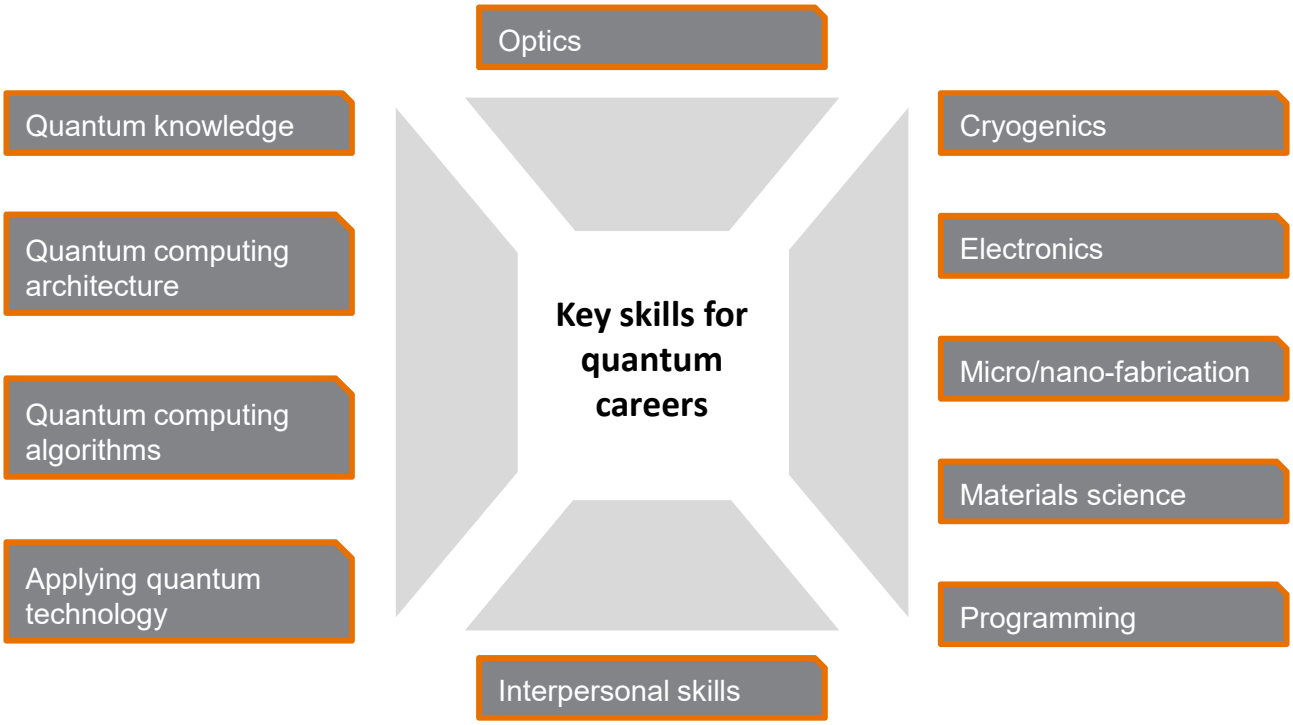
ritphotonics for quantum

Careers and Education Panel
Jan 23, 4:20-5:30 PM

What is needed for today's 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.

This document was prepared by Dr. Ben Zwickl with input from a large number of the employers in attendance at the Photonics for Quantum Workshop at RIT, Jan 23-25. Many thanks to all who provided input. Dr. Zwickl is responsible for any errors.

What is needed for today's quantum careers?

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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.

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.

Applying quantum technology – New challenges arise when moving from the research bench to commercial systems.

Miniaturization, robustness against environment disturbances, low energy consumption, fiber optic integration, making systems scalable/large scale, reliability, yield, and testing.

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

Designing and building cryocoolers/cryostats, especially closed cycle.

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.

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).

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.