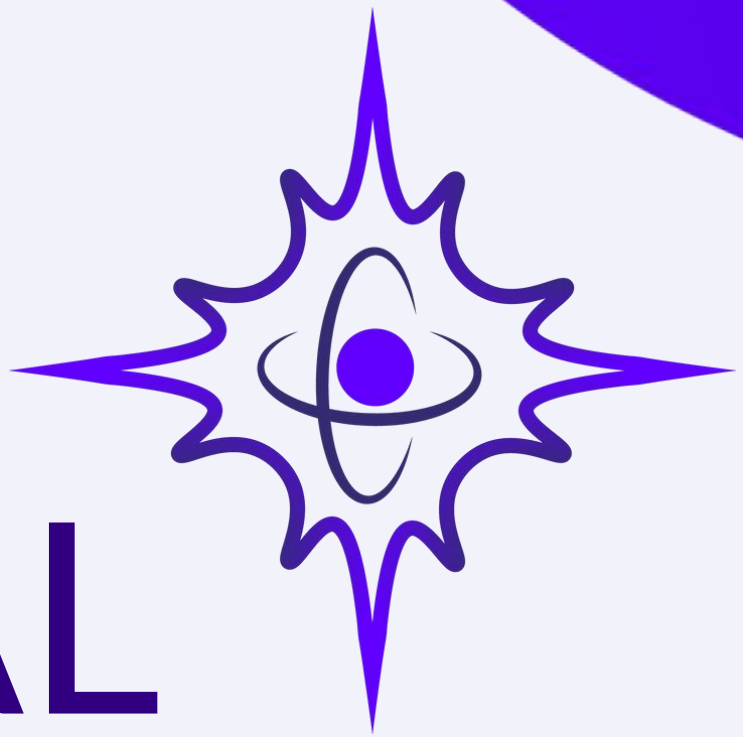


CRYSTAL

QUANTUM COMPUTING

Notre mission

Crystal Quantum Computing is designing and building a new-generation quantum computer.

A wide range of applications are involved, leading to more competitive and environmentally-friendly solutions.

The team

Quentin Bodart
Président et CEO (90%)

- Development of two **laboratory quantum computers:** [1] Stockholm University, [2] University of Sussex.
- **Head of experimental development** for the "Space Atom Interferometer" mission at the European Space Agency.
- **PhD : quantum gravimetry** at Paris Observatory.

Luca Guidoni
Chercheur CNRS (10%)

- **Researcher at CNRS – MPQ** (Materials and Quantum Phenomena)

Research topics :

- Quantum Information
- Trapping and laser cooling of ions

- **PhD : trapping in optical lattices** at the Université Pierre et Marie Curie

Economic model and outlook

2B€ in 2028

Total Market Pharmacology

150 M€

Obtainable market

35 %

Annual growth

Our value proposition : Putting unrivaled quantum computing power in the hands of customers.

- In the first years of commercialization, customers will have access to quantum computing power by buying usage time in the cloud via a Quantum As A Service (QAAS) platform.
- In the longer term, we will offer customers integrated quantum computers that can be transported as close as possible to their data centers or R&D departments.

We are focusing on hardware :

- Rydberg's trapped ion technology, designed from the outset to overcome the bottlenecks faced by our competitors.
- No in-house development of client interfaces or quantum algorithms. We will use digital subcontractors and share the added value.

Upstream of marketing:

- Diversification of Quantum Packs (demonstrations of concepts supported by the Île-de-France region)
- Provision of a quantum emulator via a digital subcontractor

Applications with quantum advantage after 2034

In the future, quantum computers will be able to solve calculations involving very large volumes of information. At the moment, quantum computers do not have the necessary power, and no standard technology has emerged from the competition. Thanks to our Rydberg trapped ion technology, our quantum computer will meet the need for quantum computing power while guaranteeing low power consumption.

Medical imaging, meteorological simulations and drug simulations are three examples of applications with a positive impact.

Early diagnosis of cancer

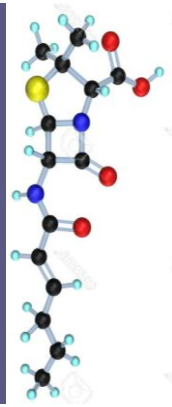
Example: detection of asymmetric patterns in medical images (Quantum Machine Learning).

Improved forecasts

Examples: sea level fluctuations, wind patterns, storms and hurricanes.

Complete simulation of the interactions between the human body and the drug

For example, penicillin can be simulated with just 286 quantum bits, whereas 10^{86} conventional bits would be needed.



Applications with quantum advantage after 2034

Quantum computers make it possible to explore problems of exponential complexity, from discrete logarithms to highly detailed fluid mechanics models, as well as very concrete problems of transport optimization and machine learning on complex or incomplete data.

For a variety of industries involving transport, cryptography, fluid dynamics or artificial intelligence, the use of quantum computing will become absolutely essential to guarantee the competitiveness of their business.

Optimising industrial production resources

by combining quantum and classical computers.

Cybersecurity

Quantum computers will be able to rapidly decode encryption based on the manipulation of large prime numbers.

Improving the efficiency of industrial processes

Example: reducing CO_2 emissions in transport

The value chain

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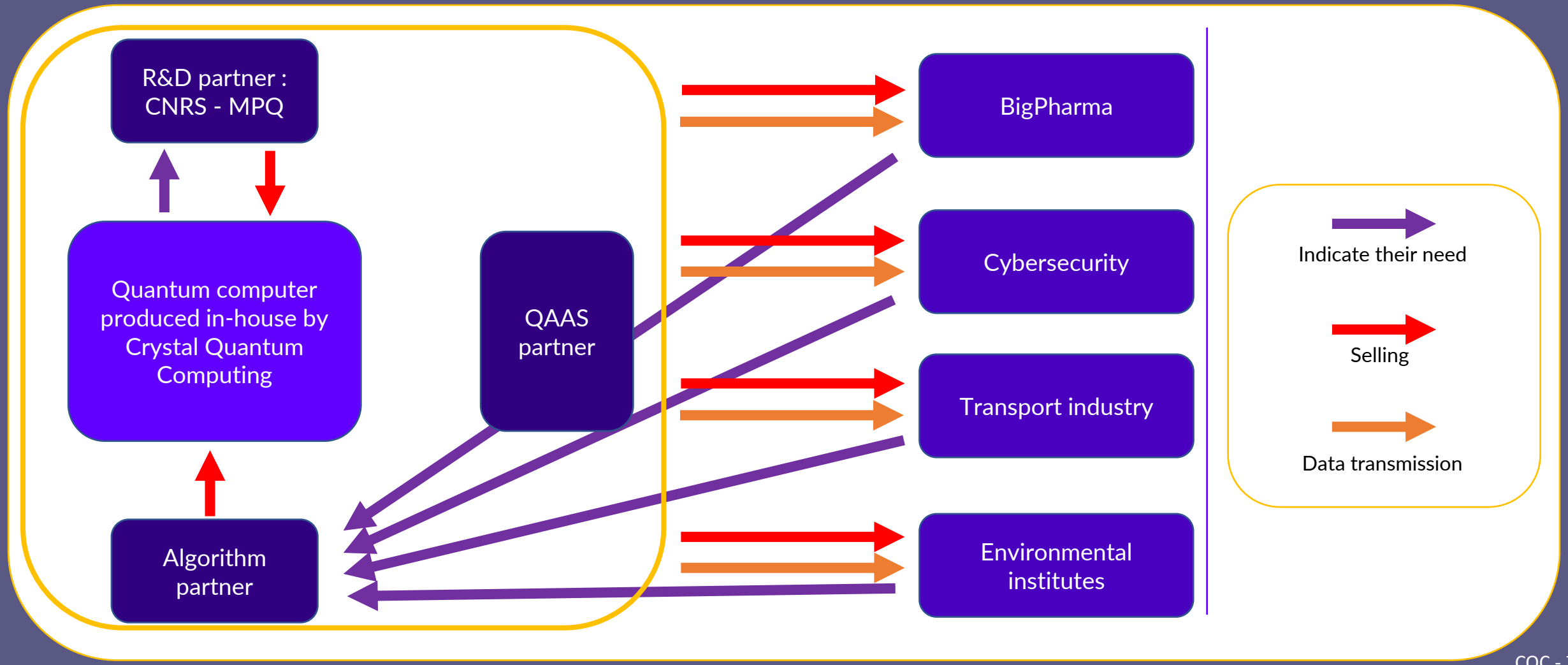

A quantum computer with Rydberg trapped-ions

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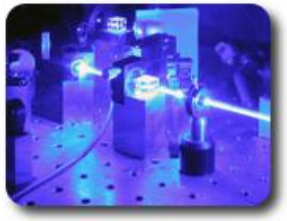
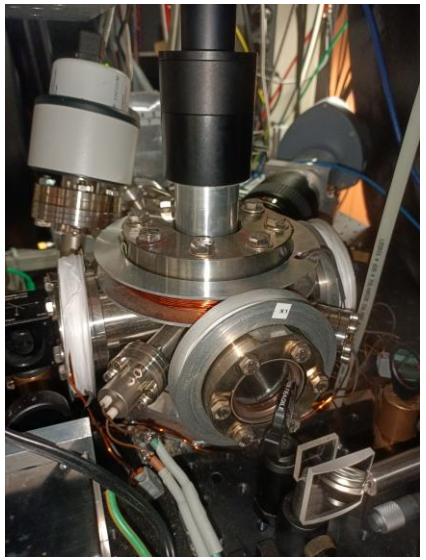
Laser system



1

Isolation system



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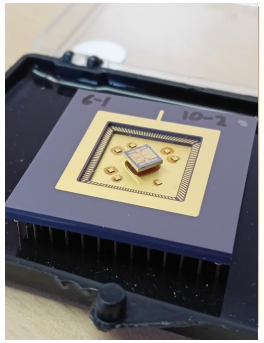
Ion trap



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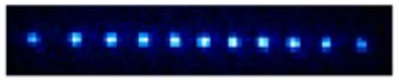

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Rydberg dipolar Interaction

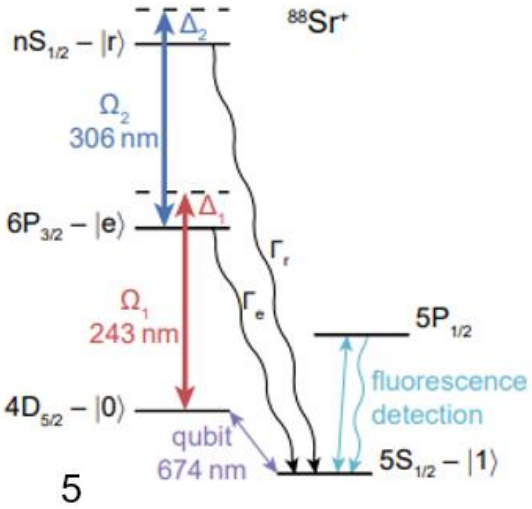

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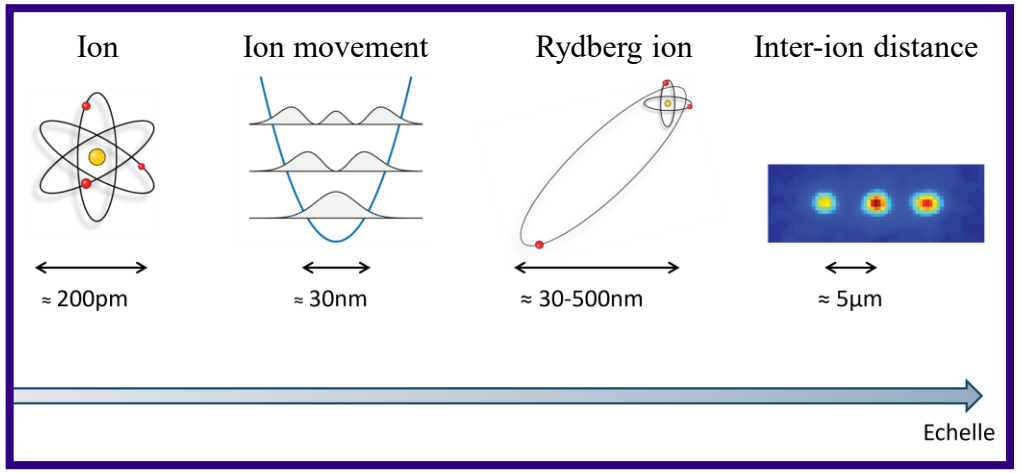
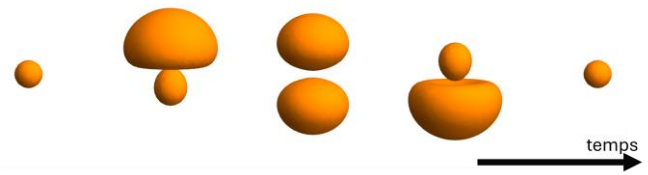
Image credit : 1, Observatoire de Paris - SYRTE, 2, 3 Laboratoire Matériaux et Phénomènes Quantiques, 4, 5, Stockholm University

State of the art: the vector of entanglement - the Rydberg quantum gate



The Rydberg electron subjected to THz radiation oscillates around the atomic core: oscillating dipole



Intrinsic advantages of quantum gates between trapped-ions through the Rydberg interaction :

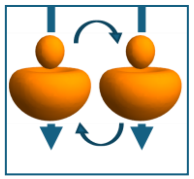
[1] Duration of the Rydberg quantum gate 700ns, 10× faster than competitors with trapped-ions.

[2] 674nm qubit transition coherence time ~1s

[3] Low sensitivity to ion trap temperature

[4] Continuous RF trapping, no optical trapping

[5] strong interaction for the successive entanglement of trapped ions ~10,000 Debye



Our goal: to obtain Rydberg ions above the atom chip

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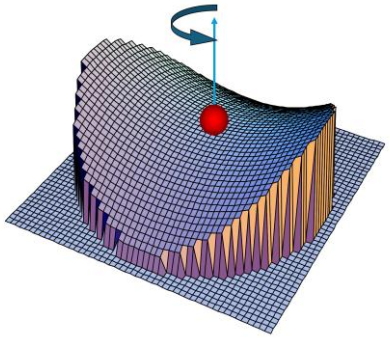
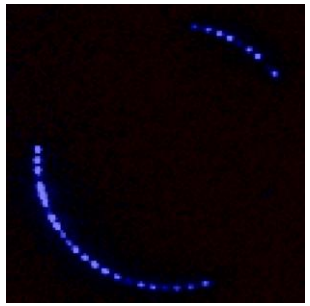
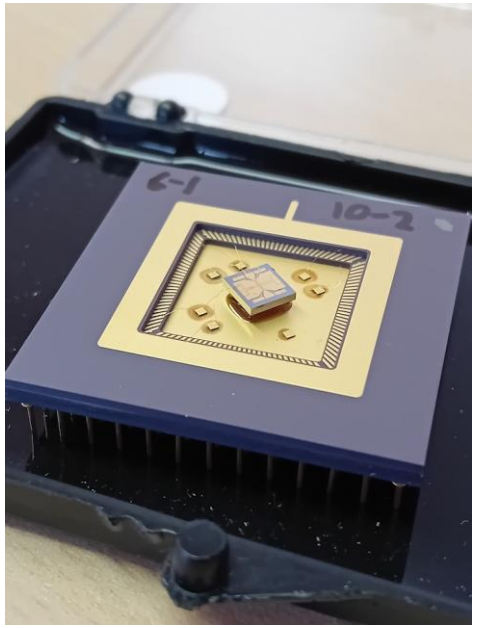
Radio-frequency electric fields



Ions trapped in a ring trap



Atom chip (MPQ)



Objectives of Crystal Quantum Computing with our future next-generation atom chip:

[1] 3-year fidelity target for Rydberg quantum gates : 99.8%

[2] 4-year target of 100 qubits on one chip

[3] Independent operations between qubits

[4] Modification of qubits arrangement

[5] Error correction

[6] Study for an on-board quantum computer

Competitive advantages over other quantum computers

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Qubits type	Limitation	Solution & Advantages of the Crystal Quantum Computing solution
Trapped ion Qubits with the Mølmer-Sørensen quantum gate	MS quantum gate slower	Rydberg quantum gate 10× faster
Supraconducting Qubits	Limitations due to heat: Target T° < 20mK	Less dependence on trap temperature: Target T° = 10K
Neutral Atoms Qubits	Instabilities in the release and recapture of neutral atoms	Continuously operating electric ion trap

Past milestones

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- March 2021: Creation of the company
- November 2022: Integration into the Télécom Paris Incubator
- September 2023: 1st R&D recruitment
- 2021 - 2024: Successive Soleau envelope filings
- April 2024: AQADOC++ partnership with Welink and EDF
- 2023 - 2024: Subsidies - CIR 28 k€, BFTE 90k€, FPI 30 k€, CIFRE 14k€/year, Innov'up Leader PIA Laureate 450k€.
- August 2024: BSA Air investment from Advans Lab: 100k€
- December 2024: Conclusion of the BFTE innovation programme, lifting of the main technological barrier
- March 2025: CIFRE partnership signed with Université Paris-Cité, the 'Matériaux et Phénomènes Quantiques' laboratory and the CNRS.

RoadMap

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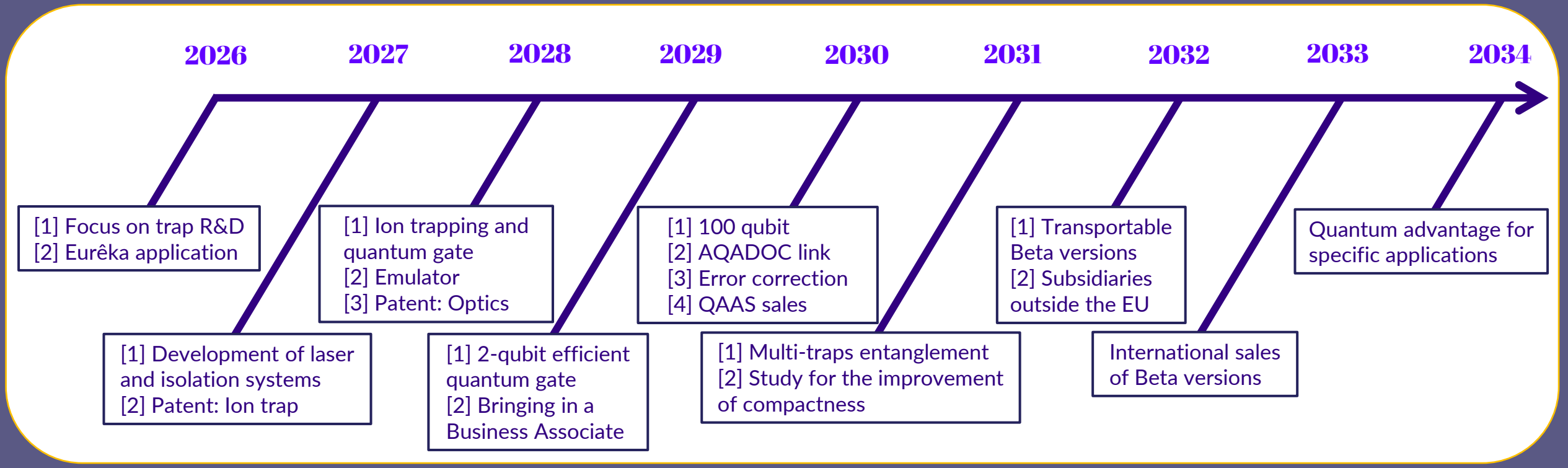

Our fundraising strategy

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Dilutive and Non-dilutive

Fundraising target: 2.000.000 €

Non-dilutive additional fundings triggered by a 350.000€ private investment:

- 450k.000€ (grant Innov'up Leader PIA - signed)
- 140.000€ (FEDER - to be confirmed)

Milestones to achieve with a 2.000.000€ fundraising

1rst year : Focus on the New-generation ion trap

- EM environment (under study)
- photonic development (FEDER)
- Realization of Ion trap V1

2nd year : Laser system, Isolation system

3rd year objective: fidelity on quantum gate 99,8%

Our annual financial need

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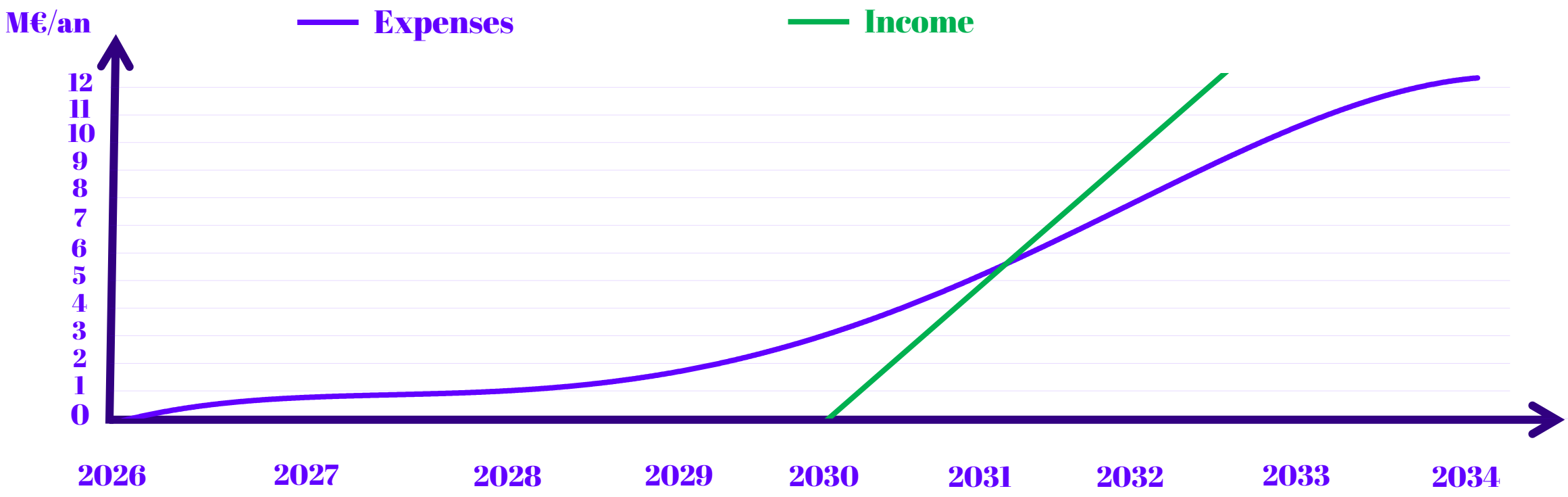


According to the precise costing for the first three years of the project, carried out for submission to the European Innovation Council.

Nos partenaires

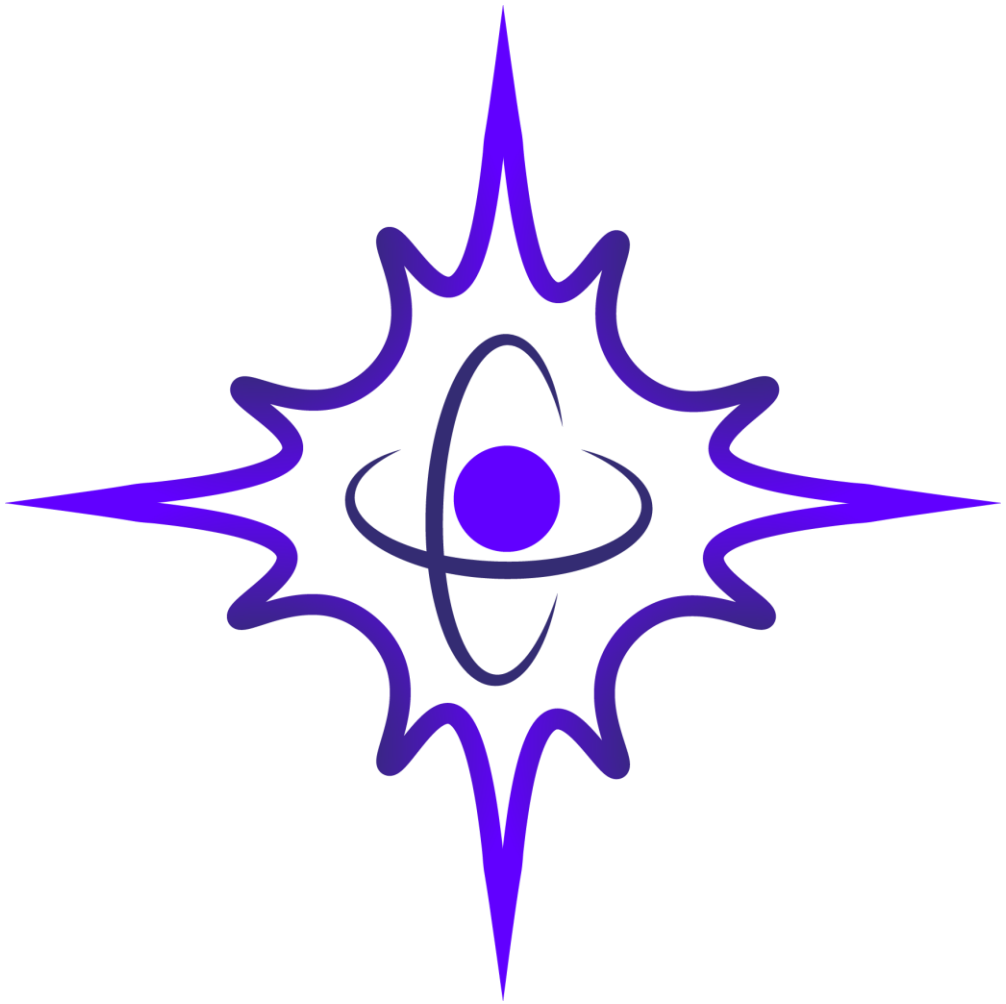
Crystal Quantum Computing is a start-up:

- Deeptech-certified by BPI France
- previously incubated at the Télécom Paris incubator, a member of the Institut Mines Télécom and the Institut Polytechnique de Paris.
- **laureate of the Innov'up Leader PIA award**

Disclaimer

The economic and technological objectives presented in this document are based on projections.

The developments required to reach the objectives involve inherent uncertainty and should not considered binding to Crystal Quantum Computing SAS.



Thank you

Crystal Quantum Computing

contact@crystalqc.io