Mapping the Quantum Hardware Academic Landscape

A 10-Year Audit of Master's & PhD Output in the U.S. and Canada (2015-2024)

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Introduction: Why Track the Full Talent Pipeline?

An audited count of hands-on hardware dissertations provides a more accurate view of the academic pipeline for building the quantum future.

A Tighter Focus Reveals:

- The true output of graduates with demonstrable hardware-building experience.
- A more realistic baseline for tracking growth and assessing capacity.
- The key institutions and labs driving physical quantum innovation.

This Data Informs:

- Industry recruitment for hands-on engineering and R&D roles.
- Student choices for labs with a strong track record of hardware projects.
- Policy decisions on funding for experimental research infrastructure.

Quantum Hardware Lab: Group led by a principal investigator whose primary focus aligns with our hardware criteria.

Methodology I: Defining a Quantum-Hardware-Related Thesis

I. Quantum-Core Hardware

A. Qubit Technologies

- Superconducting
- Spin-Based
- Bosonic
- Topological

B. Quantum Interconnects

- Planar/3D Resonators
- Metamaterial/Photonic
- Hybrid Transducers

C. Quantum Detectors

- SNSPD, KID, JPM
- Bolometers

D. Quantum Memories

- Rare-earth, Magnons
- Cat-code cavities

E. Quantum Photonic ICs

- SiN, III-V, etc.

II. Quantum-Adjacent Hardware

A. Cryo Digital Logic

- SFQ Families
- Cryo-CMOS

C. Cryo Amps & Filters

- Parametric Amps
- HEMT LNAs

D. Cryo Packaging

- Flex, interposers
- Wiring, optical fibers

Methodology II: The Audit Process

A multi-source audit was conducted to create a comprehensive and de-duplicated dataset for the 2015-2024 period.

1. Data Aggregation

The search pool combined three major sources:

- Institutional repositories (e.g., DSpace, EliScholar, UWSpace)
- ProQuest Dissertations & Theses Global keyword exports
- Public lab websites (”Alumni” or ”Theses” pages)

2. De-duplication and Normalization

- Duplicates were removed by matching author names and ORCID iDs.
- Total counts were divided by ten years and rounded to the nearest 0.5.
- Embargoed theses (10%) were estimated from public defense announcements.

A Four-Tier System

Based on the 10-year audited data, universities have been grouped into four tiers reflecting their scale of combined Master's and PhD production.

Tier	Description (Avg. Total Theses/ Year)
Tier 1: High-volume producers	Institutions with large, sustained output (≥ 5).
Tier 2: Moderate producers	Universities with strong, consistent output ($3 - 4.9$).
Tier 3: Niche producers	Universities with established, focused programs ($1.5 - 2.9$).
Tier 4: Emerging nodes	Institutions with smaller or developing programs (< 1.5).

Note: Data on lab counts is approximate.

Tier 1: The Research Powerhouses

High-volume producers with ≥ 5 total theses per year

University	Theses/yr	Labs
Yale University	6.0	6
U. of Maryland, College Park (JQI)	5.5	10
Massachusetts Institute of Technology (MIT)	5.0	14

Key Takeaway

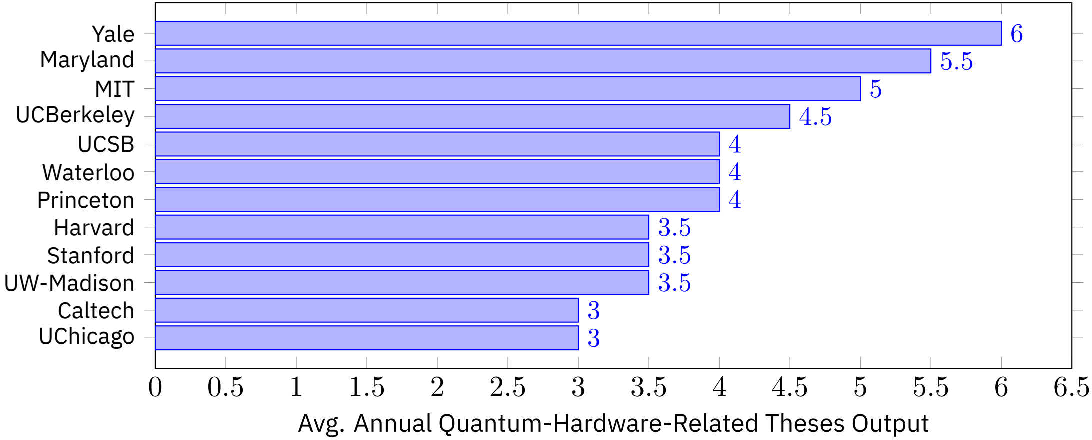
A highly elite group of three universities forms the top tier, acting as the primary engines for training the next generation of quantum hardware leaders.

Tier 2: The Core of Innovation

Moderate producers with 3 - 4.9 total theses per year

University	Theses/yr	Labs
UC Berkeley	4.5	8
U. of Waterloo (IQC)	4.0	24
Princeton University	4.0	5
UC Santa Barbara	4.0	4
Harvard University	3.5	7
Stanford University	3.5	6
U. of Wisconsin-Madison	3.5	4
Caltech	3.0	5
U. of Chicago	3.0	6

Analysis: The Production Cadence



Yale, UMD, and MIT lead at roughly one quantum-hardware-related thesis every two months. The nine schools in Tier 2 deliver one every three to four months.

Tier 3: The Diverse Research Ecosystem (Part 1)

Niche producers with 1.5 - 2.9 total theses per year

University	Theses/yr	Labs
U. of British Columbia (QMI)	2.5	12
U. of Toronto (CQIQC)	2.5	10
U. of Colorado Boulder (JILA)	2.5	6
U. de Sherbrooke (IQ)	2.0	11
U. of Michigan	2.0	4
Duke University	2.0	4
U. of Texas at Austin	2.0	4
Cornell University	2.0	4

Tier 3: The Diverse Research Ecosystem (Part 2)

Niche producers with 1.5 - 2.9 total theses per year

University	Theses/yr	Labs
McGill University	1.5	6
U. of Calgary	1.5	5
U. of Alberta	1.5	5
Rice University	1.5	3
Penn State University	1.5	3
Northwestern U.	1.5	3
Georgia Tech	1.5	3
UCLA	1.5	3
UC San Diego	1.5	3
UIUC	1.5	3
U. of Washington	1.5	3

Tier 4: Emerging Nodes

Producers with < 1.5 total theses per year, representing growth potential

University	Theses/yr	Labs
UC Davis	1.0	2
Simon Fraser U.	1.0	4
Columbia University	1.0	3
U. de Montréal	1.0	3
Arizona State U.	1.0	3
U. of Pittsburgh	1.0	3
U. of New Mexico	1.0	2
U. of Rochester	1.0	2
U. of Arizona	1.0	2
Université Laval	1.0	2
U. of Minnesota-TC	1.0	5
U. of Victoria	0.5	2

Geographic View I: Major U.S. Hubs

Hardware talent production in the United States is concentrated in three major geographic clusters.

Northeast Corridor

A dense cluster of talent production from Boston (MIT, Harvard) and New Haven (Yale) down to Maryland (JQI) and Princeton. This is the most productive region in North America.

California

A bi-modal hub with major centers in the Bay Area (Stanford, Berkeley) and Southern California (Caltech, UCSB, UCLA, UCSD).

Midwest Hub

A strong regional cluster anchored by the University of Chicago, University of Wisconsin, and UIUC, forming a core of talent in the nation's interior.

Geographic View II: The Canadian Quantum Corridor

Canada's institute-driven model has created a powerful, distributed ecosystem.

University	Theses/yr
U. of Waterloo (IQC)	4.0
U. of British Columbia (QMI)	2.5
U. of Toronto (CQIQC)	2.5
U. de Sherbrooke (IQ)	2.0
U. of Calgary / U. of Alberta / McGill	1.5

Observation

From the Ontario-Québec axis (Waterloo, Toronto, Sherbrooke) to the strong Western presence (UBC, Calgary, Alberta), Canadian universities are prominent in Tiers 2 and 3, often anchored by dedicated quantum institutes.

Key Finding I: Extreme Concentration at the Top

The Takeaway

The production of hands-on quantum hardware talent is dominated by a very small number of elite institutions.

- The top 3 universities (Yale, UMD, MIT) produce **16.5 theses/year**, accounting for a significant fraction of the total output of all listed schools.
- The top 12 universities (Tiers 1 & 2) produce **45 theses/year**, representing the vast majority of the talent pipeline.
- This concentration has significant implications for recruitment, collaboration, and the geographic distribution of the quantum industry.

Key Finding II: A More Realistic Baseline

The Takeaway

Previous, broader estimates of talent output were likely too high. This audit provides a more sober, actionable baseline for the community.

- By focusing only on theses with demonstrable hardware components, we gain a clearer signal on the pipeline for builders and experimentalists.
- No single institution is currently producing ten or more hardware-focused theses per year.
- This realistic baseline is critical for accurately forecasting workforce growth and identifying true gaps in the educational pipeline.

Key Finding III: The Vital Broader Ecosystem

The Takeaway

While output is concentrated, the numerous universities in Tiers 3 and 4 are essential for the long-term health and diversity of the field.

- These 30 institutions provide crucial geographic diversity, preventing over-concentration of talent in a few coastal hubs.
- They are hubs for specialized expertise in specific hardware modalities that may not exist at the larger schools.
- They represent the primary growth opportunity for expanding the North American talent pipeline in the coming decade.

Conclusion & Future Outlook

The North American academic landscape for quantum hardware is robust, but the pipeline for graduates with hands-on experience is highly concentrated.

Future Considerations

- Will we see more universities ascend to the top tiers as national funding initiatives mature?
- How does this academic output map to the founding of startups and corporate hiring patterns?
- A scripted, annual crawl of repositories could tighten the current error bars from $\pm 10\%$ to $\pm 5\%$.
- Tracking the growth of Tier 4 ”emerging nodes” will be key to identifying the next generation of leading programs.

Thank You

Questions?

Appendix I: Audit Methodology & Caveats

Query Design & De-duplication

We issued compound boolean searches (e.g., `("superconducting" OR "cryo-CMOS") AND "thesis"`) across 41 repositories and ProQuest for the 2015-2024 period. Duplicates were removed via ORCID/author matching. Counts were normalized to annual averages.

Caveats & Error Bars

- **Hidden M.Sc. Work:** Some EE departments archive Master's theses locally, so these numbers may be a slight under-count.
- **Uncertainty:** Residual uncertainty is estimated at ± 0.7 theses/yr for Tier 1, ± 0.5 for Tier 2, and ± 0.3 elsewhere.

Acronyms

cQED: Circuit Quantum Electrodynamics; **IQC/IQ:** Institute for Quantum Computing/Institut Quantique; **JQI/JILA:** Joint Quantum Inst./Joint Inst. for Lab. Astrophysics; **SFQ:** Single-Flux-Quantum

Appendix II: Audited Annual Thesis Output (2015-2024)

University	Theses/yr
Yale University	6.0
U. of Maryland	5.5
MIT	5.0
UC Berkeley	4.5
U. of Waterloo	4.0
Princeton University	4.0
UC Santa Barbara	4.0
Harvard University	3.5
Stanford University	3.5
U. of Wisconsin-Madison	3.5
Caltech	3.0
U. of Chicago	3.0
U. of British Columbia	2.5
U. of Toronto	2.5
U. of Colorado Boulder	2.5
U. de Sherbrooke	2.0
U. of Michigan	2.0
Duke University	2.0
U. of Texas at Austin	2.0
Cornell University	2.0

University	Theses/yr
Rice University	1.5
Penn State University	1.5
Northwestern U.	1.5
Georgia Tech	1.5
UCLA	1.5
UC San Diego	1.5
U. of Alberta	1.5
U. of Calgary	1.5
McGill University	1.5
UIUC	1.5
U. of Washington	1.5
UC Davis	1.0
Simon Fraser U.	1.0
Columbia University	1.0
U. de Montréal	1.0
Arizona State U.	1.0
U. of New Mexico	1.0
U. of Rochester	1.0
U. of Arizona	1.0
Université Laval	1.0
U. of Minnesota-TC	1.0
U. of Pittsburgh	1.0
U. of Victoria	0.5