Mapping the Quantum Hardware Academic Landscape

A 10-Year Survey of Master's & PhD Output in the U.S. and Canada

Onri Jay Benally

University of Minnesota-Twin Cities

July 27, 2025

Introduction: Why Track the Full Talent Pipeline?

Tracking both Master's and PhD dissertation output over a decade provides a comprehensive view of the academic quantum ecosystem's capacity and growth.

A Broader Perspective Reveals:

- The full spectrum of talent, from skilled technicians (Master's) to deep researchers (PhDs).
- Long-term trends and the sustained impact of funding.
- The foundational role of Master's programs in the talent pipeline.

This Data Informs:

- Industry hiring for varied roles.
- Student choices for both Master's and PhD tracks.
- Policy decisions on workforce development.

Methodology: Defining the Scope

The analysis covers a **10-year period** and includes both **Master's and PhD theses** focused on experimental quantum hardware.

Our Criteria

- **What is a "Quantum Hardware Dissertation?"**
  We included work on core qubit technologies (superconducting, trapped ion, photonic, etc.) as well as critical adjacent hardware such as quantum-limited amplifiers, SFQ circuits, and cryogenic qubit controller chips. Theoretical and software-focused theses were excluded.

- **What is a "Quantum Hardware Lab?"**
  Defined as a research group led by a principal investigator whose primary focus aligns with our hardware criteria. Data on lab counts is approximate and serves as a measure of institutional scale.

- **Degrees Included:** Both Master's (M.S., M.A.Sc., etc.) and PhD dissertations.

- **Data Source:** Aggregated from ProQuest, university libraries, institute reports, and lab websites.

A Four-Tier System

With the inclusion of Master's theses (alongside PhD theses) and a 10-year timeframe, the tier thresholds can be adjusted to reflect higher total output numbers.

Tier	Description (Avg. Total Theses/ Year)
Tier 1: Mega-producers	Institutions with massive, sustained output (≥ 10).
Tier 2: Large producers	Major research universities with very strong, consistent output ($7 - 9$).
Tier 3: Medium producers	Universities with established programs forming the ecosystem's backbone ($4 - 6$).
Tier 4: Focused nodes	Institutions with smaller or specialized programs ($1 - 3$).

Tier 1: The Epicenters of Quantum Talent

University	PhD/yr	MSc/yr	Total/yr	Labs
MIT	11.0	5.5	16.5	14
U. of Waterloo (IQC)	9.0	4.5	13.5	24
Yale University	8.0	4.0	12.0	6
U. of Maryland (JQI)	8.0	4.0	12.0	10
UC Berkeley	8.0	4.0	12.0	8
Harvard University	7.0	3.5	10.5	7
Stanford University	7.0	3.5	10.5	6

Key Takeaway

The top institutions are formidable talent engines, producing a high volume of both PhD researchers and highly skilled Master's graduates ready for industry.

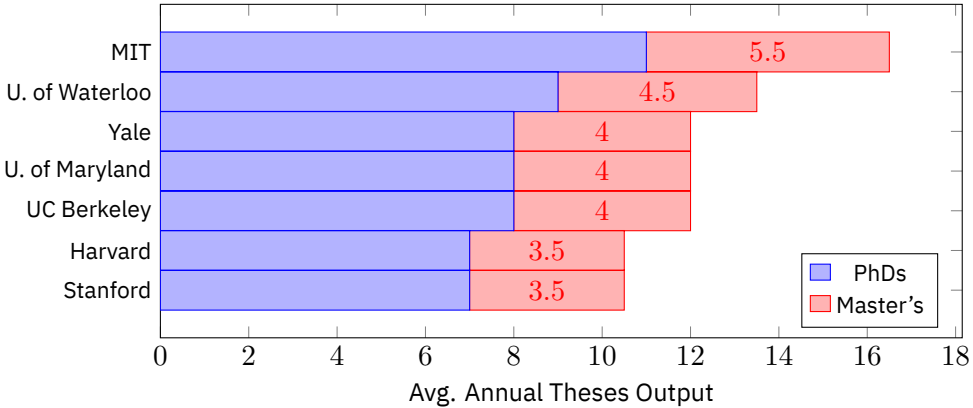
Tier 2: Powerhouses of Innovation

University	PhD/yr	MSc/yr	Total/yr	Labs
U. of Chicago	6.0	3.0	9.0	6
UC Santa Barbara	6.0	3.0	9.0	4
U. of Colorado (JILA)	6.0	3.0	9.0	6
U. of Wisconsin	5.0	2.5	7.5	4
Princeton University	5.0	2.5	7.5	5
Caltech	5.0	2.5	7.5	5

Key Takeaway

This tier remains a critical source of high-caliber talent. The addition of Master's data highlights their role in producing a balanced workforce of researchers and expert practitioners.

Analysis: The Talent Spectrum



Visualizing the combined PhD and Master's pipeline in top-tier schools.

Tier 3: The Broad and Vital Ecosystem (Part 1)

University	PhD/yr	MSc/yr	Total/yr	Labs
U. de Sherbrooke (IQ)	4.0	2.0	6.0	11
U. of Toronto (CQIQC)	4.0	2.0	6.0	10
Duke University	4.0	2.0	6.0	4
U. of Michigan	4.0	2.0	6.0	4
U. of British Columbia	4.0	2.0	6.0	12
UIUC	4.0	2.0	6.0	3
U. of Texas Austin	4.0	2.0	6.0	4
Cornell University	4.0	2.0	6.0	4
U. of Washington	4.0	2.0	6.0	3

Tier 3: The Broad and Vital Ecosystem (Part 2)

University	PhD/yr	MSc/yr	Total/yr	Labs
McGill University	3.0	1.5	4.5	6
UCLA	3.0	1.5	4.5	3
Northwestern U.	3.0	1.5	4.5	3
Georgia Tech	3.0	1.5	4.5	3
UC San Diego	3.0	1.5	4.5	3
U. of Calgary	3.0	1.5	4.5	5
Penn State University	3.0	1.5	4.5	3
Rice University	3.0	1.5	4.5	3
U. of Alberta	3.0	1.5	4.5	5

Spotlight: The Canadian Quantum Powerhouse

University	PhD/yr	MSc/yr	Total/yr
U. of Waterloo (IQC)	9.0	4.5	13.5
U. de Sherbrooke (IQ)	4.0	2.0	6.0
U. of Toronto (CQIQC)	4.0	2.0	6.0
U. of British Columbia	4.0	2.0	6.0
McGill University	3.0	1.5	4.5
U. of Calgary	3.0	1.5	4.5
U. of Alberta	3.0	1.5	4.5

Observation

Canadian institutions are major producers of both PhD and Master's graduates, reflecting a mature ecosystem supported by strategic investment in large-scale institutes.

Tier 4: Focused Nodes and Rising Stars

University	PhD/yr	MSc/yr	Total/yr	Labs
Columbia University	2.0	1.0	3.0	3
U. of Rochester	2.0	1.0	3.0	2
Simon Fraser U.	2.0	1.0	3.0	4
U. of Arizona	2.0	1.0	3.0	2
U. de Montréal	2.0	1.0	3.0	3
U. of New Mexico	2.0	1.0	3.0	2
Université Laval	2.0	1.0	3.0	2
UC Davis	2.0	1.0	3.0	2
U. of Victoria	1.0	0.5	1.5	2

Key Geographic Clusters of Quantum Research

Major U.S. Hubs

- **Northeast Corridor:**
  Boston (MIT, Harvard) to New Haven (Yale) and Maryland (JQI).
- **California:**
  Bay Area (Stanford, Berkeley) and Southern California (Caltech, UCSB, UCLA).
- **Midwest Hub:**
  Chicago, Wisconsin, and UIUC form a strong regional cluster.

The Canadian Quantum Corridor

- **Ontario-Québec Axis:**
  A dense network from Waterloo to Toronto, Montréal, and Sherbrooke.
- **Western Canada:**
  Strong presence with UBC, Calgary, and Alberta.

Summary of Key Findings

- **A Deeper Talent Pool:** Including Master's degrees reveals a significantly larger and more balanced talent pipeline than looking at PhDs alone.
- **Sustained Leadership:** The top-tier universities have demonstrated high-volume output over a full decade, solidifying their leadership roles.
- **The Ecosystem's Foundation:** Tier 3 and 4 universities are crucial for producing a large, geographically diverse cohort of both Master's and PhD graduates.
- **Balanced Workforce Development:** Leading institutions, particularly in Canada, excel at producing a healthy mix of researchers (PhDs) and expert practitioners (Master's).

Conclusion and Future Outlook

The North American academic landscape for quantum hardware is producing a robust, multi-level workforce, though talent generation remains highly concentrated.

Future Considerations

- How will the ratio of Master's to PhD graduates evolve as the industry's needs change?
- Correlating this data with industry hiring patterns for both degree levels is a critical next step.
- A more granular analysis of thesis topics could reveal emerging hardware specializations at the Master's level.

Thank You

Questions...

Appendix: Estimated Annual Thesis Output Data

University	Total/yr
MIT	16.5
U. of Waterloo	13.5
Yale University	12.0
U. of Maryland	12.0
UC Berkeley	12.0
Harvard University	10.5
Stanford University	10.5
U. of Chicago	9.0
UC Santa Barbara	9.0
U. of Colorado	9.0
U. of Wisconsin	7.5
Princeton University	7.5
Caltech	7.5
U. de Sherbrooke	6.0
U. of Toronto	6.0
Duke University	6.0
U. of Michigan	6.0
U. of British Columbia	6.0

University	Total/yr
Cornell University	6.0
U. of Washington	6.0
McGill University	4.5
UCLA	4.5
Northwestern U.	4.5
Georgia Tech	4.5
UC San Diego	4.5
U. of Calgary	4.5
Penn State University	4.5
Rice University	4.5
U. of Alberta	4.5
Columbia University	3.0
U. of Rochester	3.0
Simon Fraser U.	3.0
U. of Arizona	3.0
U. de Montréal	3.0
U. of New Mexico	3.0
Université Laval	3.0