



## **COLLOQUIUM: Quantum Computation and Simulation -- Spins Inside**

LIEVEN VANDERSYPEN

October 01, 2021

12:00 to 13:00

Auditorium

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### **PROFILE**

Delft University of Technology. Scientific Director of QuTech. Prof. Dr. Ir Lieven Vandersypen is an Antoni van Leeuwenhoek professor in Quantum Nanoscience at the Delft University of Technology and Scientific Director of QuTech, the advanced research centre for Quantum Computing and Quantum Internet of TU Delft and TNO. He received his PhD in Electrical Engineering from Stanford University for the first experiments in quantum computing. He is a pioneer in single-spin qubits in semiconductor quantum dots, for applications in quantum computing and quantum simulation. He received the IUPAP Young Scientist Prize for Semiconductor Physics and the Nicholas Kurti European Science Prize, was a member of member of The Young Academy of the KNAW, and is member of the Royal Holland Society of Sciences and Humanities. He received an ERC Starting grant, and ERC Synergy grant and an

ERC Advanced grant.

### **ABSTRACT**

Quantum computation has captivated the minds of many for almost two decades. For much of that time, it was seen mostly as an extremely interesting scientific problem. In the last few years, we have entered a new phase as the belief has grown that a large-scale quantum computer can actually be built. Quantum bits encoded in the spin state of individual electrons in silicon quantum dot arrays, have emerged as a highly promising direction. In this talk, I will present our vision of a large-scale spin-based quantum processor, and ongoing work to realize this vision.

First, we created local registers of spin qubits with sufficient control that we can program arbitrary sequences of operations, implement simple quantum algorithms, and achieve two-qubit gate fidelities of more than 99.5%. In linear quantum dot arrays, we now achieve universal control of up to six qubits.

Second, we have explored coherent coupling of spin qubits at a distance via two routes. In the first approach, the electron spins remain in place and are coupled via a microwave photon in a superconducting on-chip resonator. After reaching the strong coupling regime of a single spin and a single photon, we have recently observed coherent spin-spin interaction at a distance, mediated by off-resonant photons. In the second approach, spins are shuttled along a quantum dot array, preserving both the spin projection and spin phase.

Third, in close collaboration with Intel, we have fabricated and measured quantum dots using all-optical lithography on 300 mm wafer, using industry-standard processing, demonstrating excellent qubit performance. We expect that this industrial approach to nanofabrication will be critical for achieving the extremely high yield necessary for devices containing thousands of qubits.

When combined, the progress along these various fronts can lead the way to scalable networks of high-fidelity spin qubit registers for computation and simulation.

### **[ZOOM LINK TO JOIN IN](#)**

ICFOians are encouraged to attend this Colloquium in person. Those who are unable to attend in person may join online. Participants will be asked to register upon entry. After registering, you will receive a confirmation email containing save the date and the link to join in.

**Friday, October 1, 2021, 12:00. ICFO Auditorium**

