Unlocking the Quantum Internet: Advancements in High-Efficiency Microwave-Optical Transduction

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In the past decade, Quantum Information Science (QIS) has witnessed significant growth, driven by technological advancements that have given rise to the first generation of quantum processor units (QPUs). The next groundbreaking frontier in QIS involves the establishment of quantum networks and interconnections between these QPUs. A pivotal technology enabling the realization of distributed quantum networks is high-efficiency microwave-optical transduction, with wide-ranging applications encompassing cryptography, national security, and quantum sensing. At the DOE Fermi National Laboratory, part of our research is dedicated to developing this crucial enabling technology, employing superconducting cavities with long coherence times coupled to electro-optic non-linear materials. In this talk, we will present a comprehensive analysis and measurements that demonstrate the feasibility of achieving an impressive 50% efficiency while minimizing added noise. These findings represent a significant step forward in advancing quantum networks and sensor networks for the Quantum Internet era.