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Cryogenic Electronics for Quantum-Classical Applications

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The core of a quantum computer or a quantum sensor is generally an array of qubits or quantum detectors and classical electronics for its control; it operates on the qubits/detectors with nanosecond latency and a very low noise. Classical electronics is generally operating at room temperature, however recently, we have proposed that it moves closer to the qubits/detectors and operates at cryogenic temperatures to improve compactness and reliability. This has introduced new constraints to the electronics, especially in terms of noise and power dissipation, due to the extremely weak signals generated by quantum devices that require highly sensitive circuits and systems, along with very precise timing capability. We advocate the use of CMOS technologies to achieve these goals, whereas the circuits will be operated at 2-10K. We believe that these, collectively known as cryo-CMOS circuits, will make future qubit arrays scalable, enabling a faster growth in qubit count. Quantum sensing based on superconducting materials, will become more reliable and robust to the conditions of operation. In the talk, the challenges of designing and operating complex circuits and systems at deep-cryogenic temperatures will be outlined, along with preliminary results achieved in the control of quantum devices by ad hoc integrated circuits that were optimized to operate at low power in these conditions. The talk will conclude with a perspective on the field and its trends.

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