Valorization and Quantum Technologies

Valorization day – 25/01/2023

Matthieu Delbecq
Sorbonne Université – Laboratoire de Physique de l’ENS
Le DIM QuanTiP en chiffres :

1100 chercheurs
138 équipes
38 laboratoires
47 partenaires

Hélène Perrin

Senka Ćuk
Quantum Technologies in Paris Region

Pluridisciplinary research effort
+1000 researchers: (50% permanent 35% PhD students, 15% postdocs)
37 laboratories, 138 groups, 21 institutions, 6 scientific domains
7 startups born during SIRTEQ!

Common projects with industry

...and more
Quantum technologies: 4 ranges of application

Quantum computing

Quantum simulation

Quantum communications

Quantum sensing
Excellence in research and innovation

+200 European projects
9 Flagship among 20

7 start-ups

78 patents incl. 55 in quantum

Joint projects with +20 industrials

43 ERC*
20 IUF°

3 Nobel prizes
4 gold medals
+100 prizes since 2015

~1000 international collaborations
Objectives of Quantip

Support research collaborations
shared equipments
interdisciplinarity reactivity

Trigger innovation valorisation collaborations
Club Quantip meet 2 worlds training

Share outreach
reach young people
international conference
visibility of QT
First Quantum Revolution

- Transistor: 1947
- Ruby laser: 1960
- Laser diode: 1962
- GPS: 1995

Precise knowledge and control of discrete energy levels

1st ingredient: quantum coherence

From the classical information bit $|0\rangle$ or $|1\rangle$

...to the quantum bit $|0\rangle + e^{i\phi}|1\rangle$
Second Quantum Revolution

2\textsuperscript{nd} ingredient: entanglement

Exemple: two particules A and B with a common fate:

$$|0_A, 0_B\rangle + |1_A, 1_B\rangle$$

If particule A detected in state 0, then B is in state 0
Second quantum revolution in the media

Les entreprises fascinées par la révolution quantique
Quantum technologies hype in the media

[L'instant tech] Quand L'Usine Nouvelle teste l'ordinateur quantique photonique de Quandela

Avec l'aide de Yoann Pietri, doctorant au laboratoire d'informatique de Sorbonne Université (LIP6), L'Usine Nouvelle a pris en main l'ordinateur quantique photonique de la start-up Quandela, grâce à un accès exclusif à leur service cloud. De quoi s'offrir une petite immersion dans la programmation quantique sur le premier processeur européen accessible en ligne. Entre incompréhension et fascination.
EN CE MOMENT

Siquance, la start-up française qui développe l’ordinateur quantique
Le Crédit agricole teste avec succès le quantique pour doper ses modèles prédictifs

La banque de financement et d'investissement du Crédit agricole boucle le premier cas d'usage réel résolu de A à Z grâce à l'informatique quantique. Un projet de quinze mois mené avec les start-up Pasqal et Multiverse.
Many actors in QC

<table>
<thead>
<tr>
<th>atoms</th>
<th>electron superconducting loops &amp; controlled spin</th>
<th>photons</th>
</tr>
</thead>
<tbody>
<tr>
<td>trapped ions</td>
<td>quantum annealing</td>
<td>silicon</td>
</tr>
<tr>
<td>cold atoms</td>
<td>superconducting</td>
<td>NV centers</td>
</tr>
<tr>
<td>vendors</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>labs (*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) non exhaustive inventory, missing Chinese labs among others</td>
</tr>
</tbody>
</table>

Evolution of patenting in QT

Source: Quantum Technologies Patents, Publications & Investments, by Michel Kurek (QuantX, Le Lab Quantique)
France needs to step up in patenting !

Source: Quantum Technologies Patents, Publications & Investments, by Michel Kurek (QuantX, Le Lab Quantique)
Quantique : le réveil des investisseurs

Les investissements privés dans les start-up qui développent des ordinateurs quantiques s'envolent. Les premières introductions en Bourse arrivent. La disponibilité des capitaux, les promesses de la technologie et la levée des premiers obstacles techniques ont ouvert au secteur les vannes de la finance.
QT start-up investment activity surpassed $1.4 billion in 2021, more than double that of 2020...

>65% of total investment allocated to hardware players

>$1.4 billion

>$0.7 billion

>$2.1 billion

1. Based on public investment data recorded in PitchBook; actual investment is likely higher.
2. Public announcements of major deals; actual investment is likely higher as for 7 out of 20 deals done in 2H2021 the deal size was not disclosed.

Source: PitchBook, McKinsey analysis
Some recent fund raisings in quantum computing deeptech

- **PsyQuantum** raises $450m (2021); valuation of ~$3.15b
- **ionQ** raises $350m (2021); valuation of ~$2b
- **Xanadu** closes $100m deal; valuation > $1b

- **ColdQuanta** announces $110m
- China’s **Origin Quantum** secures $140m
- Finnish Startup **IQM** raises €128m
- **Atom Computing** raises $60m
- **Terra Quantum AG** extends series A funding to $75m
- German-Based **EleQtron** Raises €50m
- **D-Wave** begins trading, secures $150m in long-term funding
- **Silicon Quantum Computing**, prepares For a $91m funding round

- **Quantonation Ventures** announces the final closing of its €91m Quantum Technologies Fund
- **QBN and CM-Equity** sets up €100m Quantum Technologies Fund
Some consultants’ projections

An equity market analyst firm estimates that Quantinuum could offer a significant return for Honeywell investors, with a valuation that could reach well into the billions. In a paper acquired by The Quantum Insider, Vertical Research Partners reported that, based on their assumptions and projections, the discounted equity value of Quantinuum could reach circa $37 billion within a decade.

“THE VALUATIONS ARE HEADY BUT THE PROJECTIONS ARE BASED ON WHAT COULD BE AN ADDRESSABLE MARKET THAT WOULD BE WORTH TRILLIONS SPREAD OVER A NUMBER OF INDUSTRIES. BY 2050, HONEYWELL EXPECTS A $1 TRILLION IN USE CASES FOR QUANTUM AND QUANTINUUM COULD ADDRESS MORE THAN HALF — $550 BILLION — OF THAT TOTAL ADDRESSABLE MARKET.”
<table>
<thead>
<tr>
<th>EXHIBIT 2</th>
<th>The Expected Phases of Quantum Computing Maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NISQ era</strong></td>
<td><strong>Broad quantum advantage</strong></td>
</tr>
<tr>
<td>3–5 years</td>
<td>10+ years</td>
</tr>
<tr>
<td>Technical achievement</td>
<td>Error mitigation</td>
</tr>
<tr>
<td>Example of business impact</td>
<td>Material simulations that reduce expensive and time-consuming trial-and-error lab testing</td>
</tr>
<tr>
<td>Estimated impact (operating income)</td>
<td>$2 billion–$5 billion</td>
</tr>
</tbody>
</table>

*Source: BCG analysis.*
L'informatique quantique en passe de vivre une traversée du désert ?

Il semblerait que l'informatique quantique ne permettra pas de changer notre quotidien... Pour l'instant.

Par Zacharie Yazrou - @Zach_Trt
Publié le 10 janvier 2023 à 17h41 - Mis à jour le 10 janvier 2023 à 18h00

À lire aussi

Des artistes portent plainte contre une IA génératrice d'images
LIRE ARTICLE

Les applications de Google bientôt dans les voitures Porsche ?
LIRE ARTICLE

Microsoft annonce l'arrivée de ChatGPT dans Azure OpenAI Service
LIRE ARTICLE

Docaposte, filiale de La Poste, s'installe un peu plus dans le secteur de la santé
LIRE ARTICLE

Image : IBM Research / Flickr.
There will be more where that came from. So it’s time for a reality check. Quantum computers are interesting, but experience so far suggests they are exceedingly tricky to build and even harder to scale up. There are now about 50 working machines, most of them minuscule in terms of qubits. The biggest is one of IBM’s, which has - wait for it - 433 qubits, which means scaling up to 20m qubits might, er, take a while. This will lead realists to conclude that RSA encryption is safe for the time being and critics to say that it’s like nuclear fusion and artificial general intelligence - always 50 years in the future. That doubtless will not prevent Rishi Sunak from declaring his intention to make the UK “a world leader in quantum” but my money is on RSA being secure for my lifetime - and possibly even Sunak’s.
Quantum overhype? 

Gartner hype curve model & variations

- peak of inflated expectations
- plateau of productivity
- trough of disillusionment
- slope of enlightenment

Examples:
- Web 1.0 and 2.0
- Telephone, radio, television
- Micro-computers, smartphones
- Speech recognition
- Virtual and augmented reality
- Mesh networking

Quantum computing
- Nuclear fusion
- Superconducting, DNA computing
- Personal drones
- Brain-computer interfaces
- Artificial general intelligence
- Ultrawideband networks, WiMax
- Segway, flying cars

Quantum computing according to Gartner Group:
- 1. 2018
- 2. 2020
- Quantum machine learning in 2021

Quantum overhype?

We need to promote innovation and entrepreneurship to take the optimistic road

Most players are component and application software companies, but hardware start-ups still get the biggest share of funding.

<table>
<thead>
<tr>
<th>Number of QC players, by value chain segment¹</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component manufacturers</td>
<td>228</td>
</tr>
<tr>
<td>Hardware manufacturers</td>
<td>72</td>
</tr>
<tr>
<td>Systems software</td>
<td>39</td>
</tr>
<tr>
<td>Application software</td>
<td>33</td>
</tr>
<tr>
<td>Services</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
</tbody>
</table>

Number of players: >100 suppliers, which are largely not specific to quantum computer hardware; there are 38 QC-focused components suppliers that figure into the overall company count.

Share of start-up funding¹:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Component manufacturers</td>
<td>4%</td>
</tr>
<tr>
<td>Hardware manufacturers</td>
<td>73%</td>
</tr>
<tr>
<td>Systems software</td>
<td>14%</td>
</tr>
<tr>
<td>Application software</td>
<td>7%</td>
</tr>
<tr>
<td>Services</td>
<td>2%</td>
</tr>
</tbody>
</table>

¹ Includes start-ups and incumbents that develop or offer QT products; see methodology pages for details. Based on public investments in start-ups recorded on PitchBook and announced in the press; includes announced deals for 2021; excludes investments in internal QT departments or projects by incumbents; actual investment is likely higher.

Source: CapitalIQ, Crunchbase, PitchBook; press search; Quantum Computing Report; expert interviews; McKinsey analysis
QC is more than “just qubits”

Most players are component and application software companies, but hardware start-ups still get the biggest share of funding.

Success Story at 10h

Romain Stomp

Applications
- Quantum Technologies
- Optics & Photonics
- Impedance Measurements
- Scanning Probe Microscopy
- Nanotechnology & Materials Science
- Sensors
And QT is more than QC

Success Story at 15h30

Chipiron startup

Dimitri Labat

Making MRI accessible to all of humanity
An inclusive European programme will see excellent research teams and relevant industry actors collaborating on an ambitious roadmap towards a common set of goals, while balancing long-term quantum technology research with complementary investment in shorter-term programmes. Public support for innovation must be made available for companies to kick-start the supply chain for these new technologies and to translate laboratory demonstrators into commercial products. Elements of a European programme are shown in the diagram below.
A new jargon to learn

Do you know these?

- TRL
- Homme de métier
- Claims
- Innovative activity
- Know-how
- Licensing
- Pre-maturation
- Challenge+
- Scientipole
- INPI
- Statut JEI
- BPI
- Maturation
- SATT
- ASTRID
- Incubateur
- FIST
- Centrale-Supelec Entrepeneur
- Love Money
Technology Readiness level (TRL)

- TRL 1 – basic principles observed
- TRL 2 – technology concept formulated
- TRL 3 – experimental proof of concept
- TRL 4 – technology validated in lab
- TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 7 – system prototype demonstration in operational environment
- TRL 8 – system complete and qualified
- TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)
A new jargon to learn

Do you know these?

- TRL
- Know-how
- Innovative activity
- Licensing
- Pre-maturation
- Maturation
- SATT
- ASTRID
- Scientipole
- Challenge+
- Claims
- BPI
- INPI
- Statut JEI
- BPI
- Homme de métier
- Love Money
- Incubateur
- FIST
- Centrale-Supelec Entrepreneur
Key principles for scientist aiming to found a start-up

Eric Langrognnet
at 11h

• Engineer – Ecole Centrale
• CEO and founder of several companies
• Coach for entrepreneurs
A new jargon to learn

Do you know these?

- TRL
- Homme de métier
- Claims
- Know-how
- Licensing
- Innovative activity
- Challenge+
- Pre-maturation
- SATT
- ASTRID
- BPI
- INPI
- Statut JEI
- Maturation
- Incubateur
- FIST
- Centrale-Supelec Entrepeneur

Protecting your ideas
Patent: a tool for innovation

Enrico Priori
at 14h30

- PhD in laser physics.
- 20 years of experience in industrial property
- Expert in
  - drafting patent applications and defending them during examination procedures;
  - patentability, freedom to operate and infringement studies;
  - infringement litigation and patent validity.
A new jargon to learn

Financing your first steps

Do you know these?

- TRL
- Know-how
- Innovative activity
- Love Money
- Claims
- Licensing
- Challenge+
- Statut JEI
- Pre-maturation
- BPI
- SATT
- ASTRID
- Maturation
- INPI
- Incubateur
- Scientipole
- Centrale-Supelec Entrepreneur
- Homme de métier
16:50 - 17:40

Programme de prématuration du CNRS, Patrick MOREAU, INP CNRS
Activités & Programme de maturation, Yann GERARD, SATT Erganeo
Financing pre-matured – matured projects, Xavier FANTON, SATT Lutech
A new program for accelerating your innovation within Sorbonne University Alliance,
Olivia LEROY, Faculté des sciences et ingénierie, Sorbonne Université

***

"AAP 2022 Valorisation" of the DIM QuanTiP, Pascale SENELLART, C2N, DIM QuanTiP
Program of the day

09:00 - 09:30
Welcome coffee, installation of posters

09:30 - 10:00
Valorization and quantum technologies, Matthieu DELBECQ, LPENS, DIM QuanTip

10:00 - 11:00
SUCCESS STORY: Zurich Instruments, Romain STOMP

11:00 - 12:00
Key principles for scientists aiming to found a start-up, Eric LANGROGNET, Limpidea Management

12:00 - 13:00
Lunch break

13:00 - 14:30
Poster session in parallel with Technological contest

14:30 - 15:30
Patent - a tool for innovation, Enrico PRIORI, Atout[PI] Laplace

15:30 - 16:30
SUCCESS STORY: Chipiron, Dimitri LABAT

16:30 - 16:50
Coffee break

16:50 - 17:40
Programme de prématuration du CNRS, Patrick MOREAU, INP CNRS
Activités & Programme de maturation, Yann GERARD, SATT Erganeo
Financing Pre-Matured – Matured projects, Xavier FANTON, SATT Lutech
A new program for accelerating your innovation within Sorbonne University Alliance, Olivia LEROY, Faculté des sciences et ingénierie, Sorbonne Université

***

"AAP 2022 Valorisation" of the DIM QuanTip, Pascale SENELLART, C2N, DIM QuanTip

17:40
Technological contest winner announcement
Poster prize announcement