THE UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME

www.quantumcity.org.uk

QUANTUM CITY

The next generation of quantum technologies is here. Learn about quantum science with partners from the UK National Quantum Technologies Programme and see what living in a "Quantum City" might be like.

QUANTUM PHYSICS HAS CONTRIBUTED TO TECHNOLOGY SUCH AS LASERS AND SEMICONDUCTORS THAT RUN OUR COMPUTERS AND SMARTPHONES AND CONTINUES TO INSPIRE AND DRIVE INNOVATION. WITH THE HELP OF QUANTUM SCIENCE, THE UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME IS WORKING TOWARDS MAKING A POSITIVE DIFFERENCE TO YOUR EVERYDAY LIFE, FROM MEDICAL, FINANCE, ENERGY USE AND TELECOMMUNICATIONS TO IMAGING AND COMPUTING.

FANCY A FUTURE CAREER IN QUANTUM CITY?

The next generation of quantum technologies will soon be here and it is an exciting time to be a part of it. The UK is already investing in training and further development of future scientists and quantum engineers with centres for doctoral training to explore and push the boundaries of quantum science. If you're interested in finding out what it might be like to be working in the field of quantum physics, come speak to us at Quantum City. We'll be more than happy to share our experience!

YOUR TRAVELLING EXPERIENCE

Are you tired of interruptions to your journey, whether it's sitting in endless traffic jams or waiting for a delayed train? Pipes, mine shafts, sink holes or tunnels that are too far down underground to be detected by existing sensing technology can be hazardous and also cause severe disruption to roads and train lines because of extensive roadworks to find them.

The Quantum Technology Hub for Sensors and Metrology, based at the University of Birmingham, is improving gravity sensors to help reveal these hidden landscapes and improve our understanding of our underground space. Disruption to roads and train lines will be minimised as we will be able to assess what is underground more quickly and efficiently without having to dig up road surfaces. This will have a positive impact on the transport industry and your journey.

MAKING THE INVISIBLE VISIBLE

Driving in limited visibility conditions such as dense fog and falling snow can be dangerous. So imagine if one day your car might be equipped with quantum imaging technology that only requires a single pixel (that's a lot less than the mega-pixels in your smartphone!) to "see" through fog or look around corners, allowing for a safer driving experience.

At QuantIC, the UK Quantum Technology Hub in Quantum Enhanced Imaging at the University of Glasgow, we are developing new technology that will allow us to make the invisible visible. We are working on cameras that can detect leaks of invisible gases such as methane, look around corners, monitor agricultural crops more efficiently, and detectors that will push the boundaries of existing medical imaging technology.

QUANTUM COMPUTERS: A BIG IMPACT FROM BEHIND THE SCENES

Quantum computers will be with us soon. Currently, only small devices are available, but in maybe a few years they will be impacting our everyday lives. You probably won't directly access one, though, but the benefits of its computations will be felt in all sorts of ways. For example, quantum computers could be used to develop much more efficient batteries for your electric car or to find new drugs that have fewer side effects. They could be used for artificial intelligence and optimising complex problems - so autonomous vehicles are safer and your parcels are delivered more quickly.

The UK Quantum Computing and Simulation Hub, a consortium of 17 british universities, is working on a wide variety of quantum computing technologies. Their aim is to accelerate the development of the high-performance, general-purpose devices needed to make the quantum computing revolution possible.

ONLINE SAFETY GUARANTEED BY THE LAWS OF PHYSICS

The importance of data security, during both transmission and storage, is arguably more profound than it has ever been. Smartphones, computers, apps and various digital technologies rely on data security to keep countries, governments, companies, institutions and individuals safe and free from data breaches. Current secure communications technologies can have vulnerabilities, both in hardware and in their software – the implementation of mathematical encryption employed for security. We now know that some very widely deployed mathematical encryption techniques (Public Key Encryption) will be rendered insecure by the emergence of future quantum computational technologies. Worse still, encrypted communications sent now can be stored to be decrypted in the future, when quantum computers become available, so information with a requirement for long-term security is potentially already under threat today.

The UK Quantum Communications Hub, led by the University of York, is using quantum properties to develop quantum communications technologies and services for secure transactions and transmissions of data across a range of users in real-world applications: from government agencies and industrial set-ups to commercial establishments and the wider public.

QUANTUM MEASUREMENTS MAKE EVERYTHING WORK

The National Physical Laboratory (NPL) is the UK's National Measurement Institute and uses quantum technologies in many ways, including extremely accurate measurements of time and electrical current.

Atomic timekeeping is a quantum phenomenon: using discrete steps between atomic energy levels to set a reliable steady clock 'tick'. This technology, first established in the 1950s, continues to be developed, facilitating ever-more precise timekeeping. The first atomic clocks kept time to about 1 second every 300 years and instruments being developed at NPL today are expected to be accurate to within one second in the lifetime of the universe. Time is the quantity we can measure most accurately so it is used in many types of high precision measurement such as length. Inhabitants of a Quantum City use atomic timekeeping continuously in 'SatNav' (satellite navigation) systems where signals from a constellation of satellite based atomic clocks are triangulated to establish location. We rely increasingly upon this technology to know where we, our families, our taxis and our possessions are.

We can measure electrical current (flow of electrons) with unprecedented precision using a quantum device – a tiny microchip, which pumps and counts single electrons just above the lowest possible temperature. This is a new approach to defining the international unit of electrical current – the Ampere – which comes into action in 2019. The redefinition and the method will enable exciting new applications in electrical science and engineering in health, communication and transportation for the Quantum City of this century and beyond.

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The UK National Quantum Technologies Programme was established in 2014 to ensure the successful transition of quantum technologies from laboratory to industry, and is set to invest £1B of public and private sector funds over its ten-year lifetime.

The programme aims to create a coherent government,industry, and academic quantum technology community that gives the UK a world-leading position in the emerging multibillion-pound quantum technology market.

We hope you've enjoyed your visit to Quantum City. We would love to hear ideas or questions you might have for how we can use quantum technologies and how it might impact you. Visit us at www.quantumcity.org.uk to find out more about our work and let us know!

"Quantum City" is a joint initiative brought to you by the following partners of the UK National Quantum Technologies Programme:

UKRI Engineering and Physical Sciences Research Council

Quantum Computing & Simulation Hub

QUANTIC The UK Quantum Technology Hub in Quantum Enhanced Imaging

UK National Quantum Technology Hub Sensors and Metrology

QUANTUM COMMUNICATIONS HUB

NPL

UCLQ Quantum Science & Technology Institute