Press release **14/11/2024**

Quandela, the CNRS, Université Paris-Saclay and Université Paris Cité join forces to accelerate research and innovation in quantum photonics

- Quantum photonics, or the art of controlling light in the quantum regime, should revolutionise data processing and security, with an impact across a range of industries.
- Quandela, a European leader company for photonic quantum computing, is combining its know-how with that of the CNRS, Université Paris-Saclay, and Université Paris Cité in order to intensify scientific research and innovation in this field.
- The objective is to preserve French sovereignty in the design of photonic quantum computers, namely by increasing their computing power.

On 13th of November 2024, Quandela, the CNRS, Université Paris-Saclay, and Université Paris Cité inaugurated at the Centre for Nanoscience and Nanotechnology (CNRS/Université Paris-Saclay/Université Paris Cité) the QDlight associated research laboratory focusing on research in quantum photonics, which is to say the art of controlling light in the quantum regime inside nanoscale devices. Over the course of six years, the teams will expand scientific cooperation with a view to developing next generation quantum light emitters, as well as their applications in quantum information technology to secure unprecedented computing power.

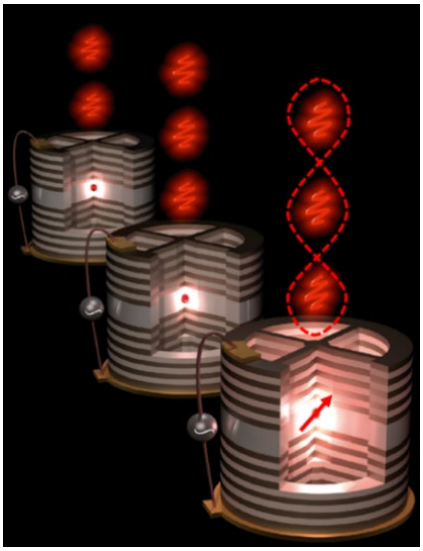
Quantum photonics, or the art of controlling light in the quantum regime

Quantum photonics, which has been developed since the late twentieth century, seeks to take advantage of the specifically quantum properties of light—especially single photons (emitted one by one)—for quantum computing and communications security. This discipline offers one of the most promising avenues for quantum computing (quantum computers and networks), as well as for inviolable key distribution protocols in encryption (quantum cryptography).

Quandela, a leading European company for photonic quantum computing that emerged from the Centre for Nanoscience and Nanotechnology (CNRS/Université Paris-Saclay/Université Paris Cité), has produced and marketed quantum light emitters in Europe since 2017–components that are indispensable to photonic quantum

computing technology–and also delivered its first photonic quantum computers in 2023. These emitters, which consist of a quantum dot that behaves like an artificial atom in a semiconductor matrix, can generate a series of on-demand and indistinguishable single photons through a succession of laser pulses concentrating on this artificial atom.

In the optimal resonance and photon extraction conditions provided by the optical cavity in which it is positioned, these quantum dots can generate a photon flux with a rate of a few dozen megahertz, which efficiently implement quantum computing protocols on a photonic chip.



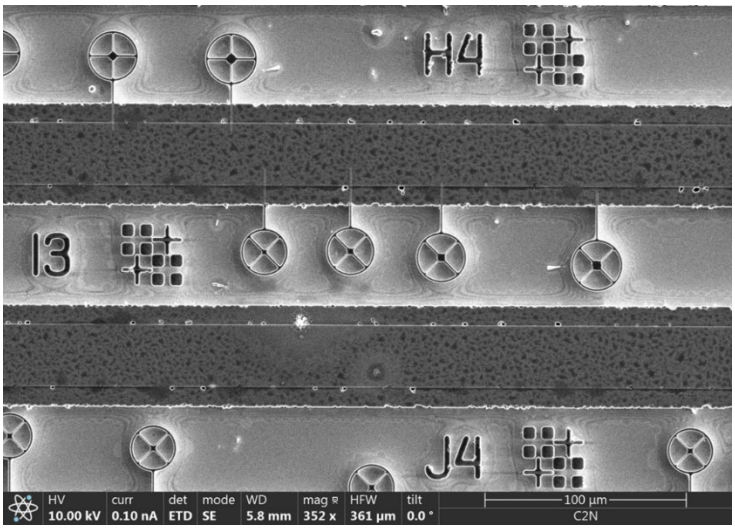
Artist's view of three single-photon sources showing the presence of a semiconductor quantum dot inside an optical microcavity, and emitting a series of single photons. When the quantum dot contains a single spin (in the foreground), entangled photons can be emitted. © *Niccolo Somaschi, 2016.*

Toward unprecedented computing power and efficiency

This new associated research laboratory aims to develop emitters and protocols to generate new quantum states of light, with a view to creating a fault-tolerant photonic quantum computer[1], and to demonstrating quantum communication protocols.

To this end, the research will pursue two research focuses:

- The project's "optical" focus will first develop quantum photonic entanglement protocols[2] in order to create multi-partite entangled photon chains and graphs. These non-classical states of light are central to the "made-to-measure" quantum computing paradigm, which is the most promising framework for creating a universal quantum machine.
- The "growth" research focus will concentrate on the quality of the quantum-dot-based photonic devices that will be produced within the Labcom. This will notably involve growing materials of very high purity–on which the "quantum purity" of photons depends–as well as increasing the reproducibility of photonic device production.



Scanning electron microscopy photograph showing the photonic devices produced by the Labcom by engraving a precisely-centred cross pattern on each pre-selected quantum dot. Each of these patterns is connected to a metal line in order to apply grid voltage. © *Huong Au (Semiconductor Source Production Director, Quandela)*

QDlight, pursuing close public-private research collaboration

This associated research laboratory (Labcom) is in line with the collaboration, since 2017, between Quandela and the research laboratory from which it emerged, the Centre for Nanoscience and Nanotechnology. This collaboration led to numerous interactions between researchers and engineers for basic research on the physics of semiconductor quantum dots, light-matter interaction in solid microcavities, protocols for the generation and measurement of quantum light, and for the first implementation of quantum protocols and computing.

The QDlight Labcom represents the next phase in conserving a global competitive head-start in semiconductor single-photon source technology, in addition to ensuring their constant improvement and using their exceptional properties in research and development activities.

"*The CNRS is thrilled by the creation of QDlight, which combines the excellence of teams from the C2N laboratory with the Quandela company, a European leader in photonic quantum computing that emerged from the academic world, and doubly contributes to positioning French public research in quantum technology at the highest global level",* explains Antoine Petit, the CNRS Chairman and CEO.

"*This research aims to preserve our global technological leadership in quantum photonics",* indicates Quandela co-founder and CEO Niccolo Somaschi.

"*It is a great pleasure to be here at C2N, a leading site for French research in nanoscience and nanotechnology, in order to inaugurate this new Labcom, a symbol of successful synergy between national research organisations, universities, and deep tech enterprises. It will combine high-level academic and technological expertise in order to overcome scientific and technological obstacles in this crucial field of quantum photonics, whilst contributing to the education of students and young researchers",* says Camille Galap, the President of Université Paris-Saclay.

"*Université Paris Cité is proud to have contributed to the creation of this joint laboratory, which illustrates the capacity for collaboration between universities, NROs and the private sector. It is essential to combine our strengths and expertise for the benefit of research and innovation, particularly in a field as strategic as quantum technology",* explains Édouard Kaminski, President of Université Paris Cité.

" We are proud of the creation of this associated research laboratory, which gives concrete form to years of a trusting relationship, and will help us support efforts to strengthen Quandela's knowledge and expertise in quantum photonics alongside our partners", emphasises Thierry Dauxois, Director of CNRS Physique.

From left to right: Niccolo Somaschi (Quandela co-founder and CEO), Giancarlo Faini (Director of Centre for Nanoscience et Nanotechnology), Valérian Giesz (Quandela co-founder and COO), Thierry Dauxois (Director of CNRS Physique and CNRS Specialist Scientific Director at Paris-Saclay), Pascale Senellart-Mardon (CNRS Research Director and Quandela co-founder), Camille Galap (President of Université Paris-Saclay), Antoine Kouchner (Vice-President Strategy International Relations of Université Paris Cité) © *Xavier Pierre*

Notes:

1- A quantum computer is a machine that uses quantum bits or "qubits" (in this case, single photons) that present the two states of 0 or 1, which can exist simultaneously by forming coherent superpositions of 0 and 1 (in the quantum mechanics sense), whereas its classical counterpart presents information in binary form (either 0 or 1). For a quantum machine, computing power increases exponentially with the number of qubits and with just fifty qubits can surpass that of the best classical supercomputers for certain tasks.
2- Called "spooky action at a distance" by Einstein, quantum entanglement is a phenomenon in which two particles, in this specific case two photons, form a system of interdependence and correlation for their observed physical properties, regardless of the distance separating them.

ABOUT QUANDELA
Quandela is a leader in quantum technologies. The company provides photonic quantum computers that are modular, scalable, energy-efficient and accessible both on the cloud and on premise. The team is specialised in the development of both software and hardware solutions for a variety of quantum applications, offering a wide range of services, from developing the most efficient and brightest single photons sources, to creating algorithms for quantum computers and providing cloud quantum computing solutions. Founded in 2017 by Pascale Senellart, research director at the CNRS Centre for Nanosciences and Nanotechnologies (C2N), Niccolo Somaschi and Valérian Giesz, internationally renowned experts in quantum physics, Quandela employs more than 100 people of 15 different nationalities, mostly researchers and engineers in optics, algorithms and information sciences. Quandela's mission is to make quantum computing accessible to everyone in order to address the most complex industrial and societal challenges. (www.quandela.com)

ABOUT THE CNRS
A major player in basic research worldwide, the National Centre for Scientific Research (CNRS) is the only French organisation active in all scientific fields. Its unique position as a multi-specialist enables it to bring together all of the scientific disciplines in order to shed light on and understand the challenges of today's world, in connection with public and socio-economic stakeholders. Together, the different sciences contribute to sustainable progress that benefits society as a whole. (www.cnrs.fr/en)

ABOUT UNIVERSITÉ PARIS-SACLAY
Université Paris-Saclay was born from the shared ambition of French universities, *grandes écoles* and national research organisations. As a leading university in Europe and the world, it covers the fields of science and engineering, life sciences and health, and humanities and social sciences. The university's science policy closely intertwines research and innovation, incorporating both basic and applied science to tackle major societal challenges. Université Paris-Saclay offers a varied range of undergraduate to doctorate level degrees, including programmes with its *grandes écoles*, all of which are focused on achieving student success and employability. The university prepares students for an ever-changing world where the ability to think critically, remain agile and renew one's skills are crucial. Université Paris-Saclay also offers a comprehensive range of lifelong learning courses. Located to the south of Paris, the university extends across a vast and rich local area. Its location strengthens both its international visibility and its close ties with its socio-economic partners (major companies, SMEs, start-ups, local authorities, charities). (www.universite-paris-saclay.fr/en/)

ABOUT UNIVERSITE PARIS CITÉ
At the heart of a global network of knowledge and innovation, Université Paris Cité is one of France's leading multidisciplinary universities. Born in 2019 from the merger of the universities of Paris Diderot, Paris Descartes and Institut de physique du globe de Paris, the ambition of Université Paris Cité is to lead and develop an exceptional potential to meet the challenges of tomorrow's society. It covers a wide range of disciplines, with one of the most comprehensive and ambitious educational offerings available in the world. Université Paris Cité is part of the incarnation of a world city, aware of its place and missions open to youth and knowledge. It has 63,000 students, 7,500 teaching and research staff, 21 doctoral schools and 117 research units. (u-paris.fr/en)

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