What is needed for today’s quantum careers?

- Quantum knowledge
- Quantum computing architecture
- Quantum computing algorithms
- Applying quantum technology
- Optics
- Cryogenics
- Electronics
- Micro/nano-fabrication
- Materials science
- Programming
- Interpersonal skills

Key skills for quantum careers

What jobs are available?

**PhD level**
- Highly technical jobs in research, design, development and testing all aspects of quantum systems.
- Application engineers that support customers in adopting quantum technology products.

**BS and MS level**
- Hands-on fabrication, building and testing of systems.
- Programming, including machine learning, artificial intelligence.
- Quantum sales engineers, and business operations.
- On-the-job training is common.

What experiences are helpful?

- Practical, hands-on experiences with broad range of technologies.
- Building experiments or projects from the ground-up.
- Projects that demonstrate a portfolio of accomplishments.
- Collaborative projects or research experiences.
- Business mindset in addition to technical drive.

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What is needed for today’s quantum careers?

**Optics** and photonics offer one approach to transferring and processing quantum information. Both integrated photonic circuits and trapped ions require optics.

*Lasers and laser locking/stabilization, high finesse optical cavities, coatings, frequency combs, linear optics theory, photonic integrated circuit components and systems.*

**Cryogenics** – Ultracold temperatures are needed to store quantum state in memory and detect them.

*Designing and building cryocoolers/cryostats, especially closed cycle.*

**Quantum knowledge** of both theoretical and experimental aspects of quantum mechanics.

*Entanglement, quantum optics, squeezed light, beyond single photons to many degrees of freedom, quantum information.*

**Quantum computing architecture** – how quantum computers are physically implemented and organize quantum memory, processing, and information transfer.

*Knowledge of physical implementations (ion traps, superconducting systems, and integrated photonics), single photon emitters and detectors, establishing minimum gates and qubits needed to implement algorithms, error correction.*

**Quantum computing algorithms** are the software that runs on quantum computers.

*Knowledge of quantum algorithms, machine learning, error-correction, artificial intelligence.*

**Micro/nano-fabrication** is needed to build detectors and integrated photonics circuits.

*Design, simulation, layout, and fabrication of integrated photonics circuits, optical lithography, electron beam lithography, scanning and transmission electron microscopy (SEM/TEM), sputtering.*

**Materials science** – advanced materials are needed to implement detectors and integrated photonic circuits.

*Superconductors for single photon detectors, optical materials for integrated photonics circuit components (e.g., beamsplitters, modulators).*

**Electronics** are essential to control and measure quantum systems.

*High sensitivity, low noise analog electronics, low noise A/D and D/A conversion, feedback and control systems, hardware-software interfacing.*

**Applications** support design, testing, and automation.

*Simulating and emulating quantum systems, field programmable gate arrays (FPGAs), embedded systems, writing test code, hardware automation, developing design software, collaborative coding.*

**Programming** supports design, testing, and automation.

*Simulating and emulating quantum systems, field programmable gate arrays (FPGAs), embedded systems, writing test code, hardware automation, developing design software, collaborative coding.*

**Interpersonal skills** – teamwork and communication are essential for complex projects.

*Good at listening and speaking with people inside and outside the organization, commercialization requires experts who interface and support customers, may require global travel and interest in interacting with diverse cultures.*