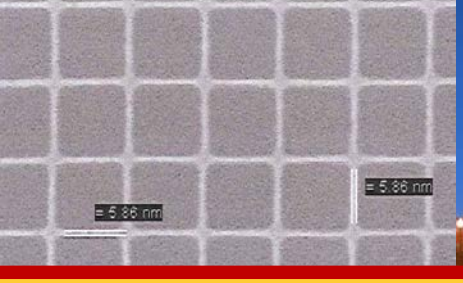




Minnesota Nano Center

NDSU Packaging Center

UNIVERSITY OF MINNESOTA
Driven to Discover℠

NDSU NORTH DAKOTA STATE UNIVERSITY

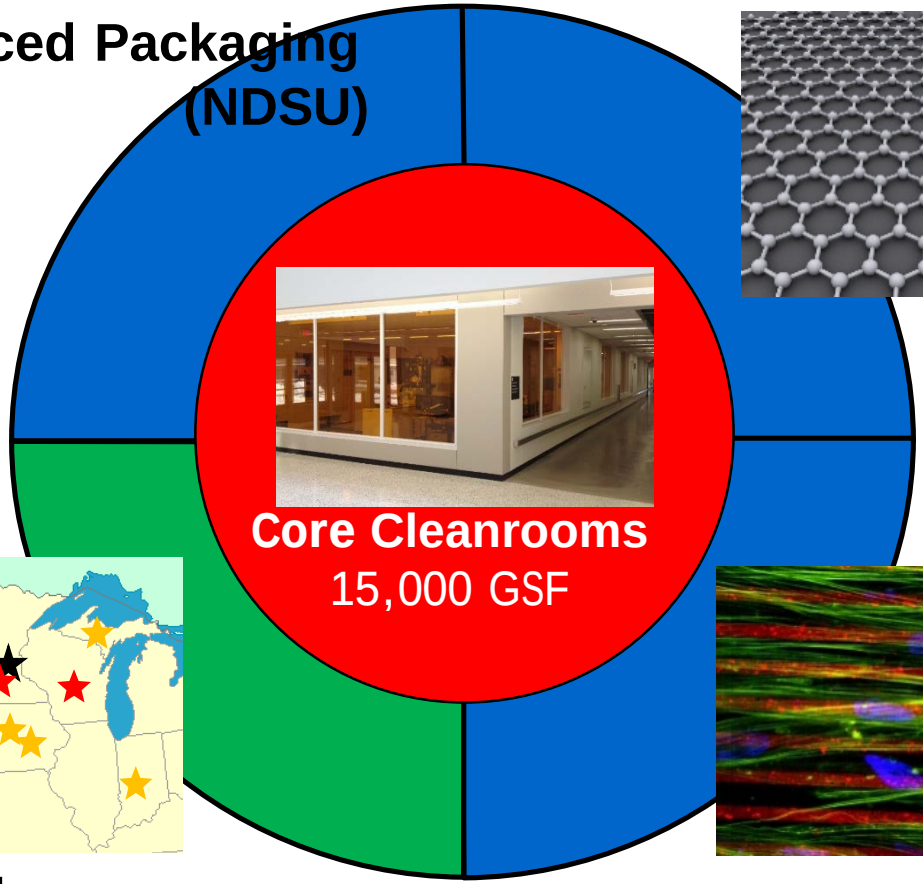
Midwest Nano Infrastructure Corridor

Steve Campbell, Greg Cibuzar, and Jim Marti

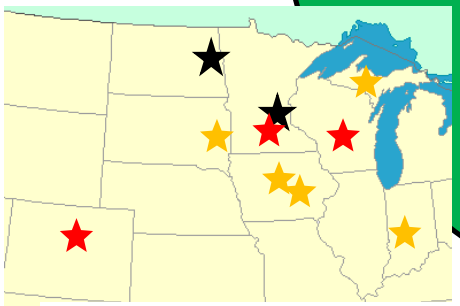
University of Minnesota

October 24, 2019

Midwest Nano Infrastructure Corridor



2D Material Integration (UMN)



Outreach (UMN and NDSU)

Bio-nano (UMN)

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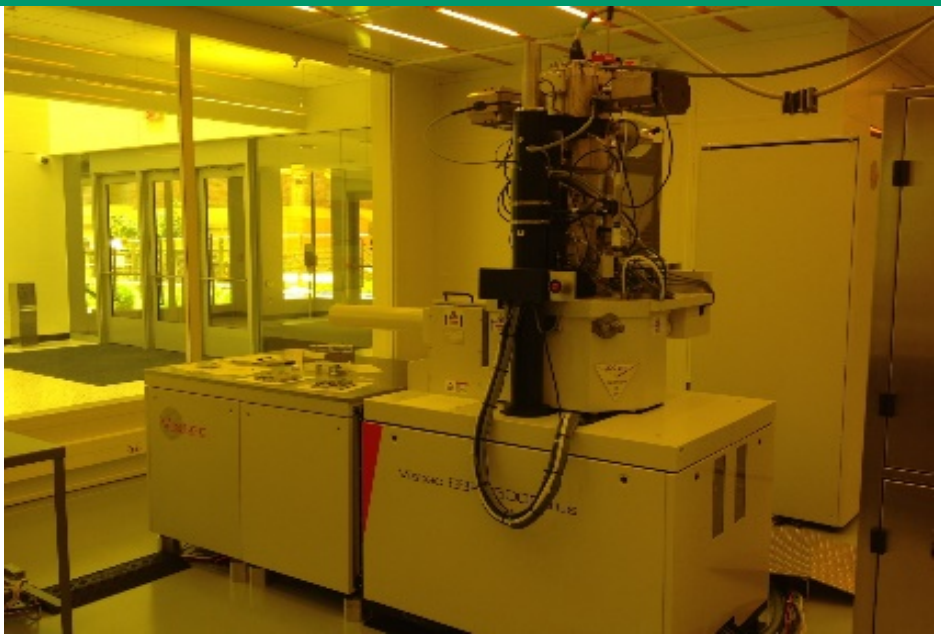
MINIC: Core Lab Flagship Equipment



Advanced Deposition

- Thermal ALD for oxides
- PE-ALD for nitrides and metals
- PECVD and HDP-PECVD

Lithography

- 6 nm, 50 MHz EBL
- Direct write optical
- i-line stepper
- Three contact printers

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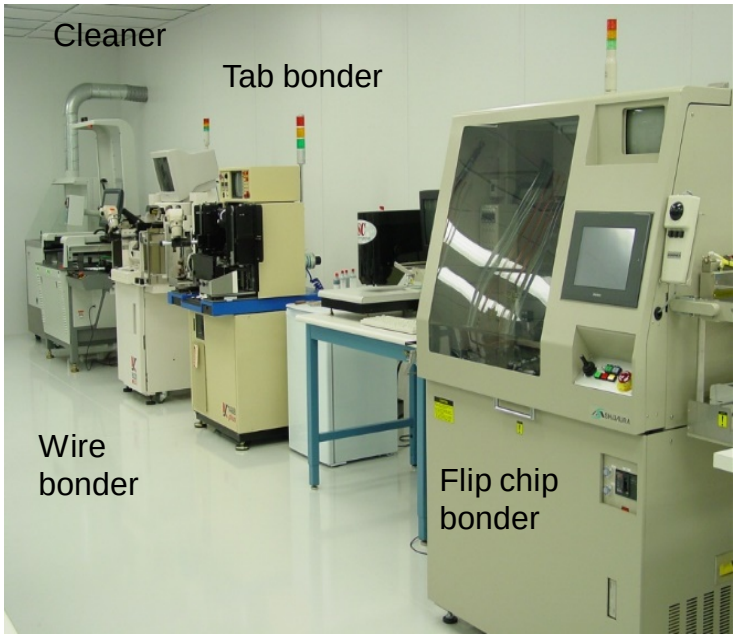
MINIC: Key Focus Area Capabilities

Nanobio
Nanparticle sizing
Cell/tissue culture
Confocal/fluorescence
BSL2 hoods

2D Process Integration
Dual tube deposition
Aligned transfer
Web-based resource: 40k hits



Advanced Packaging
RFIC packaging
Multichip packaging
X-ray imaging
Environmental testing

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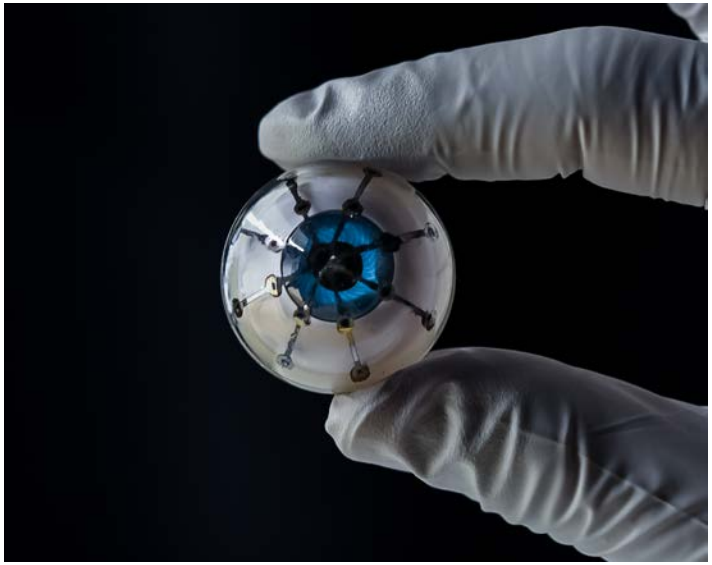
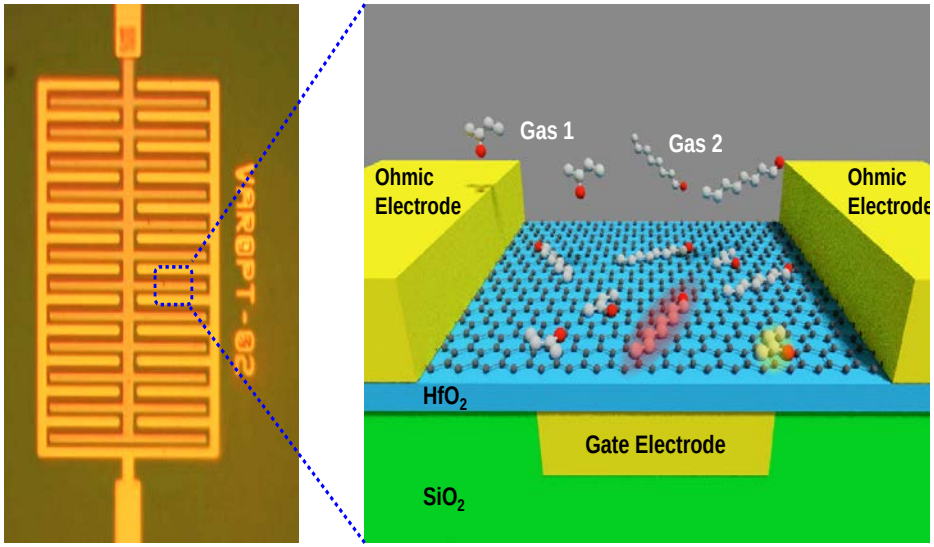
MINIC: Year 4 Research Highlights



McAlpine Group (ME, UMN)
3D printed bionic eye that can incorporate active elements.



Boston Scientific / Koester Group (ECE, UMN)
Multiple-finger graphene varactor for wireless *in-vivo* sensing.

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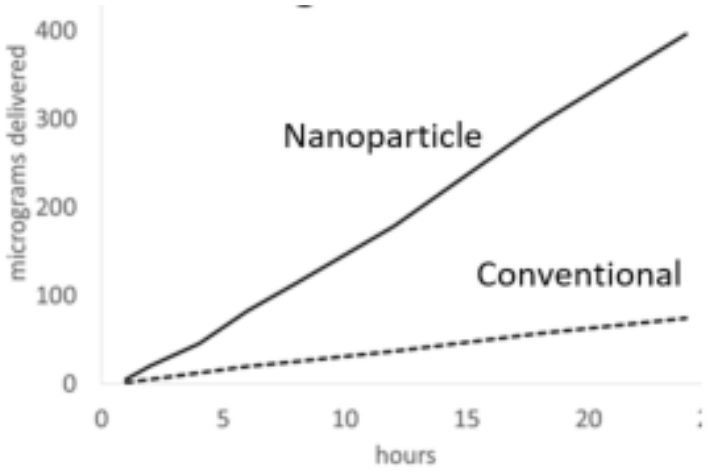
MINIC: Year 4 Research Highlights



Dynation LLC
Transdermal drug delivery is dramatically accelerated by nanoparticle attachment

Starkey Hearing Technologies
Test modules in waffle pack for thermal shock testing

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MINIC: Year 4 Education and Outreach

Intro to Nano Class: a hands-on class for grades 5-9

Survey results:

The Intro to Nano Class..	Not at all	Slightly	Moderately or a Lot
Increased my knowledge of nanotechnology.	2%	5%	93%
Increased my interest in science and engineering.	5%	33%	63%
Helped me understand the science behind nano-technology.	0%	5%	95%
Helped me understand how nanotechnology relates to the real world.	0%	7%	93%
Increased my interest in studying science and engineering in college.	12%	21%	67%
Programs Assessed	3/20/19, 7/18/19		
Total Students	43		

1500 people were reached by all outreach activities between 10/1/18 and 9/30/19.

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MINIC: Year 4 Focus Area Short Courses

2-day workshops for undergrads, grad students, faculty, and industry

	2D	Nanobio
The talks were relevant and interesting	3.7 / 4.0	3.5 / 4.0
The length of the session was appropriate	3.3 / 4.0	3.4 / 4.0
Would recommend Workshop to others	**3.6 / 4.0**	**3.6 / 4.0**

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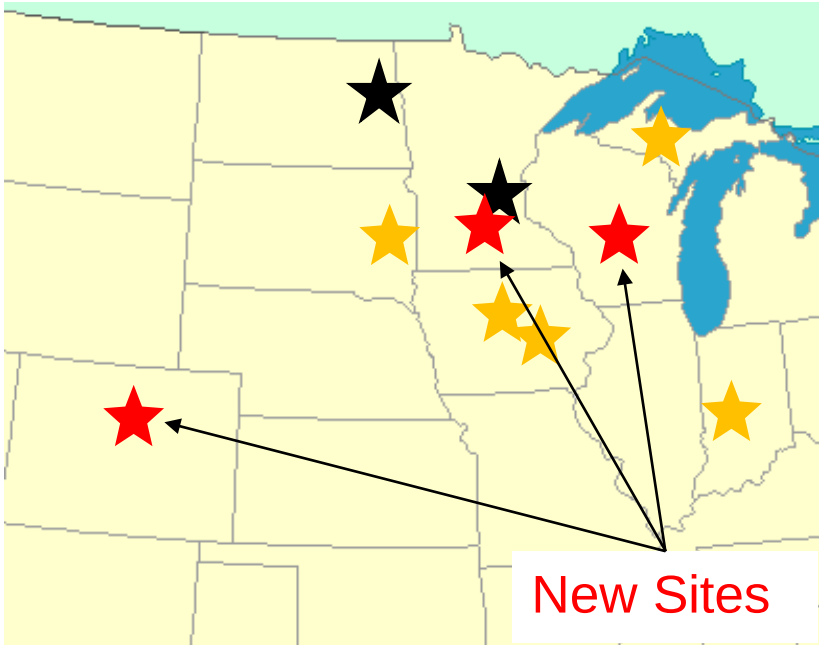
MINIC: Education and Outreach - NNLA



- Not all micro/nano skilled graduates in the upper Midwest come from the University of Minnesota
- How to support other facilities in the region?
- Added thee new member universities (UC, MNSU, UW)

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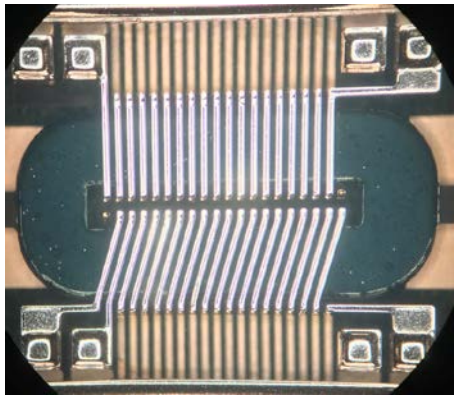
Node Impact: NNCI Year 4

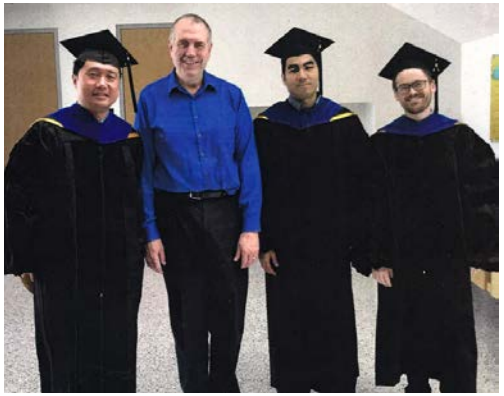
- Enables ~$20M of funded research annually
  - New NIST/SRC center:

SMART Center
Spintronic Materials for Advanced InfoRmation Technologies

External user increase of 130% over pre NNCI level



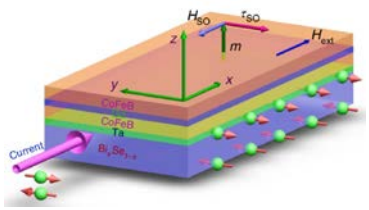
54 industry projects enabled



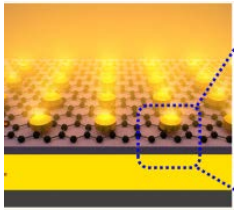
80 theses enabled

Outreach to ~1600 participants

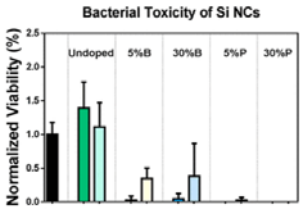
Over 200 papers and conference proceedings:



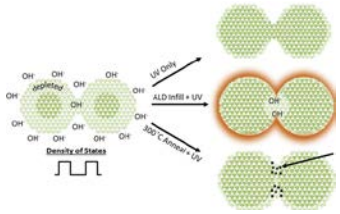
Nature Comm.



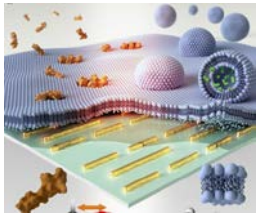
ACS Nano



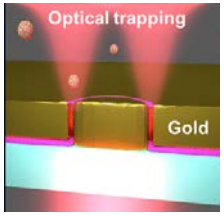
ACS Appl Nano Mat



Nanotechnology

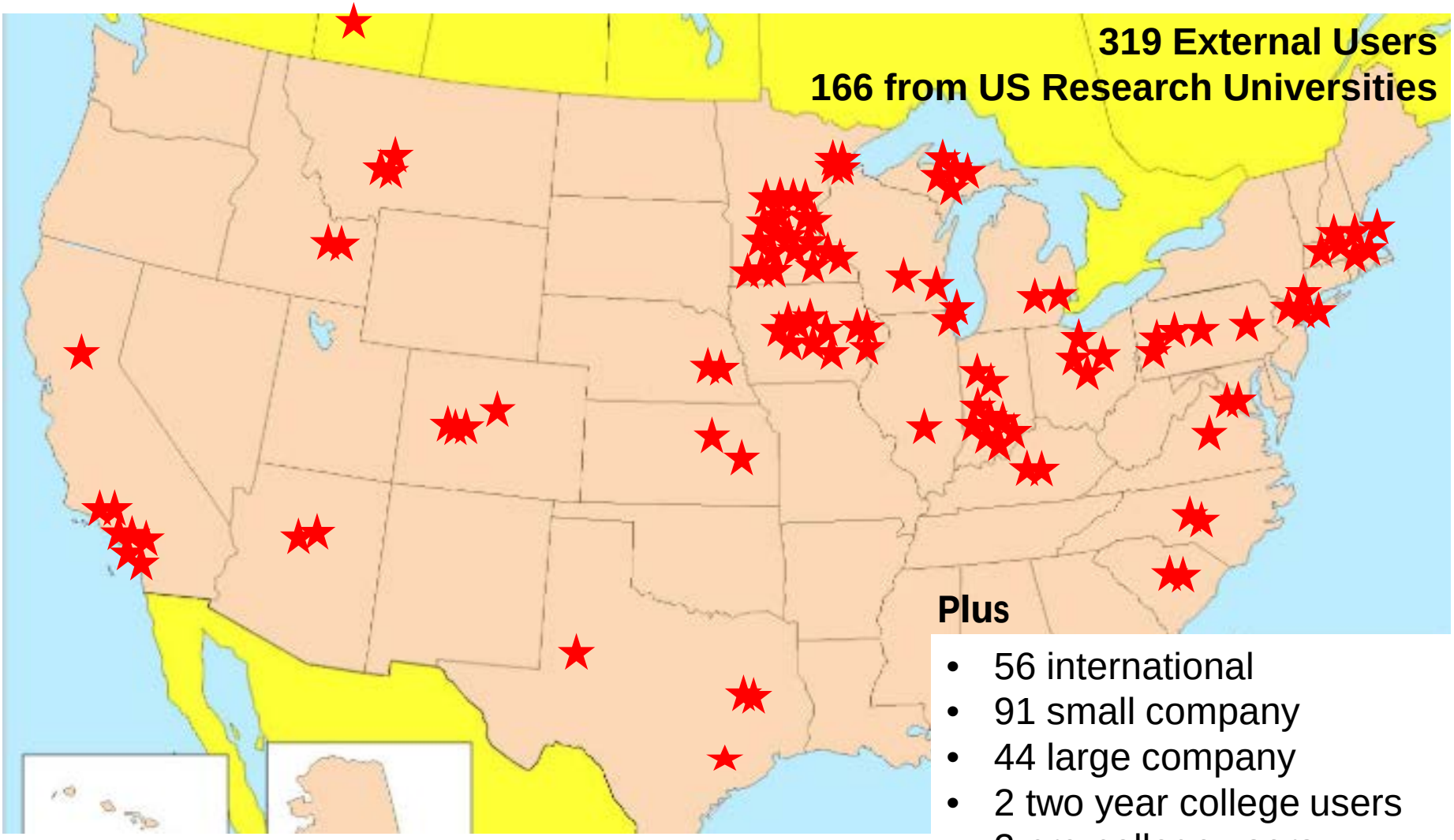


Nature Comm.



Nano Lett.

Node Impact: External Academics (To Date)



Plus

- 56 international
- 91 small company
- 44 large company
- 2 two year college users
- 2 pre-college users
- 2 state/federal govt users

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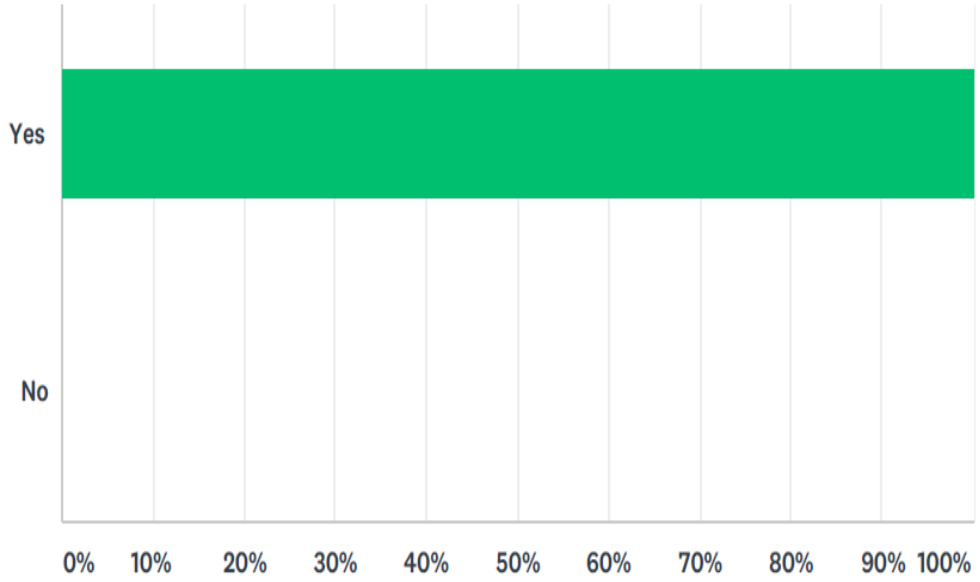
MINIC: Year 4 Self Assessment

- MINIC participates in annual NNCI site user surveys:



99% rate MINIC as **excellent** or **very good**.

100% would recommend MINIC to a colleague.

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MINIC: Network Collaboration

- Metrics Subcommittee activities
  - MINIC, SENIC, TNF, NNF, NanoEarth
  - Ongoing work to develop metrics that quantify the impact of NNCI
  - Just completed academic impact evaluation
  - Currently working on industry impact
- Other activities: Working groups
  - Jim Marti has played key roles in the new GaTech four-node RET proposal and chairs the K-12 Students & Teachers and Community Outreach.
  - Greg Cibuzar co-leads the safety working group and consults with multiple nodes on lab operating software.

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