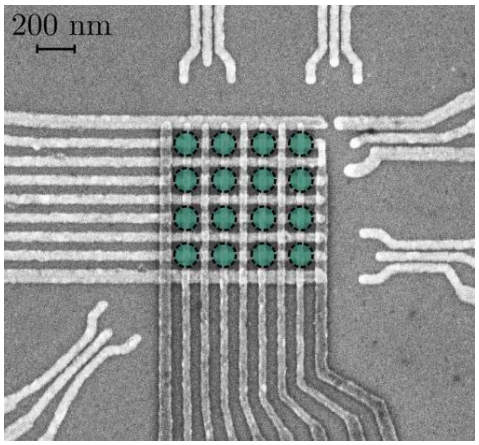
NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2021-2022

Quantum dot arrays control, characterization and automatic tuning

Context: Quantum information processing requires to be able to control 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 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 (PA Mortemousque et al, Nature Nano 2020) in the demonstration and use of the isolated regime in which one or several quantum dots are 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 perspective to scale systems while keeping the complexity of the tuning under control.

Objectives and means available: The aim of this project is to develop both characterization and automatic tuning procedure for arrays of quantum dots filled with electron spins. The Neel team has extensive knowledge on GaAs dot array devices which are highly tunable and an ongoing collaboration with CEA-LETI to access Si devices fabricated in their industrial foundry. The project will focus on both type of dot array sample. Nowadays, GaAs samples are more mature when it comes to larger arrays and bi-dimensional structures. The idea of the project will eventually be to transfer the demonstrated control to Si quantum devices Si quantum samples. As the project moves forward, some procedures may be optimized with fast electronics in collaboration with CEA-Leti and embedded in custom electronic developed at the Néel institute.



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

Interactions and collaborations: This work is part of a collaborative effort between the CEA-IRIG, CEA-LETI and CNRS-Institut Néel to push the technology of spin qubit in silicon and investigate its potential scalability. Therefore, the candidate will work in close collaboration with the LETI's device characterization team to investigate 2D array in Si devices 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: qubit integration, cryoelectronics, cryogenics at mK, low-noise electronics, computer control, characterization of CMOS quantum devices…

Foreseen start for the beginning of the internship: From January to April 2022

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

Contacts: Pierre André Mortemousque CEA Leti Pierre-andre.mortemousque@cea.fr	**Contacts**: Matthieu Dartiailh CNRS- Institut néel matthieu.dartiailh@neel.cnrs.fr	**Contacts**: Tristan Meunier Institut Néel CNRS tristan.meunier@neel.cnrs.fr

More information : http://neel.cnrs.fr