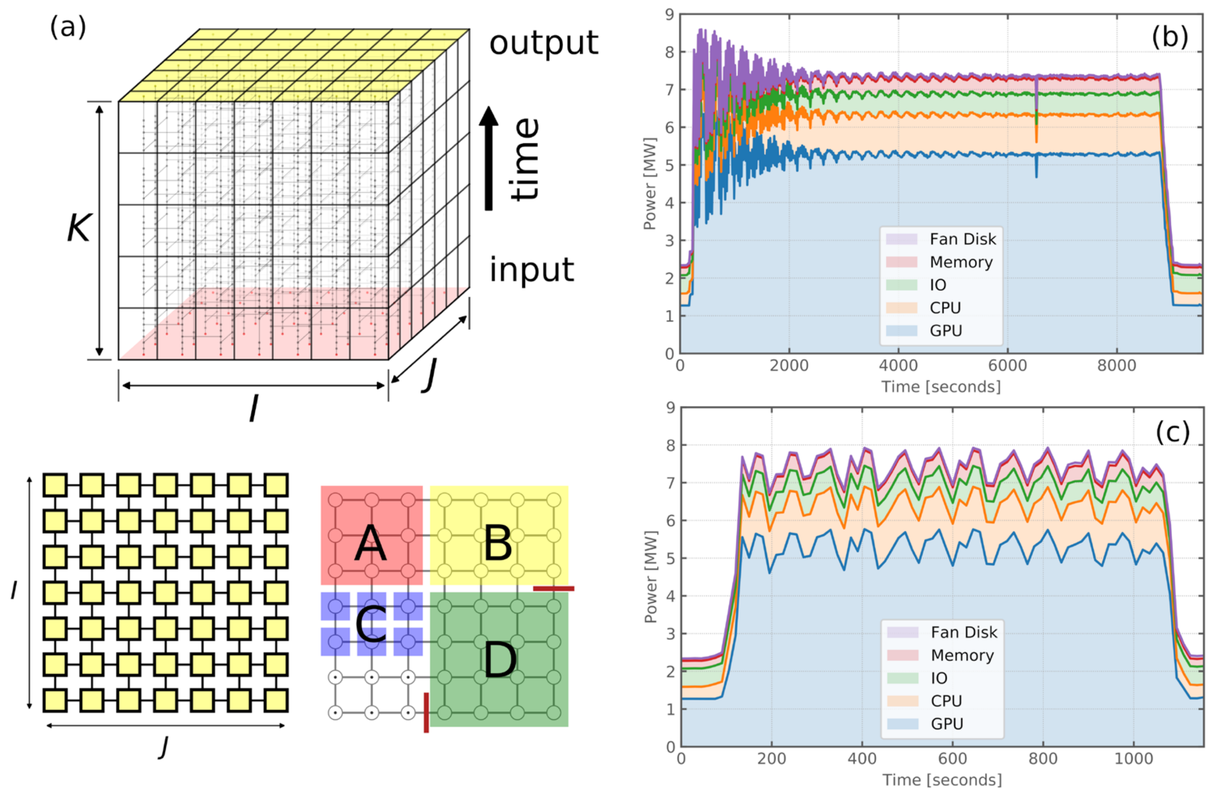
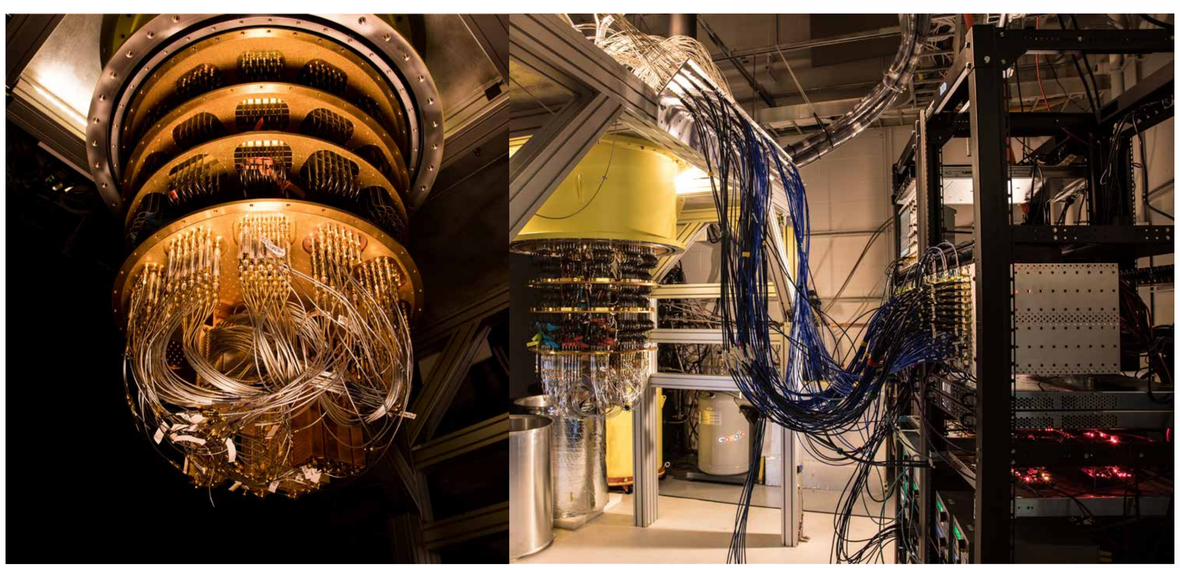
National Aeronautics and
Space Administration

NASA EXPLORES SUPERCOMPUTING

Achieving Quantum Supremacy with Noisy Intermediate-Scale Quantum Devices



Results of Random Quantum Circuit (RQC) sampling using the qFlex simulator. (a) Example of RQC used in quantum supremacy experiments. To classically simulate sampling, qFlex divides them into blocks in spatial and time directions. Each block (tensor) shares degrees of freedom with its neighbors, forming a network that explores all superposed, interfering paths in which quantum information propagates; (b,c) Power consumption of the Summit supercomputer at a given time during our simulations, using 4,550 (99%) nodes. *Salvatore Mandra, NASA/Ames; Benjamin Villalonga, University of Illinois at Urbana-Champaign*



A side by side view of a dilution refrigerator and electronic rack for Google's quantum computer. *Images courtesy of Erik Lucero, Google*

"Quantum supremacy"—the ability of a programmable quantum processor to perform a well-defined task beyond the capability of the most powerful supercomputers—is around the corner. Not to overclaim this historical milestone, we have designed a state-of-the art classical simulator of quantum circuits, called qFlex, that pushes classical supercomputers to top-notch performance rates for quantum supremacy tasks, setting a fair race between noisy quantum devices and classical supercomputers. Access to NASA's Pleiades and Electra supercomputers, as well as the Summit system at Oak Ridge National Laboratory, is of utmost importance for benchmarking classical supercomputers, as well as for understanding the strengths and weaknesses of classical technologies in this race.

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