High-fidelity qubit-operations using quantum-dot arrays fabricated on a 300 mm semiconductor line

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Quantum computers will require large numbers of highly coherent qubits in concert with precise pulse control to enable complex algorithms and quantum error correction for reliable computation. Si/SiGe quantum-dots based qubits are an excellent platform with demonstrated high fidelity control [1] and leverage the proven reliability of semiconductor manufacturing to successfully demonstrate clean, high-yielding quantum-dot arrays [2]. In this talk, we discuss details of the Intel's Tunnel Falls chip and demonstrate array tune-up of up to 12 single-spin qubits and up to 4 Exchange-Only encoded qubits. We report on 1Q and 2Q control characterisation, highlighting the tuning and control techniques that unlock high fidelity operations. Lastly, we showcase the latest results from Intel's quantum chip development aimed at transferring the learnings from small-scale high-performance qubit demonstrations to produce larger arrays that facilitate qubit initialization, manipulation and readout.

[1] Mills, A. R. et al*. Two-qubit silicon quantum processor with operation fidelity exceeding 99%.* Science Advances 8, eabn5130 (2022).
[2] Neyens, S. et al*. Probing single electrons across 300-mm spin qubit wafers.* Nature 629, 80–85 (2024).