Master Project

Electron Spin Resonance in silicon CMOS spin qubits

Quantum computing is a major new frontier in information technology with the potential for disruptive impact. Many different materials and approaches have been explored so far, with an increasing effort on scalable implementations based on solid-state platforms. Diverting silicon technology is the approach explored in our Lab. Concretely the idea is: Can we create a quantum bit (the quantum analog of a bit) from a “basic” silicon transistor? The answer is yes, as we demonstrated recently [1].

The working principle of the qubit is to trap a spin inside the channel of a silicon transistor and to manipulate this spin via microwave signals. All the experiment is done at very low temperature, typically below 0.1 K, in a dilution refrigerator. Naturally, spin manipulation is based on electron spin resonance, which consists in applying a oscillating magnetic field at a frequency matching the energy different between spin-down and spin-up states [2].

For this master project, you will develop by nano-fabrication high frequency antenna on top of a CMOS spin qubit coming from the LETI cleanroom to perform electron spin resonance. You will work on completely new devices coming from the LETI cleanroom. You will use a dry (no liquid helium) dilution cryostat equipped with a multi-axis superconducting magnet and radio-frequency electronics to characterize the high frequency antenna and conclude on the feasibility of electron spin resonance with CMOS spin qubits.

This project can evolve into a PhD thesis project consisting in the realization of quantum operations in CMOS-based device [3]. This project is part of a large research effort between CEA and CNRS in Grenoble for the development of quantum computing based on CMOS technology see: http://www.quantumsilicon-grenoble.eu.

The candidate should show a strong interest in experimental research and have a solid background in solid-state physics and quantum mechanics.

References: [1] Maurand, R. et al. Nat. Commun. 7, 13575 (2016). [2] Pla et al. Nature 489,541-545 (2012) [3] Veldhorst et al. Nature Nano. 9, 381-985 (2018)

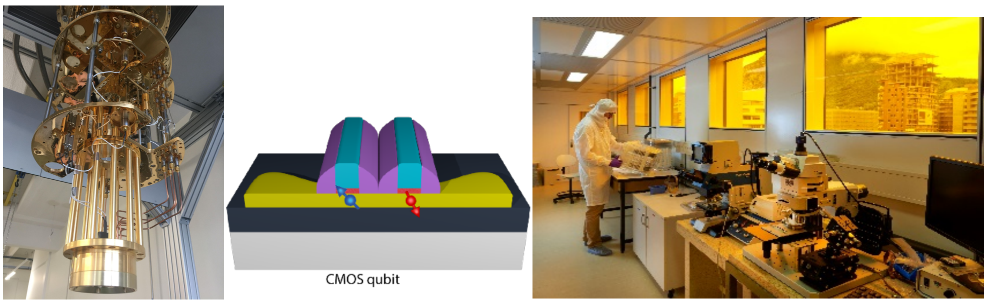

Figure: A dilution Fridge, a schematic of a CMOS spin Qubit and the clean room

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