UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME

Growing a skilled workforce in quantum technologies

The UK is uniquely positioned to train world-leading researchers in quantum technologies. In 2013, the government recognised the transformative potential of new quantum technologies by announcing a £270 million investment to form the UK National Quantum Technologies Programme (UKNQTP).

The vision is to create a coherent government, industry and academic quantum technology community that gives the UK a world-leading position in the emerging multi-billion-pound new quantum technology markets, and to substantially enhance the value of some of the biggest UK-based industries. This flyer aims to demonstrate examples of progress towards growing a skilled UK workforce in quantum technologies.

The UK's National Strategy for quantum technologies identifies five areas for action:

- Enabling a strong foundation of capability in the UK.
- Stimulating application and market opportunities.
- Growing a skilled UK workforce in quantum technologies.
- Creating the right social and regulatory context.
- Maximising UK benefit through international engagement.

The programme delivers against the strategy through five pathways:

Training the next generation of quantum engineers

The UK National Quantum Technologies Programme has invested over £28 million in graduate training, through dedicated Centres for Doctoral Training (CDTs) and Training and Skills Hubs in Quantum Systems Engineering, as well as additional funding through the EPSRC Doctoral Training Partnership (DTP). This is complemented by a further 46 studentships supported by Dstl at 16 universities across the UK.

The three Quantum Technologies CDTs, based at University College London, Imperial College and the University of Bristol, are currently training 57 students. The four-year CDT programmes include one year of Masters-level training followed by a PhD research project.

"We've been off to a great start; the quantum technologies profile across the UK and beyond is growing, and the potential applications of quantum technologies are increasing year on year. It's still early days but we're already very excited about the research our students are doing."

- Quantum Engineering CDT, University of Bristol

"The key advantage of the CDT model for quantum technologies is that the students begin research already possessing a knowledge of the field and of the UK community doing quantum research."

- CDT on Controlled Quantum Dynamics at Imperial College London

Quantum technology fellowships

To ensure that there is a skilled workforce in quantum technologies the UK National Quantum Technologies Programme is supporting the development of skills at all levels and career stages. This £16 million investment in the fellowship programme allows 14 key researchers to develop their own skills and careers through projects around quantum technologies and devices. Not only does the fellowship allow them to develop themselves, but they also play an active role in growing a skilled workforce through their interactions with PhD students, other researchers and industry partners.

Find the national strategy and technology roadmap on our website: uknqtp.epsrc.ac.uk

£11 million for new Training and Skills Hubs

The Minister for Science, Jo Johnson, recently announced investments in graduate training, which included £11 million for three new Training and Skills Hubs in Quantum Systems Engineering.

The Training and Skills Hubs, based at University College London, Imperial College and the University of Bristol, complement and build on the experience of the existing Centres for Doctoral Training in quantum engineering, and have already attracted £3.3 million in leverage from more than 30 project collaborators. Professor Andrew Fisher, lead for the Training and Skills hub at UCL, describes this award as an exciting addition to the training offered by UCL's Quantum Science and Technology Institute (UCLQ).

"The new Training and Skills Hub in quantum systems engineering will enable us to strengthen the work we already do within the CDT in Delivering Quantum Technologies by providing more training specifically focussed on whole-systems engineering, by enabling more students to work more widely within the UK National Quantum Technology Programme, and by addressing all stages of the people pipeline in quantum technologies."

- Professor Andrew Fisher

This announcement was made during a visit to the University of Oxford, which leads the Networked Quantum Information Technologies Hub, where Jo Johnson was given a tour of the laboratories, and met with researchers and PhD students including Vera Schäfer.

"It is exciting to see the interest into our research grow and to see how more and more people from industry and politics recognise it as an attractive future technology. It is thrilling to be working on quantum technologies during such a fast-moving time."

- Vera Schäfer, PhD student at the University of Oxford

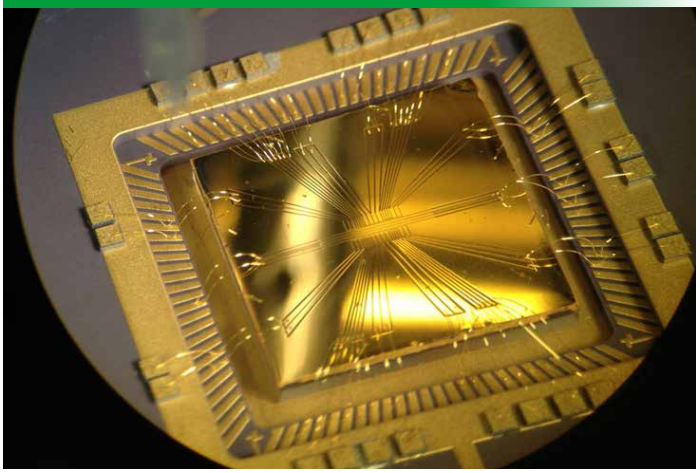
Gold ion-trap chip for quantum computation

This ion-trap chip was developed at the University of Oxford to test ideas of manipulating individual qubits using microwave electronics.

When electric potentials are applied to the chip's electrodes, single atomic ions can be trapped above the chip. Each ion can then be manipulated between two different energy states to act as a single 'qubit', allowing the system to store elementary units of quantum information. The state of the qubits can then be individually controlled by microwave signals applied to the same electrodes. This project was jointly funded by the EPSRC and the United States Army Research Office.

The Oxford team, based at the Networked Quantum Information Technologies Hub, recently achieved the world's highest-performing qubits and quantum logic operations.

Winner of the EPSRC national science photography competition: 'Microwave ion-trap chip for quantum computation' by Diana Prado Lopes Aude Craik, University of Oxford.



University of Birmingham student develops multi-sensor device for navigation

PhD student Andrew Lamb is developing a device which provides the user with information such as the tilt, rotation and direction of their platform - which could be anything from a fighter pilot to an autonomous car.

The Dstl-funded project aims to create a robust and portable quantum sensor capable of measuring two axes of rotation and absolute pointing, and the measurement of gravity, all in a single device. This offers applications in navigation, improving on the performance of current devices and increasing resilience against loss of GPS.

In developing a core system for the sensor, Andrew, with fellow researchers at the University of Birmingham, has already drastically improved the portability of cold atom systems, allowing the team to move the technology out of the laboratory.

This kind of research is an excellent way of developing the skills required to be at the cutting-edge of quantum technologies research, as Andrew explains below:

"Making something with this level of portability has meant developing skills which are not just those of a physicist – but also a strong mix of engineering skills and systems-level thinking – creating a unique skill set required for translating fundamental science into technology."

Andrew works in the UKNQT Hub for Sensors and Metrology, where the new Technology Transfer Centre enables researchers to work alongside industrial partners who want to learn and acquire the skills needed for this field.

"This creates a vibrant mix of people with different skills and expertise, all working together on quantum sensing, and also creates excellent opportunities for jobs within industry."

- Andrew Lamb, PhD student at the University of Birmingham

For more information, visit **uknqtp.epsrc.ac.uk** or contact **quantumtechnologies@epsrc.ac.uk**

The UK National Quantum Technologies Programme aims to ensure the successful transition of quantum technologies from laboratory to industry. The programme is delivered by EPSRC, Innovate UK, BIS, NPL, GCHQ, Dstl and KTN.

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