

# Quantum we do & Quantum we don't

ID Seminar

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22 Feb 2023

# What is Quantum?

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## Quantum Computing & Simulating

Quantum Bits: Superconducting, Trapped Ions, Semiconductor, Photonic, Neutral Atoms, etc.

Encode info in quantum states, exploit quantum entanglement for computation

## Correlated Electronic States

Superconductivity, Magnetism  
Topological Insulators, CDW/SDW

Relationship with material stoichiometry, structure, etc.

## Quantum Communications & Networks

Cryptography, Distributed Computing & Sensing

Both fiber-based and free-space

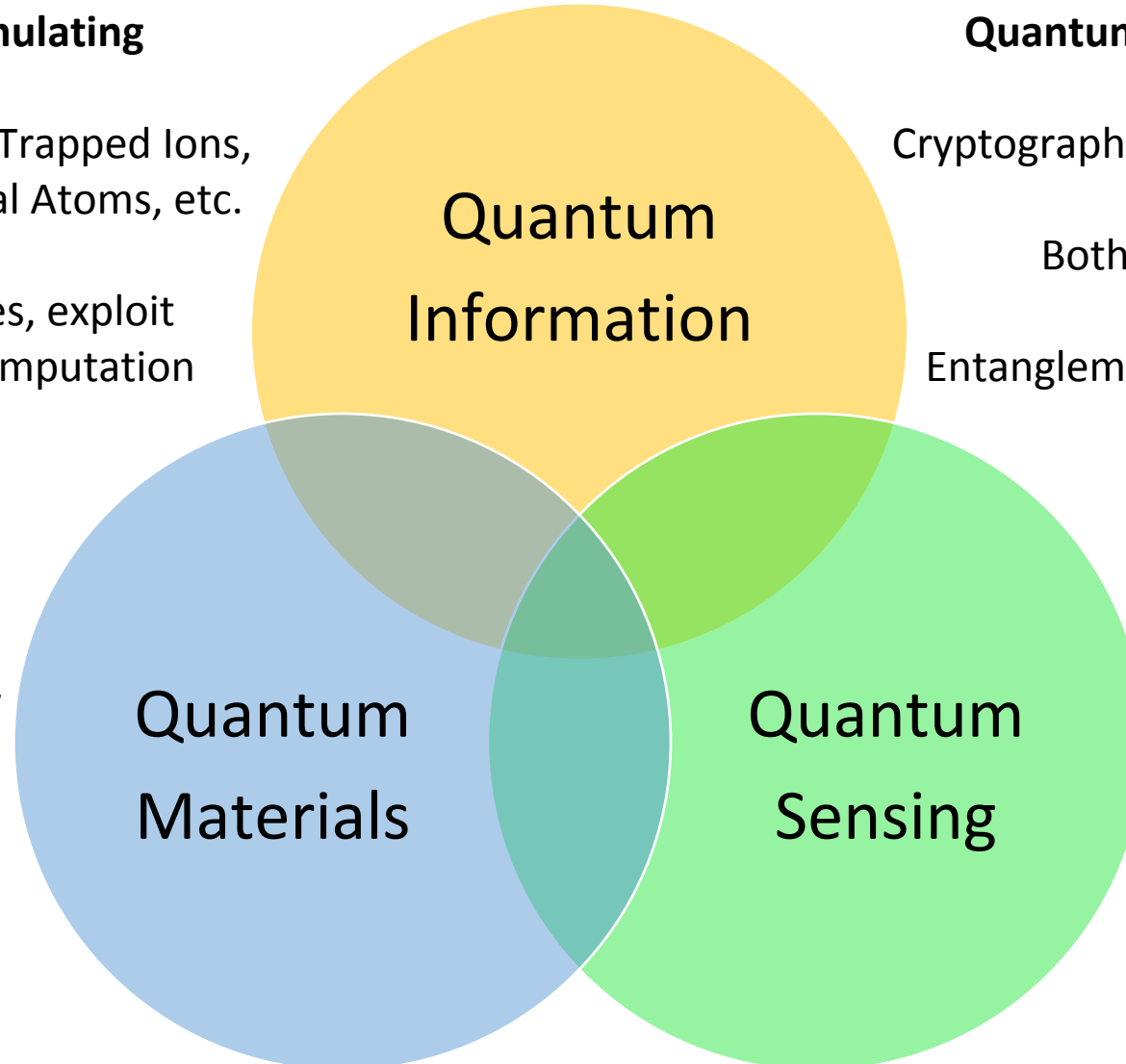
Entanglement: “spooky action at a distance”

## Precision Measurement

Sensors: Photonic, Atomic, Superconducting, etc.

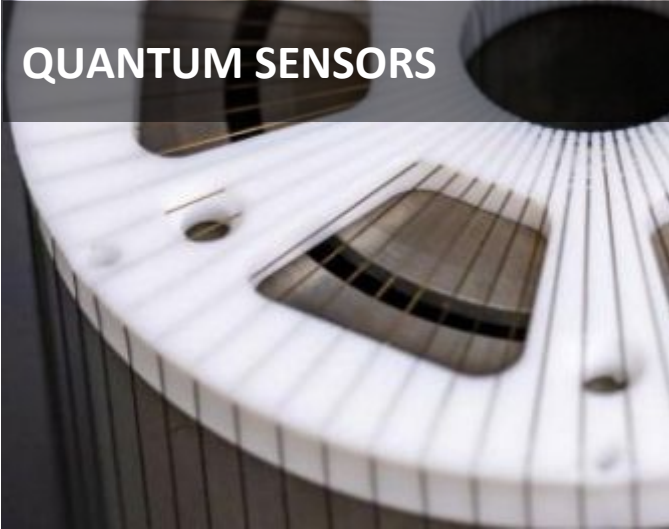
Microscopy, Communications, GPS, EM Fields, Geophysical Metrology, Imaging

Exploit quantum entanglement, interference, squeezing, etc.

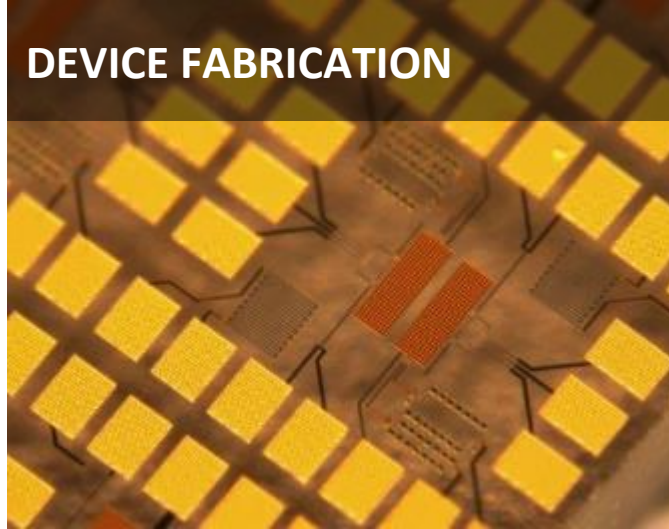


# Quantum @ SLAC

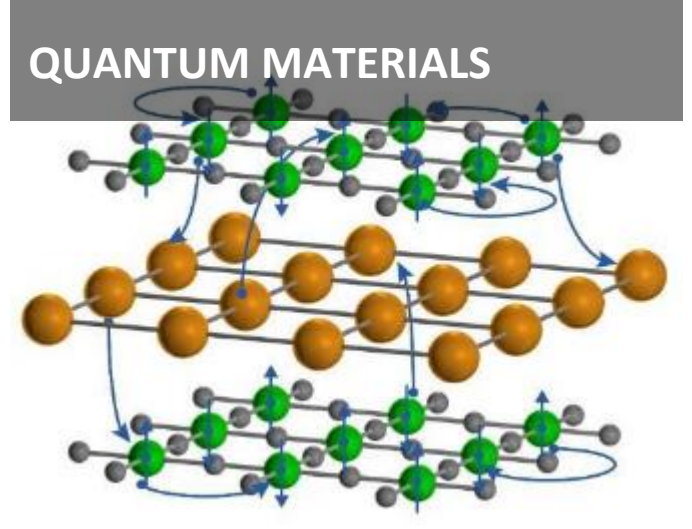
QUANTUM SENSORS



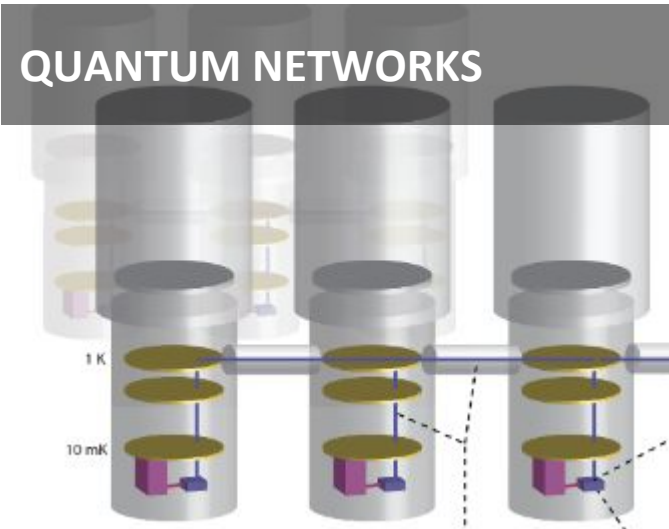
DEVICE FABRICATION



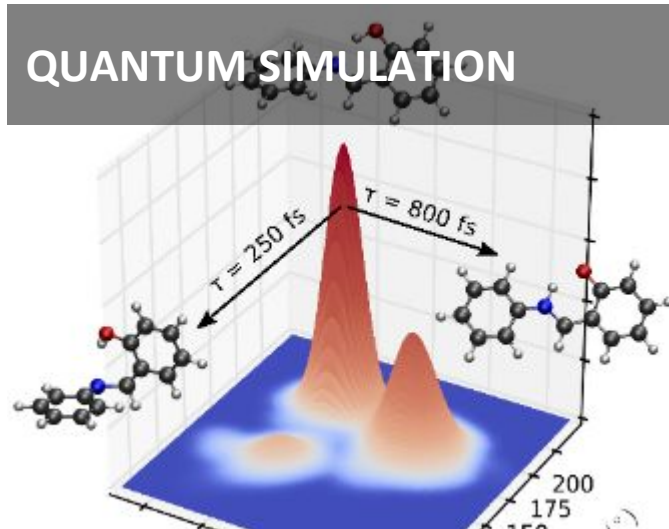
QUANTUM MATERIALS



QUANTUM NETWORKS



QUANTUM SIMULATION



CHARACTERIZATION



# Q-NEXT National QIS Research Center



3  
National Labs



10  
Universities



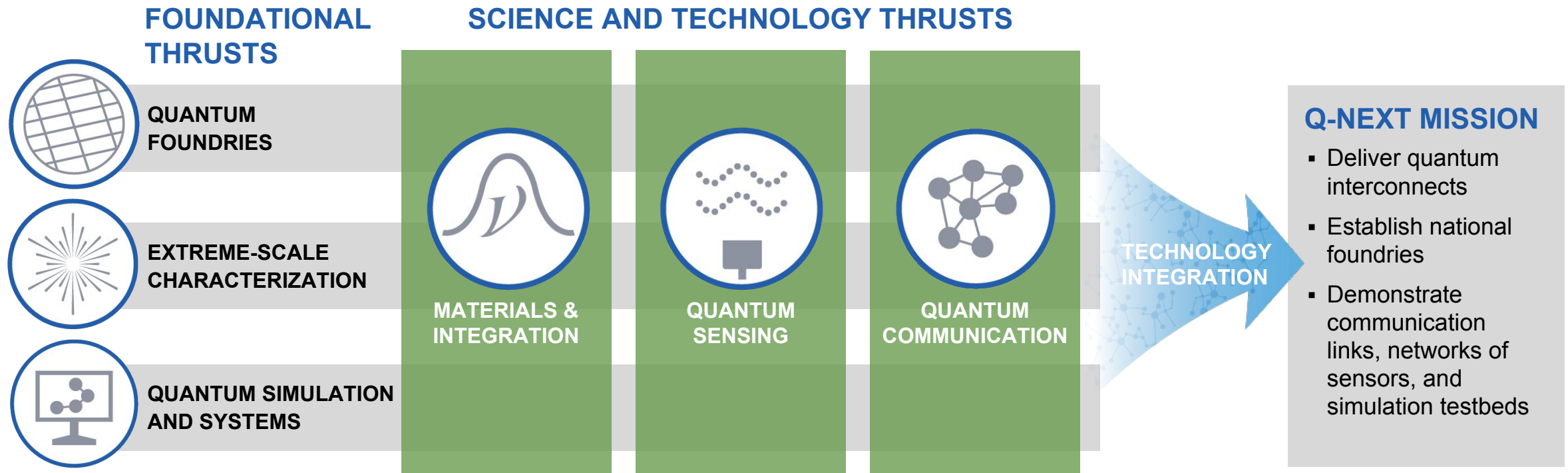
10  
Industry  
Partners



[q-next.org](http://q-next.org)

# Q-NEXT Approach: New Capabilities to Drive QIS&T

A matrixed research structure that promotes co-design of quantum information science and technology



# The Detector Microfabrication Facility

*A superconducting quantum foundry at SLAC*

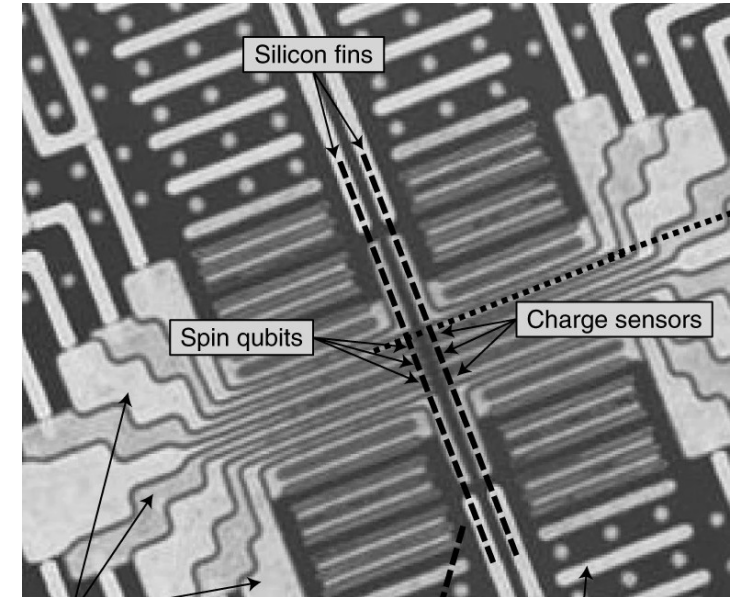
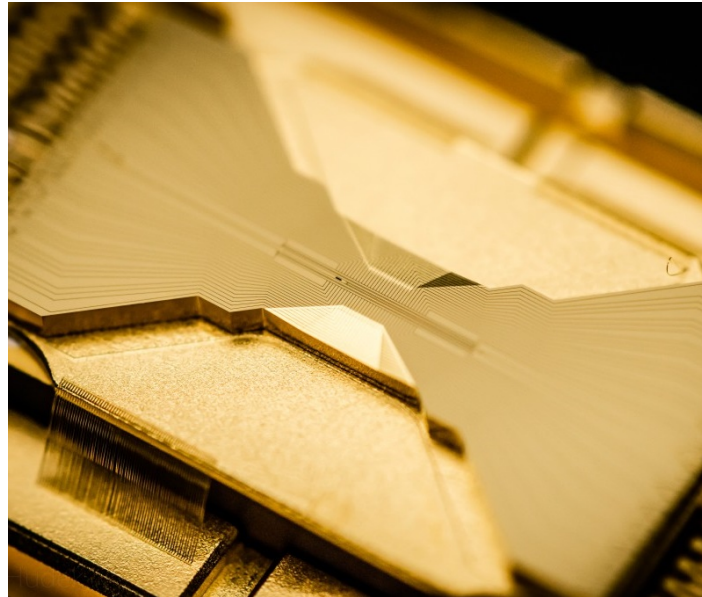
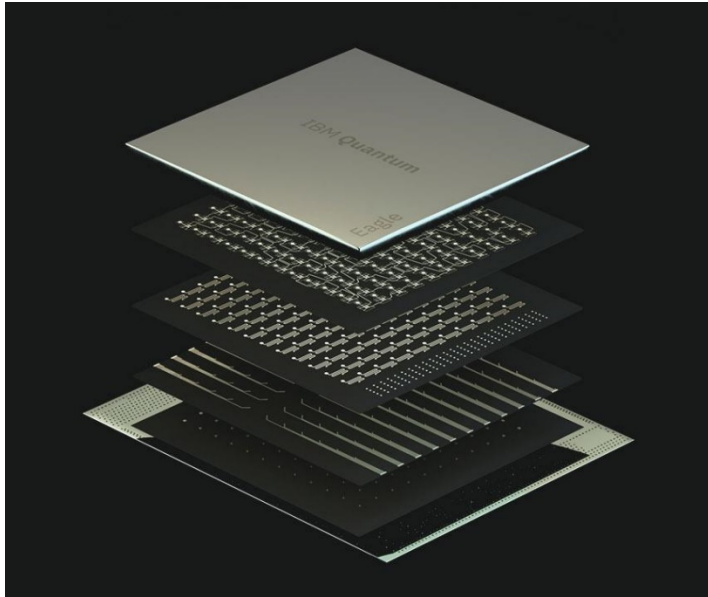
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## Detector Microfabrication Facility (DMF) at SLAC's Arrillaga Science Center

- Vertically integrated superconducting foundry for quantum sensors and devices.
- Hybrid platform development for next-generation quantum technologies.
- 5,500 square feet of class-100 cleanroom space with toolset optimized for qubits, detectors and advanced quantum devices.
- Nearby Nano-X cleanroom (3,000 sq. ft.) with complementary toolset (e.g. e-beam lithography) for rapid nano-prototyping.

# Quantum Computing Technologies



## Superconductor

- Google, IBM, Rigetti
- Non-linear resonant circuits
- Manipulate qubit states with microwaves
- Short-lived but relatively fast

## Ion Trap

- IonQ and Honeywell
- Trapped ions in a surface array
- Interactions modulated by lasers or ion shuttling
- Long-lived but relatively slow

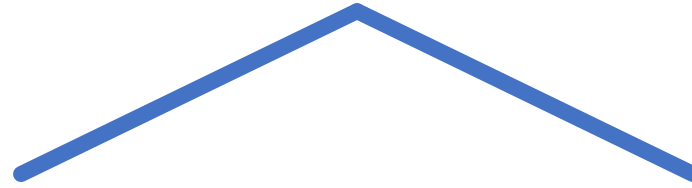
## Semiconductor

- Intel and HRL Laboratories
- Quantum dots in gated silicon
- Interactions modulated by voltage bias pulses
- Lagging but familiar fabrication

# Quantum Enabling Technologies

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## Quantum Technologies



## Enabling Technologies

