

# Quantum-Nano Fabrication & Characterization Facility (QNFCF)

Core Scientific Research Platform

## Annual Update: FY2021/22



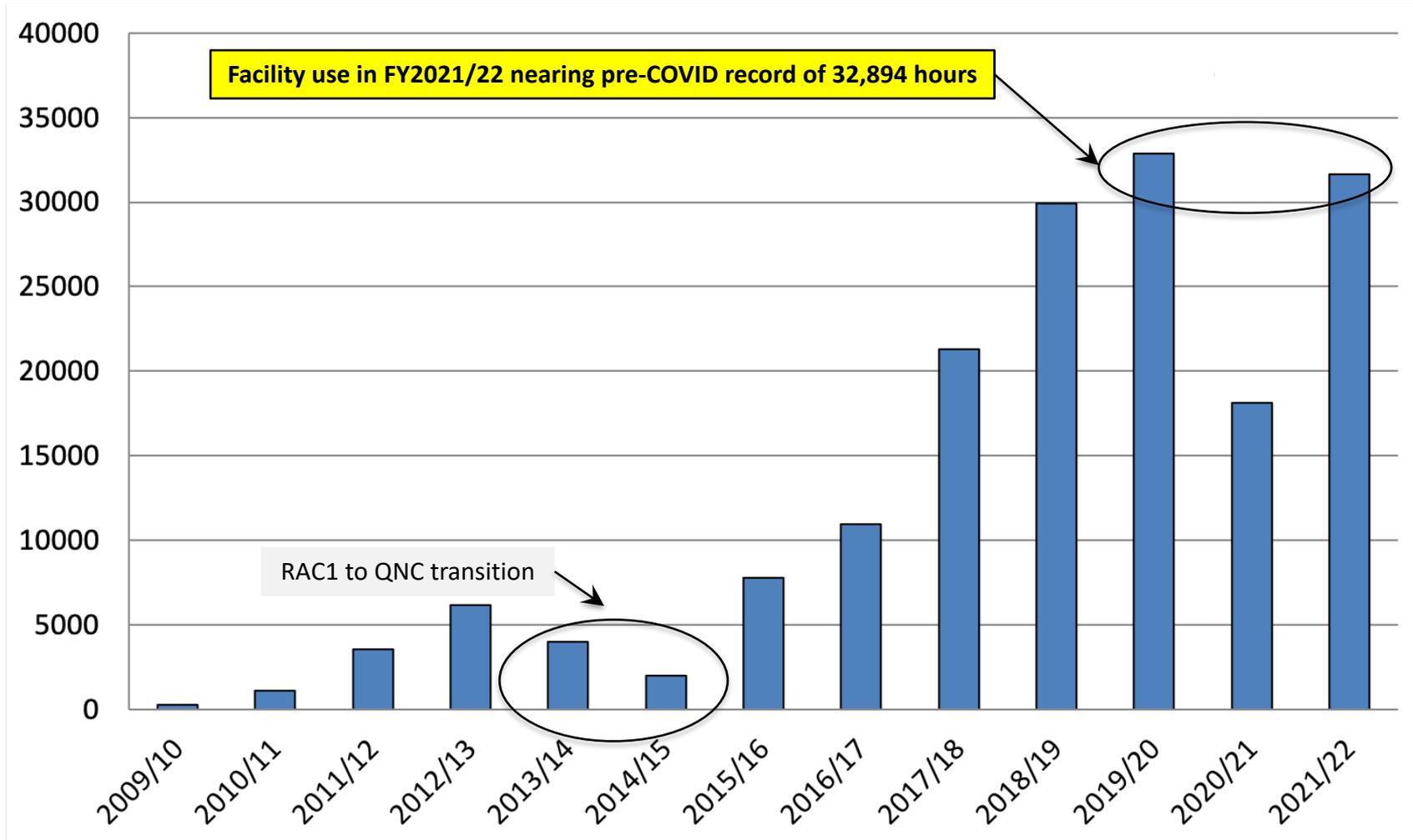
**Visit from Canada Foundation for Innovation (2017)**  
Dr. Roseann O'Reilly Runte, President and CEO  
Mr. Pierre Normand, VP External Relations & Comms



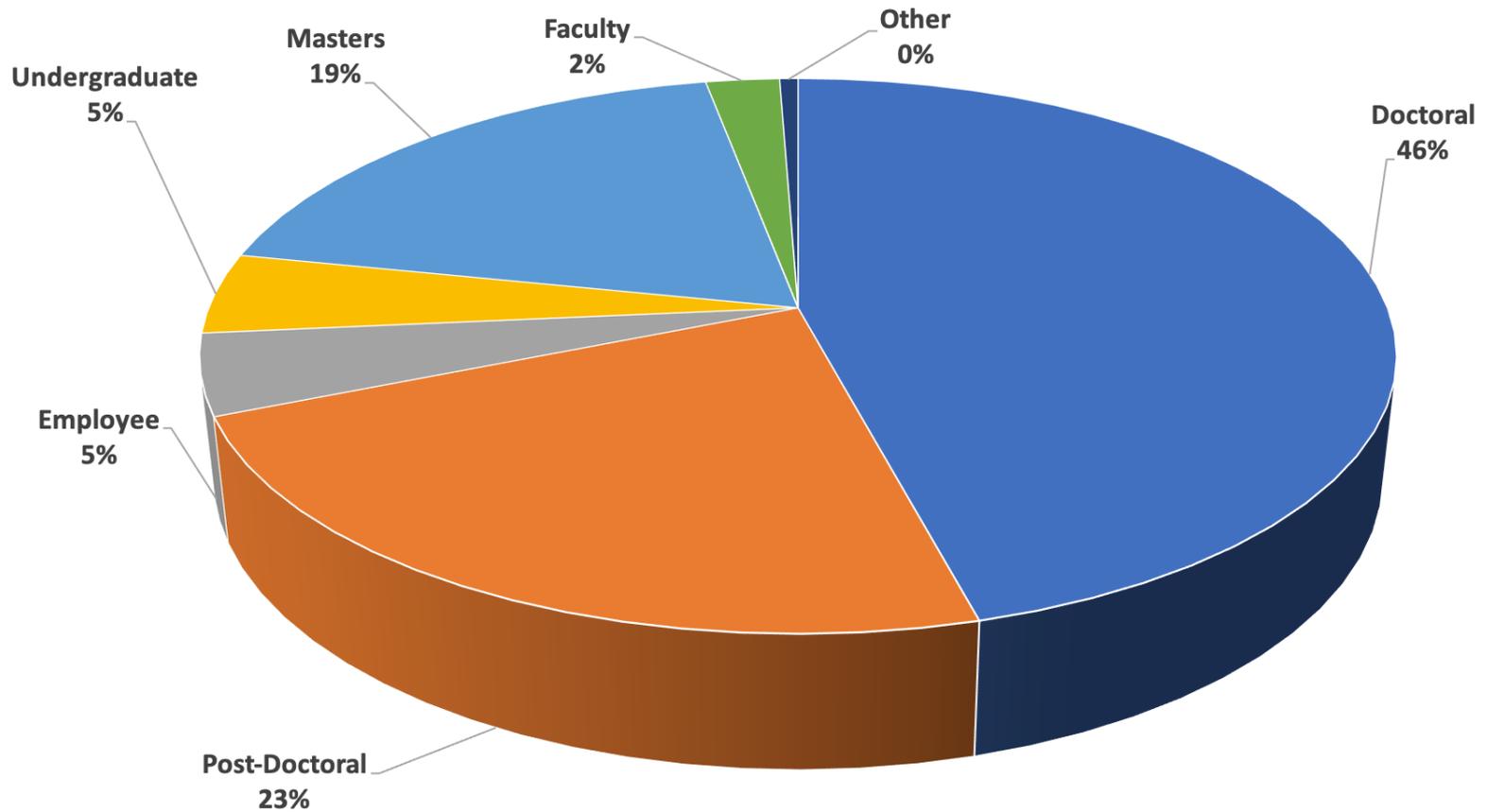
**Visit from UWaterloo senior leaders (2022)**  
Dr. Vivek Goel, President  
Dr. Charmaine Dean, VP Research & International

# Hours of equipment use invoiced per fiscal year\*

\* Fiscal years ending April 30 - graph does not include user training & support hours logged by QNFCF staff



# Well used by broad range of Lab Members (Users)

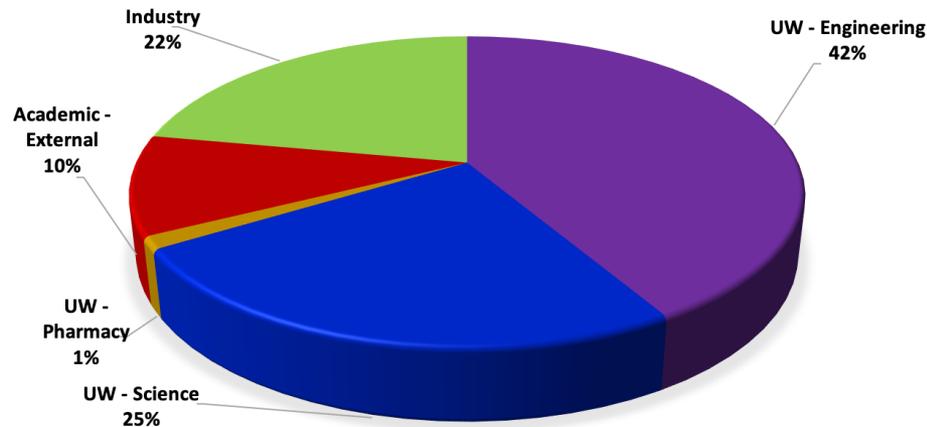


# FY2021/22: 215 Users under 77 distinct research groups

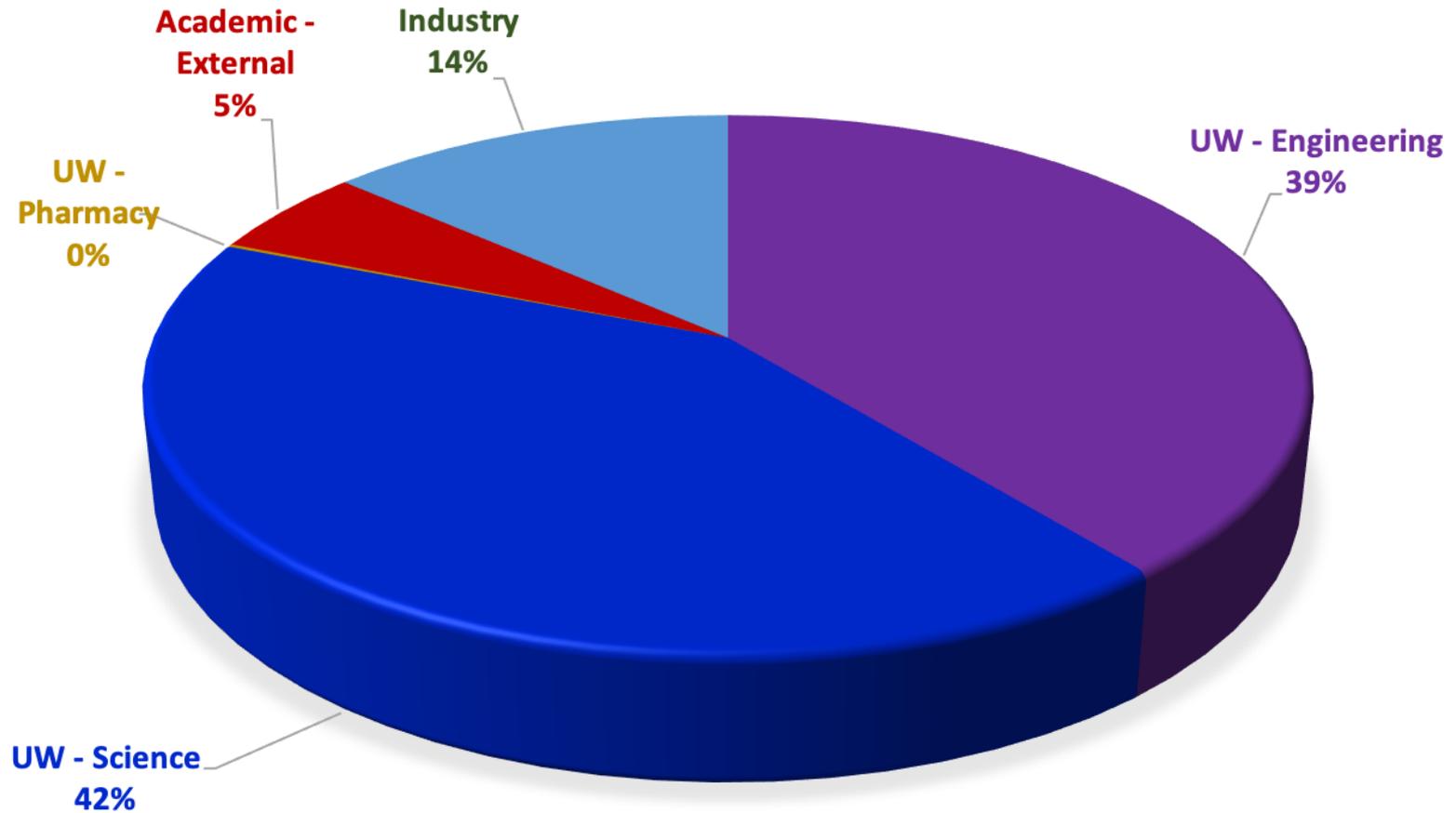
Principal Investigator	Hours of Equip Use Logged	Category: Academic, Industry, Govt, Other	Institution / Company Name	Faculty	Department
Abdel-Rahman, Eihab	20	Academic	UWaterloo	Engineering	Sys Design Eng
Alfano, Marco	34	Academic	UWaterloo	Engineering	MME
Bajcsy, Michal	454	Academic	UWaterloo	Engineering	ECE
Ban, Dayan	594	Academic	UWaterloo	Engineering	ECE
Basha, Mohamed	3	Academic	UWaterloo	Engineering	ECE
Cui, Bo	3291	Academic	UWaterloo	Engineering	ECE
Goldthorpe, Irene	39	Academic	UWaterloo	Engineering	ECE
Karim, Karim	147	Academic	UWaterloo	Engineering	ECE
Kim, Na Young	117	Academic	UWaterloo	Engineering	ECE
Levine, Peter	55	Academic	UWaterloo	Engineering	ECE
Mansour, Raafat	840	Academic	UWaterloo	Engineering	ECE
Mayer, Michael	12	Academic	UWaterloo	Engineering	MME
Miao, Guo-Xing	686	Academic	UWaterloo	Engineering	ECE
Mitra, Sushanta	95	Academic	UWaterloo	Engineering	MME
Musselman, Kevin	25	Academic	UWaterloo	Engineering	MME
Pope, Michael	32	Academic	UWaterloo	Engineering	Chem Eng
Poudineh, Mahla	163	Academic	UWaterloo	Engineering	ECE
Reimer, Michael	748	Academic	UWaterloo	Engineering	ECE
Safavi-Naeini, Safieddin	141	Academic	UWaterloo	Engineering	ECE
Shahsavan, Hamed	163	Academic	UWaterloo	Engineering	Chem Eng
Sivonthaman, Siva	46	Academic	UWaterloo	Engineering	ECE
Wasilewski, Zbig	163	Academic	UWaterloo	Engineering	ECE
Wei, Lan	18	Academic	UWaterloo	Engineering	ECE
Wilson, Chris	1498	Academic	UWaterloo	Engineering	ECE
Wong, William	575	Academic	UWaterloo	Engineering	ECE
Wu, Yimin	153	Academic	UWaterloo	Engineering	MME
Yavuz, Mustafa	556	Academic	UWaterloo	Engineering	MME
Yeow, John	1533	Academic	UWaterloo	Engineering	Sys Design Eng
Yim, Evelyn	114	Academic	UWaterloo	Engineering	Chem Eng
Yu, Alfred	48	Academic	UWaterloo	Engineering	ECE
Zhao, Boxin	6	Academic	UWaterloo	Engineering	Chem Eng
Zhou, Norman	22	Academic	UWaterloo	Engineering	MME
Slavcev, Roderick	54	Academic	UWaterloo	Pharmacy	Pharmacy
Baugh, Jonathan	2765	Academic	UWaterloo	Science	Chemistry
Budakian, Raffi	574	Academic	UWaterloo	Science	Physics
Cory, David	581	Academic	UWaterloo	Science	Chemistry
Forrest, James	34	Academic	UWaterloo	Science	Physics
Hawthorn, David	20	Academic	UWaterloo	Science	Physics
Islam, Rajibul	5244	Academic	UWaterloo	Science	Physics
Jennewein, Thomas	10	Academic	UWaterloo	Science	Physics
Kycia, Jan	2	Academic	UWaterloo	Science	Physics
Lupascu, Adrian	393	Academic	UWaterloo	Science	Physics
Maheshwari, Vivek	108	Academic	UWaterloo	Science	Chemistry
Mariantoni, Matteo	198	Academic	UWaterloo	Science	Physics
Nazar, Linda	0.42	Academic	UWaterloo	Science	Chemistry
Pushin, Dmitry	607	Academic	UWaterloo	Science	Physics
Resch, Kevin	4	Academic	UWaterloo	Science	Physics
Schipper, Derek	11	Academic	UWaterloo	Science	Chemistry
Sciaini, German	1134	Academic	UWaterloo	Science	Chemistry
Senko, Crystal	1137	Academic	UWaterloo	Science	Physics
Strickland, Donna	32	Academic	UWaterloo	Science	Physics
Tsen, Wei	404	Academic	UWaterloo	Science	Chemistry

Principal Investigator	Hours of Equip Use Logged	Category: Academic, Industry, Govt, Other	Institution / Company Name	Faculty	Department
Reznik, Alla	11	Academic - External	Lakehead University	n/a	n/a
Hryciw, Aaron	3	Academic - External	University of Alberta	n/a	n/a
Dolgaleva, Ksenia	0.22	Academic - External	University of Ottawa	n/a	n/a
Ahmed, Marya	1.23	Academic - External	University of PEI	n/a	n/a
Helmy, Amr	1578	Academic - External	University of Toronto	n/a	n/a
Howe, Jane	0.02	Academic - External	University of Toronto	n/a	n/a
Kherani, Nazir	78	Academic - External	University of Toronto	n/a	n/a
Miller, RJ Dwayne	19	Academic - External	University of Toronto	n/a	n/a
Phillips, Michael	17	Industry	Vena Medical Holdings Inc	n/a	n/a
Fathi, Ehsan	209	Industry	VueReal Inc	n/a	n/a
Weedbrook, Christian	53	Industry	Xanadu Quantum Technologies	n/a	n/a
Galaam, Ahmed	649	Industry	Sheba Microsystems	n/a	n/a
Xiang, Jingen	350	Industry	SpinQ Technology Co. Ltd	n/a	n/a
Peinke, Emanuel	256	Industry	TandemLaunch Inc.	n/a	n/a
Rezazadeh, Vallen	13	Industry	TransEON Inc.	n/a	n/a
Khosravi, Kourosh	106	Industry	Adhawk Microsystems	n/a	n/a
Robson, Mitch	280	Industry	Ambature Inc.	n/a	n/a
Najafi-Yazdi, Alireza	783	Industry	Anyon Systems Inc.	n/a	n/a
Marsh, Lee	243	Industry	Bio-Stream Diagnostics Inc.	n/a	n/a
Boorn, Andrew	9	Industry	High Q Technologies, LP	n/a	n/a
Morris, David	82	Industry	ICSPI Corp.	n/a	n/a
MacLean, Steve	97	Industry	Infinite Potential Laboratories	n/a	n/a
Hamilton, P. (UW Velocity)	40	Industry	LSK Technologies	n/a	n/a
Akhlaghi, Mohsen	788	Industry	Photonic Inc.	n/a	n/a
Shaffer, James	272	Industry	Quantum Valley Ideas Lab	n/a	n/a

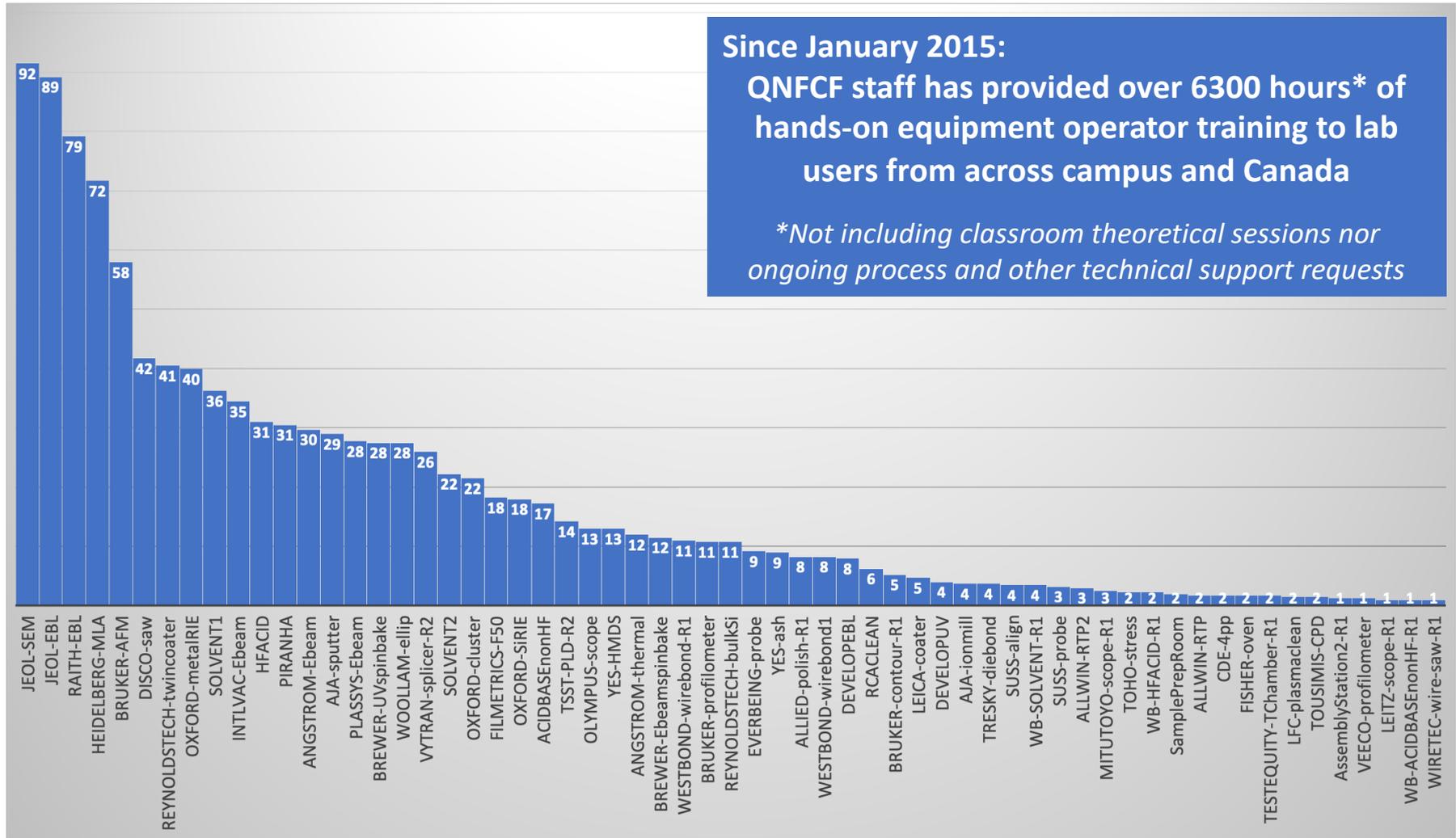
**QNFCF PI BREAKDOWN AS A FUNCTION OF AFFILIATION (FY2021/22)**



# FY2021/22: % of total hours of use per category of affiliation



# FY2021/22: Logged 1114 Hours of hands-on training



# Annual O&M expenses and User fees trends\*

\* Fiscal years ending April 30

EXPENSES	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Average Last 3 Years
<b>SALARIES &amp; BENEFITS</b>												
Sub-Total:	\$222,645	\$274,113	\$290,309	\$365,712	\$460,623	\$613,184	\$819,592	\$1,535,502	\$1,701,655	\$1,778,492	\$1,806,057	\$1,762,068
<b>SUPPLIES, MAINTENANCE &amp; REPAIRS</b>												
Sub-Total:	\$101,393	\$122,271	\$506,975	\$405,379	\$589,031	\$802,204	\$1,163,558	\$1,380,003	\$1,400,137	\$1,071,837	\$1,082,626	\$1,184,867
<b>TOTAL:</b>	<b>\$324,038</b>	<b>\$396,384</b>	<b>\$797,285</b>	<b>\$771,091</b>	<b>\$1,049,653</b>	<b>\$1,415,388</b>	<b>\$1,983,150</b>	<b>\$2,915,505</b>	<b>\$3,101,791</b>	<b>\$2,850,329</b>	<b>\$2,888,683</b>	<b>\$2,946,934</b>

<b>USER FEES COLLECTED</b>	\$86,583	\$157,915	\$111,333	\$80,860	\$348,371	\$539,638	\$994,730	\$1,376,704	\$1,763,769	\$877,024	\$1,320,204	\$1,320,332
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<b>% EXPENSES COVERED BY USER FEES</b>	27%	40%	14%	10%	33%	38%	50%	47%	57%	31%	46%	45%
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# Background Information

# QNFCF Overview

Distributed across 13 sites on campus

## \$63M in Capital Investments

### QNC Building

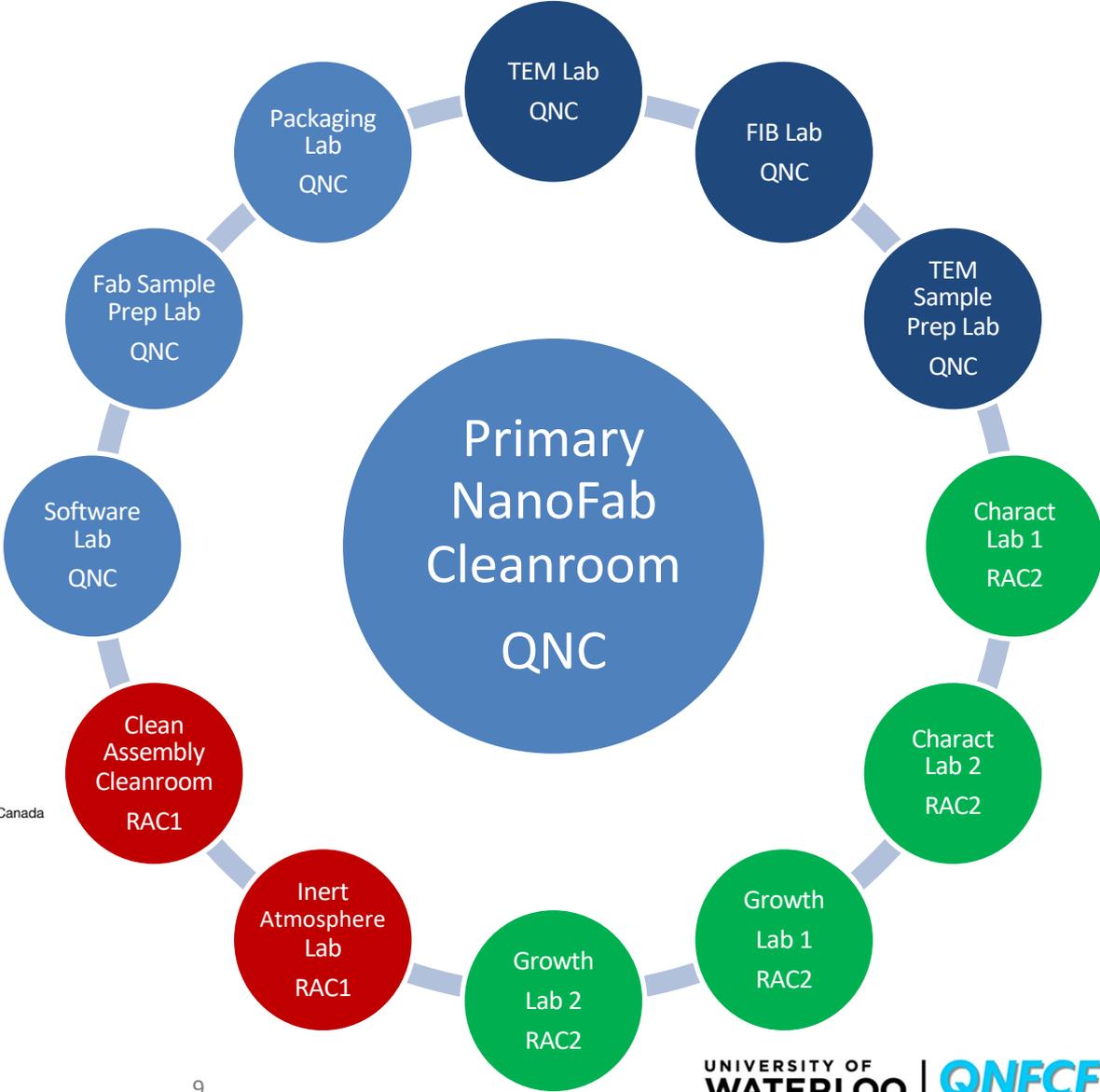
- \$25M ISO 4 rated Cleanroom
- VC-G rated Metrology labs
- \$26M Lab equipment

### RAC1 Building

- \$1M ISO 6 rated Cleanroom
- \$1M Lab equipment

### RAC2 Building

- \$10M Lab equipment



# Broad Range of Capabilities

## Deposition

1. [ALD / PECVD Cluster Deposition System](#)
2. [LPCVD Low Temperature Oxidation \(LTO\) Furnace](#)
3. [LPCVD Poly Silicon and Silicon Carbide Furnace](#)
4. [LPCVD Silicon Nitride Furnace](#)
5. [Rapid Thermal Processor #1 \(RTP\)](#)
6. [Rapid Thermal Processor #2 \(RTP\)](#)
7. [PVD E-Beam & Resistive Heating Thermal Evaporator](#)
8. [PVD E-Beam Long Throw Evaporator](#)
9. [PVD Nb Superconducting Films Sputter System](#)
10. [PVD Twin Chamber Sputter System](#)
11. [PVD Al Superconducting Films Evaporator System](#)
12. [PVD Thermal Evaporator for P-Type Contacts](#)
13. [Thermal Oxidation Furnace](#)

## Lithography

1. [E-Beam Lithography System \(30kV\)](#)
2. [E-Beam Lithography System \(100kV\)](#)
3. [Beamer/Tracer Software Suite](#)
4. [Front/Back Mask Aligner](#)
5. [Wafer Bonder](#)
6. [UV Direct Write Lithography System](#)
7. [Oven: Convection](#)
8. [Oven: HMDS & Image Reversal](#)
9. [Spin Coater: Dual General Purpose Hood](#)
10. [Spin Coater: E-Beam Resists](#)
11. [Spin Coater: UV Resists](#)

## Dry Etch

1. [Ion Mill](#)
2. [Photoresist Strip](#)
3. [RIE: Deep Silicon Etch \(DRIE\)](#)
4. [RIE: Metal & III-V Materials](#)

## Wet Benches

1. [Bulk Silicon Etch](#)
2. [Critical Point Dryer](#)
3. [Diffusion Pre-Clean \(RCA Chemistries\)](#)
4. [E-Beam Resist Develop](#)
5. [HF Acids Only](#)
6. [Non-HF Acids & Bases](#)
7. [Piranha Organics Clean & Resist Strip](#)
8. [Solvent Processing Station #1](#)
9. [Solvent Processing Station #2](#)
10. [UV Resist Develop](#)

## Characterization

1. [Bruker Atomic Force Microscope](#)
2. [Scanning Electron Microscope](#)
3. [Manual Cleaving Tool](#)
4. [4-Point Probe](#)
5. [Electrical Prober Station: Generous donation from EVERBEING](#)
6. [Electrical Probe Station](#)
7. [Ellipsometer](#)
8. [Microscope #1](#)
9. [Microscope #2](#)
10. [Reflectometer: Thin Film Mapping](#)
11. [Reflectometer: Thin Film Spot Measurement](#)
12. [Surface Profiler #1](#)
13. [Surface Profiler #2](#)
14. [Wafer Stress Measurement](#)
15. [SEM Sample Coater](#)

## Packaging Lab

1. [Convection Cure Oven](#)
2. [Dicing Saw](#)
3. [Die Bonder](#)
4. [H2 Plasma Cleaner](#)
5. [Measurement Microscope](#)
6. [Wirebonder: Manual Wedge/Ball](#)
7. [Wirebonder: Semi-automatic Wedge](#)
8. [Wire Pull Tester](#)
9. [Epoxy dispenser](#)

## QNC Metrology Labs

1. [SEM/FIB System](#)
2. [S/TEM System](#)
3. [Sample Prep - Polisher](#)
4. [Sample Prep - Microscope](#)
5. [Sample Prep - Multi-tool](#)
6. [Sample Prep - Dimpler](#)
7. [Sample Prep - Saw](#)
8. [Sample Prep - Ion Mill](#)
9. [Sample Prep - Grinder/Polisher](#)

## RAC1 Labs

1. [Assembly Station #1](#)
2. [Assembly Station #2](#)
3. [Environmental Chamber](#)
4. [Laser Welder](#)
5. [Sample Cutter](#)
6. [Sample Lapper](#)
7. [Wire Saw](#)
8. [Microscope #1](#)
9. [Microscope #2](#)
10. [Microscope #3](#)
11. [O2/Ar Plasma Cleaner](#)
12. [Wet Bench: Non-HF Acids & Bases](#)
13. [Wet Bench: HF Acids](#)
14. [Wet Bench: Solvent Processing](#)
15. [Wire Bonder](#)
16. [3D Optical Surface Profiler](#)

## RAC2 Labs

1. [Fiber Splicer](#)
2. [Microscope #2](#)
3. [Veeco Atomic Force Microscope](#)
4. [LPCVD for Carbon Nanotube Growth](#)
5. [LPCVD for Silicon Nanowire Growth](#)
6. [Pulsed Laser Deposition System](#)

# Key QNFCF success factors

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1. Outstanding multi-year financial support from IQC and CFREF-TQT
2. Rare ensemble of lab equipment backed by solid expertise
3. QNFCF Team with extensive technical & operations experience
4. Strong focus on customer service
5. Revision-tracked SOPs / well-characterized recipes / process support
6. Extensive, mandatory training
7. Stable, professionally-maintained lab equipment & infrastructure
8. Clearly defined, communicated & enforced policies (fair access to all)
9. UWaterloo's "creator owned" IP policy