

# Welcome to the 7th Annual NNCI Conference - Back In Person -



National Nanotechnology  
Coordinated Infrastructure





# ***NNCI Coordinating Office Report***



National Nanotechnology  
Coordinated Infrastructure



# Welcome and Thank You

## Welcome

- External Advisory Board Members
- NSF Program Directors
- NNCO Leadership
- Invited Speaker
- NNCI Site Leadership and Staff
- Guests

## Thank You

- CNF and NNCI Coordinating Office Staff
- NSF for Continued Support

# NNCI Advisory Board



Andrew Greenberg  
U Wisconsin



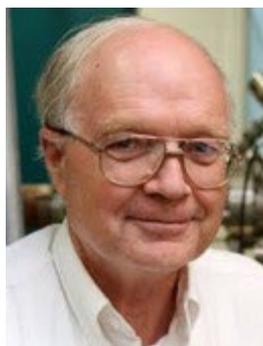
Elaine Cohen Hubal  
EPA



Angelique Johnson  
Entrepreneur



Joe Magno  
NIIT



Richard Osgood  
Columbia U



Kurt Petersen  
Entrepreneur



Tom Theis  
Utopus Insights



Ken Wise  
U Michigan

# NNCI Coordinating Office Team



David Gottfried  
Deputy Director  
Georgia Tech



Amy Duke  
Program Manager  
Georgia Tech



Mikkel Thomas  
AD Education & Outreach  
Georgia Tech



Azad Naeemi  
AD Computation  
Georgia Tech



Jamey Wetmore  
AD Societal & Ethical Implications  
ASU

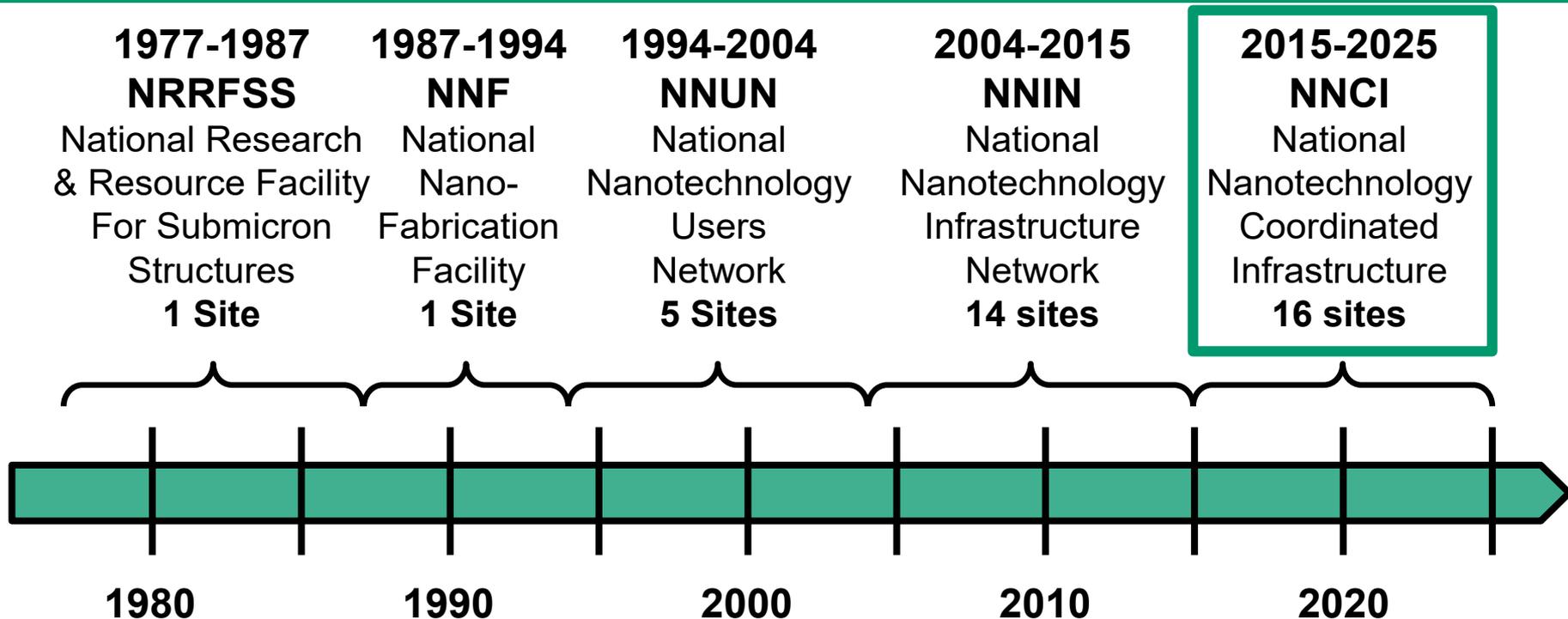


Matt Hull  
AD Innovation & Entrepreneurship  
Virginia Tech

# Outline

- What is NNCI?
- NNCI Statistics
- NNCI Impact
- NNCI Programs

# 40+ Years NSF-Funded Nano Infrastructure



*Cornell, 1983*



2000 NNI  
National  
Nanotechnology  
Initiative

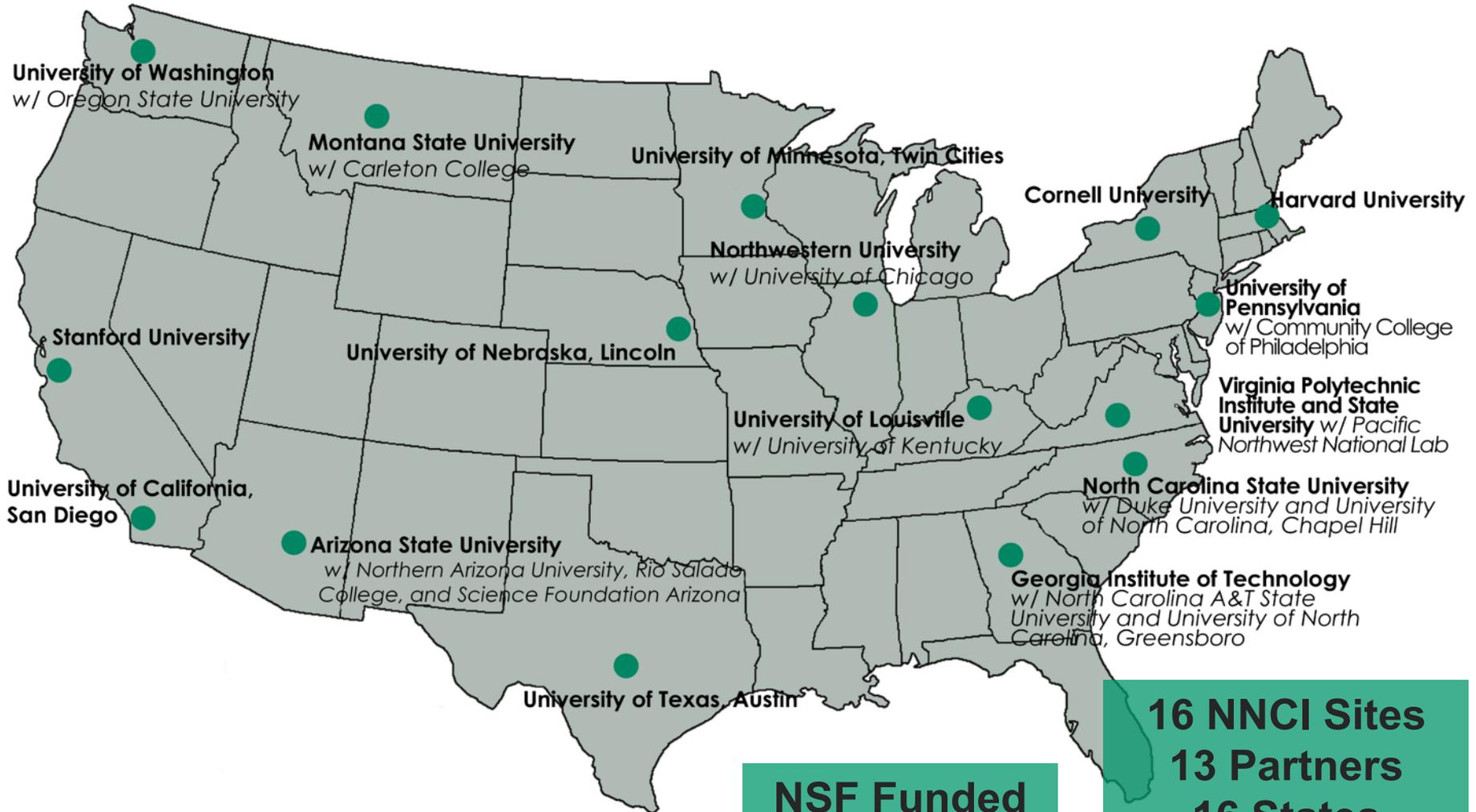


2003  
21<sup>st</sup> Century  
Research and  
Development Act



*U Penn, Singh Center, 2013*

# NNCI Network



**NSF Funded  
2015 - 2025  
\$165M total**

**16 NNCI Sites  
13 Partners  
16 States  
71 Facilities  
>2,200 Tools**

# NNCI Goals

- Provide open access to **state-of-the-art nano-fabrication & characterization facilities** and their tools across US and **staff expertise**
- Use these resources to support **education & outreach (E&O)** as well as **societal & ethical implications (SEI)** programs in/of nanotechnology
- **Coordinated approach to make whole more than the sum of its parts**



# Academic Infrastructure Strengths

- **Academic infrastructure is flexible**
  - Low-cost, open access to nanotechnology tools and staff expertise
  - Ideal to try out new ideas using new materials, devices, process modules
  - Supports fundamental and applied research
  - 100-150mm infrastructure is cost-effective for research
  - Supports microelectronics PLUS: MEMS; photonics; quantum; wide-bandgap semiconductors; heterogeneous integration; 2D electronics; bioelectronics; flexible electronics; .....
- **Academic infrastructure educates**
  - NNCI hands-on trains 4,000-5,000 new users per year; this can be scaled via regional networks; collaboration with community colleges, etc.
  - Academic infrastructure excites the next generation via K-12 outreach
- **Academic infrastructure brings people together**
  - Campus locations bring together academicians, start-ups, small & large companies, and even investors
  - Enhanced by workshops, short courses, seminars, tech showcases, etc.

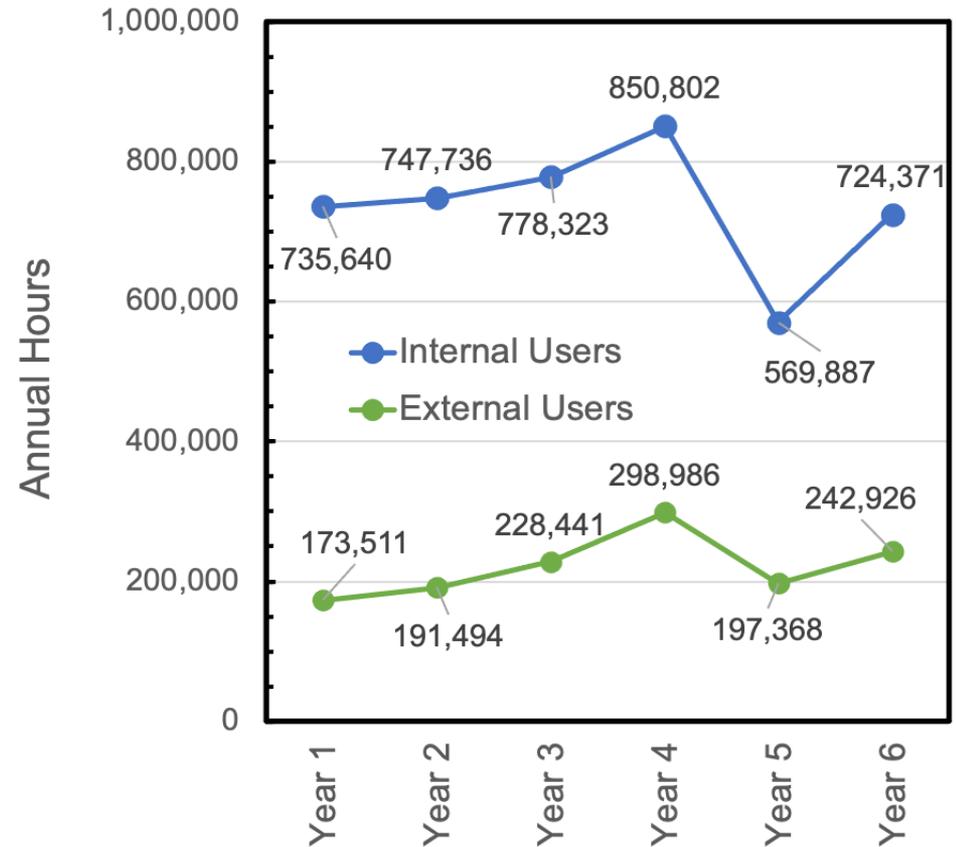
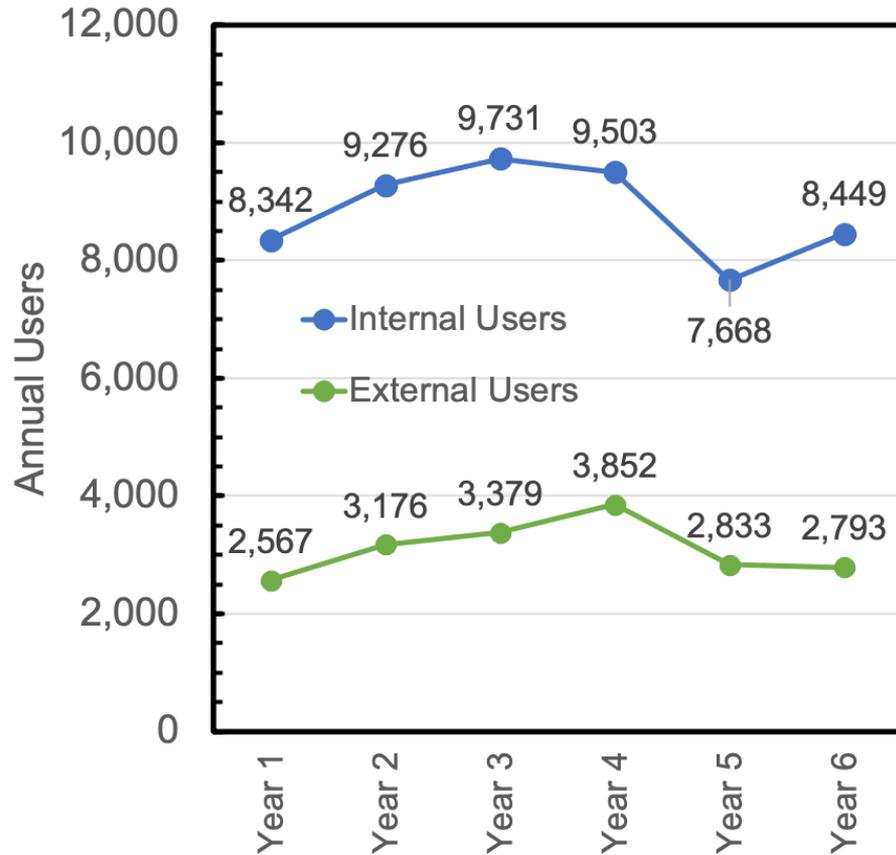
# NNCI User Statistics Year 6 (Oct. 20 – Sept. 21)

	<b>Year 6 Total</b>	<b>Mean (Min – Median – Max)</b>
Unique Facility Users	<b>11,242</b>	<b>703</b> (189 – 569 – 1,521)
Unique Ext. Users	<b>2,793</b> <b>24.8%</b>	<b>175</b> (35 – 163 – 404) <b>25.6%</b> (13.9% – 23.5% – 42.9%)
Industry Users	<b>1,619</b>	<b>101</b> (18 – 83 – 248)
Ext. Non-Industry Users	<b>1,174</b>	<b>73</b> (17 – 63 – 201)
Avg Monthly Users	<b>4,381</b>	<b>274</b> (57 – 249 – 693)
New Users Trained	<b>4,414</b>	<b>276</b> (38 – 200 – 692)
Facility Hours	<b>967,297</b>	<b>60,456</b> (7,736 – 53,794 – 159,720)
Ext. Facilities Hours	<b>242,926</b> <b>25.1%</b>	<b>15,183</b> (1,185 – 9,788 – 50,307) <b>23.9%</b> (5.8% – 20.6% – 62.9%)
Hours/User	<b>86</b>	<b>85</b> (31 – 70 – 174)
Total User Fees	<b>\$39.7M</b>	<b>\$2.48M</b> (\$258k – \$2.37M – \$6.3M)
\$/Hour	<b>\$41</b>	<b>\$42</b> (\$21 – \$48 – \$65)

# NNCI User Statistics Year 1 – Year 6

	<b>Year 1</b> 10/15-9/16	<b>Year 2</b> 10/16-9/17	<b>Year 3</b> 10/17-9/18	<b>Year 4</b> 10/18-9/19	<b>Year 5</b> 10/19-9/20	<b>Year 6</b> 10/20-9/21
Unique Facility Users	10,909	12,452	13,110	13,355	10,501	11,242
Unique Ext. Users	2,567 23.5%	3,176 25.5%	3,379 25.8%	3,852 28.8%	2,833 27.0%	2,793 24.8%
Industry Users	1,413	1,669	1,870	1,961	1,529	1,619
Ext. Academic Users	1,060	1,295	1,365	1,531	1,064	964
Avg Monthly Users	4,429	4,911	5,001	5,292	3,654	4,381
New Users Trained	4,116	4,563	4,981	5,194	2,813	4,414
Facility Hours	909,151	939,230	1,006,764	1,149,788	767,255	967,297
Ext. Facilities Hours	173,511 19.1%	191,494 20.4%	228,441 22.7%	298,986 26.0%	197,368 25.7%	242,926 25.1%
Hours/User	83	75	77	86	73	86
Total User Fees	\$34.3M	\$37.5M	\$40.5M	\$43.7M	\$29.4M	\$39.7M
\$/Hour	\$38	\$40	\$40	\$38	\$38	\$41

# NNCI Users & Hours: Years 1-6



Year 4: October 2018 – September 2019

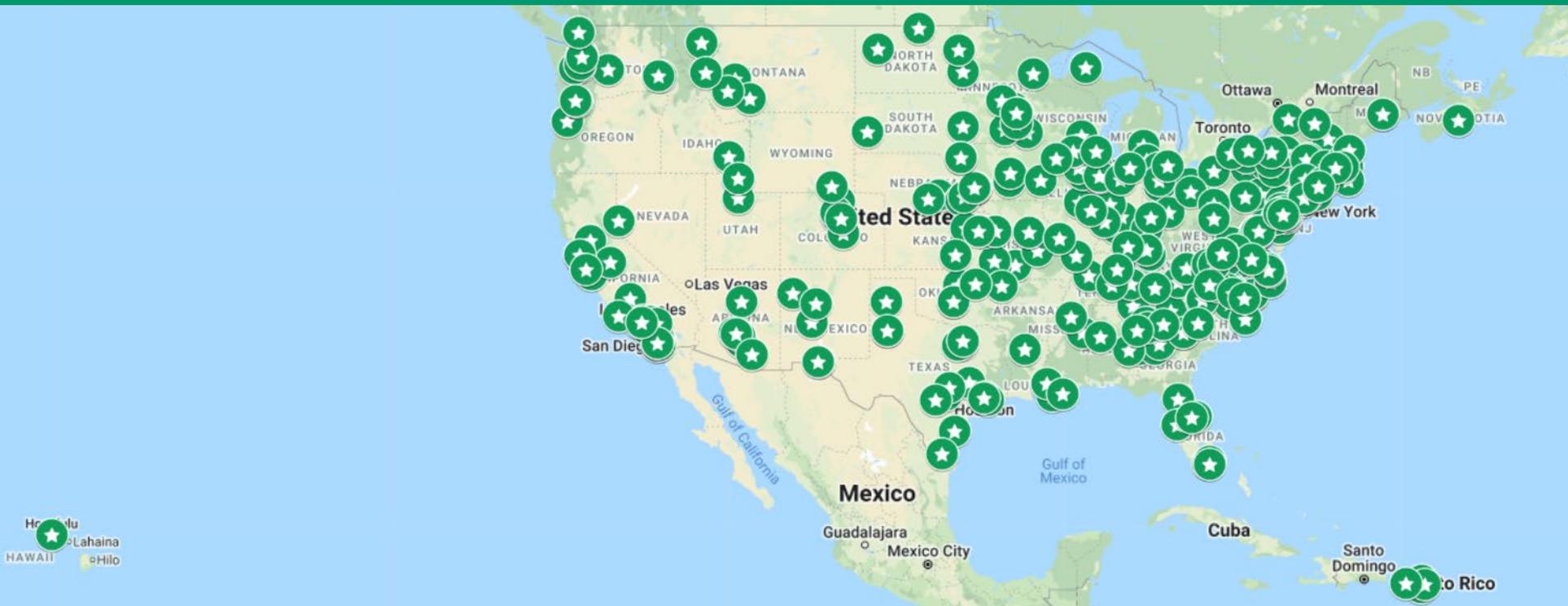
Year 5: October 2019 – September 2020

Year 6: October 2020 – September 2021

# NNCI Year 6 US Academic Institutions (198)



# NNCI Years 1-5 US Academic Inst. (370)

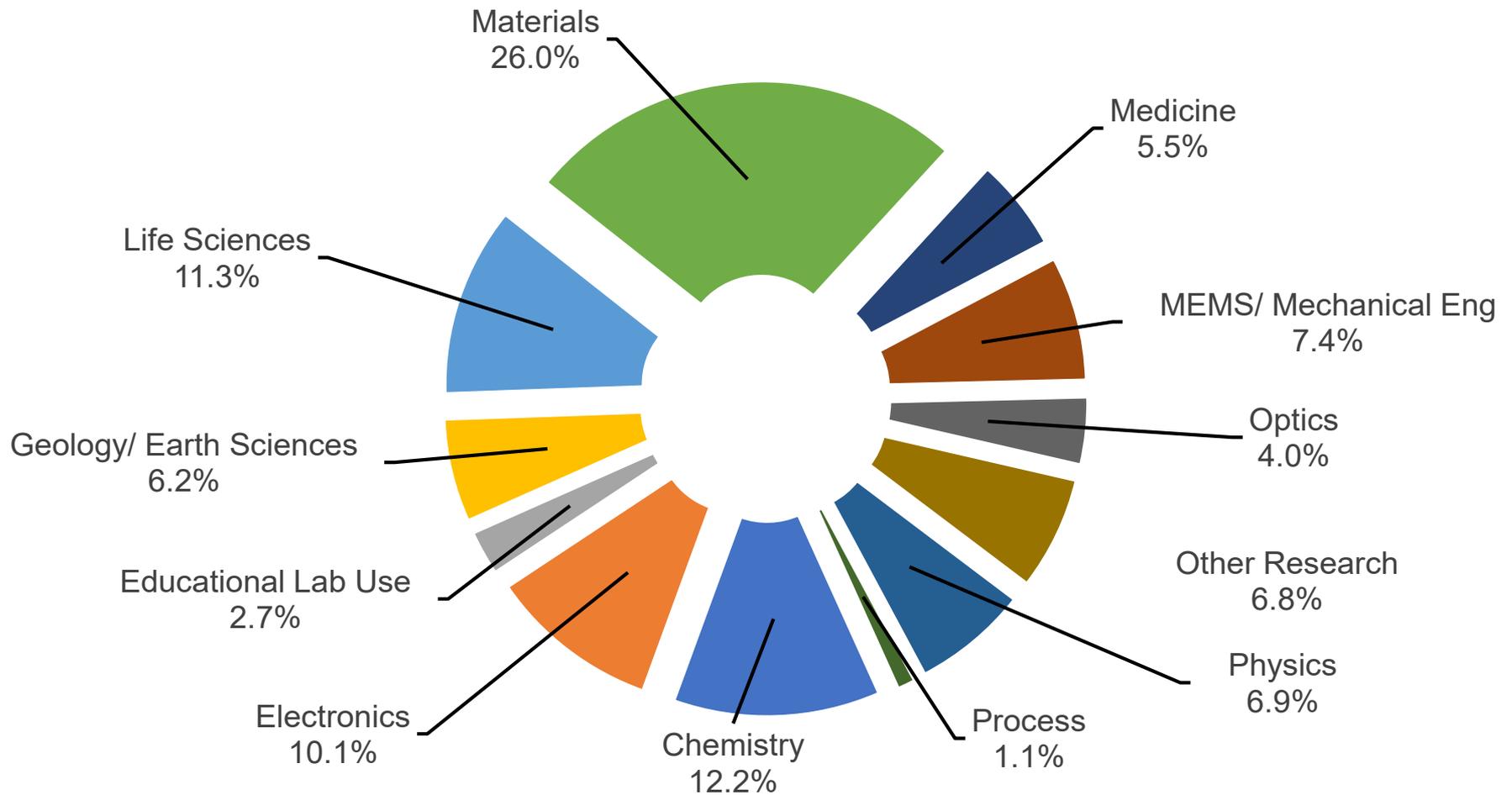


- Located in 49 states (all but Alaska) plus Puerto Rico
- 131 of the 146 (90%) R1 institutions
- 65 of the 133 (49%) R2 institutions
- 174 (47%) non-R1/R2 institutions
- 76 (21%) serving under-represented populations

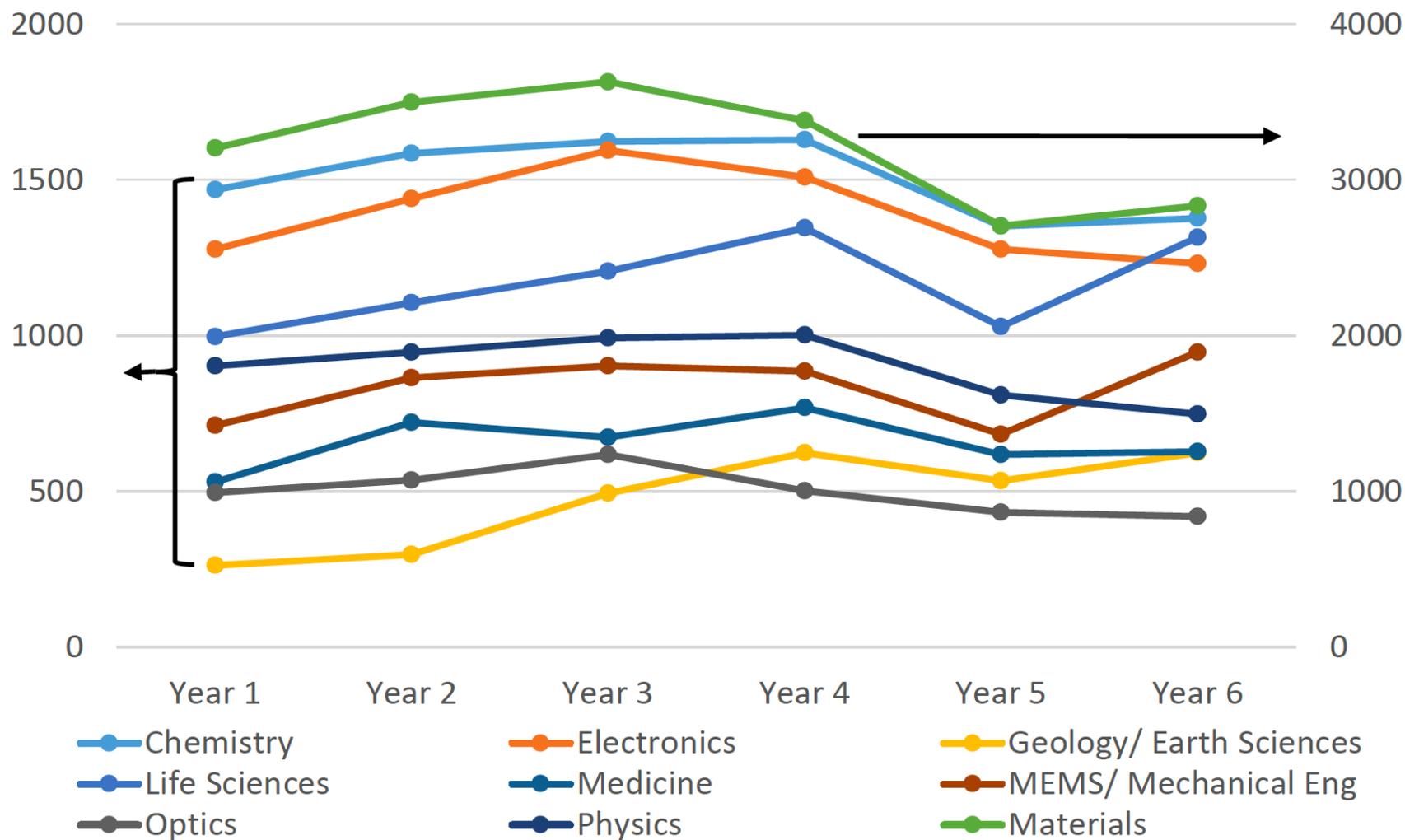
# NNCI Years 5-7 – 6 Months Data Comparison

	<b>Year 5 6 months 10/2019-03/2020 “Pre-Closure”</b>	<b>Year 6 6 months 10/2020-03/2021 “Post-Closure”</b>	<b>Year 7 6 months 10/2021-03/2022 “Recovery”</b>
Unique Facility Users	9,328	7,535	9,208
Unique External Users	2,451 / 26.3%	1,764 / 23.4%	2,157 / 23.4%
Industry Users	1,297	1,073	1,244
Ext. Academic Users	937	533	730
Other External Users	217	158	183
Average Monthly Users	4,999	4,037	4,766
New Users Trained	2,130	1,762	2,435
Facility Hours	505,830	440,011	517,130
Ext. Facilities Hours	128,856 / 25.5%	110,978 / 25.2%	122,076 / 23.6%
Hours/User	54	58	56
Total User Fees	\$19.0M	\$18.1M	\$21.5M

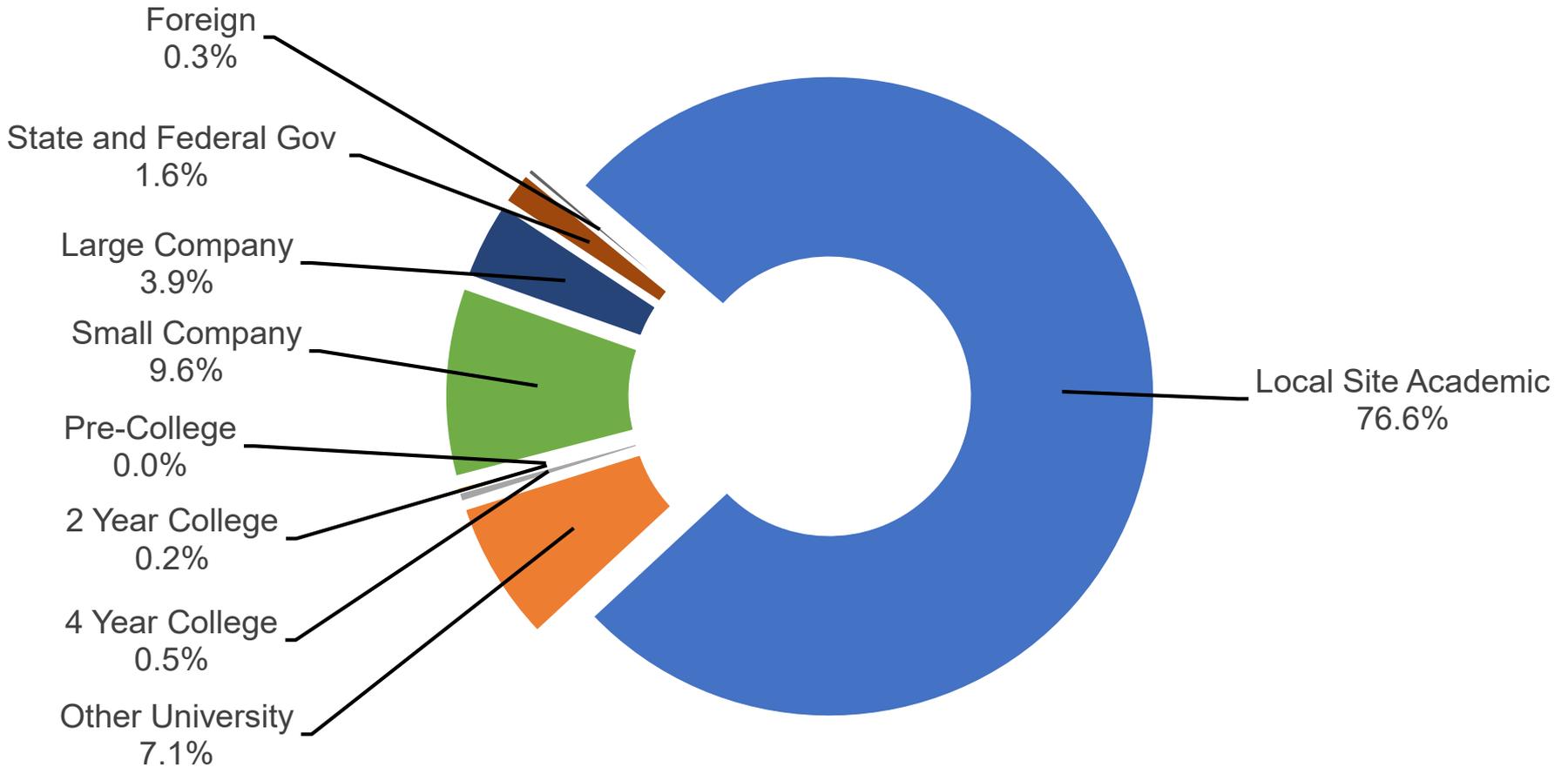
# NNCI Users by Discipline – Year 7



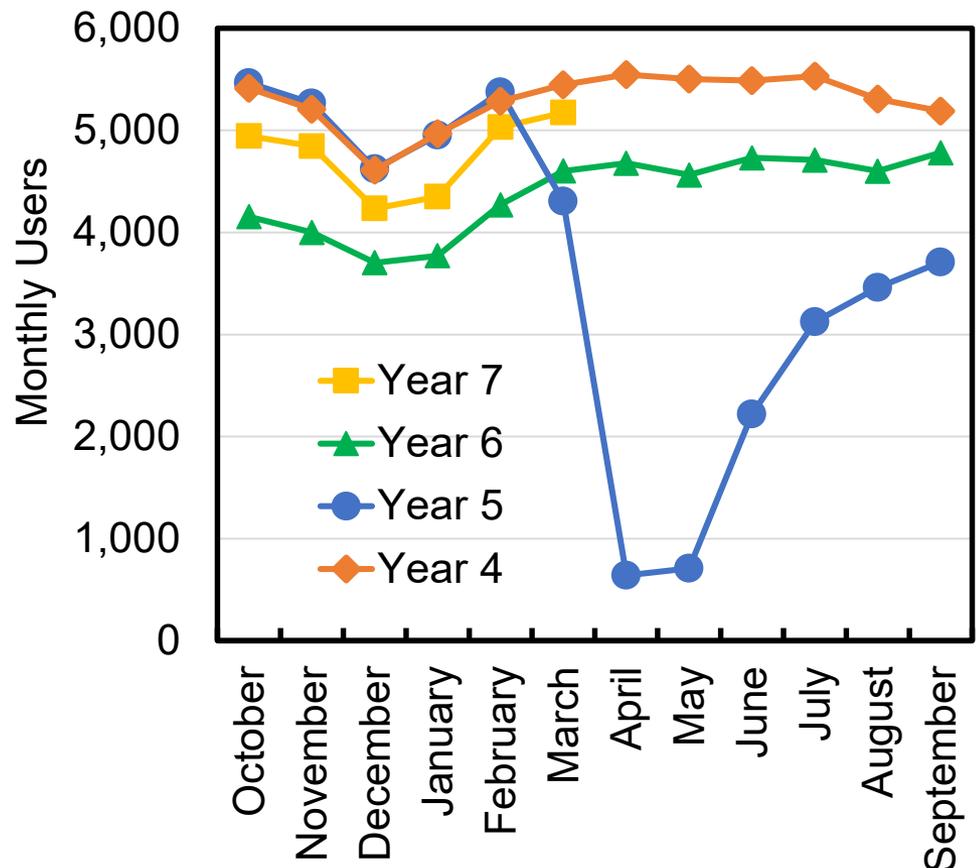
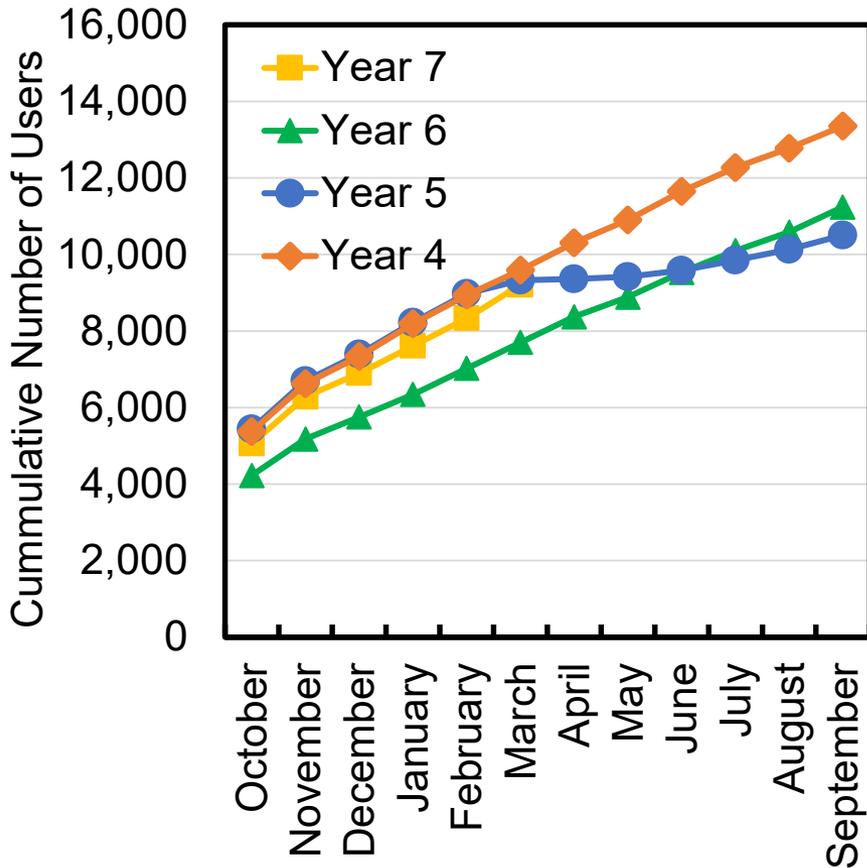
# NNCI Users by Discipline – Years 1-6



# NNCI Users by Affiliation – Year 7



# NNCI Users: Years 4-7



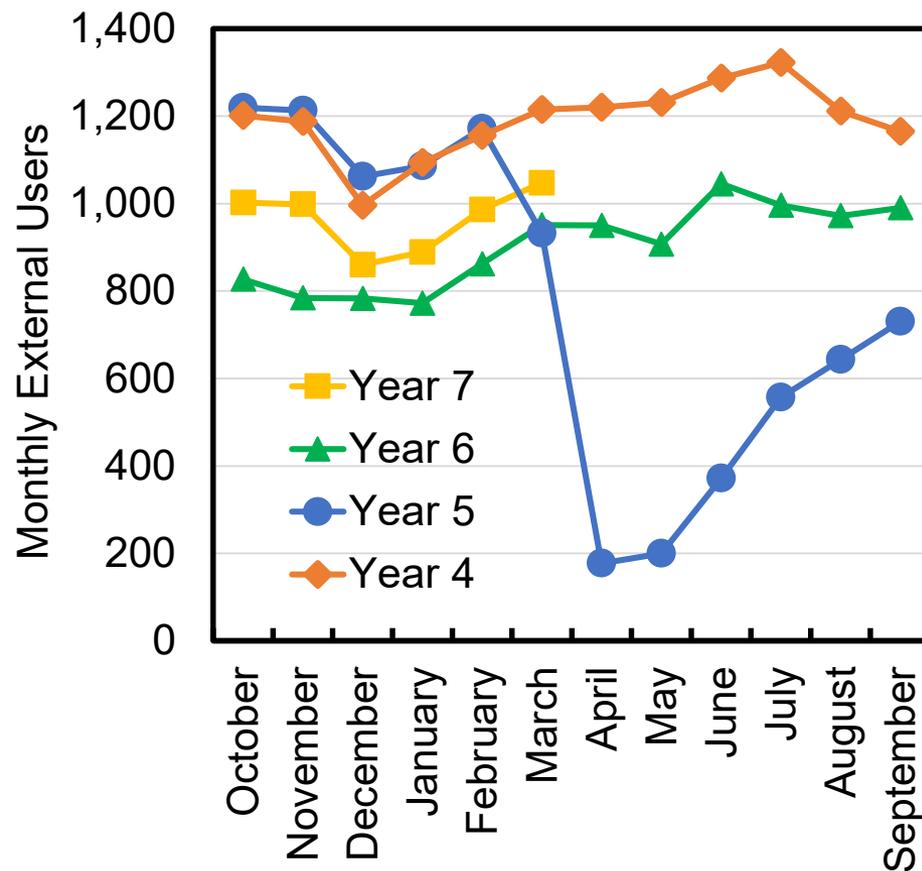
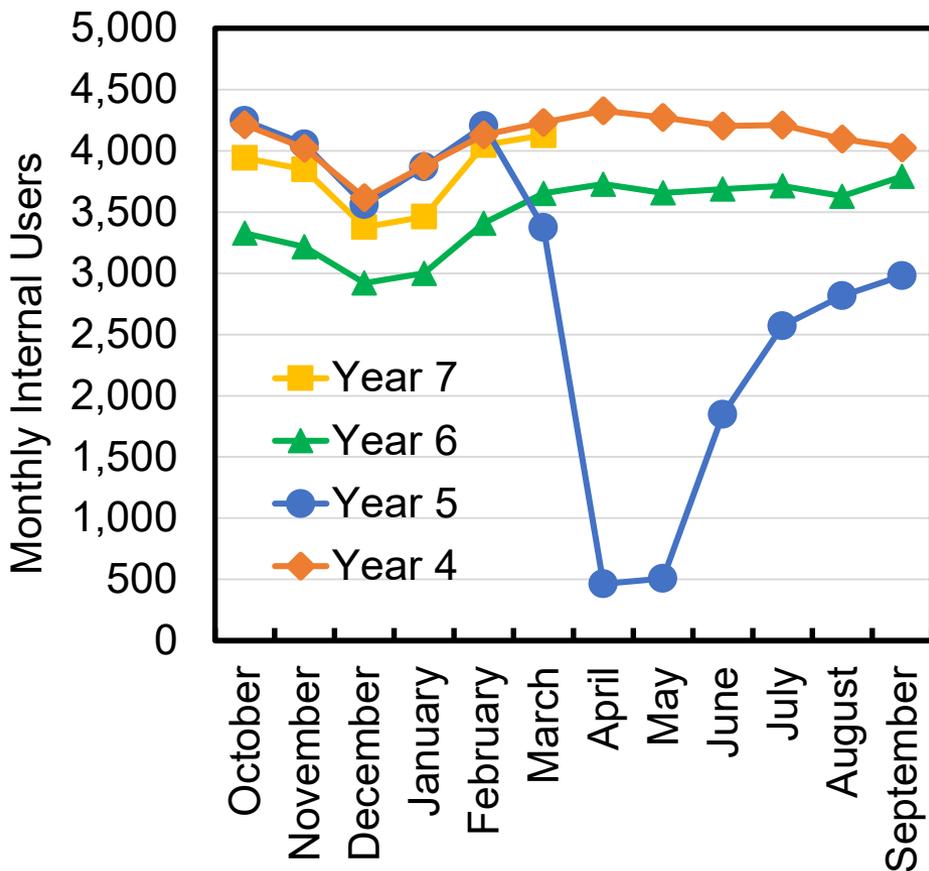
Year 4: October 2018 – September 2019

Year 5: October 2019 – September 2020

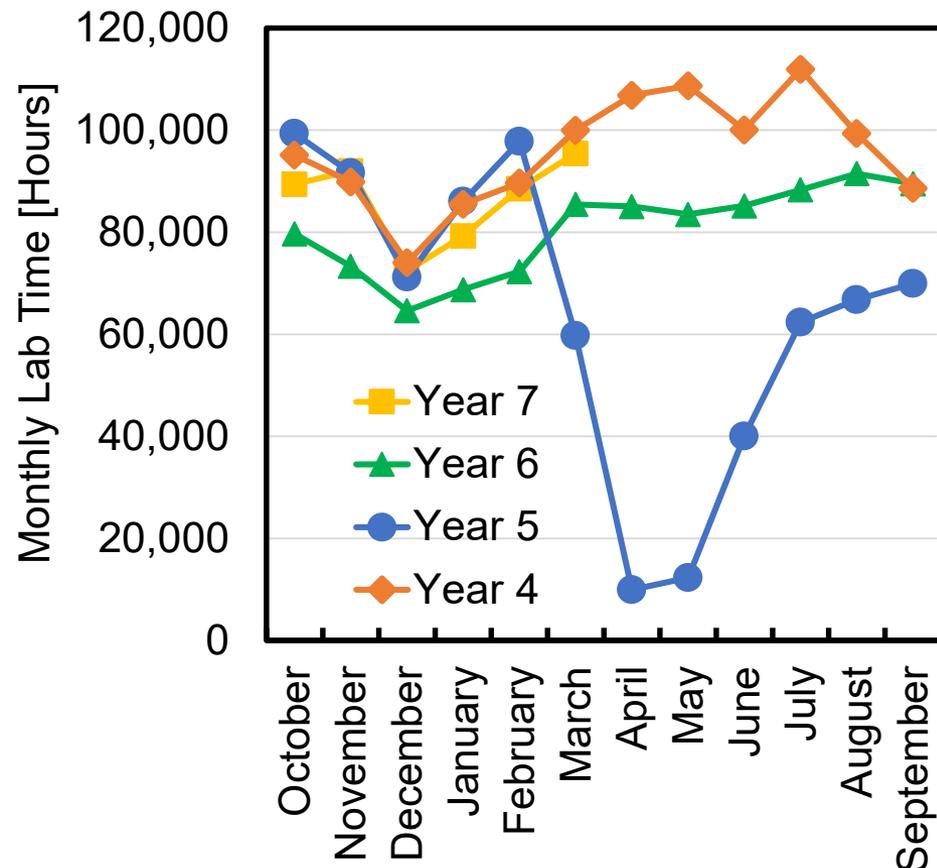
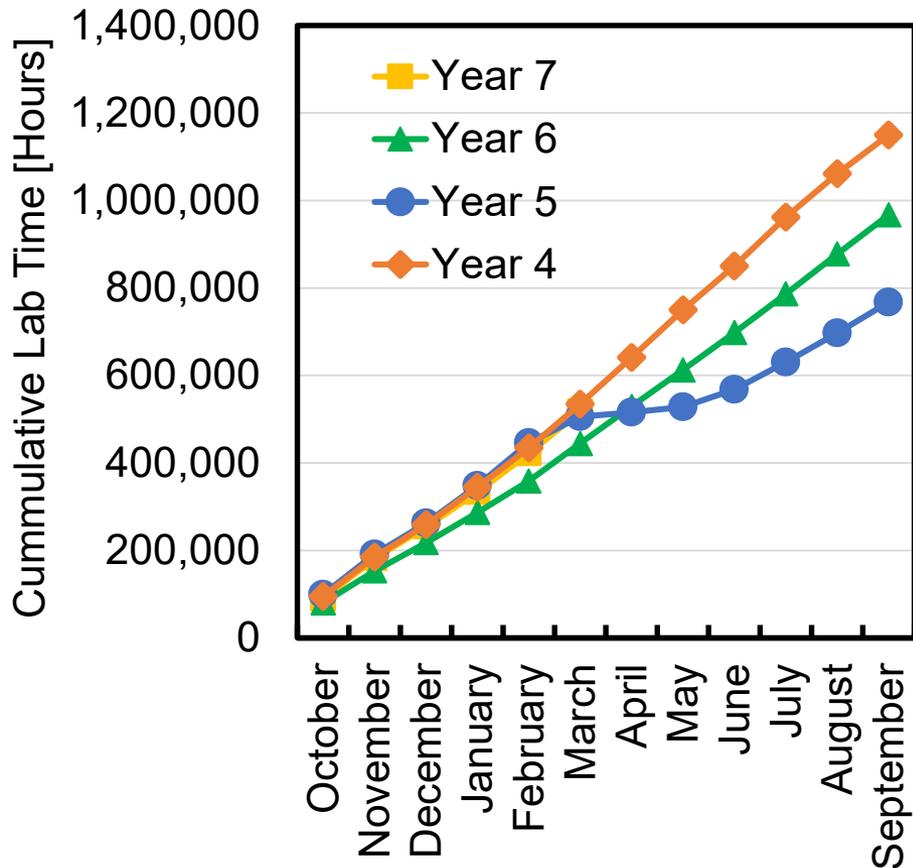
Year 6: October 2020 – September 2021

Year 7: October 2021 – September 2022

# NNCI Internal vs. External Users: Years 4-7



# NNCI Lab Time: Years 4-7



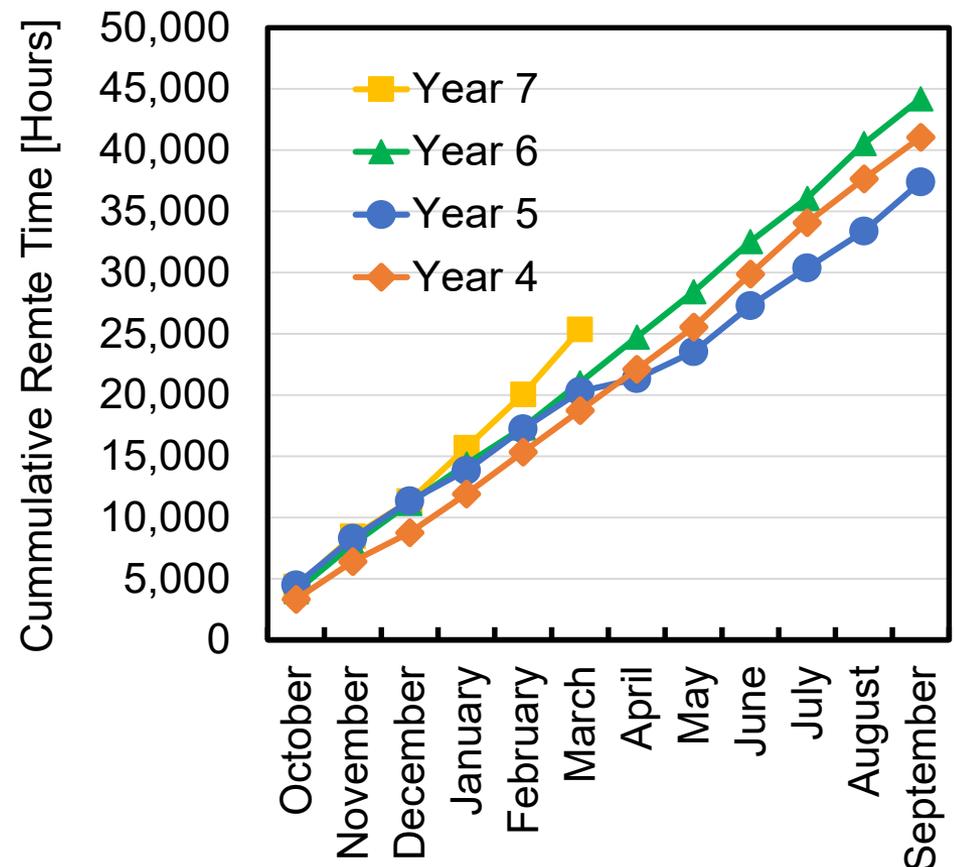
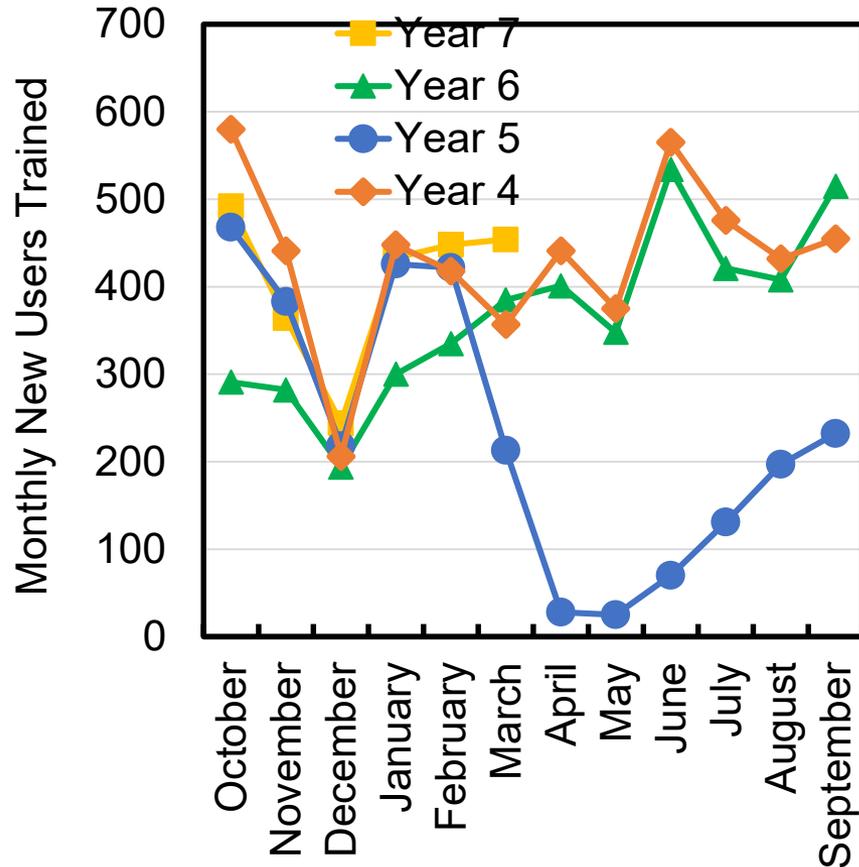
Year 4: October 2018 – September 2019

Year 5: October 2019 – September 2020

Year 6: October 2020 – September 2021

Year 7: October 2021 – September 2022

# NNCI New Users & Remote Work: Years 4-7



Year 4: October 2018 – September 2019

Year 5: October 2019 – September 2020

Year 6: October 2020 – September 2021

Year 7: October 2021 – September 2022

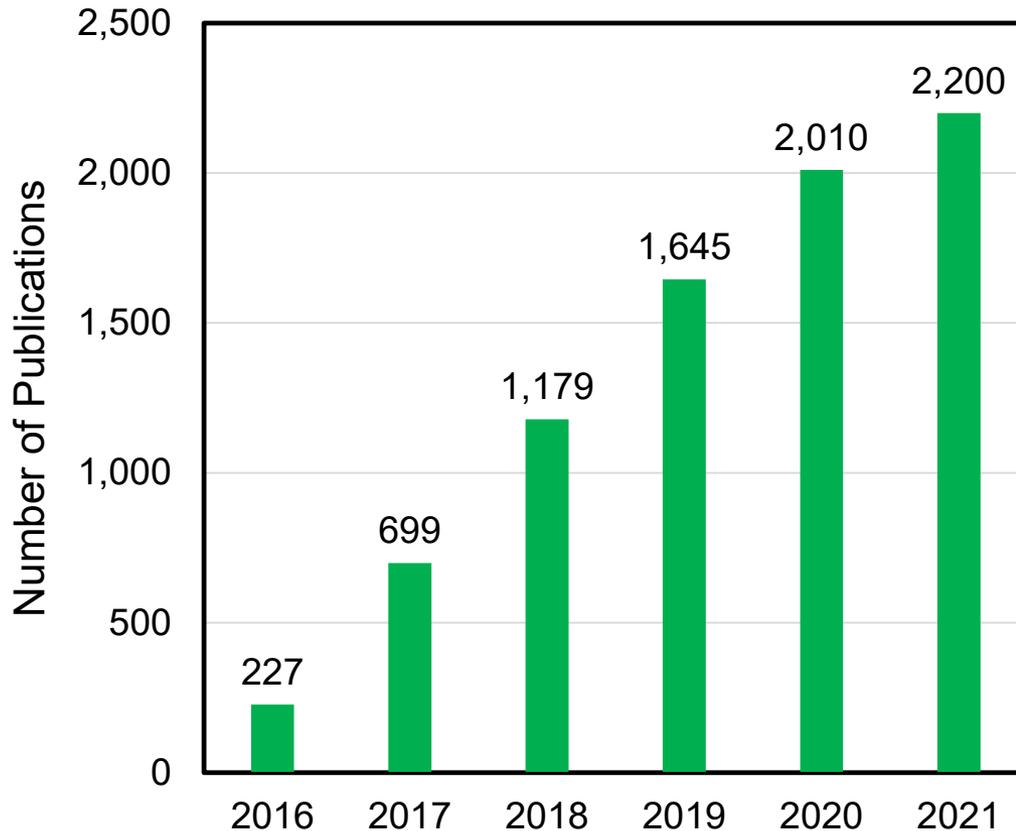
# NNCI Impact

- Scholarly Impact - Publications
  - NSF award citations
- Degrees Awarded to NNCI Users
- Supported Major Centers
- Regional Nano Networks

# NNCI Impact – Publications CY 2018-2020

Publication Type	CY 2018	CY 2019	CY 2020
Internal User (Site) Papers	2,775	2,761	2,761
External User Papers	357	293	323
Internal User Conference Presentations	1,160	1,069	<b>543</b>
External User Conference Presentations	124	62	<b>68</b>
Books/Book Chapters	41	39	19
Patents/Applications/Invention Disclosures	563	690	626
<b>Total</b>	<b>5,020</b>	<b>4,914</b>	<b>4,293</b>

# NNCI Impact – Pubs with NNCI Acknowledgement



\*Through 01/13/2022

# Degrees Awarded to NNCI Users

Fall 2020 – Summer 2021; 13/16 Sites Participating

Academic Department	BS	MS	PhD	Other	Total
Aerospace Engineering	3	3	3	0	9
Biomedical Engineering	24	27	33	3	87
4. Chemical Engineering	37	37	90	0	164
Civil and Environmental Engineering	6	14	21	0	41
1. Electrical and Computer Engineering	50	115	88	1	254
Industrial Engineering	3	0	1	0	4
2. Materials Science and Engineering	25	106	101	0	232
3. Mechanical Engineering	31	64	79	0	174
Nanoengineering	4	25	17	1	47
Nuclear Engineering	0	2	4	0	6
Biology	10	1	7	0	18
5. Chemistry and Biochemistry	17	19	78	2	116
Earth and Atmospheric Sciences	0	1	7	0	8
6. Physics	23	12	62	0	97
Nanoscience	0	5	7	0	12
Computer Science	4	12	1	0	17
Medical School	1	2	3	2	8
Other	22	26	39	11	98
<b>Total</b>	<b>260</b>	<b>471</b>	<b>641</b>	<b>20</b>	<b>1,392</b>

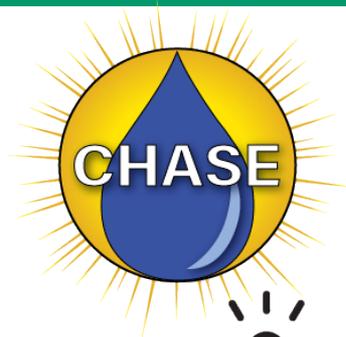
# NNCI Impact – New Research Centers

41 Reported in Year 5, incl.

- 13 NSF ERC, 3 NSF STC, 7 NSF MRSEC, 1 NSF MIP, 3 DoE EFRC, 5 NIH, 1 SRC, 1 NIST

18 New in Year 6, incl.

- 3 NSF STC
- NSF IUCRC
- NSF Research Traineeship (NRT)
- NSF Convergence Accelerator
- DoE Industrial Assessment Center
- DoE Energy Innovation Hub



# NNCI Regional Nano Networks

**7 Regional Networks  
with almost 100 Partners**



# NNCI Programs

- Subcommittees & Working Groups
- Research Communities
- NNCI Seminar Series
- NNCI User Survey
- NNCI Image Contest

# Sub-Committees & Working Groups

## Sub-Committees

- 1. Diversity**  
Bill Wilson (CNS)
- 2. Metrics & Assessment**  
Christian Binek (NNF)
- 3. Global and Regional Interactions**  
Vinayak Dravid (SHyNE), Yuhwa Lo (SDNI)
- 4. Research and Funding Opportunities**  
Chris Ober (CNF), Jim Cahoon (RTNN)
- 5. Nanotech Infrastructure of the Future**  
Debbie Senesky (nano@stanford)
- 6. Building the User Base**  
Shyam Aravamudhan (SENIC)

## Working Groups

- 1. Equipment Maintenance**  
Jeremy Clark (CNF)
- 2. Environmental Health & Safety**  
Andrew Lingley (MONT)
- 3. Vendor Relations**  
Charles Veith (MANTH)

- 4. E-Beam Lithography**  
Devin Brown (SENIC), Stanley Lin (Stanford)
- 5. Etch Processing**  
Vince Genova (CNF)
- 6. Photolithography**  
Pat Watson (MANTH)
- 7. Atomic Layer Deposition**  
Michelle Rincon (Stanford), Mac Hathaway (CNS)
- 8. Imaging and Analysis**  
David Bell (CNS)
- 9. Workforce Dev. and Community Colleges**  
Ray Tsui (NCI-SW)
- 10. K-12 and Community**  
Jim Marti (MINIC)
- 11. Assessment & Evaluation**  
Quinn Spadola (SENIC)
- 12. Technical Content Development**  
Maude Cuchiara (RTNN)
- 13. Societal and Ethical Implications**  
Jamey Wetmore (NCI-SW)
- 14. Innovation and Entrepreneurship**  
Matt Hull (NanoEarth)

# NNCI Research Communities

Research Communities are outward facing helping to develop products that benefit the larger scientific and engineering communities; activities may include

- NNCI-sponsored symposia/workshops/webinars
- Road-mapping exercises
- Identifying future infrastructure needs

Research Community	Leader(s)	Participants
Nanotechnology Convergence	Jacob Jones (RTN)	NCI-SW, SDNI, KY-MMNIN
Nano Earth Systems	Trevor ... (NCI-SW), ... yama (NanoEarth), and ... Dickensheets (MONT)	nano@stanford
Nano-Enabled Intern...	Mark Allen (MANTH)	CNF, SENIC, NNF, KY-MMNIN
Storm Quantum	Andrew Cleland (SHyNE), Robert Westervelt (CNS), and Steven Koester (MINIC)	TNF, NNF, NNI, MONT, RTNN, SENIC, CNF
Understanding the Rules of Life	Vinayak Dravid (SHyNE)	MINIC, NNI, MONT, CNF, MANTH, SENIC
Microelectronics - Semiconductors	Sanjay Banerjee (TNF), Philip Wong (nano@stanford)	NCI-SW, SENIC

**More information: Tomorrow, Oct. 21, 11:15 – 12:15 EDT**



# 2021 NNCI User Survey

- Responses: **950**  
Affiliations: 67% NNCI university; 10% non-NNCI academia; 19% Industry; 2% Government
- How did you find out about NNCI facility?
  1. Current user; 2. Referral from current user; 3. University webpage;
  4. Web search; 5. Direct contact by facility
- Overall satisfaction with NNCI facility: **92.5%** Agree or Strongly Agree
- NNCI facility had a positive impact on my work: **94.5%** Agree or Strongly Agree
- Would you recommend the NNCI facility to a colleague? **97.5%** Yes
- *170+ suggestions were received and provided to the sites*
- Ratings are slightly lower than in previous years – COVID effect?

# 2021 NNCI User Survey – Some Praises

- *The staff at ... are excellent and deserve high praise and raise. They are very considerate when interacting with students and faculty and I really appreciate their expertise.*
- *I represent a small business located near the NNCI user facility; we simply could not execute at least 50% of our current federal and commercial contracts without the support of the technology and expertise that is made available by this facility. The value of the ... to our business (both commercial endeavors and our published research) cannot be overstated!*
- *The staff at this facility works very hard to keep the tools and space functional and accessible. I have been very impressed with the dedication and work ethic of the staff.*
- *It has been a pleasure working with the staff at ... . They are very responsive and helpful. We have used them for a few years to perform chemical analysis on our products for specific projects. The analysis is performed in a timely fashion, pricing is good, and the reports are thorough. We will continue to utilize the ... and recommend them to others who may have similar needs as well.*

# NNCI Seminar Series



## NNCI Webinar: Innovation and Entrepreneurship

October 12, 2022 | 3:00 p.m. - 4:00 p.m. ET

### Lab-to-Fab: Transitioning from University Cleanrooms to Industrial Prototyping and Low-Volume Production

Miguel Urteaga | Director of Foundry Products and Services  
Teledyne Scientific Company



<https://nnci.net/nnci-events>

# NNCI YouTube Channel

[https://www.youtube.com/channel/UCN1IaymO8KcA\\_fMEB1FhPgQ](https://www.youtube.com/channel/UCN1IaymO8KcA_fMEB1FhPgQ)



National Nanotechnology Coordinated Infrastructure

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## What is the NNCI?

1,666 views • 4 years ago

An introduction to the NSF-funded National Nanotechnology Coordinated Infrastructure, a network of user research facilities.

Uploads ▶ PLAY ALL



"Lab-to-Fab" (Miguel Urteaga)  
48 views • 3 days ago



"Theoretical Exploration of Energy Efficient Spintronics..."  
49 views • 2 weeks ago



"Virtual Immersive Worlds for Experiential Learning of..."  
63 views • 1 month ago



"Science Policy Around the World in 2022"  
25 views • 4 months ago

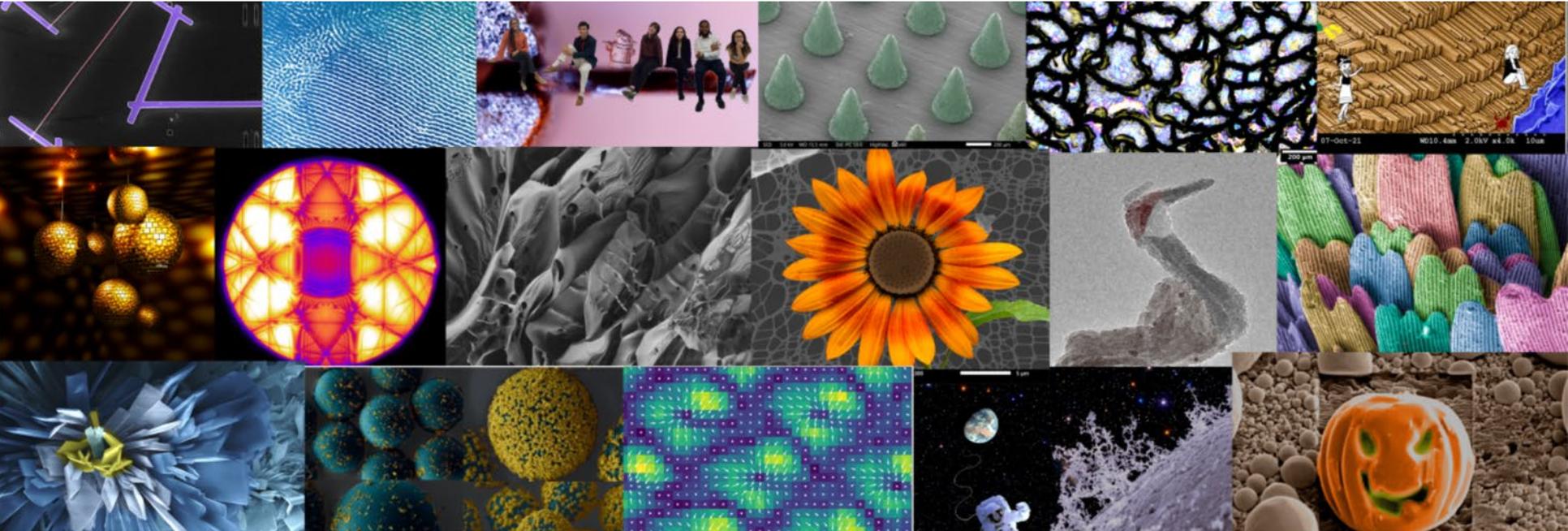


"Semiconductor Workforce Development through..."  
120 views • 5 months ago



"From Wow to Yuck to Meh: The Normalization of Nano..."  
98 views • 7 months ago

# 2022 - Plenty of Beauty at the Bottom



**Winners and Honorable Mentions to be announced by  
AD Education & Outreach!**

# Opportunities

## Are Abundant

- CHIPS and Science Act
- National Quantum Initiative
- National Nanotechnology Initiative
- COVID-19 pandemic and the growth of POC testing

## Communicate and Build on Our Strengths

- NNCI is diverse
- NNCI is flexible
- NNCI educates
- NNCI brings people together
- Micro and Nano are everywhere today!

# Site Reports & Questions

1. What new program have you introduced recently? What issue/objective does this program address? What are the benefits of this program?
  2. What impactful research emerged from your site during this past year? How can the results of this research be translated and applied?
  3. What steps has your site taken to expand access of your site facilities and expertise to underrepresented students, faculty, and research disciplines?
  4. What steps has your site taken to reduce the environmental impact of your facilities? How are you tracking these impacts?
  5. Do you see potential to accelerate your site's growth? If so, what opportunities do you see? If not, what challenges do you face?
  6. How do you measure economic or commercial impact of your site?
- Site Supplemental Material: <https://bit.ly/3y9DI5G>

# Thank You!



<http://www.nnci.net>

# Academic Infrastructure Challenges

- **Aging cleanroom infrastructure**
  - Many tools are 10-20+ years old, not vendor supported anymore, and not industry standard
  - Most academic facilities have limited 200mm plus capabilities
  - **Need to invest into upgrading toolsets**
- **Staffing**
  - University salary structure makes it difficult to retain staff
  - Staffing (and tool) cost are sometimes overlooked when building a new academic nanotechnology facility
  - **Need to invest into staff**
- **Limited possibilities to support translational activities**
  - "Open" vs. "controlled" tools; limited "standard" processes
  - **Need for controlled process modules**
  - **Need to bridge the gap between research & manufacturing**