QUANDELA

Quandela, from the Academic Research in Semiconductor Quantum Dots to the optical Quantum Computer

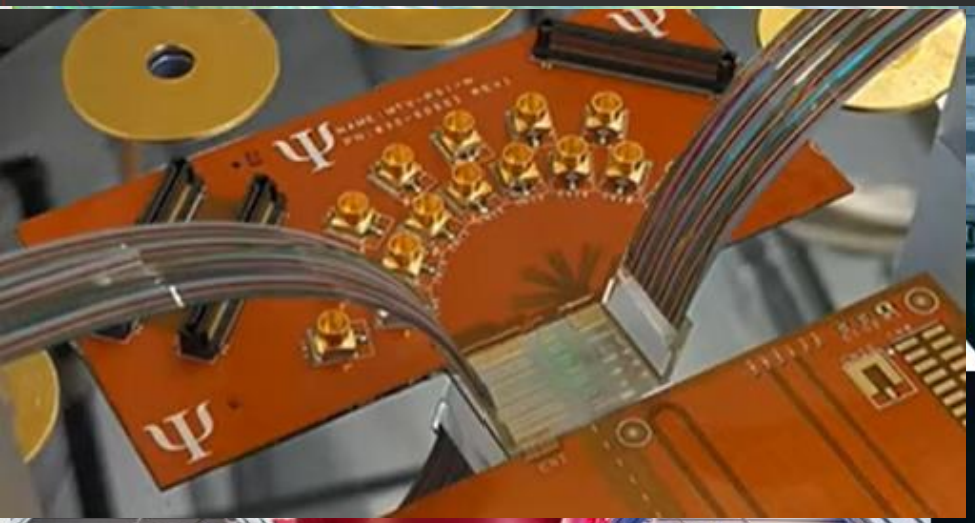
Marie BILLARD
Quality Performance Manager

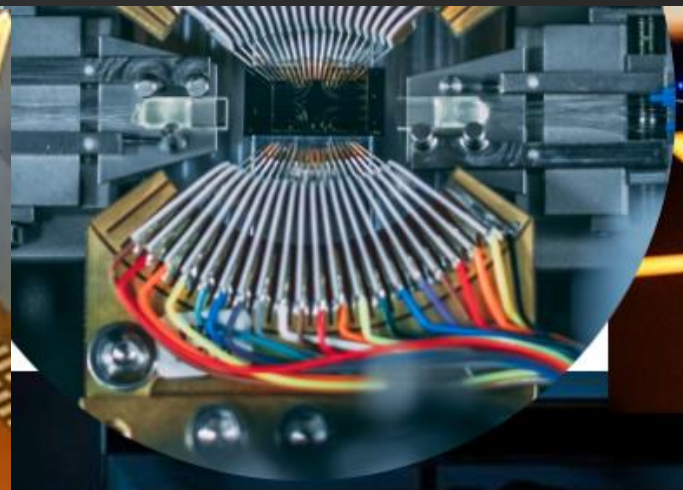
EPIC

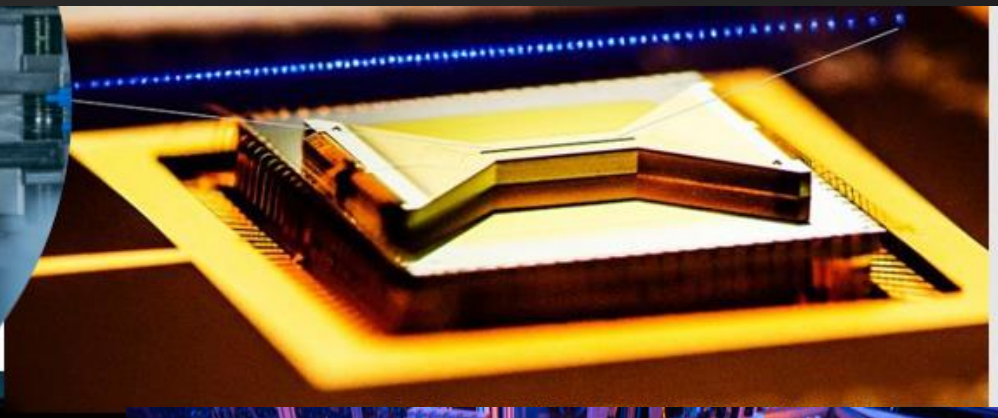
21st April 2022

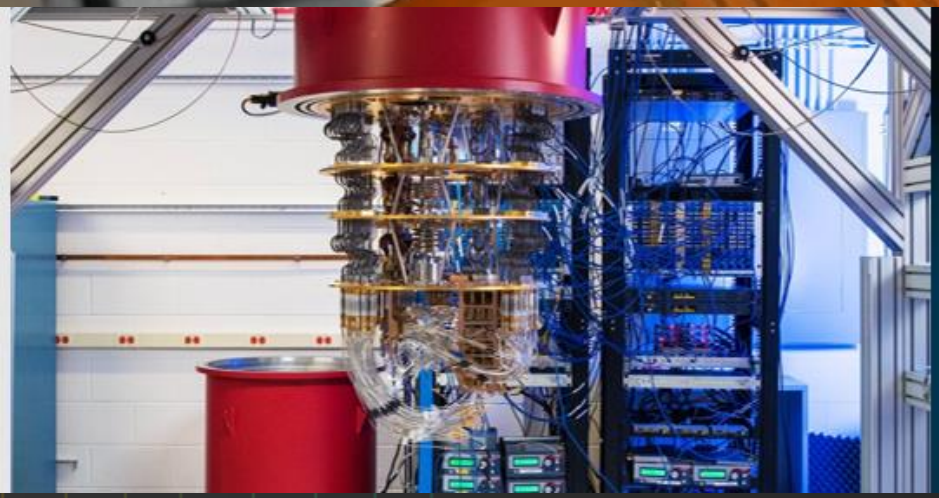
Credits slides: Niccolo Somaschi – Marie BILLARD

Quantum computing: the space race of the century

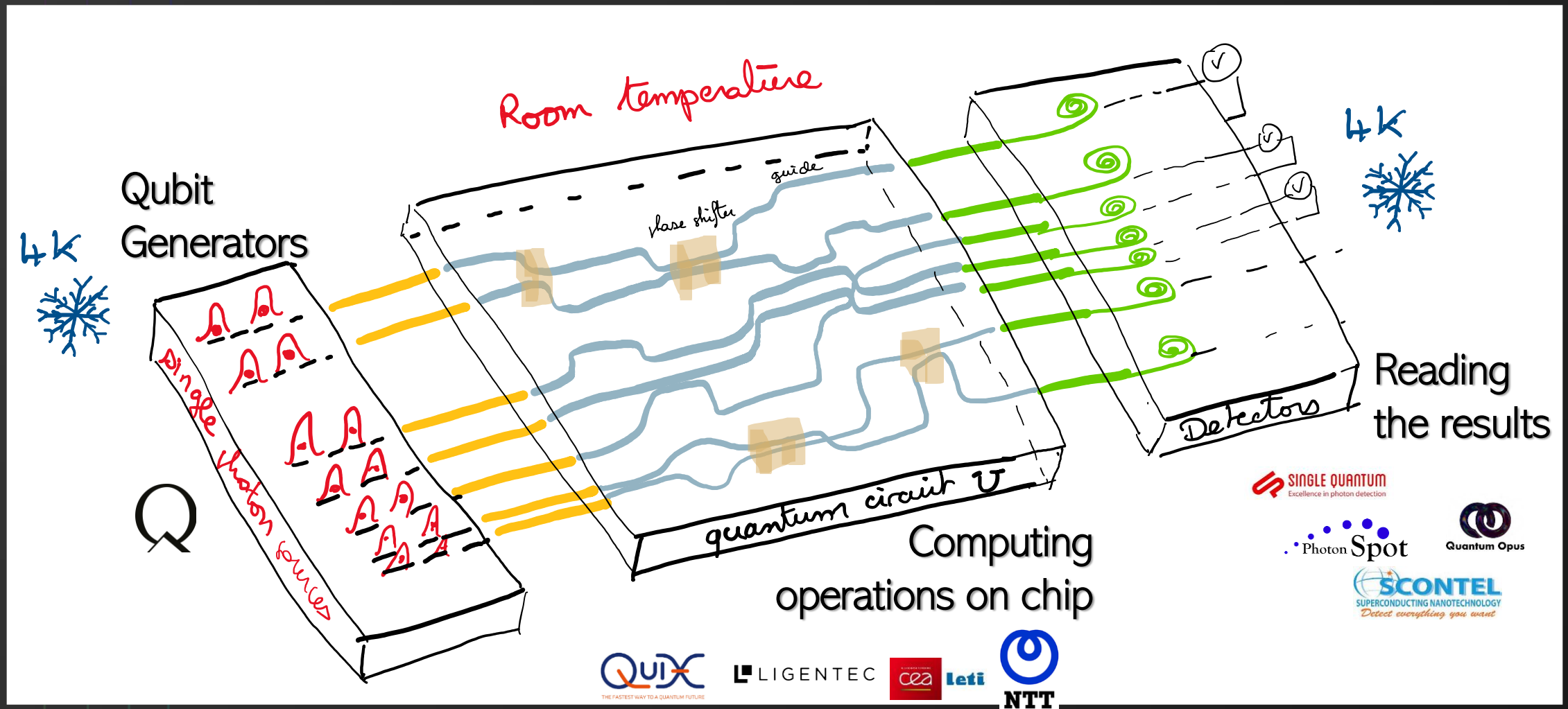








Architecture of an Optical Quantum Computer



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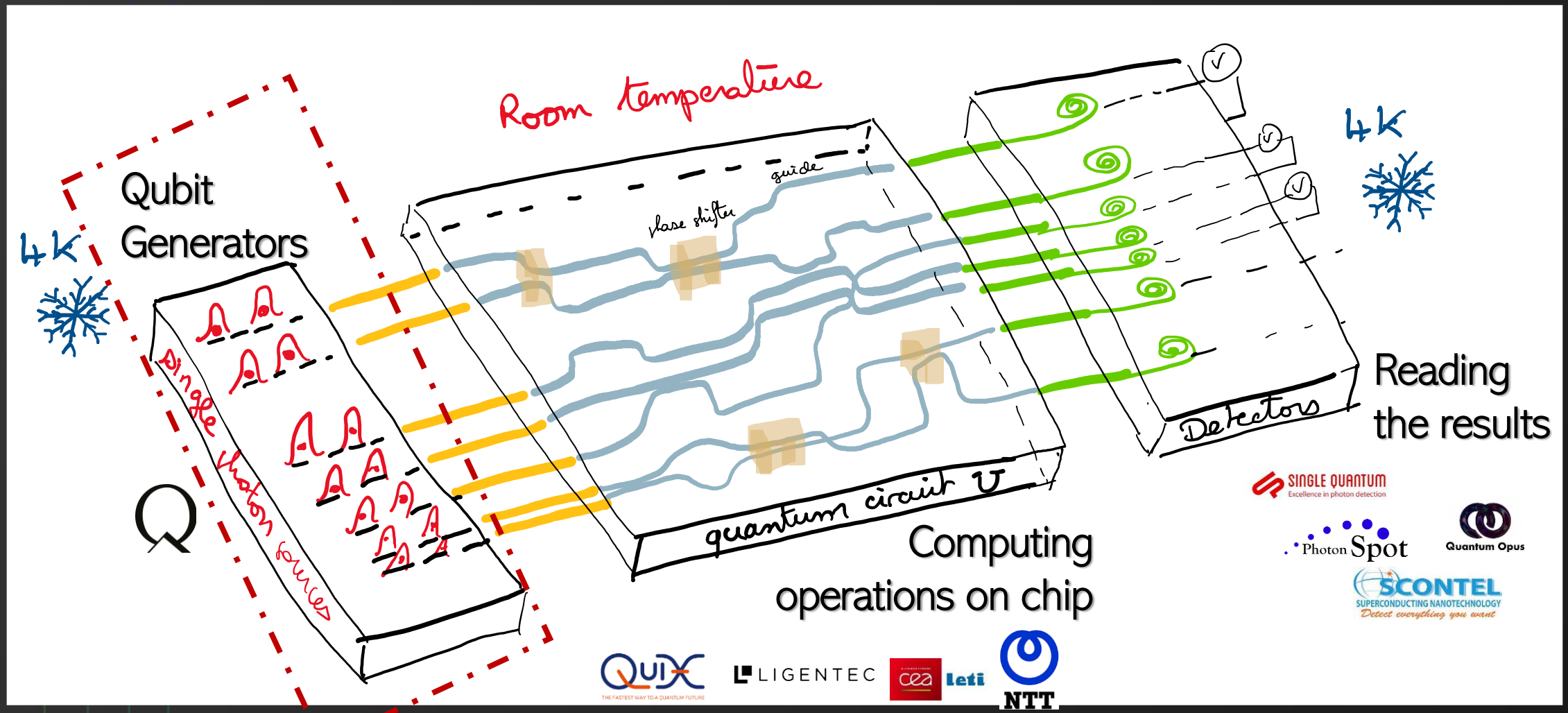


A source of single and indistinguishable photons

Photons are light particles with no mass and no electric charge

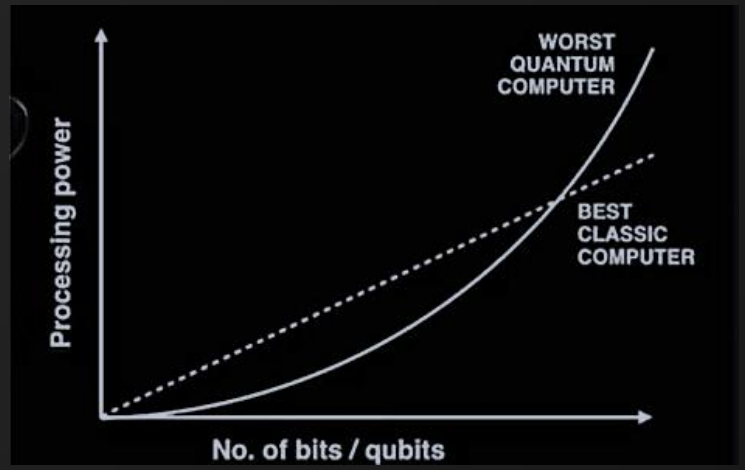
➡ Infinite coherence time

Requirement:

A **Bright** *source*

Probability of having a photon after a laser pulse

Acquisition time for a N photons protocole /10^N



A source of single and indistinguishable photons

Photons are light particles with no mass and no electric charge

➡ Infinite coherence time

Requirement:

A **Bright** *source of* ***single*** *photons*

Probability of having not more than one photon per laser pulse

Considering two consecutives entrance of a photonic chip, two waveguides.

A source of single and indistinguishable photons

Photons are light particles with no mass and no electric charge

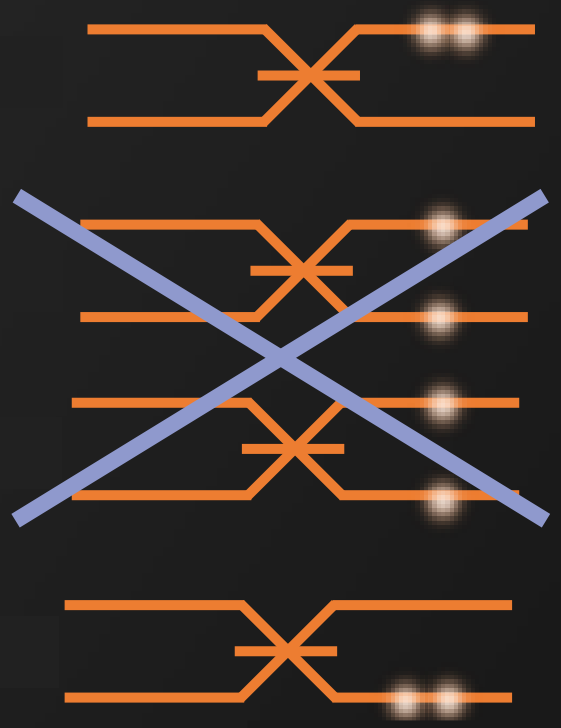
➡ Infinite coherence time

Requirement:

A **Bright** *source of* ***single*** *and* ***indistinguishable*** *photons*

All emitted photons shared the same physical properties

Hong-ou-Mandel effect



Unique know-how licenced by the CNRS
+ new patent owned by Quandela

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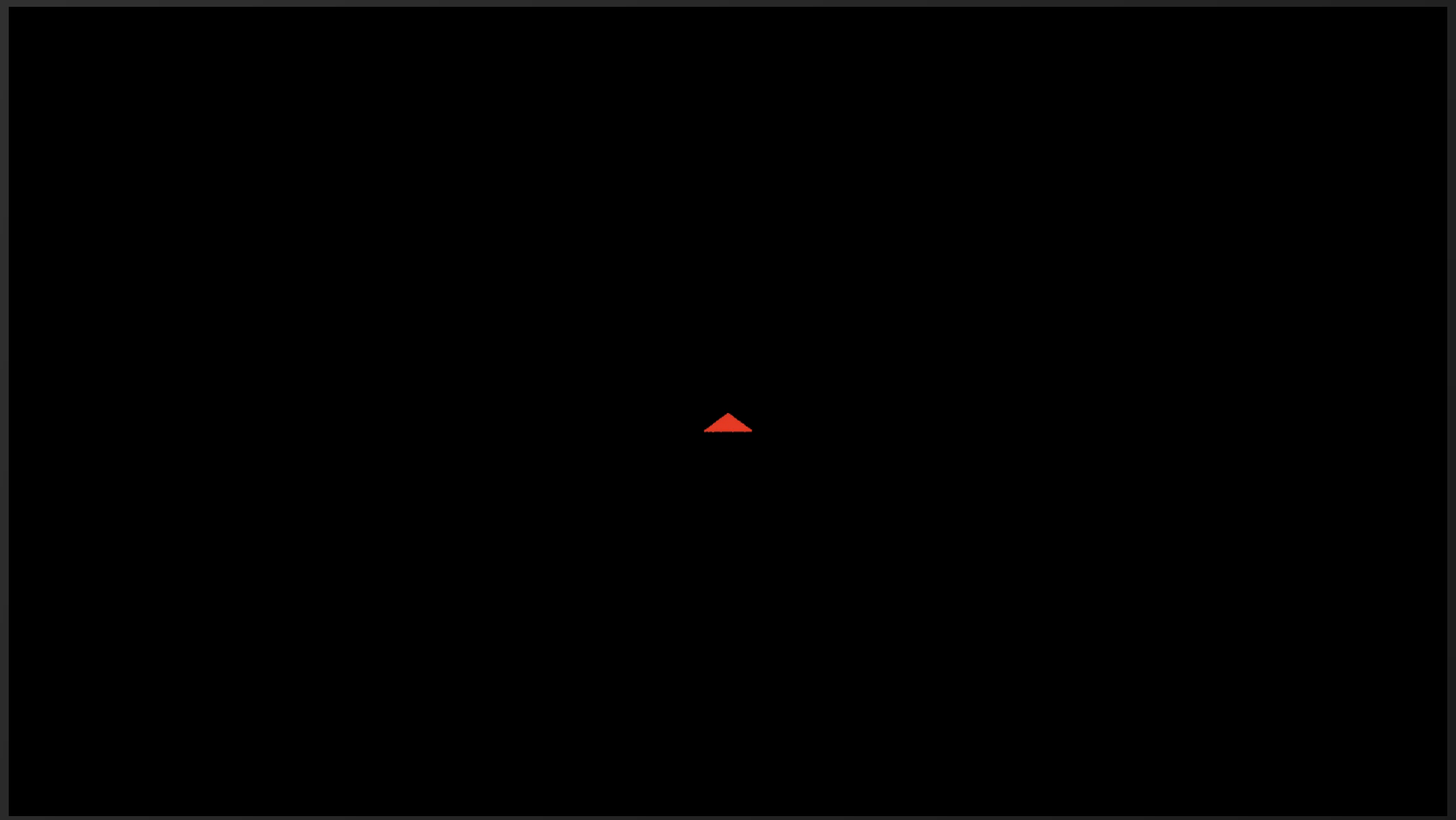

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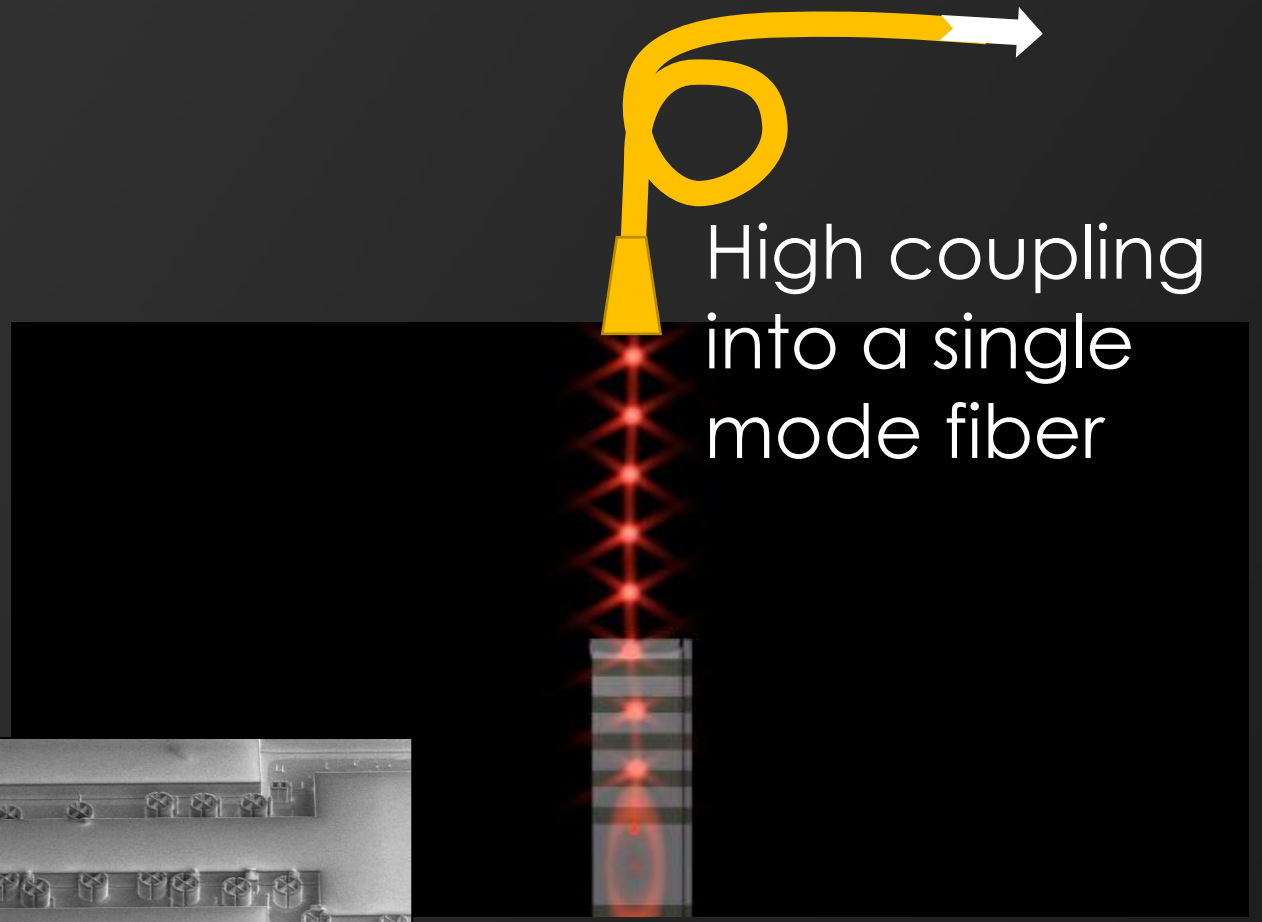
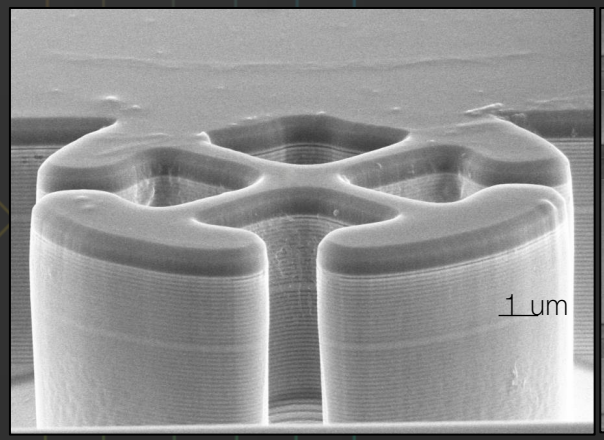
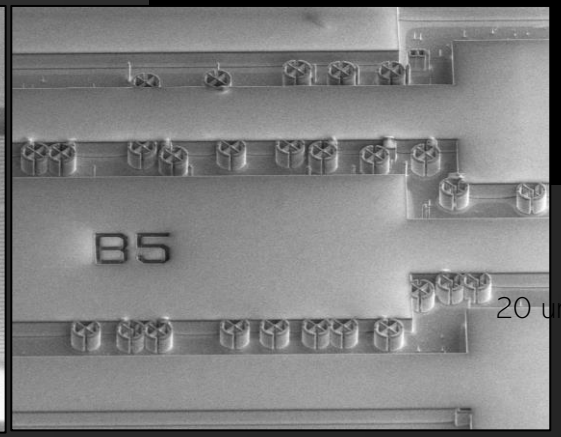
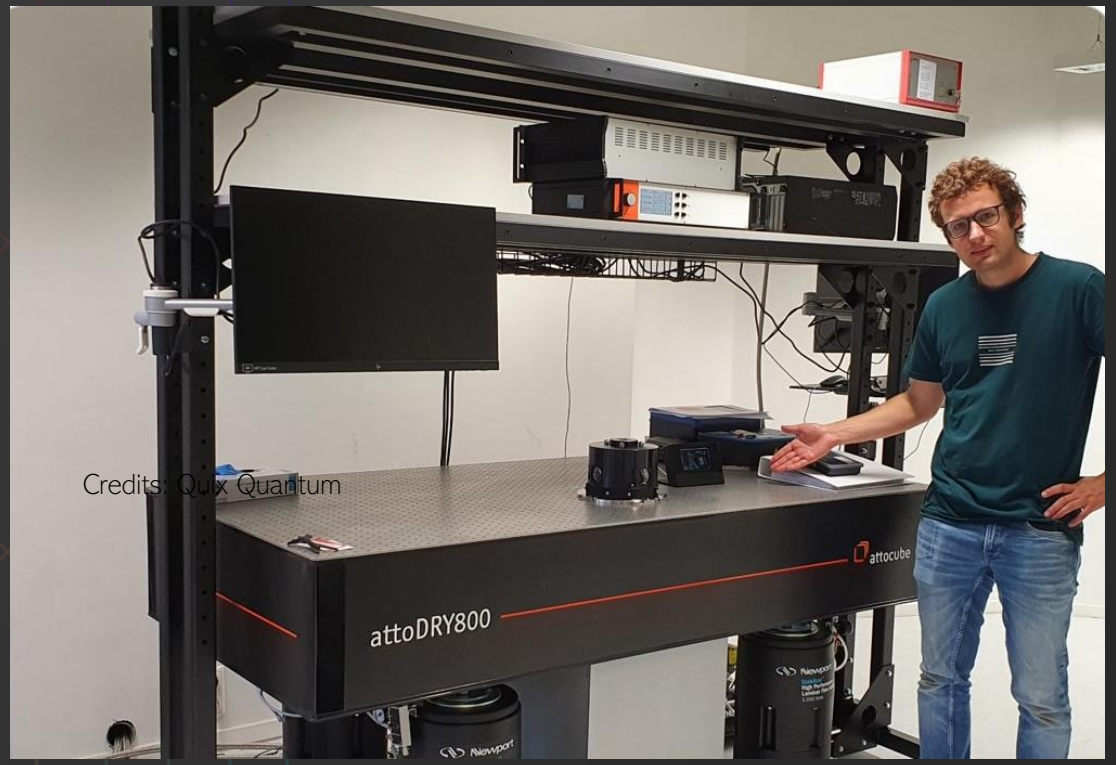


Quandela device





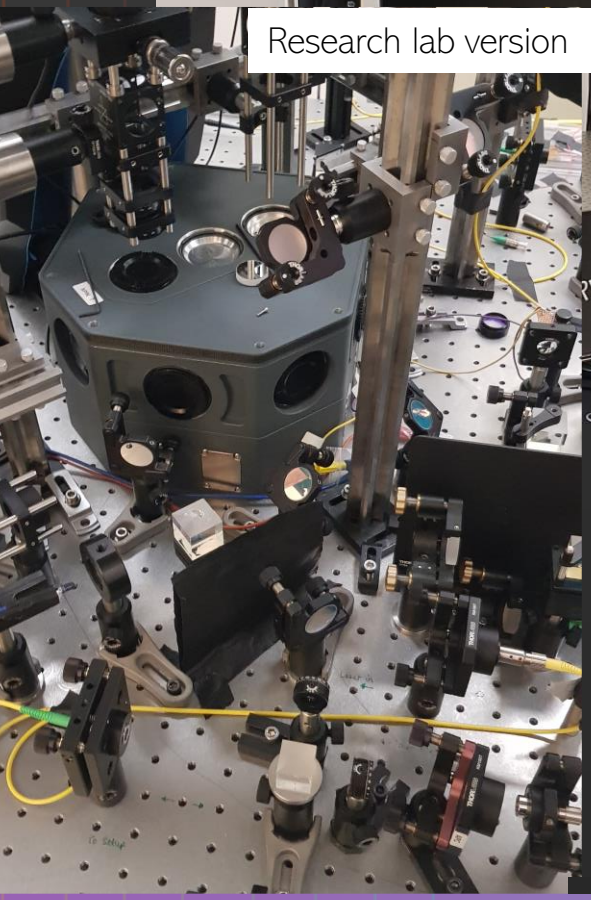
From free-space to “in-fiber” photon manipulation



Credits: Quix Quantum

From free-space to “in-fiber” photon manipulation

Research lab version



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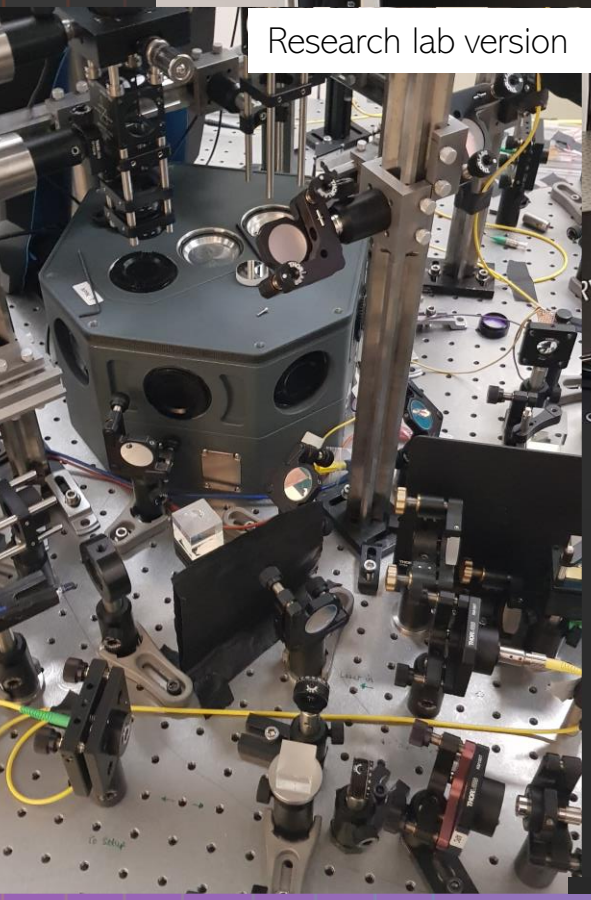
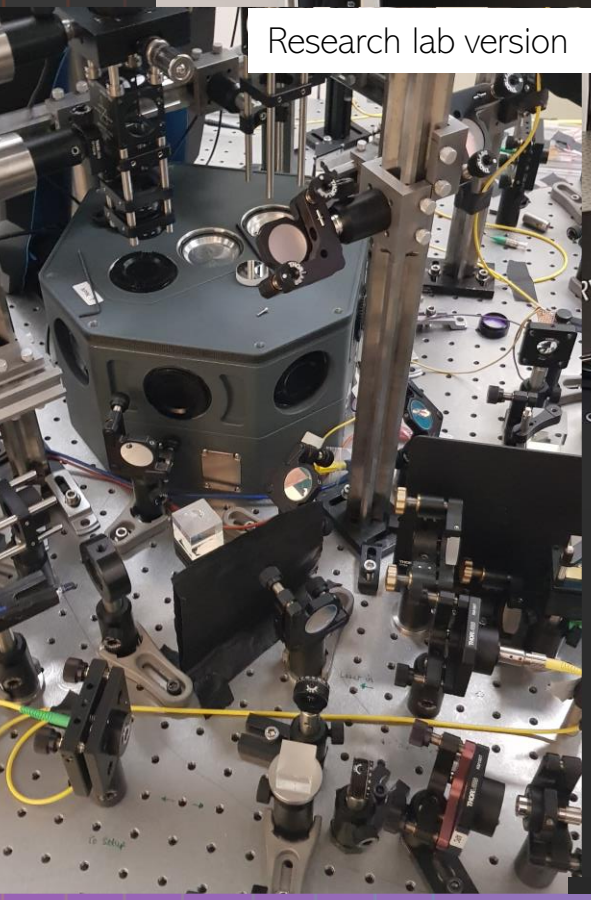


Research lab version

Usability and miniaturization must follow the increase of performance

From free-space to “in-fiber” photon manipulation

Research lab version



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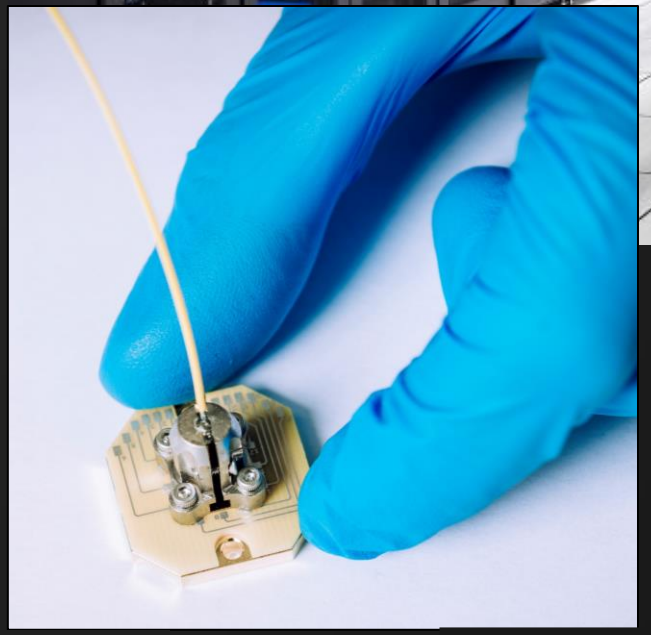
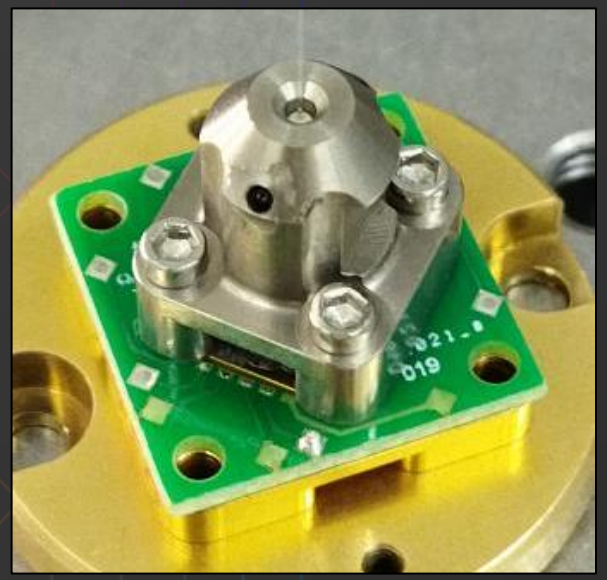
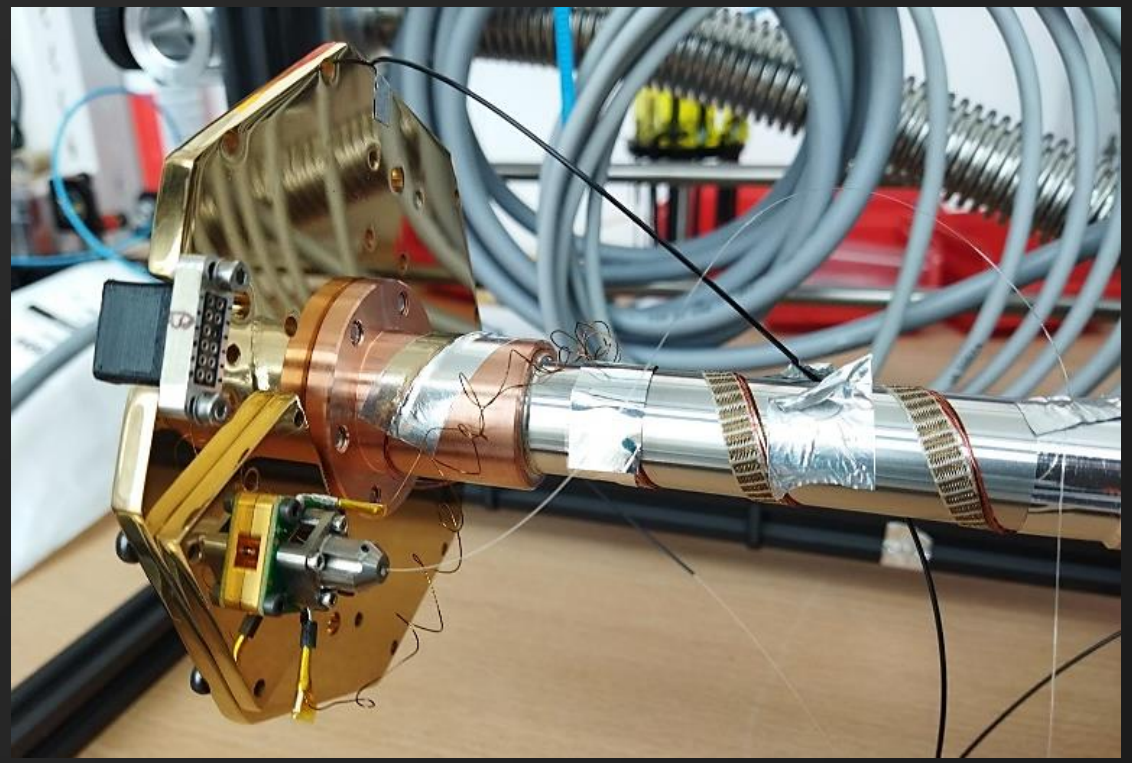


SM Fiber pigtailed single-photon sources – initial prototypes



Brightness
Fibered*
7 %
(4 MHz)

* Brightest determinic source



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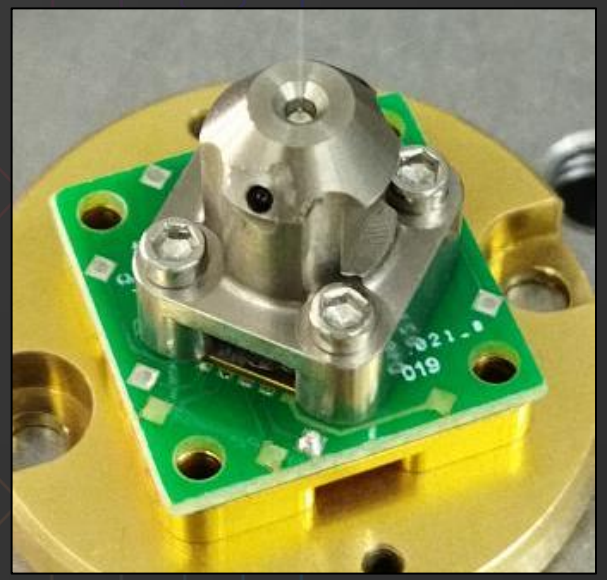

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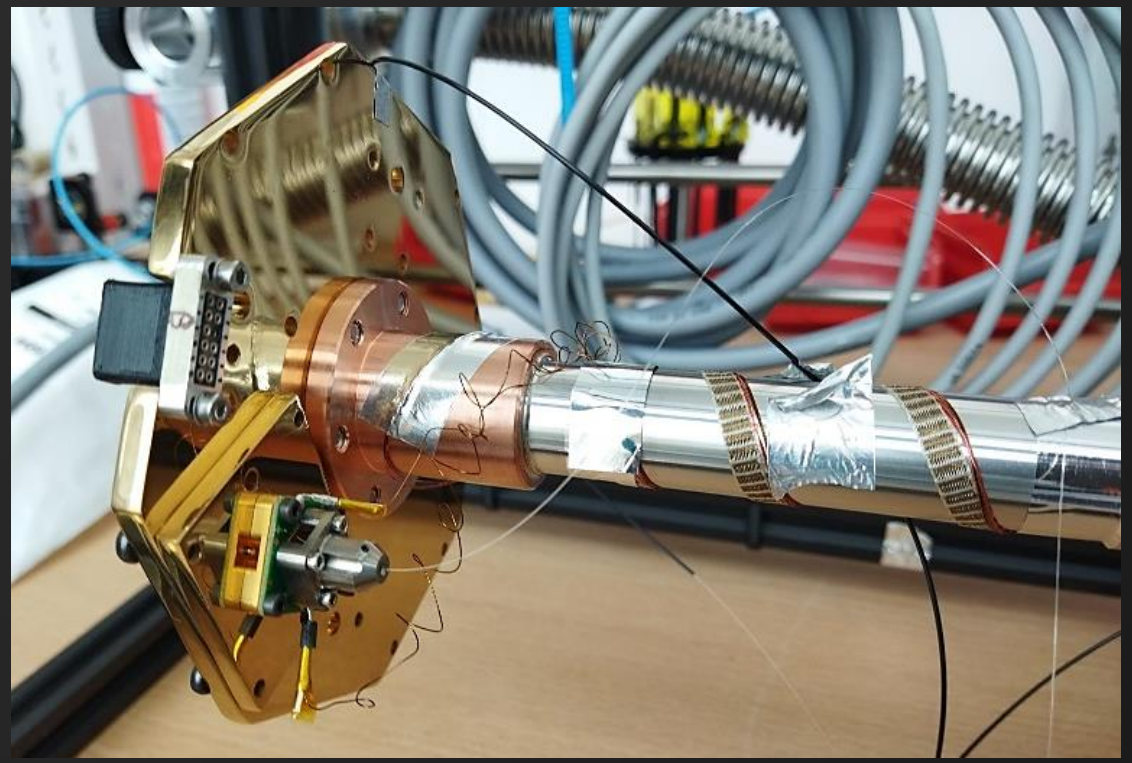
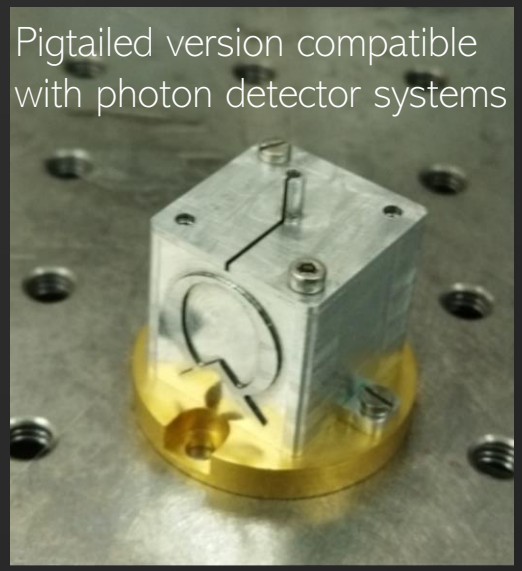
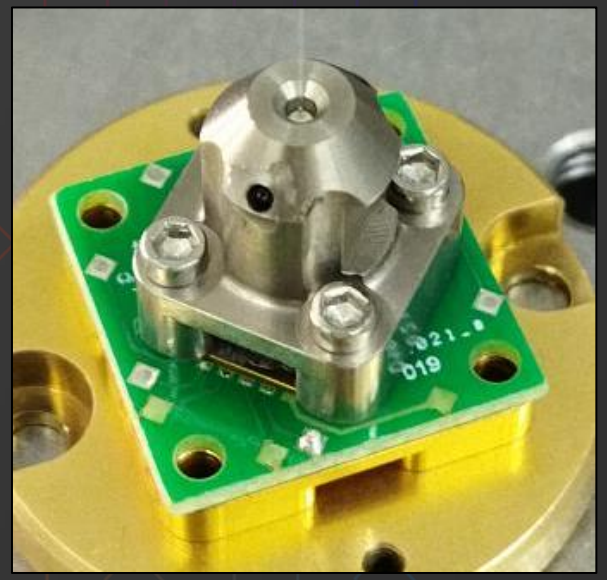
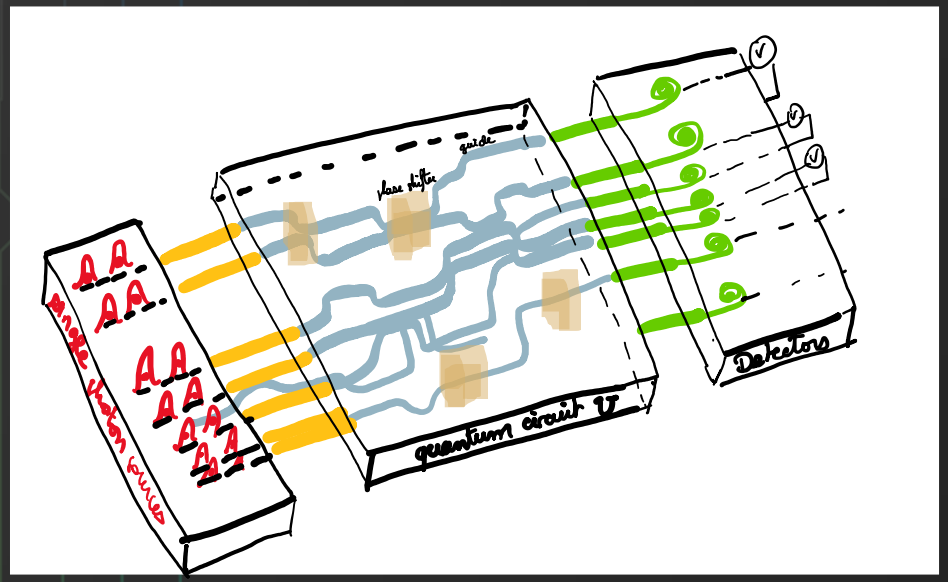


Pigtailed version compatible with photon detector systems



Towards the quantum computer





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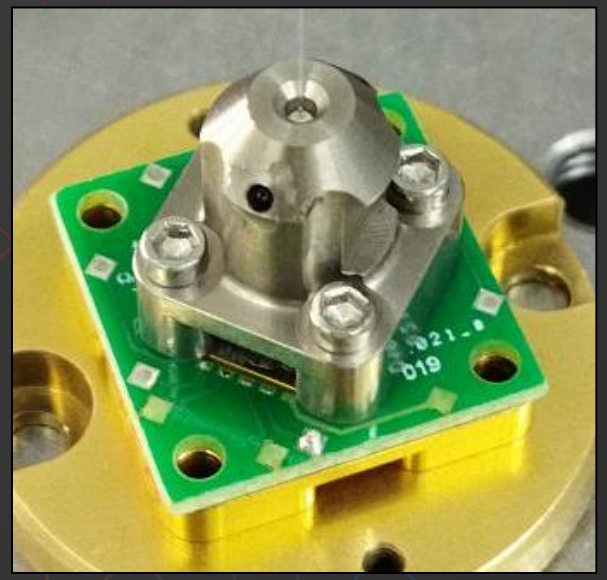

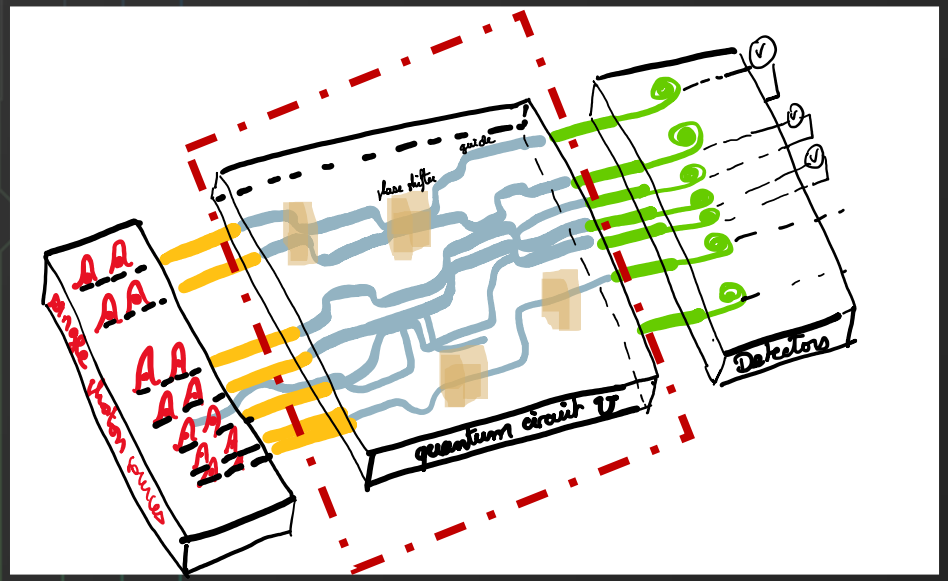

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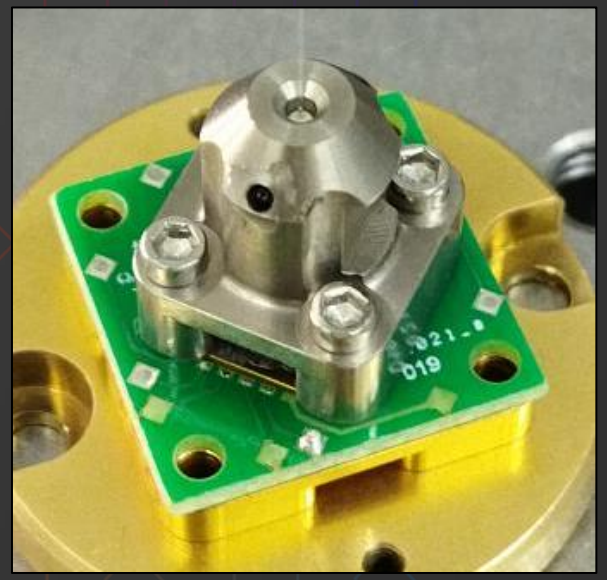

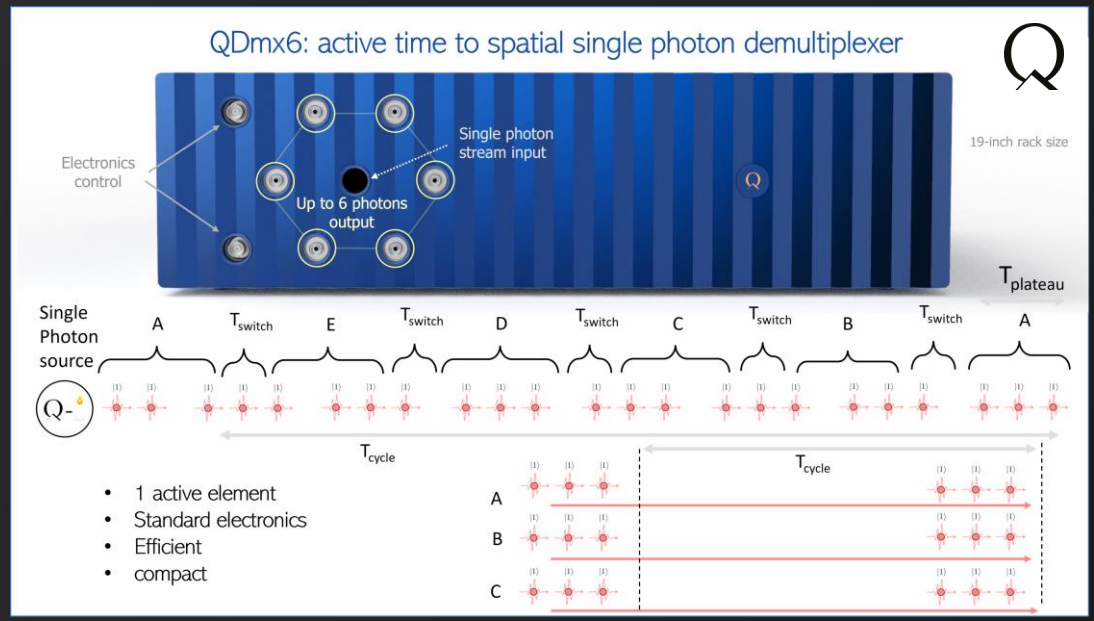

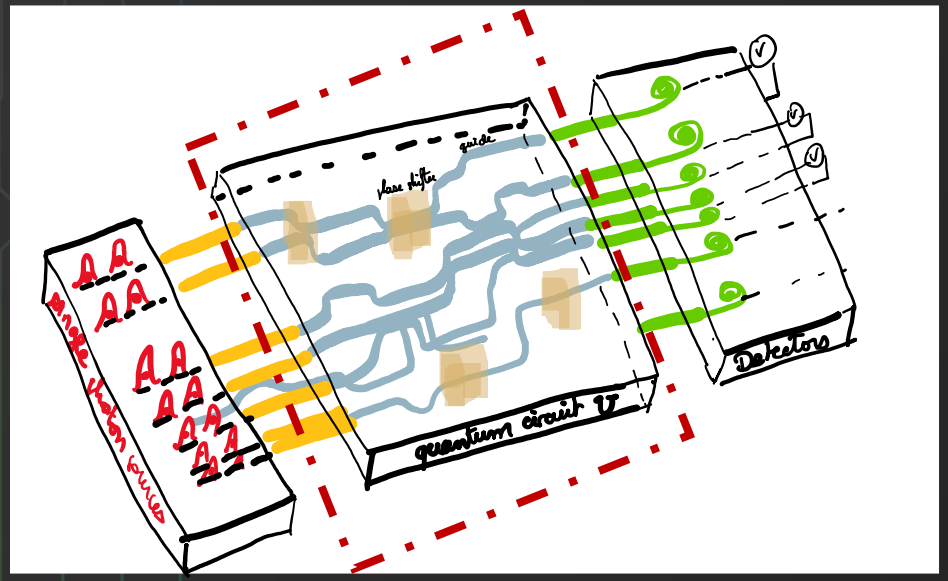

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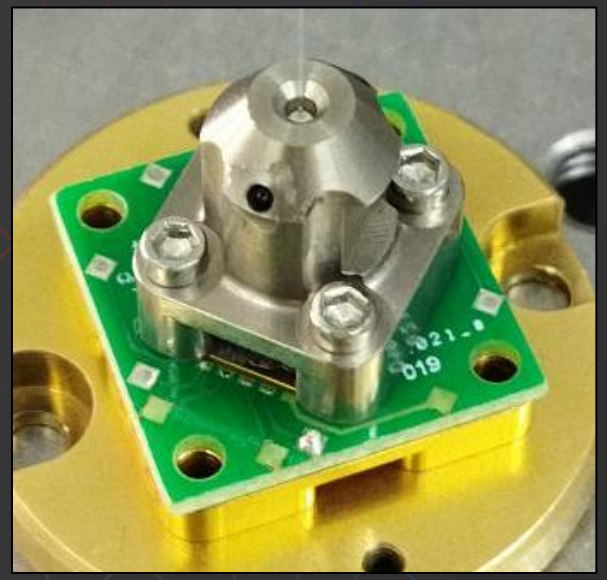
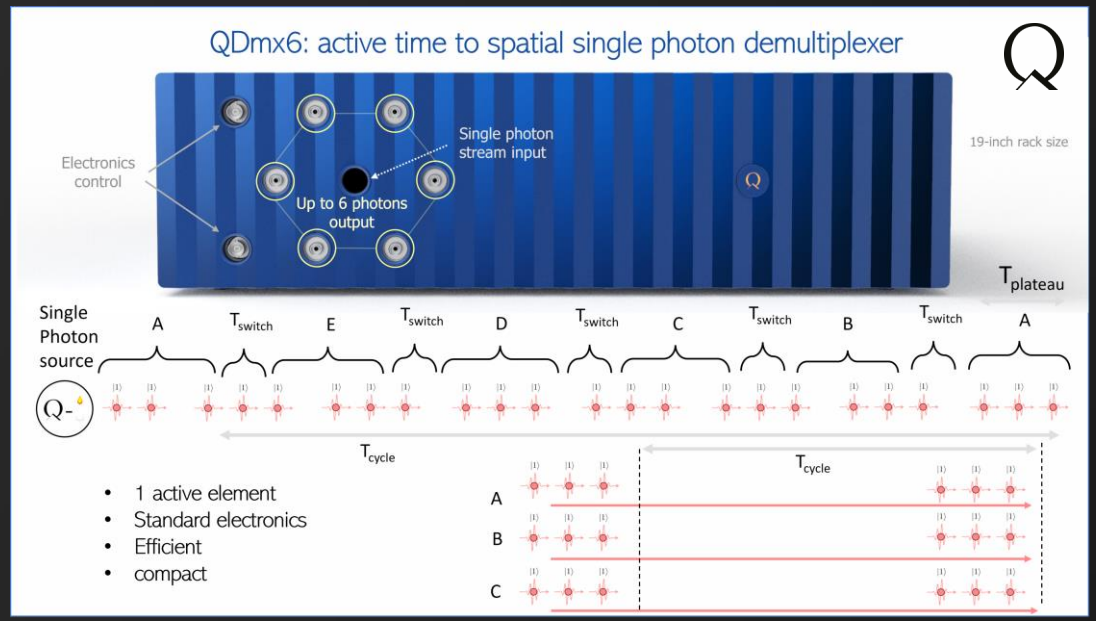
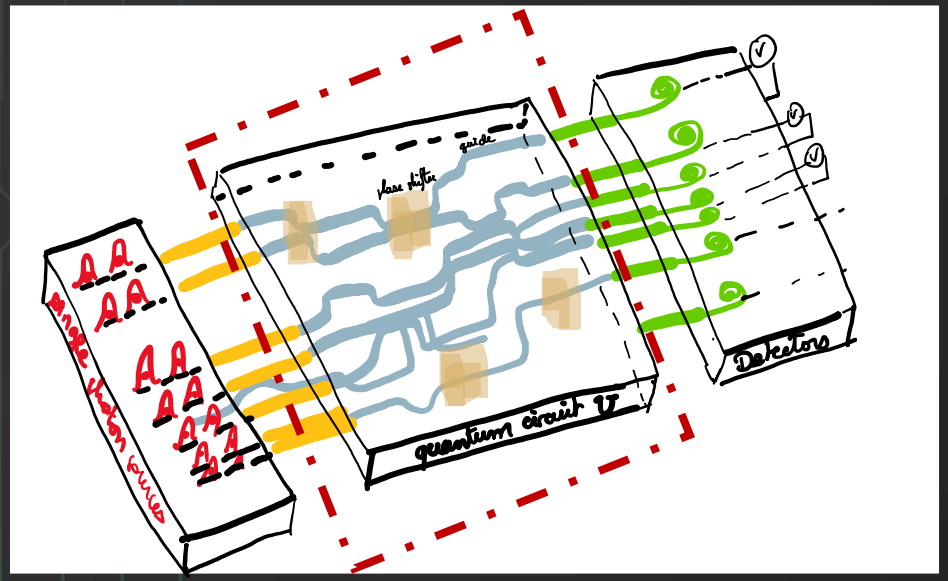


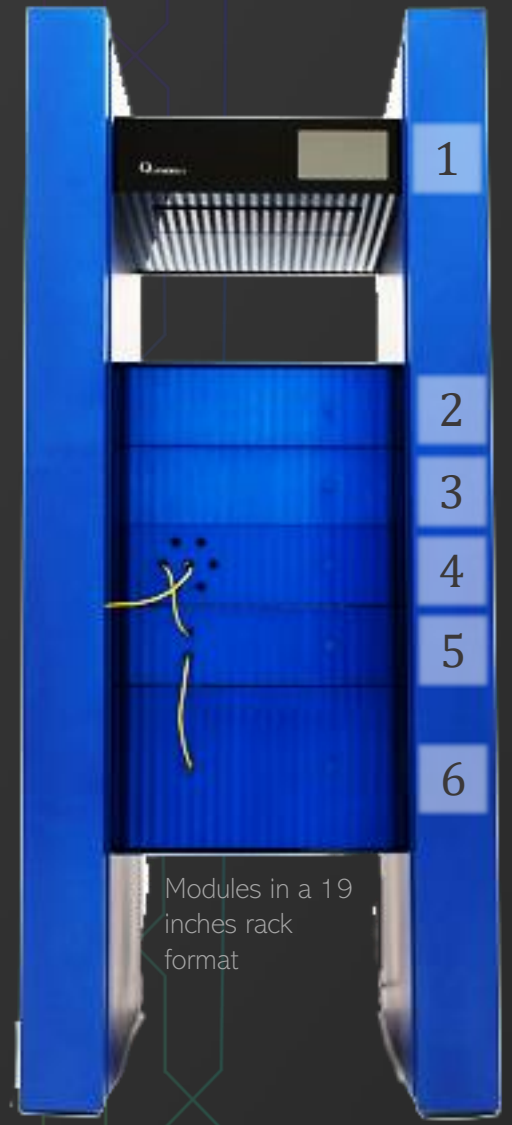




. . . and an **optical devices simulator for quantum computing** . . .

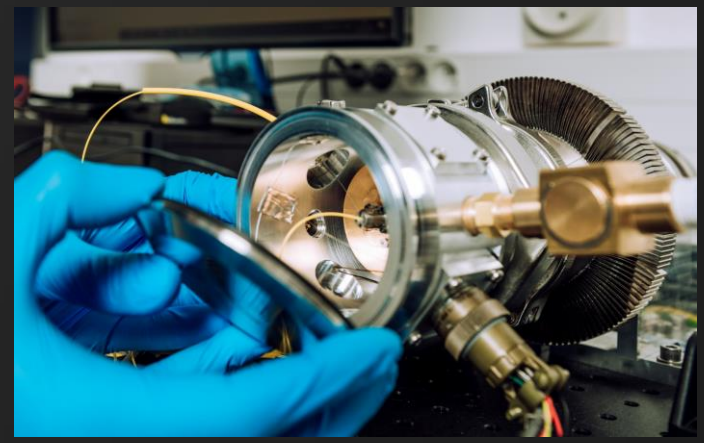
Perceval Q

Prometheus – the first standalone optical qubit emitter



An all-in-one product

1. User interface - control
2. Lasers & Electronics
3. QShaper – laser shaping module
4. QDMX-6 Photonic Qubit Router
5. QFiber – qubit control unit
6. Cryogenically cooled single-photon source eDelight (40 K or 4 K version)



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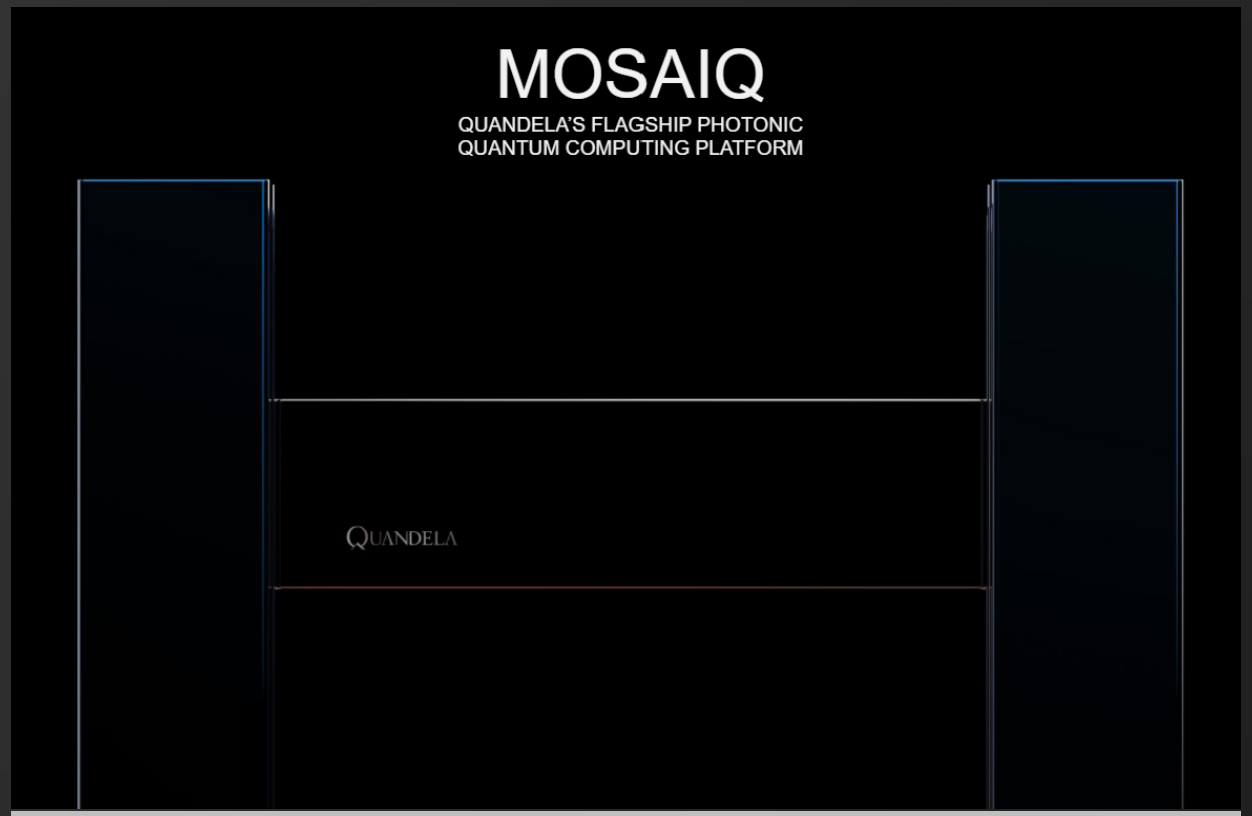


We build the
European Photonic Quantum Computer

QUANDELA

Thank you for your attention

Do you have questions?

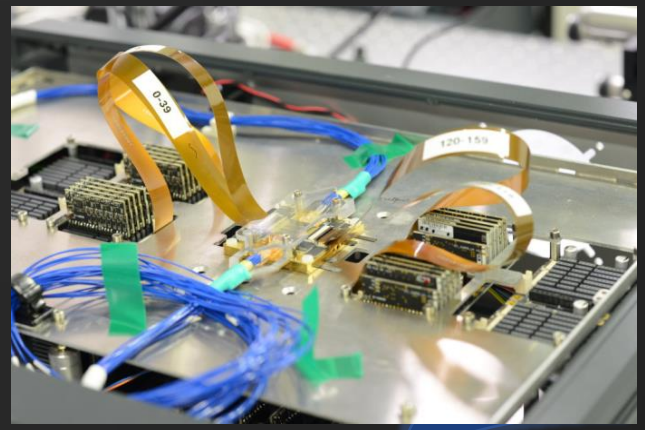
EPIC

21st April 2022

Credits slides: Niccolo Somaschi – Marie BILLARD

MosaiQ: optical quantum platform

6-qubits – Fully reconfigurable platform from summer 2022



- Double the number of qubits
- Solve VQ algorithms with "concrete" impact
  Network optimization - material design
- Add error mitigation and error correction protocols

Assessing the quality of near-term photonic quantum device, Mezher, Mansfield, arXiv:2202.04735 (2022)

MosaiQ: optical quantum platform

Front end
Python Libs, REST API, Visual/Graphical interface, Integration with existing platforms

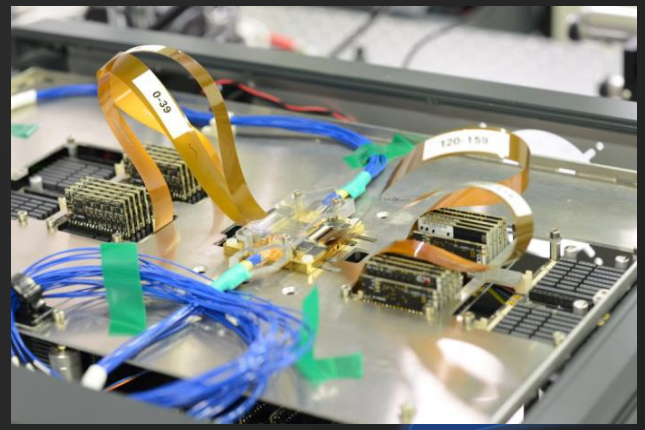
Compiler
Logical Qubits <> Photon encoding
** paper in preparation*

Assembler
Calibration, Machine Language

Hardware Modules
Electronics, FPGA, Voltage Sequence

Semiconductor Fabrication

6-qubits – Fully reconfigurable platform from summer 2022



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Semiconductor Fabrication

PERCEVAL Optical QC Simulator
(March 31st 2022)

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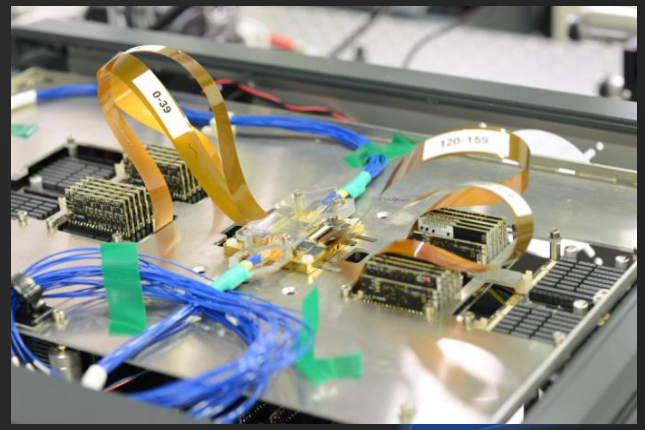

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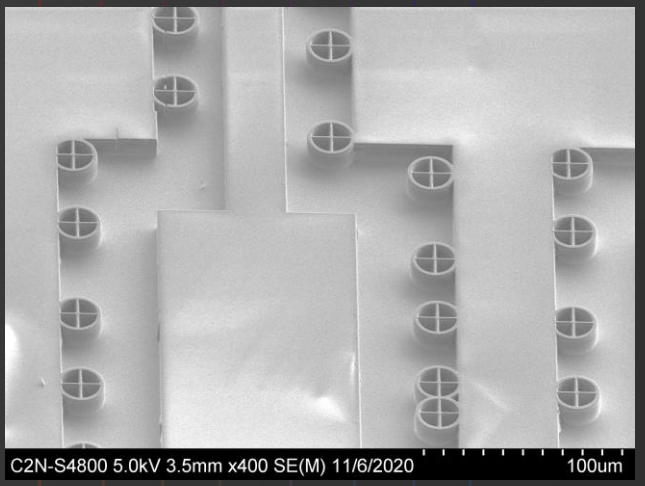
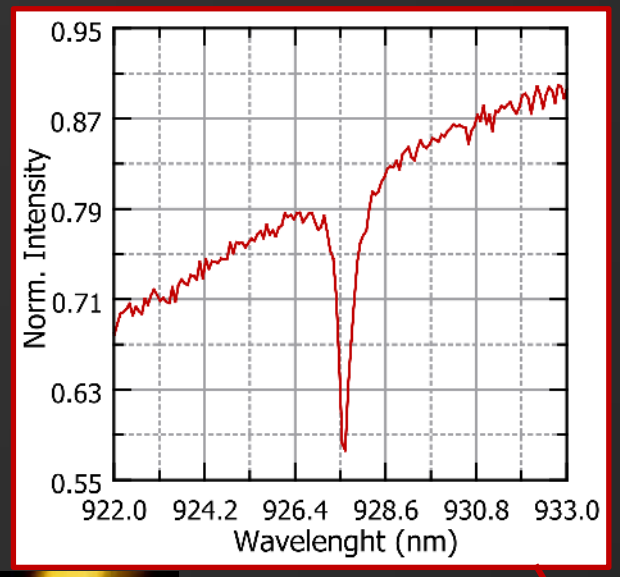
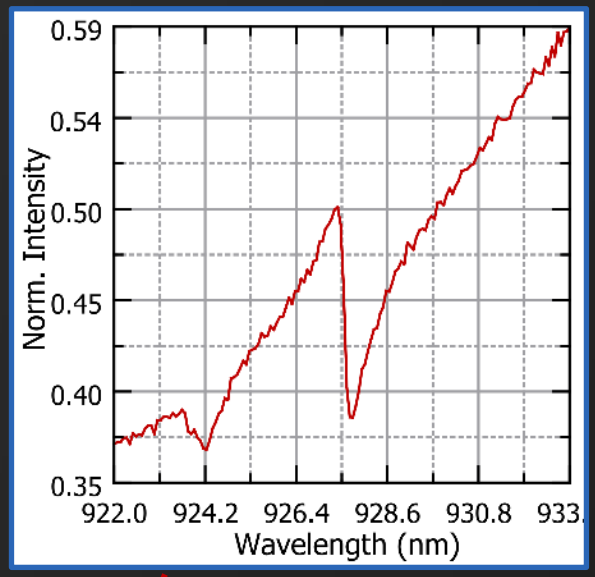
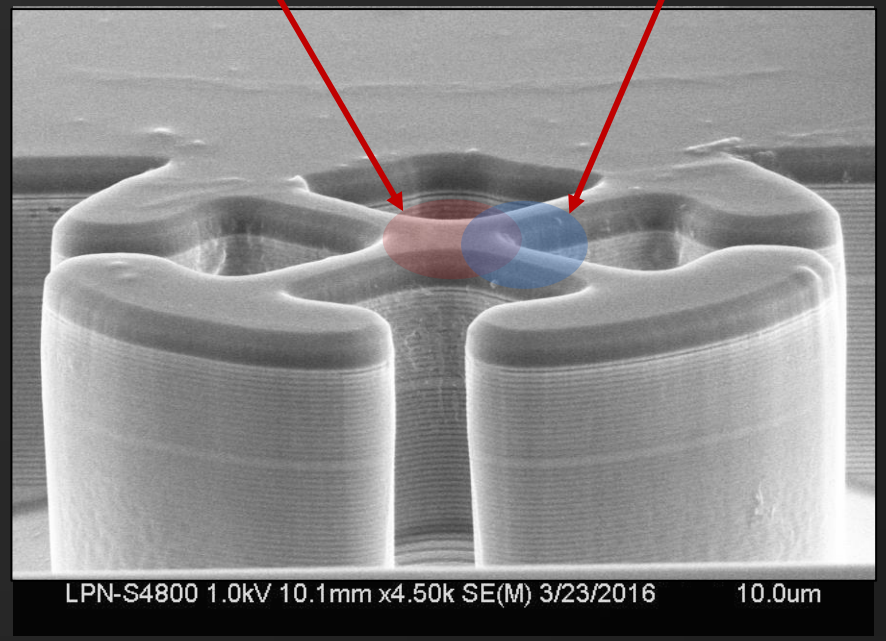




OR



X & Y alignment



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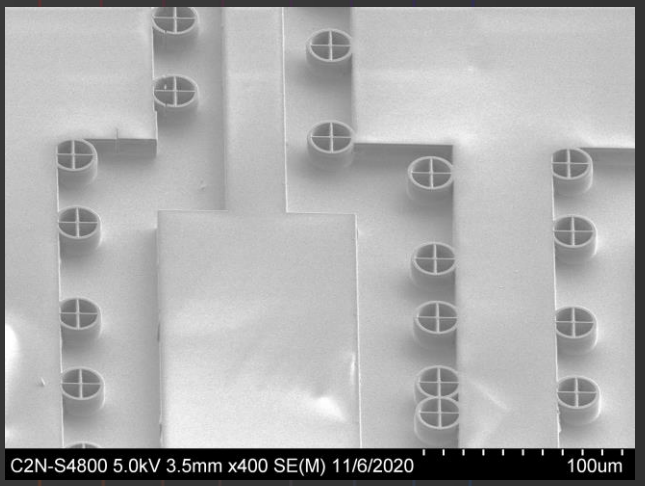

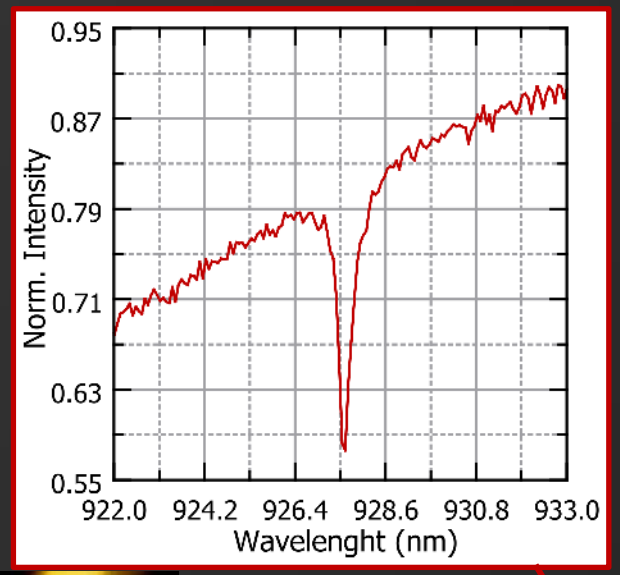

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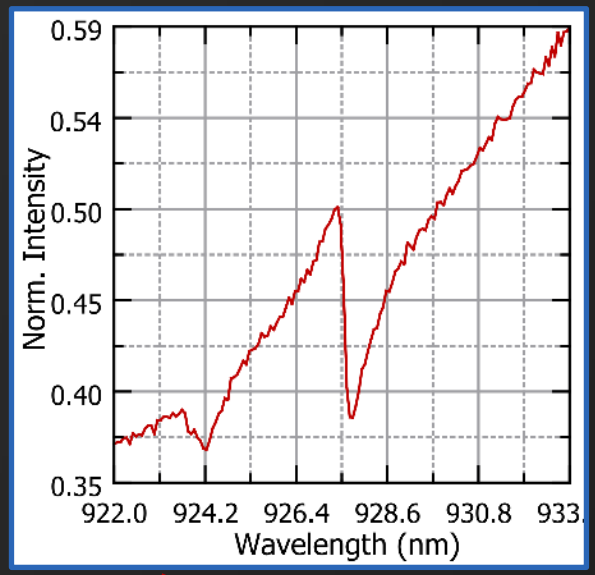

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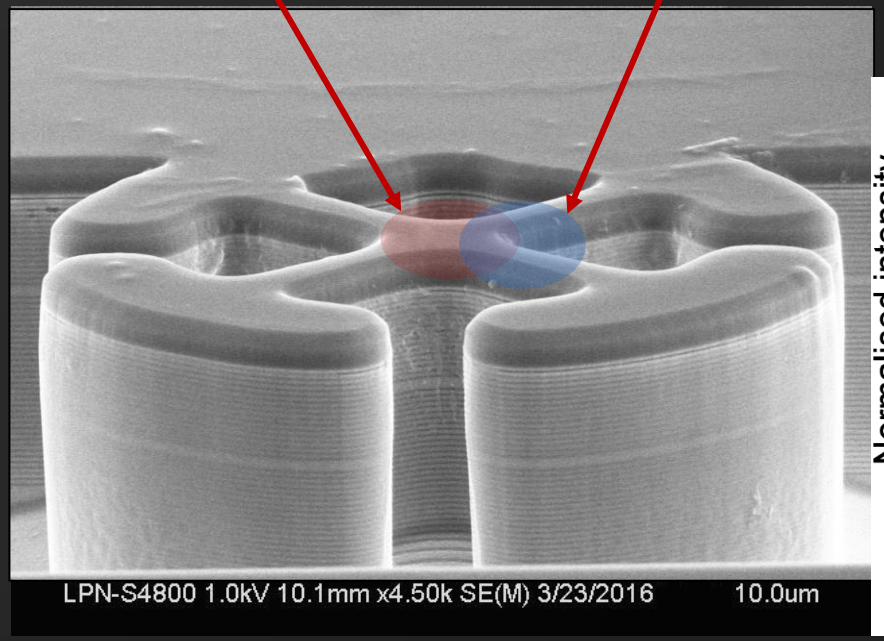

Z alignment