**ATTACHMENT (1) – RFI TECHNICAL CONSIDERATIONS**

**SUMMARY**

Lawrence Livermore National Laboratory (LLNL) is interested in receiving information that may serve, in part, for information and planning purposes to enhance LLNL’s QuDIT user facilities with state-of-the-art quantum simulation hardware, which LLNS may solicit / acquire under a future Request for Proposal. One of the standing goals of QuDIT is to make an open platform that is accessible to researchers studying quantum simulations of physical systems of interest to the LLNL mission. The primary purpose of this RFI is to explore the capability and availability of superconducting quantum processors. LLNS invites interested parties to provide information on quantum processor capability and availability including qubit type and number, connectivity, fidelities, included hardware, rough-order-of-magnitude (ROM) pricing, intellectual property considerations, and delivery lead times.

**SUPPLEMENTAL INFORMATION**

Quantum science and technology is a focal point of research at LLNL. Quantum-coherent devices offer the potential for unprecedented precision in sensing and the ability to directly simulate complex quantum phenomena that have no known efficient classical algorithms. Thus, development and implementation of quantum technologies is expected to have a significant impact on our ability to address some of the most complex national security problems. LLNL maintains projects involving a broad spectrum of Quantum information science (QIS) research activities including investigating sources of decoherence, fusion energy science simulation, nuclear physics simulation, and modeling for data-starved environments.

LLNL’s Quantum Design and Integration Testbed (QuDIT) facility is a state-of-the-art research environment for quantum processors and algorithm development developed to assist the lab’s mission in QIS. The testbed is composed of several Bluefors dilution refrigerators operating at 10 mK. The cryostats are furnished with radio-frequency wiring designed to measure superconducting qubits with frequencies between 4 and 8 GHz, and include input line attenuation, output line isolation and HEMTs, ecosorb filtering for IR, and magnetic shielding. The cryostats contain filtered twisted-wire pairs for DC operation of flux lines as well. QuDIT control electronics include direct synthesis solutions for RF signal generation as well as lower bandwidth fast-feedback control electronics for faster qubit reset and control.

LLNL is seeking information for planning purposes and for the possible future purchase of quantum processors to upgrade the quantum volume accessible to users of the QuDIT facility. Quantum processors should be compatible with minimal alteration of the current facilities and provide close to state-of-the-art specifications (quantum volume equivalent to 10+ qubits with typical fidelities).

**RFI TOPICS / QUESTIONS**

1. What types of quantum processors are available for purchase that fit the above requirements? What are the qubit Hamiltonians for the proposed systems?
2. How many qubits/qudits are typical for a quantum processor and what is the connectivity of the elements?
3. What are the typical and the guaranteed fidelities that can be expected from a quantum processor? Values for single qubit as well as multi-qubit gate fidelities are requested.
4. What kind of hardware is typically included in a quantum processor purchase? Should devices come with a sample canister that can be mounted on a cryostat or just a sample box? Should quantum limited amplifiers be included or required for operation? Are other components required (Specialized filtering e.g., Purcell filters or better IR filters, custom thermal sinking or attenuation, etc.)?
5. What is reasonable rough-order-of-magnitude (ROM) pricing for a quantum processor?
6. What kind of intellectual property concerns are there with the purchase of a quantum processor? Will an NDA be required for purchase or for use? Can the processor be opened? What kind of information can be shared about the processor for publications on the use of the processor for algorithms or for coherence studies?
7. What kind of lead times can be expected for quantum processors?
8. Should quantum processors come with a set of pre-defined software/waveforms including gates or signals that improve fidelity, readout time, repetition rate, etc?
9. What kind of troubleshooting assistance or warranty should be expected with the purchase of a quantum processor? Should support contracts be considered?
10. Are there other considerations when purchasing a quantum processor?

Comments that include information that is not widely published should include source data or citations.

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