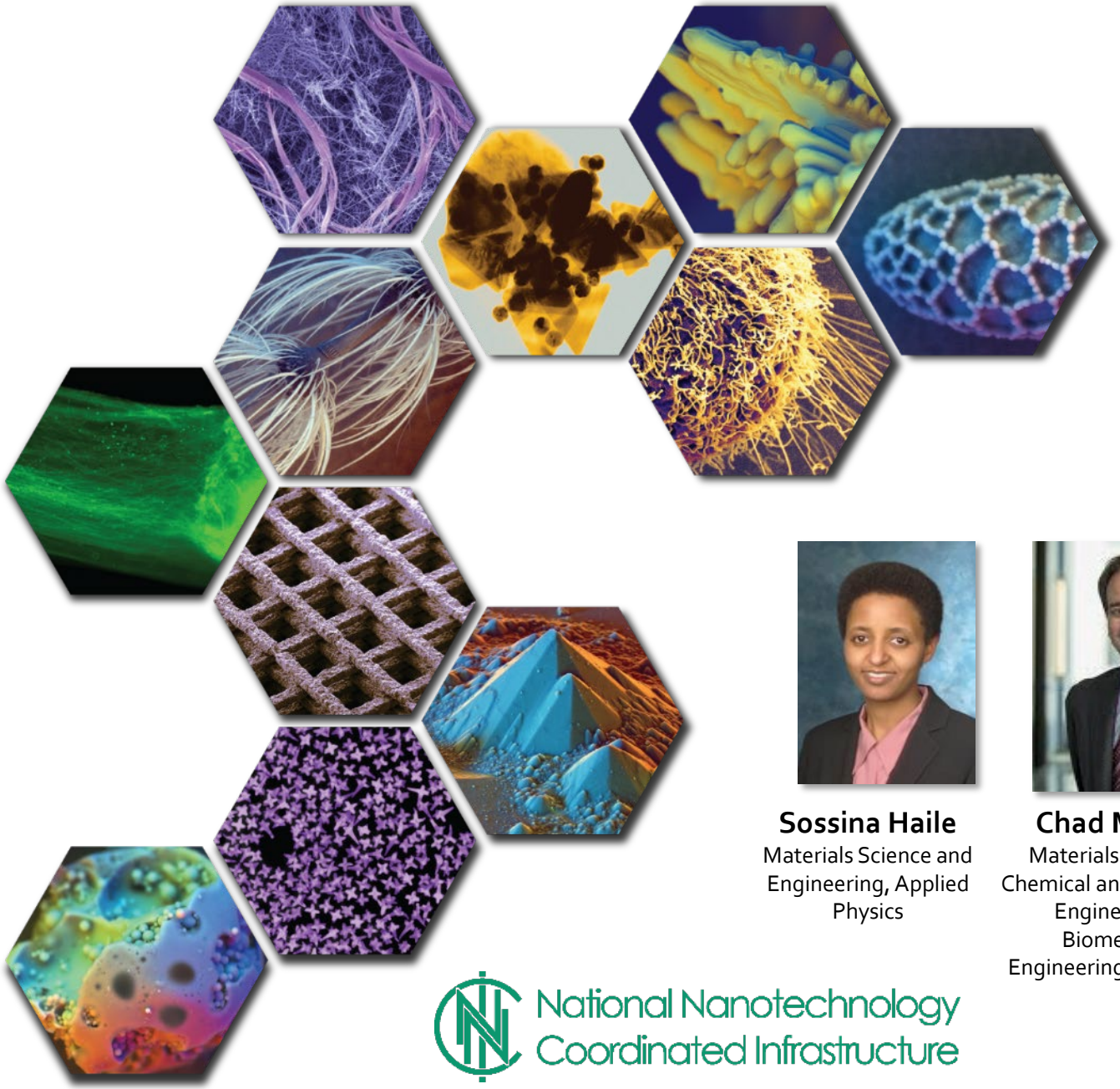


SHyNE

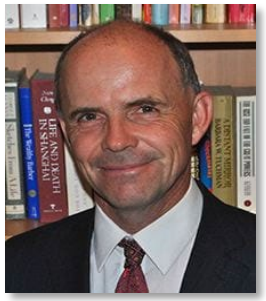
Soft and Hybrid Nanotechnology Experimental Resource

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

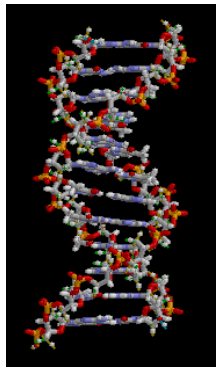
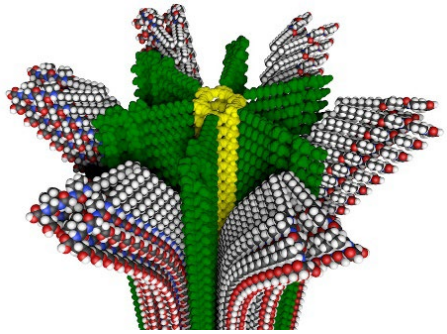
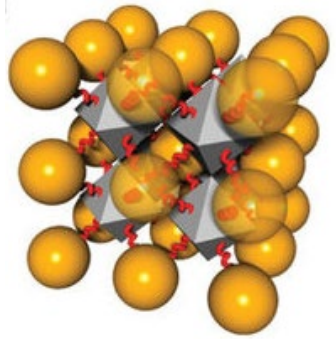


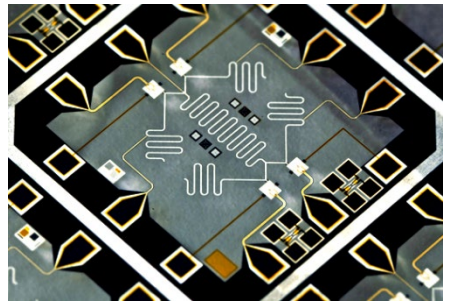
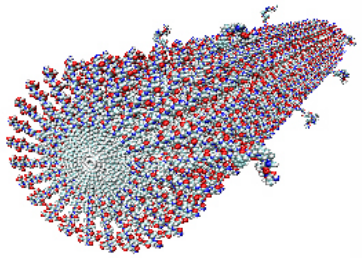
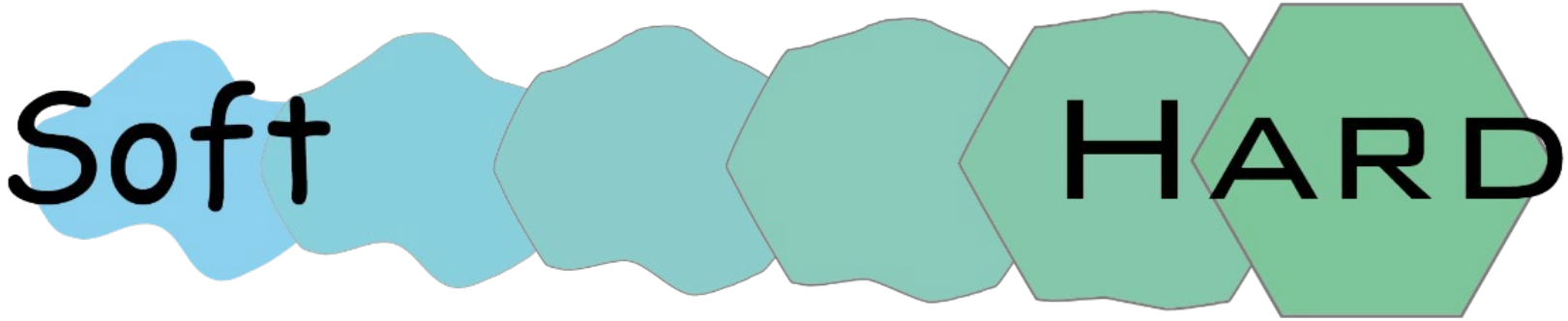
Andrew Cleland
Physics, Molecular Engineering Innovation and Enterprise

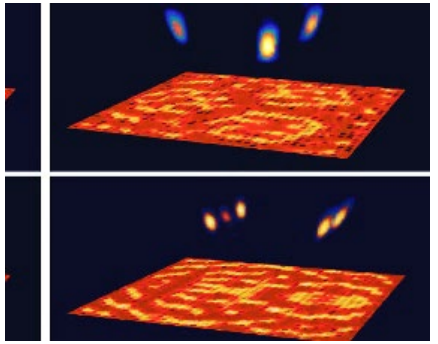
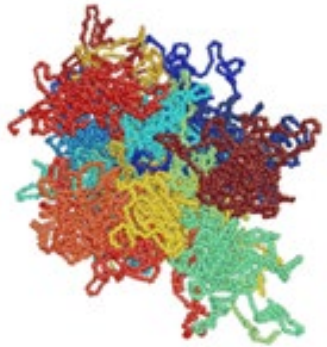
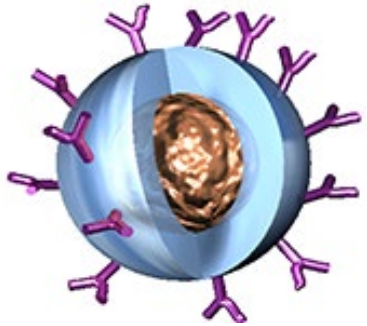
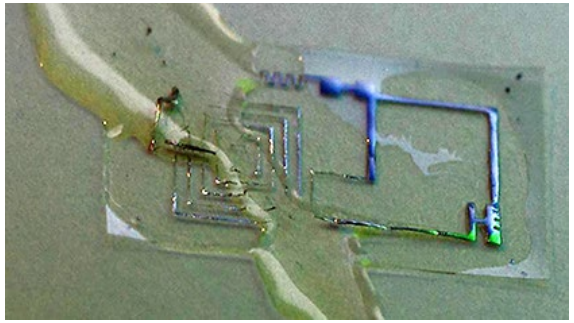
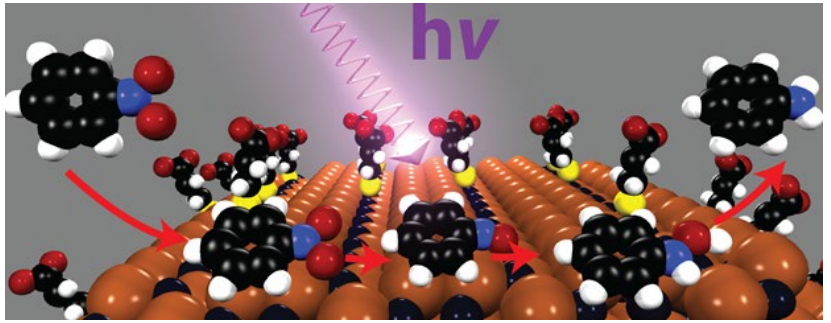
Vinayak Dravid
Materials Science and Engineering

National Nanotechnology Coordinated Infrastructure

SHyNE - Soft & Hybrid (Soft-Hard) Nanotechnology Experimental Resource

SHyNE Resource - *Mission Objectives & Initiatives*

Intellectual Merit :

- ✓ Advancing scientific, engineering research & technology innovation
- ✓ Building infrastructure for research, education & technology
- ✓ Technical training & workforce development
- ✓ Partnerships with local & regional SMEs
- ✓ Forum & town-square for research communities

Broader Impact:

- ➢ Integration of teaching/education with facilities infrastructure
- ➢ Immersion & experiential learning
- ➢ Industrial outreach and external usage
- ➢ Webinar, seminars, demos ‘n visits
- ➢ DEI-specific initiatives and local outreach
- ➢ Museum and regional connections

SHyNE Facilities

SHyNE by the numbers

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

16 Tech Staff – 14,000 sq ft

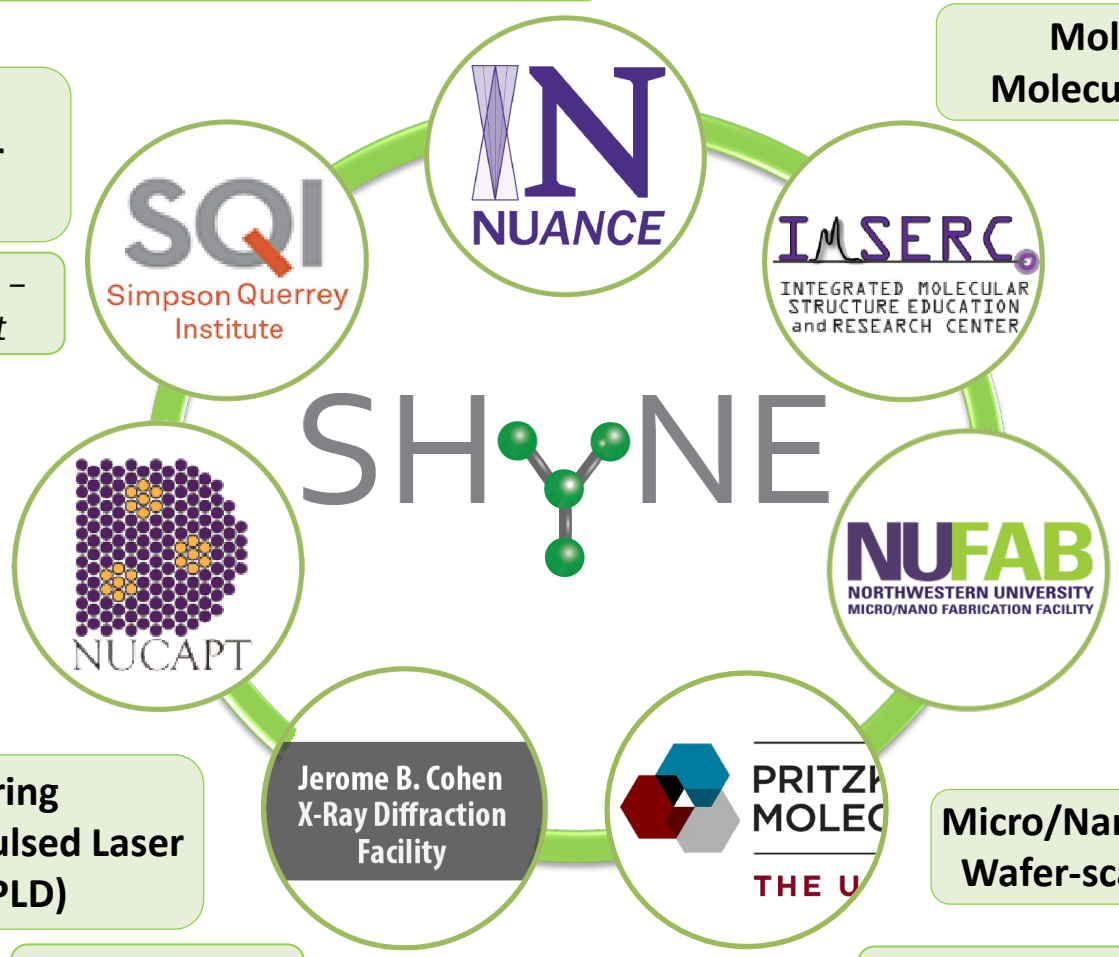
Molecular Nanotech
Molecular Characterization

10 Tech Staff – 12,300 sq ft

Bio-Molecular
Peptide Synthesis/Char
Bio-Physical Interface

5 Tech Staff – 3,400 sq ft

60+ Staff



Micro/Nanofabrication
MEMS, Physical-Bio Interfaces

6 Tech Staff – 9,000 sq ft

Atom-Probe Tomography (APT)

2 Tech Staff – 900 sq ft

$50M+ Tools

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

65,000+ ft² space

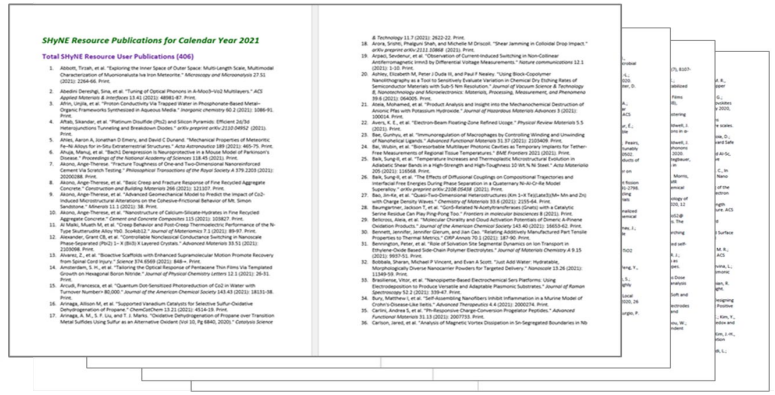
SHyNE by the numbers

SHyNE figures of merit

Years 1-7

1. Economic Impact: **91 start-ups and SMEs** (175 users) spending $770,000 (770 hours)
2. Equipment: **$25M+ new instruments** and tools
3. Products: **2000+ publications;** ~400 annually (10-15% External Users)
4. Engagement: **20,000+ participants** (500+ events)
   - K-12: 2000 students (74 events)
   - Corporate: 550 researchers (71 events)
   - Workshops/Seminars: 4300 community (113 events)
   - Academic Outreach: 4100 faculty/students (150 events)
   - Courses: 10,000+ students (138 courses)

	SHyNE Publications (per calendar year)						
Users	2016	2017	2018	2019	2020	2021	Totals: 2016-2021
Internal Users	230	279	358	367	362	341	1911
External Users	26	30	43	30	39	65	230
Totals	256	309	401	397	401	406	2141



SHyNE Resource – Regional Start-ups

ECONOMIC IMPACT

Querrey InQbation Lab ($150M investment)

- $50M investment from Illinois
- $25M philanthropy
- $75M university/alumni match

- Azul 3D – nanoscale 3D additive manufacturing
- Volexion - graphene-based cathode, Li-batteries
- EeroQ – quantum computing in superfluid helium
- MFNS-Tech – environmental remediation
- MicroMGX – synthetic biological pharmaceuticals
- Flexterra – flexible thin-film transistor devices
- AmphixBIO – nano for regenerative medicine
- NanoGRAF – graphene-based anode, Li-batteries

SHyNE – *Growth in External Users*

Identify Users	Communicate	Consultation	Onboarding

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
- User Demographics

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

SHyNE new equipment in Year 7

BUILDING INFRASTRUCTURE

Tool / Instrument	Description	Funding Source
AJA ACT Sputter	Niobium for Quantum	NU / DOE-SQMS
Raith Voyager 50kV eBL	Electron-Beam Lithography system	NU / NSF-MRI
Osiris Acid Bench	Acid Etch workstation	NU / MRSEC
Osiris Spinner Bench	Developing Station for Lithography	NU / MRSEC
Thermo - Pathfinder Mountaineer System	Dual EDS System for TEM	NU / MRSEC
IONTOF M6 ToF-SIMS	Time of Flight – Secondary Ion Mass Spectroscopy, surface analysis	NU / DOE-SQMS
Protochips Atmosphere	gas injection, *in situ* TEM atomic-resolution imaging and analysis.	NU / DOD-ARO
Protochips Axon	Drift correction, *in situ* TEM on soft and soft-hybrid nanostructures	NU / DOD-ARO
JEOL JIB-4700 FIB/SEM	Focused Ion-Beam	Consignment
JEOL JEM-1400 TEM	Cryo-bio imaging and analysis	NU / HHMI
Gatan OneView Camera	4k x 4k electron detector for TEM	NU / HHMI
Protochips Axon	Drift correction, *in situ* TEM on soft and soft-hybrid nanostructures	NU / DOD-ARO
Gatan Rio detector	CCD Electron Detector for TEM	NU / DOD-ARO
Gatan Moreno	Heating Stage, in situ SEM Analysis	NU / MRSEC
Gatan Elsa	Cryo-TEM holder	NU / DOD-ARO

BUILDING INFRASTRUCTURE

Semiconductor Microelectronics Nanofabrication Infrastructure

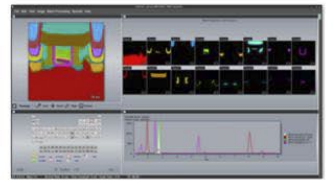
Biological-Cryogenic Electron Microscopy (BioCryo) facility

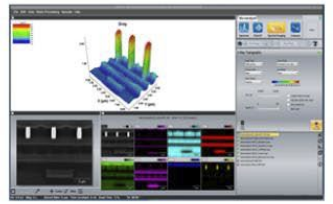
New Instrumentation

JEOL 3200FS 300kV TEM
- in-column energy filter
- K2 direct electron detector

JEOL 1400 120kV TEM
- OneView Camera

Thermo Dual EDS
- HD2300 STEM





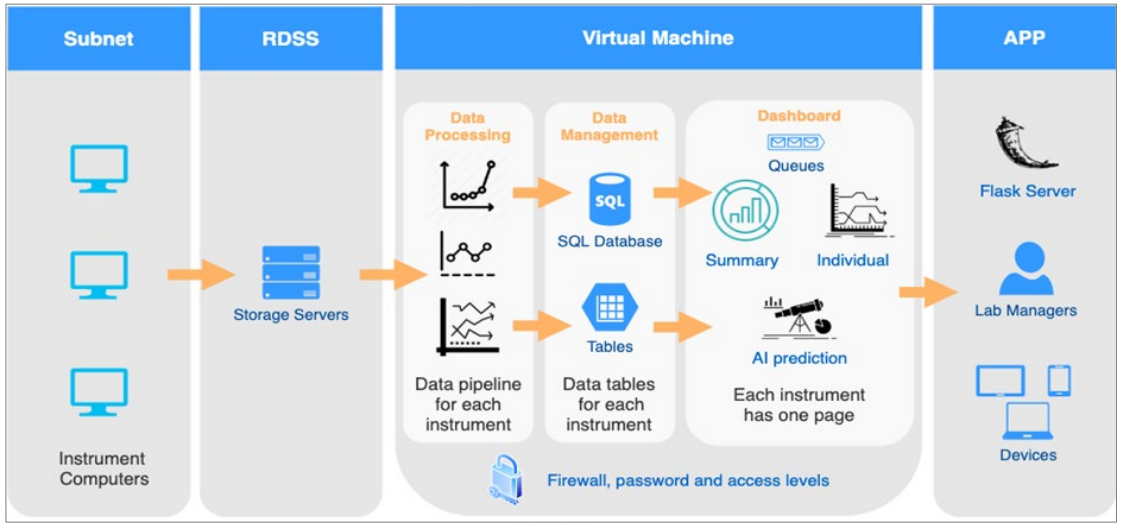
2x

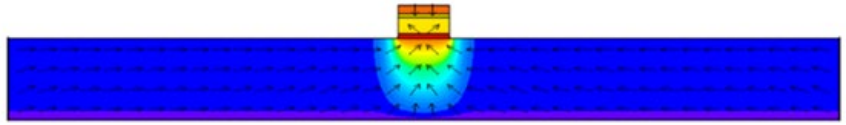
Space:
- *New AB Wing: 6400+ sq Ft*
- *Additional clean room (class 100/1000): 2000 sq ft.*

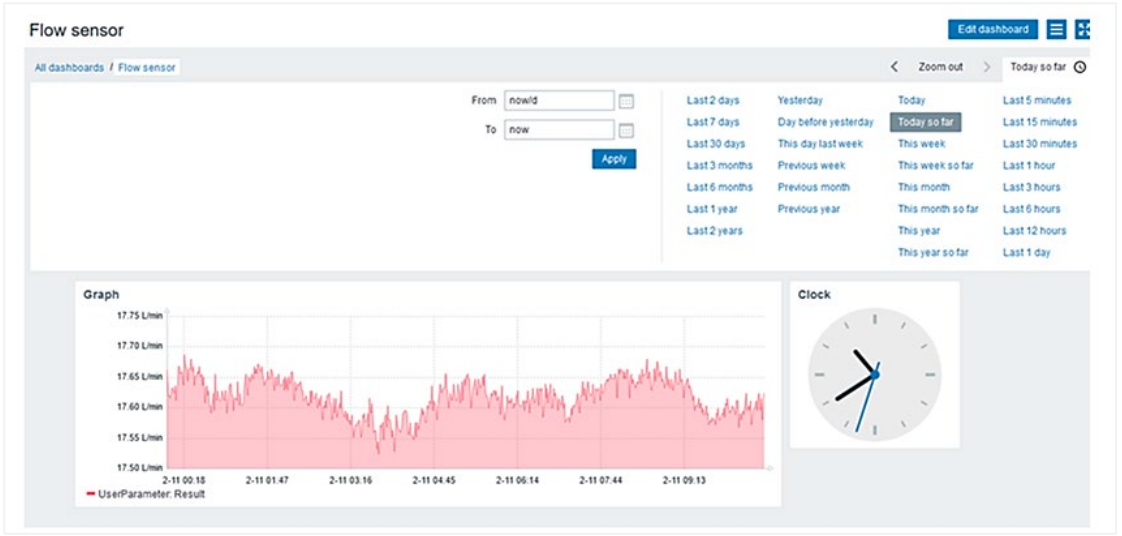
Staff & Instruments:
- *13+ new staff (across SHyNE)*
- *>$10+M new equipment (EM, XPS, SIMS, Nb/Ta fab)*

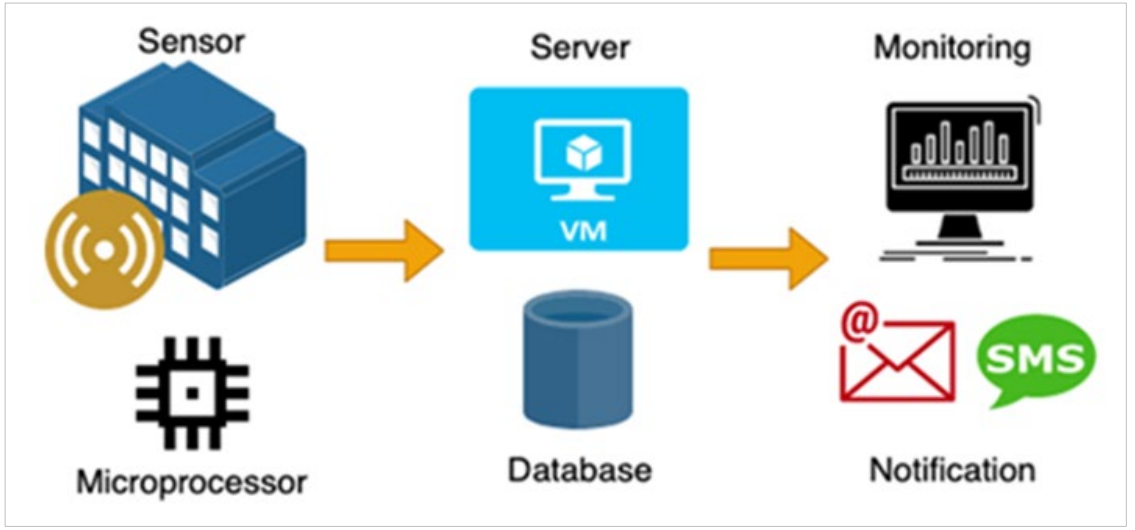
SHyNE Resource - Future Plans: Predictive Maintenance

FUTURE DEVELOPMENTS





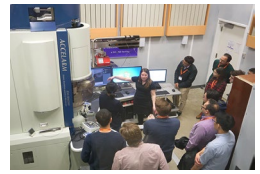
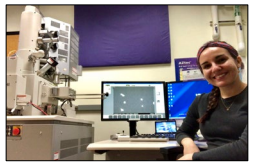




NU*ANCE* data management includes computational imaging efforts and equipment and facility predictive maintenance. Predictive maintenance program allows facility managers to detect equipment problems before the failure occurs and prescribe remedies with the assistance of machine learning algorithms.

Figures - CRM that incorporates eight different core instruments in the cleanroom (Top Left). TCAD simulation of electric field and current flux line in a 3D heterojunction phototransistor (Middle Left). An exhibition of the real-time cooling water flow rate (Bottom Left). The infrastructure of the IoT platform (Top Right).

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 

SHyNE - *Network Collaboration and Activities*

NNCI Network Interactions and National Interactions Initiatives

- ⇔ **Rules of Life (RoL) Research Community**
- ⇔ **Transform Quantum Research Community**
- ⇔ **Global and Regional Interactions (GRI) Committee**

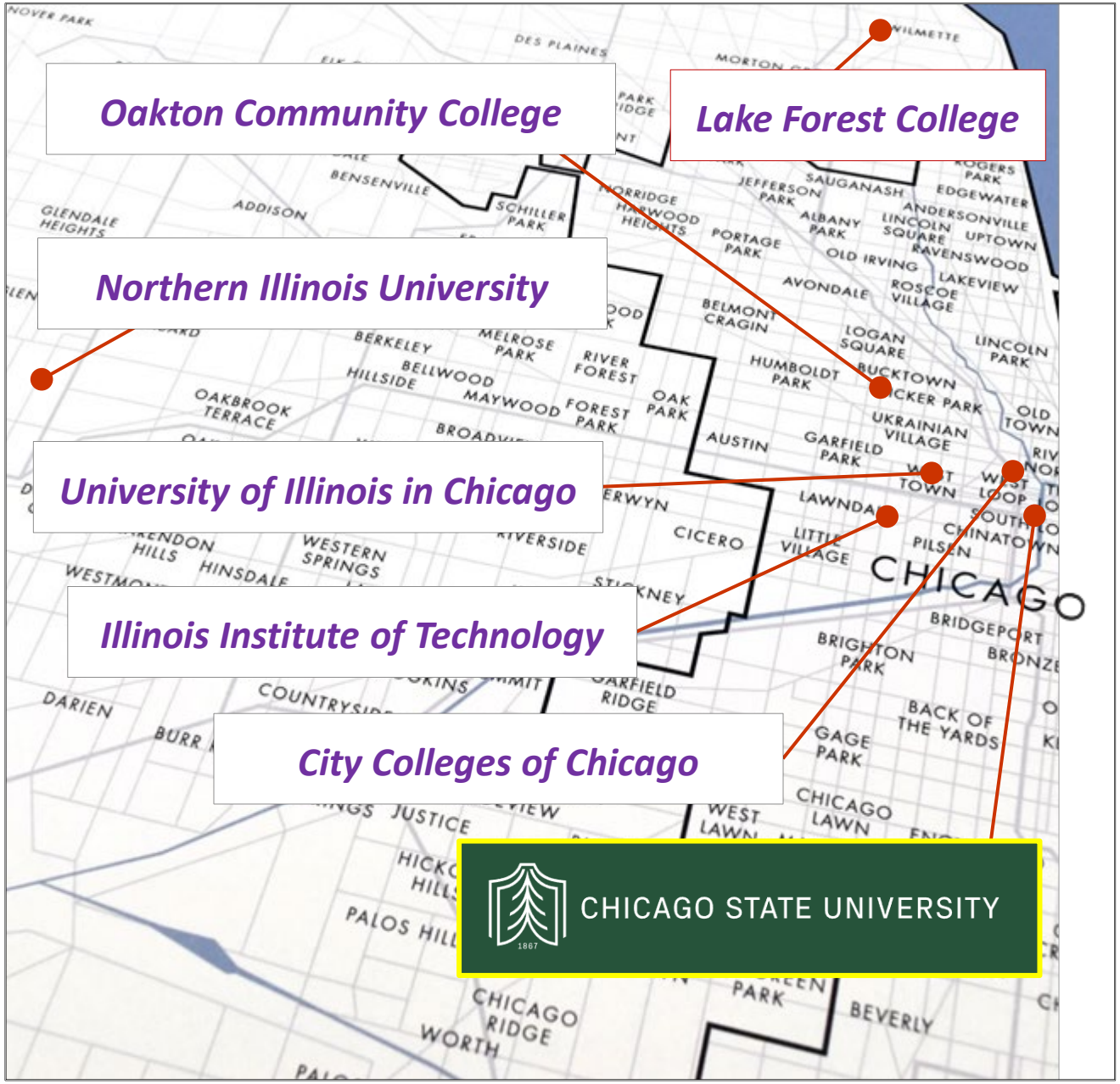
NNCI Annual Meeting Hosted by SHyNE Resource, November 2 and 3 of 2021.

Research Experience for Undergraduates The REU Program

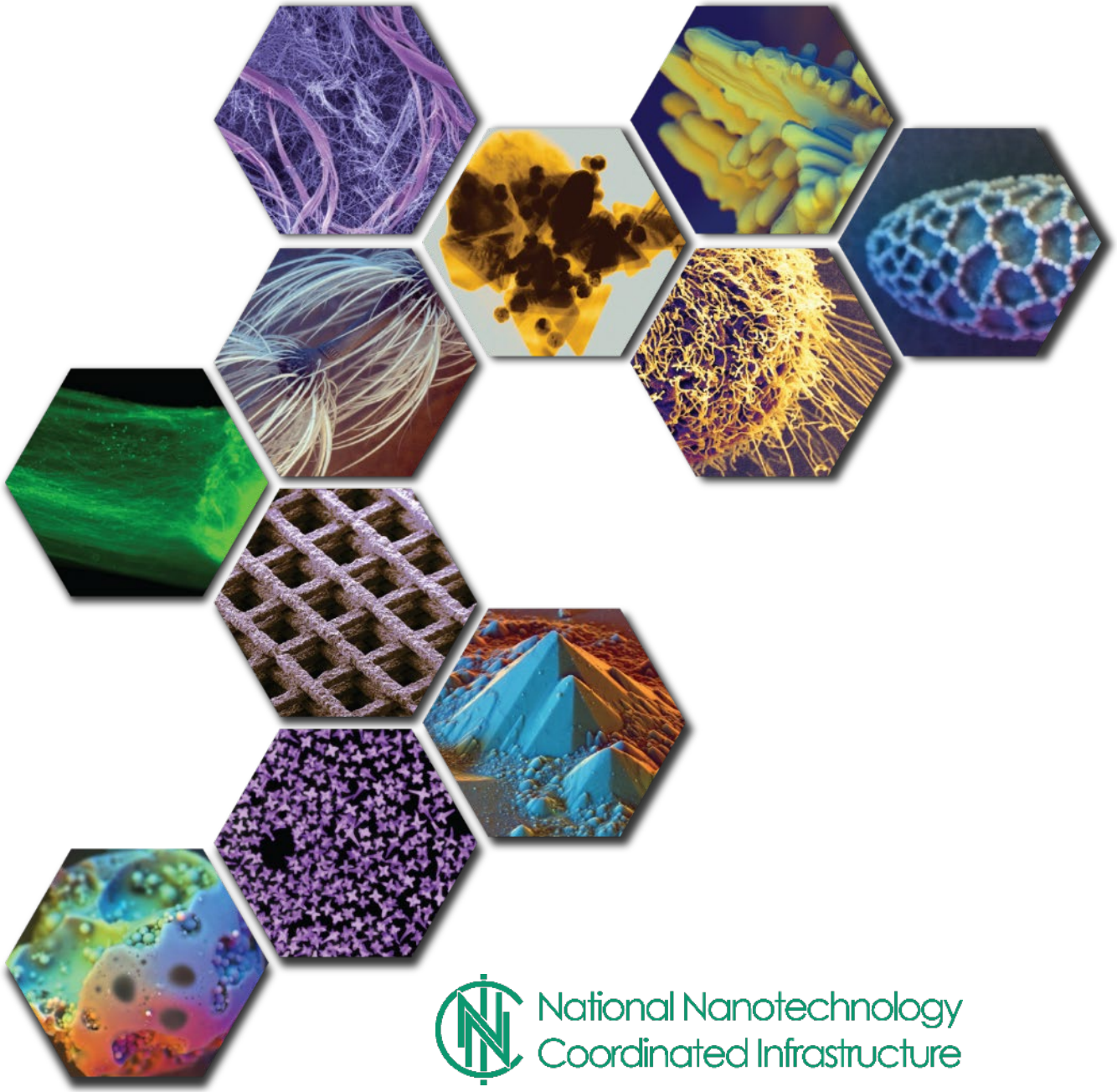
Research Experience for Teachers The RET Program

National Science Teachers Association meeting in Houston

WORKFORCE DEVELOPMENT



Chicago State University Undergraduate Summer Internship



SHyNE
Soft and Hybrid Nanotechnology
Experimental Resource

Discussion

Q & A

National Nanotechnology
Coordinated Infrastructure