Solid-state Quantum Light Sources: booster of quantum photonics technologies

Valérian Giesz
Cofounder
The future is Quantum.

The Second Quantum Revolution is unfolding now, exploiting the enormous advancements in our ability to detect and manipulate single quantum objects.
Photonics is at the core of the Quantum Revolution
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- Quantum Communications
- Entanglement Distribution
- Quantum Key Distribution
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Quantum Communications

Entanglement Distribution

Quantum Key Distribution
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Optical Quantum Computers

Start-ups + Academics
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Optical Quantum Computers

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Key challenges will be the realization of high-efficiency sources of indistinguishable single photons, low-loss, scalable optical circuits, high-efficiency single-photon detectors, and low-loss interfacing of these components.

Prof. Jeremy O’Brien, cofounder of PsiQ
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Prof. Jeremy O’Brien, cofounder of PsiQ
Since 2017

We are experts in semiconductor nanostructures and quantum photonics

Cofounded by

Prof. Pascale Senellart (CSO)

Dr. Niccolo Somaschi (CTO)

Dr. Valérian Giesz (CEO)

Spin-off from the Centre for Nanoscience and Nanotechnology in Paris-Saclay

a laboratory of and of

3000 m² clean room
Disruptive architecture to extract the light from a Quantum Dot

![Quantum photonic chip](image)
Disruptive architecture to extract the light from a Quantum Dot

Near-optimal single-photon sources in the solid state

N. Somaschi¹, V. Giesz², L. De Santis², J. C. Lorodo¹, M. P. Almeida¹, G. Hornecker⁴, S. L. Portalupi¹, T. Grange⁵, C. Antón¹, J. Demory¹, C. Gómez¹, I. Sagnes⁶, N. D. Lanzillotti-Kimura¹, A. Lemaitre¹, A. Auffeves⁵, A. G. White⁶, L. Lanco⁶ and P. Senellart⁷,⁸
Disruptive architecture to extract the light from a Quantum Dot

First solid-state emitter of single and indistinguishable photons

Compatible with III-V semiconductor industry
The ideal single photon source

Pulsed regime

Required features for Q tech:

- High brightness (high probability that a pulse contains one photon)
The ideal single photon source

Required features for Q tech:

- High brightness (high probability that a pulse contains one photon)
- High single photon purity
The ideal single photon source

Required features for Q tech:

- High brightness (high probability that a pulse contains one photon)
- High single photon purity
- High photon indistinguishability and entanglement fidelity

For High Fidelity Gates
Performance for our customers

Multi-photon manipulation on-chip

3-photon source in a tuneable tritter:
laser - 43 Hz // eDelight - 3.8 kHz (speed $\times 88$)

Exponential Speed-up for Quantum Computing

Enlarge the number of entangled photons

<table>
<thead>
<tr>
<th>Source Laser</th>
<th>Source Quandela</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 photons</td>
<td>2 weeks</td>
</tr>
<tr>
<td>4 photons</td>
<td>1 year (estim.)</td>
</tr>
</tbody>
</table>
A lot of bright single photon sources on one cm$^2$ chip

Robust and reproducible performance (during years)

High fabrication yield
You are welcome to use it

contact@quandela.com

That's all fibered and fully assisted
Don’t care about the source, focus only on your setup.

Enter in a new and unexplored regime
With millions of photons per second during days, go beyond the limits and demonstrate experiments that were impossible before.

Possible remote experiment
It is possible to leave your setup in the QuandeLAB and control it from your lab.
Quantum dots based sources are the most efficient single photon sources. 

... To do more than single photons.

Its production is fully compatible with existing semiconductor industry.

Low heating power at 10K, Toward the integration of fibered sources in a compact cryostat.

Quandelab’, a service dedicated to support the R&D in Quantum Photonics.
Performance of a typical source in the Quandelab

**Very efficient:**
More than 65% of emitted polarized photons are coupled in a single-mode fiber.

More than 32M of indistinguishable photons per second (pulsed excitation rate: 500MHz)

More than 5M indistinguishable photons per second (pulsed excitation rate: 80MHz)

**Ultra stable:**
The count rate is stable (+90%) during more than 3days.