Modeling of silicon two qubit gates

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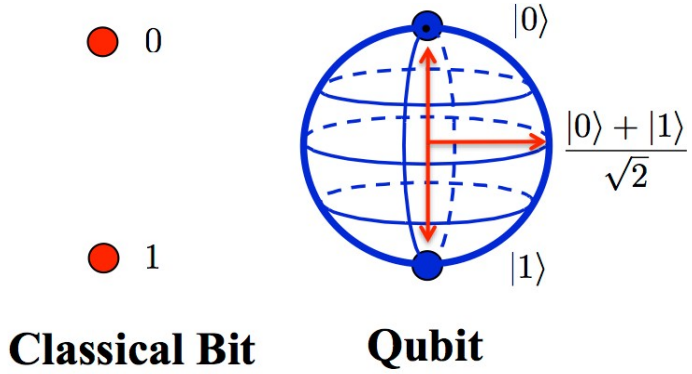


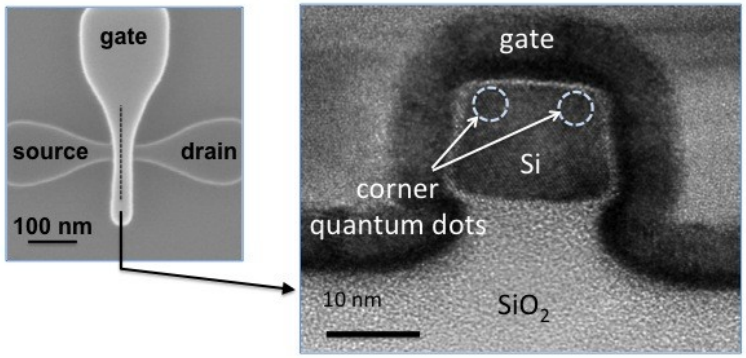
Quantum bit: Store information as a **coherent superposition** of « $|0\rangle$ » and « $|1\rangle$ » states

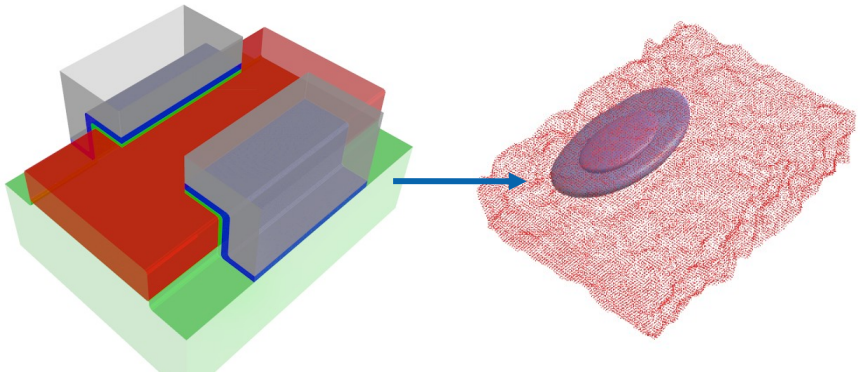
Benefits: Exponential speed-up with respect to classical information for some problems

Possible implementation: $|0\rangle \equiv |\downarrow\rangle$, $|1\rangle \equiv |\uparrow\rangle$ states of an electron in a « **single electron transistor** »

The spin is manipulated with RF pulses on the gates

Quantum computation: Entanglement by exchange (Coulomb+tunnel) interactions between qubits

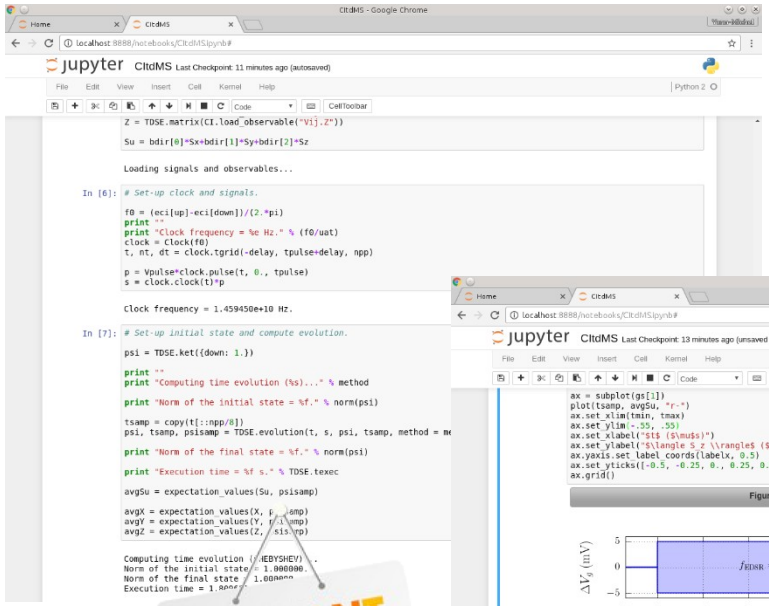


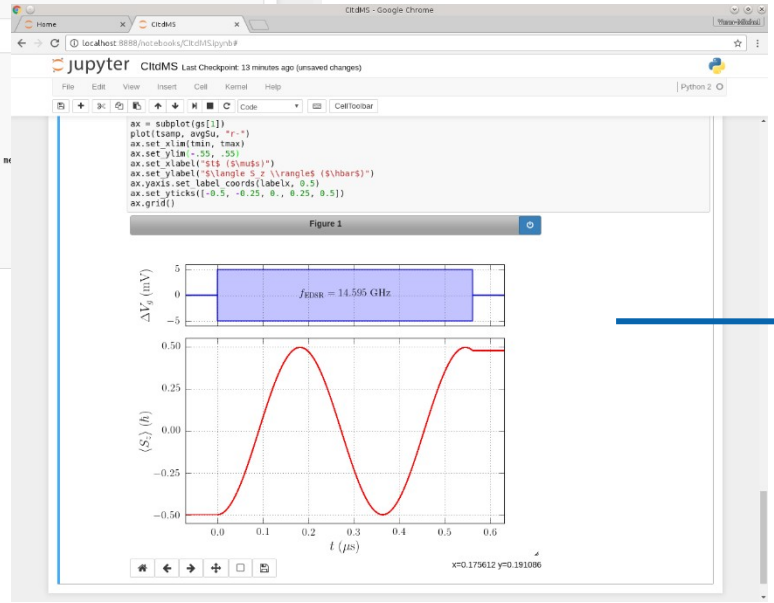


Strong need for modeling:
Quantum confinement and Coulomb correlations, manipulation based on spin-orbit coupling, decoherence....

Objective: **Modeling of the exchange coupling between two qubits and time-dependent simulation of a two qubit gate.**

Framework: Electronic structure calculations on realistic geometries (HPC).
Interactive Python scripts for time-dependent simulations.
Analytical, effective models for interacting qubits.





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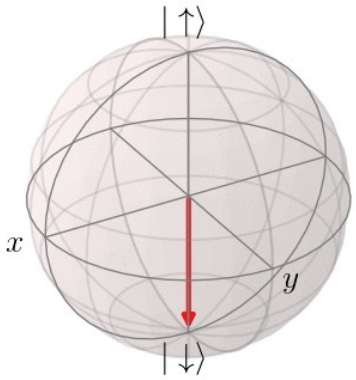
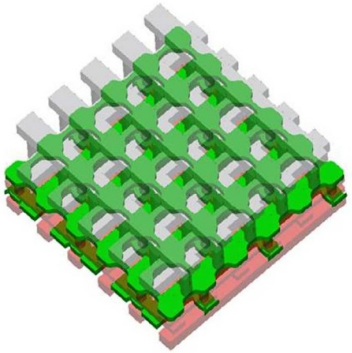
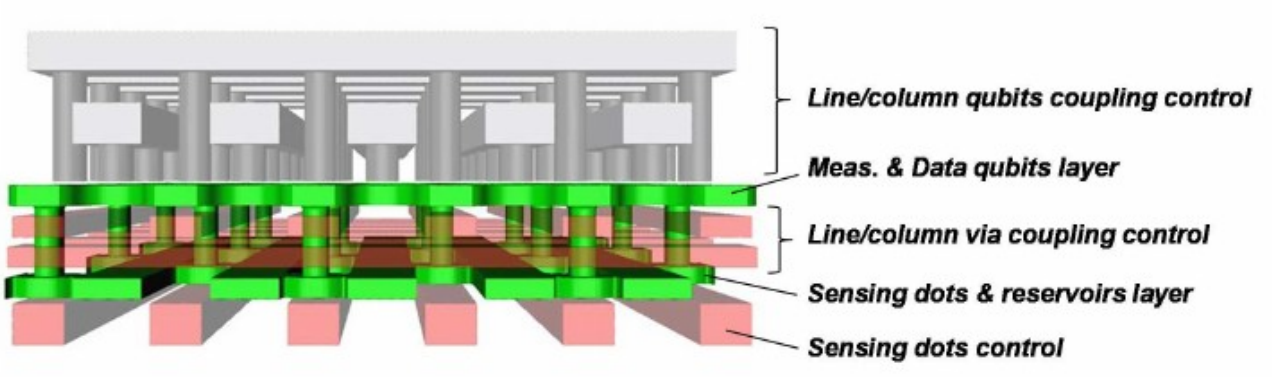


Context: **ERC Synergy “quCube” (2019-2024) gathering CEA/LETI, CEA/INAC and CNRS/Néel around the realization of 2D arrays of qubits (budget: 14 M€).**





Strong connections already existing with experimental teams at CEA and in Europe (6 joint publications in 2018).