QANT

Photonic Computing for HPC

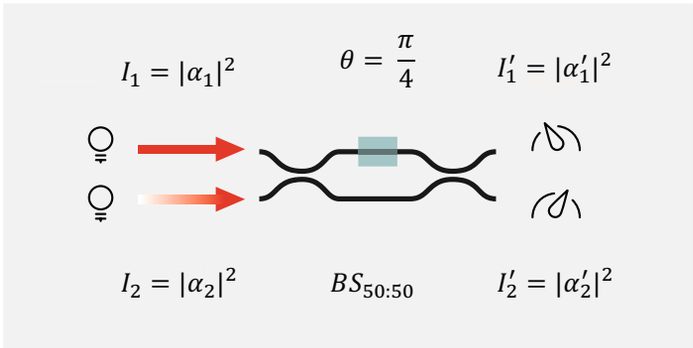
Pushing boundries with Photonic Processors,
Photonic Integrated Circuits and Algorithms

www.qant.com/photonic-computing

Photonic Efficiency for Matrix-Vector Multiplications

The way to more energy-efficient AI is to make MVM more energy-efficient.

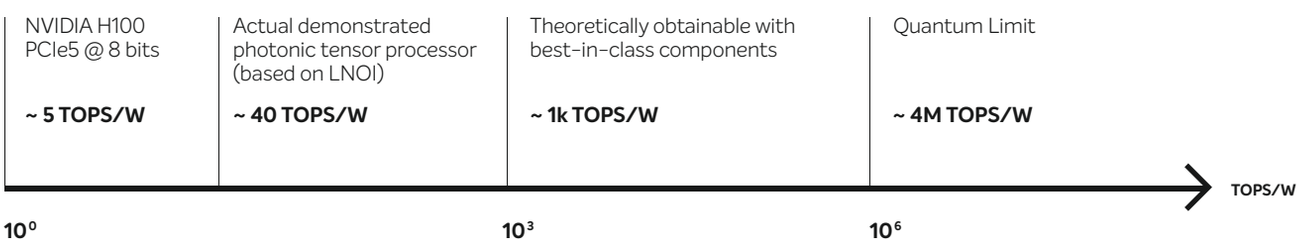
- Information is encoded as the intensity of laser beams
- In-memory computing: the intensity is manipulated directly using optical components
- Measuring the intensity gives the result of the computation
- One optical operation = 1 addition and 1 multiplication



$$BS_{50:50} = \frac{1}{\sqrt{2}}\begin{pmatrix}1 & -1\\ 1 & 1\end{pmatrix} \qquad I_1' = |\alpha_1'|^2 = \frac{1}{2}(\alpha_1 - \alpha_2)\cdot(\alpha_1 - \alpha_2)$$

$$\begin{pmatrix}\alpha_1'\\ \alpha_2'\end{pmatrix} = \frac{1}{\sqrt{2}}\begin{pmatrix}1 & -1\\ 1 & 1\end{pmatrix}\cdot\begin{pmatrix}\alpha_1\\ \alpha_2\end{pmatrix} \qquad I_2' = |\alpha_2'|^2 = \frac{1}{2}(\alpha_1 + \alpha_2)\cdot(\alpha_1 + \alpha_2)$$

Energy Efficiency

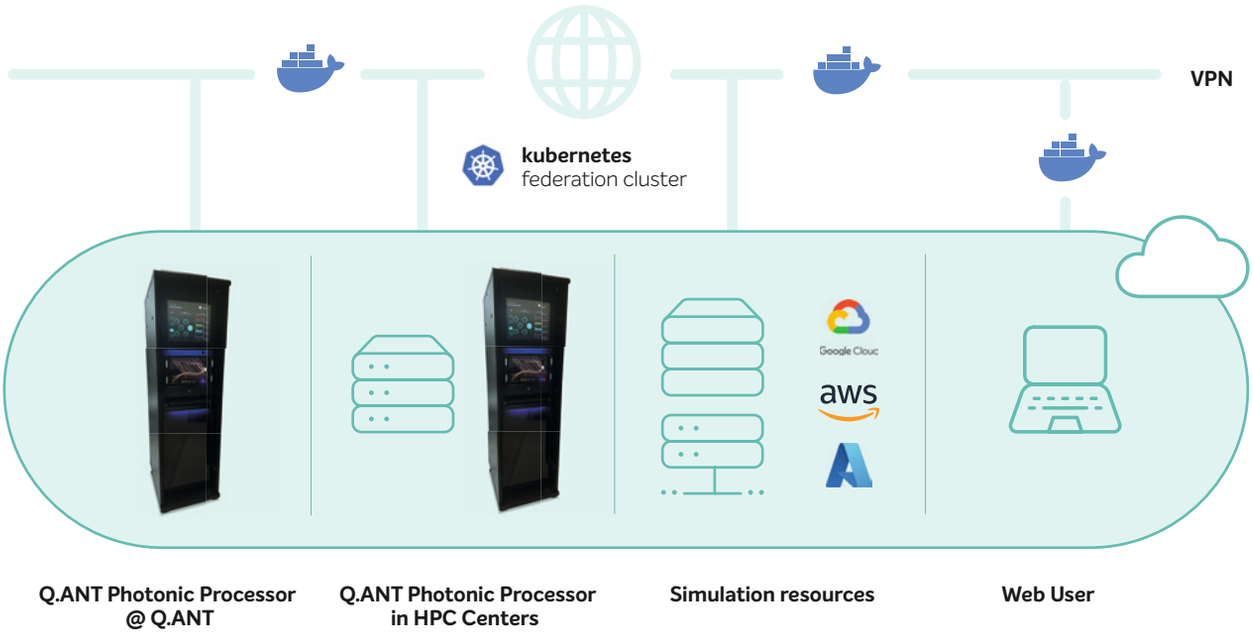


NVIDIA, Ou et al. 2024, Hamerly et al. 2019

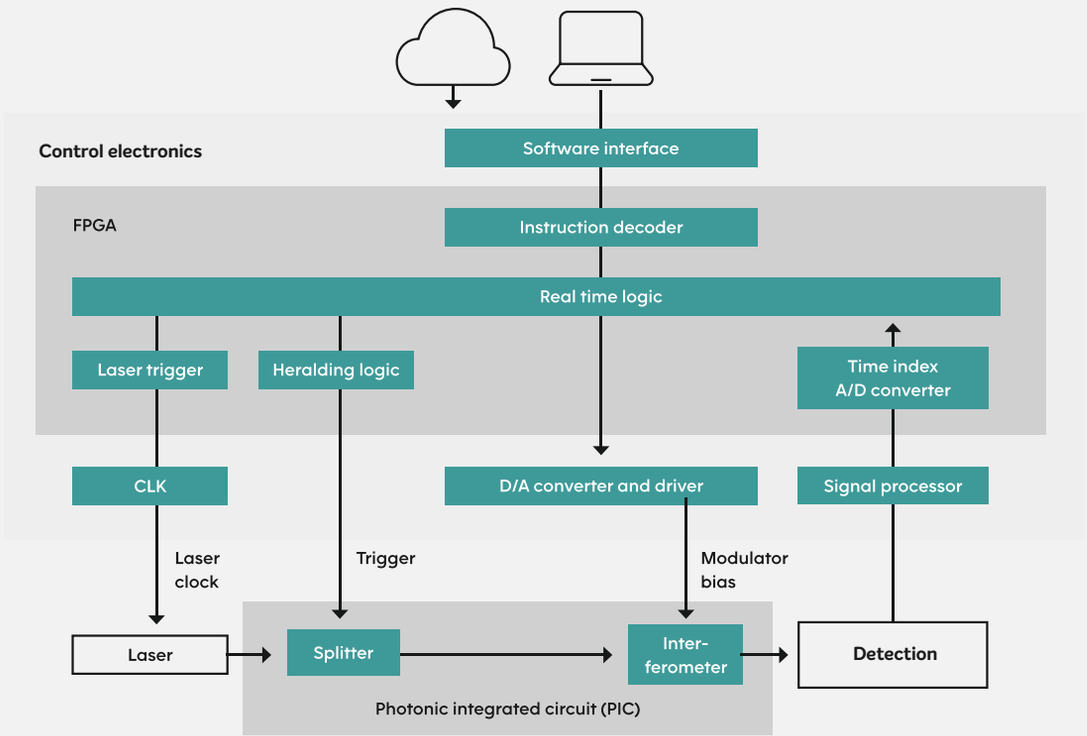
The Power of Photonic Algorithms

	Photonic quantum processor	Photonic processor	Photonic processor
Application	(Job-Shop) Scheduling	Flight gate assignment problem	Machine learning, AI, ODEs, PDEs
Abstraction	Max-Clique	QUBO	Vector-matrix multiplication
Algorithm	Gaussian Boson Sampling	All-optical coherent Ising machine	MZI matrix Core
Processor Architecture	4 mode GBS processor	4 mode interferometer with feedback	4 mode interferometer

Q.ANT's Photonic Processors integrate seamlessly into Federation Clusters by Kubernetes



Q.ANT offers the full Computing Stack

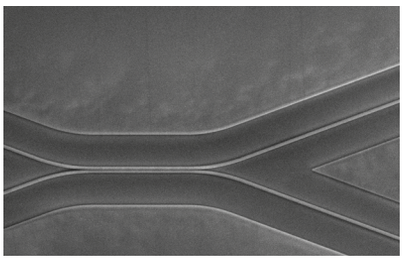


The Power of Lithium Niobate

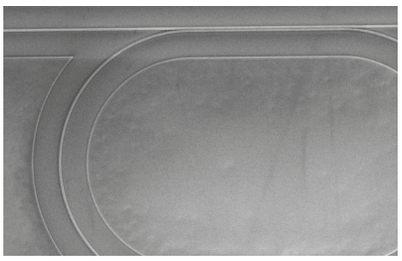
Q.ANT relies on its own technology platform for quantum photonic chips and photonic integrated circuits – PICs. The central components of the chips are optical waveguides, modulators, beam splitters and resonators, which enable the control of light and quantum effects in a highly integrated form. Very 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 computing.

PICs based on LNOI show several main advantages:

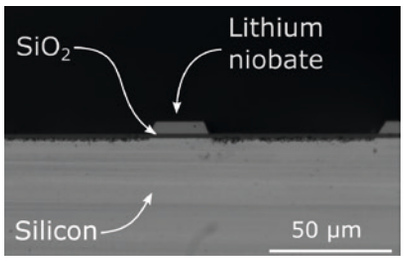
- No thermal crosstalk between optical modulators due to the use of electrical fields to change the refractive index in its waveguides – allowing smaller processors
- Faster modulation and switching speeds in the MHz range, applications more tolerant to losses can even reach GHz
- Direct and lossless 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



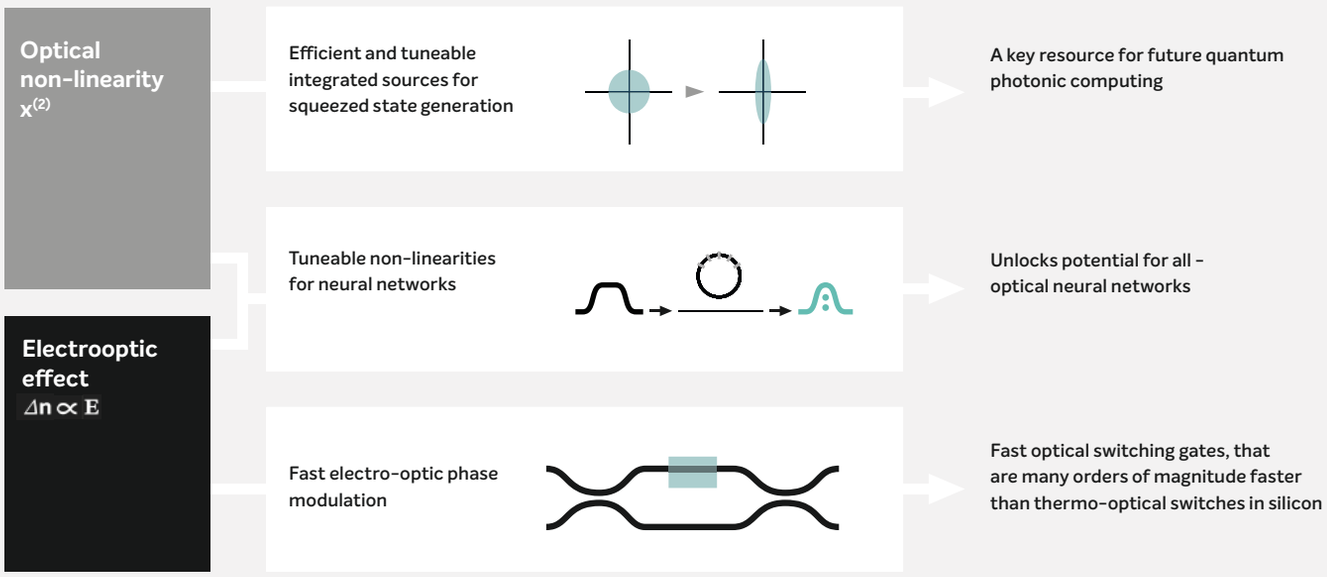
Resonator



Cross Section of Wave Guide

The Perfect Material of Choice

We selected lithium niobate as matieral platform for its superior characteristics



Unlocking the Power of Photonic Computing for HPC

The landscape of high-performance computing is undergoing a seismic shift caused by various new types of hardware accelerators. Among them, photonic computing platforms offer the unique potential for high throughput combined with low power consumption in classical computing as well as a technology path towards future quantum computing architectures.

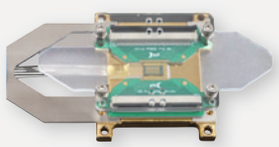
In particular the field of machine learning will benefit immensely from classical photonic computing. The major part of the power consumption of today's neural network models is spent on matrix-vector multiplications (MVMs) which can be boosted by leveraging the wave-like properties of light. Thus photonic computing is an essential driver that will enable the scaling to larger neural network models in the future.

Photonic computing by Q.ANT is special because of our holistic approach. We cover the entire value chain, from the development of our custom photonic chips and processors, over computing systems and all the way up to photonic algorithms and applications. Photonic chips and processors from Q.ANT integrate easily and securely into HPC architectures and data processing. Embark on our photon-powered adventure into the future of high-performance computing. Let's dive in and unlock the photonic advantage!

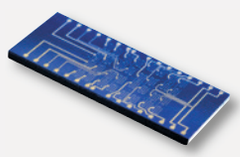
The Q.ANT One-Stop-Shop from Chip to Application

- Accelerates data processing
- Reduces energy consumption
- Custom-fit soft- and hardware
- Seamless integration in HPC infrastructure
- Scales easily
- Next level of hybrid computing
- Works at room temperature without need for vacuum, liquid or cryostatic infrastructures

Photonic Processor



Packaged Photonic Chip



Photonic Chip

The Q.ANT Photonic Processor

Q.ANT GmbH | Handwerkstraße 29 | 70565 Stuttgart, Germany
+49 711 45969613 | info@qant.de | www.qant.com