All-optical superconducting qubit readout

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The rapid development of superconducting quantum hardware is expected to run into significant I/O restrictions due to the need for large-scale error correction. Classical data centers rely on fiber-optic interconnects to remove similar networking bottlenecks. In the same spirit, ultra-cold electro-optic links have been used to generate qubit control signals, or to replace cryogenic readout electronics. So far, these links suffered from low efficiency, low bandwidth [1], or breaking of Cooper pairs. In this work [2], we realize electro-optic microwave photonics at millikelvin temperatures to implement a radio-over-fiber qubit readout that does not require any active or passive cryogenic microwave equipment. We demonstrate all-optical single-shot-readout by means of the Jaynes-Cummings nonlinearity [3]. Importantly, we do not observe any direct radiation impact on the qubit state. This compatibility between superconducting circuits and telecom wavelength light is not only a prerequisite to establish modular quantum networks, it is also relevant for multiplexed readout of superconducting photon detectors and classical superconducting logic.

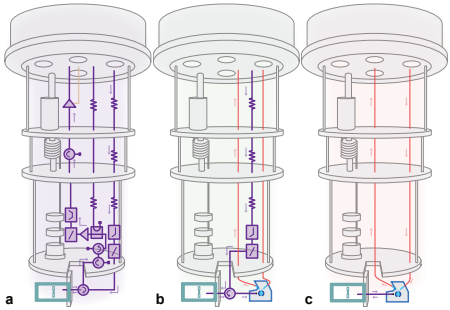

Fig. 1: Comparison of conventional and optical qubit readout setups in a dilution refrigerator. a, microwave in - microwave out **b**, microwave in - optics out **c**, optics in - optics out (all-optical)

References

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[3] M. D. Reed, L. DiCarlo, B. R. Johnson, L. Sun, D. I. Schuster, L. Frunzioan & R. J. Schoelkopf, Phys. Rev. Lett. **105**, 173601 (2010)

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