Single-qubit Operations and Statistics in a Dense 10-qubit Array

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In recent years, planar germanium qubits in Ge/SiGe heterostructures emerged as a compelling platform for quantum computation [1]. Their favourable properties enabled the demonstration a four-qubit quantum processor [2], high-fidelity two-qubit gates [3] and the implementation of extensible control strategies [4]. However, to prove a quantum advantage with semiconductor qubits, larger quantum dot architectures need to be developed meeting the stringent requirements in device quality and operations fidelities.

Here we investigate an extended 10-quantum dot array operated in the few hole regime, in an external magnetic field of a few tens of mT. We statistically characterise single-qubit properties of each of the 10 spin qubits defined in the same dc voltages configuration.

We determine the g-factors and coherence times across the array with a variability of less than 10%. We also map the driving efficiency of all the plunger and barrier gates to study the locality, directionality, and possible crosstalk of driving mechanisms in a dense qubit array. Using the most efficient driving gate, we perform randomised benchmarking on the 10 qubits and obtain fidelities above 99% for all. Finally, we also show our efforts in tuning and calibrating the system based on automated operations to achieve a better control over the qubits.

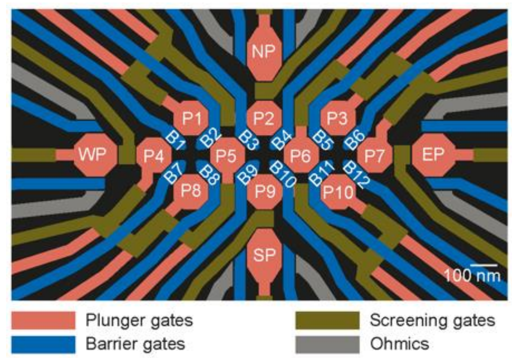

Fig.1. Layout of the 10-quantum dot array with four charge sensors located at the cardinal points.

References

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[3] C.A. Wang et al., arXiv: 2402.18382 (2024)

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