

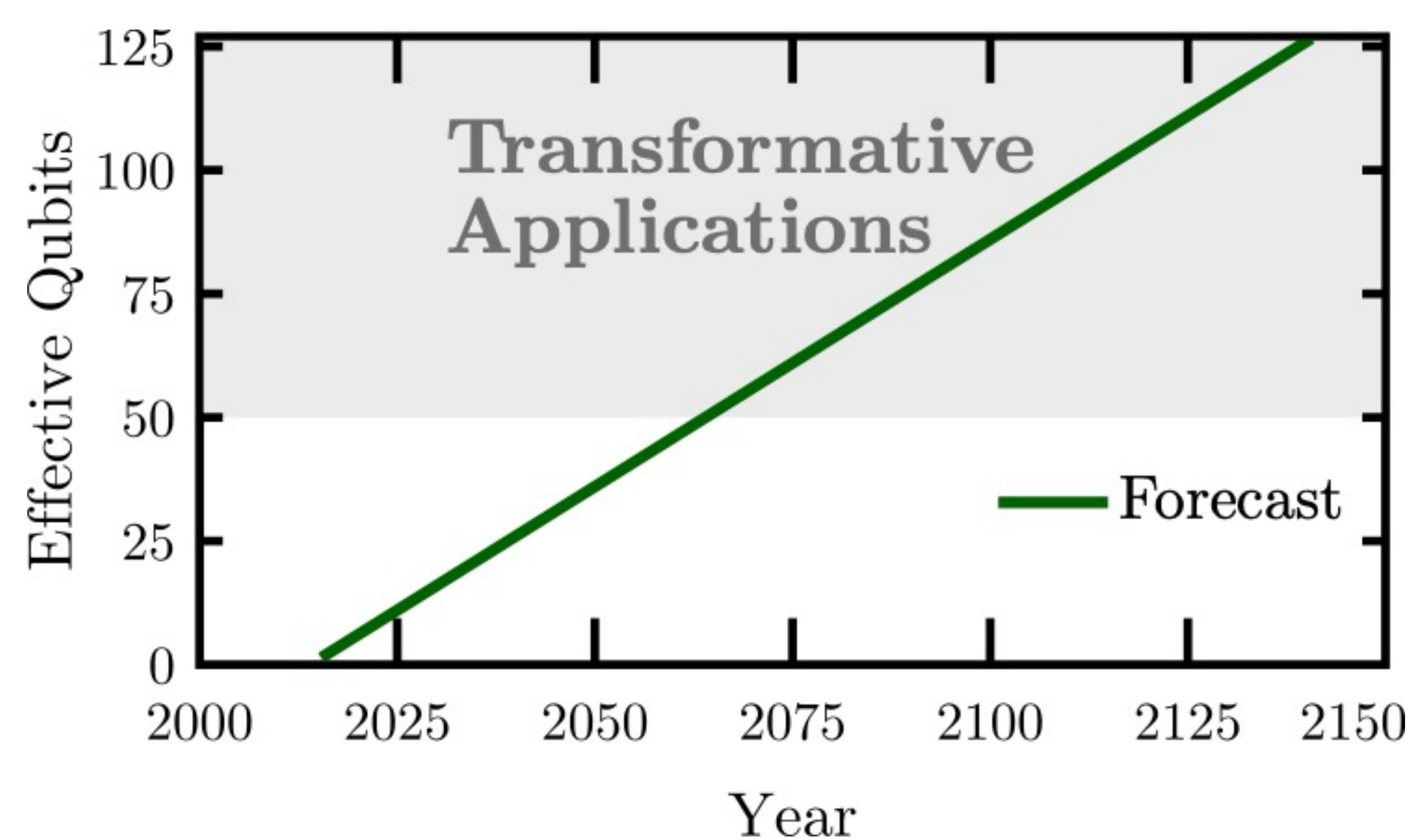
Accelerating Quantum Technologies Through Fermilab SRF Expertise

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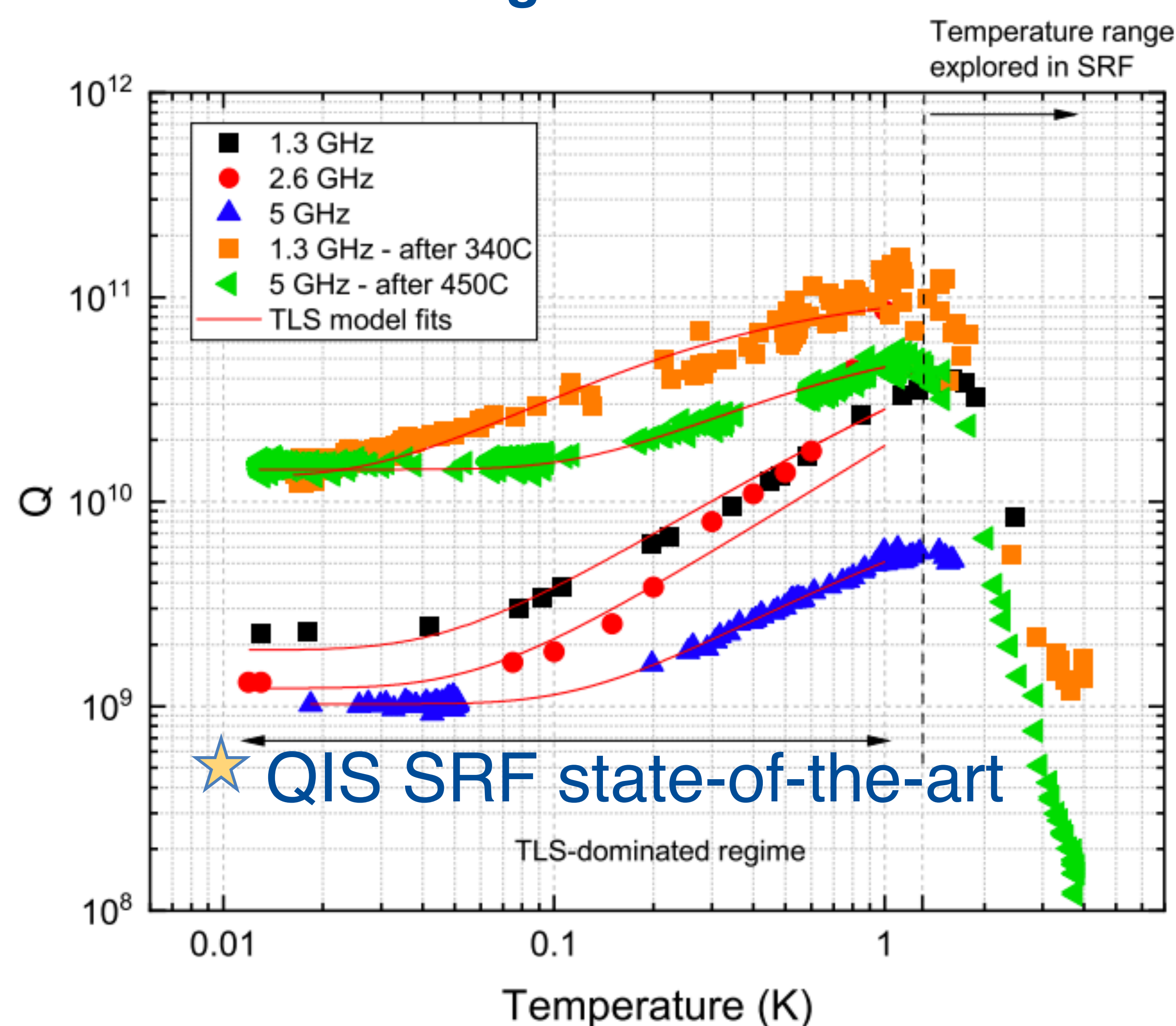
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Time Scale for Transformative Quantum Computers is set by Decoherence



Industry forecast of exponential growth in quantum computing power still predicts that transformative applications are decades away. System performance is limited by decoherence and requires 5-10x the number of physical qubits per effective qubit.

Superconducting Radio Frequency Cavities Enable Breakthroughs in Quantum Coherence

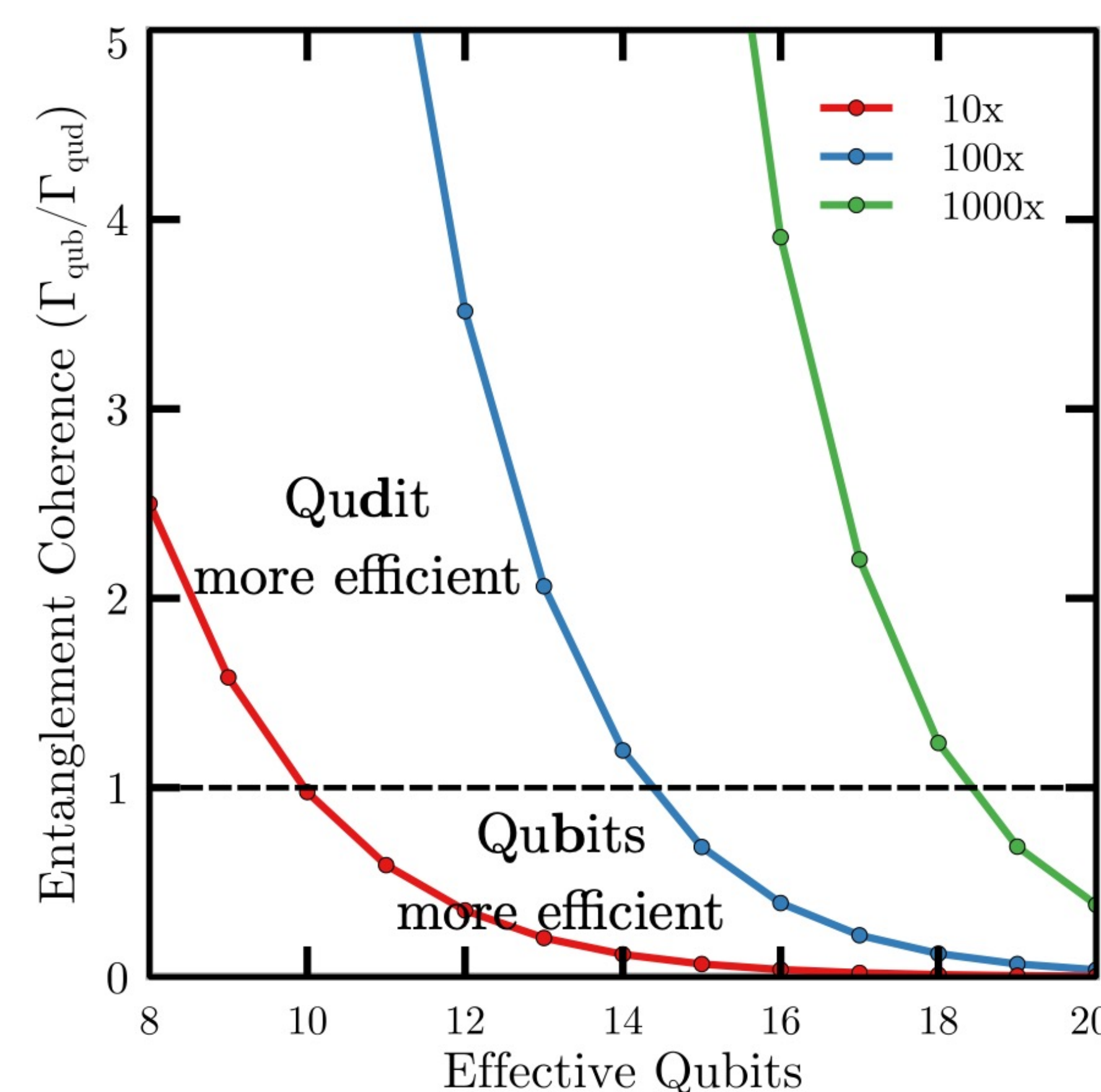


Using Fermilab SRF expertise as a starting point, these cavities have demonstrated more than two orders of magnitude longer coherence than the previous quantum regime record for SRF cavities. Additionally, Fermilab SRF cavities have more than three orders of magnitude longer coherence times than the best state-of-the-art superconducting qubits.

Reference: A. Romanenko, R. Pilipenko, S. Zorzetti, D. Frolov, M. Awida, S. Posen, and A. Grassellino. *arXiv:1810.03703*



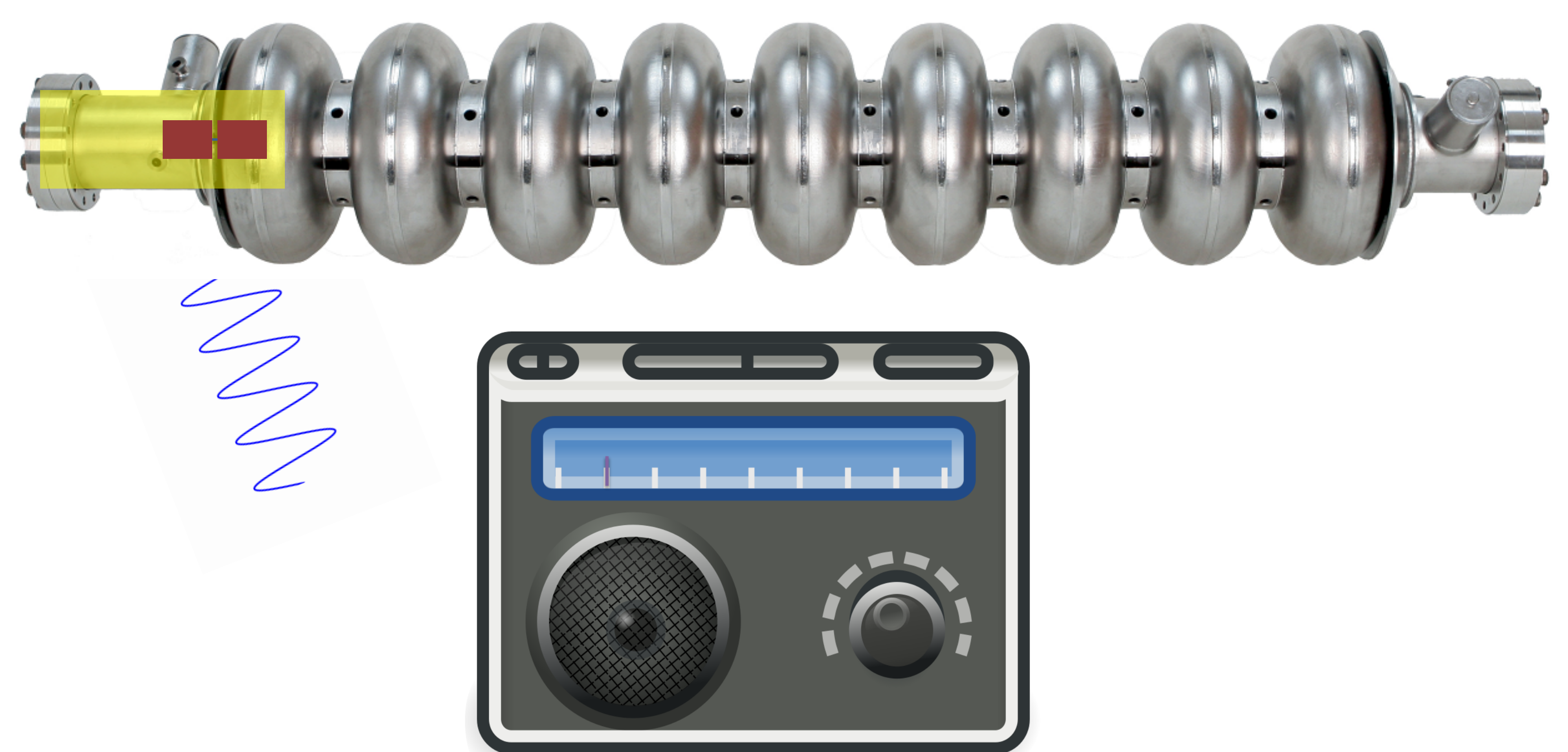
A Single Cell SRF Cavity (Qudit) Can Perform as Many Effective Qubits



Effective Qubits	Photons in SRF Cavity
1	1
3	7
5	31
7	127
10	1027
14	16383

Long coherence in SRF cavities enables a single cell to support more photons and therefore preserve highly entangled states for a longer time than could be achieved in a multi-qubit system. Even 16,383 photons only amounts to 0.176 eV of energy.

Scaling Up Quantum Systems Through Multi-Cell SRF Technology



To scale up this quantum technology we will couple a superconducting qubit to a multi-cell structure and control it similar to a radio. The number of cells used multiplicatively increases the number of effective qubits. **A nine-cell structure could support between 63 and 128 effective qubits enabling quantum simulations a half century faster than forecasted.**

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