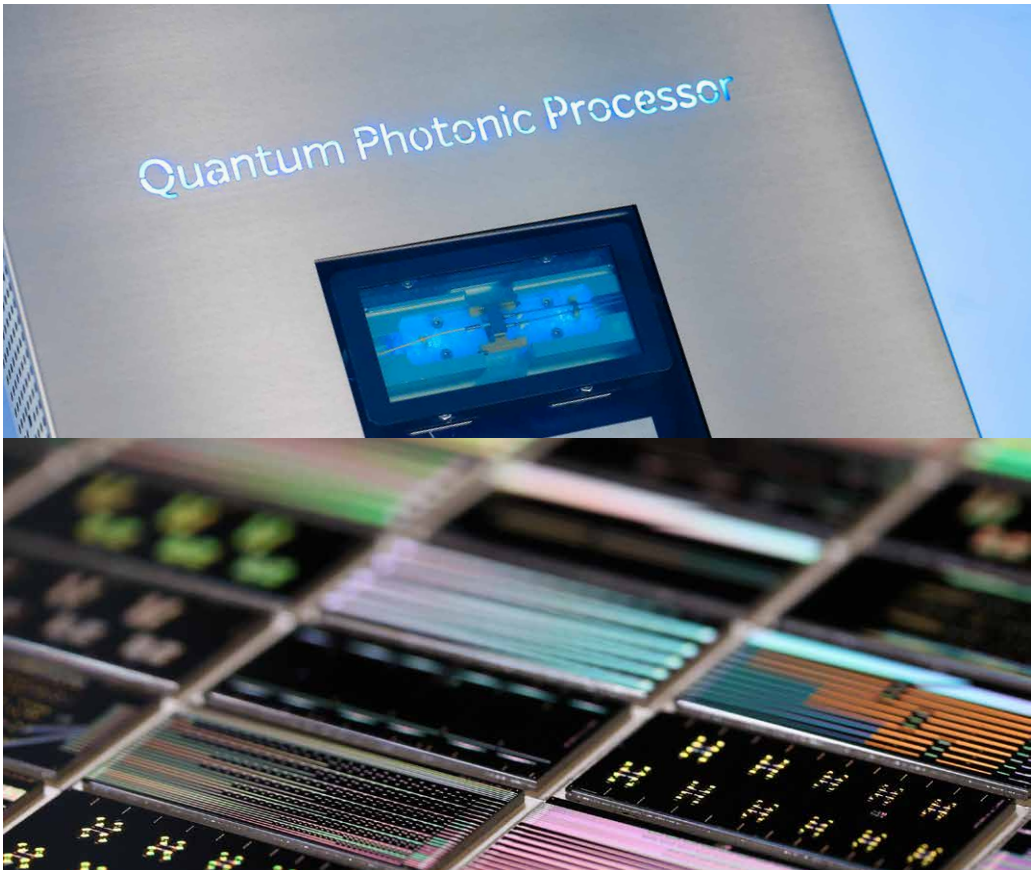
QANT




# Photonic Quantum Computing

Pushing boundries with Quantum Photonic Processors, Photonic Integrated Circuits and Quantum Algorithms

**www.qant.com/quantum-computing**

# Quantum Computing – real and relevant today and tomorrow

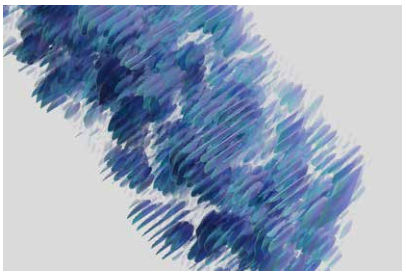
Fields with high-dimensional data and complex mathematical problems, where todays state of the art supercomputers fail and quantum computing promise computational solutions.

Big Data Analytics

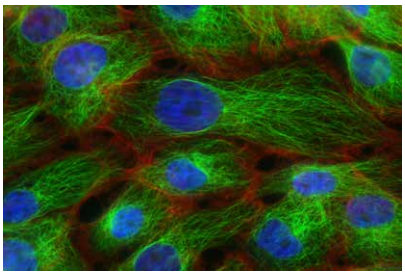

Logistics

Finance

Energy Systems



Machine Learning



Material and Genomic Simulations

# The Q.ANT way for Business Partnerships

Q.ANT has developed a dedicated scheme to address specific customer requirements. Coming from the customers problem setting, we support with hard- and software solutions – tailored individually to the needs.

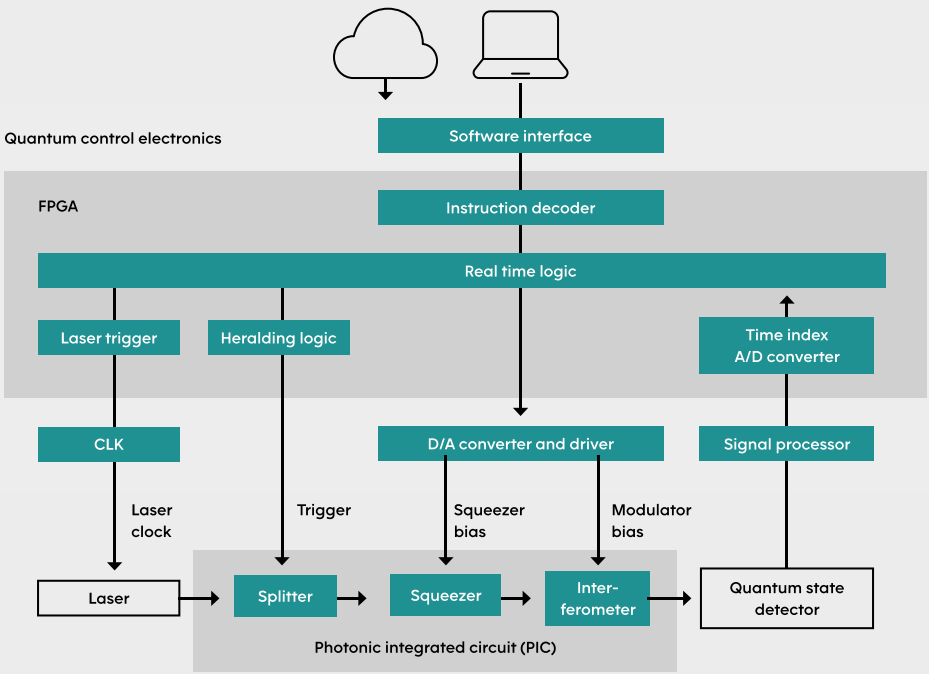
| | Offerings | Photonic quantum processor | Photonic processor | Communication processor | Photonic integrated circuit |
|---|---|---|---|---|---|
| Customer | | Scientific/Research | Logistics company | Public services | Laser company |
| Applications | SaaS | Molecular docking | Traveling salesman problem | Secure communication | Laser beam shaping |
| Abstractions | | Max-Clique | QUBO | Communication over quantum channel | - |
| Algorithms | | Gaussian Boson Sampling | All-optical Coherent Ising Machine | CV Quantum Secure Direct Communication | Delay and sum beamforming |
| Processor Architecture | Photonic Processors | 20-mode GBS Photonic Quantum Processor | 20-mode Processor with Feedback | Quantum communication processor | - |
| Layout & Design | PIC Design Services | 20-mode interferometer with sources | Ising 20-mode interferometer / On-chip squeezers | MZI chips | Phase shifting networks |
| Fabrication & Chips | PIC Fabrication Services | | | | |

# The Power of Quantum Computing

The world of information technology is on the brink of a transformative leap forward. Quantum computing has become a reality, revolutionizing the way of processing and analyzing data. Quantum computing isn't just about faster calculations; it's about solving problems that were once considered unsolvable. It holds the potential to tackle some of the most pressing challenges of our time. The future is quantum, starting here.

Q.ANT is a high-tech startup industrializing photonic quantum technologies in the fields of computing and sensor technology. We at Q.ANT provide our customers new insights based on photonic data generation and data processing supported by photonic quantum technologies. Our product line Quantum Computing offers quantum photonic processors and algorithms to advance high performance computing.

# Q.ANT offers the full Computing Stack



# The Power of Quantum Photonic Processors

Photonic processors offer several advantages in the field of quantum computing and information processing:

- Speed: Photons travel at the speed of light, making photonic processors exceptionally fast for information transfer and computation. ■
- Scalability: Photonic systems can be more easily scaled up for more qubits by adding more optical components. ■
- Coherence: Photons are barely susceptible to detrimental environmental noise and decoherence compared to other qubit implementations, making them more robust and stable. ■
- Low Energy Consumption: Photonic processors operate at room temperatures and consume less energy compared to other quantum computing implementations. ■
- High Fidelity: Photons can be manipulated with high precision, allowing for the creation of high-fidelity quantum gates. This precision is essential for error correction and maintaining the integrity of quantum information. ■
- Integration with existing Optical Technology: The use of photons aligns well with existing optical technologies, potentially allowing for easier integration into current data transmission and processing systems.


# The Power of Quantum Algorithms

Tackling todays and tomorrows complex problem settings with Quantum Algorithms

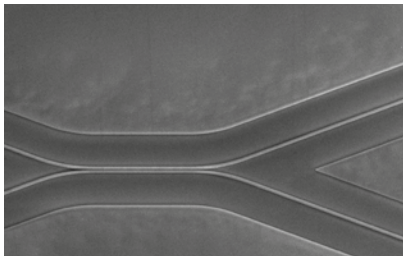
| Application | Abstraction | Algorithm | Architecture |
|---|---|---|---|
| Flight-Gate Assignment, Travelling salesman, Job Shop Scheduling, Supply chain management, and many more | Combinatorial Optimization (QUBO and PUBO) | Variational Quantum Eigensolver (VQE) | GBS |
| | | Coherent Ising Machine | Coherent Ising Machine |
| Drug design, Chemical Reaction Mechanisms | Vibronic Spectra | Quantum sampling | GBS |
| Molecular Docking, Network analysis, Data mining | Dense subgraphs, Max-Clique | GBS-enhanced classical heuristics | GBS |

# The Power of Lithium Niobate

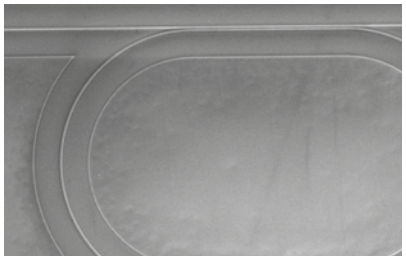
Q.ANT relies on its own technology platform for quantum chips and photonic integrated circuits – PICs.
The central components of the chips are optical waveguides, modulators, beam splitters and resonators, which enable the control of light and quantum effects in a highly integrated form. Very thin layers of lithium niobate are applied on silicon and then structured into optical waveguides. We believe that lithium niobate on insulator – LNOI – is the key to future photonic quantum computing.

**PICs based on LNOI show several main advantages:**

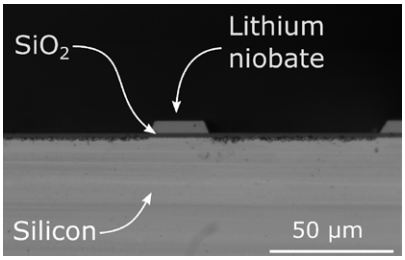
- No thermal crosstalk between optical modulators due to the use of electrical fields to change the refractive index in its waveguides – allowing smaller processors
- Faster modulation and switching speeds in the MHz range, applications more tolerant to losses can even reach GHz
- Direct and lossless integration of efficient quantum light sources and Mach-Zehnder interferometers onto a single chip
- Room temperature operation opens up a wide range of application fields



Beam Splitter



Resonator



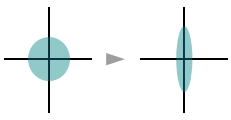

Cross Section of Wave Guide

# The Perfect Material of Choice

We selected lithium niobate as matieral platform for its superior characteristics

**Optical non-linearity** $x^{(2)}$

Efficient integrated sources for squeezed state generation



The required pump power is 103 times lower compared to silicon-based material platforms

Tuneable sources for indistinguishable squeezed states

Allows the generation of large numbers of squeezed states, e.g., for large cluster states

**Electrooptic effect** $\Delta n \propto E$

Fast electro-optic phase modulation

Fast optical switching gates, that are many orders of magnitude faster than thermo-optical switches in silicon

Q.ANT

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We need to benchmark against the existing technologies to demonstrate the benefits of Quantum Computing – demonstrated at data processing in calculation time and energy consumption

**Michael Förtsch, CEO Q.ANT**

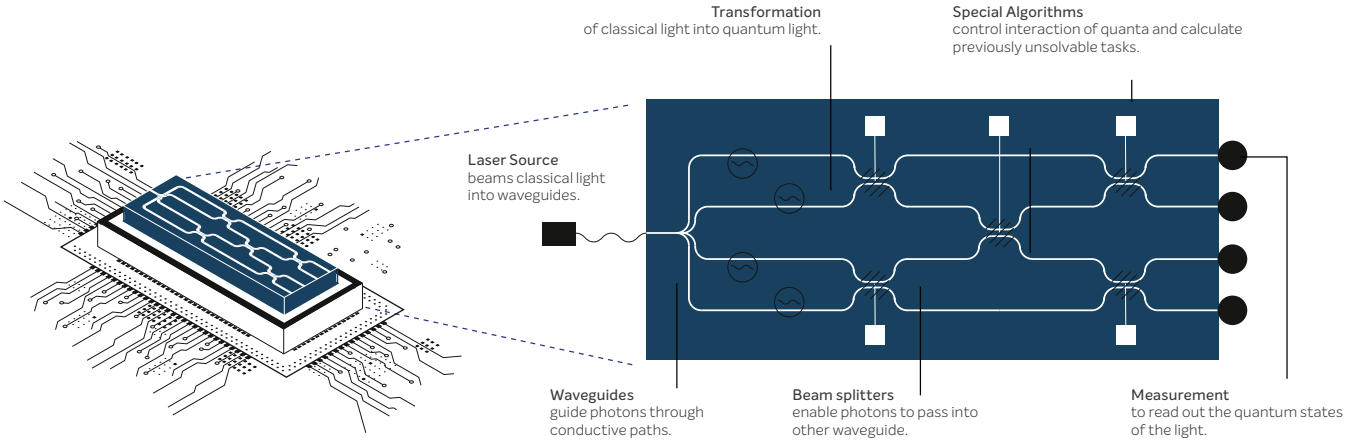
# How the Q.ANT Photonic Integrated Circuits work

### The Q.ANT Photonic Framework

For Q.ANT, light is the essential resource for exploiting the potential of quantum technologies. The photonic quantum technology is therefore at the center of product development at Q.ANT. The expertise lies in mastering and controlling the entire optical and electronic process chain up to data processing. This includes the conversion of electrons into photons, the generation and exploitation of optical quantum effects and the reconversion of photonic quantum information into electrical signals and data.

### The Q.ANT Lithium Niobate Platform

Q.ANT is developing its own process design kit for producing photonic integrated circuits in lithium niobate. This material platform was specifically chosen for its favorable properties for quantum computing. The benefits of integrations are a high stability as well as a scalable and reproducible production. Lithium niobate enables the creation of fast switches as well as high non-linearities for efficient generation of quantum resource states, while allowing for low loss at the same time.





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