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Wafer-level characterization of industrial grade Si-based qubit devices.

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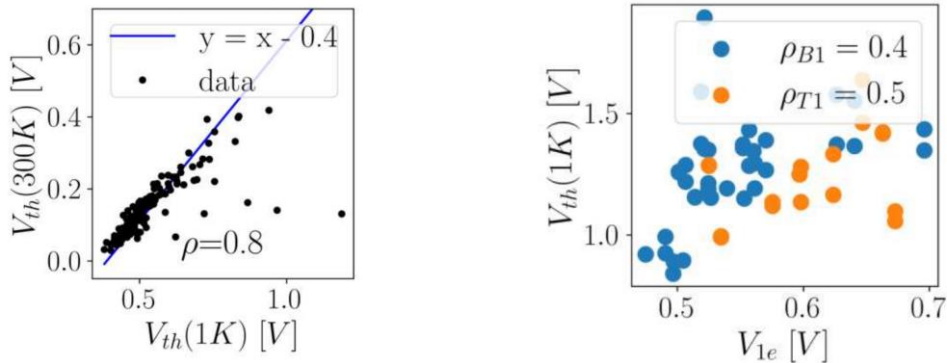
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Efforts in improving the quality and number of solid-state spin qubits within a single device are currently hindered by the lack of large-scale characterization tools. Such tools are routinely available for “transistor-like” room-temperature characterization, but quantum-dot measurements at 1K are crucial to obtain specific information about the spin-qubit confinement and provide meaningful feedbacks to the process integration.

Here, we present the characterization of Si-based spin qubit devices at the wafer level at both 300K and 1K. We propose a methodology to evaluate such devices in a 3-step characterization protocol: 300K “transistor-like” metrics informative on material quality and process variability, 1K transistor and quantum dot metrics in the many-electron and in the few-electron regime.

We compare these different metrics to show their relevance, and discuss automation efforts for the analysis. Thanks to this large-scale characterization, we study the correlations between (i) 300K and 1K transistor-like metrics, and (ii) 1K transistor-like and quantum-dot properties. In particular, we show how the transistor threshold-voltage evolve with the temperature and how it relate to the voltage for which the first electron enters the quantum-dot. We discuss the correlation conditions and how they can help to speed up the characterization process.



Left panel: Correlations of constant-current threshold voltage at 300K and 1K for different devices of a same wafer. **Right panel:** Correlations between the threshold voltage in the transistor regime and the voltage for which the first electron enters the quantum-dots.