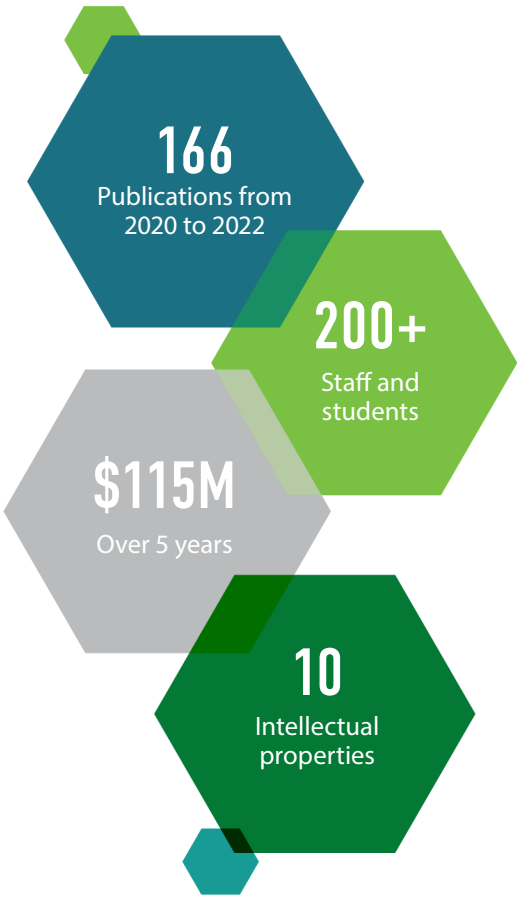
OAK RIDGE NATIONAL LABORATORY

Quantum Science Center

The manipulation and control of quantum mechanics will revolutionize a range of technologies, including computers and sensors exponentially more powerful than today's state of the art and information networks that are virtually unhackable. To realize this potential, Oak Ridge National Laboratory (ORNL), with its academic and industrial partners, is working to better understand and manipulate the behavior of the tiny entangled particles that serve as the building blocks of matter and exhibit the exotic properties that make quantum technologies possible.

The Quantum Science Center (QSC) is tasked with realizing the potential of topological quantum materials for manipulating, transferring, and storing quantum information. Simultaneously, the QSC's research process creates a pipeline moving new discoveries to industry to enhance US economic competitiveness, national security, and scientific leadership.



Research Initiatives

The QSC balances the short-term effort to understand quantum behavior with the long-term goal of achieving breakthroughs in protecting and using quantum information via three main areas of research.

- **Quantum materials discovery and development**—Quantum particles are notoriously fragile under even the most subtle interferences and stresses. More resilient materials to store, transfer, and manipulate these particles are being developed to make quantum computing and sensing more reliable.
- **Quantum algorithms and simulation**—QSC researchers are building tools for algorithms, optimizations, and implementations that take advantage of novel quantum computing and sensing technologies.
- **Quantum devices and sensors for discovery science**—New quantum devices and sensors offer higher resolution, lower error rates, and other improvements compared with their conventional counterparts. The resulting hardware will be applied to real-world science problems of interest to the US Department of Energy (DOE).

"We lead in the discovery, design, and application of quantum materials, in quantum algorithm research, and in the development of new quantum devices that will significantly impact the national quantum ecosystem."

—QSC Director **Travis Humble**

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Critical Collaboration and Program Leadership

The QSC is one of five multidisciplinary National Quantum Information Science Research Centers supported by DOE's Office of Science. As headquarters of the QSC, ORNL leads a consortium of 16 partners representing national laboratories, academia, and industry. The Laboratory's quantum research program dates back nearly two decades and has achieved numerous quantum science breakthroughs. These accomplishments include setting the record for quantum information transfer, increasing the range covered by quantum key distribution systems, and partnering with industry to demonstrate quantum supremacy—the notion that a quantum computer can outperform a world-leading classical computer at certain tasks.

The Path Forward

A key component of the QSC's efforts to overcome long-standing quantum research roadblocks and design next-generation technologies is the professional development of early-career scientists and engineers. Students and postdoctoral associates participate in QSC-related research efforts at collaborating institutions, cultivating the expertise needed to help achieve the QSC research goals and ensure America's scientific leadership and national security. To efficiently advance scalable and coherent quantum information systems, QSC researchers of all levels follow a codesign philosophy that involves coordination across the QSC's initiatives as well as close collaboration with industry partners and other stakeholders from the earliest stages of development through the completion and distribution of novel technologies to the marketplace. This strategy ensures that future quantum applications will effectively address the needs of both the quantum research community and the private sector.

QUANTUM SCIENCE CENTER

PARTNER ORGANIZATIONS

Oak Ridge National Laboratory · Purdue University · Los Alamos National Laboratory · Microsoft · Fermilab · Pacific Northwest National Laboratory · Berkeley University of California · Harvard University · University of Washington · UC Santa Barbara · ColdQuanta The Quantum Atomics Company · IBM · Caltech · Princeton University · The University of Tennessee Knoxville · UCLA

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