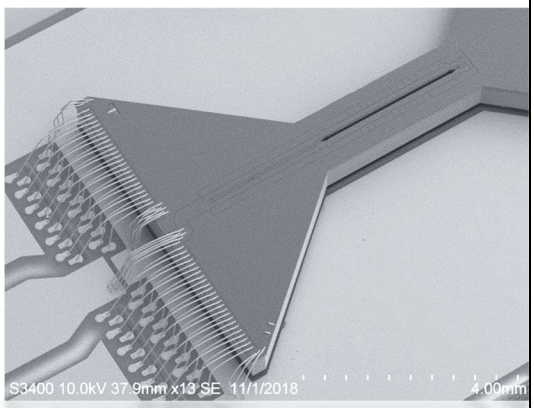
Sandia National Laboratories

QUANTUM

at Sandia National Laboratories

What we do

Sandia's Quantum Information Program targets advances in the understanding and mastery of quantum systems for enabling the manipulation of information with greater sensitivity, speed, and security than is possible with classical information processing methods. The Quantum Information Program at Sandia leverages our engineering facilities and expertise while drawing on our science base to link engineering with basic science. Through theory, computational modeling, and experimentation, our program advances the art of the possible in many facets of quantum information sciences. Over the past 15 years Sandia has developed exceptional expertise and capabilities through focused internal investments coupled with Department of Energy (DOE) and other federal program support.



Why Sandia?

Sandia has built an exceptional Quantum Information Program spanning the entire breadth of Quantum Information Science (QIS) through focused research programs and by utilizing its unique technical capability areas: micro-electronics and quantum device fabrication, nanotechnology, tailored materials, and high-performance computing. Sandia is home to world-class researchers and cutting-edge facilities and is dedicated to supporting our engineering talent in all pursuits from design and test, to control systems and measurement. With both established and exploratory programs, Sandia has expertise and capabilities in a variety of disciplines.

Quantum Information Expertise

Qubits: qubit design / development / fabrication / test, entanglement, noise modeling, design tools

Quantum engineering: architectures, robust controls for quantum gates, qubit and quantum processor performance characterization

Algorithms/apps: algorithm development, demonstration of few-qubit applications

Modeling and Simulation: quantum device modeling, design toolkits, error correction simulators

Communication: Quantum Key Distribution (QKD), photon source development, single photon detectors, quantum networking

Sensing: ultra-high precision timing, acceleration sensing, magnetometry, and electric field sensing; sensing employing both atom and matter wave interferometry

Engineering: dramatic size-, weight-, and power- reductions for QKD, atomic clocks, and atom interferometers – lasers, photon source, control electronics, integrated photonics, vacuum packaging and systems

Key Quantum Capabilities

- **Trapped ion qubits:** Sandia designs and fabricates MEMS-scale surface electrode ion traps which isolate ions by applying electromagnetic fields. These produce an exceptionally pure environment for manipulating the system's atomic states, providing high-fidelity operations for one- and two-qubit manipulations. Sandia hosts an ion trap foundry that has provided the world's best surface electrode ion traps to 12 institutions in 5 countries. Among other accomplishments, the Sandia High Optical Access (HOA) trap has achieved the highest two-qubit gate fidelity in any surface trap.

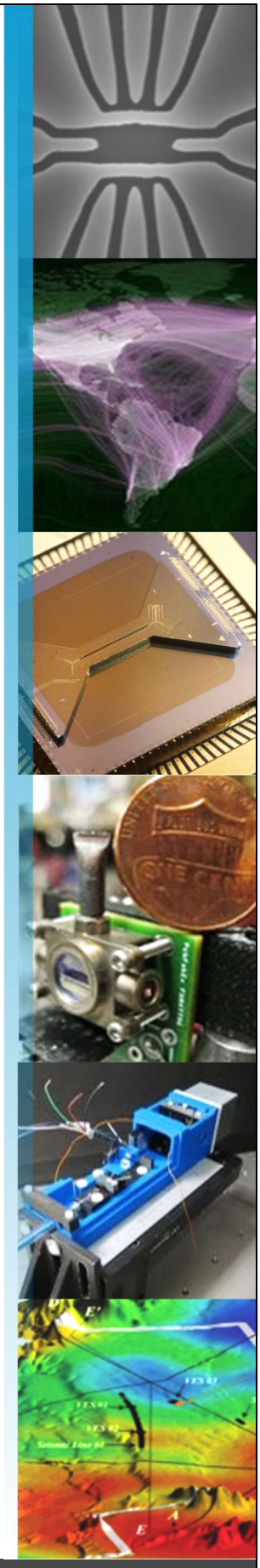
- **Silicon qubits:** Silicon qubits leverage the massive investment the classical microelectronics industry has made in device fabrication to build a stable, low-noise environment for quantum computing. Silicon can be isotopically enriched to a spin-free environment that allows exceptionally long qubit lifetimes. Sandia has developed qubit technologies based on both silicon quantum dots and donor atoms in silicon. Key enabling technologies support the silicon effort, including ion implantation, e-beam lithography, low temperature device measurement, and extensive modeling and simulation capabilities.

- **Quantum characterization, verification, and validation (QCVV):** Sandia leads the world in characterizing qubits, having developed gate-set tomography and other techniques that allow actionable assessments of the performance of systems of qubits. These techniques have now been applied to many different qubit technologies (semiconductors, ions, neutral atoms, superconductors) at Sandia and other institutions.

- **Additional qubit technology:** Sandia developed a variety of additional capabilities for qubits and quantum technologies. The AQUARIUS project developed a range of novel technologies around adiabatic quantum computing, including diffractive optical element-based traps for neutral atom qubits. Sandia developed GaAs and Ge devices that use hole spins as qubits. Sandia has expertise in the development of topological materials to search for Majorana fermions, using proximity-effect devices made from superconductors and topological insulators. Additionally, Sandia has created numerous cutting-edge capabilities to aid the development of qubits, ranging from qubit design tools to models/simulations of noise and quantum control to qubit simulators.

Sandia's Quantum Future

Sandia is well positioned to continue providing world class research in quantum information sciences to serve the nation in an impactful way. Building on its 15 years of successful investments and R&D activities, Sandia will continue to utilize its unique and exciting capabilities to push the boundaries on the art of the possible. The Sandia Quantum Program is looking to hire multiple positions in disciplines including physics, materials science, chemistry, computer science, mechanical engineering, electrical engineering, mathematics, and more. If you would like additional information regarding opportunities for how you could engage in unique, challenging, and meaningful work in the pursuit of national security, feel free to contact us at **quantumjobs@sandia.gov**.



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