

Appendix 5: UK Quantum Technologies Challenge, Scotland's Participation

Data compiled from [Quantum Technologies Challenge Directory](#)

Project Name	Brief Description	Project Leader (bold typeface for Scottish)	Participants in Scotland	Other Participants
369GaN	Development of GaN lasers with a wavelength of 369nm to use in Ytterbium atomic clocks	TopGAN	TopGAN Quantum Technologies; Fraunhofer UK; University of Glasgow; Helia Photonics	
3QN	Quantum Key Distribution for satellite communications	Arqit	Heriot-Watt University; Wideblue Ltd; Fraunhofer UK	Arqit Ltd; Teledyne E2V Ltd; University of Cambridge; BT plc; University of York; RedWave Labs Ltd; NPL Management Ltd
Abgrav	Cold-atom gravity sensing	M-Squared Lasers	M-Squared Lasers	Oxford County Council
Advanced Manufacturing Toolkit for Quantum Sensing and Quantum Computing	Atomic-layer deposited films for superconducting and hybrid quantum systems to form integrated quantum circuits for academic and commercial purposes	Oxford Instruments	University of Glasgow	Element Six; <i>this project is in collaboration with Canada with support from the Canadian Natural Sciences and Engineering Research Council</i>
AirQKD	To establish a 'UK ecosystem' for secure free-space communication (based on QKD)	BT	University of Strathclyde; Fraunhofer UK; University of Edinburgh; Heriot-Watt University	BT; University of Warwick; University of Bristol; NPL Management Ltd; Arqit Ltd; Compound Semiconductor Catapult; Bay Photonics Ltd; Angoka Ltd; OpenLightComm Ltd; Nu Quantum Ltd

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AQuaSec	Quantum-resistant techniques for secure cryptography	Toshiba Europe Ltd	Heriot-Watt University; University of Glasgow	Toshiba Europe; BP plc; IQE plc; Queen's University Belfast; BT plc; Dashboard Ltd; University of Sheffield; Senetas Europe Ltd; University of Cambridge; Tethered Drone Systems Ltd; Bay Photonics Ltd; KETS Quantum Security Ltd; NPL Management Ltd; Royal Holloway University of London
Compact Optics for High-performance Portable Atomic Timing and Quantum Sensors	Development of an optical cooling system that would then be used to generate ultra-cold strontium atoms for atomic clocks	Kelvin Nanotechnology Ltd	University of Strathclyde; Wideblue Ltd	University of Birmingham
Connectorising Integrated Quantum Photonics Devices	Development of interconnects between integrated quantum photonics devices and optical fibres	Duality Quantum Photonics Ltd	Heriot-Watt University	Duality Quantum Photonics Ltd; <i>this project is in collaboration with Canada with support from the Canadian Natural Sciences and Engineering Research Council</i>
Diamond NV Sensors for Quantum-limited magnetic field measurements	To build a quantum magnetometer	M-Squared Lasers	M-Squared Lasers	University of Nottingham; <i>this project is in collaboration with Canada with support from the Canadian Natural Sciences and Engineering Research Council</i>

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Discovery	Development of test-beds for scalable, high fidelity qubit generation, including microfabrication, vacuum technology, photonics and advanced lasers, electronics and control systems	M-Squared Lasers	University of Strathclyde; University of Glasgow; Kelvin Nanotechnology Ltd;	University of Oxford; TMD Technologies Ltd; NPL Management Ltd; Orca Computing Ltd; Oxford Ionics Ltd
High-BIAS 2	Development of quantum technology rotation sensors for navigation	Coldquanta UK Ltd	Fraunhofer UK; Alter Technology UK; Caledonian Photonics	Coldquanta UK Ltd; PA Consulting Ltd; BAE Systems plc; RedWave Labs Ltd
Kairos	Development of a prototype miniature atomic clock	Teledyne E2V UK Ltd	Leonardo MW Ltd; Alter Technology UK	Teledyne E2V UK Ltd; University of York; NPL Management Ltd; Integrated Compound Semiconductors Ltd; Cardiff University; HCD Research Ltd; Altran UK Ltd
MIRUS	Extending the operating range of single-photon avalanche photodiodes to the near-infrared	Covesion Ltd	Fraunhofer UK	Covesion Ltd; BAE Systems plc
Next generation Satellite QKD	Development of quantum communications technologies with the ultimate objective of developing a QKD satellite constellation	Arqit	Heriot-Watt University; Fraunhofer UK	Arqit Ltd; STFC Laboratories; BT plc; Toshiba Europe Ltd; Nu Quantum Ltd; Orca Computing Ltd; Aegiq Ltd

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PICAS2	Development of a cold-atom source system for quantum technology sensors and quantum information systems	Coldquanta UK Ltd	Fraunhofer UK; Alter Technology UK	Coldquanta UK Ltd
Pioneer Gravity	Development of quantum technology gravitational sensors	RSK Environment Ltd	Fraunhofer UK; Alter Technology UK; Uniklasers Ltd	RSK Environment Ltd; Geomatrix Earth Science Ltd; Teledyne E2V Ltd; University of Southampton; Silicon Microgravity Ltd; Magnetic Shields Ltd; University of Birmingham; Altran UK Ltd; Qinetiq Ltd
PRISMS	Assessment of vulnerabilities of nanosatellites to 'backdoor' attacks on quantum payloads (e.g. to circumvent cryptographic techniques) and to develop counter-techniques	Craft Prospect Ltd	University of Glasgow	Craft Prospect Ltd; Dotquantum Ltd; Barrier Networks Ltd; NPL Management Ltd
QT Assemble	Development of waveguide writing, nanoscale alignment and monolithic integration for quantum technology platforms	Fraunhofer UK	Fraunhofer UK; University of Strathclyde; Power Photonics Ltd; Caledonian Photonics Ltd; Alter Technology UK Ltd; Uniklasers Ltd	University Southampton; Inex Microtechnology Ltd; Photon Force Ltd; Gooch and Housego Ltd; Coldquanta UK Ltd; Covesion Ltd; Redwave Labs Ltd; Aegiq Ltd
QuantTICo	Development of THz imaging systems	Unitive Design and Analysis Ltd	Alter Technology UK Ltd; Fraunhofer UK	Durham University; Procter and Gamble Ltd

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Quantum Computing Platform for NISQ-era Applications	Development of quantum computing, including hardware, infrastructure, supply chain, applications and the ecosystem	Rigetti UK Ltd	University of Edinburgh	Rigetti UK Ltd; Oxford Instruments Ltd; Phasecraft Ltd; Standard Chartered Bank Ltd
Quantum Sensors for End-of-line Battery Testing	Quantum technology magnetometers to diagnose current flow in lithium cells for use in assembly and testing of batteries for automotive applications	AMTE Power	AMTE Power Ltd; University of Strathclyde; Alter Technology UK Ltd; Kelvin Nanotechnology Ltd	University of Sussex; Magnetic Shields Ltd; CDO2 Ltd; Compound Semiconductor Centre Ltd; Centre for Process Innovation Ltd; Compound Semiconductor Technologies Global Ltd
QuEOD	Development of short-wavelength infra-red detectors for quantum technology applications	Photon Force Ltd	Heriot-Watt University; Leonardo MW Ltd	Photon Force Ltd; University of Sheffield; Cardiff University; Arqit Ltd; Compound Semiconductor Applications Catapult; IQE Ltd; QLM Technology Ltd
ReFQ: Modular WCP Sources and RFI Protocols for Space-based QKD Demonstrations	To allow UK-based QKD technology to fly on the Canadian QEYSSAT satellite mission	Craft Prospect Ltd	University of Strathclyde	University of Bristol
Reliable, High-throughput Production and Characterisation of Coherent Superconducting Devices (FABU)	Development of superconducting quantum circuits at the commercial scale	Oxford Quantum Circuits Ltd	University of Glasgow; Kelvin Nanotechnology Ltd	Oxford Quantum Circuits Ltd; Royal Holloway University of London; SEEQC UK Ltd; Oxford Instruments Ltd

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Safire	Development of diode-pumped solid-state lasers for cold-atom-based quantum instruments	Caledonian Photonics	Caledonian Photonics; Alter Technology UK Ltd	STFC Laboratories; NPL Management Ltd
Sidewinder	Development of a component generating dual optical frequencies with narrow linewidth for control of atomic states (e.g. cooling) for quantum technology applications	RedWave Labs Ltd	Fraunhofer UK	Redwave Labs Ltd; Bay Photonics Ltd
SOLACE	To design and build core components for a commercial atomic clock based on the strontium atom	M-Squared Lasers	M-Squared Lasers	University of Birmingham
SPIDAR	Single-photon ranging and imaging for autonomous vehicles	Toshiba Europe Ltd	Thales Ltd; Heriot-Watt University; University of Edinburgh; University of Glasgow	Toshiba Europe Ltd; Network Rail Ltd; Bay Photonics Ltd; IQE Ltd; Compound Semiconductor Technologies; University of Cambridge; Horiba Mira Ltd
STREAMLINE	Develop the handling and packaging of GaN semiconductors to enable a commercial solution for cooling of strontium ions for use in quantum technologies	Alter Technology UK Ltd	ToGAN Quantum Technologies Ltd; Fraunhofer UK Ltd	
TuNaFISH	Development of tunable laser modules for cold atom interferometry	Alter Technology UK Ltd	Fraunhofer Research Ltd	

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ViSatQT	Develop techniques to allow QKD for satellite communication to enable operating in daytime and in cloudy conditions, and greatly increase the rate of key distribution	Airbus Defence and Space Ltd	University of Strathclyde	Airbus Defence and Space Ltd; Satellite Applications Catapult; Craft Prospect Ltd; KETS Quantum Security Ltd; Nu Quantum Ltd; Archangel Lightworks Ltd