

Optical links for control and readout of superconducting qubits: toward scalable, low heat load architectures

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Two major challenges in scaling state-of-the-art superconducting quantum processing units (QPUs) are (i) the passive heat load of coaxial cables used for microwave I/O and (ii) the active heat load of cryogenic amplifiers [1]. Hence, optical signal delivery over near-zero thermal conductivity optical fibers is a promising alternative [2, 3]. Here, we present a roadmap towards a scalable framework for control and readout of superconducting qubits via optical links. We show that this approach, which is based on cryogenic operation of photodiodes and microwave-to-optics transducers, will allow for scaling in excess of tens of thousands of qubits within a single cryostat. We further experimentally demonstrate that our control platform is capable of high-fidelity qubit operations and accordingly compatible with modern quantum error correction schemes.

References

- [1] Krantz, et al. Applied physics reviews 6.2 (2019).
- [2] Lecocq, et al. Nature 591.7851 (2021): 575-579
- [3] Van Thiel, T. C., et al. Nature Physics 21.3 (2025): 401-405

Figures

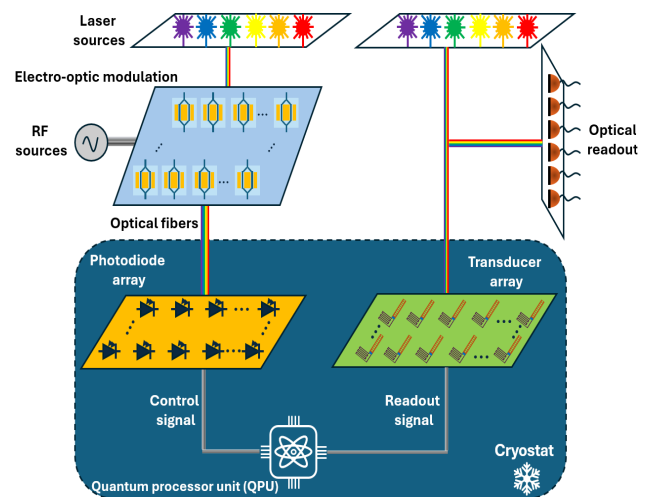


Figure 1: High-level scheme for scalable optical readout and control of superconducting qubits