Q.ANT
Quantum Computing using Photonic Chips

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CEO
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EPIC Technology Meeting on Electronics & Photonics


QANT

The Q.ANT Vision

We are …

Revolutionizing the
Quality
how

Machines
Analyze
their environment

People
Notice
information
and the way

Humans
Think

FOUNDED IN 2018 IN STUTTGART

Quantum Technology meets Photonics

Q.ANT is part of the TRUMPF Group

Footprint
> 1.600 m²

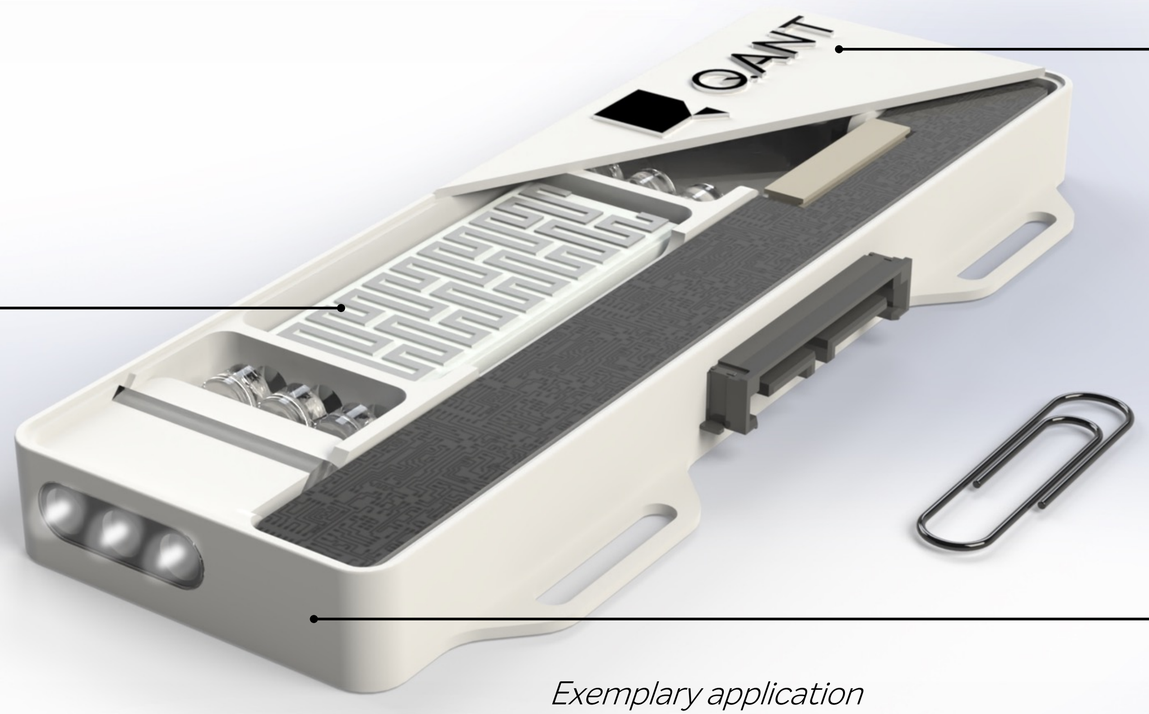
Q.ANT Team
Today: 50 ➔ 100 (2023)

Product Developments
3 Sensors and 1 Chip

Public Funding
6 Projects

Q.ANT delivers Photonic Quantum Technology

for industrial applications together with our partners



Exemplary application

Electron to photon conversion

- Solid state diodes
- Low-noise current drivers

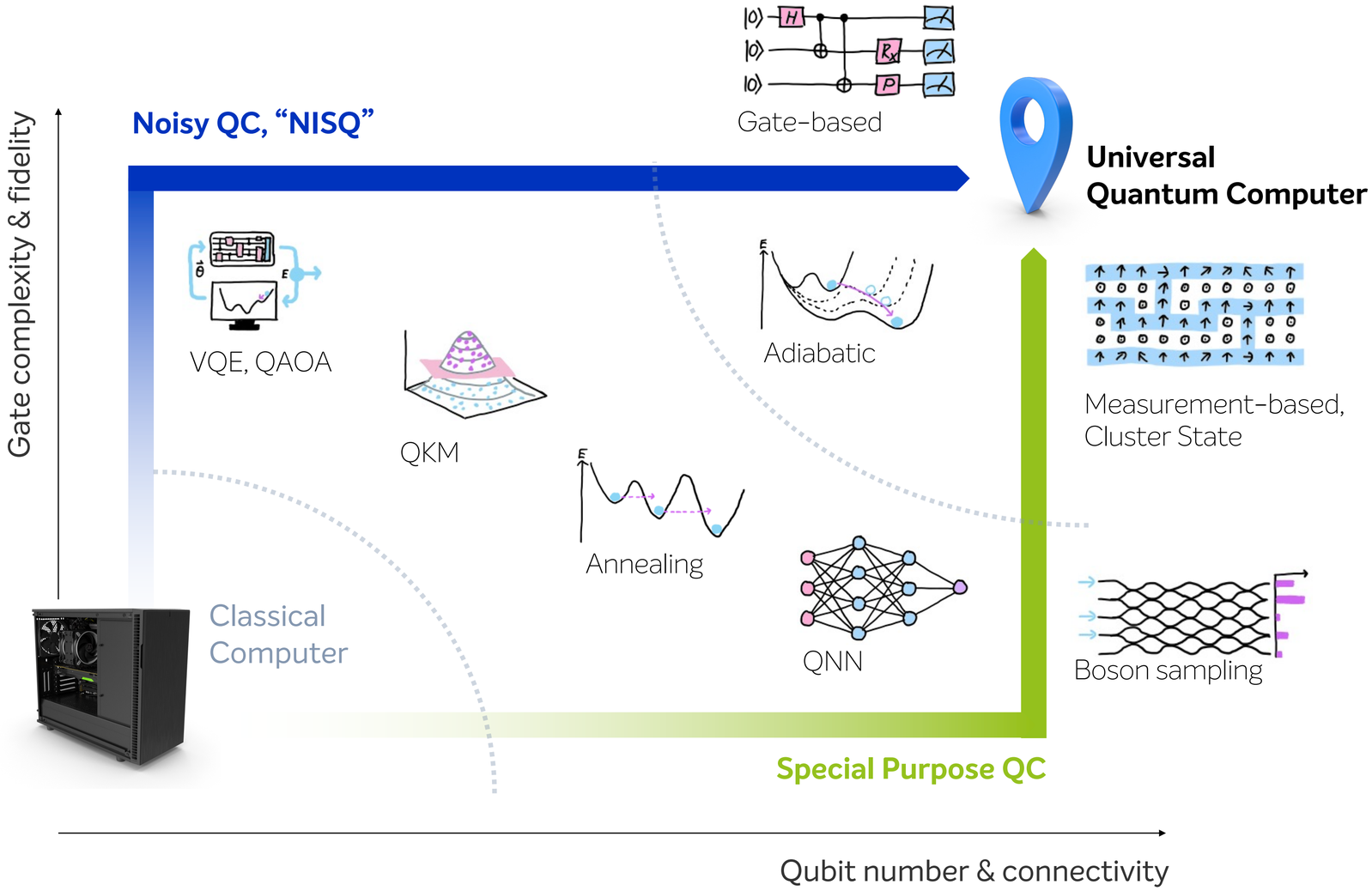
Quantum controls

- Nonlinear waveguides
- Tailored optical elements

Photon to Electron conversion

- Low-noise amplifiers
- Analog to Digital conversion
- Signal process

Hypotheses: Depending on the platform, **different success stories are possible**



Our Platform

Other Platforms

VQE: Variational quantum eigensolver

QAOA: Quantum approximate optimization algorithm

QKM: Quantum kernel methods

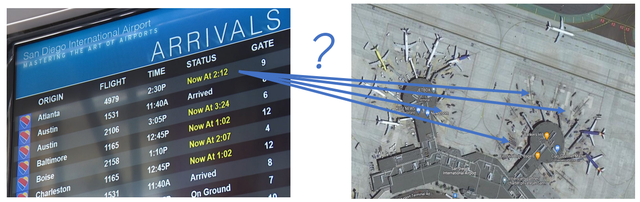
QNN: Quantum neural networks

Tackling real-word industrial optimization problems

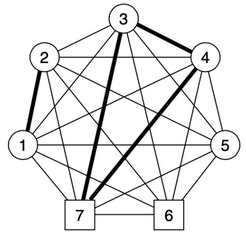
with photonic quantum accelerators

Work in progress

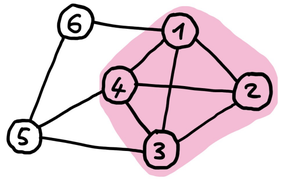
Flight gate scheduling



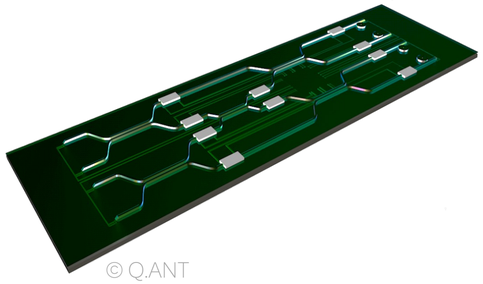
Network representation



Network solution



Photonic integrated chip



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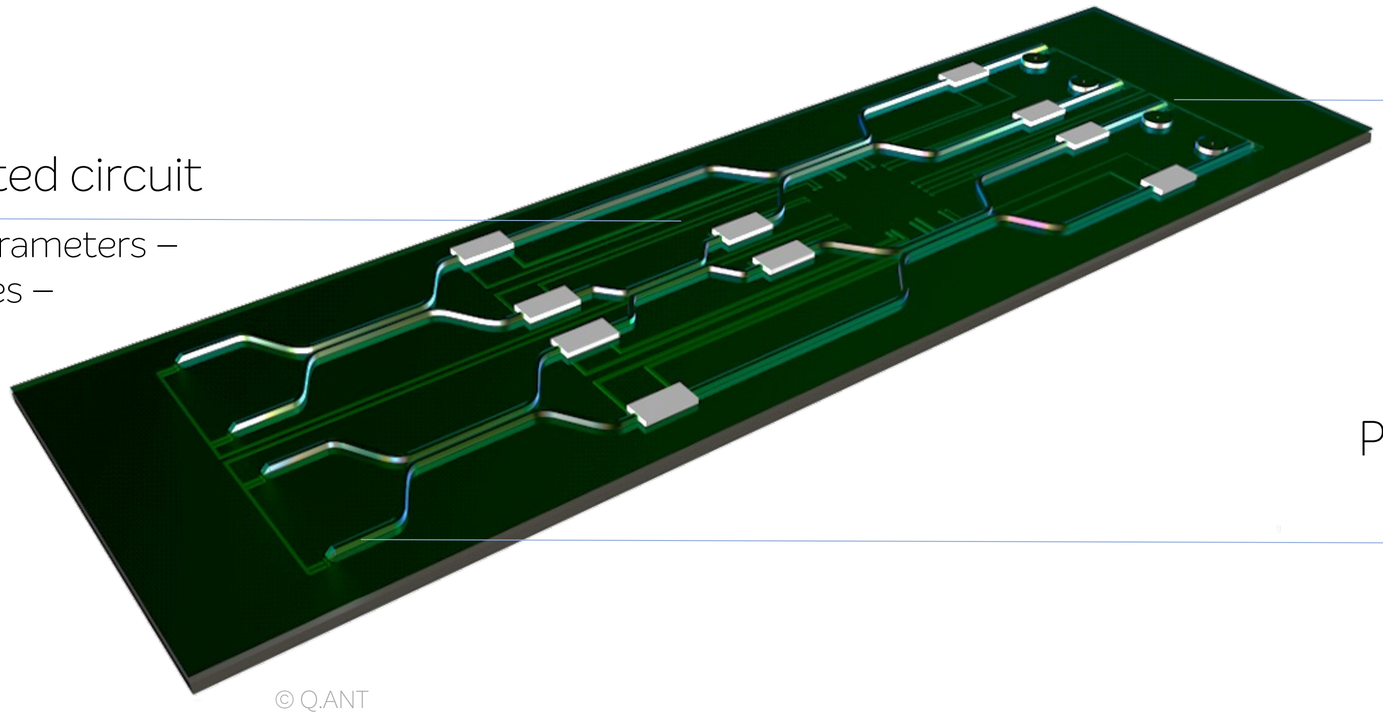
Q.ANT connects hardware with software and algorithms …

… to perform Photonic Quantum Computing.

Photonic integrated circuit

– Optimal material parameters –
– Low-loss waveguides –
– Tunable couplers –



Generation of photon resource states

– Nonlinear effects –
– Low noise –

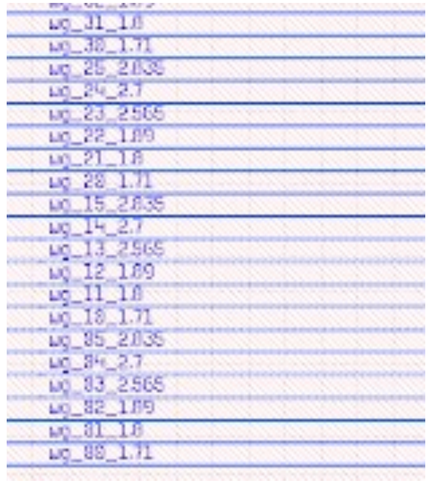
Photon state detection

– Low-noise –
– High fidelity –

All components for spooky actions can be integrated on photonic integarted circuits

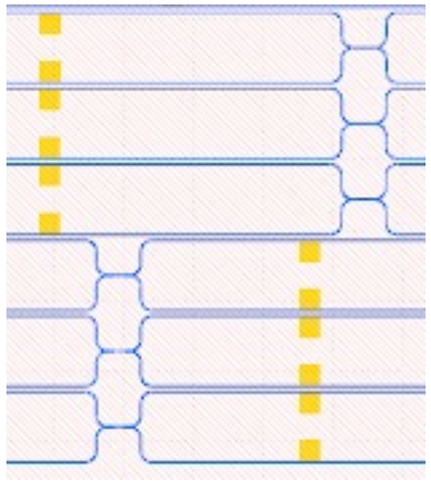
Waveguide

- Connecting compo-nents to each other
- Objective is to get wave guides with the least attenuation possible



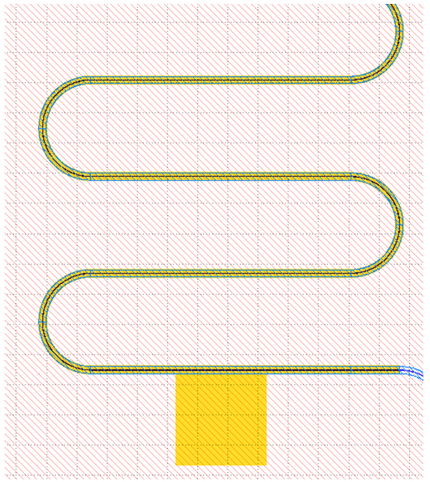
Interferometer

- Entangling photons
- Changing the direction through the circuit
- Objective is to have exactly 50/50 splitting



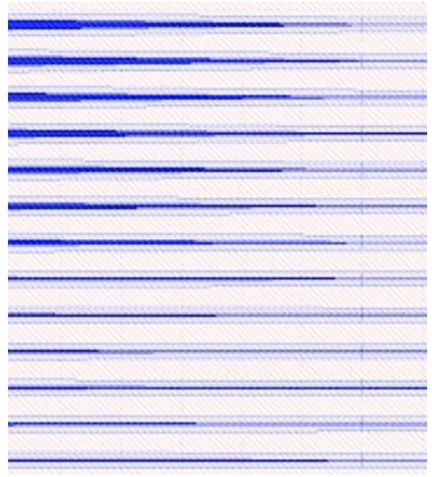
Electro Optical Modulators

- Shifting the phase of / delay photon packages
- Objective is to switch in GHz speed respectively 20V/ns



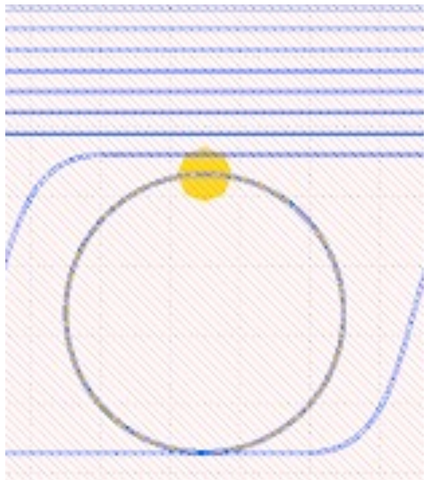
Fiber Couplers

- Connecting fibers to the photonic integrated circuit
- Objective is to reach coupling efficiencies >> 90%



Resonators

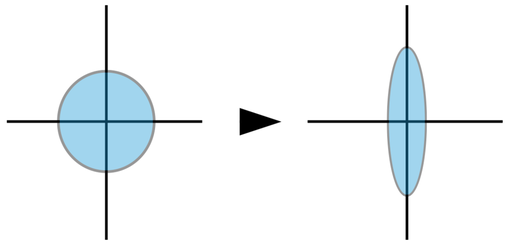
- Creating squeezed states
- Objective is to reach 10 dB squeezing (10 photons per state)



We choose lithium niobate because of its material properties

Optical non-linearity
$\chi(2)$

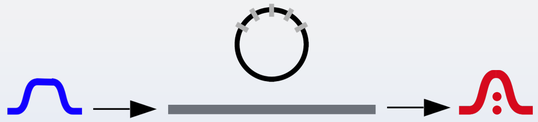
Efficient integrated sources for squeezed state generation



The required pump power is 10^3 times lower compared to silicon-based material platforms

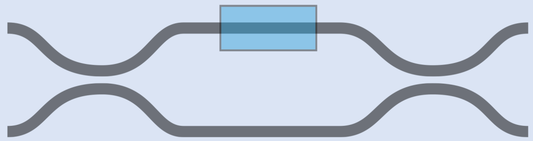
Electro-optic effect
$\Delta n \propto E$

Tune able sources for indistinguishable squeezed states



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

Fast electro-optic phase modulation



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

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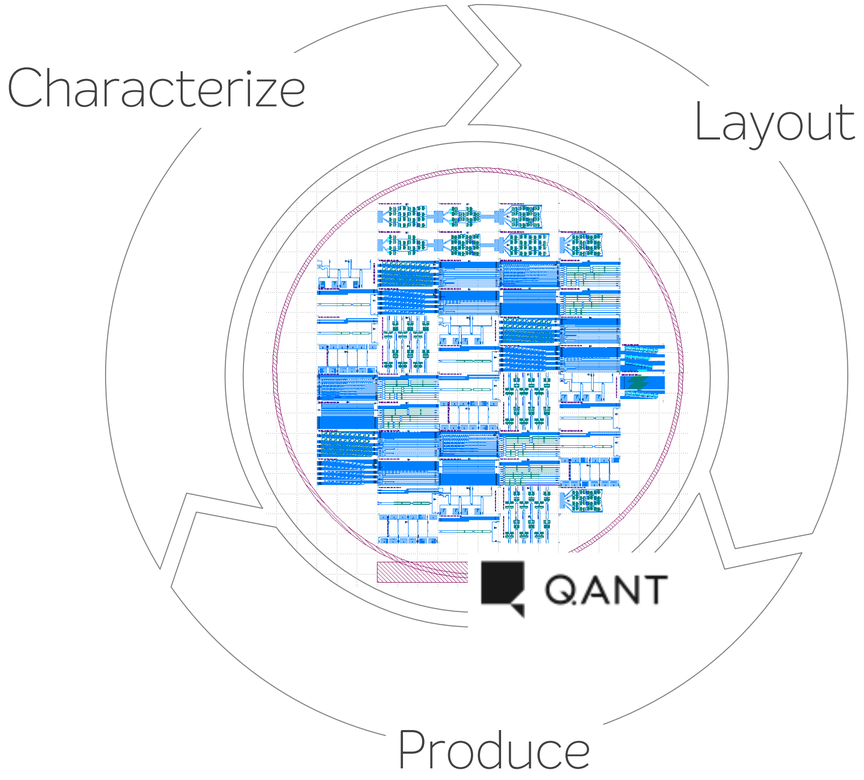
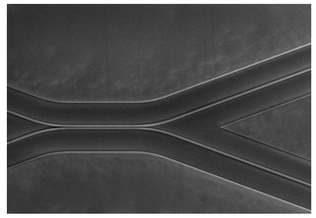
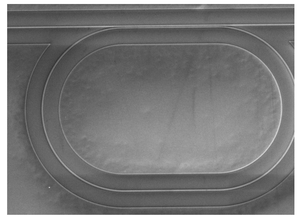
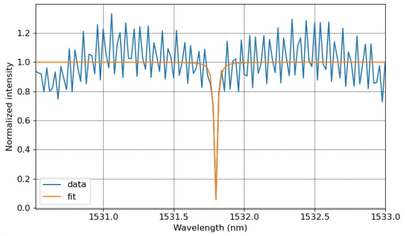


Interferometer



Resonators





Q = 800.000 ≙ 10 dB/m

Photonic integrated circuit

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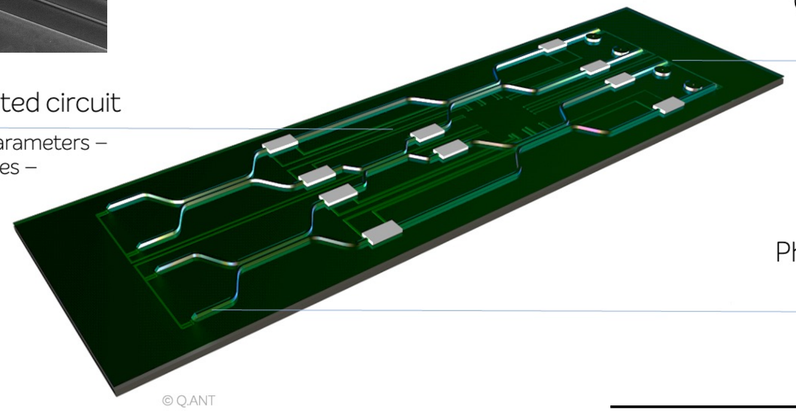
– Tunable couplers –



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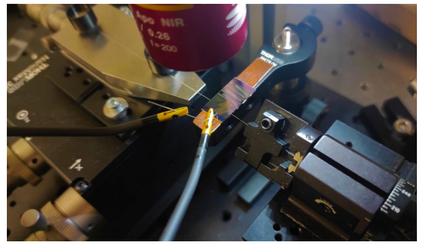
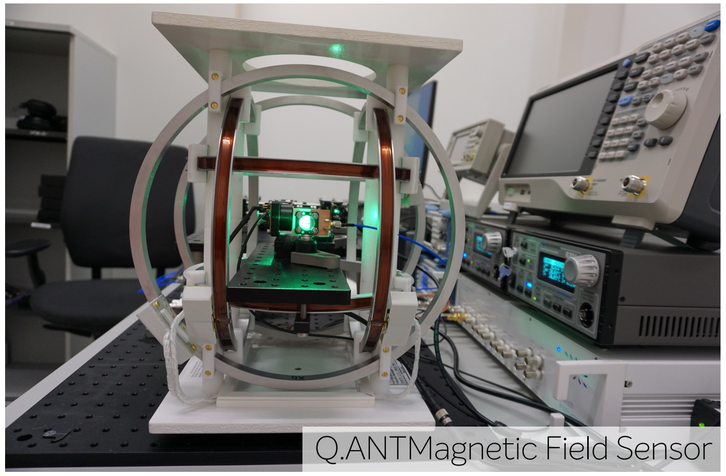
Electro Optical Modulators

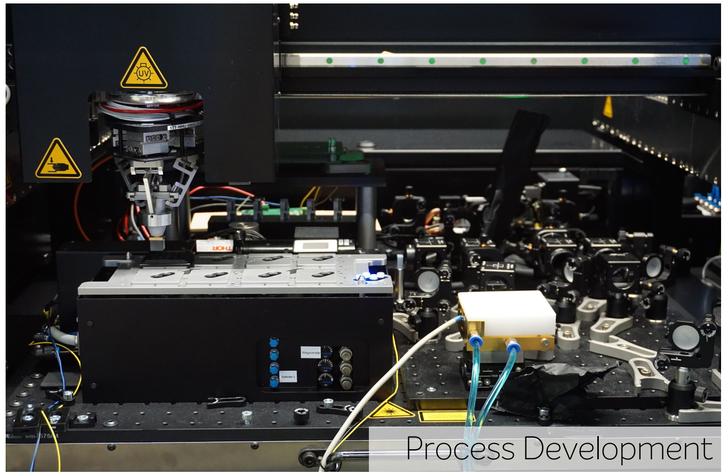


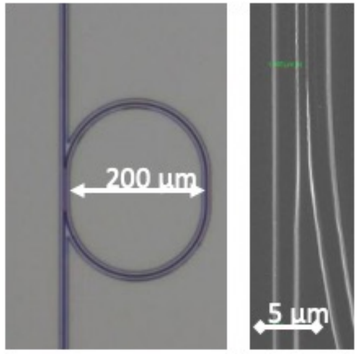
	Q.ANT
Π-Voltage / phase shift 180°	32,7 V
Length of electrode	0,36 cm
Modulator performance	11,8 Vcm
Extinction ratio	8 dB

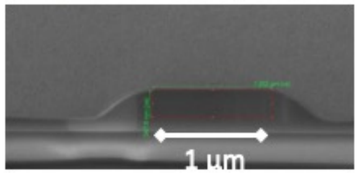
Q.ANT in pictures:

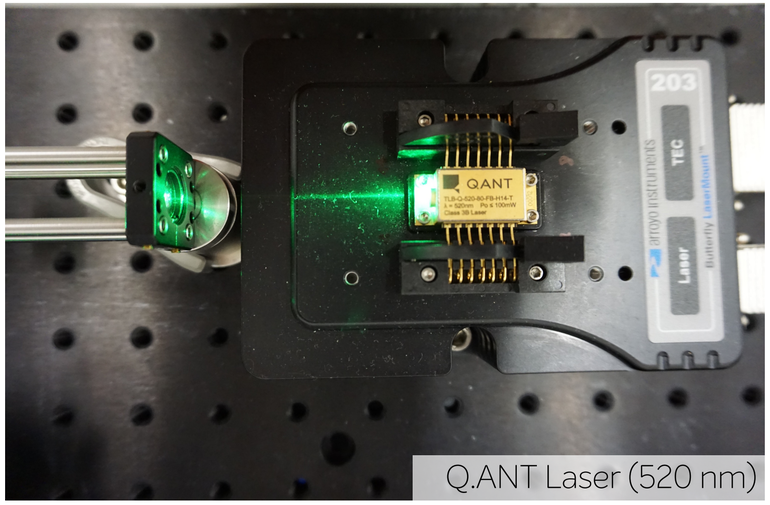
Enabling Technologies, Quantum Sensing and Quantum Computing.


Q.ANTMagnetic Field Sensor

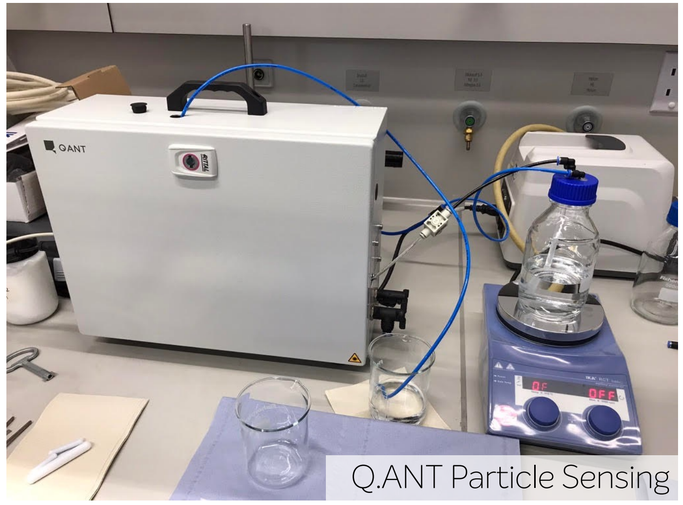

Process Development



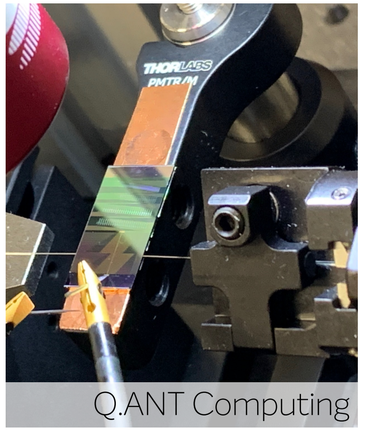




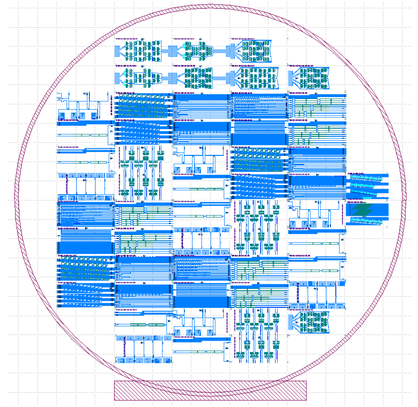
Q.ANT Laser (520 nm)



Q.ANT Particle Sensing



Q.ANT Computing



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