OAK RIDGE National Laboratory

Quantum Sensing at ORNL

Quantum Sensing and Related Technologies for Infrastructure Panel, UPISC
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ORNL is managed by UT-Battelle, LLC for the US Department of Energy

U.S. DEPARTMENT OF ENERGY

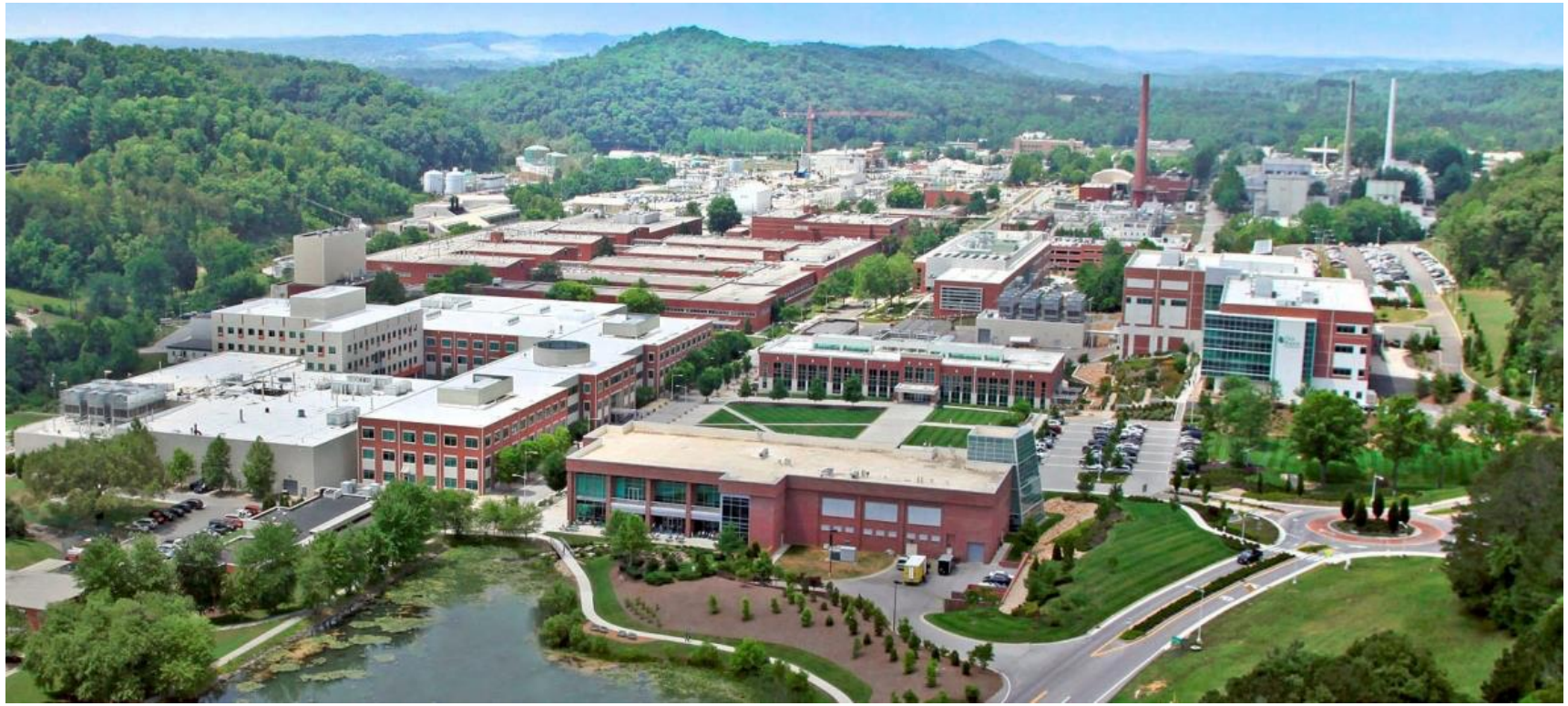
Oak Ridge National Laboratory

- **One of DOE's 17 national Laboratories**
- **Staff:** 6,000+, including scientists and engineers in more than 100 disciplines
- **Users and visiting scientists, annually:** 3,200
- **Budget:** $2.7 billion
- **Established:** 1943 as part of the Manhattan Project
- **US patents issued (since 2010):** 1,046
- **Active licenses:** 142
- **R&D 100 Awards:** 145; more than any other national laboratory
- **Management and operating contractor:** UT-Battelle LLC
- 30,000 acre reservation

What ORNL Does

- Oak Ridge National Laboratory delivers scientific discoveries and technical breakthroughs needed to realize solutions in energy and national security and provide economic benefit to the nation.

- Science Areas:
  - Biology & Environment
  - Clean Energy
  - Fusion & Fission
  - Isotopes
  - Physical Sciences
  - National Security
  - Neutron Science
  - **Supercomputing**



ORNL's grid research spans 12+ groups, 100+ people, and four directorates

OAK RIDGE National Laboratory

Quantum Information Science Section (N. Peters, Section Head)

Groups (36 staff & postdocs)

- Q. Computational Science (R. Bennink, Group Leader-GL)
- Quantum Computing and Sensing (A. Marino, GL)
- Quantum Communications and Networking (M. Kiran, GL)

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Mission Statement

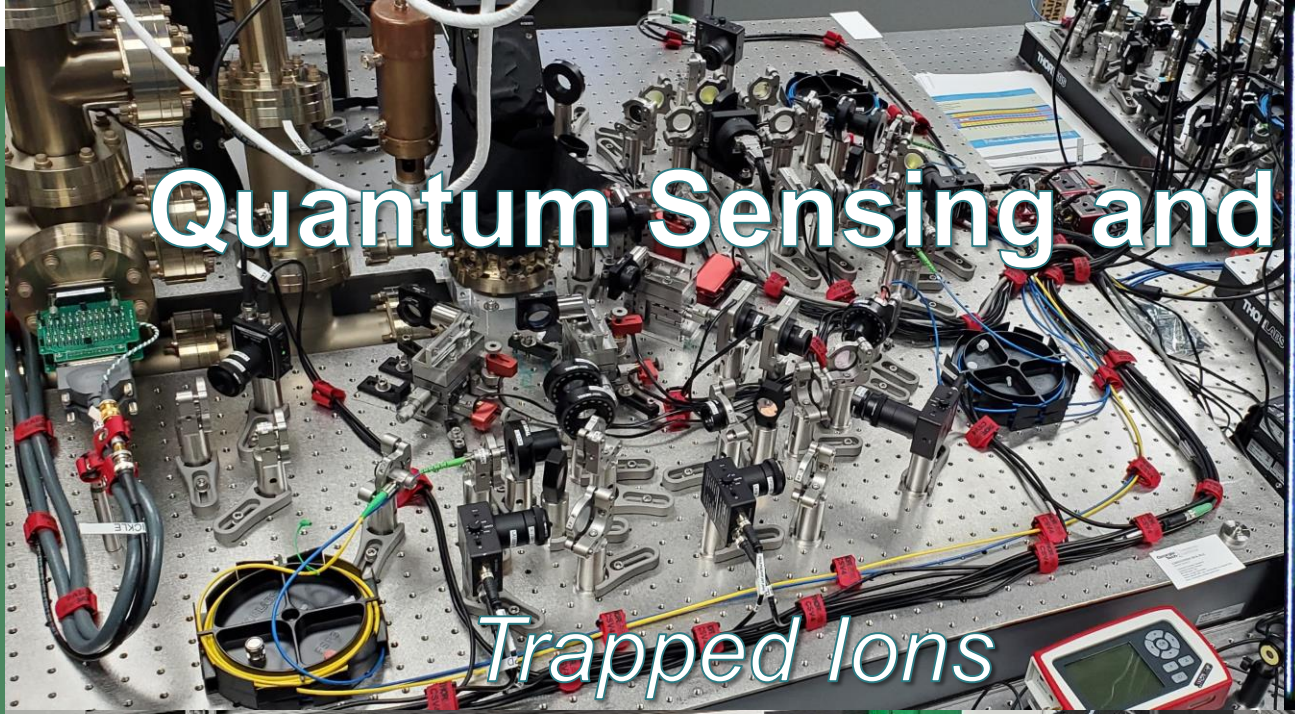
Foundations and advances in quantum information sciences will enable quantum computers, quantum sensors and networked quantum systems

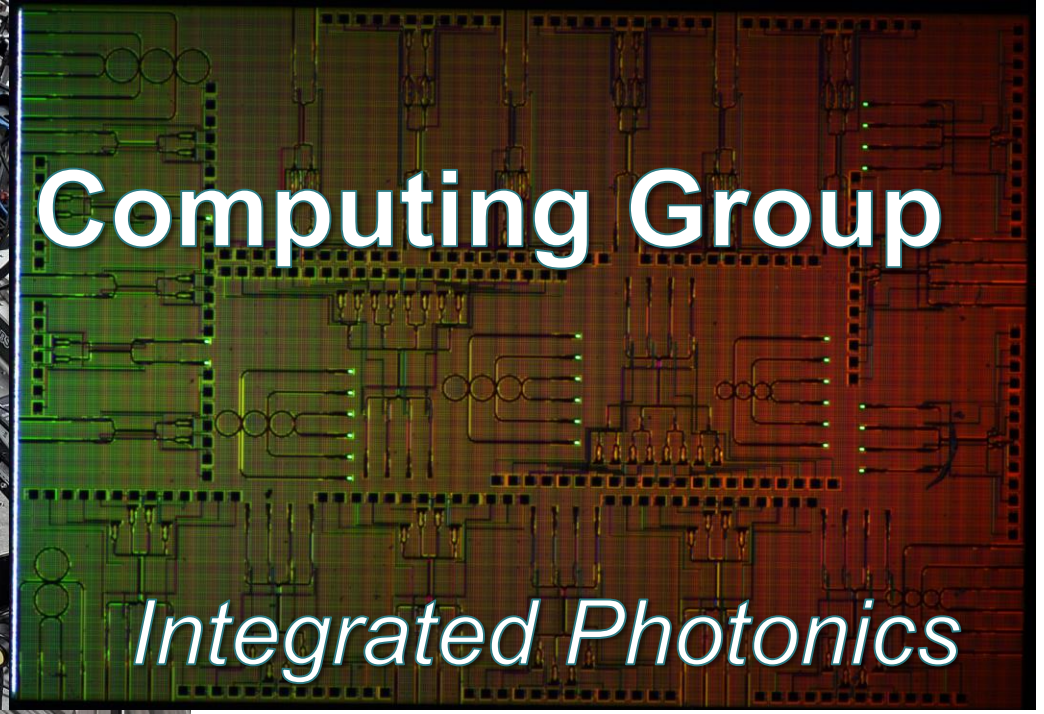
Capabilities

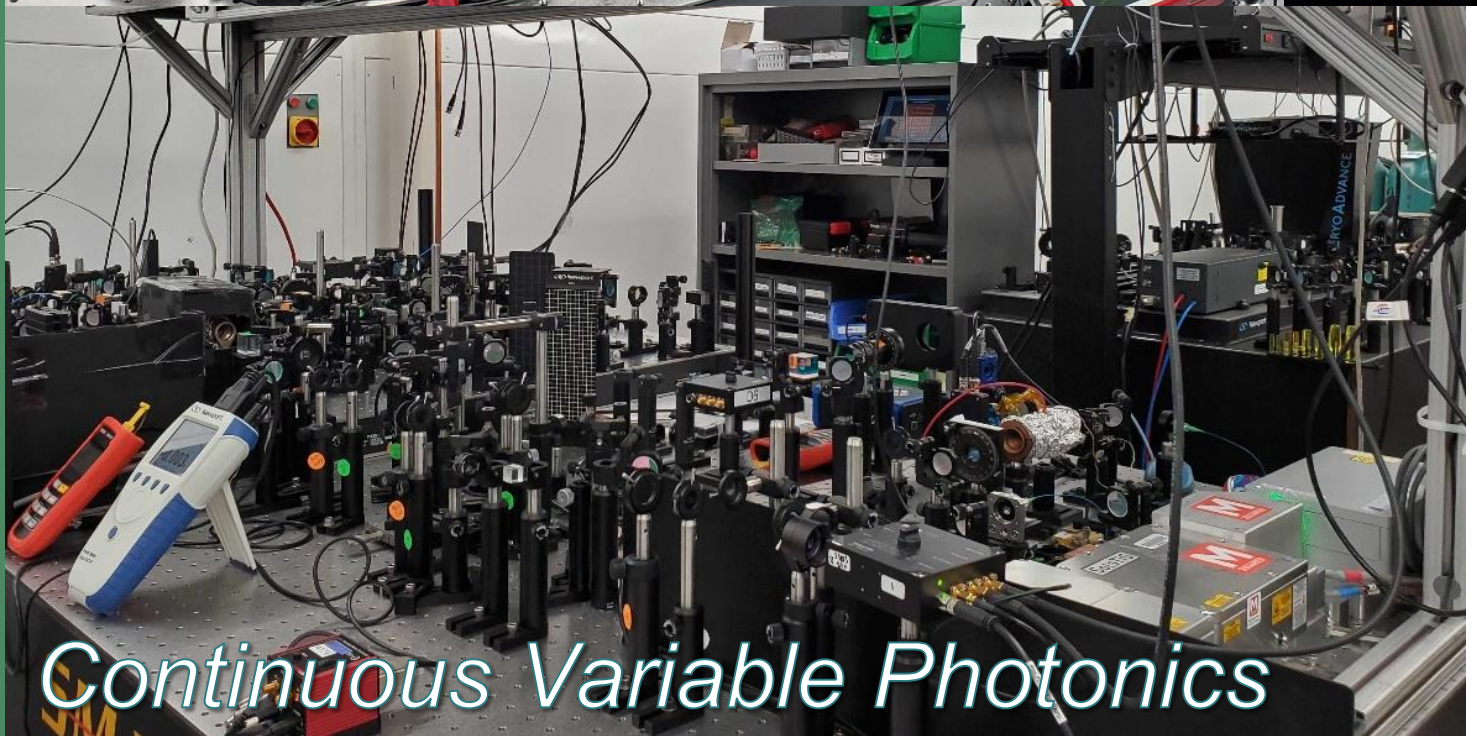
- Quantum algorithms and software for materials simulation, machine learning, and optimization
- Quantum networking and key distribution
- Ion trap computers
- Quantum sensing, benchmarking, machine learning, and materials simulation

TRC: late 2024, QISS will grow to >10k ft^2 lab space.

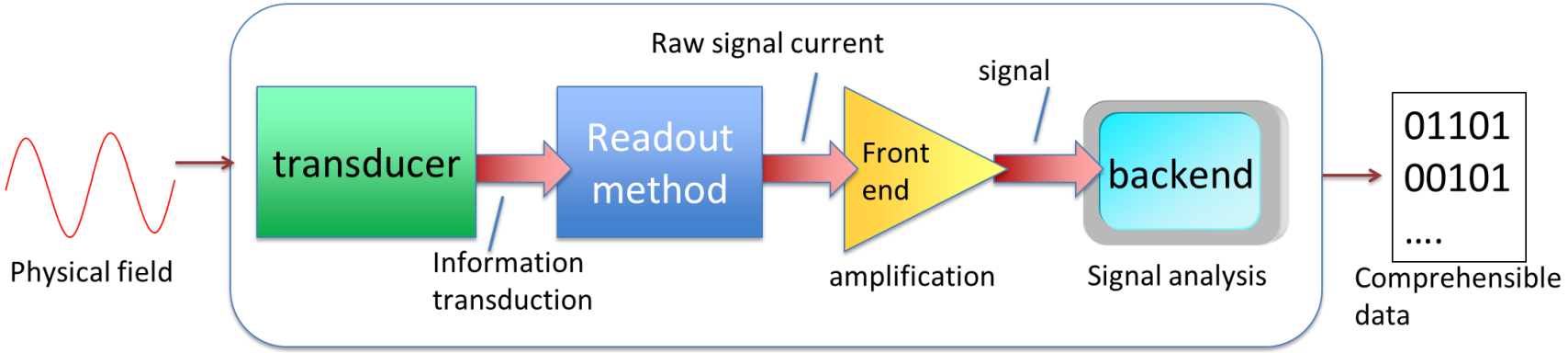
Quantum Sensing and Computing Group







Components of a Quantum Sensor



A sensor that relies on one or more quantum effect is a *quantum sensor*

You might need a quantum sensor if:

- Your current sensor is at the classical limit (the classical noise has been made as low as possible)
- The thing you want to sense is near or below the classical limit
- The thing you want to sense might be damaged by ”turning your sensor up to 11”

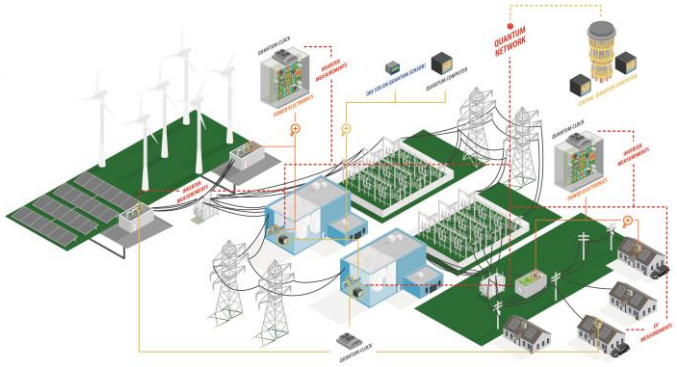
Grid Research, Integration, and Deployment for Quantum (GRID-Q) Stakeholder Engagement

Project Description:

The complexity of the power grid is increasing significantly, with faster acting and more controllable power electronics devices. Maintaining reliability, security, and resilience of such a complex power grid will have challenges that may need leap-of-faith new solutions like quantum technologies. The focus of this project is to establish an ecosystem for evaluation of quantum technologies in the power grid to showcase their value to the power grid.

Value Proposition and Impact:

Theoretically, it is known that quantum technologies can provide greater security to the power grid and potentially, greater reliability and resilience with their ability to achieve global optima and enhanced security.

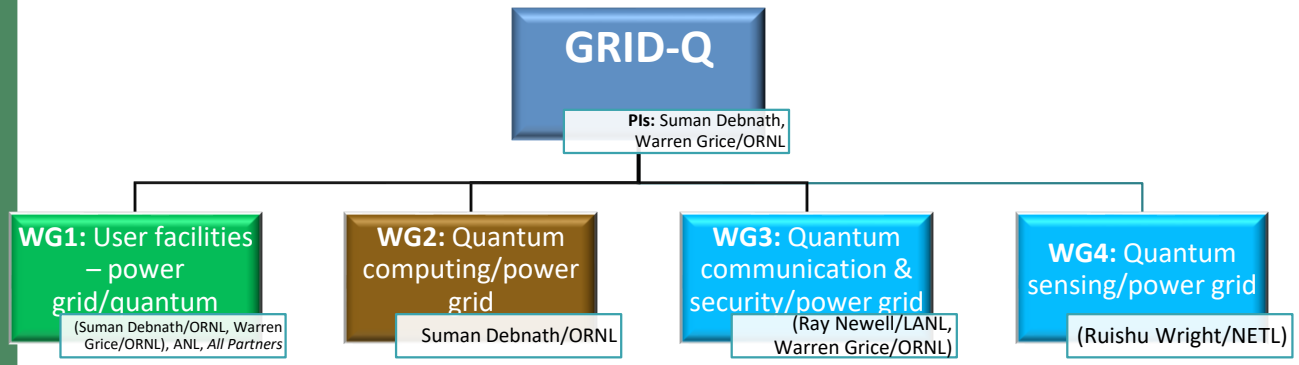


Project Objectives

- **Engage stakeholders to identify gaps and develop roadmap for key technologies of interest**
  - **Identify key commercialization opportunities**
- An applied power grid and quantum **facility** (leveraging GRID-C, QCUP)
  - Develop simulated capabilities for understanding the impact of quantum technologies on the power grid
  - Design hardware-in-the-loop, hardware, and field demonstration testbeds
- Establish **use cases** for quantum information science for power grid
  - **Computing** techniques for contingency analysis and optimization (unit commitment, planning)
  - **Security** for the grid using advanced quantum networking & communication techniques such as secure relays, resilient timing distribution, and QKD on hybrid channels, with development aided by simulated environments
  - **Sensors** for power grid operation and failure event and gas leak detection

Grid Research, Integration, and Deployment for Quantum (GRID-Q) Stakeholder Engagement

Stakeholder Engagement: Working Groups



Working Group Scope and Meetings

Scope

- Information gathering – state-of-art and ongoing R&D
- Prepare for workshops
- Prepare gap analysis
- Prepare technology roadmap

Meetings

- Working Group Quarterly Meeting (1 hour)
- Semi-annual Stakeholder engagement (2 hours)
- Workshop every year (1-2 days)

Impact and Value Proposition of Stakeholder Working Group

- **Engage with leading research teams at National Labs, Industries, and Universities**
  - Join invitation-only workshops with industry peers, research community, and federal representatives
  - Learn from experts in all fields of quantum technology
  - Stay up-to-date with latest news, understand broad trends
- **Help set priorities for research investment, federal engagement, and policy makers**
  - Shape research directions and guide future investments
  - Share your perspectives, represent your interests

Join a Working Group!
gricew@ornl.gov

The best way to predict the future is to create it

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