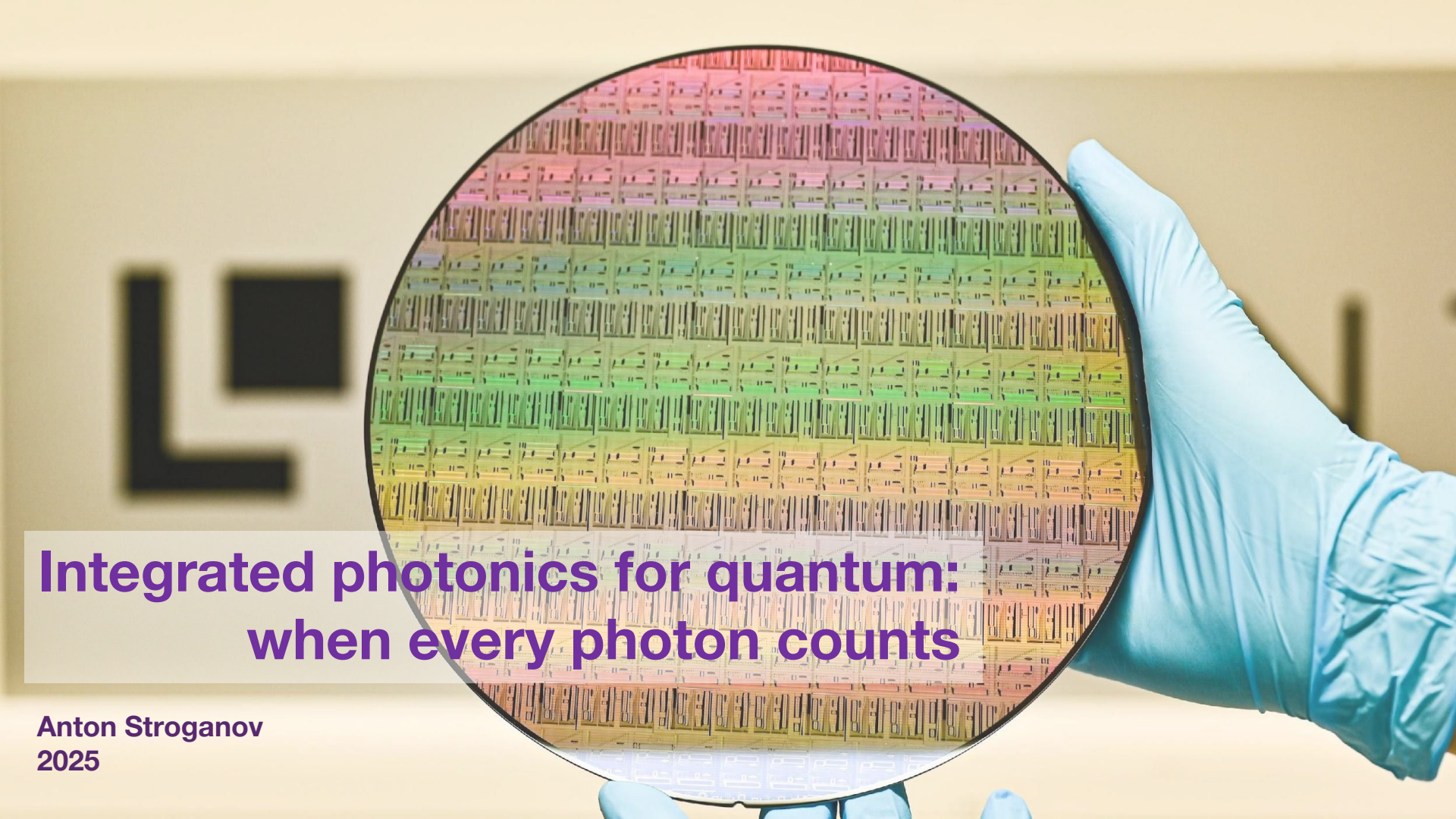


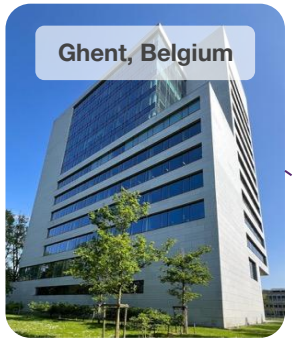
Integrated photonics for quantum: when every photon counts

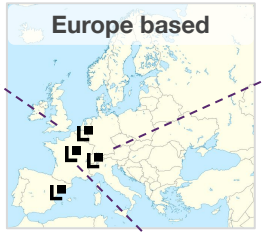
Anton Stroganov
2025

European PIC manufacturing company with a global reach

LIGENTEC key facts

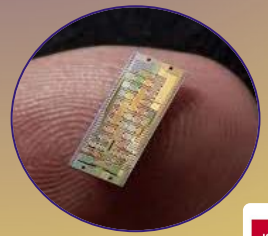
LIGENTEC





Best-in-class Silicon Nitride integrated photonic circuits

- **Low Loss SiN**
  (down to < 1 dB/m)
- **3+ technology platforms**
  (AN150, AN350, AN800)
- **Integration with actives**
- **Extensive PDK**



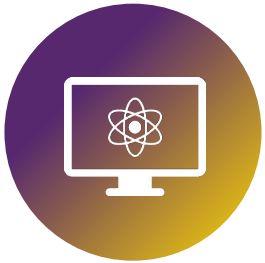
ISO 9001
BUREAU VERITAS Certification

LIGENTEC Platform Application Areas

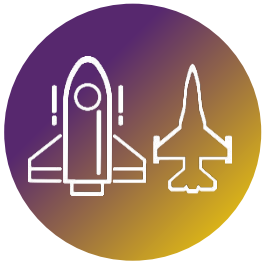
LIGENTEC

We are proud to serve leading companies and research institutions in many different domains

LIDAR



QUANTUM



SPACE & DEFENSE

MORE APPLICATION AREAS

BIOSENSING & MICROSCOPY

SENSORS

TELECOM & DATACOM

NEUROMORPHIC COMPUTING

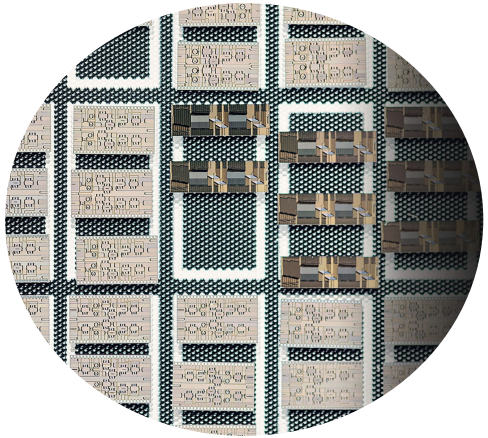
AUGMENTED REALITY

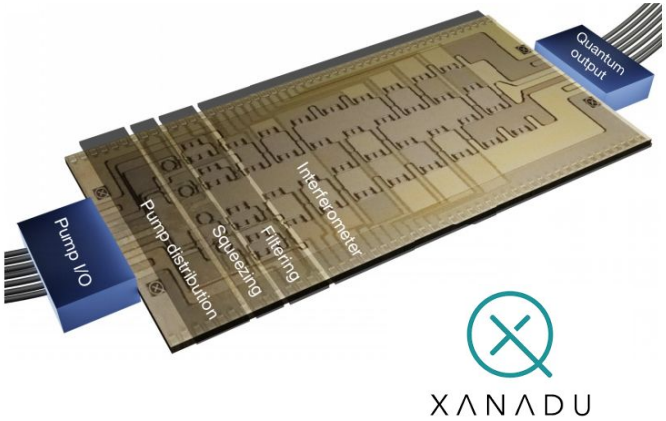
METROLOGY

Showcase: **Quantum Computing**

LIGENTEC

Our chips served as key part of a photonic quantum computer to generate and manipulate quantum states



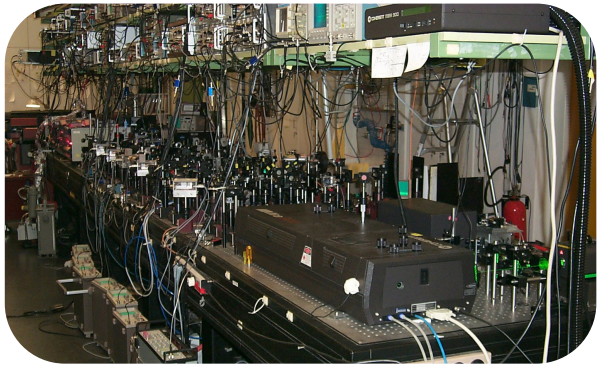


Photonic Quantum Computer with Ligentec PICs

Arrazola et al., Nature (2021) *Zhang et al., Nature Communications (2021)*
V. Vaidya et al., Sci. Advances (2020) *K. Tan et al., Optics Letters (2020)*

Potential of Photonic Integration

LIGENTEC

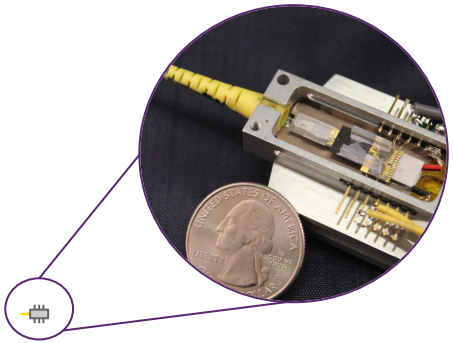


Year 1998, ~several m^3

MAX-PLANCK-INSTITUTE OF QUANTUM OPTICS GARCHING MPQ

Year 2008, ~1 m^3

MenloSystems



Year 2020, ~1 cm^3

CORES Chip-scale Optical Resonator Enabled Synthesizer UCSB EPFL

Why Photonic Integration?

Why in the scope of quantum?

Miniaturization: size, weight, power

Lowering complexity: no discrete (moving) parts

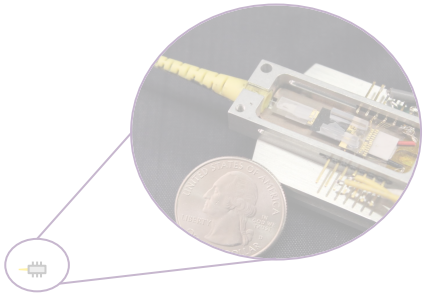
Scalability and cost

Potential of Photonic Integration - Quantum computing

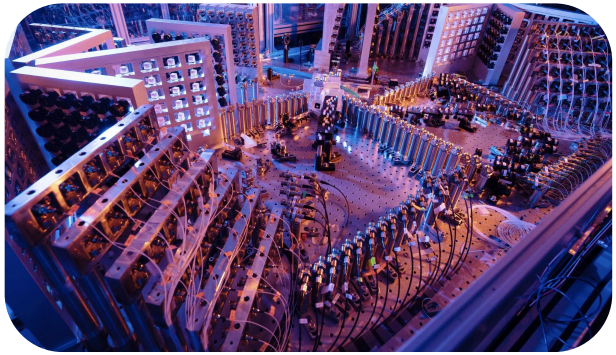
LIGENTEC

Year 1998, ~several m^3 MAX-PLANCK-INSTITUTE OF QUANTUM OPTICS GARCHING MPQ

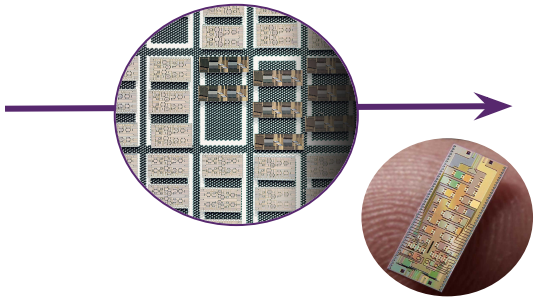
Year 2008, ~1 m^3 MenloSystems



Year 2020, ~1 cm^3 CORES UCSB EPFL



Year 2021, ~several m^3 *IEEE Spectrum*



?

Business Model & Offering

LIGENTEC is photonic integrated circuits manufacturing provider with mature scalable technology and strong well-established network of partners within the photonic ecosystem

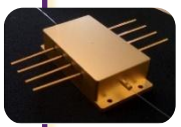
LIGENTEC

Design | Chip Manufacturing | Packaging | Module | Products

Technology Development | Wafer Fab | Test & Measure

- R&D support in Design & Packaging
- From Prototype to Volume

- Circuit IP stays with customer



Ansys / LUMERICAL

LUCEDA PHOTONICS

SYNOPSYS® Silicon to Software™

GDS FACTORY

VPIphotonics

Mentor® A Siemens Business

LIGENTEC Platform

Mature and versatile platform with modular approach and unique expertise in thick films

SiN as a material:

Si Photonics

+

Wide Transparency (400-3500nm)

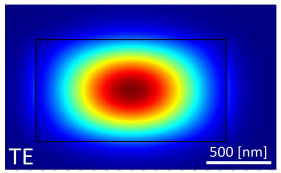
High power handling (no TPA)

Higher thermal stability

Lower Loss

Thick SiN platform:

High confinement waveguides



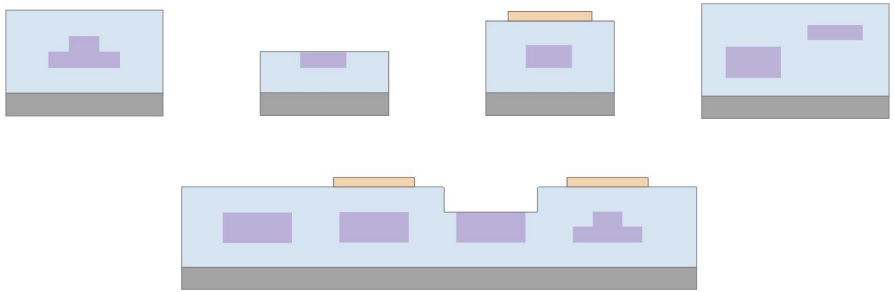
Very low loss (down to <1 dB/m)
Small footprint

+

Dispersion Engineering
Access to nonlinear effects

Basic Process: SiN waveguides

+ Cross-compatible modules:



+ Extensive PDK and component library

Integrated Photonics for Quantum Computing

LIGENTEC

nature

https://doi.org/10.1038/s41586-025-08820-7

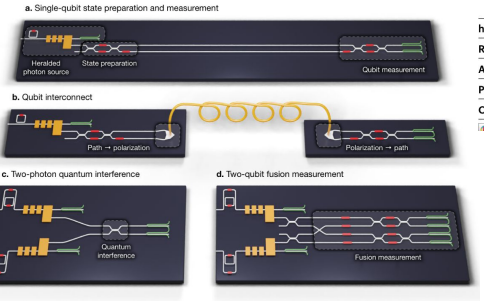
Accelerated Article Preview

A manufacturable platform for photonic quantum computing

Received: 30 July 2024

Accepted: 20 February 2025

PsiQuantum Team



Article

Scaling and networking a modular photonic quantum computer

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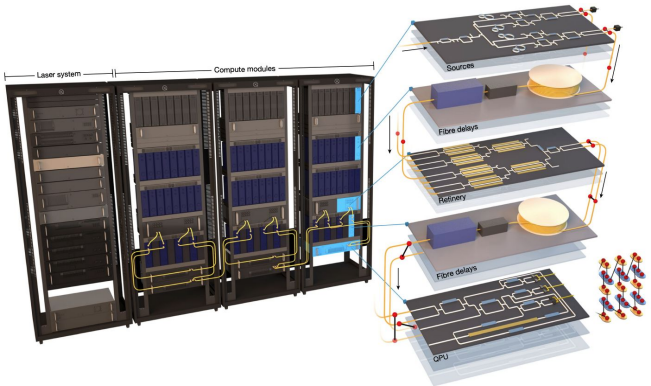
H. Aghaee Rad[1], T. Ainsworth[1], R. N. Alexander[1,2], B. Altieri[1], M. F. Askarani[1], R. Baby[1], L. Banchi[1], B. Q. Baragiola[1], J. E. Bourassa[1], R. S. Chadwick[1], I. Charania[1], H. Chen[1], M. J. Collins[1], P. Contu[1], N. D'Arcy[1], G. Dauphinais[1], R. De Prins[1], D. Deschenes[1], I. Di Luch[1], S. Duque[1], P. Edke[1], S. E. Fayer[1], S. Ferracin[1], H. Ferretti[1], J. Gefaell[1], S. Glancy[1], C. González-Arciniegas[1], T. Grainge[1], Z. Han[1], J. Hastrup[1], L. G. Helt[1], T. Hillmann[1], J. Hundal[1], S. Izumi[1], T. Jaeken[1], M. Jonas[1], S. Kocsis[1], I. Krasnokutska[1], M. V. Larsen[1], P. Laskowski[1], F. Laudenbach[1], J. Lavoie[1,2], M. Li[1], E. Lomonte[1], C. E. Lopetegui[1], B. Luey[1], A. P. Lund[1], C. Ma[1], L. S. Madsen[1], D. H. Mahler[1], L. Mantilla Calderón[1], M. Menotti[1], F. M. Miatto[1], B. Morrison[1], P. J. Nadkarni[1], T. Nakamura[1],



- ➔ **Low-loss**
- ➔ **Mature process**

  (but pushing the limits!)
- ➔ **Scalability**
- ➔ **Modularity**
- ➔ **Efficient interfaces**

Further integration:

PD / PNRD

Fast modulators

Amplification

Other

The best of two worlds: two fabs with a different focus

LIGENTEC

R&D line: Non-Standard

Flexibility and Speed

Non-standard SiN offering

- Prototyping to mid-volume fabrication of non-standard / development SiN stacks

R&D

- New concepts & technologies

Heterogeneous Integration

- New materials & methods

200 mm line: Standard & Volume

Maturity & Control & Capacity

Standard SiN offering

- Standard SiN stacks
- MPW runs, Pilot & niche quantities
- High volume production

Automation & Quality

- Highly automated process flow
- Fully automated testing
- IATF 16949 certified / ISO 13485 compliant

One basis, large diversity in the add-ons

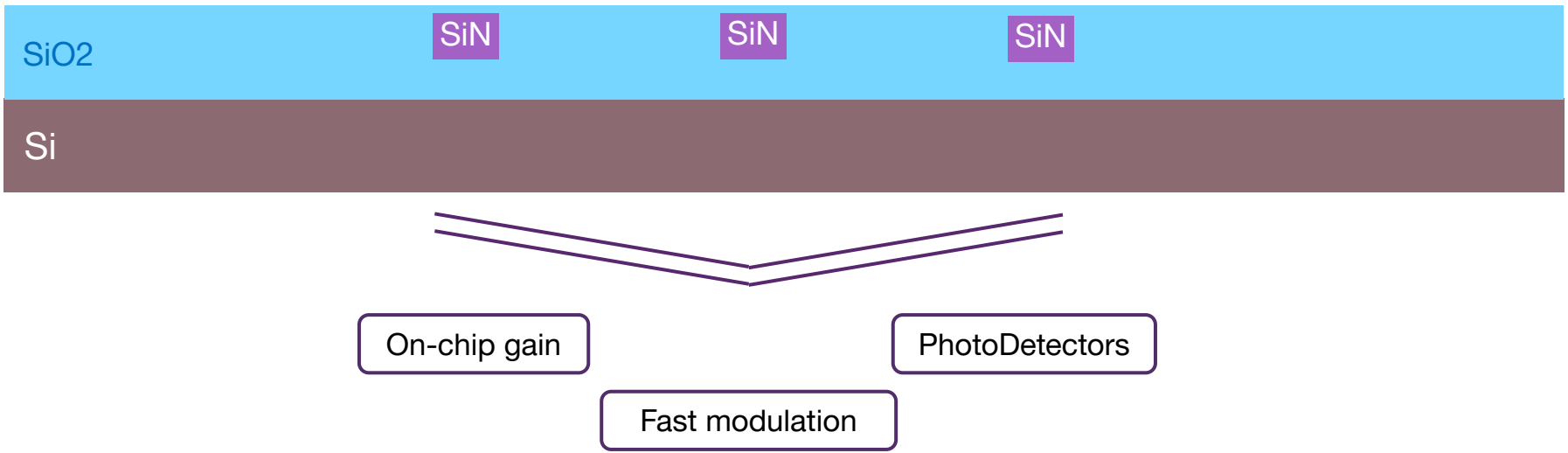
Materials and Functionalities

LIGENTEC

Many great materials, each with their own merits:

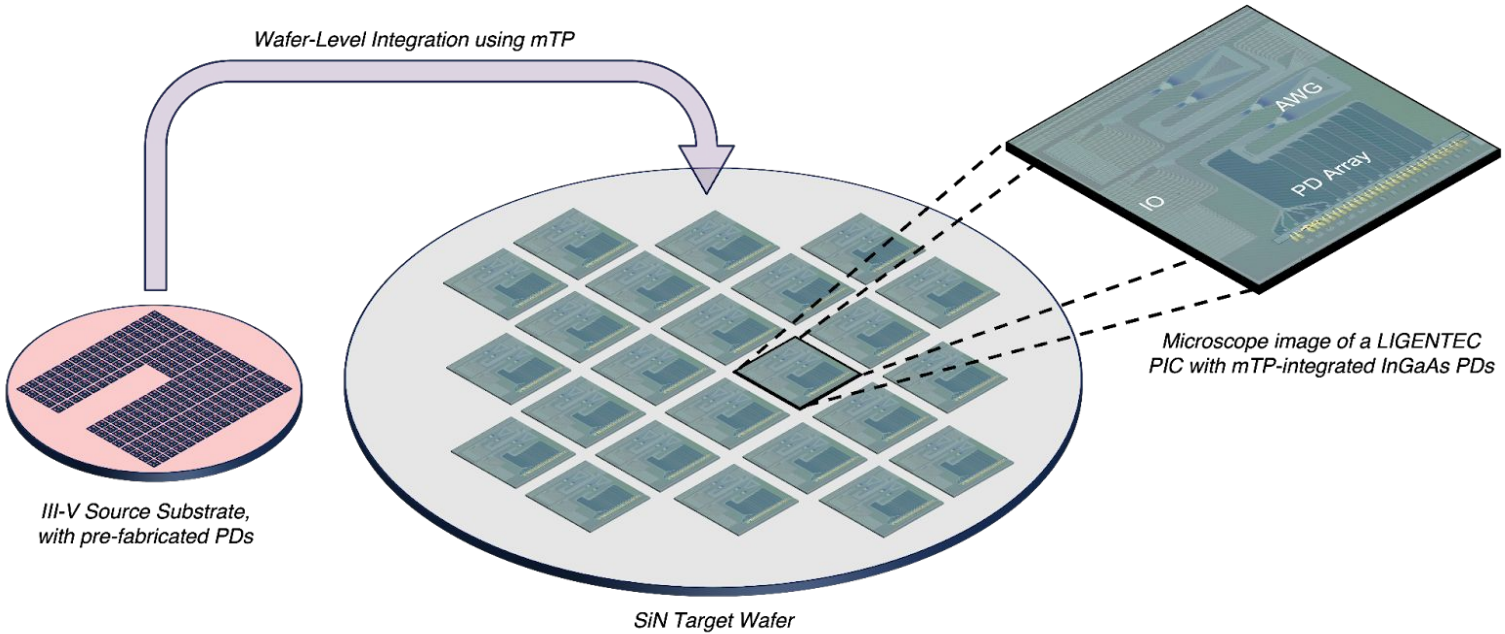
InP | GaAlAs | BTO | Plasmonics | Polymer | LNO | AlN | …

+



Heterogeneous integration of photodiodes

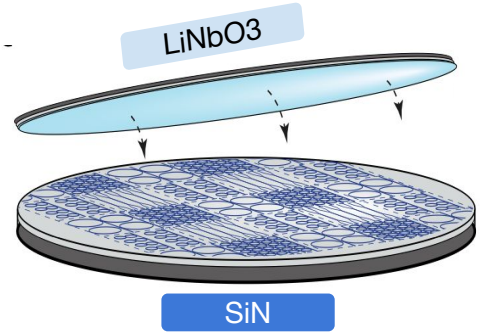
Micro-Transfer Printing: high-throughput wafer-level integration technique



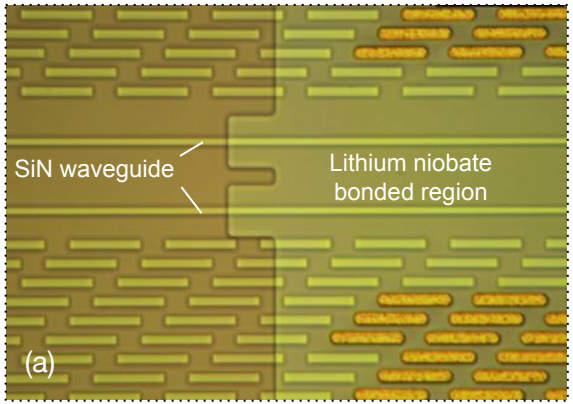

LIGENTEC
xfab
Celeprint
World's first integrated value chain platform initiative for heterogeneous integration in photonics

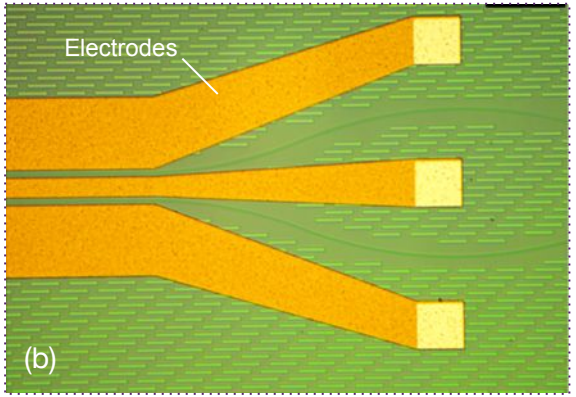
Wafer bonding of thin-film lithium niobate

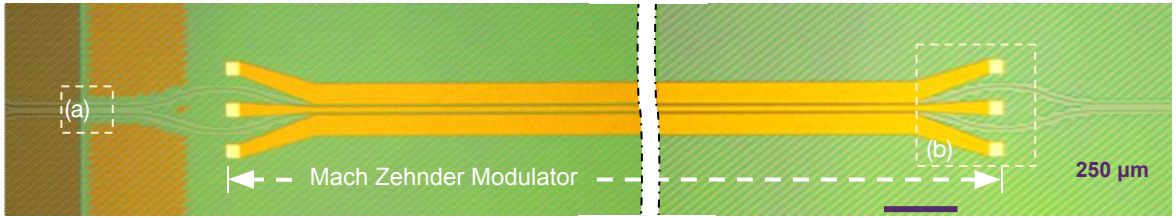
LIGENTEC



Churaev et al., Nature Comms (2023)





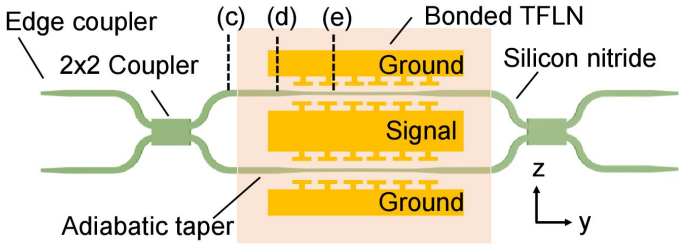


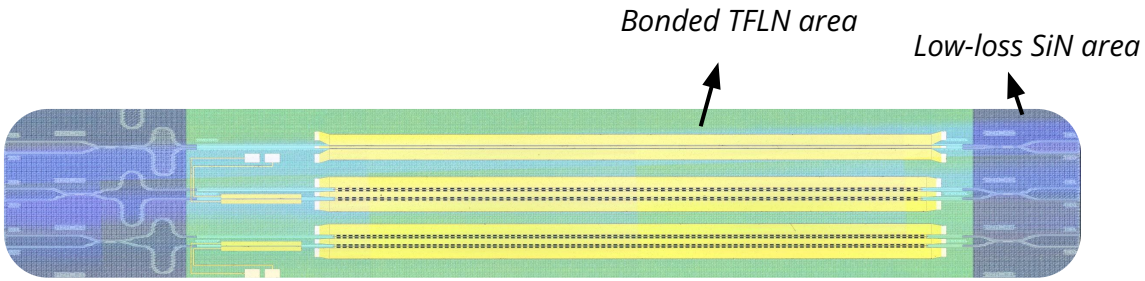
Fast modulators on mature SiN platform.
Scalable, wafer-level approach.

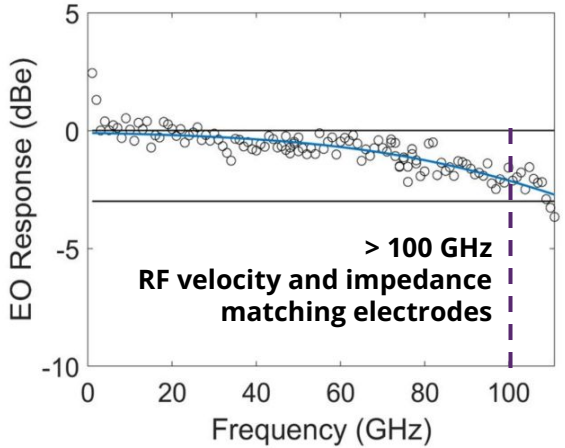
Heterogeneous modulators: achievable results

LIGENTEC

*No extra design complexity; up to **>100 GHz bandwidth demonstrated***







Electro-optic response normalized to 3 GHz
Bandwidth up to **110 GHz** measured
VπL = 3.4 V.cm

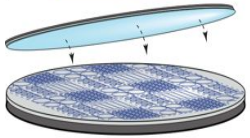
"High-performance Hybrid Lithium Niobate Electro-optic Modulators Integrated with Low-loss Silicon Nitride Waveguides on a Wafer-scale Silicon Photonics Platform":
https://arxiv.org/abs/2504.00311

To sum it up

LIGENTEC

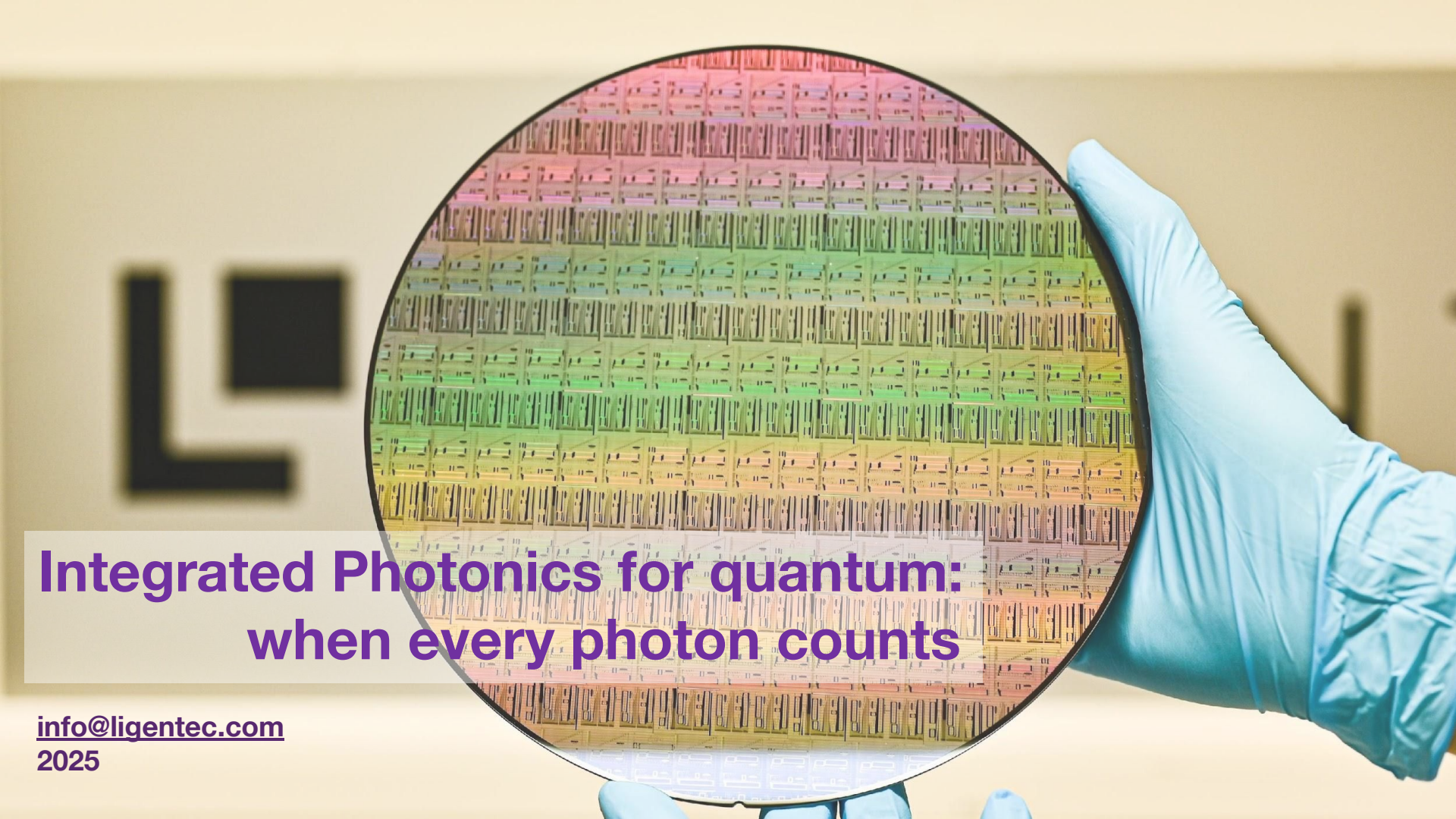
LIGENTEC - European open-access PIC foundry;
Clear path from prototype to volume production

Versatile modular technology for variety of applications;
Visible to Mid-IR wavelength ranges
Quantum Computing, QRNG, QKD, and many more



Activation of low-loss integrated photonics
Scalable heterogeneous integration of fast modulators and photodiodes

Reliable partner at all stages;
Design / Layout / Engineering assistance for your development



Integrated Photonics for quantum: when every photon counts

info@ligentec.com

2025