Mid-Atlantic Nanotechnology Hub (MANTH)

MANTH – Mid-Atlantic Nanotechnology Hub

New Programs And Efforts In NNCI Years 6-10

NNCI Annual Meeting, October, 2020

National Nanotechnology Coordinated Infrastructure

NSF

SINGH Center for Nanotechnology

Mid-Atlantic Nanotechnology Hub

Penn

Community College of Philadelphia

The Next Phase of NNCI at MANTH

As informed by our strategic plan, **our goals** for the next five years are

1. To continue to **grow capacity** to enable the mid-Atlantic nanotechnology community to realize their research goals and fulfill their educational needs;
2. To help **define future directions in nanotechnology** through the synthesis, analysis, dissemination, and encouragement of the efforts of our community;
3. To **deepen education, outreach, and workforce development** programs, providing nano literacy opportunities, hands-on access to tools and technologies, and experiential internship opportunities, that will develop a skilled, knowledgeable, and diverse nanotechnology workforce; and
4. To assist our community through seed grant programs, proposal support, and leveraging regional incubator and investment resources, to **translate research results into innovative, tangible products**

Goal 1: Growing Our Capacity

Things We Will Sustain

- Processes to collect and assess user feedback; adapt as appropriate to best serve users
- Use of our center to foster collaboration
- Outreach to industry as well as external and internal academic users in our region

Things We Will Build

- **Equipment Base:** we will invest in new equipment and expertise/training for staff.
- **Enhanced Analytics on Usage Patterns:** Our ongoing assessment of user activity will allow us to understand future trends in nanotechnology to stay ahead of demand.
- **Continually Improved Onboarding Processes:** While MANTH has streamlined the entry process for new users, we will continue this process with new initiatives, including video training and further simplification of usage agreements.

Goal II: Helping Define Nanotechnology's Future

Things We Will Sustain

- Annual User Meetings
- Network Committee and Working Group Leadership
- Information Dissemination publications and workshops

Things We Will Build

- **Faculty Engagement:** The investments in new nanotechnology faculty and researchers both by Penn and by members of our local academic community will seed vital new ideas we can analyze to understand future trends.
- **Research Communities:** Both participation in and leadership of network-wide *Research Communities* that will greatly enhance intra- and inter-site knowledge transfer
- **Knowledge Generation and Dissemination Events:** On-site and off-site local events, including tours, Research Community symposia, vendor events, and scientific conferences, to inform the external nanotechnology community of current results and trends. We will emphasize including a diverse set of institutions.

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Goal III: Deepening Education and Outreach

We will be sustaining these successful education and outreach programs

Pre-college Students
- Engineering Summer Academy
- NanoDay@Penn
- Elementary School Visits

Community College of Philadelphia Partnership
- CCP Courses in Additive Manufacturing, Intro to Nano
- New curricular addition: Robotics

Undergraduate Experiences
- Research Experience for Undergraduates (we plan to add 2 slots/year to compensate for 2020 cancellation)
- Local College Fieldtrips

Master's Program-level Students
- Graduate Student Fellows Program

and..

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Goal III: Expanding our Community College of Philadelphia Partnership

- Build a paid 15-week summer **internship bridge** for Nanotech-immersed CCP students, beginning with training at the Quattrone Nanofabrication Facility
- Provide summer interns with an initial 1-2 week cleanroom **bootcamp** before beginning internship
- Introduce an **engagement and recruitment** effort that will expand the pipeline of students through a STEM/Nano job shadowing program with MANTH Staff. CCP students enrolled in STEM courses or participating in STEM student clubs will be targeted

Goal IV: Facilitating Nanotechnology Translation

Things We Will Sustain

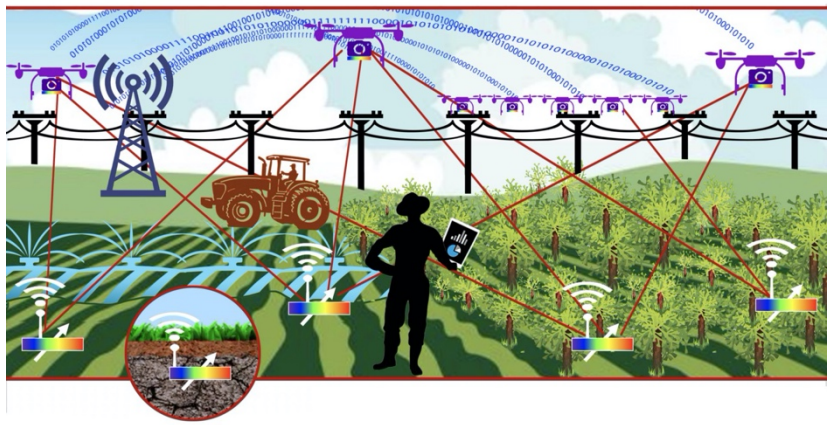
- Innovation Seed Grant Program
- Outreach to Industrial Users and New Commercial Nanotech Ventures
- Leveraging University and other local resources to assist MANTH spinouts from internal and external users

Things We Will Build

- **CLUB Nano:** Simplifying external access using comprehensive access programs
- **Expanded SBIR Proposal Support:** Writing letters of support and assisting in fabrication plans for the small companies using our facilities
- **Industry Programming:** Engaging larger industry users through hands-on boot camp programs as well as symposia that leverage our highly visible event spaces

New Programs: NSF ERC for the Internet of Things for Precision Agriculture (IoT4Ag)

Penn (lead), Purdue, University of California (Merced), University of Florida
Director: Prof. Cherie Kagan



Theme: **IoT4Ag** researchers will create miniature soil-based sensors and swarms of aerial and ground-based robots, find new ways to network them together in communication-constrained environments and develop high-level data science techniques that will allow data from different sensors in the field to be integrated with data from weather reports and commodity markets, synthesizing it into actionable information.

Thrust 1: Agricultural Sensor Systems (Eshani, Rowland)
Thrust 2: Communication and Energy Systems (Allen, Love)
Thrust 3: Decision and Response Systems (Buckmaster, Mangharam)

- Research Community Leadership: **Nano-IoT (**leverage ERC activity)
- Research Community Participation: **Rules of Life**, reflecting the significant number of our users from life sciences and medicine.

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New Infrastructure Synergies Coming at Penn

Vagelos Energy Science And Technology Building

- Enable wet-lab energy research
- Adjacent to Singh Center
- Seamless connection for nano+energy

Tangen Hall

- Incubator and maker spaces
- Student-led ventures
- Penn VentureLab

San Diego Nanotechnology Infrastructure (SDNI)

San Diego Nanotechnology Infrastructure (SDNI)

Overview:
Located in San Diego, CA, SDNI brings a history of success in supporting cutting edge academic and industrial research, a grand vision broadening STEM education, and strong commitments to diversity and inclusion.

Forward-looking Vision:

- Continuously expand user base and build technical strengths in ***Nano/Meso/Metamaterials, NanoBioMedicine, NanoPhotonics, and NanoMagnetics.***
- Support and enable transformative research in top priority areas for the nation and NSF. We will particularly enable and advance ***convergence research of significant societal impact.***
- Become a major force in building the ***nation's economy*** by training the work force, seeding innovations, and helping the industry develop and commercialize nanotechnology products.
- Strengthen K-12 (especially high-school) and community college ***STEM education*** and ***promote diversity***. Make a ***"scalable education program"*** for the state of California.

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Yo sdni San Diego Nanotechnology Infrastructure

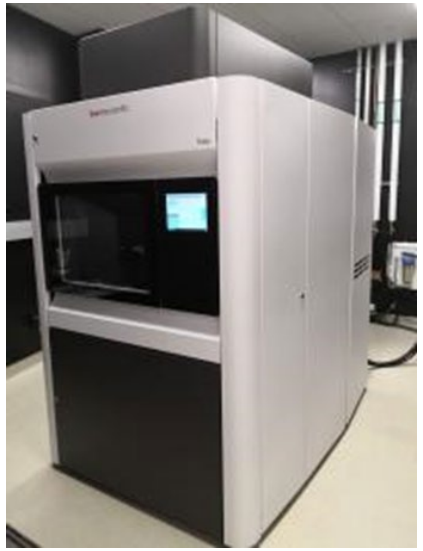
SDNI Initiatives (2020-2025)

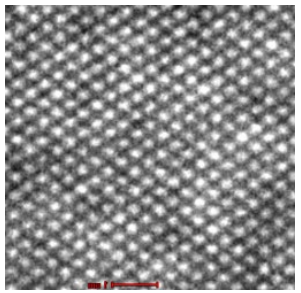
- Advance state-of-the-art materials characterization facilities
- Education and outreach initiative
- Convergence research initiative

SDNI: Material Characterization Initiatives

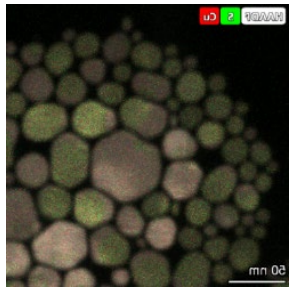
Expand *independent access* to *advanced* materials characterization capabilities

- New, state-of-the-art Transmission Electron Microscopy Facility, optimized for materials characterization, including energy dispersive X-ray Spectroscopy (EDS) and electron energy-loss spectroscopy (EELS) for high-quality chemical analysis.
- Strong focus on training user to enable successful ***independent utilization*** of high-end instrumentation.
- Completed major laboratory renovation, full installation of instrumentation by 5/2020.
- Trained 20 users for fully independent access since June 2020.

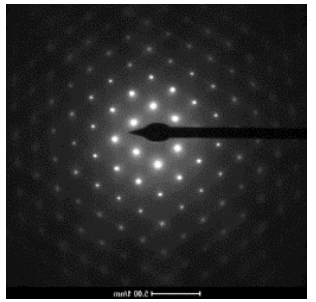




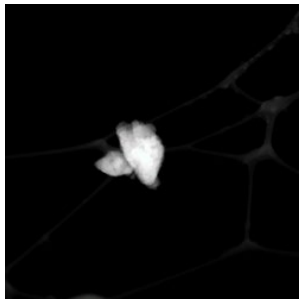
HR TEM



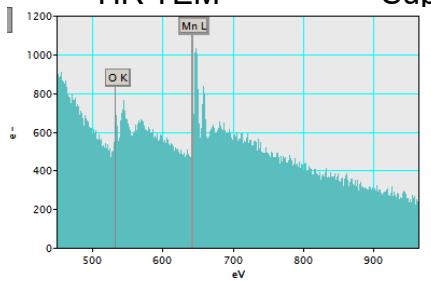
Super-X EDS



Diffraction



Tomography



Single and Dual EELS capability

Newly acquired instrumentation: Thermofisher Talos F200 S/TEM (with high-end EDS, EELS, Tomography), Fischione plasma cleaner, and high-end data analysis workstation.

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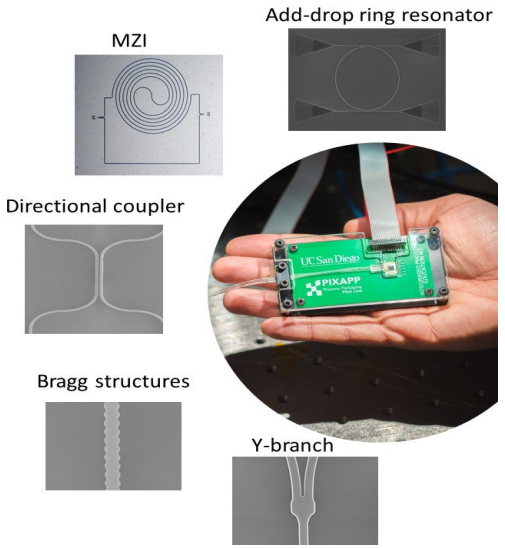
SDNI Education and Outreach Initiatives

- California Nanotechnology 2025
  - Scale up the education/outreach/diversity program to reach the State of California and other US states (through collaborations with other sites).
- NNCI education/outreach annual conferences.
- Undergraduate STEM education initiative
  - Use ***AR/VR and AI*** for undergraduate/community college nanotechnology education (NSF IUSE proposal).
  - Team up with non-profit organization to develop nanotechnology digital course content linked to "***virtual research projects***" designed by university professors.
- Graduate STEM education and convergence research
  - Integrated photonics education kit (IPEK)



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SDNI Convergence Research Initiatives

- Organize seminars from ***key thought leaders*** on socially important problems to foster a community of convergence research.
- Collaborate with the ***Qualcomm Institute*** (QI), other ***NNCI sites*** (RTNN, NCI Southwest, KY Multiscale, etc.), and the newly awarded UCSD ***MRSEC*** to advance convergence research.
- Partner with UCSD ***Education Department***, ***Data Science Institute*** to conduct research on ***remote learning and education*** (an emerging convergence research area of lasting societal impact).
- Some possible convergence research areas under consideration include public health and wellbeing, intelligent agriculture and food supply under climate change.

Texas Nanofabrication Facility (TNF)

Texas Nanofabrication Facility (TNF) 2020-2025

- Fabrication at MRC cleanroom
- Metrology at TMI
- Nanomanufacturing at NASCENT nm-Fab
- Added ACC as a partner for year-long REU program for 5 students
- New effort on Computation and Webinars related to Quantum Leap

S. K. Banerjee
Site Director

S. Majumder
Site Coordinator

L.A. Kahlor
SEI Director

S.V. Sreenivasan
nm-Fab Director

R. Manthiram
TMI Director

L.F.Register
Computation

A.Quinonez
ACC

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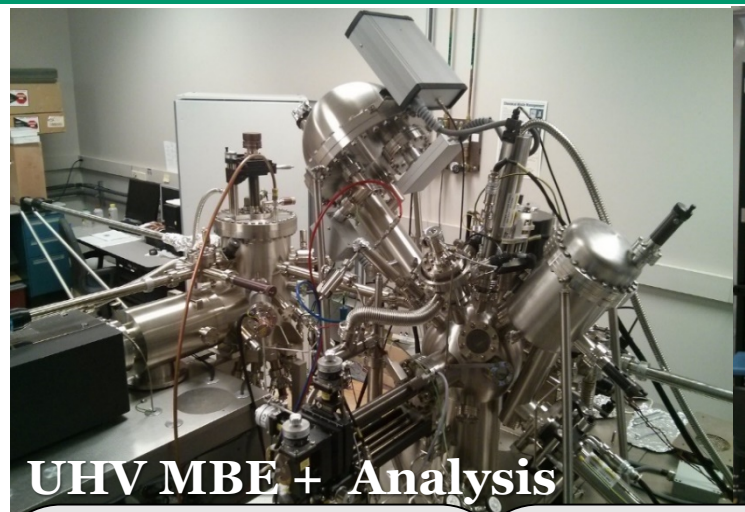
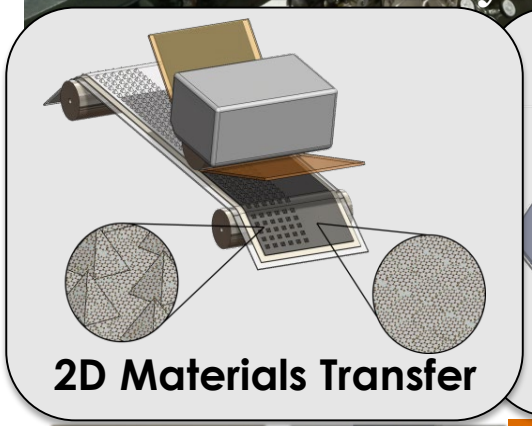
TNF TEXAS

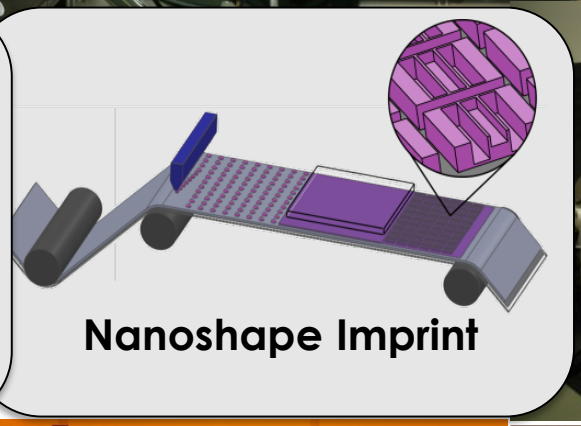
TNF Resources – 130+ tools and 25 Staff (7 funded by NNCI)

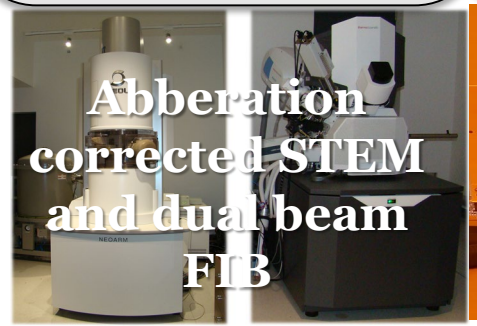
- 15,000 sq. ft. of Class 100 cleanroom at MRC
- Advanced Metrology at TMI
- 5,000 sq.ft. nano manufacturing at nmFab

- 1.2M$/yr. from UT and 1.3M$/yr. user fees









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Nanomanufacturing-Fab (nmFab) Facility
Prototyping projects will be done by TNF for ~30k$+

Unit Process	Wafer Substrates	Roll-to-Roll Substrates
Substrate type	3", 4" and 6" diameter wafers (silicon, glass, flex polycarbonates, others upon request)	Flex polycarbonate substrates, widths ranging from 80 to 350 mm.
Initial Substrate Prep	Wet wafer clean	Linear ion source for organic contaminant removal
Patterning	Nanoimprint Lithography	Nanoimprint Lithography
Vacuum Deposition of Thin Films	E-beam and sputtering deposition of metals and dialectrics	E-beam and sputtering deposition of metals and dielectrics
Wet Processing of Thin Films	Spin Coating, Ink-jetting	n/a
Etch	Wet etching and reactive ion etching	Wet etching and reactive ion etching
Final Substrate treatments	Wafer Dicing available	Roll slitting, protection of patterned surfaces with polymer interleaf layers

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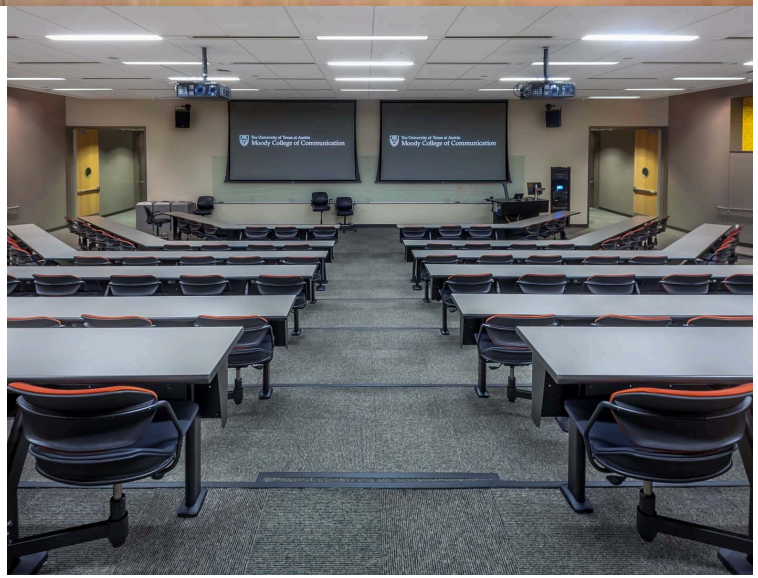
TNF TEXAS The University of Texas at Austin

Social & Ethical Implications

Next five years

- NNCI-Wide SEI engagement workshop
- Focus: 1) Talking about SEI (in ways that recognize the benefits of emerging technology), 2) Meaningful advocacy for diversity and inclusion, and 3) Measuring the impacts of the work we do.
- Keynote (E.g., NYT science writer), panels, activities, create “wish lists” of information and tools for Website.
- Bi-yearly, 1-day workshop in years 2 and 4.
- Will require start-up funds, then sustained with attendance fees.



TNF Vision and Future Goals

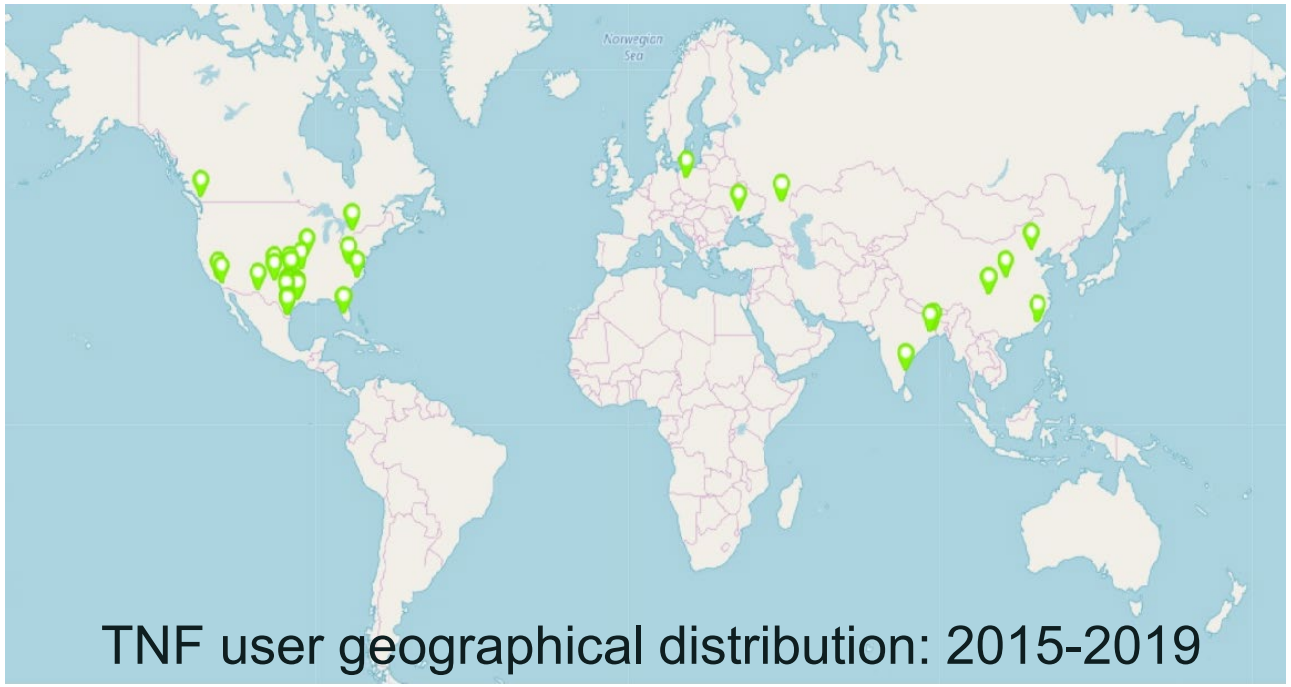
Vision:

- Enable and foster breakthrough nano-innovation - electronics, healthcare and energy

- Engage underrepresented minorities (URM), particularly Hispanics and women.

Future Goals:

- Science of scalability: (nmFab)
- Engage URM in NNCI-TNF: (ACC)
- Innovation Ecosystem
- Leveraging the Dell Medical School



TNF user geographical distribution: 2015-2019

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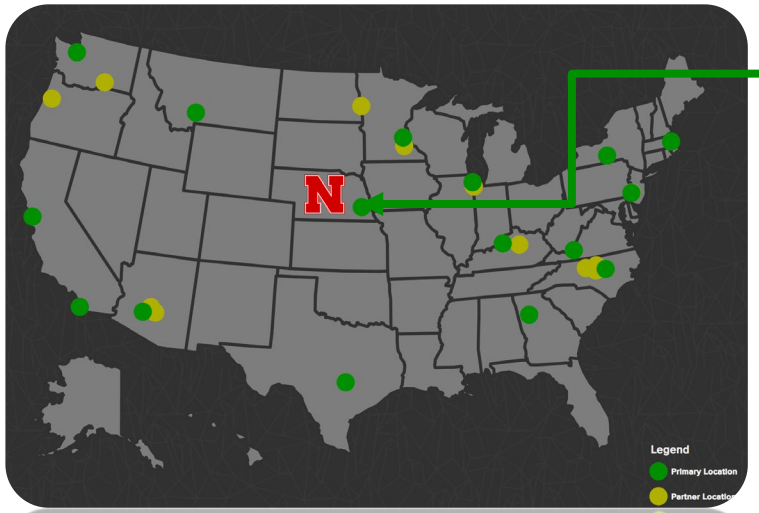
Nebraska Nanoscale Facility (NNF)

NEBRASKA NANOSCALE FACILITY: NNF

NNCI 2019 Annual Conference
NNF program overview years 6-10

Christian Binek*, Jacob John,† Terese Janovec§

*Director: NNF & NCMN, †Coordinator & Program Manager: NNF, §E/O Coordinator: NNF



NNF
NCMN

Voelte-Keegan Nanoscience Research Center @ University of Nebraska

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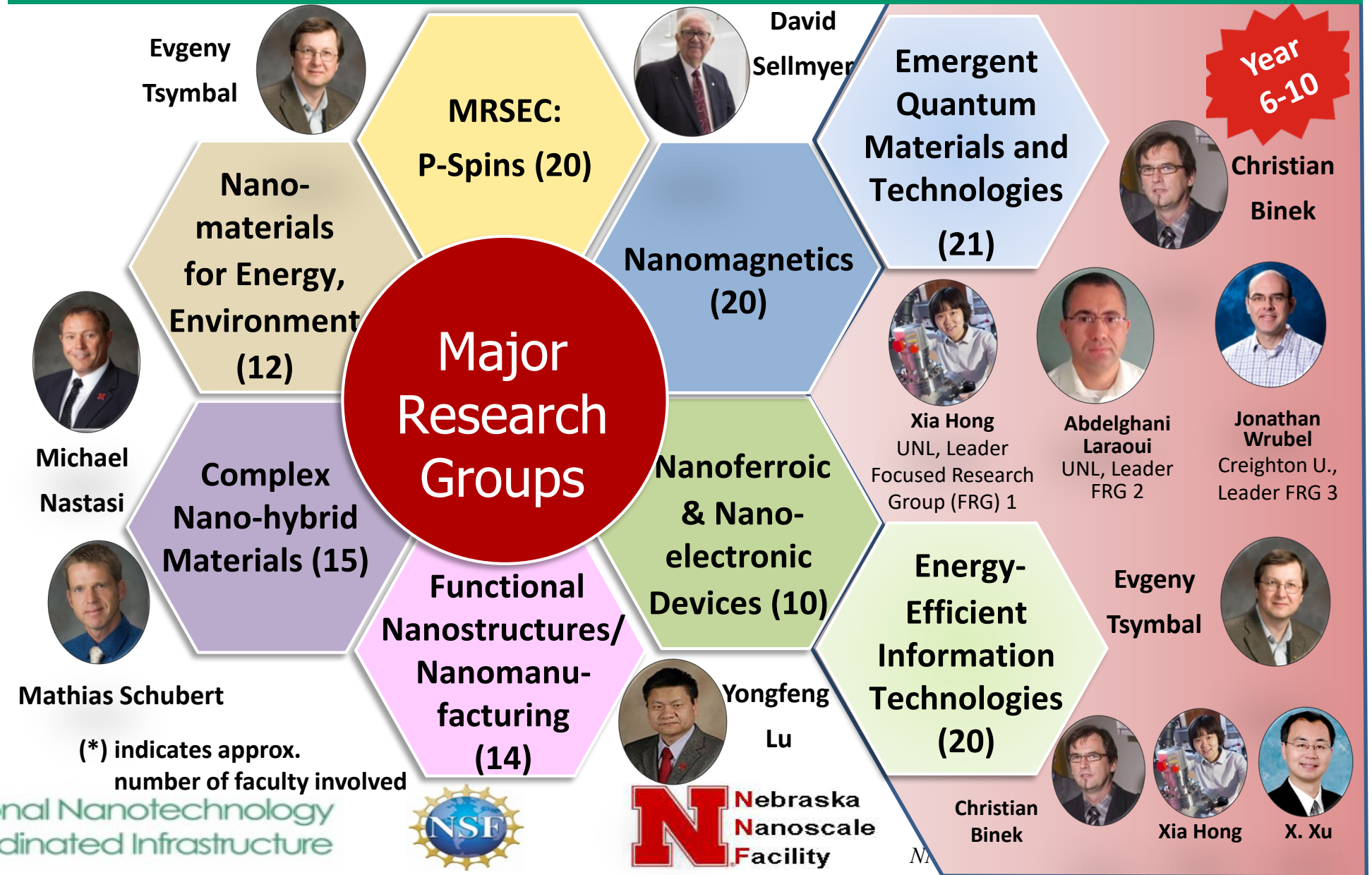
Research Focus Areas



NNF within the Quantum Leap Research Community

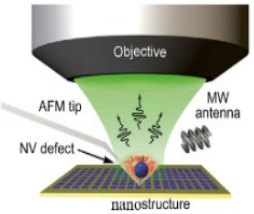
Emergent Quantum Materials and Technologies

EQUATE: Emerging Quantum materials and Technologies

NNCI Quantum Leap Research Community (12 NNCI sites)

3 lead organizations: UChicago@SHyNE; UMn@MiNiC; Harvard@CNS

Quantum sensing instrumentation



NNF contribution to best practices

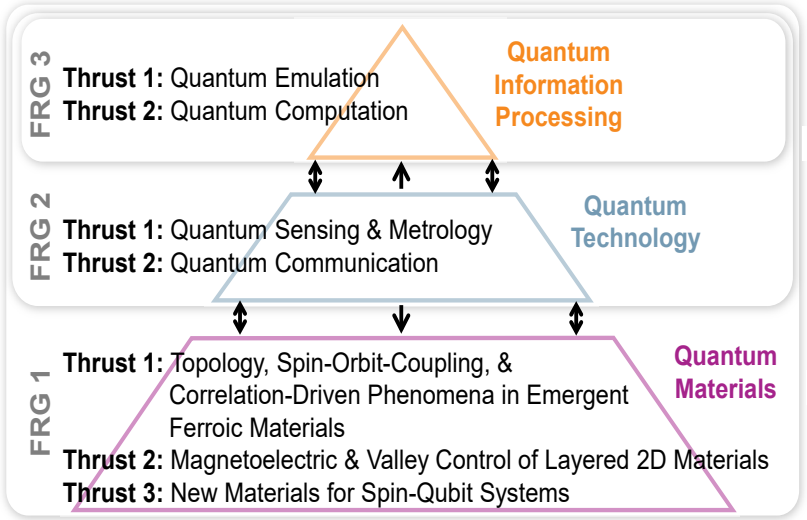
- Materials processing &characterization
- Integration of quantum devices

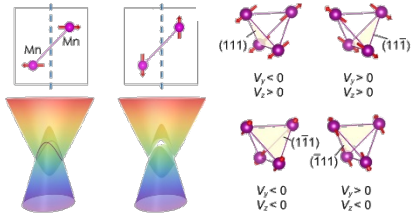
Sharing NNF resources with NNCI Quantum leap

- EQUATE symposia open for NNCI

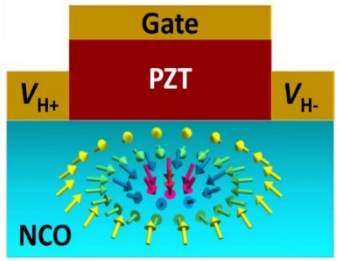
March 26-27, 2020

EQUATE under leadership of NNF/NCMN

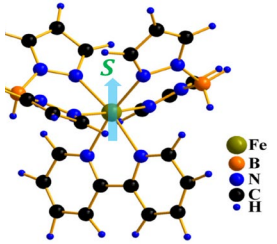




Topological AFM spintronics



spin crossover molecule as qubit platform



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NNF within the Nano-IoT Research Community

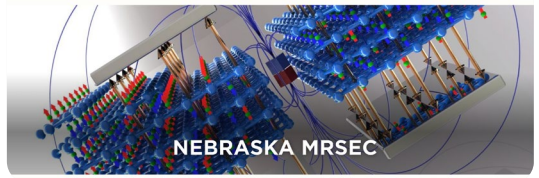
Energy-Efficient Information Technologies

Nano-IoT Research Community

Nebraska background in post CMOS electronics

Ongoing

PSPINS: Polarization and Spin Phenomena in Nanoferroic Structures



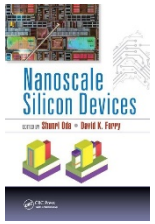
SRC Semiconductor Research Corporation

nCORE Nanoelectronic Computing Research

- Antiferromagnetic Magneto-electric Memory and Logic Center (AMML)

Past

Center for NanoFerroic Devices



Chapter: "Potential of Nonvolatile Magnetoelectric Devices for Spintronic Applications" (2015) Peter A. Dowben, Christian Binek, and Dmitri E. Nikonov

Applied Physics Letters PERSPECTIVE scitation.org/journal

NNF brings in experience in IoT device design/ fabrication/characterization/benchmarking

- Non-volatile memory
- Ultra low power dissipation
- scalability

Azad Naeemi
Andrew Marshall
Shaloo Rakheja

Magneto-electric antiferromagnetic spin–orbit logic devices

Cite as: Appl. Phys. Lett. **116**, 080502 (2020); doi: 10.1063/1.5141371
Submitted: 5 December 2019 · Accepted: 15 February 2020 ·
Published Online: 27 February 2020

P. A. Dowben,[1,2] D. E. Nikonov,[3] A. Marshall,[4] and Ch. Binek[1,2,a)]

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NNF's Additional Future Programs Education/Outreach (2020-2025)

Discover Engineering Days:

- Increase partnership support with UNL College of Engineering to introduce middle school students and teachers to STEM areas

4H/RAIN Remote Events:

- Expand partnership with University of Nebraska Extension Office/4-H Program for remote analysis services to NE students
- Provide nano program at National 4-H Youth Summit Series with Cornell, Mont, & NanoEarth

Community College Partnerships:

- Add customized summer REU programs for community college undergrads

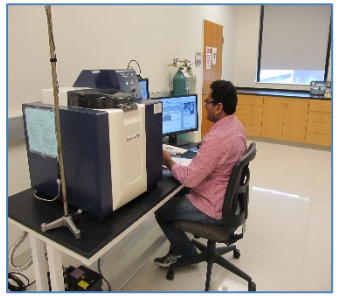
Teacher Development:

- In partnership with Stanford we will provide 4 day annual workshops with tours, lesson planning, and other activities to 10 Nebraska teachers each summer

  NNF E/O coordinators attended Stanford's workshop this summer ➡ model for NNF workshop in 2021
- NNF will support 5 participants/year in a 6 week summer research experience in collaboration with 3 other NNCI sites

Traveling Exhibits:

- Regional expansion of Traveling Nano Exhibit with museums, community colleges, tribal schools especially in South Dakota. Second STEM exhibit will tour 8 NE museums





Girls Inc. Summer Camp

Not mentioned above

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NNF Education/Outreach Programs Assessment 2020-2025

NNF will expand and improve assessment/evaluation of various EO activities impacts

Development of an in-depth plan to evaluate the impact of education and outreach

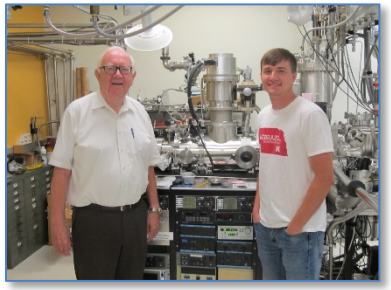
NNF uses modified NNIN Evaluation Plan logic model, Evaluation Matrix, and NNCI expected impact chart for evaluating EO programs and future program planning.

These tools provide a method to:

- summarize inputs, activities, outputs, outcomes, impact
- organize efforts by goals and focus areas.

Evaluation steps include:

1) defining and following an evaluation plan,
2) considering population and measurement methodology,
3) assessing and analyzing the data,
4) applying results to planned and future activities and sharing lessons learned with others.



Add an independent evaluator

- Mary White, Ph.D from the College Research and Evaluation Services Team (CREST), Arizona State University. (supported NNCI for a number of years)
- NNF seeks assistance of an agency associated with UNL

NNCI Impacts Evaluation Tool example

Inputs	Activities	Outputs	ST outcomes	Int outcomes	LT outcomes
PIs and research staff K-12 partners Community college and university partners NSF funding Industry partners Equipment and materials Others?	K-12 outreach	#s Involved Types of activities	Increased awareness, interest; Positive attitudes/ satisfaction	Increased knowledge of Nano concepts; Increased skills from program content	n/a
	High school interns	#s Involved Types of activities	Increased awareness, interest; Positive attitudes/ satisfaction; College and career knowledge	Improved STEM self-efficacy, motivation; Enhanced knowledge and skills; Continued enrollment in STEM courses; 21st Century skills	Increased academic learning and achievement in STEM STEM careers
	REU program	#s involved; Conference presentations and publication counts	Increased interest, knowledge, and skills; College and career knowledge; Positive attitudes/ satisfaction	Improved STEM self-efficacy, motivation; Enhanced knowledge and skills; Continued program participation; Enrollment in STEM courses; STEM majors and career development (decisions, interest, knowledge); 21st Century skills	Increased learning and achievement in STEM; Entry and retention in STEM careers; Diverse, creative workforce
	RET program	#s involved; #s of classrooms; Conference presentations and publication counts	Increased interest, knowledge, and skills; Positive attitudes/ satisfaction; In-school course delivery with feedback; Improved confidence	Continued course integration; Enhanced knowledge and skills; Continued program participation; Teaching practice skills: pedagogical knowledge and practice, content knowledge; Increased understanding of nano college and career opportunities; Unsure	Sustained course integration and impact evaluation feedback from students; Continued training or connection to NNCI
	Undergraduate and graduate students in university labs	#s involved Conference presentations and publication counts;	Increased interest, knowledge, and skills; College and career knowledge; Positive attitudes/ satisfaction Mentoring?	Improved STEM self-efficacy, motivation; Enhanced knowledge and skills; Continued program participation; Enrollment in STEM courses; STEM majors and career development (decisions, interest, knowledge); 21st Century skills	Increased learning and achievement in STEM; Entry and retention in STEM careers; Diverse, creative workforce; Unsure

National Nanotechnology Coordinated Infrastructure

Nebraska Nanoscale Facility

Symposium March 2020 on Emergent Quantum Materials and Technologies

Goal: Connect internationally renowned experts in modern field of quantum materials science with researchers from EQUATE

Invited Speakers:

Michael E. Flatté, Univ. of Iowa

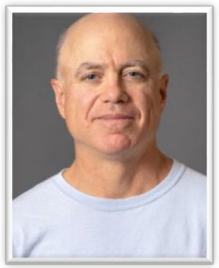
New Materials and Devices for Quantum Coherent Technologies

Axel Hoffmann,
Univ. of Illinois at Urbana-Champaign

Topological Quasiparticles: Magnetic Skyrmions

Paul Lett, NIST
Quantum Measurement Division

Quantum Sensing with Photons and Atoms



David Meyer, UC San Diego

New Directions for Quantum Walks

Gary Wiederrecht, Argonne Nat. Lab

Ultrafast nanophotonics applied to quantum optics and plasmonics

Research Triangle Nanotechnology Network (RTNN)

NEW INITIATIVES in Years 6-10

Executive Committee: Jacob Jones (NC State), Nan Jokerst (Duke), Jim Cahoon (UNC), David Berube (NC State), Mark Walters (Duke), Phil Barletta (NC State), Bob Geil (UNC), Maude Cuchiara (NC State)

THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

Duke UNIVERSITY

NC STATE UNIVERSITY

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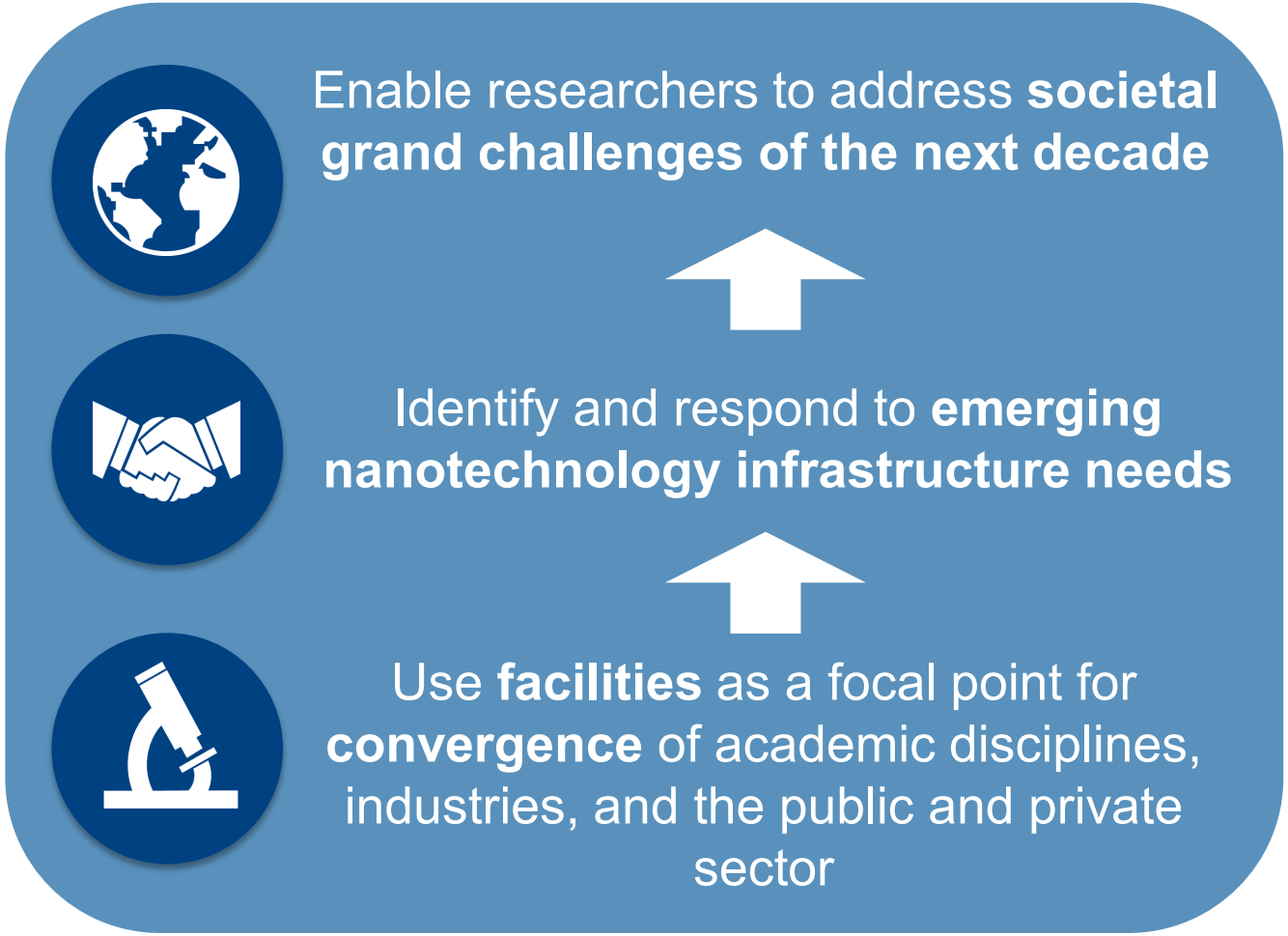
The Research Triangle Nanotechnology Network
Convergence Nanotechnology Hub

Aspirational Vision



Major Goals

1. **Facilitate convergence using infrastructure** by enhancing ***cross-disciplinary access*** to university nanotechnology tools and creating ***"bump-in" collisions***
2. **Innovate programs** to lower barriers of entry, ***e.g. cost, distance, and awareness***
3. **Deeply assess socio-technical integration** by ***evaluating user and participant experiences*** in RTNN facilities and programs

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NC STATE UNIVERSITY

EXPAND Kickstarter - Creating More Returning Users

Kickstarter is RTNN's "Accelerator" program to overcome barriers of entry for new and non-traditional users, providing free time on tools

Up to $1,000 of use at internal rate

Grow program to >20 projects annually

Provide option of **travel support** to encourage on-site use by participants who could not travel here otherwise

Encourage **remote connection** of participants with technical staff during/following fabrication and analysis

Use Kickstarter to integrate **facility use into courses at more non-R1 institutions**

- Provide model experiments: photolithography, nanoparticle synthesis

Previous Participants Come from a Variety of Institutions

North Carolina School of Science and Mathematics

NCCentral University

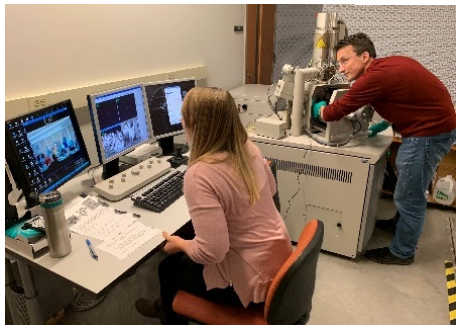
Smart Material Solutions

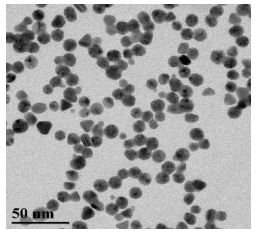
UNIVERSIDAD EAFIT

ECSU Elizabeth City State University Founded 1891

Genturi

YMERON





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Duke University

NC State University

CREATE NEW MODULES
"Coursera NanoMaker: Structures and Devices"

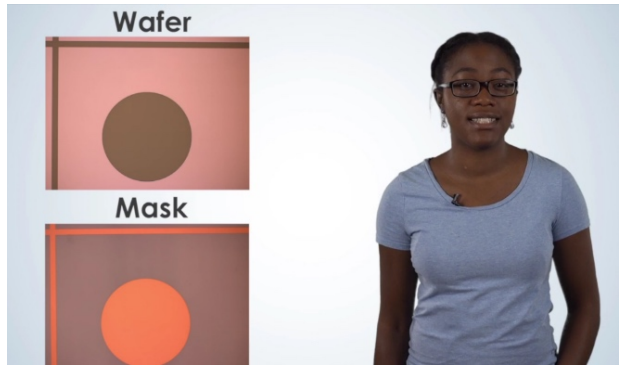
Leverage past successes in Massive Open Online Course on Coursera, providing education in nanofabrication and characterization

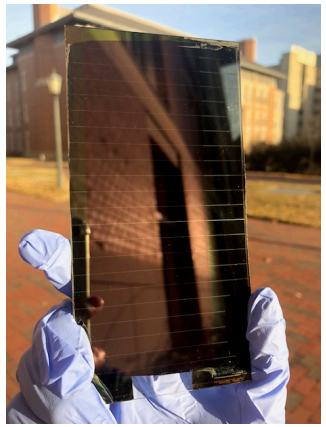
Lectures and in-lab demonstrations in RTNN labs by RTNN students, faculty, and staff from diverse backgrounds

Driven by user feedback, **NEW stand-alone modules** will leverage and build out from the existing (continuing) course

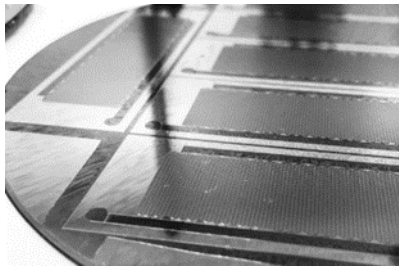
Modules Focused on **Making Structures and Devices**

- While original course presented tools separately, **Making Devices** will integrate tools together for specific fabrication projects
- Early modules will be linked to RTNN technical focus areas (e.g. solar cells, microfluidic devices)
- Expand to modules that emphasize novel tools and/or processes





Deng, Y. et al. Nat. Energy, 3 (2018).



Abedini-Nassab, R. et al. Adv. Funct. Mater., 26 (2016).

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INTERCONNECT the Triangle Community

- Launch **RTNN Affiliates Network**, modeled after similar NNCI-site-led regional networks
  - Connect researchers to complementary facilities
  - Efficiently communicate and strategize across facilities
- Partner with **economic development organizations, technology incubators, and organizations focused on workforce diversification**
  - e.g. AgTech-Research Triangle, Innovate Raleigh, Triangle Women in STEM
- Attend conferences and events that cater to small businesses (e.g. SBIR workshops)
- Monthly on-site training workshops
  - Provide Continuing Education Unit (CEU)

CHEMICAL RESEARCH INSTRUMENTATION TEACHING & CORE LABS | CRITCL

ALEXANDRIA LaunchLabs

RTI INTERNATIONAL

Shared Core Research Facilities

INNOVATE RALEIGH

SBIR · STTR America's Seed Fund™ POWERED BY SBA

FRONTIER RTP

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STRENGTHEN Engagement with K-Gray Participants

RURAL COMMUNITY FOCUS

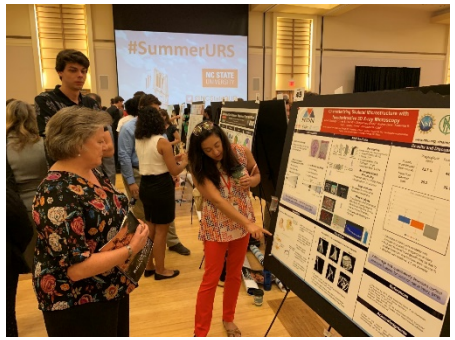
Bring successful **hands-on activities and portable SEMs** to rural schools, museums, and libraries

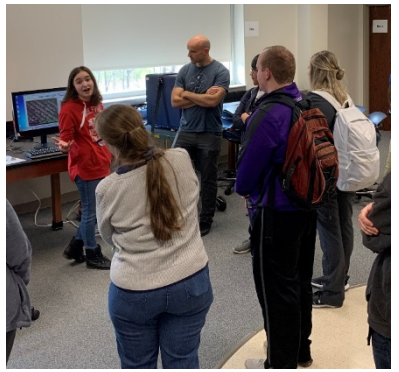
- Piloted in Fayetteville, Hickory, and Asheville in partnerships with volunteers from JSNN (SENIC site)
- Portable and agile program
- Pivoted to online SEM programming during COVID

COMMUNITY COLLEGE FOCUS

Provide STEM Internships to support transfer students, facilitate matriculation and retention

Expand existing nanotechnology lectures and demonstrations to new community colleges and courses





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ENHANCE Connections and Communications

PROFESSIONAL EMAIL CONTENT

Monthly newsletter managed through Bronto

>3,700 subscribers

Feature RTNN user research as human-interest stories with focus on interdisciplinary collaborations

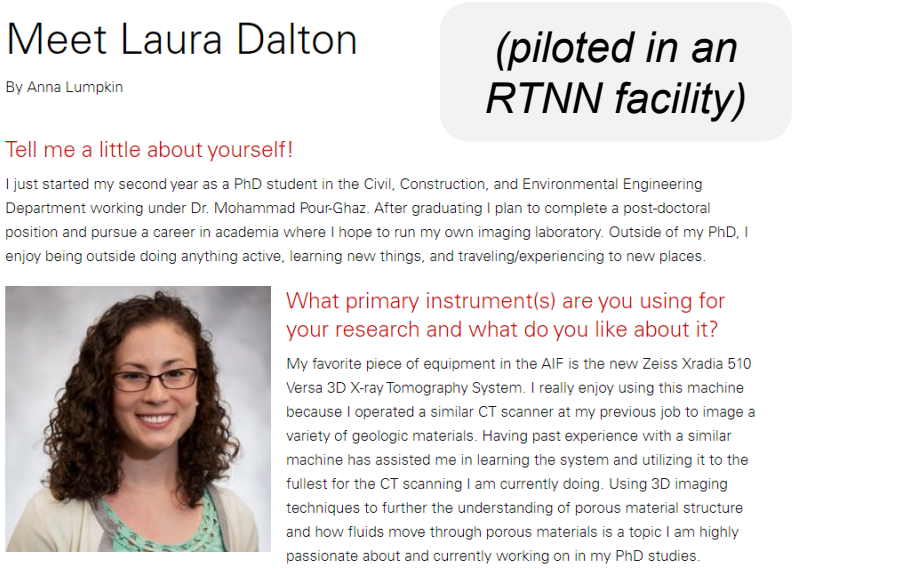
Proactively disseminate more job opportunities to users

SOCIAL MEDIA

>700 followers/subscribers on social media sites (Facebook, Twitter, LinkedIn)

Introduce **new sites** (e.g. Instagram; Sina Weibo, China; and VKontakte, Russia)

Short **takeover exercises** where student groups or nano organizations from external institutions can post content on our sites *(RTNN retains control)*



Meet Laura Dalton

By Anna Lumpkin

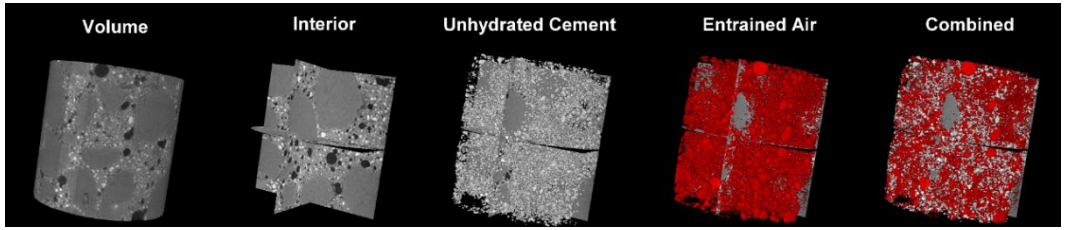
(piloted in an RTNN facility)

Tell me a little about yourself!

I just started my second year as a PhD student in the Civil, Construction, and Environmental Engineering Department working under Dr. Mohammad Pour-Ghaz. After graduating I plan to complete a post-doctoral position and pursue a career in academia where I hope to run my own imaging laboratory. Outside of my PhD, I enjoy being outside doing anything active, learning new things, and traveling/experiencing to new places.

What primary instrument(s) are you using for your research and what do you like about it?

My favorite piece of equipment in the AIF is the new Zeiss Xradia 510 Versa 3D X-ray Tomography System. I really enjoy using this machine because I operated a similar CT scanner at my previous job to image a variety of geologic materials. Having past experience with a similar machine has assisted me in learning the system and utilizing it to the fullest for the CT scanning I am currently doing. Using 3D imaging techniques to further the understanding of porous material structure and how fluids move through porous materials is a topic I am highly passionate about and currently working on in my PhD studies.



Instagram

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PURSUE NEW RESEARCH in Social and Ethical Implications of Nanotechnology (SEIN)

In addition to assessment and method development and improvements, we are actively engaging in the following work:

ZOOM FATIGUE Research

Computational text analysis of online meeting fatigue with follow-up on science meeting specifics; presenting at SRA meeting in December 2020

Examining MICRO-AGGRESSIONS in Lab Settings

Collecting data to determine prevalence of micro-aggressions as a component of race and gender discrimination within RTNN facilities

In collaboration with SENIC, RTNN will **develop and test an ASSESSMENT TOOLKIT that will:**

Analyze NNCI publications to **assess geographic and interdisciplinary impact**

Include a human resource tool to **study careers of student alumni** that used facilities

Apply a model to estimate **economic impact of facilities**

How important is employment in deciding whether to provide nano-infrastructure support?

How significantly does nano-infrastructure support impact productivity & growth?

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RTNN Faculty and Staff

RTNN Faculty and Staff

Congratulations to our NNCI Award Winners

User Support

Carrie Donley
UNC-Chapel Hill

Education and Outreach

Nicole Hedges
NC State University

Technical Staff

Justin Gladman
Duke University

Montana Nanotechnology Facility (MONT)

MONT
Montana Nanotechnology Facility

An NSF NNCI Node in the Northern Rocky Mountain Region

New Programs for Y6-Y10

David Dickensheets

NNCI Annual Meeting, Oct. 26, 2020

nano.montana.edu

Our Team

David Dickensheets
Project Director (MMF)

New!

Stephanie McCalla
Deputy Director

Recep Avci
co-PD (ICAL)

Phil Stewart
co-PD (CBE)

Dave Mogk
co-PD (ICAL, E&O)

Carolyn Plumb
Assessment

Heather Rauser
Program Administrator

Mark Young
(TEM)

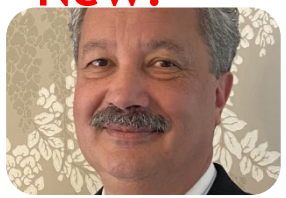
Brian Bothner
(MPMS)

Sean Fox
Education Specialist
Carleton College
Science Education Resource Center

New!

Jason Carter
VP REDGE

New!



Yves Idzerda
Dean, CLS

Brett Gunnink
Dean, COE

MONTANA STATE UNIVERSITY
Mountains and Minds

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MONT

Initiatives for Y6-Y10

- Staffing for external user success
- Facility Enhancements
- Research initiation grants (AKA “kickstarter”)
- MONT/EMPOWER Scholars program **New!**
  (engaging populations under-represented in STEM)
- Research Communities **New!**
  - (increasing NNCI impact in areas of national priority)

Focused on users

- Outreach and Education
  - Online education (with SERC) **Expanded!**
  - On-site education
  - 4-H across Montana **New!**
  - Salish-Kootenai Tribal College
- Northwest regional lab network **New!**
  (engaging beyond NNCI)

Outward looking

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MONT

Growing the Impact of the NNCI Network

Connect MONT users to NNCI through new Research Communities

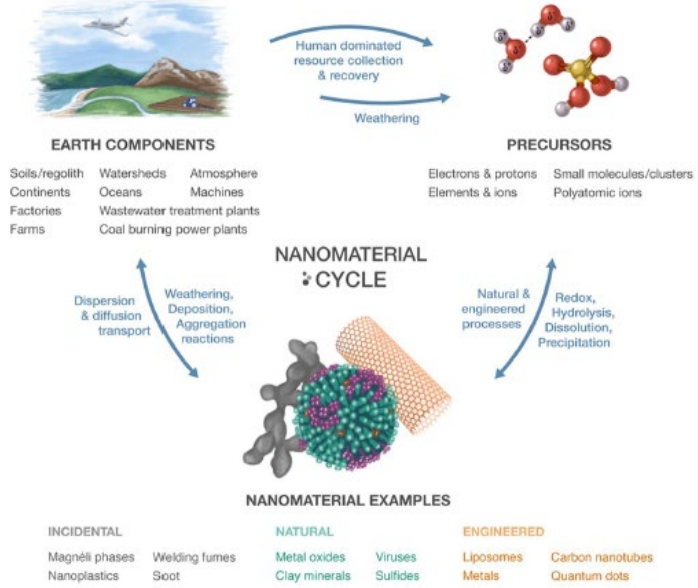
MONT will engage with: **Rules of Life, Quantum Leap**

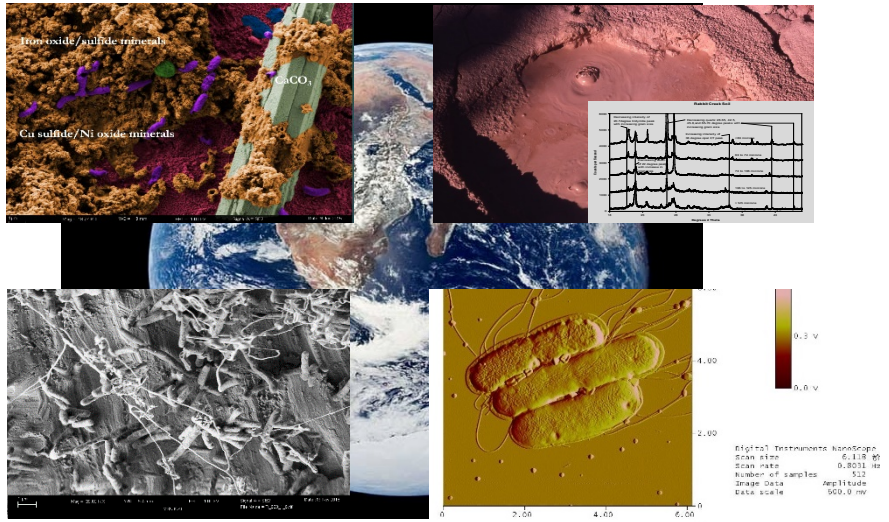
MONT will co-lead RC on nano-Earth Systems
(with nanoEarth, NCI-SW, nano@Stanford)

Nano-ES intersects National Priorities targeting Clean Water and Global Health, as well as NSF Convergence Research

- Annual workshop, researchers and staff from all nano-ES sites + others
- Week-long staff exchange program
- Joint REU program with weekly virtual activities

- MONT users study natural, incidental and engineered NPs in Earth Systems
  - Bio-mineralization and Bio-corrosion
  - NPs in global biogeochemical cycling (Antarctic to Yellowstone)
  - Thin films and coatings on Earth materials
  - Clay mineralogy (”tight shales” as gas reservoirs)





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Emphasis on Diversity

Mentored Research

MONT/EMPOWER Scholars Program

- EMPOWER serves UG students underrepresented in STEM
  - student center, drop-in tutoring and advising, guidance in arranging research internships, and scholarships
- Modeled after USP: stipend + research budget
- 3 Scholars annually paired with MONT PIs

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New Avenues for Outreach

- Montana 4-H – following MSU's Land-Grant mission, connecting rural regions to nano science/technology
  - On-site: 4-H Congress
  - Remote: Nano 4-H Curriculum
  - Coordinating with nanoEarth, CNF, NNF
- Activities with Area Middle/High Schools
- Partner with Salish-Kootenai College (Flathead Reservation)
  - MSU students → SKC
    - High School Outreach (Upward Bound)
    - Family Science Night
  - SKC, K-12 students → MSU
    - Develop Research Experiences at MONT

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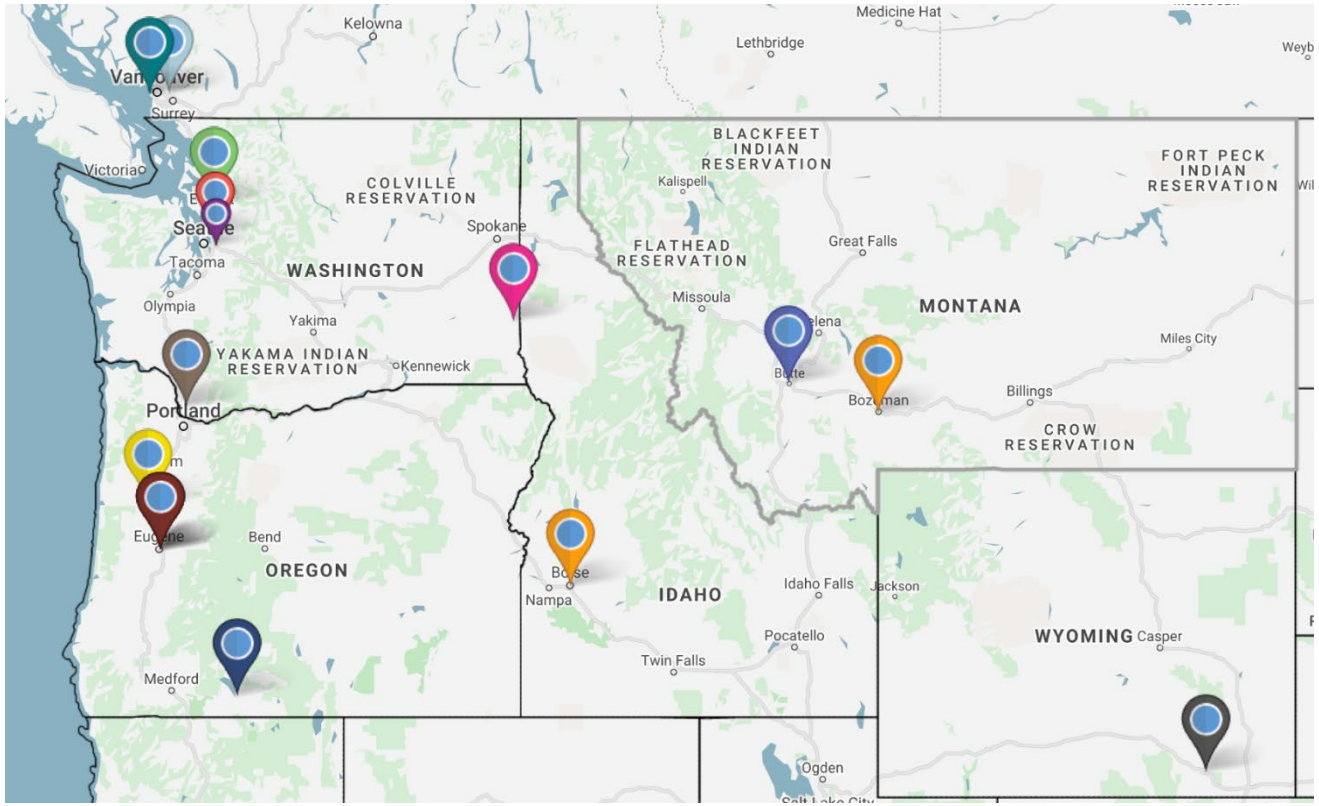
Growing the Impact of the NNCI Network

Northwest Nano-Lab Alliance

Regional Network, modeled after MINIC's NNLA

- ~ 15 University labs so far
- Build relationships, grow awareness of capabilities, needs, vendors, NNCI resources
- Annual meeting at UW, MSU, or UGIM (alternate years)
- Regular virtual meetings



Center for Nanoscale Systems (CNS)

Harvard University:
Center for Nanoscale Systems

NNCI Annual Meeting

Site Review

October 25, 2020

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Center for Nanoscale Systems
Harvard University
FAS • SEAS

Epicenter for Interdisciplinary Nanoscience Research at Harvard:
LABORATORY FOR INTEGRATED SCIENCE AND ENGINEERING (LISE)

CNS Activities: Overview

- ***CNS*** serves as a one-stop shop for all things *"Quantum & Nano"* (almost fully self-use)
- ***CNS*** serves as a important regional, nanoscience community resource. (open access)
- ***CNS*** serves to support the primary innovation thrusts within the Harvard research community. NNCI allows us to serve the Nation.
- ***CNS*** have initiated new training and educational programs to engage larger numbers of undergraduates, non-traditional, and Under-represented external users, in nanofabrication, advanced characterization and advanced imaging techniques.
- ***CNS*** is developing and expanding experimental platforms expanding our experimental capabilities; (example, Scanning probe spectroscopy platforms, LEEM, Video rate AFM)
- ***CNS is*** offering support for new Start-up companies and is establishing alliances with local technology incubators.

Robert Westervelt
Director

William L. Wilson
Executive Director

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Center for Nanoscale Systems
Harvard University
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CNS: Key Focus Areas

Quantum Science & Engineering:

- **Quantum information Science-Systems and Devices**
- **NanoOptics, NanoPhotonic devices, NanoSpectroscopy**

Quantitative Biology:

- **NanoMechanics; Nanoscale structural analysis**

BioEngineering *(Translational Bioscience/Biomedical Research)*

- **Advanced Imaging (CryoElectron Microscopy)**

Key Partner: NSF Science & Technology Center

CIQM CENTER for INTEGRATED QUANTUM MATERIALS

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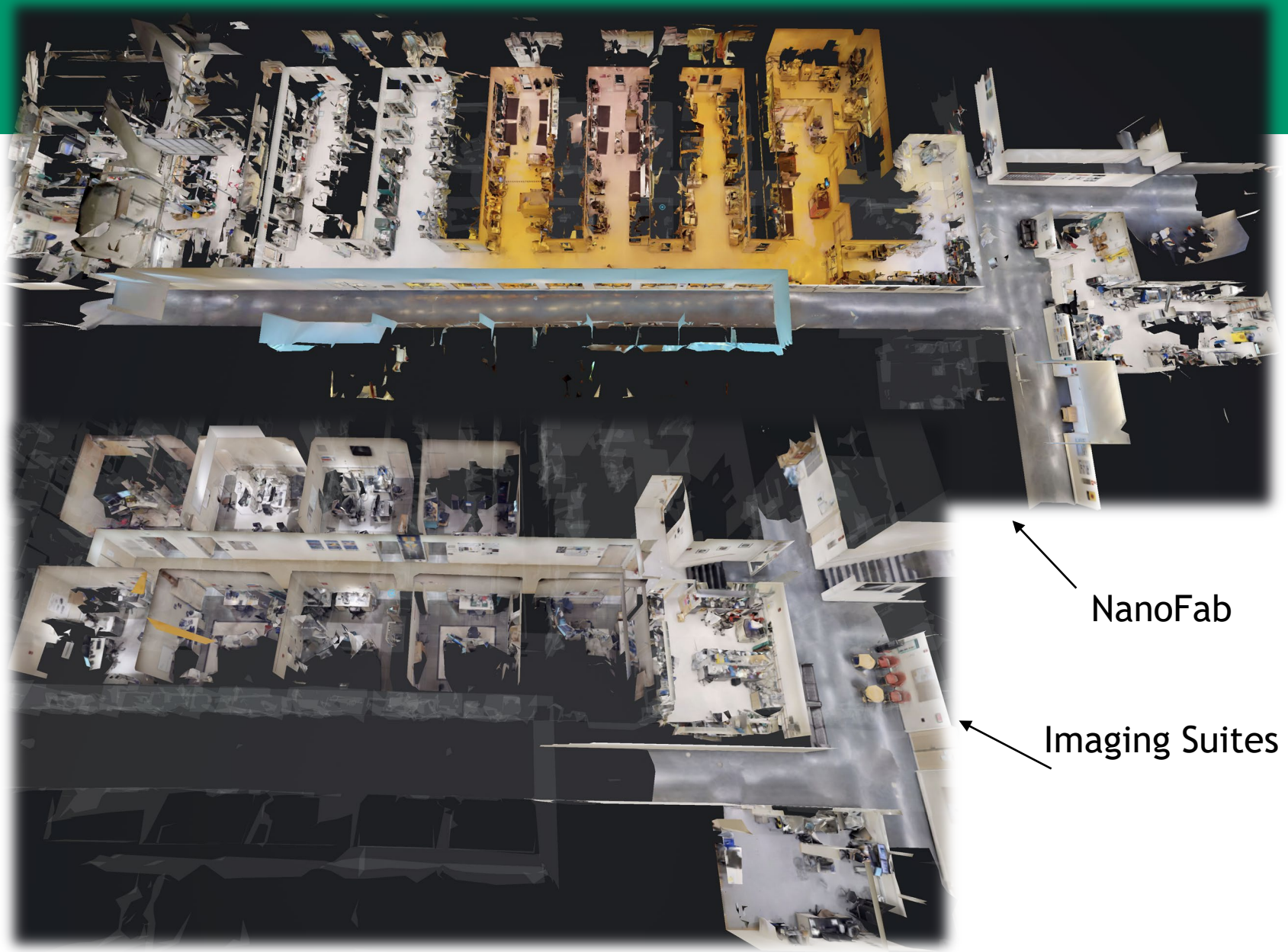
Center for Nanoscale Systems Harvard University FAS • SEAS



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Center for Nanoscale Systems
Harvard University
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https://my.matterport.com/show/?m=rVhrkRCTdHD

CNS: *New Initiatives*

- ✓ Continue to expand the frontiers of **Research and Technology Support.**
- ✓ Enhancement of our CNS Scholars diversity efforts driving *"Inclusive Excellence";* providing more connections to collaborative interactions. We has sponsored a Harvard University Student Chapter of the National Society of Black Physics
- ✓ Growth of our Start-up Outreach Initiatives: more extensive development of incubator partnerships; supporting pathways to NanoManufacturing.
- ✓ Expanding our Research experiences for Veterans (REV) activities by driving more collaborative interactions with *the Warrior Scholar Initiative* and other programs supporting STEM training of Veterans.
- ✓ Extensive expansion of CNS Remote and On-line tool/instrument training*

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Harvard University
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CNS: *External Advisory Committee*

Katherine Aidala
Louis E. Brus
Kenneth Evans-Lutterodt
Gilbert Herrera
Xiuling Li
John Rogers
Meni Wanunu

Mount Holyoke
Columbia University in the City of New York
Brookhaven National Laboratory
University of Maryland
Illinois – University of Illinois at Urbana-Champaign
Northwestern University
Northeastern University – Boston, Massachusetts

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NSF
Center for Nanoscale Systems – Harvard University FAS • SEAS

Thank you!
Questions?

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Center for Nanoscale Systems
Harvard University
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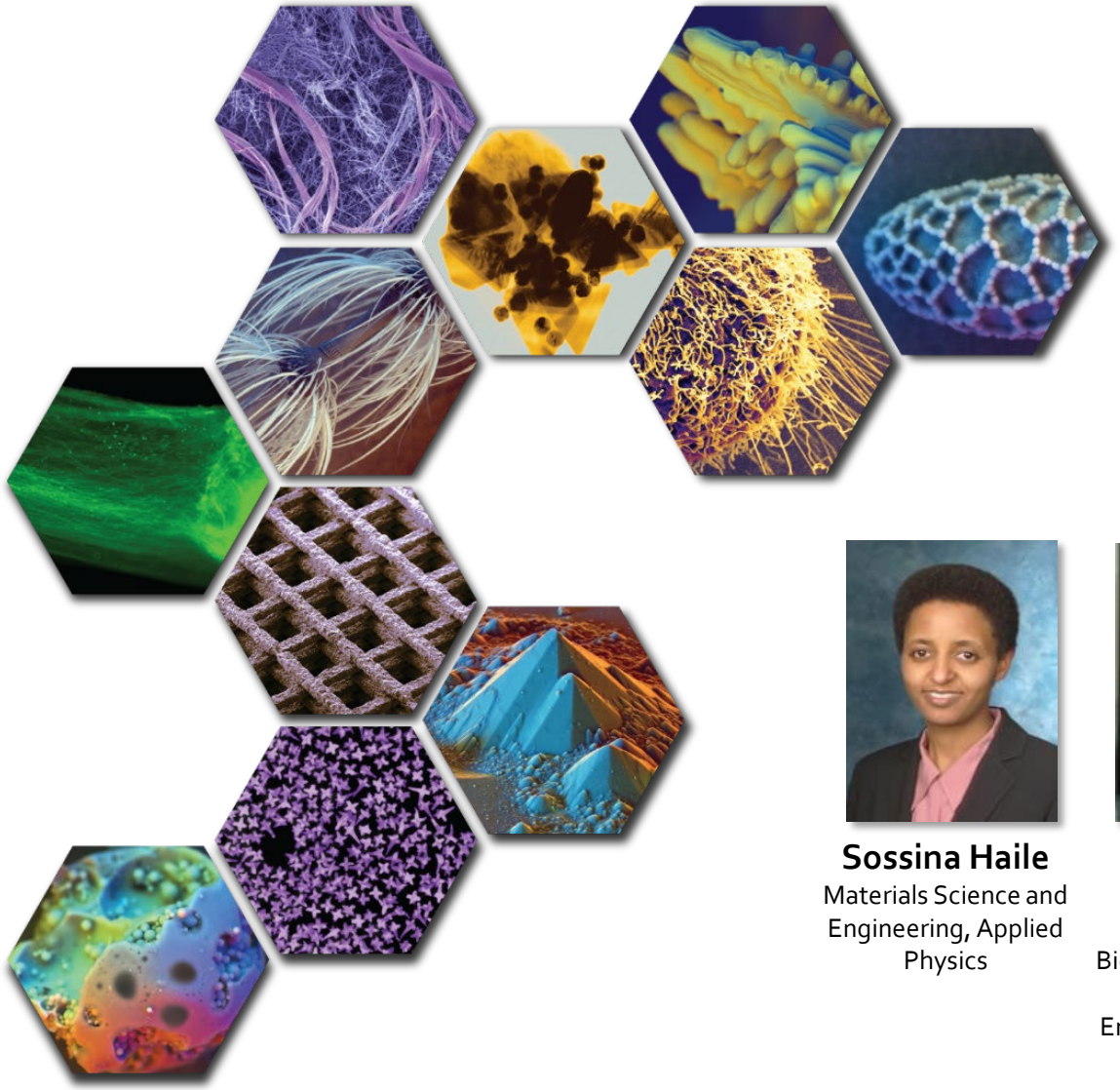
Soft and Hybrid Nanotechnology Experimental (SHyNE) Resource



SHyNE

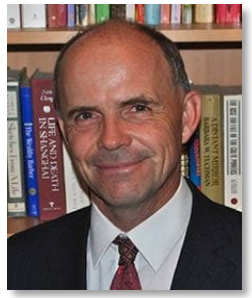
Soft and Hybrid Nanotechnology Experimental Resource

ILLUMINATE YOUR RESEARCH

Sossina Haile
Materials Science and Engineering, Applied Physics

Chad Mirkin
Materials Science, Chemical and Biological Engineering, Biomedical Engineering, Medicine

Jian Cao
Mechanical Engineering, Civil and Environmental Engineering, Materials Science and Engineering



Andrew Cleland
Physics, Molecular Engineering Innovation and Enterprise

Vinayak Dravid
Materials Science and Engineering

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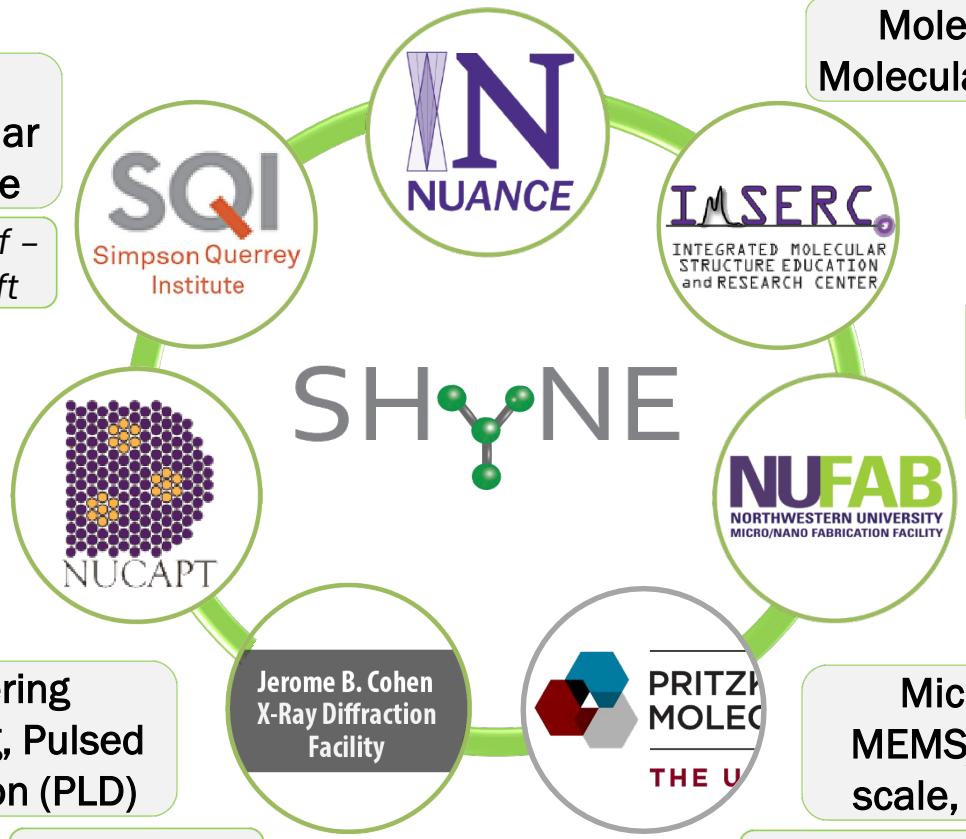
SHyNE | Soft Hybrid Nanotechnology Experimental Resource

THE UNIVERSITY OF CHICAGO

Northwestern University

SHyNE: Facilities



Soft nanopatterning, fabrication
Surface/Interface characterization
Cryo-bio microscopy/analysis

16 Tech Staff – 14,000 sq ft

Molecular Nanotech
Molecular Characterization

10 Tech Staff – 12,300 sq ft

Bio-Molecular
Peptide Synthesis/Char
Bio-Physical Interface

5 Tech Staff – 3,400 sq ft

Micro/Nanofabrication
MEMS, Physical-Bio Interfaces

6 Tech Staff – 7,000 sq ft

Atom-probe Tomography (APT)

2 Tech Staff – 900 sq ft

X-ray scattering
APS Prototyping, Pulsed Laser Deposition (PLD)

3 Tech Staff – 2,500 sq ft

Micro/Nanofab
MEMS/NEMS Wafer-scale, integrated fab

6 Tech Staff – 24,000 sq ft

$75M+ Tools

60,000+ sq ft. space

60+ Staff

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SHyNE | Soft Hybrid Nanotechnology Experimental Resource

THE UNIVERSITY OF CHICAGO

Northwestern University

SHyNE: Impact - Intellectual Merit

- ✓ ***Soft & Hybrid*** – unique theme
  Total Users: 1699 (highest in NNCI)
  Growth - *External Users & Usage*
  Publications: 1363+ (highest in NNCI)
  Patents: 250+
  Process & product development
  Museums and Public Institutions

- ✓ **$50+ M** in new equipment's
- ✓ **State-of-the-Art Space: J, AB Wings**
- ✓ ***SEED*** funding - new user engagement

2016 Chemistry Nobel Prize;
"Design & production of molecular machines"
Fraser Stoddart
Founding Director, IMSERC
a SHyNE Facility

- **Regional Coordination**
  - Chicago Quantum Exchange
  - iNano, CBC, M3S
- **NNCI Network Activities**
  - Global & Regional Interactions
  - Staff exchange
  - Machine Learning for Predictive Maintenance
  - ChiMaD, MFRN - MRSEC
- **SME collaboration and development**
- **SHyNE fostered multiple start ups**
- **SHyNE-Global Initiatives**

SHyNE Publications (Years 1-4)

Publications	Yr1 (2016) Internal	Yr1 (2016) External	Yr2 (2017) Internal	Yr2 (2017) External	Yr3 (2018) Internal	Yr3 (2018) External	Yr4 (2019) Internal	Yr4 (2019) External	Yrs 1-4 Totals Internal	Yrs 1-4 Totals External
SHyNE Publications	**230**	**26**	**279**	**30**	**358**	**43**	**367**	**30**	**1234**	**129**
NNCI Publications-Total	n/a		703		1136		1692		**3760**	
SHyNE / NNCI (%)	*n/a*		*40%*		*32%*		*22%*		***33%***	

Patents	Y1 (2016)	Y2 (2017)	Y3 (2018)	Y4 (2019)	Y1-4 Totals
	55	64	59	72	250

CHICAGO QUANTUM EXCHANGE
THE UNIVERSITY OF CHICAGO · WISCONSIN · ILLINOIS · Northwestern University · Argonne NATIONAL LABORATORY · Fermilab
IBM · BOEING · rigetti · ColdQuanta · Quantum Opus · HRL LABORATORIES · APPLIED MATERIALS make possible

National Nanotechnology Coordinated Infrastructure · NSF · SHyNE Soft Hybrid Nanotechnology Experimental Resource · THE UNIVERSITY OF CHICAGO · Northwestern University

SHyNE: Growth in External Users

Identify Users | **Communicate** | **Consultation** | **Onboarding**

External Users
- Academic
- Small Company
- Large Company
- Govt/non-Profit

Identify PIs:
- Targeting **URM** Orgs
- Regional Institutions
- Start-ups & SMEs
- Large Companies
- Govt/non-Profits

Networking:
- Referrals, NNCI/Users
- Corporate Liaison Networks
- Innovation HUBs
- Govt. Economic Development Offices
- Regional Partners

Targeted Contact:
- Invited Seminars
- Workshops/Demos
- Direct Mail / Email
- Invited Webinars
- Hosted Conferences

Outreach:
- Website, Social Media
- Brochures
- Open Houses
- Conference Booth

URM inclusion statement

Technical Discussion
- CTO project mtgs
- Web Meetings

Statement of Work

SEED funding
- Trial Runs
- 50% URM Institutions

Contact Tracking:
- Follow-up
- Referrals

Efficiencies:
- Non-Disclosure Agreement
- Lab Services Agreement
- Purchase Orders

Satisfaction Survey:
- Continual improvement
- Referral Forms
- URM demographics

ART INSTITUTE CHICAGO · CHICAGO BOTANIC GARDEN · bp · ILLINOIS INSTITUTE OF TECHNOLOGY · Argonne NATIONAL LABORATORY · Abbott · Baxter · SHURE · Fermilab · MONSANTO · UIC UNIVERSITY OF ILLINOIS AT CHICAGO · excicure · Cabot Microelectronics · The Field Museum

National Nanotechnology Coordinated Infrastructure · NSF · SHyNE Soft Hybrid Nanotechnology Experimental Resource · THE UNIVERSITY OF CHICAGO · Northwestern University

SHyNE: Integrated & Comprehensive Approach

Outreach and Education

Diversity and Inclusion

- Nano-Journalism, Social Media
- Nanotech Exhibits, Museums
- Lecture series, iNANO, M3S

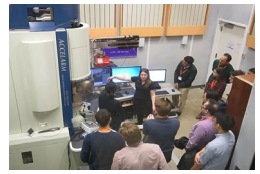
Public, Community

- Science Chicago, Regional outreach
- Chicago Museums, URM community
- Women in Nano, SWE, SBE hiring

- Industry Workshops, Demos
- Vendor Relations
- SEED Funding, Targeted Marketing

Industry, Entrepreneurs

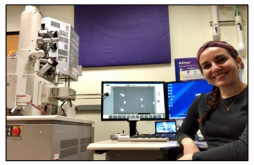
- Diversity Survey - demographics
- - external user onboarding
- - Improved tracking and metrics



- Seminars, Courses, User meetings
- Technical Workgroups
- Proposal Development

University, Faculty

- Targeting URM universities
- Diversity Survey – demographics
- Coordination: Dean Williams



- REU – Workforce Development
- CC Internship Program
- Open House, Image Contest

Comm. College, Undergrad

- SHyNE REU - 100% Women/URM
- Community College interns
- MRSEC REUs

- RET - curriculum Development
- Science in Society (SiS) - camps, science clubs, Boys/Girls Clubs, URM
- Lab Tours, Demos, Remote Learning

K-12

- RET 100% URM teachers
- SiS Targets Chicago schools,
- Diversity Survey – demographics
- Tracking outcomes

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SHyNE: Network Collaborations & Activities

Across the Network

- NNCI Subcommittees & Working Groups
- Staff Exchange Initiative
- Research Communities:
  - Quantum, Rules of Life
- Regional Coordination: iNANO-Illinois Nano Centers Consortium, CBC
- Global connections: KAIST, NTU, TUM..
- SHyNE Resource - 2020 NNCI Annual Meeting, Oct. 26-27

Multi-Site

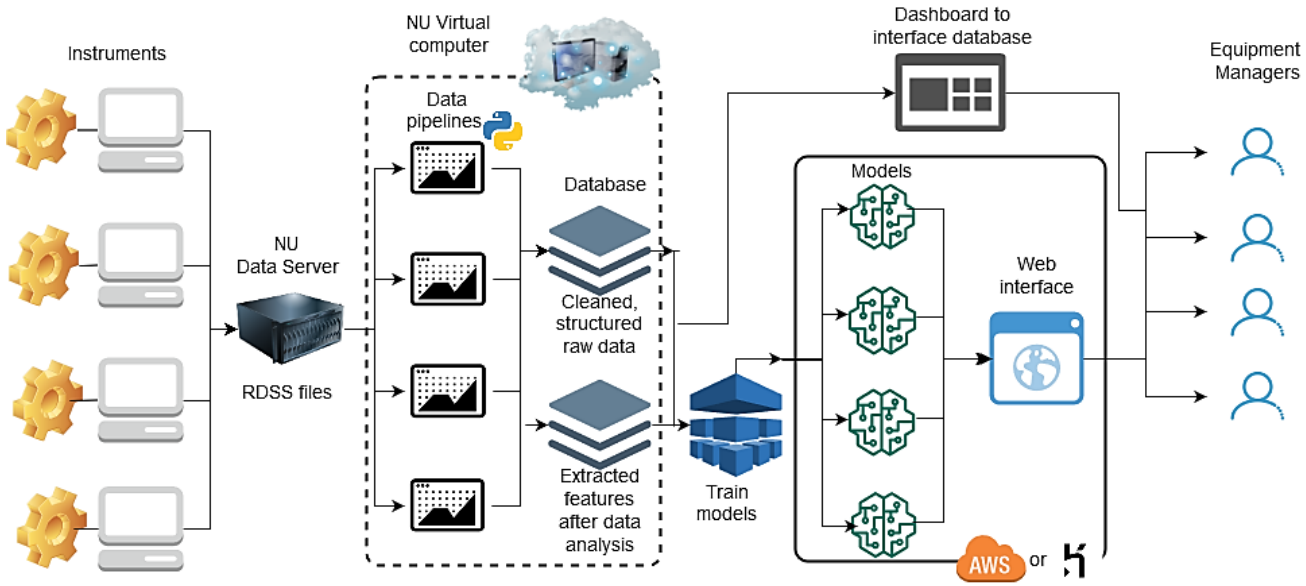
- RET/REU Proposals
- Webinars, Working groups

On Behalf of the Network

- USA Science & Engineering Festival - SHyNE staff
- NSF-MFRN Shared Facilities Workshop

Machine Learning for Predictive Maintenance

- SHyNE staff - new development
- Predictive maintenance - before the failure!



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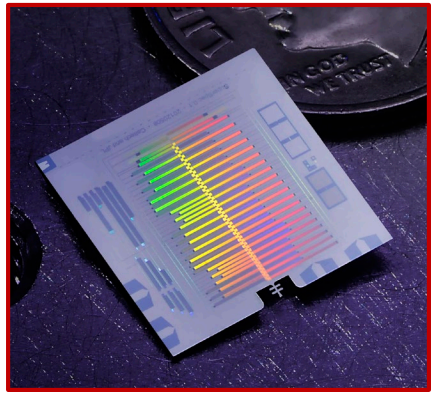
SHyNE: Year 5 – 10 Plans & Beyond

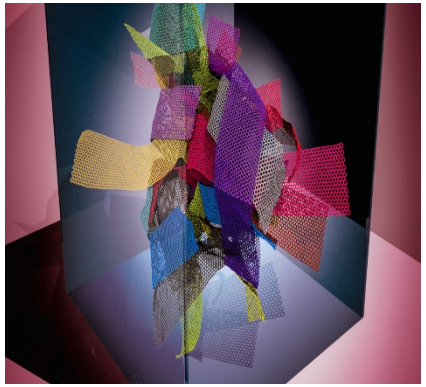
Intellectual Merit

- **Continued excellence - Soft & Hybrid Nanotechnology**
  - Food, Ag products, Biomaterials and Nano-Bio interfaces
  - "Energy-Enviro-Water-Food" Nexus
  - Quantum Information Systems – leveraging Nano Infrastructure
- **Collaborations within and beyond NNCI: Federal, Industry, Non-Profits, Foundations, Museums and Public Institutions**
- **Growth of External Academic & Industry Users**
  - Multifaceted and Coordinated Approach
  - Expanding SHyNE SEED funding and Enhance TEG interactions
  - Open houses, short courses, webinars and workshops
  - ➔ ***New A/B Space: One-stop-shop & problem solving***
- **Data Science Initiatives – CHiMaD and MRSEC collaborations**
  - Predictive Maintenance, Material Genome, Data mining…
- **New/Future Opportunities and Diversification**
  - Extra-Terrestrial Materials Analysis, Covid-19 aftermath

Broader Impacts:

- Integrated & Comprehensive Approach
- Regional Coordination:
  - iNANO, URMs, Community colleges
  - Science Chicago, Nanotech exhibit at Chicago MSI
- Expanding REU and RET programs
- Local Museums: Art Institute of Chicago, Field Museum and Botanical Garden





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