Theme: Quantum computer

WACQT | Wallenberg Centre for Quantum Technology

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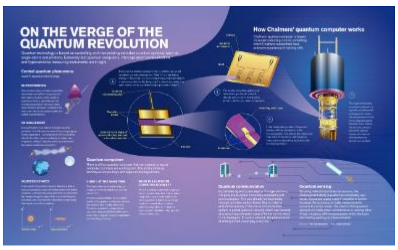
Dear reader,

Welcome to this first newsletter from WACQT, the Wallenberg Centre for Quantum Technology! I am very happy that Swedish industry has shown such a strong interest in the Centre, and that we now have seven highly relevant industrial partners on board the ship. Collaboration between academia and industry is crucial if Sweden is to take a forefront position in the coming quantum revolution. I really look forward to our cooperation.

The purpose of this newsletter is to inform you – our partners – about the progress within the quantum technology area. We will keep you up to date on the progress within WACQT and give you early notice of new results and innovations. In addition, the newsletter will help you keep track of quantum technology developments worldwide – we will present a selection of useful and important news in each issue. We intend to post three newsletters per year. I hope you will find them useful, and we welcome any suggestion for improvements.

Per Delsing
Director of the Wallenberg Centre for Quantum Technology

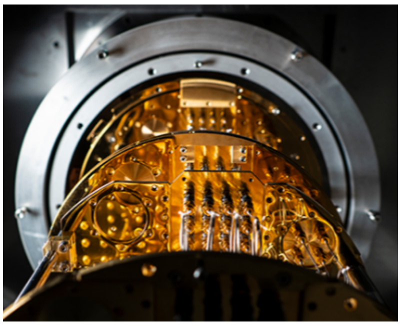
Recap for newcomers



Not familiar with quantum technology and WACQT – the Wallenberg Centre for Quantum Technology? Don't worry, we'll guide you through the basics.

Quantum technology is about controlling and using the strange and marvelous properties of individual quantum systems, such as electrons and photons, in order to make completely new things possible. The progress of research in quantum technology in recent years has brought the world to the brink of a new technology revolution – the second quantum revolution. Extremely powerful computers, intercept-proof communications, and hypersensitive measurement methods are in sight. Read more about quantum technology and its four sub-areas in the article Quantum technology – popular science description and in the graphic On the verge of a quantum revolution from Chalmers magasin.

The **Wallenberg Centre for Quantum Technology (WACQT)** is a decade-long, SEK-1-billion investment programme that aims to take Swedish research and industry to the forefront of the second quantum revolution. Read more in the WACQT research programme description



THEME: Quantum computer

There are many different approaches to building a quantum computer – no obvious winner has yet emerged. How can one compare the performance between different candidates, and how could the greatest obstacle to all kinds of quantum computers be handled?

Theme article Quantum computer

WACQT news

Seven industrial partners have boarded the ship

Seven companies with an obvious interest in exploitation of quantum technology have now joined WACQT as industrial partners: ABB, Astra Zeneca, Ericsson, Jeppesen, Saab, SEB and Volvo Group. Fruitful collaboration between academia and industry is a key component for reaching the goal of taking Sweden to the forefront of the quantum revolution. Read about the partner companies' main interests in quantum technology.

On 23–24 May, an industry workshop will be held at Chalmers, where representatives from the partner companies will meet WACQT researchers. The purpose is to strengthen the understanding of various projects, spot new opportunities and synergies, and identify new projects. Read more about the industry workshop.

Star-studded boards will provide guidance

The Board of the Wallenberg Centre for Quantum Technology and our Scientific Advisory Board are now complete, and we are happy to announce that we got an all-star cast.

The WACQT Board is chaired by Professor Lena Gustafsson, former president of Umeå University. The Board members all have extensive experience of leading and running large research or development initiatives, either in academia or in industry. We are assured that they will help steer WACQT in a successful direction.

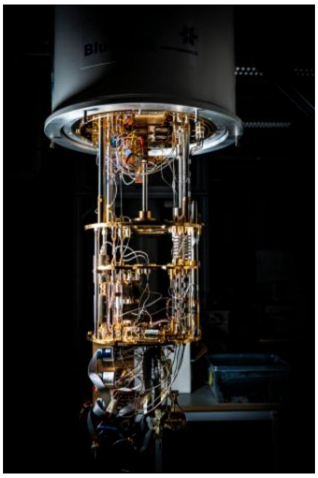
In the still largely unexplored realms of quantum technology, there are many crucial decisions to be made in realising the envisaged quantum products. In such situations, we expect to get extremely competent advice from the quantum experts in our Scientific Advisory Board, chaired by renowned Professor Steve Girvin from Yale University (also holding an honorary doctorate from Chalmers).

Our Industrial Advisory Board is almost complete, several strong names from industry have already accepted. Its first meeting will be held in September 2019.

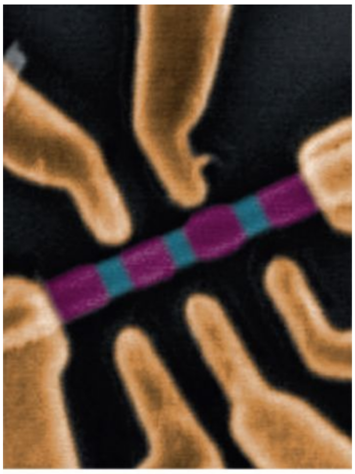
WACQT Board members

Scientific Advisory Board members

Upgraded quantum computing labs



As a first upshift before the mission to build a quantum computer, Chalmers has carried out a complete renovation of its laboratory. The experimental capacity was upgraded from two to four advanced cooling units (superconducting quantum computers require refrigerators for extremely low temperatures) with all necessary microwave equipment to run experiments. The experimental team also moved to new premises in order to house the quickly growing number of members.



Improved double quantum dots are promising for sensing

Double quantum dots, that is tiny structures of semi-conductor, hold great promise as building blocks for quantum technology. Using different materials to form the quantum dots, rather than electrostatic gates, gives rigid dots that are stable over time. However, an unresolved problem has been how to individually address the material-defined quantum dots, which is necessary for controlling the quantum states.

But by using very advanced semiconductor growth techniques, a research group in Lund has now managed to manufacture stable double quantum dots which also are individually addressable.

“They are very promising for sensing applications. Most straightforward would be to use them for measuring electrical signals such as voltages or charged particles,” says Ville Maisi, leader of the research group.

Read more in Applied Physics Letters

New quantum communication projects

Three new projects in quantum communication are now up and running.

In Linköping, work is being done on using multimodal optical fibres for quantum cryptography. Today, quantum cryptography is often criticized of being slow. But with a multimodal fibre – which can transmit several signals simultaneously – it should be possible to increase the secret key generation speed.

At Stockholm University, there is a new project focusing on device-independent quantum communication. By doing a test, more specifically a Bell test experiment, on the received binary string, one can conclude if the string is secure or not. The choice of equipment then becomes less important from a security point of view.

At KTH, work is done on components for creating entangled photons in lithium-niobate crystals. High-energy photons sent through the crystal are converted into two low-energy photons. If done in a clever way, the low-energy photon pair will come out entangled, which is very useful in quantum communication.

The EU has launched a €1-billion flagship initiative on quantum technology

In October 2018, the EU launched a ten-year research programme on quantum technology – the Quantum Flagship with the purpose to drive the quantum revolution in Europe. It will be funded by at least €1 billion by the European Commission and encompasses the four pillars of quantum technology as well as the basic sciences, just like WACQT. Read more at the Quantum Flagship website.

There is a close connection between WACQT and the Quantum Flagship. Chalmers is a partner in the OpenSuperQ project to build a European superconducting quantum computer, and Ericsson, Volvo Cars and Astra Zeneca are members of the OpenSuperQ user board. Lund University is a partner in the Square project to use rare earth ions for quantum computing, and KTH is a partner in the S2QUIP project to develop on-chip quantum light sources.

OpenSuperQ

The OpenSuperQ project aims at developing a quantum computing system of up to 100 qubits, and to make it available to external users. The open approach will allow the system to serve a large community of early adopters and educate the next generation of quantum scientists, developers, and users. “Building a quantum computer with 100 qubits is a very ambitious and difficult task. By joining forces in Europe and contributing with our respective expertise, the task will be easier to solve,” said Jonas Bylander, associate professor at Chalmers and one of the principal investigators in OpenSuperQ. Read more in the article Joining forces for a European quantum computer

OpenSuperQ website

Square

Square is a basic science project that aims at establishing individually addressable rare earth ions as a fundamental building block of a quantum computer, and to overcome the main roadblocks on the way towards scalable quantum hardware. The goal is to realize the basic elements of a quantum processor node.

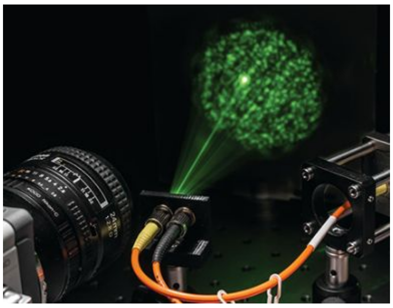
Square website

S2QUIP

S2QUIP is a basic science project that aims at developing quantum integrated photonic circuits which on-demand will provide the end user with carriers of quantum information to share with other users via quantum communication channels.

S2QUIP website

Selected world-wide news



Quantum-inspired imaging extends human vision capabilities. Traditional imaging technology generally relies on detecting light at relatively high intensity. However, emerging technologies now rely on sensors that can detect single photons. By cleverly combining such one-photon detection with conventional techniques for signal analysis and numerical image reconstruction, researchers have managed to construct devices that can "see" around corners as well as through opaque media, such as human tissue. The Science review-article Quantum-inspired computational imaging is well-worth reading (the one-page structured abstract is open to anyone).

Optical clocks measure height differences below 1 cm. The best optical atomic clocks have uncertainties down to only 10-18 seconds per 1 second. Such clocks are useful not only for measuring time very precisely. They can also be used for measuring height differences down to the centimetre level, since time passes more slowly close to massive objects, according to Einstein's theory of relativity. The ability to detect such small changes in gravitational fields means that it is possible to measure variations in the earth's crust down to several kilometres. Read more in Atomic clock performance enabling geodesy below the centimetre level in Nature (subscription is required for full-text).

Post-quantum cryptography goes commercial – prematurely? Quantum computers are predicted to change the field of computation, and thereby possibly making currently used cryptographic protocols vulnerable to attacks. However, there is an ongoing effort to find classical protocols that are exponentially difficult even for a quantum computer to break. These protocols are called post-quantum. Now companies are starting to sell their expertise in this field. A problem is that there is not yet any consensus on what protocols are quantum computer safe.

Quantum crypto in conventional networks gains momentum. There is a trend to use the currently deployed fibre networks and standard telecom components to build point-to-point quantum crypto links to keep costs low. This is reflected in current papers, but maybe even more so at optical communication conferences. This year, quantum communication is included in the technical program at several large conferences in the field, such as OFS (San Diego, 3–7 March), ICTON (Angiers, France, 9–13 July), and ECOC, (Dublin, 22–26 September).

IBM unveiled a commercial quantum computing system. At the Consumer Electronics Show in January, IBM unveiled what they claim to be the world's first integrated quantum computing system for commercial use. IBM also announced its plans for opening a quantum computation centre for commercial clients in Poughkeepsie, New York, later this year. After the earlier success with the cloud-based IBM Quantum Experience, this commercially available platform for business and science applications offers a more powerful processor as well as user support. Read more in IBM's pressrelease.

Rigetti opens quantum cloud service. At the end of January, Rigetti Computing publicly opened a beta version of its quantum cloud service. It offers developers access to Rigetti's quantum processors and classical computing for building and testing the quantum algorithms. In line with IBM's cloud-access, Rigetti is also growing a user-base outside of the organization to help explore new quantum algorithms and their applications. Read more in HPC Wire.

WACQT calendar

23 May, 14:45. Secure communications in quantum networks
Colloquium with Eleni Diamanti, CNRS, Université Pierre et Marie Curie, France
Kollektorn, MC2, Chalmers

23-24 May. Industry workshop on quantum technology
Kollektorn, MC2, Chalmers

21-26 August. Summer school for PhD students
Säröhus, Göteborg

Autumn 2019. Lab course for PhD students

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