Q-NEXT: NATIONAL QUANTUM INFORMATION SCIENCE RESEARCH CENTER

MARTIN SUCHARA
Computational Scientist
Mathematics and Computer Science

CELS, PSC, PSE

Argonne NATIONAL LABORATORY

Martin Suchara
Computational Scientist

What is Q-NEXT?

Next Generation Quantum Science and Engineering

- **Major Cross-Cutting Challenge:** Manipulating and interconnecting entangled states of matter.
- **Mission:** Deliver quantum interconnects and establish a national resource to provide pristine materials for new quantum devices.

- Nearly 100 researchers from 3 national laboratories, 10 universities, and 10 industry partners
- $115M from DOE and an additional $93M from industry partners

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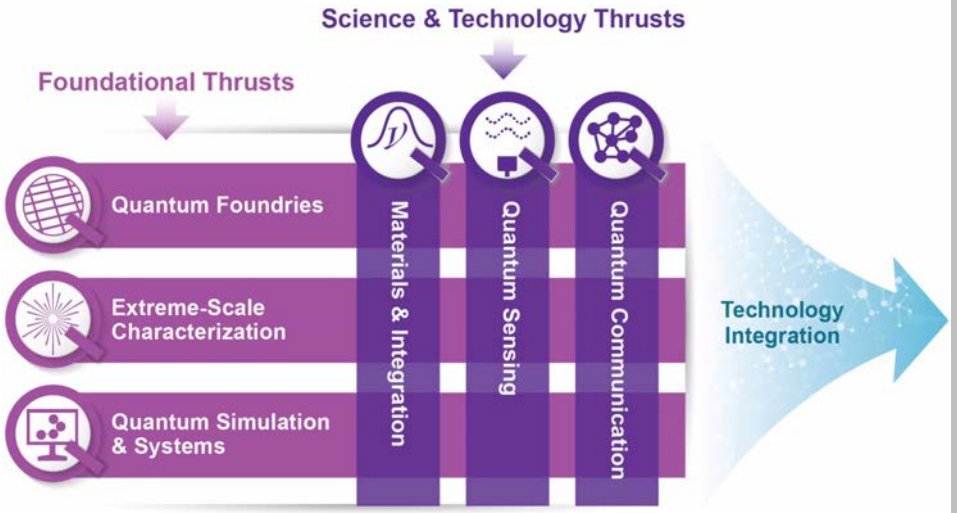
Thrusts and Leadership Structure



Executive Team:


P. Kearns


D. Awschalom


S. Guha

Thrust Leaders:


J. Heremans


M. Holt


M. Suchara

Q-NEXT Mission

- ✓ Deliver quantum interconnects
- ✓ Establish national foundries
- ✓ Demonstrate communication links, networks of sensors, and simulation testbeds

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Computational Scientist

Foundational Thrusts

Quantum foundries: Systematically solve materials growth, sample preparation, and fabrication challenges. Establish a foundation of standardized fabrication, synthesis, and measurement techniques.

Extreme-scale characterization: Create a suite of material characterization capabilities, enabling dynamic quantum system imaging from the single-spin qubit level to the integrated system.

Simulation and systems: Develop simulation techniques to improve control and scalability of qubit platforms, networks, and sensors. Use quantum computers and classical supercomputers.

Science & Technology Thrusts

Materials and integration: Evaluate, fabricate, and integrate materials into devices. Down-select materials, processes, and integration strategies.

Quantum sensing: Implement electromagnetic quantum sensors, integrated into a photonic quantum network, to sense across length and frequency scales.

Quantum communication: Enable distribution of entanglement over distance by developing repeater nodes. We will pursue two different architectures with different source and memory technologies.

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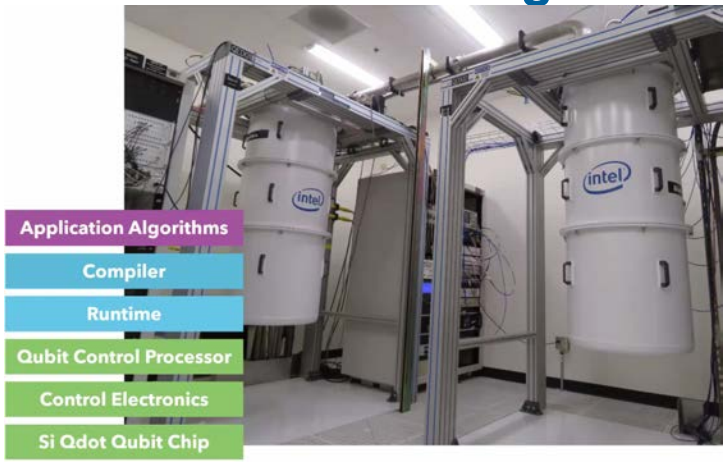
Computational Scientist

Intel Testbed at Argonne



- Complete HW/SW computing system
- Enables full-stack algorithm research, pulse engineering, new use cases

Argonne Quantum Foundry

- 6,000-ft2 solid state systems foundry that will attract scientists nationwide to Argonne
- Operational by end of 2022

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Quantum Simulation and Systems Thrust

- **Modeling and development of multi-qubit systems**
  - Optimize hardware platforms (Intel, ColdQuanta)
  - Develop an open quantum system solver
- **Quantum algorithms for materials simulation**
  - Formulate problems as digital quantum circuits
  - Evaluate circuits on experimental hardware
- **Exploiting entanglement in communications, computing and sensing:**
  - Develop network simulator and protocols
  - Scalable computation through coherent connections (IBM) and communication systems
  - Develop theory and protocols for sensing