Innovate UK

Results of Competition: Commercialisation of Quantum Technologies 4

Competition Code: 1707_CRD_EE_QUANTECH_4

Total available funding is £6M from Innovate UK and £3M from EPSRC

Note: These proposals have succeeded in the assessment stage of this competition. All are subject to grant offer and conditions being met.

Participant organisation names	Project title	Proposed project costs	Proposed project grant
QUANTOPTICON LTD.	Simulation Software for Modelling Quantum Light Sources	£182,588	£127,812
Tyndall National Institute		£5,000	£0
University of Cambridge		£88,046	£88,046
University of Oxford		£89,276	£89,276

Project description - provided by applicants

Quantum photonics is an emergent field of technology promising to revolutionise science and day-to-day life alike. Amongst other benefits, it is anticipated that it will usher in ultra-secure communication, powerful super-fast computers and vastly increased data storage. These advancements are all based on the premise of developing single-photon sources: special sources of light characterised by emitting one photon at a time. Semiconductor QDs, consisting of nanometre-sized inclusions of one semiconductor within another, are atom-like systems emerging as attractive candidates for SPSs. However, they operate at very low temperatures requiring liquid helium cooling, which is a major drawback. In this project, we will apply our unique simulation software for prediction of the interaction of light pulses with quantum nanostructures to design, build and optimise integrated nitride SPSs that can produce single photons at temperatures in excess of 200 K reachable by on-chip thermoelectric cooling. By applying our software to this cutting-edge quantum technology area, we aim to prove its integrity and predictive power. This will be an important step on the road to developing an indispensable toolkit for quantum photonics research and engineering.

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RIVER LANE RESEARCH LTD	Quantum Collective Knowledge	£209,430	£146,601
DIVIDITI LIMITED		£190,339	£133,237

Project description - provided by applicants

Quantum Collective Knowledge (QCK) is a product that enables businesses to be ready for the revolution in computing power offered by quantum computers. QCK organises and simplifies the devise quantum computing offering allowing companies to initiate and lead groundbreaking, interdisciplinary and collaborative research projects into hybrid quantum and classical computing. QCK enables fair and reproducible benchmarking, optimization and co-design of quantum software and hardware while dramatically reducing time to market and R&D costs. It represents the first practical framework for hybrid quantum and classical computing.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
CHRONOS TECHNOLOGY LIMITED	Quantum Fibre Clock (QFC)	£109,615	£76,730
TMD TECHNOLOGIES LIMITED		£196,832	£118,099
University of Bath		£186,783	£186,783

Project description - provided by applicants
There is clear evidence of Quantum innovation from two key publications -- The UK Blackett report published by the Government Office for Science on 'The Quantum Age: Technological Opportunities' and the EU Report 'Quantum Manifesto'. These both address the growing importance of quantum technology and in particular for the development of future atomic clocks. Atomic clocks offer unparalleled accuracy and stability without dependence on GPS. At present, many applications in the defence, broadcast and financial industries are vulnerable to jamming, spoofing or errors in the GPS system itself. The Quantum Fibre Clock (QFC) project will use hollow-core optical fibre filled with caesium vapour to produce an atomic clock which is smaller, lighter and more efficient than existing technologies. QFC will capitalise on UK momentum to stay ahead and give the UK a competitive advantage in the market place. The project will research the evolution of the hollow core fibre quantum research invented and undertaken by University of Bath in partnership with TMD Technologies Ltd and led by SME Chronos Technology Ltd. The previous research has concentrated on manufacturing an efficient hollow core fibre architecture, filling with rubidium vapour to create the physics package and developing the interface electronics to enable stability testing at 10 MHz and 1PPS. This project will concentrate on the filling of the hollow core fibre with caesium, and subsequent creation of a working prototype clock and a small quantity of demonstrators. These will be used to inform prospective users that the technology is viable and enable testing in appropriate applications and environmental conditions such as temperature, pressure, shock and vibration.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
CRAFT PROSPECT LTD	Augmentation of Future Quantum Key Distribution Networks with CubeSat Systems	£74,818	£52,373
University of Bristol		£7,811	£7,811
University of Strathclyde		£14,225	£14,225

Project description - provided by applicants

CubeSats (< 10 kg nanosatellites, with dimensions 10-40 cm) offer an accepted cost-effective and rapidly deployed opportunity to provide both proof-of-concept to a wider market and for technology raising. They are also now part of the final service delivery in some markets disrupting the status quo; for example, in Earth Observation where CubeSats support the delivery of monthly < 5 m resolution imagery of global landmass. This feasibility study seeks to determine the extent to which the momentum and agility of the CubeSat marketplace and the progress made in overall performance can be applied and aligned to capitalise on the emergence of space-based Quantum Key Distribution (QKD). QKD offers a highly secure method for encryption key distribution critical to modern data systems security from financial transactions through the internet to military communications. In looking across technology demonstration through to service delivery opportunities for CubeSats, key concerns over mission assurance and quality of service achieveable will need to be addressed. As such, the work will bring together business needs and capabilities across stakeholders from telecoms providers, investors, mission architects and quantum technologists.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
OPTOCAP LIMITED	SLAM - Squeezed Light quAntum MEMS Gravimeter	£215,833	£107,917
IQE SILICON COMPOUNDS LIMITED		£85,225	£42,613
University of Glasgow		£198,903	£198,903

Project description - provided by applicants

Work at the University of Glasgow has already taken a silicon fabricated mass on a spring fabricated using the same Micro- Electro Mechancal System (MEMS) technology to the gyroscope in all smart phones that determine orientation and improved the sensitivity by a factor of 5000\. This MEMS gravimeter has the potential to be used to search for new oil & gas researches, find buried utilities quickly thereby reducing roadworks and provide an early warning for volcanic eruptions. The project aims to deliver a quantum squeezed light source with pairs of correlated photons that can be used to measure the output of the MEMS gravimeter improve the sensitivity by up to a factor of 40\. The project involves developing a photodetector that can detect single photons which also has applications of rangefinding (determining how far away objects are by bouncing photons off them and timing their return) at wavelengths of light that can see through rain, mist and fog.   A key objective is to secure a UK supply chain using IQE to deliver commercial Ge on Si epitaxy for single photon detectors and Optocap to produce chip-scale vacuum packages with fibe-optic access which are essential components for the MEMS gravimeter.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
OPTOCAP LIMITED	rAmpart	£234,999	£117,500
FRAUNHOFER UK RESEARCH LIMITED		£193,704	£193,704
PHOTON FORCE LTD		£62,626	£43,838

Project description - provided by applicants

This project will develop tapered-amplifiers and single-photon detection techniques in order to develop a Time-of-Flight underwater 3D imaging system. These systems use new single-photon counting detectors and timing techniques to enable imaging with low-light return levels and offer sub-centimeter depth resolution. The developed systems will offer order-of-magnitude improvements over competitive commercial systems and the developed components will have widespread applications.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
M-SQUARED LASERS LIMITED	TORQUE: Atom Interferometric Rotation Sensor for Quantum Enhanced Navigation	£249,261	£149,557
University of Birmingham		£248,750	£248,750

Project description - provided by applicants

M Squared Lasers and the University of Birmingham are aiming to collaborate in the area of atom interferometric rotation sensors, in order to establish a capability in the strategically important area of quantum-enhanced navigation hardware. The partners have a track record of commercialisation and project delivery in atom interferometry and related gravimeter devices. The proposed work will build upon the partners' collective expertise and close working relationship built up over the last few years in collaborations through Knowledge Transfer Studentships, the Quantum Technology Hub for Sensors and Metrology and Innovate UK projects in atom interferometry and gravimetry. Quantum-enhanced navigation systems aim to deliver ground-breaking performance levels for a variety of applications. The use of atom interferometry for rotation sensing is intended to enable a step change in capability for a key subsystem in future quantum inertial measurement units.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
M-SQUARED LASERS LIMITED	IOTA: Compact Ion Clock for Precision Timing Applications	£251,155	£150,693
University of Sussex		£248,840	£248,840

Project description - provided by applicants

Precision timing plays a vital role in the economy, from enabling satellite-free navigation to protecting the integrity of electronic financial trading. In this project, M Squared Lasers, together with the University of Sussex will develop a portable optical atomic reference based on trapped ions and an optical micro-comb. Both systems together can function as an atomic clock with a significantly improved accuracy compared with current commercial systems. This 12 month project will establish a commercial capability in this strategically important field, bringing the academic outputs into the industrial domain and towards practical deployment in a range of sectors.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
M-SQUARED LASERS LIMITED	MICROCOMB: Compact and Portable MicroCombs for Frequency Metrology and Photonic Applications	£252,819	£151,691
NATIONAL PHYSICAL LABORATORY LIMITED		£244,727	£244,727

Project description - provided by applicants

The aim of this project is to develop an ultracompact frequency comb based on a microresonator to be used for frequency metrology and photonics applications. Microcombs can be used for optical frequency metrology, trace gas sensing, and as channel generator in telecommunication networks.   Conventional laser based frequency combs can be used for highly accurate frequency metrology however their large SWaP characteristics preclude their adoption. A key application area is in the telecoms industry where data is transmitted at a number of closely packed wavelengths using dense wavelength division multiplexing (DWDM) systems. The number of these channels keeps increasing and requires higher resolution spectrum analysers than the currently used systems.   Researchers at NPL have demonstrated that a chip-based microcomb can be developed that is compact and portable and presents an ideal tool to service this need. It is well recognised that increasing broadband capabilities has direct benefits to the UK economy, with a recent government report finding for every £1 invested £20 is returned on investment.   The microcomb can be used as a method of ensuring a lasers frequency is stable. Lasers are used across a range of industries and their precision is essential. A key goal of this project is to implement and test the microcomb on M Squareds main Ti:Sapphire laser system the SolsTiS. This will provide a rapid commercialisation route to an immediate market with an established customer base and sales and distribution network. Furthermore, the microcomb is an essential component to many quantum technologies in particular optical clocks, and would be used to increase accuracy of atom interferometric systems such as gravimeters, rotational sensors and accelerometers. M Squared is a key player in the commercial quantum technology landscape and the microcomb will play a key-enabling role across this sector.   This project presents an opportunity for knowledge transfer from academic leaders in microcombs at NPL to experienced photonics commercialisation partners at M Squared Lasers. The immediate applicability of the microcomb offers a unique opportunity to disrupt industries with a quantum technology, and generate early returns on investment in order to gain traction for the technology in the telecoms industry and the quantum field in general.

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REDWAVE LABS LTD	Compact control systems for quantum technologies CONE	£145,010	£101,507
University of Birmingham		£144,953	£144,953

Project description - provided by applicants

Quantum technology has the potential to have great impact upon various aspects of our daily lives. Across the UK National Quantum Technology Programme, work is underway to realise benefits to multiple sectors, for example within healthcare, transport, energy, communications and defence. One area within the programme is quantum sensing, where the UK National Quantum Technology Hub in Sensors and Metrology is creating the next generation of high performance sensors and aiming to bring these into everyday applications. These sensors are based upon the use of clouds of atoms as probes where, through the use of laser cooling (winning the Nobel prize in 1997), the atoms can be slowed down sufficiently that they are almost stationary during a measurement. This provides an extremely clean and well controlled sensor, allowing exceptionally precise measurements. For example, modern cold atom based clocks are stable enough that they would not drift by one second during the age of the Universe. The use of cold atoms also presents a challenge, as in order to create such as system requires high precision technology including stable and precise lasers and magnetic fields. This typically results in systems being large and complicated, traditionally filling an entire laboratory. Modern advances have allowed significant improvements in portability and size, but a considerable challenge still remains regarding power and driving electronics. The objective of the CONE project is to create compact and robust electronics for cold atom sensors, and trial their use in a demonstration system. The aim is to realise a 50% reduction in the overall system size, through both miniaturisation and better integration of the electronics. CONE aims to transfer knowledge to Red Wave Laboratories in order to enable them to fill an important gap within the UK quantum technology supply chain, enabling them to provide robust electronics solutions and potentially future integrated systems.

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TELEDYNE E2V LIMITED	QUANTIFY	£120,096	£60,048
SATELLITE APPLICATIONS CATAPULT LIMITED		£29,996	£29,996
University of Birmingham		£88,036	£88,036

Project description - provided by applicants

New developments in quantum technology have resulted in the ability to cool atoms close to absolute zero using lasers and magnetic fields. Laboratory experiments have shown that these cold atoms can be used as ultra-sensitive sensors for measuring gravity. Using these sensors in space will enable the mapping of tiny changes in the strength of gravity across the surface of the Earth. This project will investigate the potential applications and markets that these sensors will enable from space. These include the prospect of more accurate monitoring of changes in polar ice mass ocean currents and sea level thereby enhancing the capability of global climate models. Higher resolution data would lead to the ability to monitor smaller water sources and discover new underground natural resources which are currently not detectable. Similar technology could also be used for deep space navigation and for providing higher precision timing sources in space. The project will also study the technical feasibility of producing a space based system and will propose a roadmap showing the steps to achieving a commercial space sensor.

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CAMBRIDGE QUANTUM COMPUTING LIMITED	Compilation & Circuit Layout Optimisation For Superconducting Quantum Processor	£196,020	£137,214
OXFORD QUANTUM CIRCUITS LIMITED		£142,749	£99,924
University of Oxford		£145,402	£145,402

Project description - provided by applicants

Oxford Quantum Circuits Limited (OQC), established in June 2017, are developing quantum computing processors based on superconducting circuits. A fundamental business question for OQC is what applications (quantum algorithms) are best suited for its technology, and how to most efficiently realise first generation processors that will be capable of running these applications, and hence generate sales. This project addresses this challenge from two angles; development by Cambridge Quantum Computing Limited (CQC) of a quantum compiler dedicated to the OQC hardware architecture, and prototype development and assessment of circuit layouts with differing connectivity maps. These two directions will be combined with assessment of mapping of quantum algorithms onto the OQC architecture to produce clear direction for OQC R&D in the next phase of its development.

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CHROMACITY LIMITED	Polarisation Entangled Photon Emitter	£151,789	£106,252
COVESION LIMITED		£69,519	£48,663
University of Glasgow		£142,475	£142,475

Project description - provided by applicants

The UK government has invested nearly £300M in the last three years to stimulate the translation of quantum mechanics, one of the most successful scientific theories of all times, to new quantum technologies for the benefit of its citizens. Quantum-enhanced optics also enables new levels of sensitivity in the measurement of minute changes in the structure of the space, such as those induced by gravitational waves. At the core of all these optically-enabled quantum-based technologies are entangled photons: particles of light sharing a unique state even when spatially separated, which does not have a counterpart in the classical world. Here we propose to develop a source of entangled photons using fibre laser based technology. Fibre-based lasers are now the reference tools for low-noise ultrashort pulse metrology and are rapidly becoming the workhorse of companies and research centres working with ultrashort laser pulses.

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COGNIZANT BUSINESS SERVICES UK LIMITED	Handheld Quantum Wireless for Secure Financial Transactions and Sensitive Information	£250,017	£125,009
University of Bristol		£96,839	£96,839
University of Oxford		£124,146	£124,146

Project description - provided by applicants

Quantum key distribution (QKD) is a cryptographic scheme which provides an unprecedented level of data security. It can be used to secure financial transactions over ATM machines and wireless payments as well as any personal or corporate confidential data. Our project seeks to develop a free-space, handheld (credit-card size), steerable QKD system prototype to secure real-world bank/payment transactions. This Consortium understands real-world banking transaction needs and has the knowledge in developing novel optical techniques to tailor make a practical handheld QKD system, completed with suitable hardware-to-user interface and a software stack for commercial deployment. We seek the opportunity to show the world that not only UK is leading QKD in academic research, but that we are also at the forefront of quantum technology development. Using real bank/payment transaction data, this project will demonstrate QKD usage in wireless financial application.

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COMPOUND SEMICONDUCTOR TECHNOLOGIES GLOBAL LIMITED	CoolBlue2	£139,623	£83,774
Aston University		£32,007	£32,007
Helia Photonics Limited		£110,057	£77,040
NATIONAL PHYSICAL LABORATORY LIMITED		£98,218	£98,218
University of Glasgow		£119,171	£119,171

Project description - provided by applicants

CoolBlue2 is a highly innovative project with a goal to develop next generation laser technology for use in the emerging field of quantum sensing. CoolBlue2's disruptive technology has the potential to transform conventional quantum sensing systems making them cheaper and more compact. We will make use of compound semiconductors, advanced materials that can be made to emit light over a wide range of wavelengths, and process them into laser chips using specialised manufacturing techniques. Our chips will emit high quality blue light, displacing current commercially available solutions due to superior performance and lower cost. The devices produced during the project will be packaged and used to verify their efficacy in existing laser cooled systems. The project will be led by CSTG Ltd in partnership with Helia Photonics, National Physical Laboratories, the University of Glasgow and Aston University.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
COMPOUND SEMICONDUCTOR TECHNOLOGIES GLOBAL LIMITED	High-powEr phosphorous-based DFB Lasers for Cold ATom Systems (HELCATS)	£252,831	£151,699
NATIONAL PHYSICAL LABORATORY LIMITED		£52,244	£52,244
University of Glasgow		£192,499	£192,499

Project description - provided by applicants

Every electronic product needs a clock to keep it working and synchronised within the system and nowadays, across the world. Atomic clocks allow the highest possible precision in defining time, which is critical in determining position in navigation and defence systems, and in next generation telecommunications systems that power the internet age. Atomic clocks are presently bulky and expensive, and the world is demanding ever more timing accuracy. A main cost and size factor comes from the laser and optical systems used inside these next generation of clocks based on a lattice of strontium atoms. The miniaturisation of these systems and their cost reduction is now required to enable entry to a wider commercial market. This project develops special semiconductor laser light sources optimised to enable this miniaturisation and cost reduction. State of the art materials growth at CST Global and chip fabrication at the University of Glasgow is brought together alongside the UKs national measurement institute, NPL to solve these challenges.

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COLDQUANTA UK LIMITED	MITAS: Miniaturised Ion Trap Atomic Source	£257,689	£180,382
University of Oxford		£54,769	£54,769

Project description - provided by applicants

The next 20 years are poised to see the 'second quantum revolution', with the widespread emergence of technologies and devices, leveraging the properties of superposition and entanglement which govern the dynamics of light and matter at the smallest scales. Potentially most disruptive of all quantum technologies is quantum computing, which permits the efficient computation of a variety of problems that are effectively intractable with conventional computers, including searching large databases, advanced materials design in aerospace applications and pharmaceutical drug discovery. The UK is currently taking a leading role in the development of both hardware and software for quantum computing, and has fostered a wide base of expertise in these areas. This project aims to develop a compact vacuum system complete with integrated atomic source for use within ion trap quantum computers. One of the specific challenges on the road to developing a large quantum computer is the high level of engineering required to produce the devices and their subcomponents. This project seeks to develop a key subcomponent for an ion trap quantum computer within an industrial setting using scalable techniques. The successful execution of this project will bolster UK industry's position within the emerging international market in quantum computing and permit the future development of highly integrated systems.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
OXFORD ELECTROMAGNETIC SOLUTIONS LIMITED	QV2 - Feasibility of commercialising QT microgravity sensors in non-utility markets	£95,414	£66,790
University of Birmingham		£95,301	£95,301

Project description - provided by applicants

QV2 is a continuation of the InnovateUK funded QVision project (132541) which investigated the feasibility of commercialising microgravity QT devices in the utility market sector when integrated with the OXEMS system. QVision, almost complete, has been successful and includes proposed new layered data and associated ROI models using Artificial Intelligence (AI) and Machine Learning (ML) techniques to automate the surveying process and deliver enhanced value for utilities. QV2 is a feasibility study to continue investigating the market potential for microgravity QT devices but to broaden the future market focus from utilities to all other markets that have a need to survey underground structures. Moreover, QV2 will develop novel inversion techniques based on numerical modelling combined with machine learning to help with the location of buried features, while also investigating the potential of obtaining condition information. QV2 is a collaboration between OXEMS and the University of Birmingham (UoB) which will provide access to the QT-Hub in Sensors and Metrology led by the UoB. The overall aim is to generate a comprehensive understanding of the potential future market for QT microgravity sensors in the UK and overseas.

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Compact Cryogenics	Miniature Dilution Refrigerator	£114,646	£80,252
HALL SCIENTIFIC LIMITED		£16,651	£11,656
University College London		£38,465	£38,465

Project description - provided by applicants

The commercialisation of quantum technologies is inextricably liked to the availability of the low-temperature platforms required for quantum device operation. The vast majority of systems currently available require large spaces and considerable quantities of rare Helium-3, together with either provision of liquid cryogens, or large electrical power and cooling water. The cost of such systems is typically several hundred thousand pounds. Our vision is to dramatically reduce the space, power and cost required to operate a device at very low temperatures. The objective of this project is to create a system small enough to be desktop or rack-mounted, using only single phase power and air cooling and the minimum possible quantity of Helium-3\. The system will include provision for mounting of electronic or optical components at several temperatures, typically 40K, 4K, 0.6K and <100mK, with easy routing of cables etc. between the various stages. In order to make this objective achievable, the main focus of the project is to develop a new type of helium pumping system. This would remove the need for the large external pumping racks normally associated with dilution refrigerator systems and so lead to higher efficiency, lower dead volume of Helium-3 and lower overall cost. The development of this pumping system has the potential to revolutionise the construction of low-temperature equipment. While the motivation of this project is its application to desktop-scale cryostats, the concept is completely scaleable and so could greatly simplify the construction and operation of everything from the high-power dilution refrigerators currently used for quantum computers to the miniature coolers required for space applications. By the end of the project we expect to have a working demonstration device in operation at the London Centre for Nanotechnology, consisting of cryocooler, cold gas circulation system and dilution-refrigerator still. Measurements will be made of cooling-power, stability, vibration and other key parameters and the device compared with existing equipment when used for the investigation of quantum devices currently. A superconducting nanowire single photon detector system will be installed in collaboration with Glasgow University to demonstrate a future commercial application of the technology.

Note: you can see all Innovate UK-funded projects here
https://www.gov.uk/government/publications/innovate-uk-funded-projects Use the Competition Code given above to search for this competition's results

Innovate UK

Results of Competition: Commercialisation of Quantum Technologies 4

Competition Code: 1707_CRD_EE_QUANTECH_4

Total available funding is £6M from Innovate UK and £3M from EPSRC

Note: These proposals have succeeded in the assessment stage of this competition. All are subject to grant offer and conditions being met.

Participant organisation names	Project title	Proposed project costs	Proposed project grant
TELEDYNE E2V LIMITED	iXon Quantum	£242,608	£121,304
ANDOR TECHNOLOGY LIMITED		£119,474	£59,737

Project description - provided by applicants

Low noise and high sensitivity imaging technologies are crucial to the success of quantum technologies. In many cases, the performance of these imaging technologies directly relates to the sensitivity that can be achieved by quantum sensors, the performance of quantum imaging technologies and/or the speed of quantum computer systems. **Teledyne e2v were the pioneering inventors of the EMCCD technology in the 1990s, which was introduced to the science market by Andor in 2001-02\. The iXon camera developed through this relationship remains the very best on the market when very low noise or single-photon sensitivity is needed.** **This project will allow Andor and Teledyne e2v to build on this established relationship to develop new, quantum-specific EMCCD cameras. These cameras will significantly improve the infrared response, noise and speed, thereby allowing for improved sensitivity, performance, measurement and characterisation of quantum devices beyond what was available before. This R&D will allow Andor to maintain a leading position in the sale of scientific cameras into the quantum science market and it will help Andor and Teledyne e2v investigate future industrial and academic imaging requirements for the emerging quantum technologies industry.**

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
TOPGAN QUANTUM TECHNOLOGIES LIMITED	EleGaNt	£262,424	£183,697
FRAUNHOFER UK RESEARCH LIMITED		£147,268	£147,268

Project description - provided by applicants
The EleGaNt project will develop high-power single-frequency stabilised 422 nm GaN laser diodes with applications in optical clocks, atom interferometer, quantum key distribution and as a reference source for nearby atomic transitions.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
FLUORETIQ LIMITED	Rapid Detection of Bacteria using Quantum Optics	£143,602	£100,521
University of Bristol		£59,862	£59,862

Project description - provided by applicants
This project aims to address the need for rapid tools for detecting bacteria in patient samples. FluoretiQ Limited and the University of Bristol, will develop a new quantum-optics enhanced bacteria diagnostic solution which utilises novel, non-toxic labelling technology to detect bacteria directly, at the point of care. Unlike currently proposed alternatives to bacterial culturing methods, this solution will trace the source of the infection and thereby, discourage the use of broad spectrum anti-biotics.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
UNIKLASERS LTD.	DPSS Laser stabilised at 813nm for Sr Clock Application (LQT813)	£252,572	£176,800
FRAUNHOFER UK RESEARCH LIMITED		£103,859	£103,859
University of Birmingham		£134,999	£134,999

Project description - provided by applicants

Quantum technologies are considered to have a similarly wide and ubiquitous social impact that electronics have enjoyed after the invention of the transistor, but to achieve this it will be necessary to make a vital transition from research labs and large scale installations into industrial and consumer markets. In particular, the development of compact and rugged single-frequency light sources is required by QT to manipulate the quantum states of atoms and ions. In this project, using our innovative propriotery technology platform, we will develop a compact single-frequency solid-state laser for controlling quantum states of Strontium atoms via light-matter interaction at their near-Infrared transition at 813nm. We will reduce the size and cost of this critical component enormously, without losing performance, in order to place the UK at the vanguard of QT development and commercialisation.

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Innovate UK

Results of Competition: **Commercialisation of Quantum Technologies 4**

Competition Code: **1707_CRD_EE_QUANTECH_4**

Total available funding is £6M from Innovate UK and £3M from EPSRC

Note: These proposals have succeeded in the assessment stage of this competition. All are subject to grant offer and conditions being met.

Participant organisation names	Project title	Proposed project costs	Proposed project grant
CHROMACITY LIMITED	High-speed quantum random number generation for secure data communications	£83,579	£58,505
Heriot-Watt University		£71,014	£71,014

Project description - provided by applicants

Random numbers are essential for creating the cryptographic keys that ensure our personal information is secure online. Generating truly random numbers in software alone is impossible, since computers use a completely predictable algorithm for this purpose. Only hardware random number generators can produce true random numbers, and even these are limited by aging effects in classical noise sources. To be truly random one needs a quantum random number generator (RNG), and such devices will be integral to the future of cryptography, forming the basis of secure communications and data processing. Due to their respective technological approaches the clock speeds of commercially available quantum RNGs are limited to few-hundred Mbit/s data streams, a bottleneck that is incompatible with future telecommunications demands. In this project we will demonstrate a route to 100s-of-Gb/s quantum RNG based on novel laser technology. Excitingly, our proposed approach is highly scalable, enabling the performance provided by the system to keep pace with the demand for high-bit-rate random numbers continues to increase.

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