Wave Photonics leads £500k Innovate UK feasibility study project to create photonics chips for trapped ion quantum computers.

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Wave Photonics, a Cambridge-based startup is leading a £500k Innovate UK project to develop integrated photonic components for trapped ion quantum computers and develop a UK supply chain. Working alongside Oxford-based quantum computing company, Oxford Ionics, the CORNERSTONE foundry at the University of Southampton and the Compound Semiconductor Applications (CSA) Catapult, this project further aims to develop the UK supply chain for integrated photonics and quantum technologies.

Trapped ions are one of the most promising approaches for building a scalable, useful quantum computer – it involves taking individual atoms, using precisely controlled lasers to remove one of their electrons and to suspend them in space to form qubits, which are then controlled at extremely low error rates using electric fields.
A challenge to scaling this technology to a large number of ions is due to the quantity of bulk optical components required. As such, the ever-increasing complexity of these optical setups have to become more scalable and compact. The answer: integrated photonics.

Integrated photonics uses the same manufacturing processes used to make traditional electronics chips (such as those found in your phone or computer), but to make chips that use light. This technology is already used by companies like Intel and Cisco to move massive quantities of data through datacentres. The SiNQ project (Silicon Nitride for Quantum Computing) will apply component design and optimisation techniques in development at Wave Photonics to design better performing devices faster to work with the multiple wavelengths of light that are needed for trapped ion quantum computers.

Wave Photonics will be building upon its core photonics design capability and software to create component designs for the huge span of wavelengths needed to readout and manipulate the trapped ions. Jiangbo Zhu, Senior Photonics Engineer at Wave Photonics said “It’s exciting to see how all of the progress in chip manufacturing developed for datacentre applications over the past several years can, with some adaptations to the component designs, be made useful for frontier technologies like quantum computing.”

Project partner, Oxford Ionics will be guiding the requirements of the project and providing feedback on the performance of the devices for ion-trapped quantum computing applications. Chris Lewins, Quantum Processor Engineering Team Lead, said “Integrated photonics is a key enabling technology for our scalable quantum processors. Existing photonics design tools are not well suited to operating at the numerous and wide range of wavelengths we need. We’re excited to be working with this new approach to photonics design: this will enable us to quickly optimise our designs across challenging operating conditions.”

The Compound Semiconductor Applications (CSA) Catapult will be supporting the project developing wafer scale testing facilities. Testing photonic chips at wafer scale is an available

service for telecoms applications, but there are not services available for the wavelengths required for many quantum applications. CSA Catapult will build up this capability in the project, allowing this service to be made available to UK industry. Joe Gannicliffe, Head of Photonics at CSA Catapult, said: “Quantum technologies enable the manipulation and control of light leading to specialist quantum computers that can enable important applications in drug and chemical research, cybersecurity, and healthcare diagnostics. However, these systems are complex and require miniaturisation and standardisation – integrated photonics provides this route whilst also benefitting from the scalability of semiconductor manufacturing.”

Consortium member University of Southampton, engaged via the CORNERSTONE foundry, will produce the chips and develop a fabrication process to manufacture Silicon Nitride chips suitable for the visible wavelength ranges required by this project. Callum Littlejohns, Professorial Fellow-Enterprise at the University of Southampton said “Silicon nitride is becoming a very important platform for integrated photonics for a number of reasons, one of which being its transparency in the visible wavelengths required for some ion trapping technologies. It is very exciting to work with leading experts from across the country to develop this important functionality.”

About Wave Photonics:

Wave Photonics is Cambridge-based start-up that is using computational techniques to accelerate integrated photonics design. Integrated photonics is a scalable technology that is currently largely used in datacomms, but has the potential to be used as a platform for upcoming technologies such as quantum computing and communication, healthcare and biosensing, lidar and sensing. However, the lack of readily-available libraries of photonics components and the difficult of accounting for process imperfections means that entrants to these markets face high barriers to product development. Wave Photonics is developing tools to automatically account for process imperfections and develop high-quality, robust libraries of components to enable photonic chip designers to rapidly develop and scale their products.
For more information, visit https://www.wavephotonics.com.

About Oxford Ionics:
Oxford Ionics is the high-performance quantum computing company, delivering world-leading innovations to create the most powerful, accurate and reliable quantum computers to solve the world's most important problems. Unparalleled precision is realised by combining the world's highest quality qubits – trapped ions – with a unique noiseless electronic qubit control technology. Oxford Ionics achieves the highest performance ever demonstrated while using chips manufactured on a semiconductor production line.

For more information visit http://www.oxionics.com.

About University of Southampton:

CORNERSTONE is an open source, license free silicon photonics rapid prototyping foundry. We offer a plethora of different platforms to support a wide range of applications ranging from telecoms to sensing, LiDAR, quantum and more. Each platform possesses a standard component library to lower the barrier to entry for non-photonics experts. We will gladly experiment and try new things for the benefit of our users. This flexible approach helps us to support early stage R&D projects and successfully fabricate proof of concept prototypes.

For more information, visit https://www.cornerstone.sotonfab.co.uk/

About CSA Catapult:

Compound Semiconductor Applications (CSA) Catapult was established in 2018 by Innovate UK to help the UK become a global leader in compound semiconductors through collaboration with both large companies and start-ups to develop and commercialise new applications.

CSA Catapult is the UK's authority on compound semiconductor applications and commercialisation.

CSA Catapult is a centre of excellence that is home to state-of-the-art equipment that specialises in the measurement, characterisation, integration, and validation of compound semiconductor technology.

CSA Catapult has a world-leading team of experts with a breadth of knowledge and experience in compound semiconductor technologies and applications and their commercialisation.

About Innovate UK

Innovate UK drives productivity and economic growth by supporting businesses to develop and realise the potential of new ideas.
We connect businesses to the partners, customers and investors that can help them turn ideas into commercially successful products and services and business growth.

We fund business and research collaborations to accelerate innovation and drive business investment into R&D. Our support is available to businesses across all economic sectors, value chains and UK regions.

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