

Quantum meets Agriculture

Dr Cathy Foley

Australia's former Chief Scientist and Quantum Enthusiast

14 August 2025

**SCIENCE**

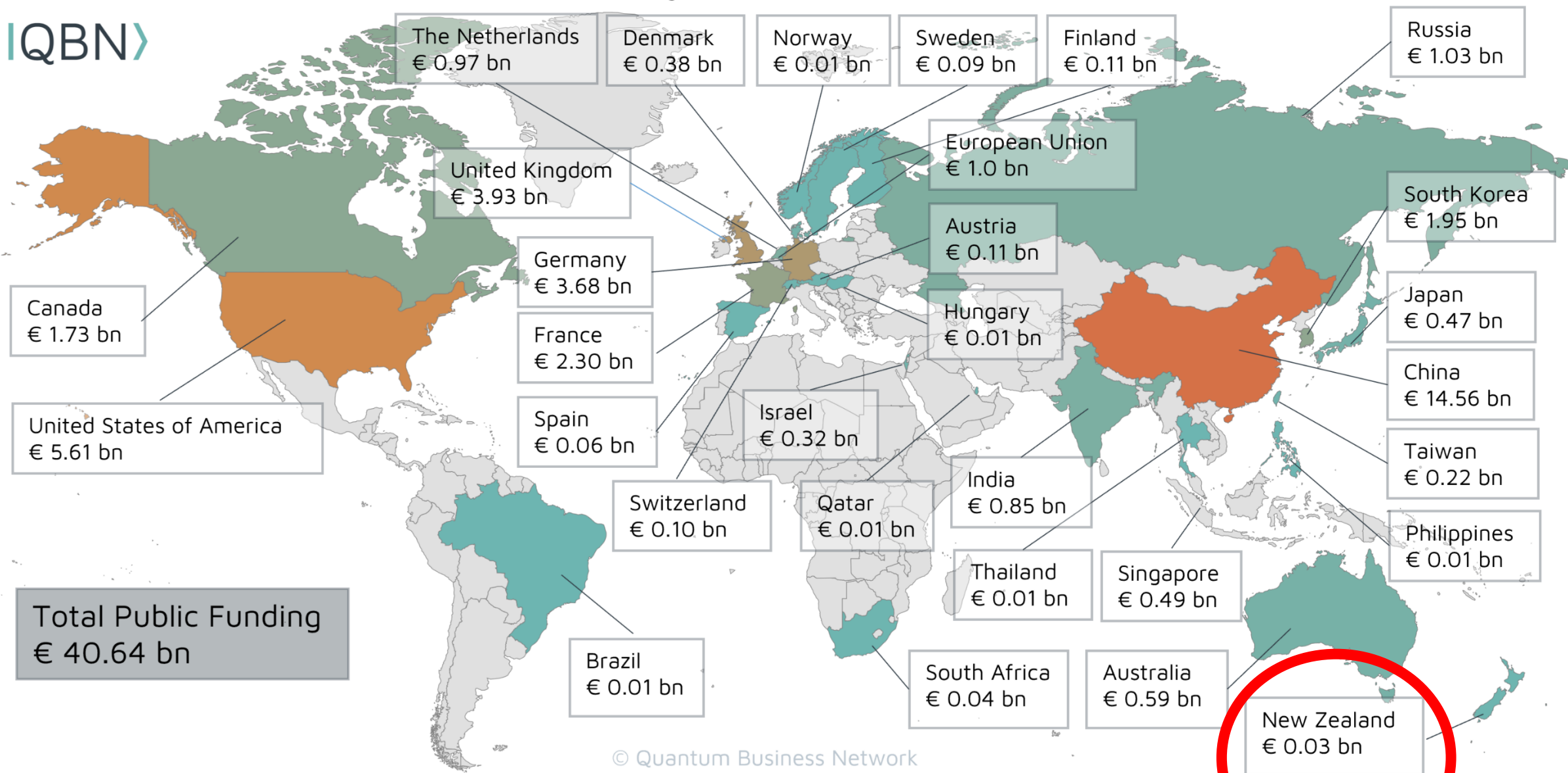
Why the world is now in a race to achieve 'Quantum Superiority'

By **Eric Spitznagel**

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



Global Quantum Initiatives



Who'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



QUANTUM
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European
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Australian Government

Department of Industry,
Science and Resources



NATIONAL
QUANTUM
OFFICE
SINGAPORE



<quantum|gov>



内閣府
Cabinet Office



UKQuantum

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+

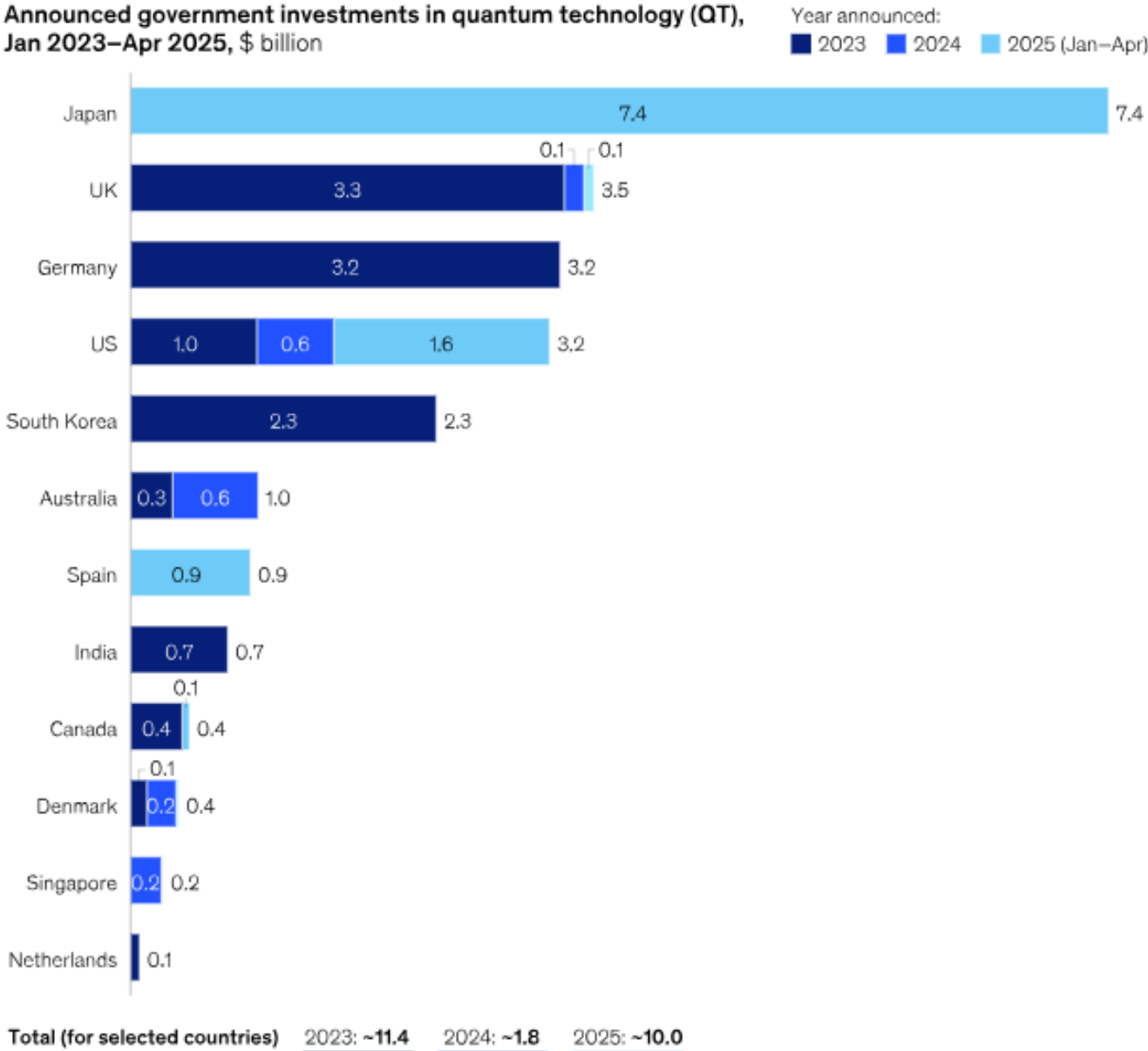
No. of **Grants** • 3500+

Global **Manpower** • 1 million+

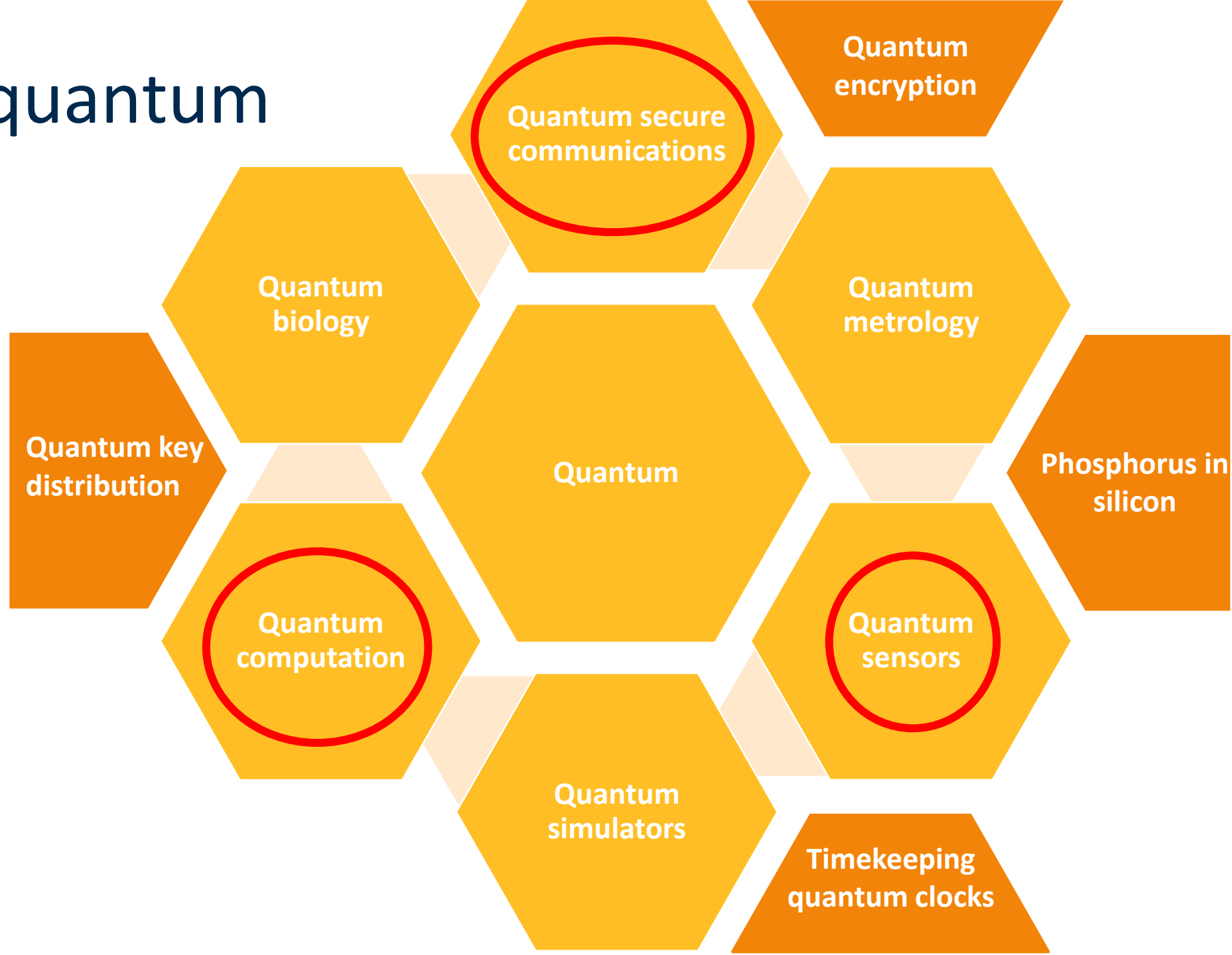
Top 5 **Country Hubs** • USA, UK, India, Germany, Canada

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.

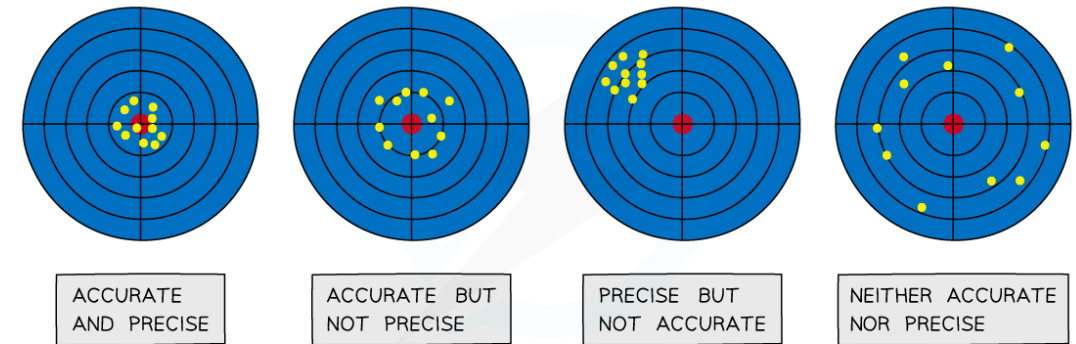


What will quantum deliver?



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



Quantum Sensing

Electric Fields

- Atomic electric field sensors
- Solid-state defects

Time and Frequency

- Atomic clocks

Magnetic Fields

- Atomic magnetometers
- Superconducting magnetometers
- Solid-state defects

Quantum Sensors
leverage quantum phenomena to
measure fields, forces, or time

Acceleration due to Gravity

- Atomic gravimeters
- Superconducting gravimeters

Inertial Acceleration

- Atomic accelerometers and gyros
- Superconducting accelerometers and gyros
- NMR gyros

**WHY BUILD
QUANTUM
SENSORS?**

Compared to traditional sensors, quantum sensors offer the potential for:

Improved Performance

and/or

Smaller SWaP
(size, weight, and power)

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

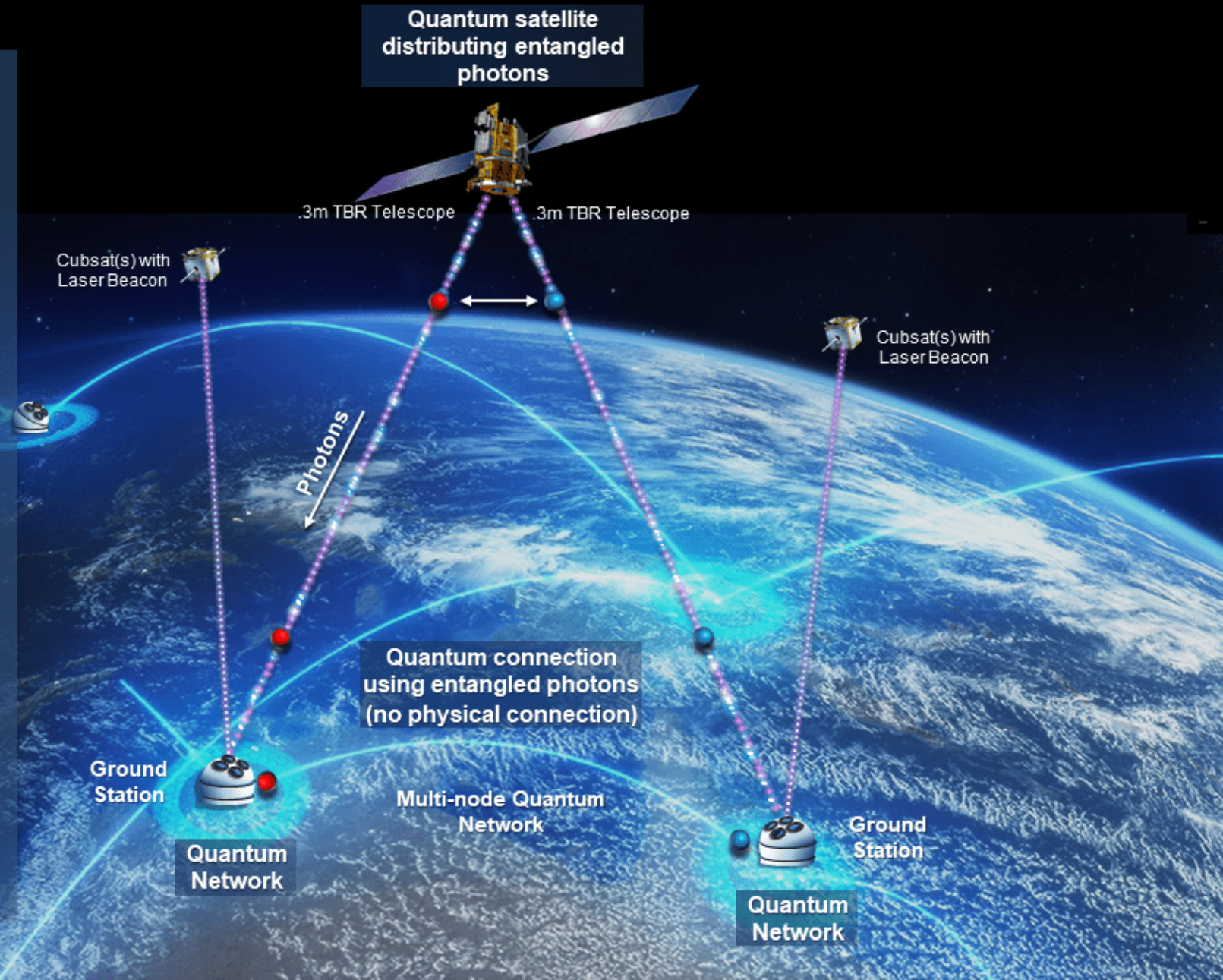
Quantum Communications

Information can now be encoded (represented) by multi-state quantum bits (qubits)

- Entangled photons as qubits can interact with each other at any distance
- By having a satellite distribute entangled photons via optical links to well separated stations on Earth, those stations can “talk” to each other via the entangled photons - without needing to be physically connected

Benefits

- Quantum networks with space links
- Data security
- Improved energy efficiency for optical communications
- Improved bandwidth efficiency for optical communications



Quantum Computers

Global race

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

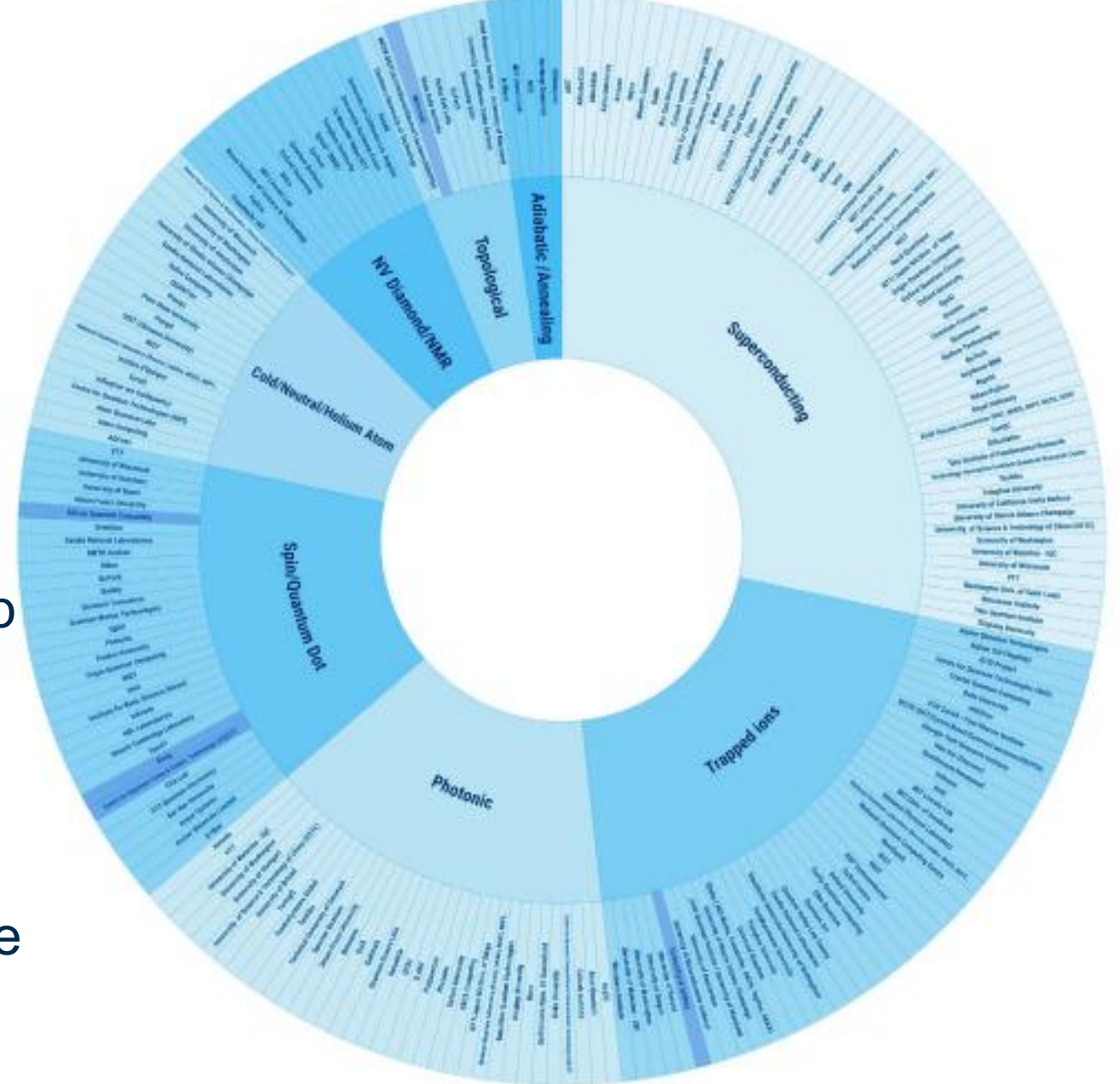


Figure 1. Global summary of the companies and academic programs developing the eight major quantum hardware technologies. Sourced from the Michel Kur, CEO of Multiverse Systems SAS,⁴⁶ and modified to highlight companies and academic efforts specific to NSW. ■ Companies specific to NSW

Quantum Computers

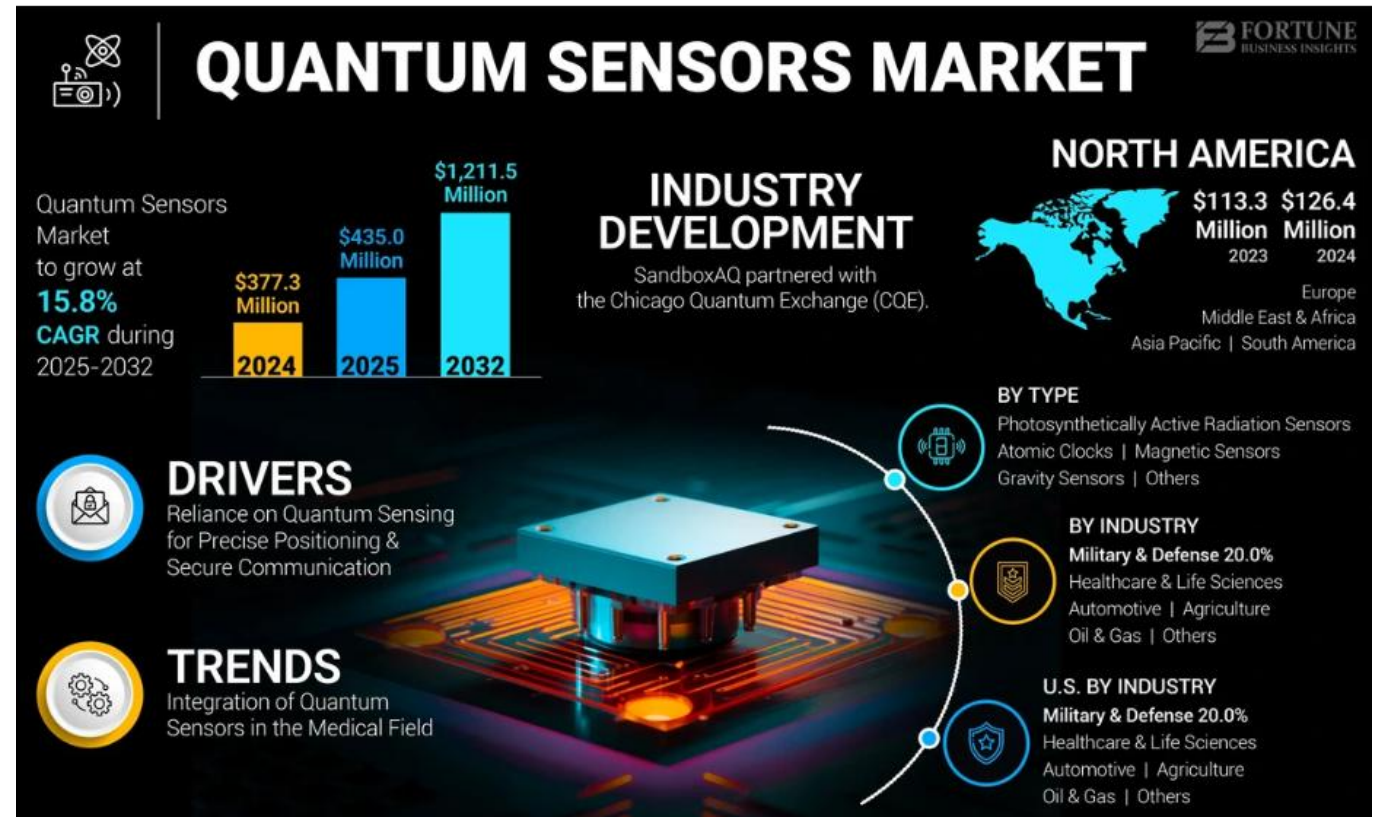
Global race

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

inside the games

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David Owen: The opportunity - and responsibility - for sport to be a force for good



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 AND FARMING

**Quantum and Farming: Revolutionizing
Agriculture with Cutting-Edge Technology**



More than this
Humic acid
product

Precision Agriculture Revolution

A. Quantum Sensors for Enhanced Monitoring

- Soil composition analysis with unprecedented accuracy
- Real-time nutrient and moisture mapping across farms
- Early disease and pest detection through quantum-enhanced imaging

B. Weather Prediction and Climate Modelling

- Improved forecasting for planting and harvesting decisions
- Better drought and flood preparation
- Long-term climate adaptation strategies

Our work

Earth observation

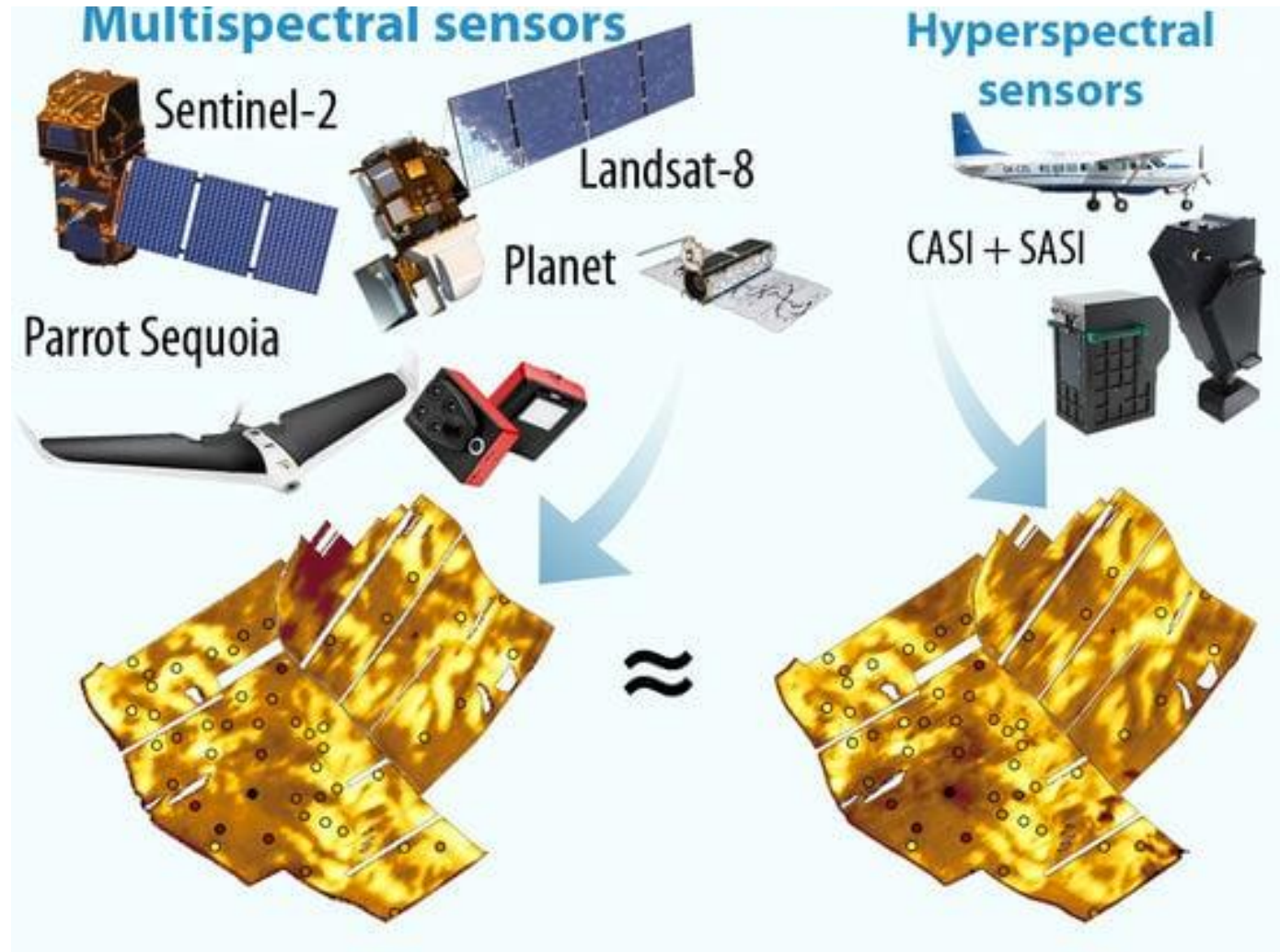
Geospatial data enabled by a new generation of quantum sensors

Convert tiny signatures into new insights

Hyperspectral imaging and synthetic aperture radar have expanded our tools to measure and map our planet, but a revolutionary new capability is coming online. We are making the next generation of quantum sensors a reality by augmenting our toolkit for earth observation through magnetism and gravity detection.

Adding quantum-enabled gravity and magnetic-field observation provides a new set of eyes to see the unseen; measure tiny changes that are currently invisible; map deviations in underground aquifer levels, monitor changes in the ice caps, and detect subsurface impacts from mining or covert activities.

Mapping Soil Carbon



Optimised Farm Operations

A. Resource Management

- Water usage optimisation through quantum algorithms
- Fertiliser application precision to reduce environmental impact
- Energy-efficient farming practices

B. Livestock Management

- Health monitoring through quantum biosensors
- Optimised breeding programs using quantum machine learning
- Feed efficiency improvements

Quantum optimization methods in water flow control

Dilnoz Muhamediyeva^{1*}, Nilufar Niyozmatova¹, Dilfuza Yusupova² and Boymirzo Samijonov³

¹ Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, National Research University, Tashkent, Uzbekistan

² Tashkent University of Information Technology after named Muhammad al-Khwarizmi, Tashkent, Uzbekistan

³ Sejong University, South Korea, Seoul, Korea

* Corresponding author: dilnoz134@rambler.ru

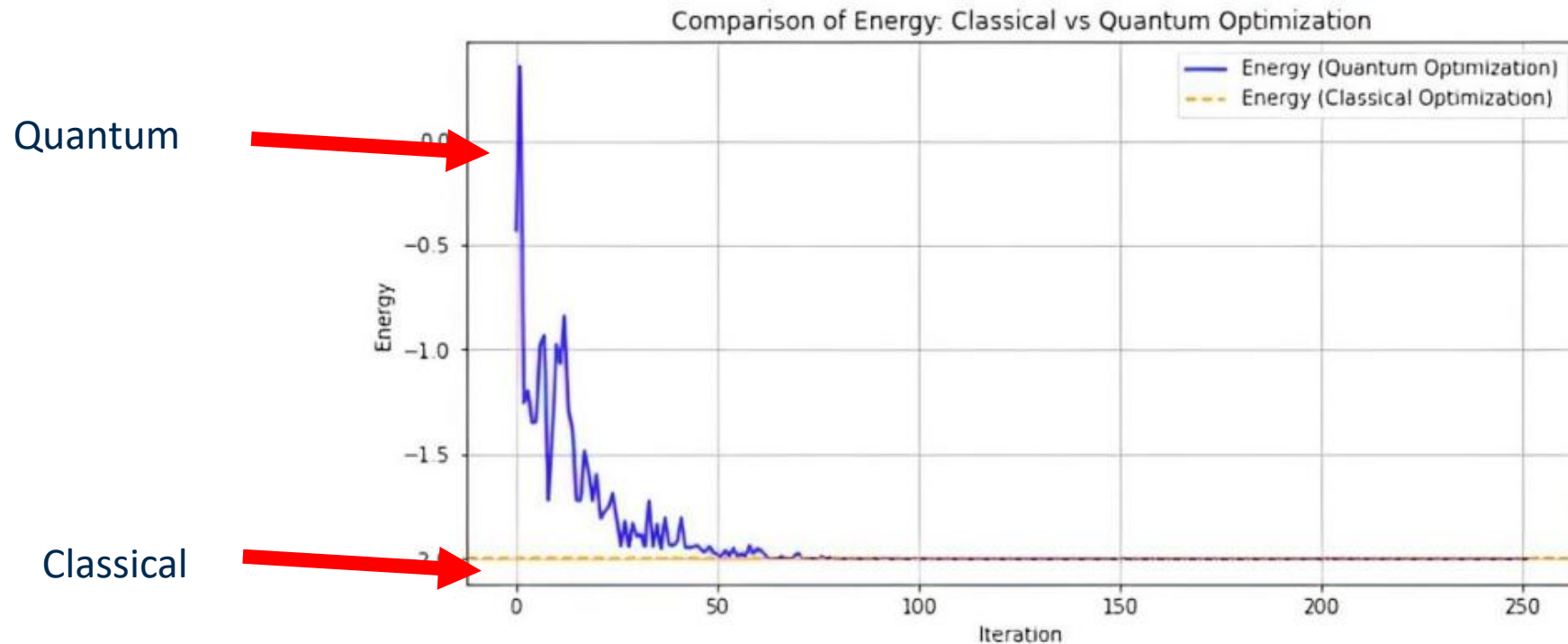


Fig.4. Energy comparison graph: classical and quantum optimization

Supply Chain and Market Applications

A. Logistics Optimisation

- Route planning for farm-to-market transportation
- Cold chain management for dairy and meat exports
- Inventory optimisation across the supply network

B. Market Analysis and Price Forecasting

- Quantum-enhanced commodity price predictions
- Risk management for export markets
- Consumer demand pattern analysis

OPEN Solving a real-world package delivery routing problem using quantum annealers

Eneko Osaba^{1✉}, Esther Villar-Rodriguez¹ & Antón Asla²

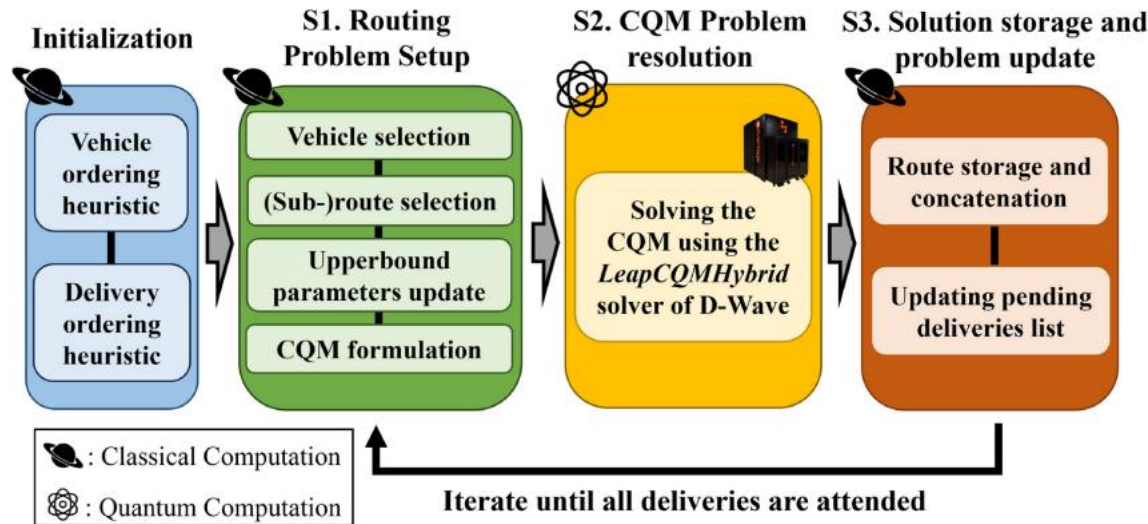


Fig. 2. General workflow of Q4RPD.

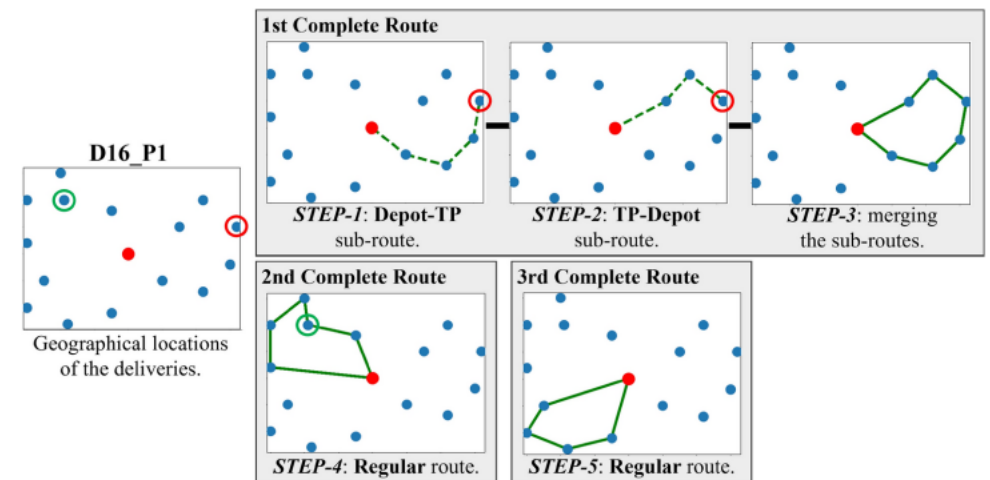


Fig. 6. Step-by-step resolution of D16_P1, consisting of non-priority 15 deliveries and one TP (surrounded by a red circle). Two non-priority demands belong to the same client (surrounded by a green circle), which are served by the same truck.

Crop Development and Genetic Research

A. Accelerated Plant Breeding

- Quantum simulations for understanding plant genetics
- Faster development of climate-resilient crops
- Enhanced nutritional content development

B. Sustainable Agriculture Solutions

- Reduced pesticide dependency through precision targeting
- Carbon sequestration optimisation
- Biodiversity preservation strategies
- Biosecurity



Review article

Assessing the potential of quantum computing in agriculture

Torsten Pook ^{a,*,} Jeremie Vandenplas ^{a,} Juan Carlos Boschero ^{b,} Esteban Aguilera ^{b,}
Koen Leijnse ^{c,} Aneesh Chauhan ^{d,} Yamine Bouzembrak ^{e,} Rob Knapen ^{f,} Michael Aldridge ^a

^a Wageningen University & Research, Animal Breeding and Genomics Group, 6708 PB Wageningen, The Netherlands

^b TNO, 2595 DA Den Haag, The Netherlands

^c Quantum Application Lab, 1098 XH Amsterdam, The Netherlands

^d Wageningen University & Research, Food and Biobased Research, 6708 PB Wageningen, The Netherlands

^e Wageningen University & Research, Information Technology, 6708 PB Wageningen, The Netherlands

^f Wageningen University & Research, Earth Observation and Environmental Informatics, 6708 PB Wageningen, The Netherlands



Computers and Electronics in Agriculture

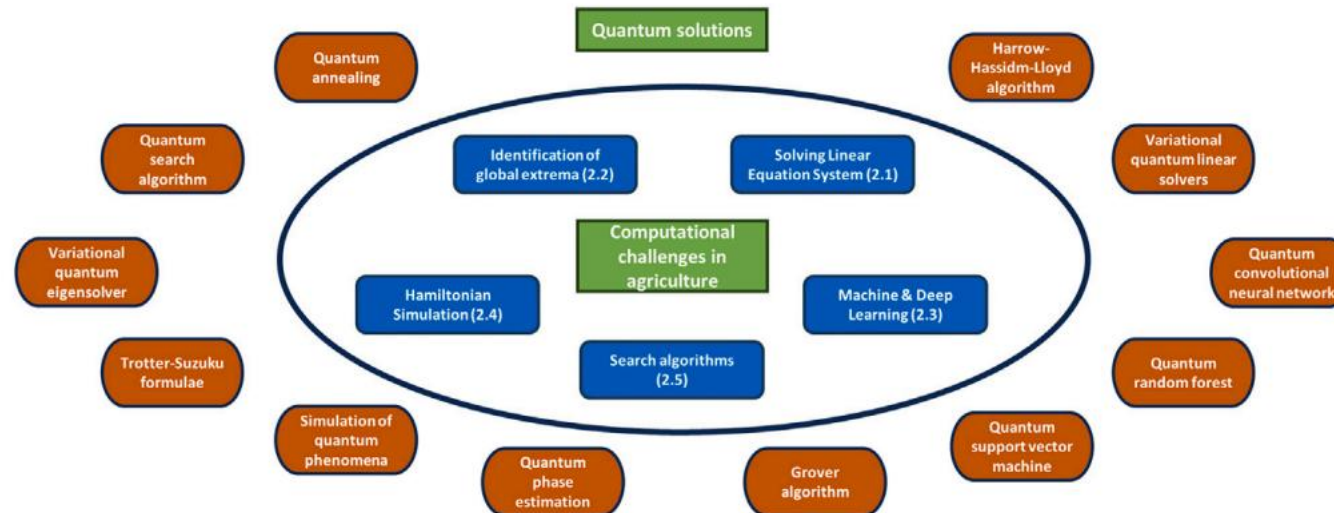


Fig. 1. Overview of potential use cases of quantum computing in agriculture.

Quantum computing - potential

- Opens the door to skipping the crossbreeding process
- Directly identify genes responsible for important traits
- CRISPR, an incredibly powerful genetic editing tool, create new varieties with the desired traits
- Proceed straight to trials stage
- Happen in a fraction of time needed to bring elite genetics to market compared to right now

New Zealand-Specific Opportunities

A. Leveraging Existing Strengths

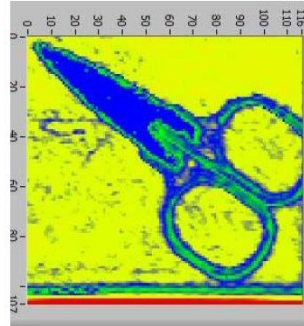
- Enhancing dairy industry efficiency and quality
- Optimising sheep and beef production systems
- Advancing horticultural exports (kiwifruit, wine, etc.)

B. Geographic Advantages

- Isolated ecosystem management
- Unique biosecurity applications
- Sustainable farming as a competitive advantage

Materials differentiation

THz imaging



Pest detection using Q sensors

Asbestos

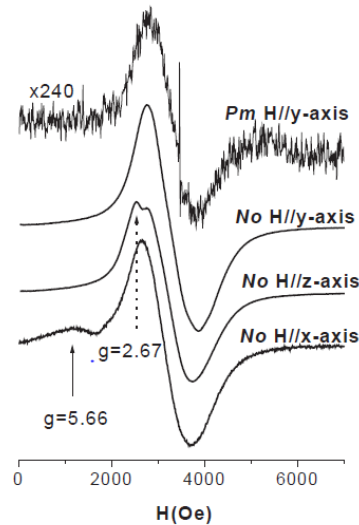
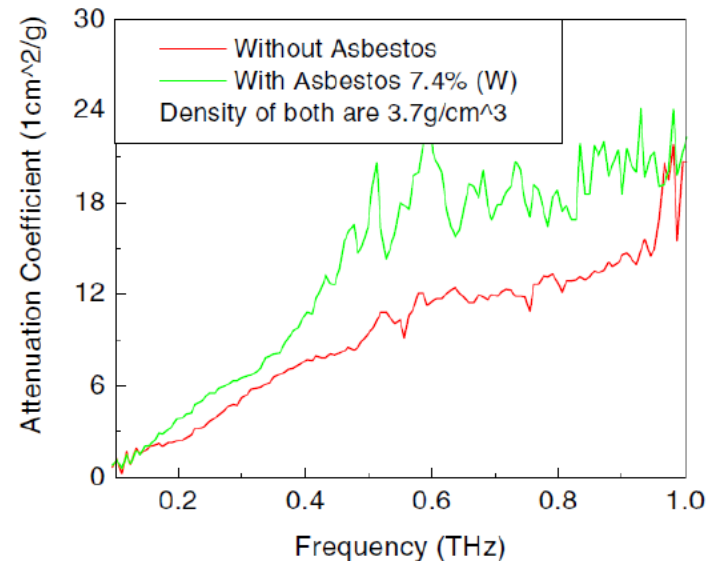


Fig. 3. RT termite FMR spectra with the applied magnetic field parallel to each axis indicated in the Fig. 1 scheme and to y-axis for migratory ant.

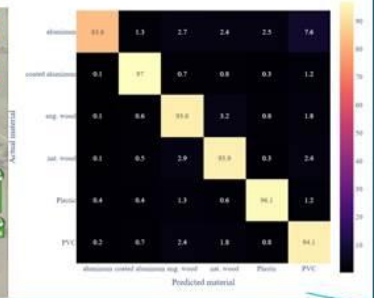
New LiDAR concept –resources and recycling

Baraja

Recycling Materials:
Accuracy 95%



Recycling materials

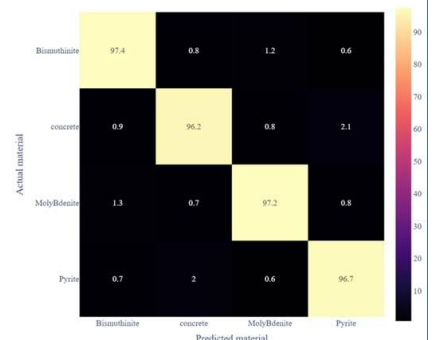


Baraja

Mining Ores:
97% accuracy



Sulphides



Today

- Could quantum tech help support the agribusiness sector?
- Looking for great ideas
- Start to link up the agriculture 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?



AFN



The question is not whether quantum computing will transform agriculture, but who will lead this transformation, says Joseph Byrum.



Thank you