

# Quantum Meets the Health

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Dr Cathy Foley

Australia's Former Chief Scientist and Quantum  
Enthusiast

13 August 2025

CTIONS



**NEW YORK POST**

Space Environment Wildlife Archaeology

**SCIENCE**

# Why the world is now in a race to achieve 'Quantum Superiority'

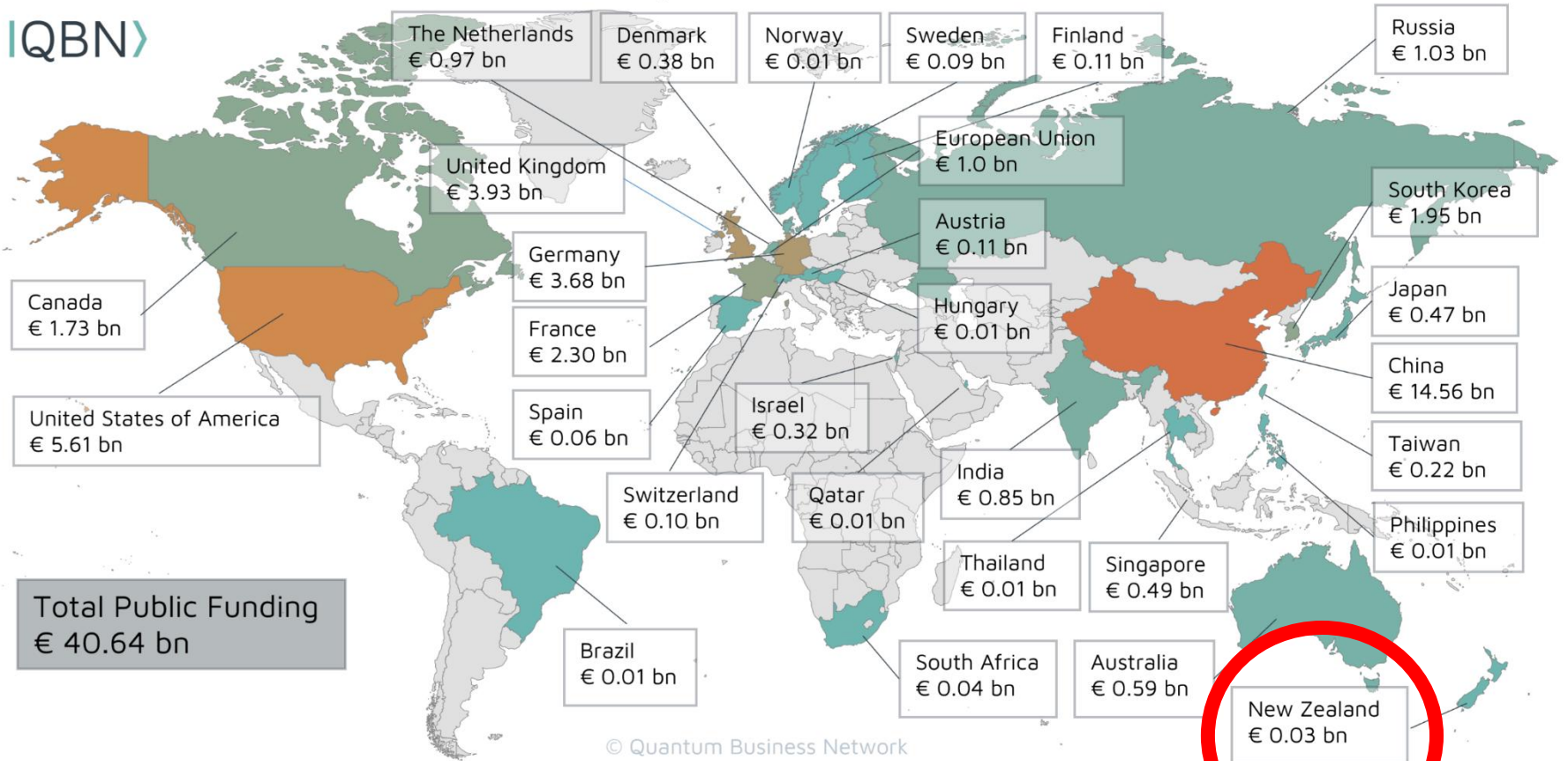
By [Eric Spitznagel](#)

Published May 3, 2025, 2:00 p.m. ET



62 Comments

## Global Quantum Initiatives



# What's backing quantum?

## Corporate investors:

- Intel, Google, IBM, Microsoft, AWS and many others
- Private investment reached >\$2B in 2024
- Generated \$650-750M revenue in 2024 – expect >\$1B in 2025

## Governments:

- Considered **“urgent”** and **“critical”**
- **Strategies produced** by China, USA, UK, Europe, Japan, Canada, S. Korea (>20 countries)
- **Public investment** increased >50% in 2022
- Global public funding now \$44.5B
- **Singapore hub** collaborates with businesses on use cases.
- **UK 5 quantum hubs** to speed up commercialisation
  - Govt GBP 606M - industry GBP 54M
- **Australia's investment** \$1.2B through multiple programs



Department for  
Science, Innovation  
& Technology



Australian Government  
Department of Industry,  
Science and Resources



QUANTUM  
FLAGSHIP  European  
Union



NATIONAL  
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SINGAPORE



<quantum|gov>



内閣府  
Cabinet Office



UKQuantum



<https://www.ukri.org/news/five-hubs-launched-to-ensure-the-uk-benefits-from-quantum-future/>

<https://qt.eu/about-quantum-flagship/>

<https://www.forbes.com/sites/sylvainduranton/2024/06/26/quantum-now/>

<https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/steady-progress-in-approaching-the-quantum-advantage>

# Quantum Computing Outlook 2025



**5.24%**

Industry Growth in the last year



**13 000+**

Total Companies in the database



**59 000+**

Employee Growth in the last year

## 5 Innovative Quantum Computing Startups



**BlueQubit**  
USA



**SuperQ**  
India



**Qool**  
Denmark



**QC Design**  
Germany



**TreQ**  
UK

The map highlights the global distribution of

**368**

quantum computing startups



No. of **Patents** • 296000+

No. of **Grants** • 3500+

Global **Manpower** • 1 million+

Top 5 **Country Hubs** • USA, UK, India, Germany, Canada

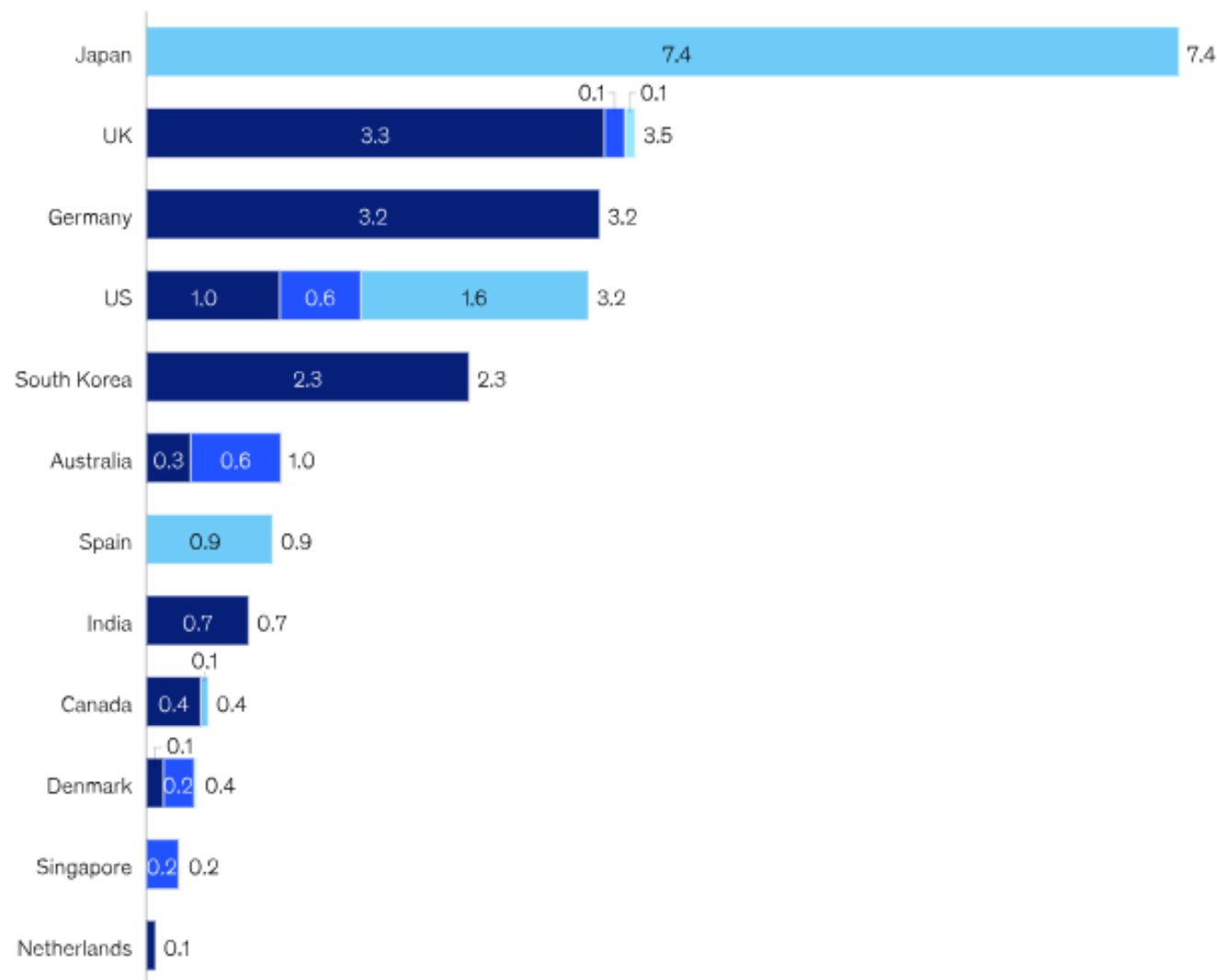
Top 5 **City Hubs** • London, NY City, Singapore, Sydney, Toronto

## Announcements of public investments in quantum technology reached \$10 billion in early 2025, with Japan accounting for nearly 75 percent.

Announced government investments in quantum technology (QT),  
Jan 2023–Apr 2025, \$ billion

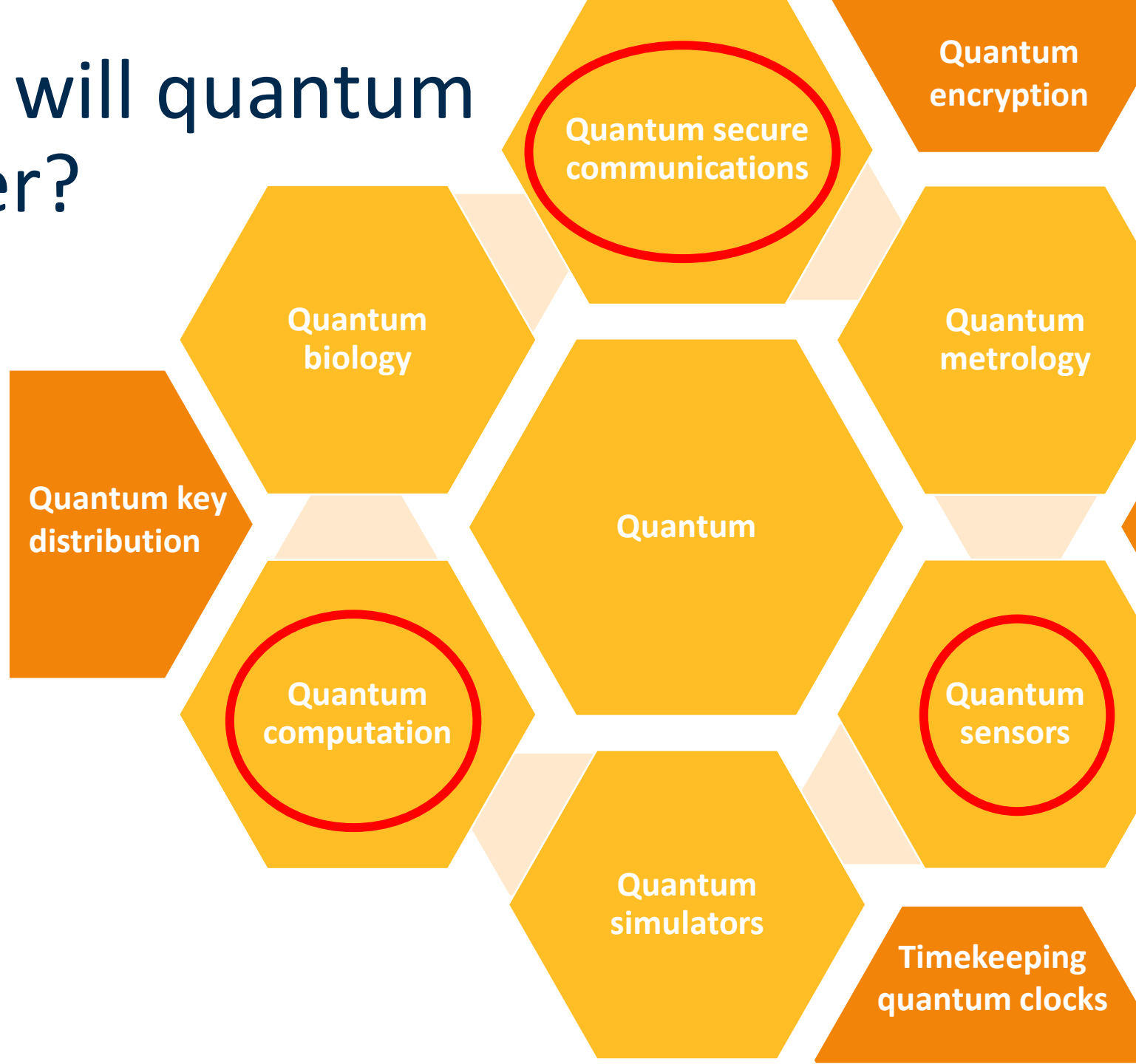
Year announced:

■ 2023 ■ 2024 ■ 2025 (Jan–Apr)



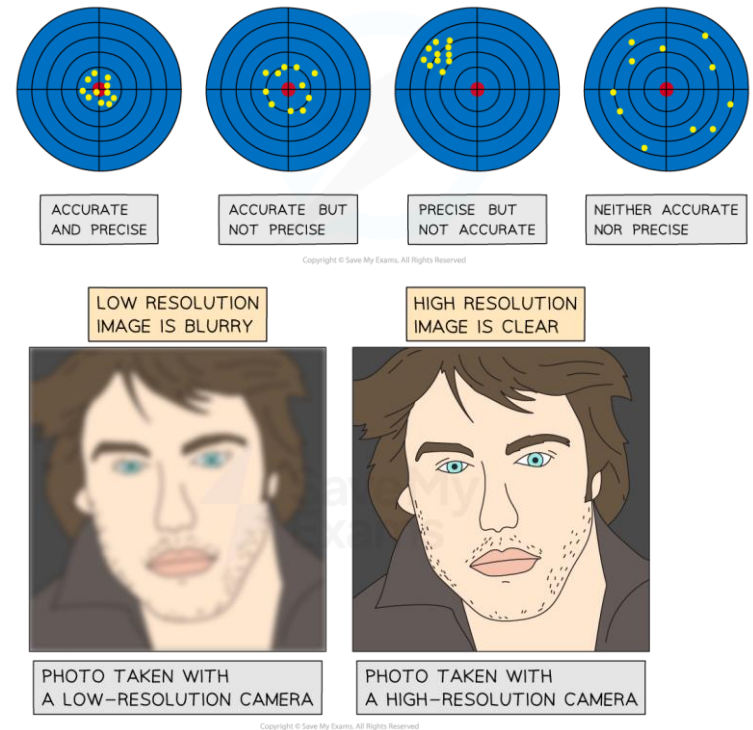
Total (for selected countries) 2023: ~11.4 2024: ~1.8 2025: ~10.0

# What will quantum deliver?

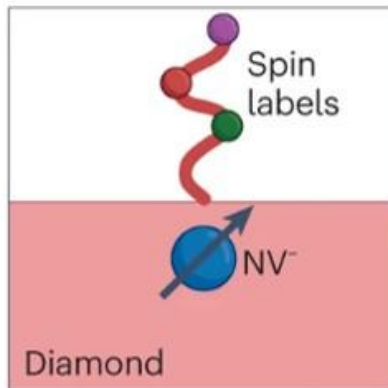


# Quantum sensors

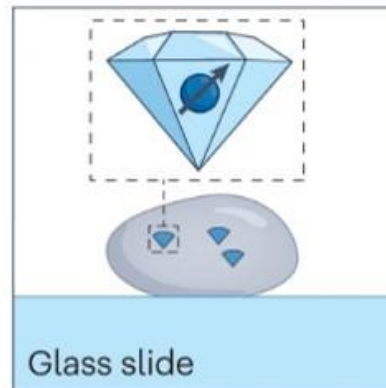
- Higher sensitivity
- Better accuracy
- Precision
- Size weight power
- Atomic to macro size
- Spatial resolution
- They can measure physical quantities:
  - Magnetic fields
  - Electric fields
  - Temperature
  - Pressure
  - Chemical composition
  - Gravity
  - Shapes



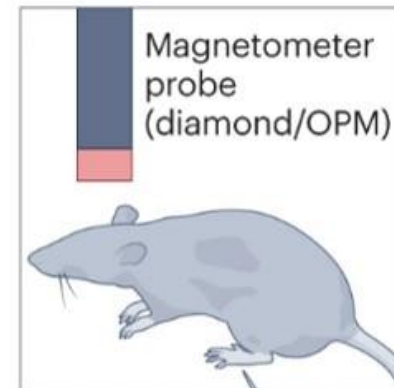
### Molecular structure determination



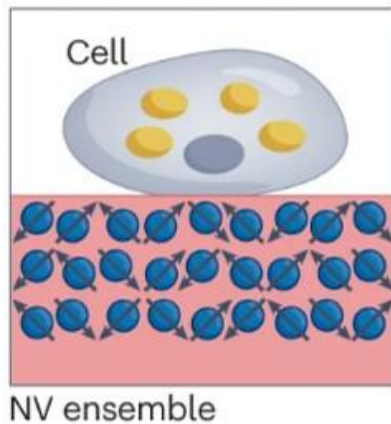
### Thermal measurements with nanodiamonds



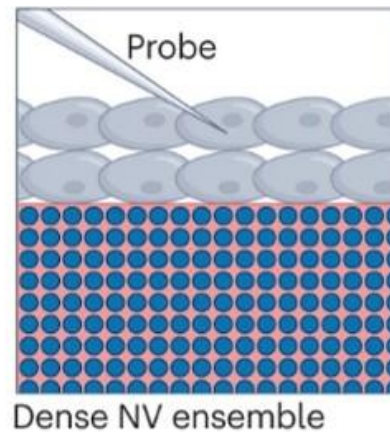
### In vivo magnetic activity in animals



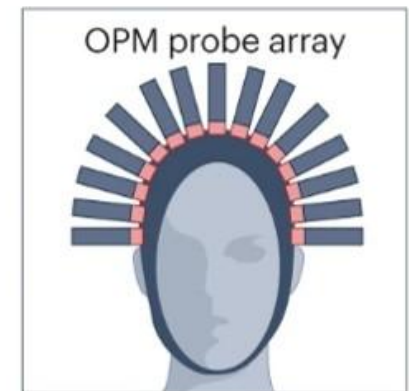
### Subcellular organelle metabolic studies



### Electrical activity studies in cellular cultures



### Clinical diagnostics in humans



Molecular scale

Cellular scale

Organism scale

# Quantum communications

- Quantum networks with space links
- Quantum satellites
- Data security
- Improved energy efficiency for optical communications
- Improved bandwidth efficiency for optical communications
- Positioning, navigation and timing without GPS

# um Communications

can now be encoded  
) by multi-state quantum bits

ed photons as qubits can interact  
h other at any distance

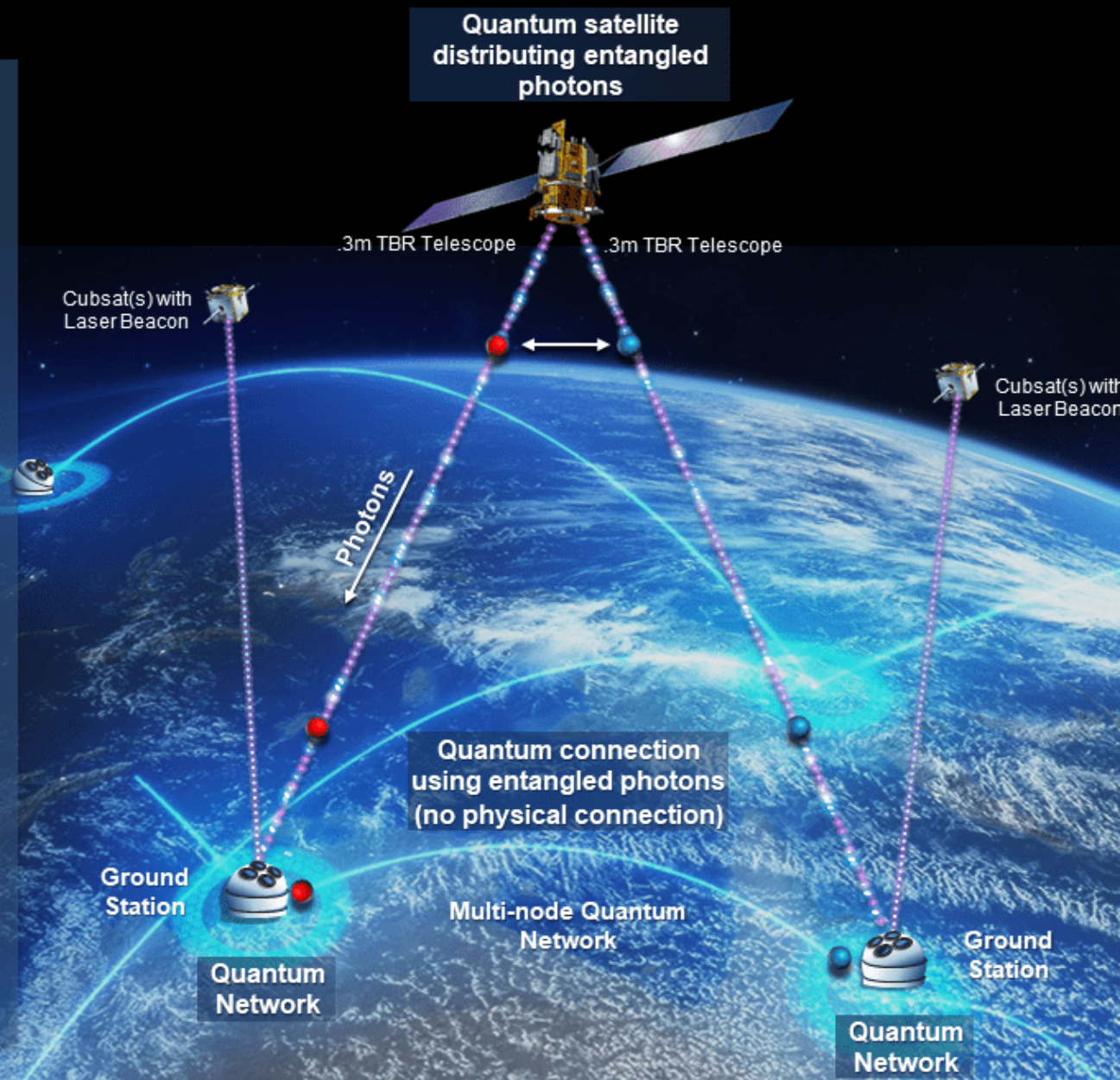
g a satellite distribute entangled  
via optical links to well  
ed stations on Earth, those  
can "talk" to each other via the  
ed photons - without needing to  
cally connected

m networks with space links

urity

d energy efficiency for optical  
ications

d bandwidth efficiency for  
ommunications



# Quantum Computers

## Global race

- Exponential computational speedup for specific problems
- Ability to simulate quantum systems,
- Potential breakthroughs in cryptography and materials science

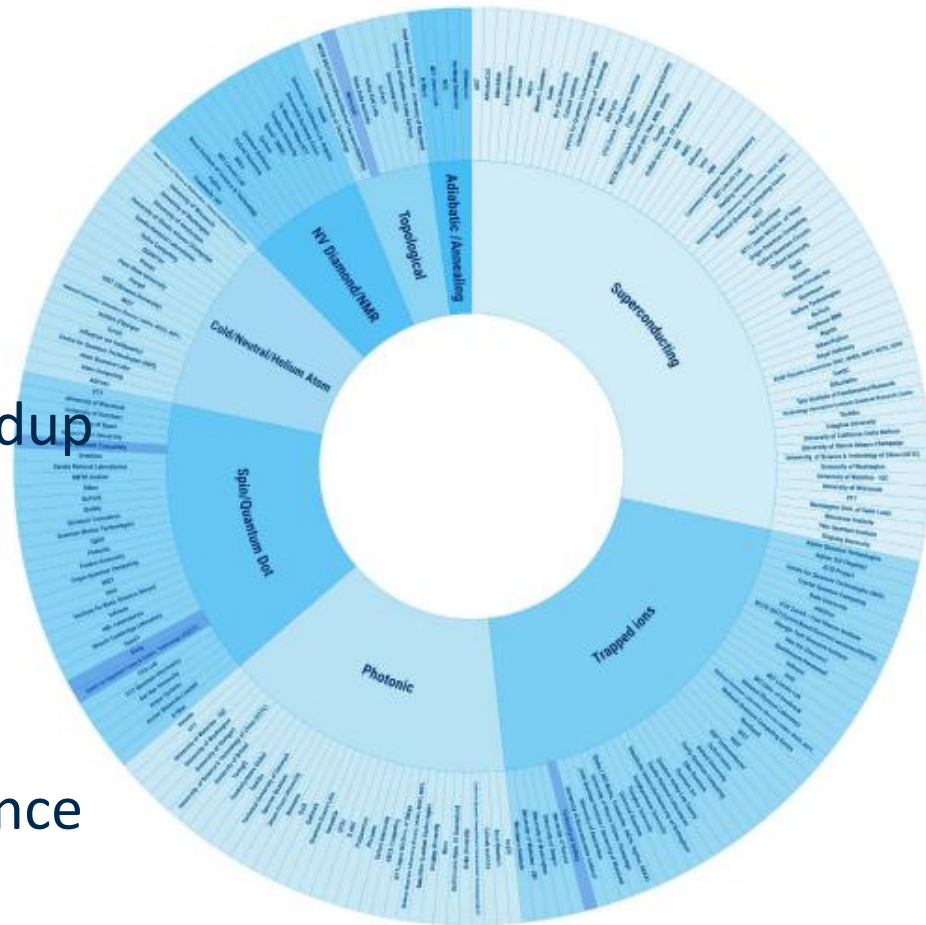


Figure 1. Global summary of the companies and academic programs developing the eight major quantum hardware technologies. Sourced from the Michel Kur, CEO of Multiverse Systems SAS,<sup>46</sup> and modified to highlight companies and academic efforts specific to NSW. ■ Companies specific to NSW

# Quantum Computers



## Global race

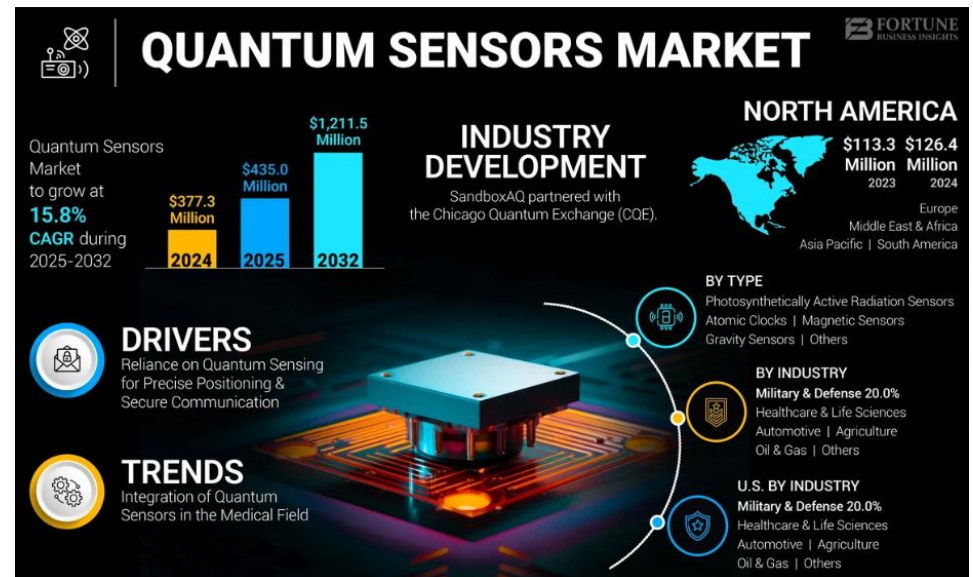
### Different types of quantum computers:

- Useful/Fault Tolerant – here soon
- Fully error corrected – different views on when that will be delivered
- Annealers – available now on the cloud - D-Wave
- Analogue quantum simulations
- Noisy Intermediate Scale Quantum (NISQ) Computer – available now via cloud - AWS, Rigetti, Xanadu, IBM, Google
- Quantum accelerator on HPC – available now Quantum Brilliance on Pawsey high-performance computer

# Industry sectors

- **Health and biotech**

- Resources
- AeroSpace
- Communications
- Transport
- Environmental protection
- Defence
- Infrastructure
- Agriculture
- Energy
- Research
- Sport
- Financial services



# Quantum Meets Sport 10 August 2022

## inside the games

The inside track on world sport

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Popular Judo Ju-Jitsu Weightlifting Sambo FISU Judo Baseball and Softball OCA Taekwondo Karate Boxing Ju-Jitsu W

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Mike Rowbottom: Knowing when to say goodbye

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## Olympics Challenge to showcase "quantum technologies" at Brisbane 2032

By Dan Palmer

Monday, 9 October 2023



Queensland is to launch a \$AUD5 million (£2.6 million/\$3.1 million/€3 million) Olympics Challenge in a bid to showcase "quantum technologies" from the state during the Brisbane 2032 Olympic and Paralympic Games.

The initiative is included in a document called the Queensland Quantum and Advanced Technologies Strategy.

Scientific breakthroughs are said to have been made in areas including computing and communications which can be highlighted at Brisbane 2032.

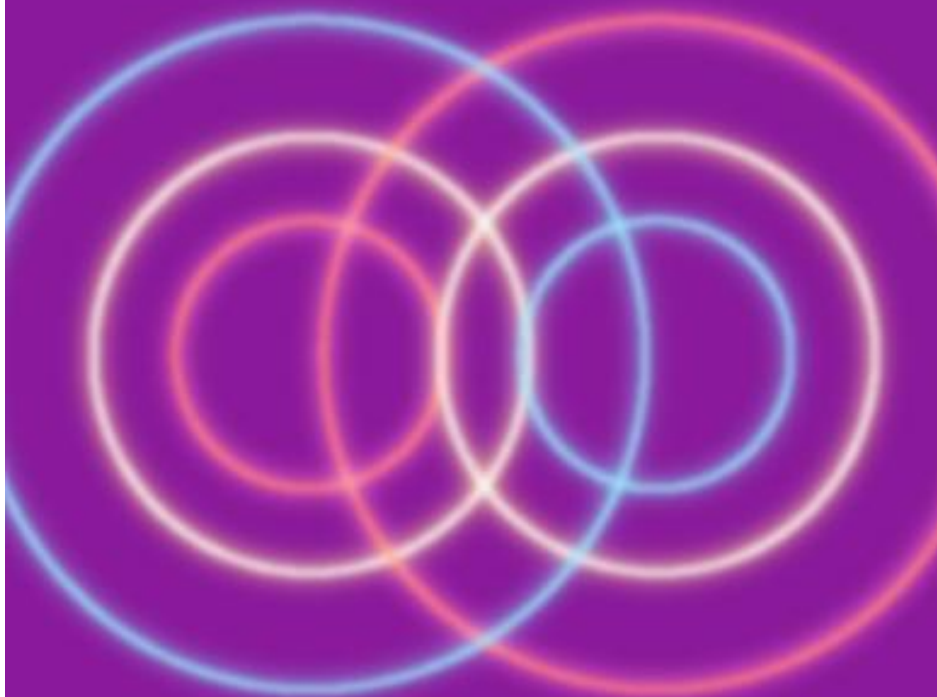
It is hoped that promoting the technology will lead to investment and jobs.

"Potential users of quantum technologies do not need to understand the science, but rather the transformative applications that are enabled," the strategy says.

"Over the past 30 years, Queensland has steadily built a reputation for being at the global frontier in science and advanced technologies such as robotics, artificial intelligence, nanotechnology and synthetic biology.

# Quantum for Life

How UK life sciences and healthcare can  
benefit from quantum technologies



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**Review ended** 08/19/2024

**Published** 08/22/2024

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**DOI:** 10.7759/cureus.67486

## Open Access Review Article

# Revolutionizing Healthcare: The Emerging Role of Quantum Computing in Enhancing Medical Technology and Treatment

Naveen Jeyaraman <sup>1</sup>, Madhan Jeyaraman <sup>2, 3, 1</sup>, Sankalp Yadav <sup>4</sup>, Swaminathan Ramasubramanian <sup>5</sup>, Sangeetha Balaji <sup>5</sup>

1. Orthopaedics, ACS Medical College and Hospital, Dr MGR Educational and Research Institute, Chennai, IND 2. Orthopaedics, South Texas Orthopaedic Research Institute, Texas, USA 3. Clinical Research Associate, Virginia Tech India, Dr MGR Educational and Research Institute, Chennai, IND 4. Medicine, Shri Madan Lal Khurana Chest Clinic, New Delhi, IND 5. Orthopaedics, Government Medical College, Omandurar Government Estate, Chennai, IND

**Corresponding author:** Sankalp Yadav, drsankalpyadav@gmail.com

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# Why does Quantum matter for Health?

Global Investment

**\$49B**

2024\*\*

**1 in 4**

industries

Pharmaceuticals

**\$1.3T**

Short term benefit\*

\*\* Resonance The Quantum Insider Annual Report TQI 2024

\*McKinsey <https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-quantum-computing>

# Value at stake by 2035

McKinsey estimates:

- For the 4 industries set to benefit most, the value at stake ranges from \$US620 billion to \$US1.3 trillion
- For pharmaceuticals and medical products, the value at stake ranges from \$US74 billion to \$US183 billion

Four industries expected to see first impact

Value at stake with incremental impact of QC by 2035, \$ billion



Source: McKinsey

# Applications in pharmaceuticals and medtech

# The quantum potential



Quantum computing for drug discovery

## Revolutionise medical and pharmaceutical industries



Quantum sensing for medical imaging



Quantum cryptography for security for sensitive medical data

# Pharmaceutical and medical applications

- Better microscopes and biosensors
- Quantum-enabled imaging
- Improved simulations of molecular processes through quantum computing
- New capabilities to **control** the behaviour of biomolecules and chemical reactions
- Biological systems as components in quantum technologies
- Diagnostics and investigative technologies
  - neuronavigation, cancer detection, quantum scanning
- New drug discovery, modelling and streamlined trials

# Drug development

# Drug development

**\$1-2B**

per drug

Quantum  
Computing  
Game changer  
Faster

**Decade**

to market

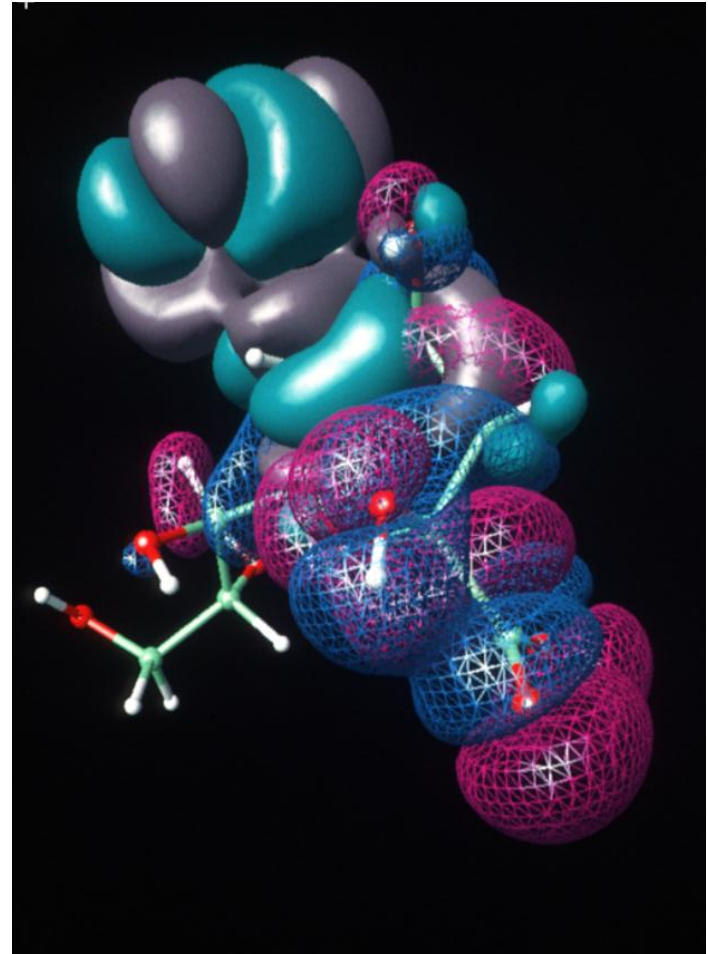
# What quantum computing offers

- Today
  - trial and error
  - beyond classical computers to predict behaviours at the atomic level
  - behaviour of medium-size drug molecules - lifetime to compute accurately using conventional computers
- Quantum computing
  - more accurate understanding of the structure and behaviour of molecules
  - ability to understand, predict and simulate interactions between molecules
  - full quantum simulations for faster, more accurate simulations of large molecules
  - create new drug-candidate libraries - no longer restricted to small molecules but include peptides and antibodies
- Future
  - drug discovery and testing entirely a virtual process, vastly more accuracy
  - personalised medicine on a mass scale
  - new ways to control and simulate biological systems

# Examples

## Overseas with local collaborations

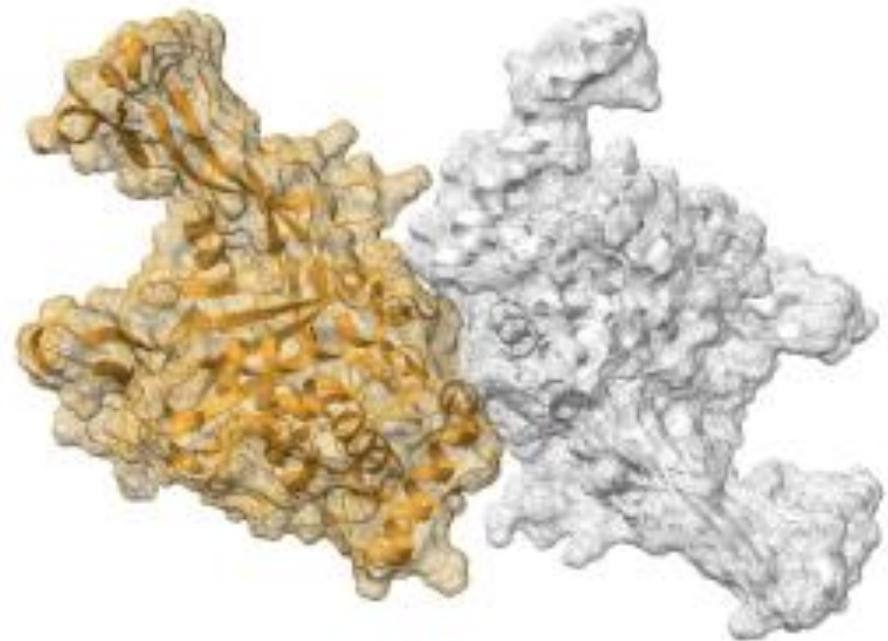
- March 2023: IBM delivered a quantum computer to the Cleveland Clinic dedicated to healthcare and life sciences research
- October 2023: \$US40 million to Cleveland Clinic, IBM and Algorithmiq for projects predicting protein conformations and drug behaviour in cancer prevention and treatment
- Newcastle Medical Research Institute collaborating with them
- September 2023: MIT/University of Chicago are working with Inflection to harnessing AI and quantum computing for personalised cancer care treatments



# Qubit Pharmaceuticals with NVIDIA

Accelerating drug molecule simulation  
and modeling with hybrid quantum computing

Dramatically reduce drug discovery time and cut  
its cost by a factor of 10

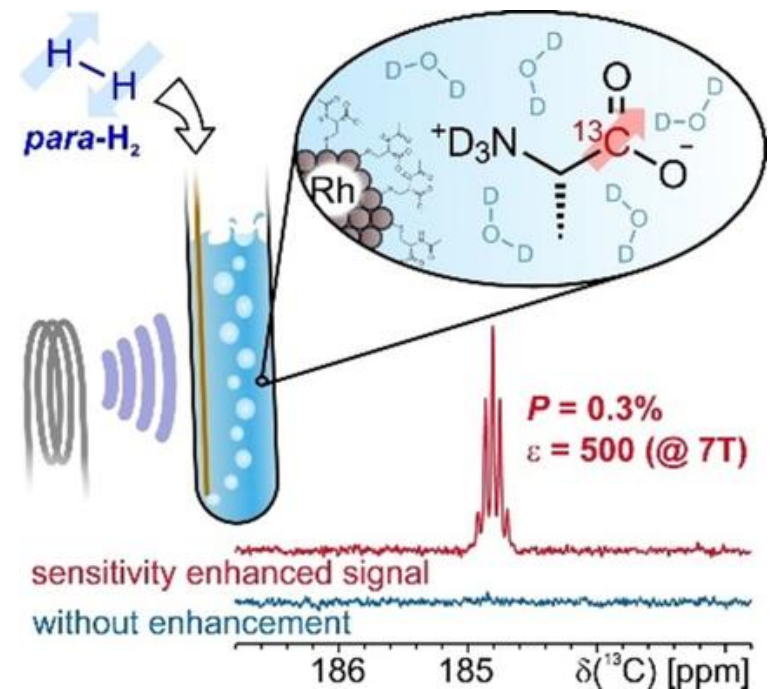


# Diagnostics – sensing and imaging

# Diagnostics

- Neuronavigation
- Cancer detection
- Quantum scanning

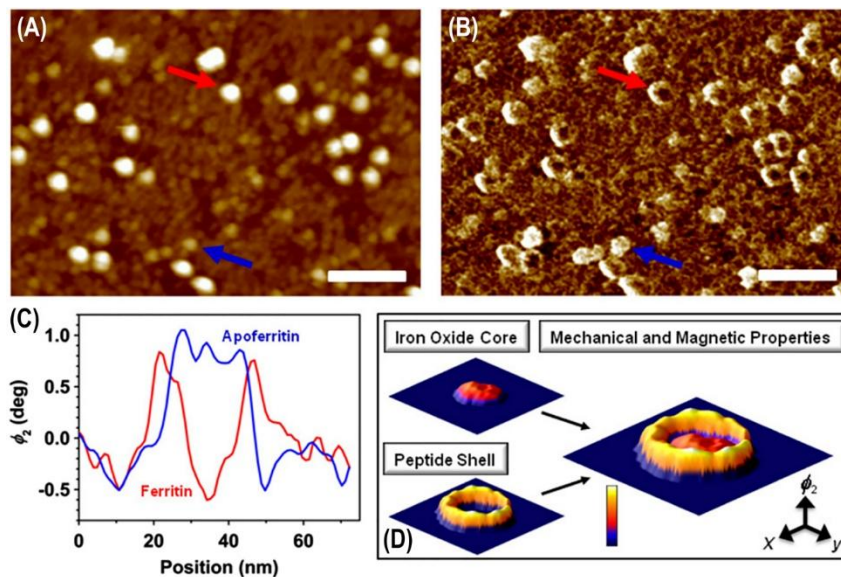
Hyperpolarization could be used to detect cancerous tumours with greater accuracy and better resolution



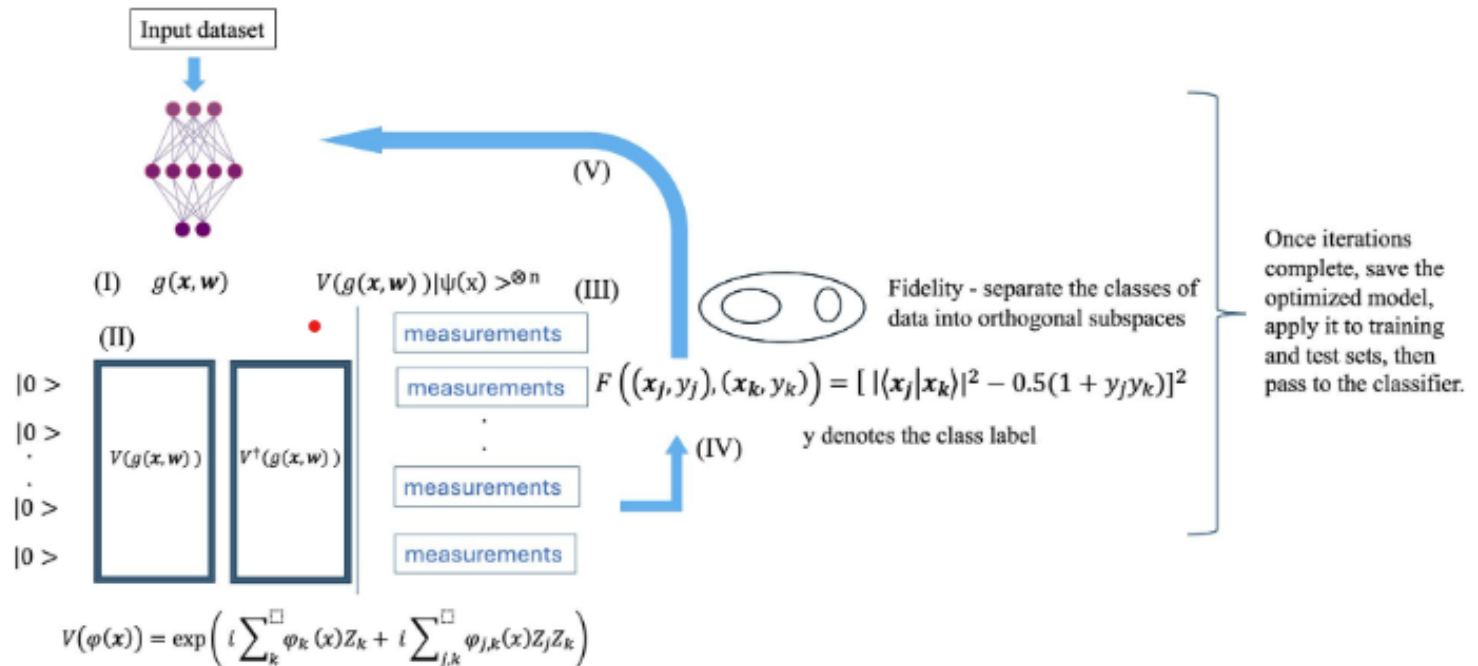
# Example


The University of Melbourne and Florey Institute have developed a quantum sensing technique for directly measuring ferritin bound iron

- an improvement on current methods because it is not confounded by inflammation



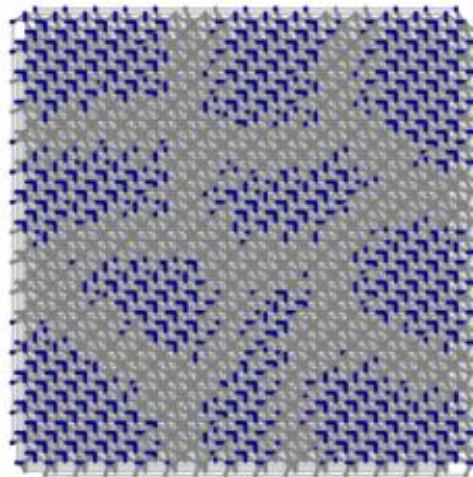
## USE OF HYBRID QUANTUM-CLASSICAL ALGORITHMS FOR ENHANCING BIOMARKER CLASSIFICATION



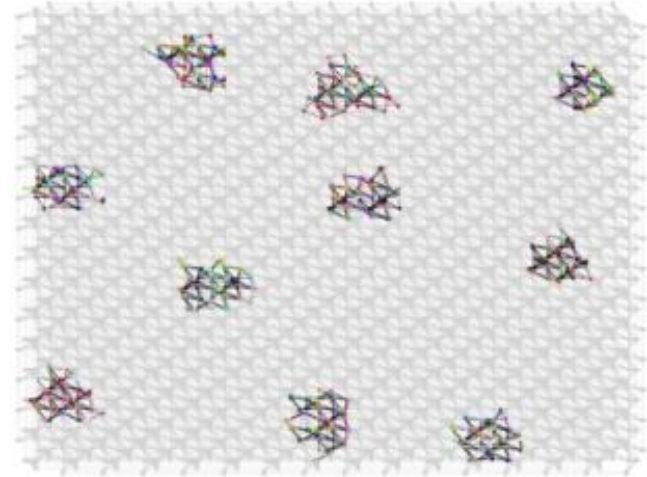
 Astuti et. al., Figure 2, PLOS ONE, 2025

Neural quantum embedding with quantum support vector classification and quantum neural networks to classify gene and microRNA expression profiles linked to metastasis.


## QUANTUM BOLTZMANN MACHINES USING PARALLEL ANNEALING FOR MEDICAL IMAGE CLASSIFICATION



(a) Regions and buffer zones



(b) Resulting embedding

 [Schuman, Figure 2, arXiv, 2025](#)

Through a new parallel quantum annealing technique, they reduce the quantum processing time required for training Quantum Bio-Markers, making quantum-enhanced medical image analysis more practical in the near term.

# Quantum imaging

Can resolve fainter and smaller structures than is possible with other techniques

Precision imaging tools are used for diagnosis of vascular diseases, brain conditions, studies of complex cancers, real-time monitoring of drug delivery

Photonic sensing - cell structures observed beneath the noise of conventional microscopes -better quantify the health and dynamics of cells (e.g., for cell therapies, disease diagnostics...)

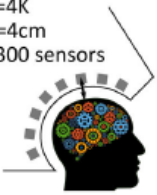
# Examples

## Australia: quantum diamond electrometers for neural imaging

- higher resolution
- more precise imaging of neural activity
- understanding the effect of drug candidates on the brain

b) SQUID

T=4K  
d=4cm  
~300 sensors

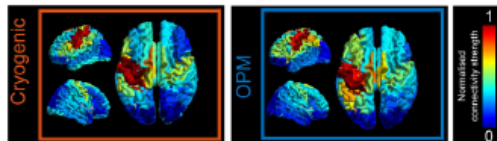


OPM

T=300K  
d~2mm  
50 sensors



Future OPM-MEG



- Full sensor coverage
- Increased spatial resolution
- Increased sensitivity
- Wearable device

## UK has developed a wearable magnetoencephalography system

- improved brain imaging
- insights into epilepsy
- Alzheimer's disease and other conditions

# Understanding biological processes

# Could quantum improve understanding of biological processes ?

## Some science questions:

Natural enzymes accelerate reactions by as much as 15 orders of magnitude, but we can't engineer artificial enzymes with the same capability – is quantum the reason?

In olfaction, it has been proposed that sensitivity to quantum mechanical collective vibrations is required to fully explain our sense of smell, augmenting lock-and-key mechanisms based on shape alone

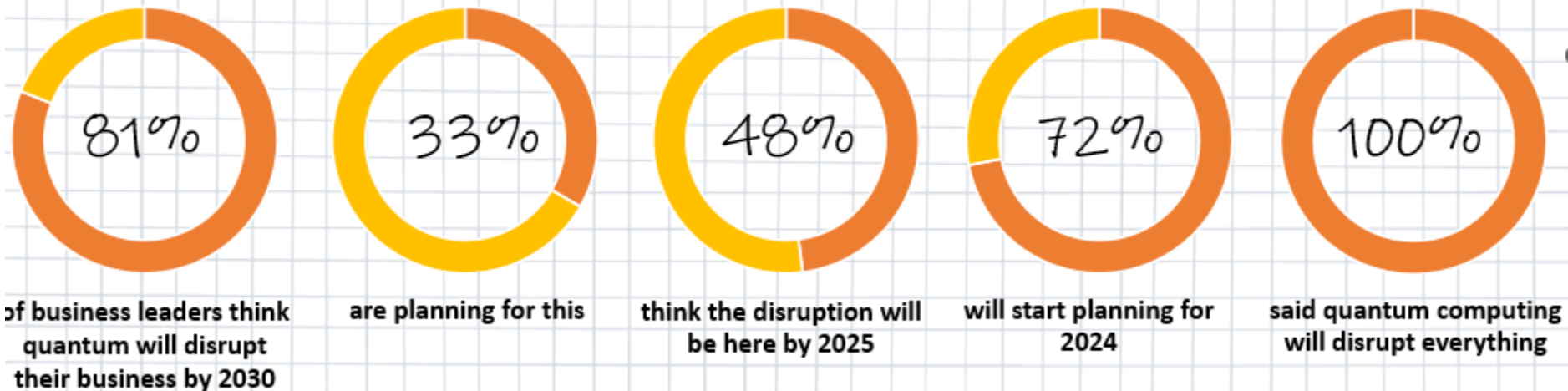
In experiments with fruit flies, vibrational frequencies of the odorant were changed without significantly changing its shape, and was shown to result in a change in perceived odour

It has been suggested that quantum coherence in neuronal microtubules may form the basis of human consciousness



# Quantum impact and readiness?

A UK report found:



# Today

- Could quantum tech help support health and biotech sector?
- Looking for great ideas
- Start to link up the health and biotech sector with quantum
  - Speed dating
  - Fall in love?
- What are some specific projects?
- Where could these projects get funding?
- Are there business opportunities for any start-ups?



**Thank you**