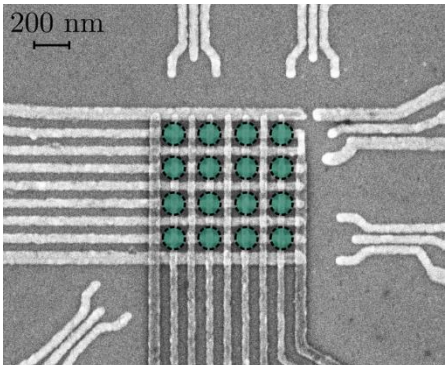
INSTITUT NEEL Grenoble

Topic for Master 2 internship – Academic year 2021-2022

Quantum dot arrays characterization and automatic tuning

Context: Quantum information processing requires controlling many qubits with long coherence times. In this context, the electronic spin of a single electron trapped in a Si quantum dot has been identified as a promising platform for quantum information processing due to both its long coherence time and the possibility to leverage the well-established fabrication of Si foundries. However, quantum dots require to be finely tuned to operate in the right regime which becomes extremely time-consuming as the size of the system grows. The QUANTECA team has been a pioneer in the demonstration and use of the isolated regime in which one or several quantum dots are fully isolated from the leads allowing to tune the system with a constant number of electrons in the structure hence reducing the dimensionality of the space to explore. The extension of this technique to larger arrays and the exploitation of device symmetries offer interesting perspectives to scale such systems while keeping the complexity of their tuning under control.



2D array of Quantum dots using 2 layers of gates on GaAs

Objectives and means available: The aim of this project is to develop both characterization and automatic tuning procedures for arrays of quantum dots. The Neel team has extensive knowledge of GaAs devices that are highly tunable and an ongoing collaboration with CEA-LETI to access Si devices fabricated in their industrial foundry. The project will likely focus on GaAs samples which are more mature when it comes to larger arrays and bi-dimensional structures. However, the device characterization part will be shared with the CEA-LETI team which performs wafer scale characterization using a cryogenic probe station. As the project moves forward, some procedures may be embedded in custom electronics developed at the Néel institute in collaboration with the electronic department.

Interactions and collaborations: This work is part of a large collaborative effort between the CEA-IRIG, CEA-LETI, and CNRS-Institut Néel to develop and push the technology of spin qubit in silicon and investigate its potential scalability. Therefore, the candidate will work in close collaboration with LETI's device characterization team to develop and improve simple device characterization schemes while he will benefit from interaction with the CNRS-Institut Néel when it comes to larger devices. A common data acquisition platform shared between the CEA and the CNRS will ensure a smooth collaboration on the automation tools.

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. All along this project, the candidate will acquire important skills in the field of quantum nanoelectronics: data acquisition, analysis automation, low-noise electronics, qubit integration, cryoelectronics, computer control, characterization of CMOS quantum devices… Python is the language of choice for ongoing developments.

Starting date: From September 2022 to April 2023

Possibility of continuation as a PhD on the same subject with funding already secured.

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