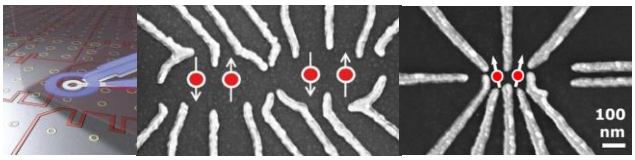


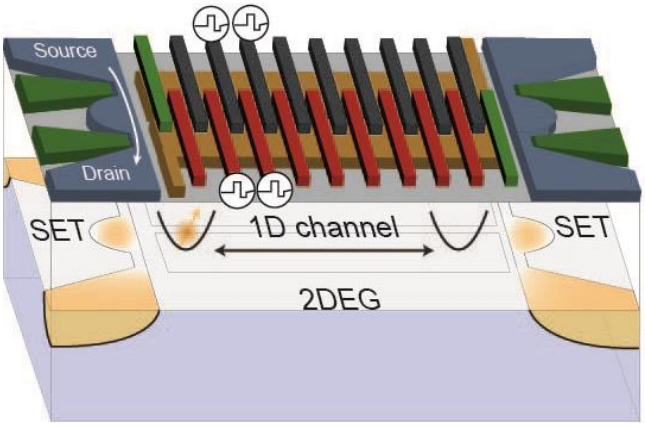
Quantum Technology Group

RWTH AACHEN UNIVERSITY

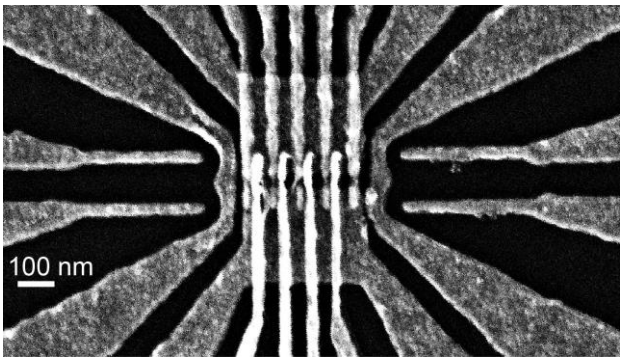
Fabrication and characterization of a quantum-bus in silicon

Master's project starting 2019

Scientific background The main building blocks of a silicon quantum computer operating with single electrons spins as qubits were already demonstrated: (I) Single spin manipulation for qubit superposition and (II) two-qubit gates for qubit entanglement. However, for a scalable quantum computer architecture containing millions of qubits, the qubit information has to be transferred via a **quantum bus (QuBus)** over a few microns.



Research goal We electrostatically trap single electrons with biased metallic nano-gates patterns on top of a Si/SiGe heterostructure providing a 2D electron gas (2DEG). These gates can be used to create a wave-like potential within the heterostructure, which coherently transports electron spins within a 1D channel between quantum dots and thus leads to scalable quantum computation. We performed electrostatic simulations and fabricated suitable three-layer metallic gate structures by electron-beam lithography at the Helmholtz Nano Facility in FZ Jülich. In several steps, our QuBus has to be tested and optimized in a dilution refrigerator at 20 mK.



Top: Schematic of the single electron spin QuBus. Metallic top-gates induce charges (yellow) in the Si/SiGe 2DEG. Bottom: Scanning electron micro-graph of the metallic gates on top of the sample.

Your task You will learn about the complex fabrication of the three layer gate patterns in the high-tech clean room facility in FZ Jülich. Cooling down the samples in a dilution refrigerator at our institute, you have to tune the voltages on the metallic gates in order to create and test single charge detectors using a single-electron transistor and form quantum dots that can be adiabatically displaced along a 1D channel. You will gain experience in

- Optical lithography and cutting edge electron-beam-lithography at the technical limit
- Low temperature physics at 10 mK
- High-frequency, low-noise electrical measurement techniques
- Numerical simulations using COMSOL physics and matlab.

Furthermore, you will attend group seminars and journal clubs to learn about new developments in quantum computing.

Cooperation partners: Helmholtz Nano Facility in Jülich, University of Regensburg, Delft University of Technology, Intel Cooperation, Centre national de la recherché scientifique (Grenoble), Institute of Physics Polish Academy of Sciences

Contact: Dr. Lars Schreiber, Physikgebäude 28A327, lars.schreiber@physik.rwth-aachen.de