



## FRANCE: A MAJOR PLAYER IN QUANTUM TECHNOLOGIES



# QUANTUM STRATEGY: ORGANIZING THE COUNTRY'S INDUSTRIAL AND RESEARCH FORCES OVER TIME TO MAKE FRANCE A MAJOR GLOBAL PLAYER IN QUANTUM TECHNOLOGIES

## IN THE FIELD OF COMPUTING

- Becoming the leading country to have a complete prototype of a first-generation general quantum computer from 2023.
- Being a global leader in the race for a universal quantum computer.

## ORGANIZING INDUSTRIAL FORCES

- Harnessing critical industrial sectors in the area of quantum technologies.
- The leading nation to have a complete production sector of industrial  $^{28}\text{Si}$ , needed to produce qubits.

## IN THE FIELD OF TRAINING

- Developing skills and human capital.
- Strengthening technological infrastructures, creating an entrepreneurship-friendly environment for technology transfers.
- Promoting attractiveness with international players and the best global talent.

## ENABLING TECHNOLOGIES

- Asserting its position as one of the global leaders, e.g. in cryogenics and lasers for quantum technologies



# FRANCE HAS UNIQUE, STAND OUT ADVANTAGES

## SOLID FUNDAMENTALS

### GOVERNMENT COMMITMENT



Creation of **16,000** jobs by 2030.



**€1.8 billion**  
Total public-private commitment over five years

### SCIENTIFIC EXCELLENCE

#### Nobel Prize in Physics

Albert Fert and Serge Haroche, who are developing spintronics and cavity quantum electrodynamics.



#### Alain Aspect

Gold medal winner at the National Center for Scientific Research (CNRS), historic evidence of quantum entanglement



**295,800** researchers and more than **875,000** engineers.

### SKILLS AND ENTERPRISE



Intensification of training through research of nearly **1,700** young researchers in the field.



**5 000** new talents trained (researchers, engineers, technicians).

#### Quantonation

The leading investment fund in Europe dedicated to quantum technologies.



# RESEARCH AT THE HIGHEST LEVEL AND A CULTURE OF TECHNOLOGY TRANSFER

## PUBLIC SECTOR RESEARCH

CNRS  
INRIA  
CEA  
ONERA  
SACLAY  
INSTITUT  
NÉEL



## TECHNOLOGICAL AND INDUSTRIAL RESEARCH

ATOS  
THALÈS  
AIR  
LIQUIDE  
ORANO  
STMICRO  
ORANGE



## STARTUPS

QUANDELA  
PASQAL  
CRYTONEXT  
VERY CLOUD  
ALICE & BOB  
C12





# A PROLIFIC ECOSYSTEM

Atos

Atos has improved its commercial quantum simulator QLM with new hardware architecture, which became QLM E(nhanced), the most efficient quantum simulator in the world.

THALES

December 2020: Thales is developing a super-conductor quantum antenna based upon the use of SQUID networks (Superconductor Quantum Interference Devices) capable of detecting a large spectrum of frequencies.



December 2020: The European consortium HPCQS, built around the Franco-German axis GENCI and the Center for Research in Jülich, was selected by EuroHPC to build the first European super-computer in 2023 integrating a quantum accelerator of at least 100 qubits.

Air Liquide

September 2020: Air Liquide acquired the French SME Cryoconcept, specializing in refrigeration dilution, a technology enabling refrigeration to very low temperatures. This movement marks Air Liquide's commitment in the field of extreme cryogenics.



December 2020: The CEA-Leti is sampling its electron-spin qubits, which improve the control of qubits.



September 2020: The startup Quandela launches Prometheus, its new generation of indistinguishable photons that can be used for quantum computing and cryptography.





# A PROJECT WITH DECISIVE ADVANTAGES FOR SOCIETY

## TAKE CARE OF OURSELVES

By enabling us to identify very quickly the remedy to a disease agent, quantum computers could become one of the most powerful tools ever developed to tackle health crises.

## FEED OURSELVES BETTER

Quantum computers could help us to discover efficient catalyzers to produce ammonia in ambient conditions, thereby helping us to reduce the carbon footprint of agriculture.

## FIGHT BETTER AGAINST CLIMATE CHANGE AND ANTICIPATE NATURAL DISASTERS

Quantum sensors onboard satellites in low orbit could enable us to measure variations in the field of gravity, thereby bringing us new predictive capacities.

## TRAVEL BETTER

Capable of complex real-time system optimization, quantum computers will provide drivers with balanced routes, causing smoother flowing traffic, more efficient journeys and reduced pollution.

## PROTECT OURSELVES BETTER FROM COMMUNICATION SECURITY THREATS

The field of research in post-quantum cryptography will enable us to develop protocols for exchanging information that are robust to the decoding abilities of quantum computers.



# AN AMBITIOUS AND SYSTEMATIC STRATEGY

Research (CNRS, CEA, INRIA, ONERA, CNES,  
EU program, infrastructures) €725 million

Training (PhD, engineers, masters, technicians)  
€61 million

Technological maturity €171 million

Breakthrough Innovation (quantum computing)  
€114 million

Support for industrial deployment (pilot lines,  
cryogenics) €224 million

Public procurement policy (computing, defense)  
€72 million

Enterprise (investment funds, incubators)  
€439 million

Standardization, intellectual property €9 million

**€1.8 BILLION OVER THE PERIOD  
2021-2025**



## TANGIBLE STATED GOALS

Developing and disseminating the usage of NISQ simulators and accelerators (€352 million)

Developing large scale quantum computers(€432 million)

Developing quantum capture technologies and applications (€258 million)

Developing the post-quantum cryptography offer (€156 million)

Developing quantum communications systems (€325 million)

Developing an offer of competitive enabling technologies (€292 million)

**€1.8 BILLION OVER THE PERIOD  
2021-2025**





"Quantum technology is part of the keys to the future that France must possess... With this plan, we intend to sustainably base France in the first circle of countries that master quantum technologies. It is a question of nothing less than conquering our sovereignty in this technological field that will shape the future."

**Emmanuel Macron,  
President of France  
Saclay, January 21, 2021**





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**GOUVERNEMENT**

*Liberté  
Égalité  
Fraternité*

