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Quantum Information Science (QIS)

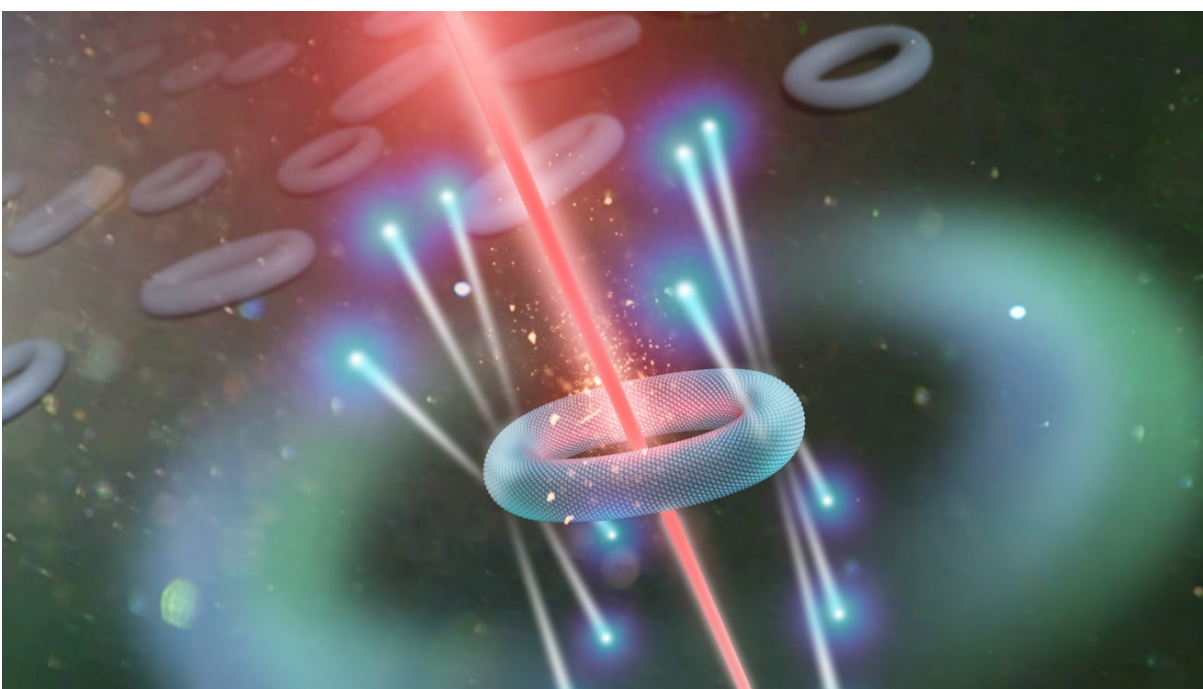


Image courtesy of Argonne National Laboratory
 Semiconductor quantum rings are illuminated by a laser and emitting single photons.

Advanced Scientific Computing Research (ASCR) supports fundamental research in quantum information science, computing, and networking relevant to DOE's science and energy mission. ASCR issued its first funding opportunities in quantum information science (QIS) in FY 2017, with additional calls in subsequent years. The awards span topics including: quantum algorithms and machine learning; hybrid quantum-classical methods; hardware-aware compilers and quantum software stack; error characterization, management, and mitigation; scalable quantum networks, architectures and communication protocols; and quantum testbeds.

ASCR has held multiple workshops on quantum computing and quantum networking. The priority research directions identified in the research community-driven workshops include:

- Models of quantum computation
- Efficient quantum simulations and algorithms that deliver quantum advantage
- Benchmarking, and validation and verification of quantum algorithms
- Software toolchains and programming environments to program and control quantum systems
- Quantum software stack that offers resilience to noise and errors
- Fundamental building blocks for a quantum internet
- Hardware and protocols for scalable quantum networks
- Quantum hardware characterization, validation, and verification

The ASCR-sponsored user facilities are collaborating on quantum efforts to better understand and prepare for how quantum information systems are anticipated to revolutionize computing. These activities include helping researchers develop quantum algorithms, resource estimators, and benchmarks, and providing accurate quantum hardware emulators by using quantum circuit emulators running at scale on systems including [Aurora](#) at the [Argonne Leadership Computing Facility \(ALCF\)](#), [Frontier](#) at the [Oak Ridge Leadership Computing Facility \(OLCF\)](#), and [Perlmutter](#) at the [National Energy Research Supercomputing Center \(NERSC\)](#). The OLCF [Quantum Computing User Program \(QCUP\)](#) connects researchers to commercial quantum computing resources through vendor partners. NERSC, through the [QIS@Perlmutter](#) program, is undertaking multiple endeavors in quantum information focused on topics related to the integration of quantum information technologies with classical high-performance computing HPC technologies. The [Energy Sciences Network \(ESnet\)](#) quantum network research team is advancing simulation of the quantum network and its components and developing techniques to integrate quantum networks with classical networks.

Through investments in Quantum Information Science, Computing, and Networking, ASCR accelerates scientific discovery and transforms science and energy research.

ASCR Funding

- FY2024: EXPRESS: 2024 Exploratory Research for Extreme-Scale Science: [Press Release](#), [Award List](#), [Funding Opportunity](#)
- FY2024: Accelerated Research in Quantum Computing: [Press Release](#), [Award List](#), [Funding Opportunity](#)
- FY2023: Scientific Enablers of Scalable Quantum Communications: [Press Release](#), [Award List](#), [Lab Funding Opportunity](#)
- FY2023: Quantum Testbed Pathfinder: [Press Release](#), [Award List](#), [Funding Opportunity](#)
- FY2023: EXPRESS: 2023 Exploratory Research for Extreme-Scale Science: [Press Release](#), [Award List](#), [Funding Opportunity](#)
- FY2022: EXPRESS: 2022 Exploratory Research for Extreme-Scale Science: [Press Release](#), [Award List](#), [Funding Opportunity](#)
- FY2021: Quantum Internet to Accelerate Scientific Discovery: [Press Release](#), [Award List](#), [Lab Funding Opportunity](#)
- FY2021: Entanglement Management and Control in Transparent Optical Quantum Networks: [Press Release](#), [Award List](#), [Funding Opportunity](#)
- FY2020: National Quantum Information Science Research Centers: [Press Release](#), [Award List](#), [Funding Opportunity](#)
- FY2019: Transparent Optical Quantum Networks for Distributed Science: [Press Release](#), [Award List](#), [Lab Funding Opportunity](#)
- FY2019: Accelerated Research in Quantum Computing (ARQC): [Press Release](#), [Award List](#), [Funding Opportunity](#), [Lab Funding Opportunity](#)
- FY2018: Quantum Testbeds for Science: [Press Release](#), [Award List](#), [Lab Funding Announcement](#)
- FY2018: Exploratory Research for Extreme-Scale Science: Quantum Computing Application Teams (QCATS): [Press Release](#), [Award List](#), [Lab Funding Announcement](#)
- FY2018: Quantum Testbed Pathfinder: [Press Release](#), [Award List](#), [Funding Announcement](#), [Lab Funding Announcement](#)

Award abstracts and information about awards made prior to FY2018 can be found [here](#).

ASCR Workshops and Reports

- [Report for the ASCR Workshop on Basic Research Needs in Quantum Computing and Networking \(July 2023\)](#)
- [From Long-distance Entanglement to Building a Nationwide Quantum Internet: Report of the DOE Quantum Internet Blueprint Workshop \(February 2020\)](#)
- [Quantum Networks for Open Science \(QNOS\) Workshop \(April 2019\)](#)
- [ASCR Report on a Quantum Computing Testbed for Science \(December 2017\)](#)
- [ASCR Workshop on Quantum Computing for Science \(June 2015\)](#)

Press Releases

- [Department of Energy Unveils Blueprint for the Quantum Internet at 'Launch to the Future: Quantum Internet' Event \(July 2020\)](#)

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