

What is the maximum control line density in a superconducting quantum computer?

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Scaling superconducting quantum processors requires increasingly dense cryogenic control wiring [1], motivating the exploration of microwave structures beyond conventional coaxial geometries. In this presentation, we will outline Bluefors' efforts towards holistic integration of scalable control wiring, focusing on flexible printed microwave lines within the cryogenic environment [2, 3]. Because this approach substantially reduces the physical separation between control lines, microwave crosstalk allocation becomes a central design constraint [4]. We will illustrate how an analytical transmission-line model, combined with a two-transmon framework, can be used to quantify fidelity loss in an all-microwave universal gate set. We further derive the equal-level far-end crosstalk (ELFEXT) required to meet specified gate-fidelity targets and, using a system-scaling argument, we demonstrate how fidelity constraints bound the number of physical qubits per chip.

References

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- [3] P. Paluch *et al.*, Applied Physics Letters, **126** (2025) 034003
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Figures

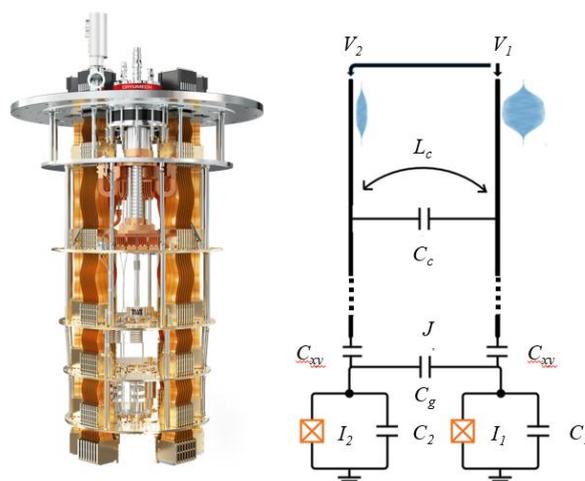


Figure 1: Left - Illustration of a dilution refrigerator depicting an implementation of flexible printed circuit wiring. Right - Equivalent circuit diagram of a pair of transmission lines connected to a 2-transmon system.