Automated tuning of a quadruple quantum dot array

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The automatic tune-up of a controlled quantum system is a necessity for large-scale quantum computation and device fabrication characterization. Gate-defined quantum dots require careful adjustment of several voltages for dot formation, charge state control, and tunnel barrier control.
In recent years, several methods and tools for tune up automation have been proposed and published [1, 2, 3]. So far, most of the attention has focused on measurement data analysis and quantitative algorithm descriptions while benchmarks of complete tuning runs are limited.
We developed a completely defined algorithm for tuning a quadruple quantum dot array into the single electron regime. The algorithm uses the pinch-offs to calculate scan ranges and a cross capacitance model for iterative tune up similar to Volk et al. [4]. Human intervention was only required to execute defined algorithm steps that had not been implemented at the time. Importantly, our method relies solely on (virtual) single-dot charge stability diagrams. This will simplify implementing automated data analysis in the future. The algorithm was tested on a single sample utilizing sample symmetries and thermal cycles to approximate independent tuning runs.

References

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[2] T. Botzem et al., Phys. Rev. Applied, 10 (2018) 054026
[3] M. Lapointe-Major et al., Phys. Rev. B, 102 (2020) 085301
[4] C. Volk et al., npj Quantum Information, 5 (2019) 29

Figures

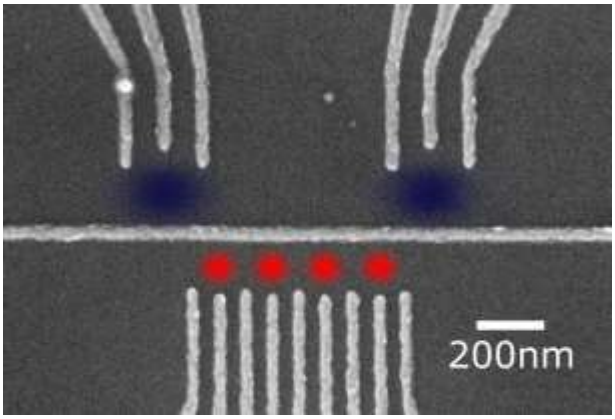

Figure 1: SEM image of gate layout for a quadruple dot system in GaAs. The intended dot positions of the four array dots for qubits (red) and the two sensor dots for charge sensing (blue) are marked.