Charge sensing using a single-electron double-box in a silicon quantum dot array

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With progress made in the scalability of semiconductor-based spin qubits, the development of highly integrated architectures has become essential [1]. Although CMOS technology provides advantages for integration and scaling [2] mostly due to advances in manufacturing processes, the use of structures like single electron tunnelling devices limits de facto the latter because of the presence of contacts and the requirement for extra control gates. The use of dispersive charge sensing in single electron boxes (SEB) [3] has significantly improved device footprints while maintaining a high-fidelity readout. However, the presence of a reservoir still limits its use in high density architectures in practice.
With the view of better scalability and higher qubit density, we have investigated a compact single electron double box (SEDB) integrated into a Si-CMOS array and performed high quality readout without the need of any reservoir.
The device itself is based on a multi-gate CMOS architecture with independent tuneable control and exchange gates [4]. Readout is implemented by a double resonant circuit with superconducting inductors [5].
By comparing a double-box to a single-box in the same Si-CMOS system, the charge readout capabilities of the double-box are assessed. This compact, reservoir-less charge sensor offers a promising approach for spin readout in a large and dense qubit architecture.

References

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Figures

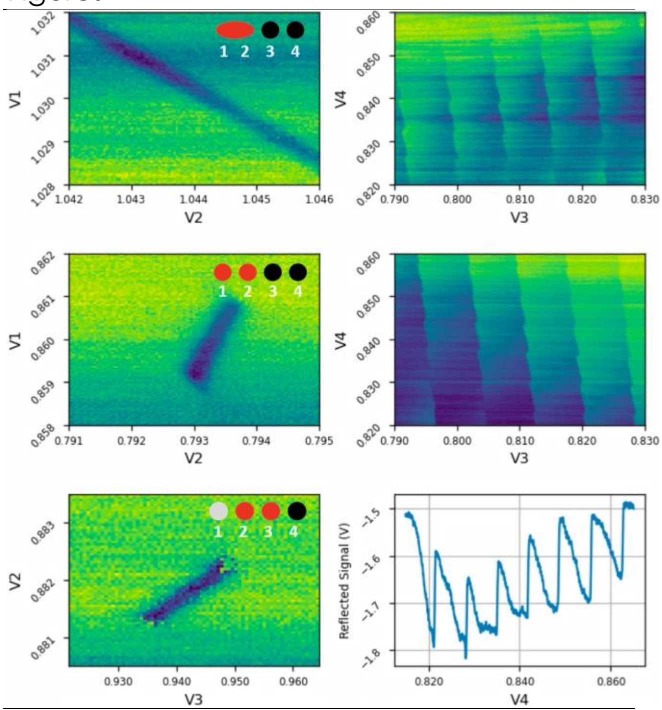

Figure: Comparison between the SEB and SEDB readouts in the configurations indicated in the inset (detector in red, sensing in black, unused in white). The left panels show the dispersive signal whereas the right panels display the charge sensing. The 'Vi' are voltages applied to the dots 'i'.