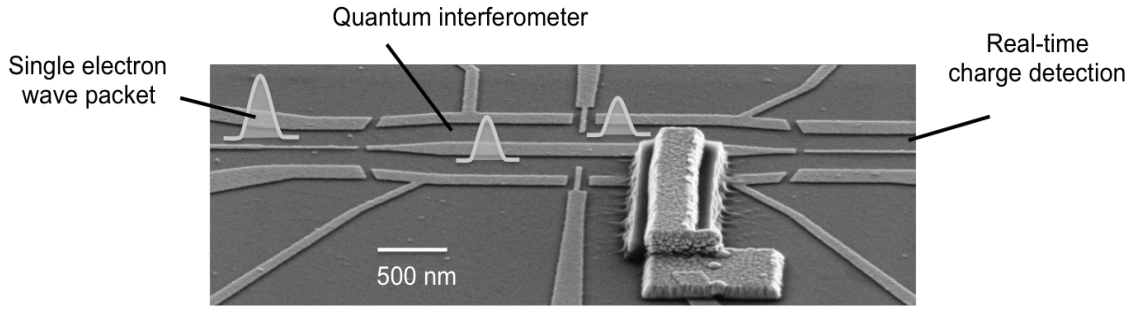
Proposition for a Long Master Thesis (2018-2020)

Flying Qubit architectures using ultra-short single-electron charge pulses

Project description: Coherent manipulation of single electrons in solid-state devices is attractive for quantum information purposes because they have a high potential for scalability. Depending on the system used, the charge or the spin may code binary qubit information. A particular appealing idea is to use a single flying electron itself as the conveyor of quantum information. Such electronic flying qubits allow performing quantum operations on qubits while they are being coherently transferred. Information processing typically takes place in the nodes of the quantum network on locally controlled qubits, but quantum networking would require flying qubits to exchange information from one location to another. It is therefore of prime interest to develop ways of transferring information from one node to the other. The availability of flying qubits would enable the possibility to develop new non-local architectures for quantum computing with possibly cheaper hardware overhead than e.g. surface codes.
The aim of the proposed Long Master Thesis is to participate in a collaborative effort to develop flying qubit architectures using ultra-short single-electron charge pulses. In order to generate such ultra-short electron wave packets, we will leverage on the progress made on THz photon production and use photon to electron conversion devices to engineer THz electronic charge pulses that can be used in quantum nanoelectronics.



A flying electron qubit can then be realized by injecting such a single-electron charge pulse into a quantum interferometer made from a two-dimensional electron gas as shown in the figure above.

References:

Hermelin et al., Nature 2011; Dubois et al., Nature 2013;
Bertrand et al, Nature Nanotechnology 2016, Roussely et al. arXiv: 1711.03509

Contact:

Name: BAUERLE Christopher
Institut Néel - CNRS
Phone: 04 76 88 78 43
e-mail: christopher.bauerle@neel.cnrs.fr
http://neel.cnrs.fr