INSTITUT NEEL Grenoble

Post doc position in Si spin qubits– Academic year 2017-2018

Long-range quantum bus for electron spin qubits in silicon

Context : Electron spin qubits in silicon form a serious contender for the realization of a large-scale solid-state quantum computer. Solid-state realizations are considered scalable in general, but silicon spin qubits stand out by their extremely long coherence times, compatibility with reliable and reproducible industrial fabrication techniques and the feasibility to integrate classical electronics. Universal electron spin manipulation with excellent fidelities was demonstrated in this system. However, a key challenge for true scalability of silicon quantum computer architectures remains the realization of a coherent link between distant quantum registers on a chip. Such a link would serve two important functions. First, it enables a modular structure that allows expanding the number of qubits beyond the limits of local registers. Second, coherent links between registers create space for classical control circuits to be integrated with the qubits on-chip.

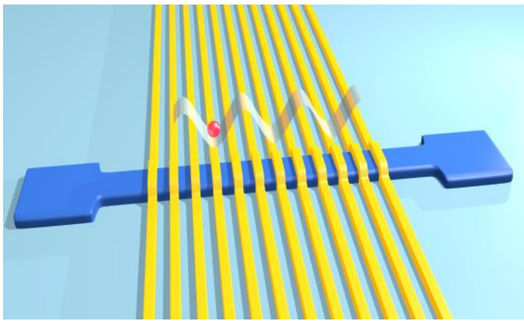

Figure: Artistic view of the sample envisioned to realize a multi-dot structure to perform operations and algorithms with a few electron spin qubits.

Objectives and means available: The goal of the project is to demonstrate a fault-tolerant quantum bus (QuBus) that coherently transfers a single electron with an arbitrary spin qubit state between quantum dots separated by 1 to 10 microns. The quantum dots (QDs) will be electrostatically defined in silicon-on-insulator (SOI) nanostructures – two very promising systems that will be fabricated in cooperation with industry. We shuttle the electron using an array of electrostatic gates. As a benchmark for the coherent and integrated operation of the QuBus, we will use it to distribute an EPR pair and to realize the first probabilistic quantum teleportation performed in silicon. All the samples will be fabricated at CEA-LETI with a state of the art CMOS facility to enable maximum output and reproducibility. To control and manipulate the electron spin coherently, the applicant will benefit from the long-standing expertise of the Neel-group in AlGaAs based electron spin qubits (computer control, low temperature cryogenics, low-noise electronics, Radiofrequency electronics).

Interactions and collaborations: This work is part of a large collaborative effort between the CEA-INAC, CEA-LETI and CNRS-Institut Néel to develop and push the technology of spin qubit in silicon and investigate its potential scalability. The funding is related to the QUANTERA collaborative project Si QuBus between TU Delft, RTW Aachen and University of Warsaw which aims specifically to demonstrate a quantum bus for electron spins in Si.

Skills and training: The experimental project relies on the knowledge accumulated in the field of few-electron quantum dots and its new implementation in Si devices. Experience with one of the following techniques would be strongly appreciated: nanofabrication, cryogenics, low-noise electronics, computer control of complex experiments…

Foreseen start for the position: From March to October 2018
Salary : from 2050 to 2850 euros after tax, depending on experience
Duration : 24 months (extensions are possible)

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