modules commercially available

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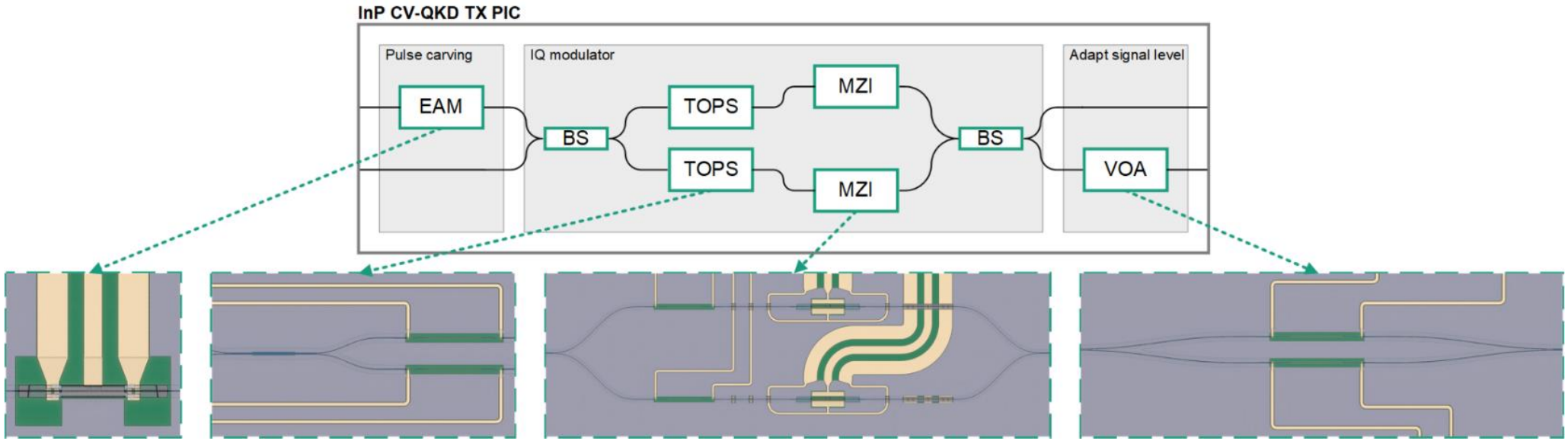
Quantum PICs on InP MPW Runs

Monolithic integration of standard functionalities

Continuous-Variable Quantum Key Distribution Transmitter (CV-QKD TX)

- Includes several actives (EAM, TOPS, CIPS) and passives (waveguides, spot-size converters, MMI)
- Designed with PDK and fabricated on HHI InP transceiver MPW platform



J. Aldama et al., "Integrated InP-based transmitter for continuous-variable quantum key distribution," Opt. Express 33, 8139-8149 (2025)

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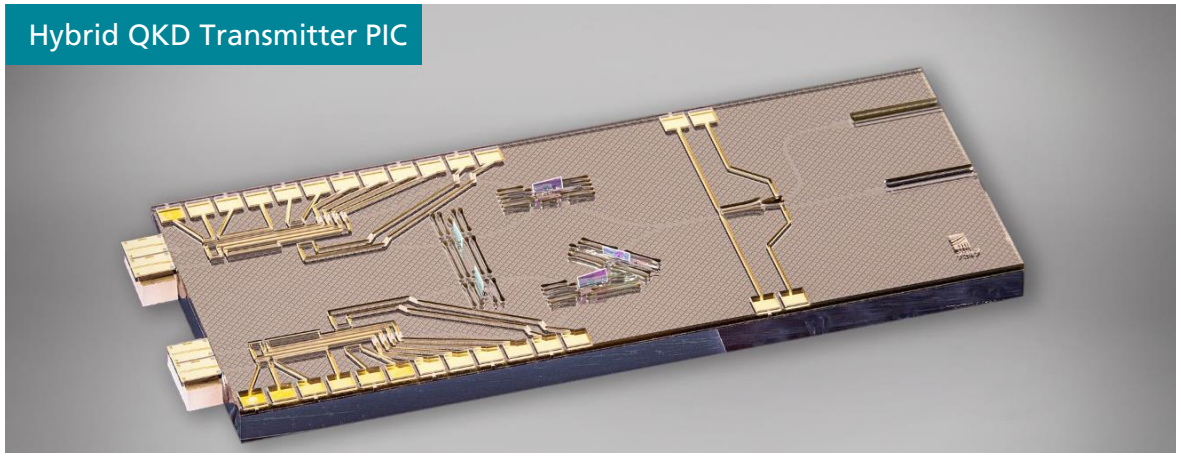
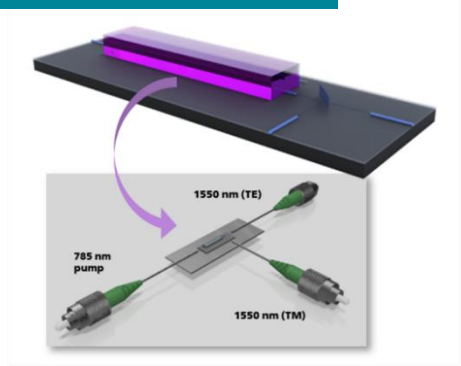
Quantum PICs by Hybrid Photonic Integration

For Quantum Communication, Sensing and Computing

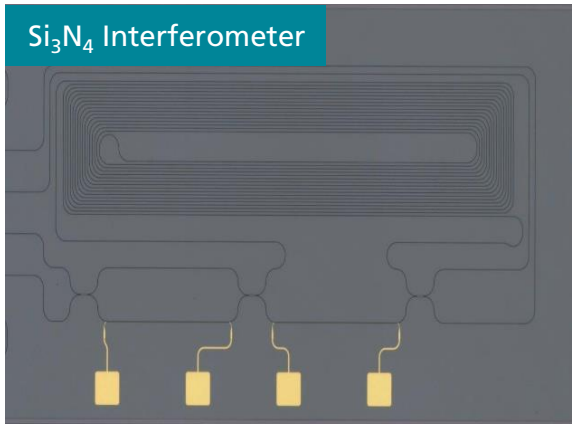
Hybrid QKD Transmitter PIC



Entangled Photon Source



Si_3N_4 Interferometer



Application

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

Technology

Hybrid Photonic Integrated Circuits (PIC) based on PolyBoard and Si3N4 platform

Our Offer

Hybrid Integration of Polymer, SiN, TFLN waveguides with InP, GaAs, GaN elements and highly efficient micro-optics, isolators, NLO

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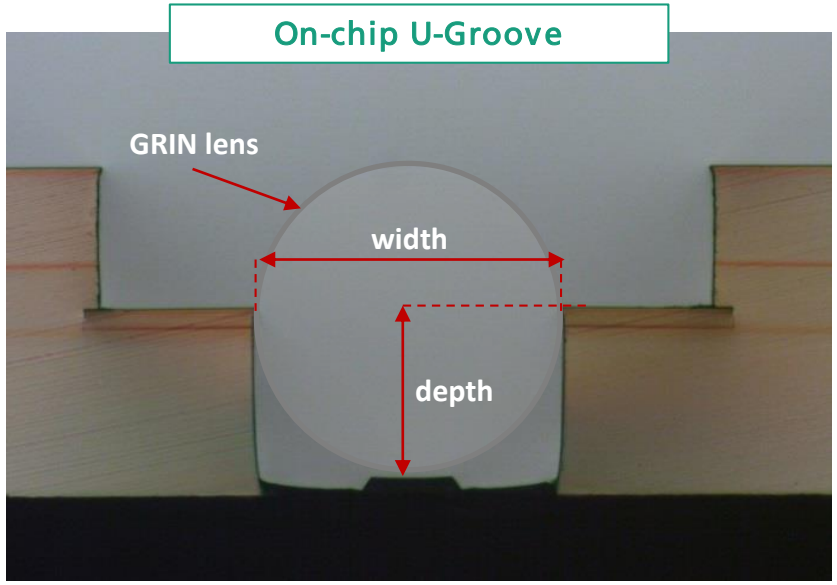
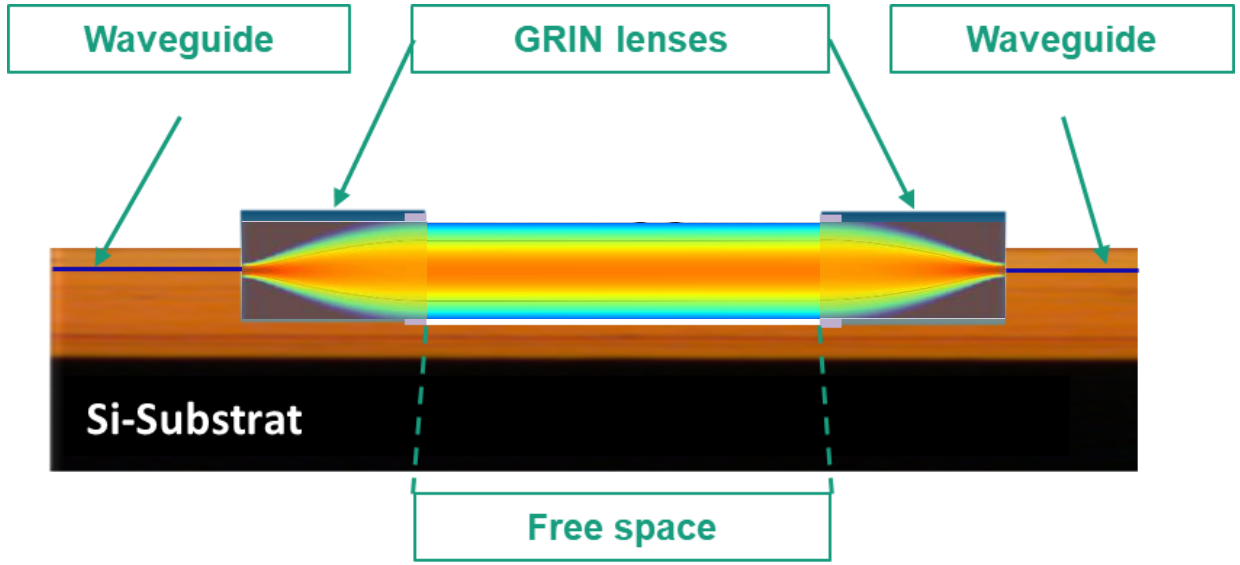
Micro-Optical Bench for PICs

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

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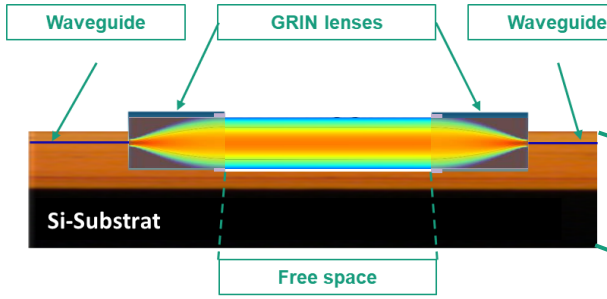
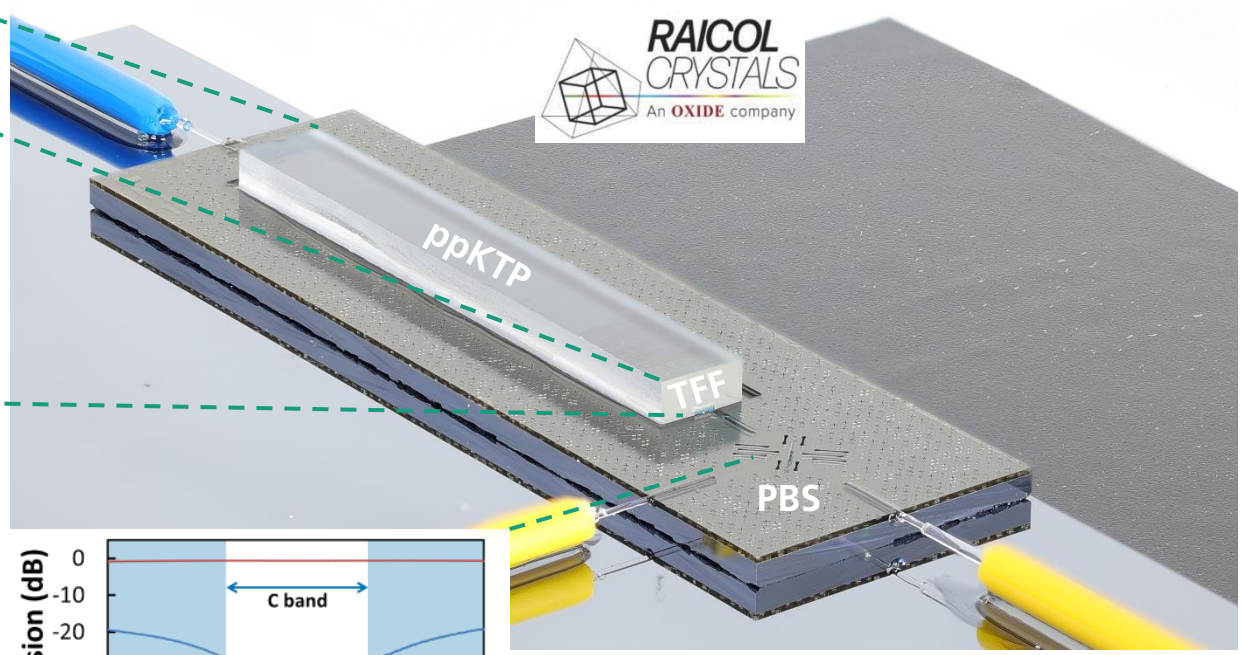
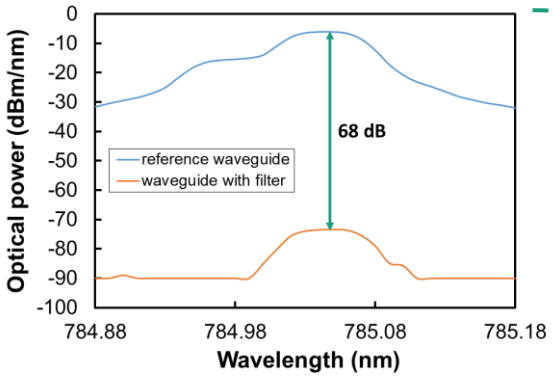
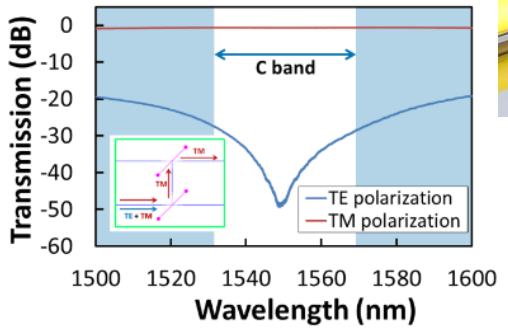
Integrated 1550 nm photon pair source

Enabled by micro-optical bench and hybrid integration

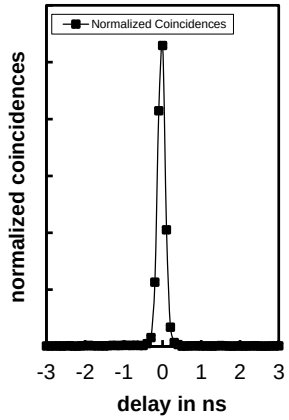








Photon pairs → bunching



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Fraunhofer as a Supplier of Small & Medium Volumes

Customized designs available for dedicated applications

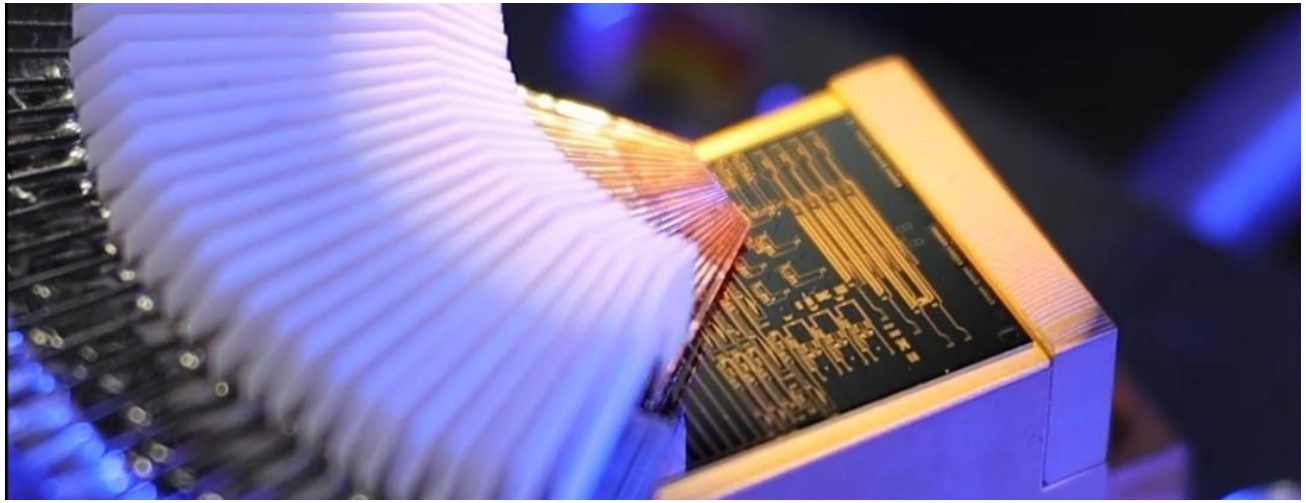
Single or array **photonic components** in different materials:

- Laser, detectors, modulators, etc.

Monolithic and hybrid integrated PICs with various functionalities

- Communication, sensing, computing, etc.

Packaging and assembly for photonic modules



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Thank you
for your attention.

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