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News: Optoelectronics

8 December 2021

NTU Singapore launches Quantum Science and Engineering Centre

Singapore's Nanyang Technological University (NTU) has launched the Quantum Science and Engineering Centre (QSec), which aims to develop devices and technologies powered by quantum science.

The centre, the first of its kind in Singapore, will conduct research on using semiconductor fabrication technologies to develop and produce quantum chips that form the backbone of quantum devices such as quantum chip processors, networks and sensors. These have

key applications in areas such as quantum computing, communication, cryptography, cybersecurity and sensor technology.

The center aims to train skilled manpower for quantum engineering, the application of quantum science to real-world scenarios, and to promote and develop Singapore's quantum industry. It will collaborate with the Centre for Quantum Technologies (CQT), a Research Centre of Excellence established since 2007, on quantum technology research and engineering application, and look to establish an international platform to collaborate with other overseas partners.

Picture: (From left to right) QSec's launch ceremony was witnessed by professor Liu Ai Qun; professor Lam Khin Yong (senior VP, Research); NTU president professor Subra Suresh; guest of honor Chan Chun Sing (Minister for Education); professor Ling San (deputy president & provost); and associate professor Kwek Leong Chuan.

The opening ceremony for QSec was witnessed by Minister for Education Chan Chun Sing and NTU president professor Subra Suresh.

"Quantum science, technologies and engineering have drawn huge investments worldwide. Singapore is a long-standing investor in its potential and remains at the forefront of this field," says Education Minister Chan Chun Sing. "In 2018, the National Research Foundation started a quantum engineering program with the goal of establishing a competitive quantum engineering research community and industry ecosystem to translate the technology into real-world applications. We look forward to the Quantum Science and Engineering Centre's (QSec) contributions to Singapore's efforts in advancing quantum technologies, especially in the development of quantum computing chips and quantum communications," he adds.

"The Quantum Science and Engineering Centre (QSec) aims to conduct ground-breaking research in several areas: quantum key distribution chips, quantum computation, quantum and classical neural network, cluster state computation and quantum sensing," notes NTU

president professor Subra Suresh. “NTU’s focus in these areas is part of our strategy to be a key enabler in the development of quantum science technologies to support Singapore’s efforts in quantum engineering for the benefit of industry and society.”

Housed at NTU’s College of Engineering, the research center’s current projects include research into quantum chip processors, quantum chip networks, and quantum chip sensors.

“QSec aims to not only take up a key role in supporting the local quantum industry, but to also build up strong international collaboration in quantum technologies which will benefit Singapore,” says center co-director professor Liu Ai Qun of NTU’s School of Electrical and Electronic Engineering.

“The Centre hopes to enhance Singapore’s impact on quantum science, engineering and technologies by leveraging on our capability in chip-based devices,” says fellow co-director Dr Kwek Leong Chuan, a principal investigator at the Centre for Quantum Technologies (CQT) hosted at the National University of Singapore. “We are also hoping to train and enthuse more engineers and secondary school students in this emerging direction.”

Creating light-based quantum chips

One of the QSec’s main research projects is the development of a quantum computing chip that can perform quantum calculations using an integrated photonic chip, which can be made with semiconductor materials on a silicon wafer.

Such quantum processor chips hold the promise of solving complex calculations that are impossible for classical computers. Classical computers rely on binary bits as their building blocks, as all computational information can be reduced to either ones or zeros. Instead of using such bits, quantum processors use quantum bits (qubits), which can exist in quantum states such that they represent both one and zero at the same time. This allows qubits to encode far more information than binary bits.

QSec researchers are exploring how photonics engineering can be used in a quantum context. Classical computers use electricity to flip the binary switches between their one and zero states. However, quantum chips can use single particles of light (photons) to represent qubits.

By using lasers and beam splitters within a chip circuit, researchers can manipulate individual photons as qubits. This method (termed boson sampling) uses light to perform quantum calculations that can far exceed the performance of supercomputers. Creating such a quantum photonic chip that can do this will open the possibility of bringing quantum computers into mainstream, real-world use.

These quantum computers should be able to rapidly solve calculations and tackle problems in diverse fields such as financial modelling, transport optimization, and artificial intelligence (AI) and machine learning.

Keeping communications secure with quantum cryptography

As cyberattacks become more sophisticated and hacking tools become more powerful, quantum cryptography offers an alternative to secure sensitive information against future cyber-attacks and unforeseen technological advances.

The most well-known developed application of quantum cryptography is quantum key distribution (QKD), a method that allows two remote users — who are embedded in an untrusted network such as the Internet — to exchange secret keys in the presence of an attacker who may own unlimited computing resources.

By taking advantage of the sensitivity of quantum signals, QKD chips can detect when an attacker attempts to eavesdrop on communication. The secret keys, which are transmitted

as a series of quantum signals, become disturbed and will scatter if an attacker intercepts it, rendering them useless.

QSec researchers have managed to develop a quantum communication chip small enough to fit into everyday devices such as laptops or smartphones, which could lead to highly secure, encrypted communication.

QSec is also currently developing a version of QKD chips called measurement-device-independent quantum key distribution (MDI-QKD) that aims to make QKD even more secure. MDI-QKD chips will also allow multi-user quantum communication, going beyond the two-user applications of traditional QKD.

Further educational goals

The Centre currently houses 30 researchers including professors, research fellows, PhD students, and engineers. It is jointly funded by a Ministry of Education (MOE) Academic Research Fund Tier 3 grant (which supports high-impact, multi-disciplinary research programs) and by NTU.

It also offers outreach activities for secondary and upper-secondary school students in quantum technologies, especially in chip-based engineering and technology, and its researchers have given educational talks to various schools.

“We welcome the Centre’s outreach activities in secondary and tertiary education institutions, which helps to boost interest in the field among our aspiring scientists, engineers and researchers,” says Chan.

QSec is described as an important chapter for NTU’s 2025 Strategic Plan, as the university expands and enriches its research and postgraduate educational offerings. QSec’s high-level research in quantum engineering is expected to translate into innovative solutions and technologies that will benefit industry and society through partnerships.

This also aligns the Centre with Singapore’s Research, Innovation and Enterprise 2025 (RIE2025) Plan under the Academic Research, and Innovation and Enterprise pillars.

Tags: Quantum computing

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