



UK National Quantum Technology Programme Strategy and its global context

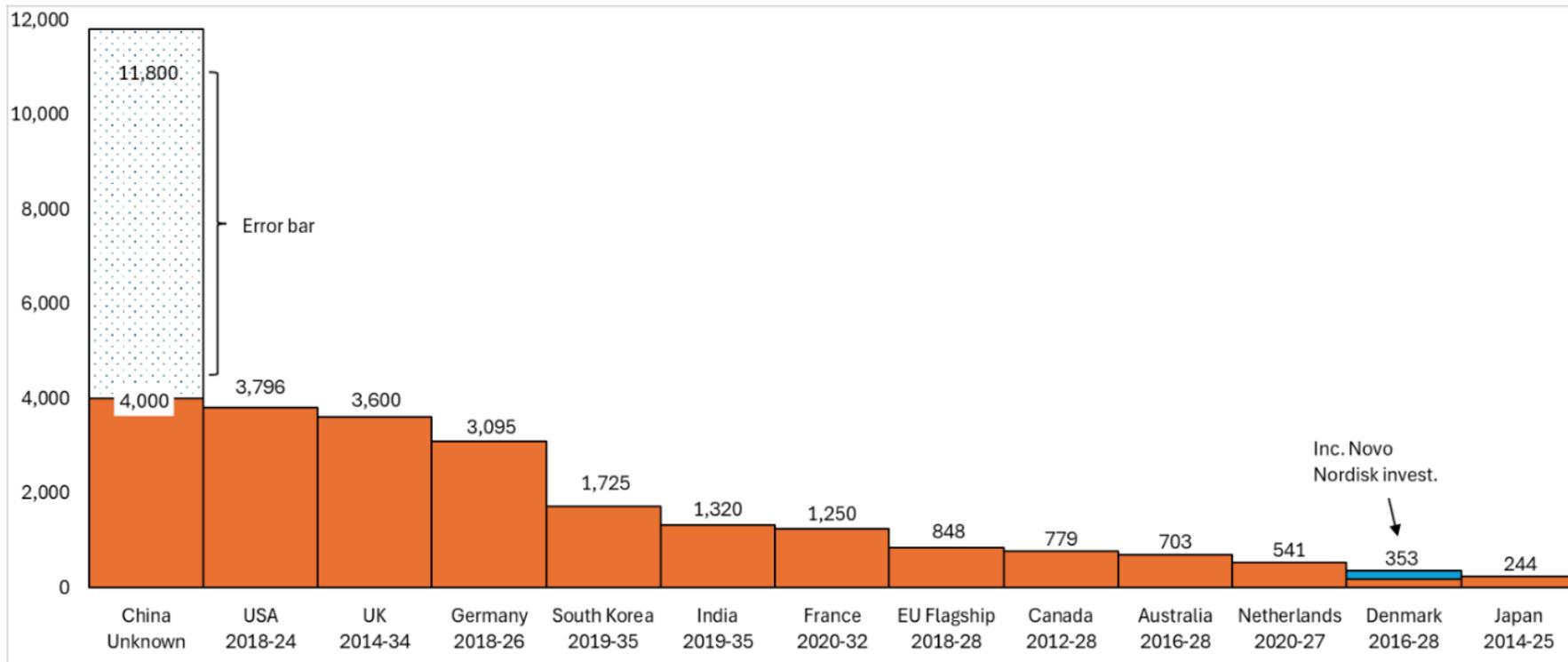
- Peter Knight
- UK National Quantum
Technology Programme

QTFP Meeting, Jan 25

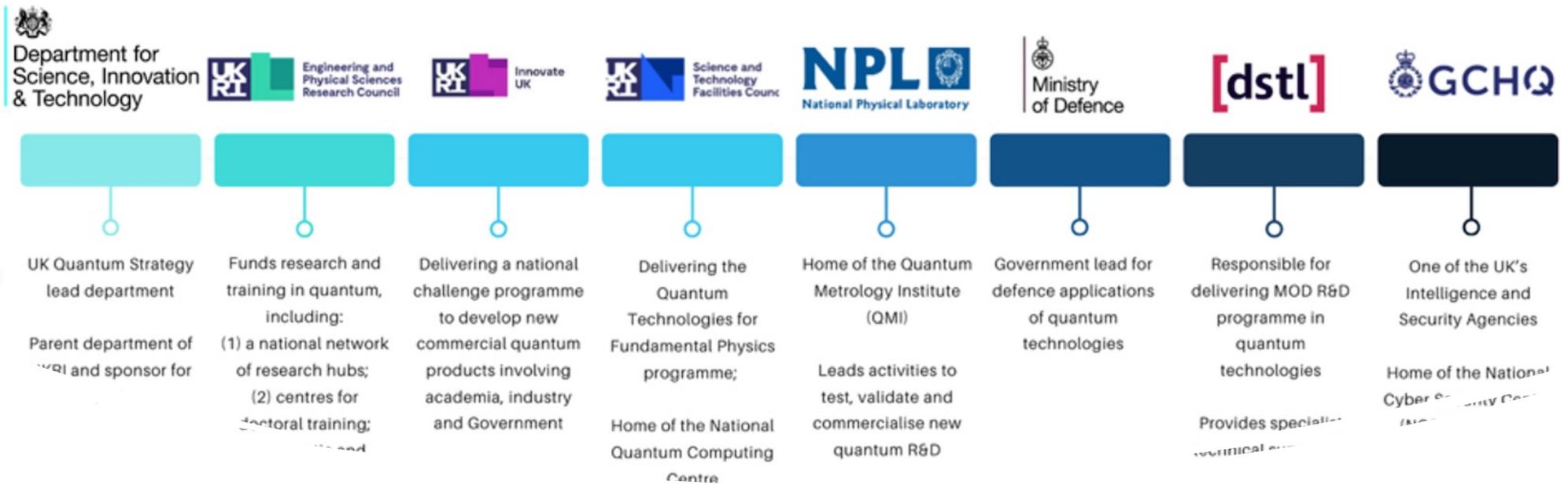
- *Does not necessarily
represent UK government
policy*

United Nations International Year of Quantum 2025

International comparison of government quantum commitments (GBP)
(DSIT internal analysis, Quantum Insider, 2024).



THE UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME (NQTP): PARTNERS AND GOVERNANCE



- Coordination: DSIT Office for Quantum; NQTP Programme Board and NQTP SAB (independent advice)

UK NATIONAL QUANTUM STRATEGY



Department for
Science, Innovation
& Technology

A ten-year plan building on the foundations laid by the National Quantum Technologies Programme since 2014, with four key pillars.



Ensure the UK is home to **world-leading quantum science** and engineering



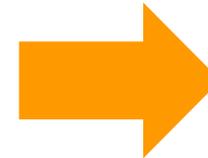
Make the UK the go-to place for quantum **businesses.**



Drive the use of quantum technologies in the UK to **benefit the economy, society and security**



Create a national and international regulatory framework that **supports innovation and the ethical use of quantum**



**Office for
Quantum**

UK £1.1BN INVESTED SINCE 2014

Research

44% of spend



- **World-leading research:** 3rd globally for quality and impact, several world firsts and university spinouts
- **Broad set of capabilities:** strengths across all quantum technologies and the supply chain

Innovation

25% of spend



- **High-levels of private investment:** 2nd globally for attracting private investment
- **Thriving business community:** 2nd globally for number of quantum companies, 180 businesses and research organisations collaborating

Infrastructure

22% of spend



- **Facilities to support early research and development** including testing and assurance capabilities pioneered through the National Physical Laboratory, Boulby Underground Lab and the National Quantum Computing Centre to accelerate scaling and readiness

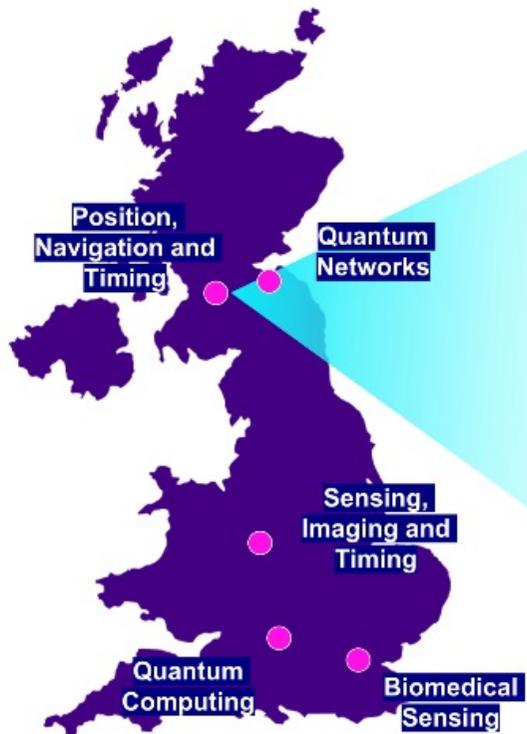
Skills

9% of spend



- **Trained over 570 PHDs since 2014** through a variety of programmes such as centres for doctoral training and doctoral studentship schemes
- **Apprenticeships programme** to train engineers to join the quantum workforce

CONTINUED COMMITMENT: £100m for new hubs



Science Secretary on quantum:
"We are at the foothills of where quantum technology is going to take us and that provides a huge opportunity for British science and British research and development."

UK: FIVE NEW HUBS, FIVE MISSIONS; £2.5BN COMMIT OVER NEXT 10 YEARS

New £100 million in government funding for five new research hubs



Hub for **Quantum Computing** via Integrated and Interconnected Implementations (University of Oxford):



By 2035 UK-based **quantum computers** capable of running 1 trillion operations that provide benefits well in excess of classical supercomputers.

Integrated **Quantum Networks** Quantum Technology Hub (Heriot-Watt University)



By 2035, the UK will have deployed the world's most advanced **quantum network at scale**, pioneering the future quantum internet.

The UK Quantum **Biomedical Sensing** Research Hub (University College London and University of Cambridge)



By 2030, **every NHS Trust will benefit from quantum sensing-enabled solutions** through early diagnosis and treatment, helping people live healthier, longer lives.

The UK Hub for **Quantum Enabled Position, Navigation and Timing** (University of Glasgow)



By 2030, **quantum navigation systems**, including clocks, will be deployed on aircraft, providing independent next-generation accuracy for resilience.

UK Quantum Technology Hub in **Sensing, Imaging and Timing** (University of Birmingham)



By 2030, mobile, **networked quantum sensors** will have unlocked new situational awareness capabilities, exploited across critical infrastructure.

Success

Commercialising QT challenge metrics		
Total number of Projects	207	230
Number of supported Businesses	157	189
Number of involved RTOS and Universities	44	
Total project cost	£300m	
Total allocated funding	£227m	£273M
Generated investment	£610m	£692M

So translation is working.
How about underpinning science



UK Quantum Technology Hub in Sensing, Imaging and Timing (QuSIT)

Led by: Professor Michael Holynski, University of Birmingham
Host university and partner support (cash and in-kind): £27.5 million

QuSIT aims to overcome the key research barriers to quantum sensing, imaging and timing being used at scale.

This will allow us to see the invisible, with demonstrations in sectors as diverse as healthcare, infrastructure, transport and security. Examples include:

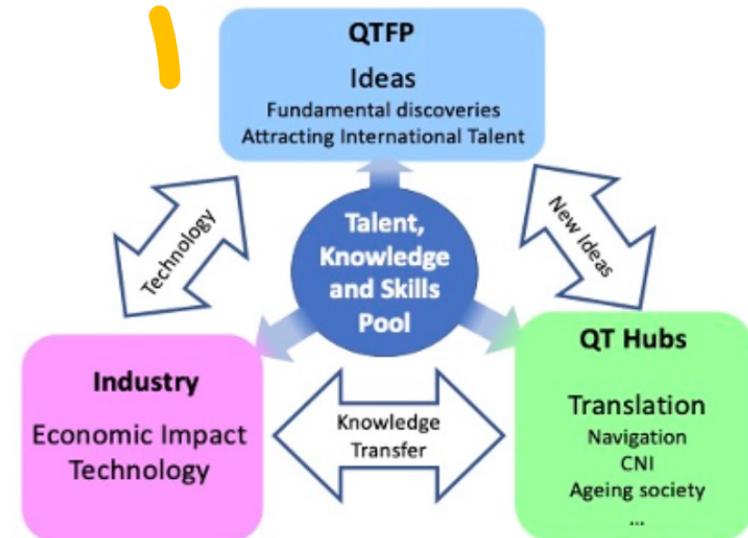
- quantum brain scanners will enhance investigation of dementia and epilepsy
- quantum microscopy will measure biomarkers for cancer diagnostics
- quantum clocks will enhance radar systems to allow better use of future airspace
- quantum cameras will detect gas leaks and hidden objects
- quantum sensing of gravity and magnetic fields will increase resilience and capacity of critical infrastructure

The hub will also work closely with industry to develop skills and people, creating the leaders of tomorrow.

QuSIT will create a pathway to widespread use and manufacture of quantum technologies, accelerating economic and societal benefits.

QTFP

- The primary purpose of QTFP is to enable advanced quantum technologies, recently innovated and demonstrated to be developed, customised and refined to enable major advances in understanding of some of the greatest scientific mysteries in fundamental physics: including the origin of the universe, the nature of dark matter, gravity, and black holes, and foundational questions in quantum mechanics.
- Addressing these internationally recognised, Nobel-calibre topics is necessarily bringing together individuals, institutions and communities who have not worked together previously into scientific collaborations.
- QTFP selected seven large projects with funding commenced in February, 2021 for up to 41 months; comprising 101 faculty and scientists, 66 post docs, 11 Engineers and technicians, 5 administrative staff and 32 PhD students (the students are funded from other sources).
- SR(1) modest extension but SR(2)? Relation to Hubs?



QTFP International

- UK-US collaborations have been spawned and MoUs signed between QTFP projects and their US counterparts e.g.
- AION(UK)-MAGIS(US),
- QSHS(UK)-ADMX(US),
- QUEST-DMC(UK)-HERALD(US),
- QTNM(UK)-Project-8(US).

UK-based and US-based scientists work side by side and in the future in some projects will be networked to enhance science reach, similar to LIGO with VIRGO/KAGRA. There are 76 partnerships between QTFP institutions and international institutions, and many institution to institution collaborations

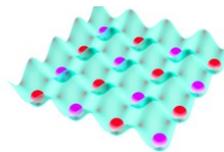
- **Boulby:** The UK has a unique opportunity to host the world's first large-scale **Dark Matter Observatory**, targeting potential Nobel-Prize-winning discoveries in the coming decades
- This will be **first international flagship** facility launched in the UK **since the 70's**, when the Joint European Torus (fusion experiment) was agreed

Computing investment has been focused on superconductors and on ion trap QC, but other platforms for quantum computing possible



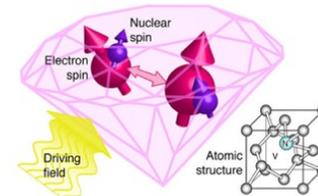
Neutral atom lattices

May offer a fast track to 1000s of qubits, initially great for simulation.



Diamond

May combine matter qubits (store and process) and light to interlink



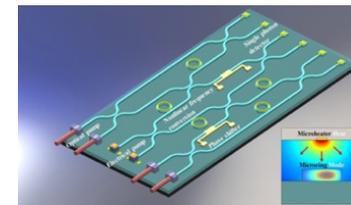
Dots or Spins in silicon

Leverage conventional fabs, ultimately could put 1 billion qubits on one chip.



All optical

All qubits are photons; may operate at room temperature.



National Quantum Computing Centre

Quantum Computing Testbeds

- Strong leadership team

Strategic Intent:

- Gain access to a range of platforms enabling evaluation and benchmarking of performance
- Drive both in-house development and external platform evaluation
- Evaluate and de-risk deployment to help drive user-adoption
 - cost, time, performance ...
- Accelerating UK Government as an informed customer and user

£30m investment

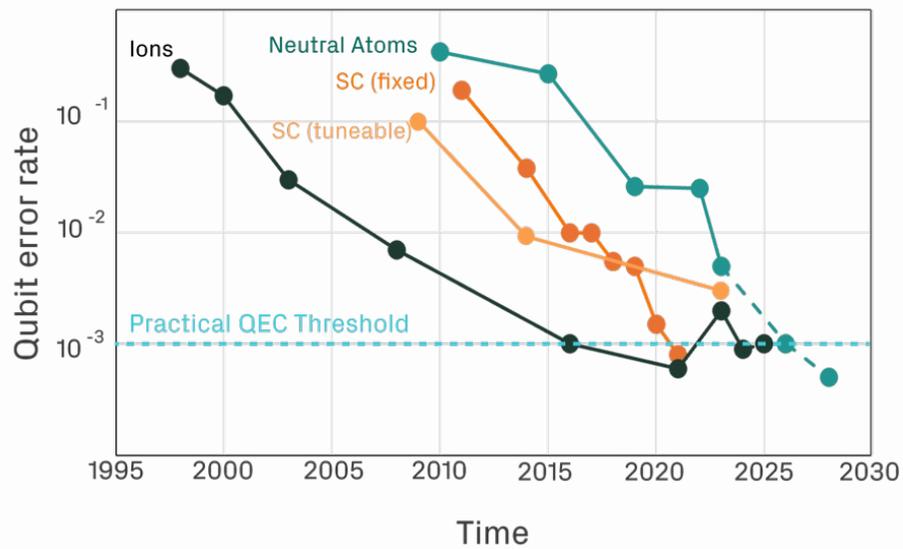
- 15 month deployment
- 24 month evaluation

Supplier	Platform Type
AEGIQ	Photonic
Cold Quanta UK	Cold Atom Tweezer Array
ORCA Computing	Photonic
Oxford Ionics	Trapped Ions
Quantum Motion	Si Quantum Dots
QuEra Computing	Cold Atom Tweezer Array
Rigetti UK	Superconducting

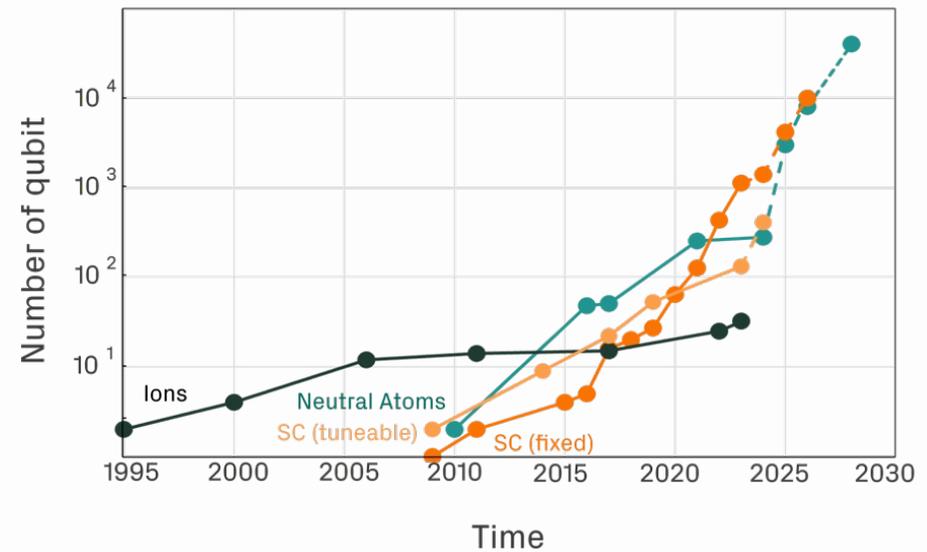


National Quantum
Computing Centre

Two decades of progress in qubit technologies mean that the QEC era is now



Qubit error rates are now at the practical QEC threshold

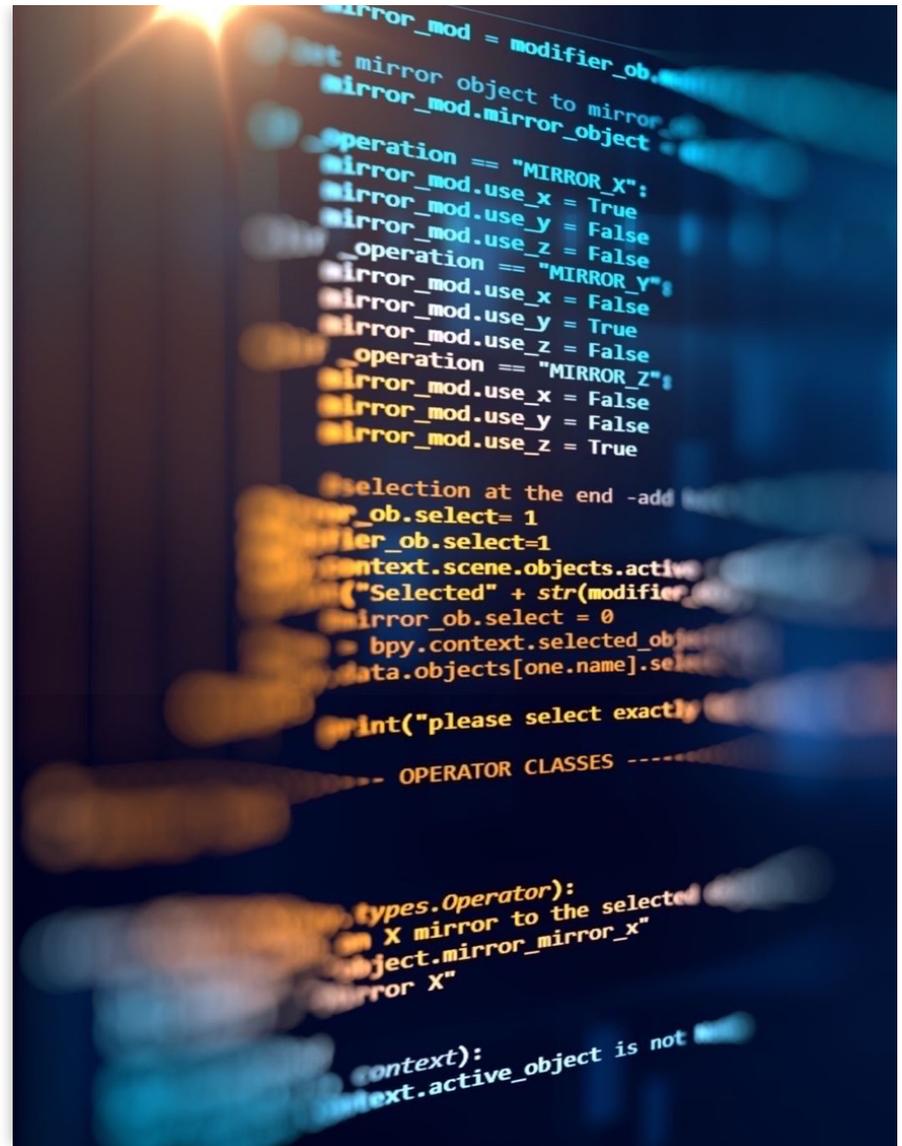


Multiple companies have a clear path to scaling qubit numbers

Microsoft and Quantinuum: 12 logical qubits from 56 physical qubits (99.8% 2-qubit fidelity); logical qubits entangled in GHZ state, circuit error rate 0.0011, 22x better than physical qubit circuit error rate; repeated qec rounds successful. And hot off the press, Google's Willow Chip and QEC rounds

Drowning in data- error correction

- Running a program on an error-corrected quantum computer generates a very fast continuous stream of QEC data.
- A commercial-grade quantum computer would stream about 100 Terabytes of QEC data per second.
- That's the equivalent of Netflix's total global streaming rate.
- This flood of data must be processed in real-time by sophisticated algorithms, whose task is to identify the underlying errors and issue corrective measures.





United Nations International Year of Quantum

- The U.N. June 7, 2024 declaration: a signal for any individual, group, institution, or government to use 2025 to increase awareness of quantum technology. The IYQ Steering Committee plan global events, particularly those that reach audiences unaware of the importance of quantum technology.
- Quantum technology: a key cross-cutting scientific field of the 21st century, with tremendous impact on critical societal challenges highlighted by the U.N.'s 2030 Sustainable Development Goals, including climate, energy, food safety and security, and clean water.
- The most important step in finding new insights and solutions will be inspiring young people, drawn from all over the world, to be the next generation of quantum pioneers who will use quantum science to make a positive difference in the lives of others. This International Year is an opportunity to learn more about the ways quantum science underpins the physical world around us, drives technological innovation, affects government policies, impacts the global economy, and influences art and culture.
- In the lead up to 2025, any individual, group, organization, institution, or government can help aid the mission of the International Year by facilitating the creation of events or resources to improve understanding of the importance and impact of quantum science and technology.



- the current UK Quantum programme focus on translation and on fostering quantum science
- Great research turning into economic and societal benefit
 - The international picture of rapidly increasing interest and investment
 - Major UK push on Quantum Technology (not just computing!) reflecting our increased ambition: be bold! Similar elsewhere in other countries.
- 2025 UNESCO International Year of Quantum: join us in celebrating!

