

KY MULTISCALE

The NSF NNCI Multi-Scale Manufacturing & Nano Integration Node

“Converging Nanoscale Science and Engineering with Emerging Advanced Manufacturing Technologies”

**NNCI Annual Meeting
Stanford University
Oct 25-27, 2023**



Examples of KY Multiscale Programs, Activities, and Relationships that could be Expanded for Multiple Sites in a Future Network

Actively Target Complementary Research Communities

KY Multiscale Annual Nano + Additive Manufacturing Summit

200 Attendees, 5 Keynotes,
30 Technical Talks, 50 Posters



Should the future NNCI network offer more “Nano + X” Outreach Activities?

What about an NNCI Research Celebration?

We have a successful annual REU Convocation, it is time for the future NNCI Network to host its own nanotechnology Research Conference?

Build upon the success of the Annual NNCI REU Convocation

Audience – Users (faculty, students, post doc, research staff, external users, etc)

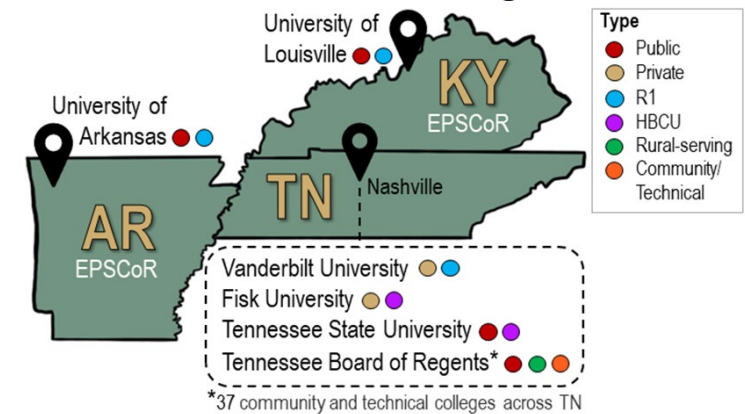
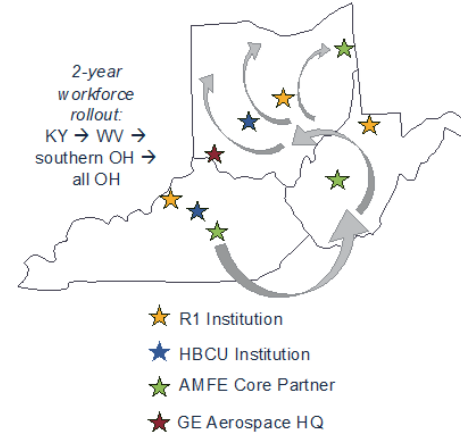
Host in DC to so that the event..

- **Brings more visibility to the research enabled by the NNCI**
- **Is seen by Program Managers**
- **Influences Politicians**

Leveraging Complementary Regional Networks

Some KY Multiscale Examples

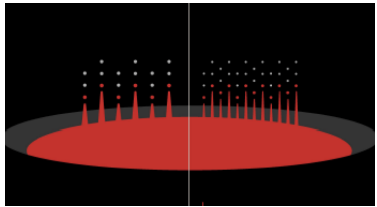
- **NIH KY INBRE Microscopy Network**
 - Kentucky IDeA Networks of Biomedical Research Excellence
- **Midwest MicroElectronics Consortium (MMEC)**
 - Won a DOD ME Commons Hub Award
- **Finalists for a Type 2 NSF TIP Engine**
 - Additive Manufacturing Forward Engine (AMFE)
 - Focus - Moore's Law for 3D Metal Printing
- **NSF BioFoundry Hub Proposal with Vandy**



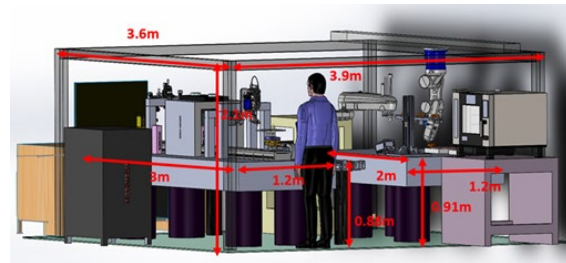
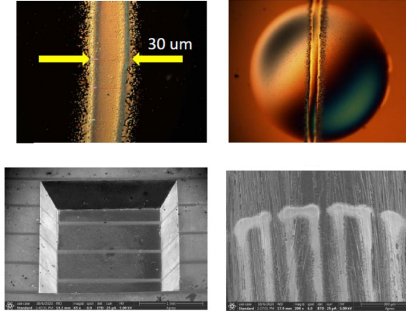
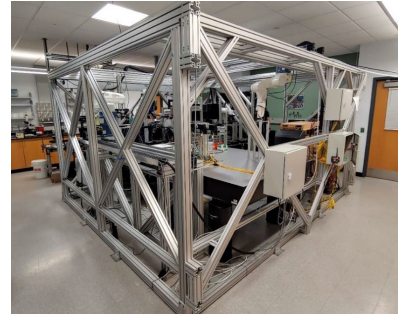
How does the future NNCI network participate with, leverage, and support these regional hubs and networks?

Creative Ways to Purchase New Equipment

- Leverage Infrastructure Programs like the NSF MRI



\$170K NSF MRI Award for an AmazeMet rePowder Metal Atomizer System



\$1.5M NSF MRI Award for a Custom NEXUS Automated Advanced Manufacturing System



- Loan Program to Acquire a New \$900K DRIE System (workhorse tools especially)



\$900K Oxford Deep Reactive Ion Etch System Funded through a University Loan System

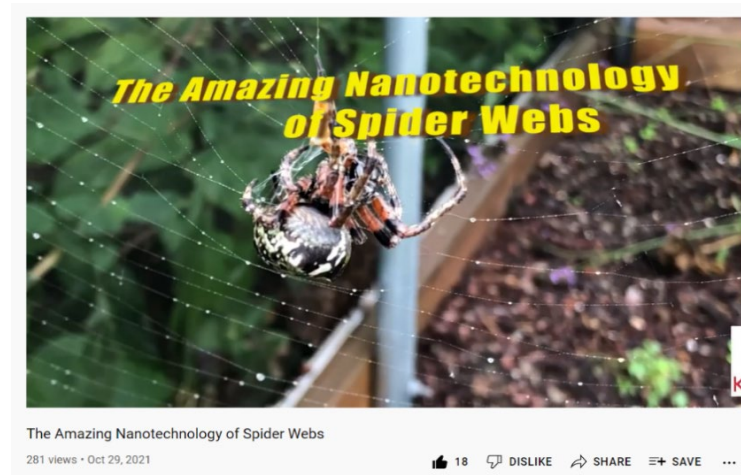
Are there other and better creative ways to acquire new tools?

Importance of a Vibrant Newsletter and Social Media Presence

- KY Multiscale Newsletter now reaches over 16,000 recipients (Ana Sanchez)
- Expansion of our social media efforts during COVID with new engaging videos



KY Multiscale Newsletter – from 8,830 to 16,384 recipients

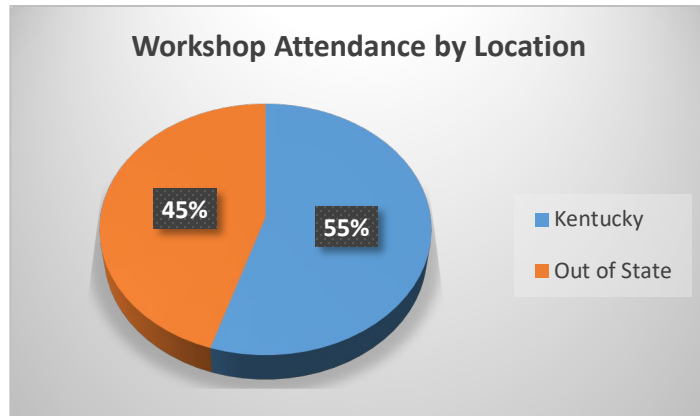


New Spider and Cicada Nano Videos on YouTube

- The NNCI is one of America's best kept secrets? Can the future network enhance visibility?
- For example, should every site have their own newsletter which feeds a central NNCI newsletter?
- Should the future Network expand its Social Media Presence? These efforts require resources.

Importance of Workshops and Seminars

Etch Workshop by Plasma Therm Technical



Vacuum Workshop by Kirk Lesker University



Should the future network lean into this service more heavily?

Expand Seed Programs to further Democratize Nanotechnology

Recipient Name	Industry/Academia	Project Title
Prof Kent McCorkle	Academia – <u>MiraCosta</u> Com College	Octopus Inspired Suction Cup Molds using the <u>Nanoscribe</u> System
Prof Hans Mayer	Academia – California Polytechnic State University, San Luis Obispo (MSI)	Development of New Microelectronics/Microfluidics/MEMS Mask Set for Cal Poly SLO Microfabrication Laboratory
Prof Josh Hood	Academic – UofL Department of Pharmacology and Toxicology	A Microfluidic Device to Fractionate Colloidal Suspensions of Nanoparticles and Nanovesicles
Prof Michael Merchant	Academia – UofL School of Medicine	Lab-on-a-chip approach for the study of archived tissue multi-omics studies
Prof Daniel Moore	Academic – UK Department of Ophthalmology	<u>Nanoplastics</u> in the Human Eye (follow on funding from the Center for Appalachian Research)
Prof <u>Shachaf</u> Polakow	Academia - UofL Arts & Sciences (Fine Arts)	Research into how different perspectives and scales contribute into the artist discourse and definition about landscape art.

- Currently the NNCI website lists 10 sites that have Seed Programs.
- Should the future NNCI Network significantly expand Seed Funding opportunities to lower the barrier to entry and encourage more users?

More Proactively Plug Core Facilities into REU and RET Programs

Our KY Multiscale Cores Support 3 NSF REU and 2 RET Programs at UofL and UK

UofL REU - IMPACT-NG REU (Interdisciplinary *Micro/nano/additive* Program Addressing Challenges Today – the Next Generation)

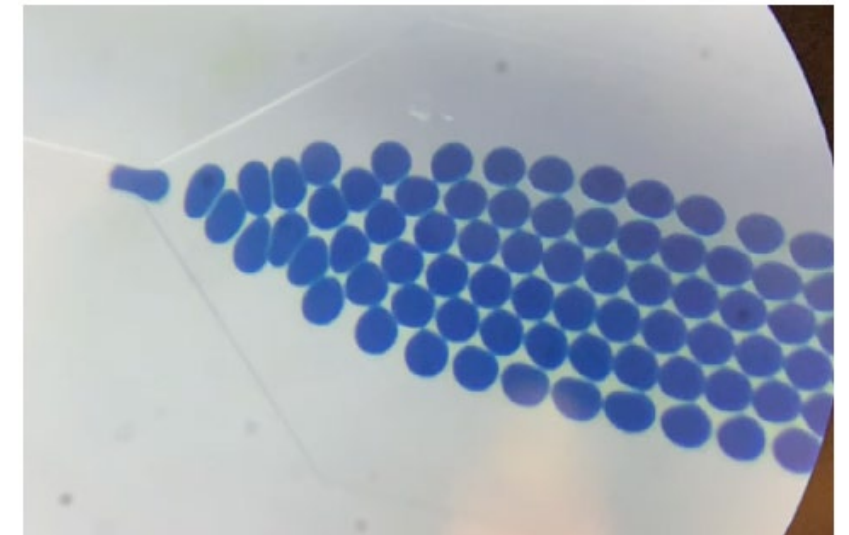
UK REU - Engineered *Bioactive Interfaces and Devices*

UK REU - Research in *Symmetries in Physics*

UofL RET - Reinvigorating *Energy* Teaching via Research with Engineers

UofL RET - *Additive Manufacturing* Automation and Simulation

NSF shows 743 REU Sites. If each site has 10 students, that equates to over 7,000 UG students being trained a year. How can we expose more of those students to our amazing State-of-the-Art Core Facilities?



Lean into Undergraduate Opportunities in the Next Network

1) Allow the future NNCI network to support their own summer REU Programs. This provides continuity and sustainability which 3-year NSF sites do not. Also allow the NNCI sites to be eligible for REU Supplements.

2) Host the Annual NNCI REU Convocation in DC so that it is...

- More visibility (include virtual broadcasting)
- Seen by Program Managers
- Influences Politicians

3) Solicit Best Practices from our NNCI REU Sites

- UofL – Common Hands-on Micro/Nano/Additive Experience during Week 1
- UofL – Mandatory Weekly Progressive Research Talks during Weeks 2-9 (1min, 4min, 5min, ... 8min) where students receive feedback and suggestions by their peers and mentors

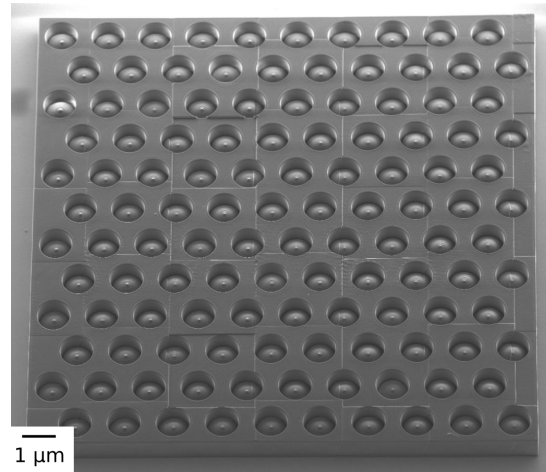
Increase Staff to Allow for More Remote Processing

Nanoscribe Enabled Projects for Education, Outreach, and Undergraduate Research



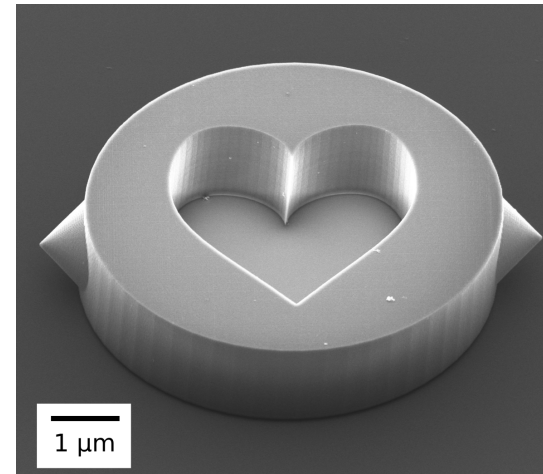
What Nano-Pet should we print?

Cassidy Elementary School with Kristi Fehr (***U.S. Presidential Award for Excellence in Math and Science Teaching***)



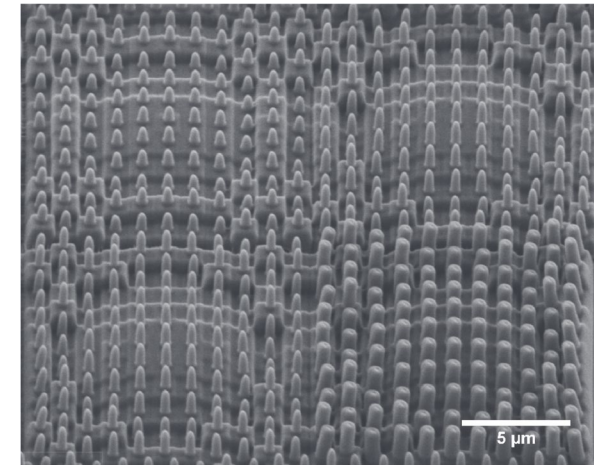
Octopus Inspired Suction Cup Arrays for Human Skin

MiraCosta Community College



Heart Structure for Outreach Program

University of California San Diego



Structural Color Filter Array for Digital Photography

Paul Lawrence Dunbar High School, Lexington, KY (with University of Kentucky)

Prototyping 3D nanostructures with two-photon lithography is ideal for short events and fast projects.

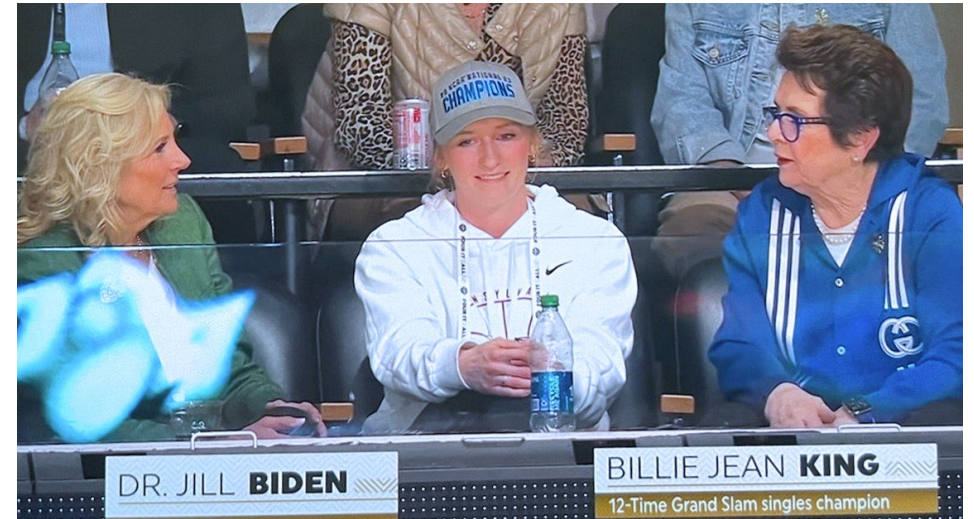
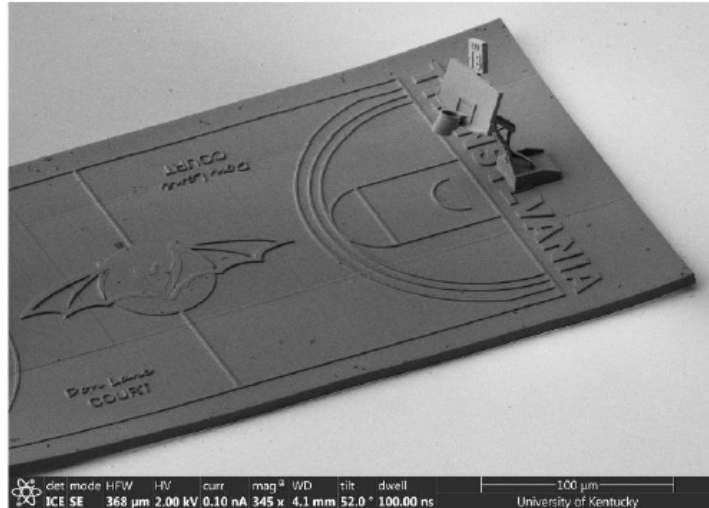
Increase Relationships with Community Colleges

Collaboration with Somerset Community College in KY



Assist Neighboring Academic Entities with Nanotechnology Offerings

UG Interdisciplinary Nanoscience Course at Transylvania University in Lexington (with UK)



Prof Stephen Johnson
(Transylvania Physics),
Prof Belinda Sly
(Transylvania Biology),
and Prof Todd Hastings
(UK ECE)

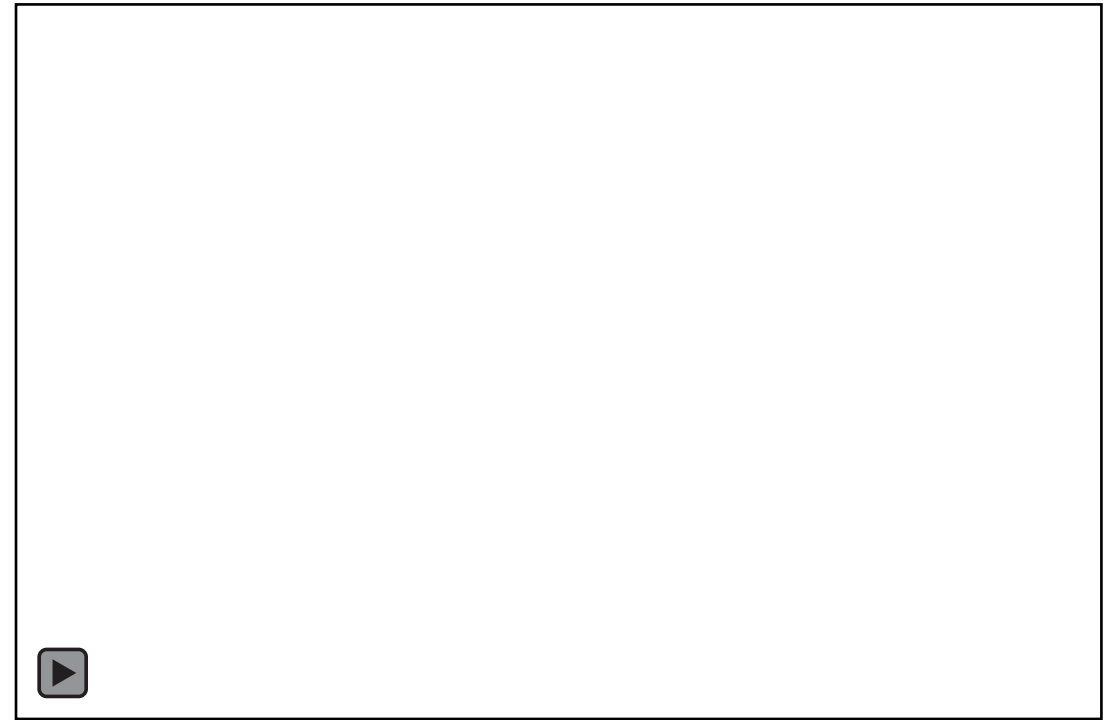
Three-dimensional micro/nano-
structures produced by Transylvania
University undergraduates as part
of an interdisciplinary nanoscience
course conducted in collaboration
with UK's CeNSE and EMC.

Course participant **Madison Kellione**
(with Dr. Jill Biden and Billie Jean King)

- Fabricator of nano-basketball court at left
- Physics major at Transylvania Univ.
- ***D3 Women's Basketball Championship MVP***
- NCAA Elite 90 (highest GPA in NCAA finals)

Fund a National Nanotechnology Competition

Could we start a successful national competition like the Rocket Team and Baha Team Competitions
NNCO was interested in this idea, but it did not take off because of needed team resources



What should the Priorities be for the Future Network

The present NNCI Network is doing all of the following...

- 1) Purchasing, Maintaining and Replacing Equipment (plus few sites have 8" capability)**
- 2) Providing staff needed to support external users (both on-site and remote processing)**
- 3) Addressing the many network administrative, reporting and marketing overhead**
- 4) Developing and funding Workforce Development programs**
- 5) Delivering effective E&O and DEI initiatives**
- 6) Funding Economic Development initiatives**

It is challenging to do all of the above well, especially on a national scale. Some difficult decisions may need to be made.

Thank You



KY Multiscale – Overview and Focus

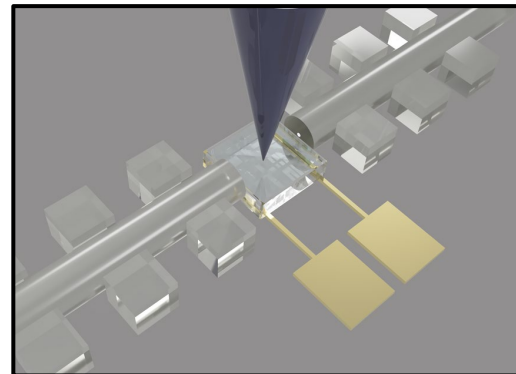
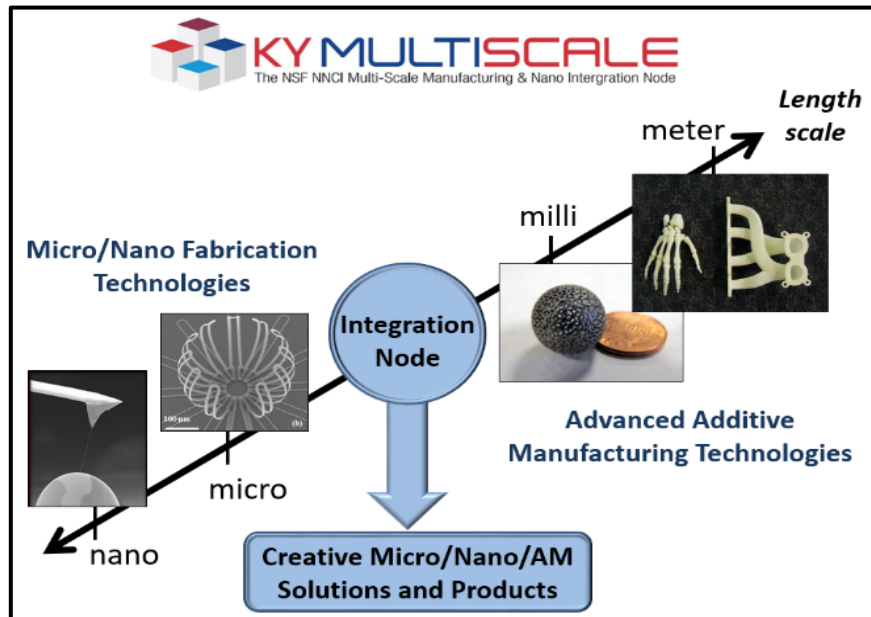
KY MULTISCALE is a new NNCI site between the Universities of Louisville and Kentucky

...that consists of 8 state-of-the-art Core Facilities

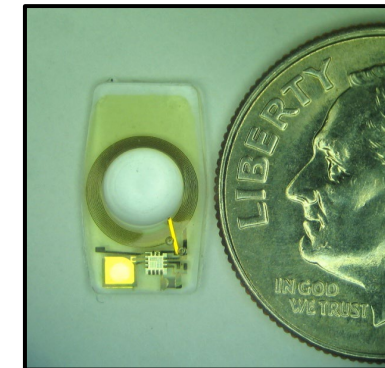
...which provides users the training and ability to perform research and build prototypes

...over various lengthscales and in a variety of material

...using a diverse set of nano/micro/milli/meso advanced manufacturing technologies.



3D printed micro-reservoir for in-situ spectroscopy



Glaucoma sensor for a start-up company



MMEC was 1 of 8 DoD Microelectronics Commons Hubs Selected

- **Midwest Microelectronics Consortium (MMEC)**

- ✓ Three technology areas: Commercial Leap Ahead (CLA), Quantum, and Electromagnetic Warfare (EW) systems addressing emerging platforms, directed energy applications,
- ✓ The University of Louisville's MMEC focus area is CLA
- ✓ MMEC awarded \$24.3M for FY24 with 65 members
- ✓ More details on projects and funding logistics will be announced soon.



*The map was based off of data provided as of September 15, 2023.

Additive Manufacturing Forward Engine (AMFE)

NSF Regional Innovation Engine Type 2 Proposal Through TIP Directorate

VISION: AMFE will implement rapid advances in metal 3D printing deposition speed (**Moore's Law for 3D Metal Printing**), which will result in AM entering mainstream manufacturing sectors. This regional innovation engine will sustainably produce an inclusive, AM-trained workforce.

Currently one of 16 finalists, with 5 targeted to be selected. **Up to \$160M for 10 years!**

AMFE PARTNERS

R1 Universities Delivering Technical Capabilities

WV THE OHIO STATE UNIVERSITY UNIVERSITY OF LOUISVILLE

Corporate Partners Delivering POs

ASTRO ASTRO Raytheon Technologies LOCKHEED MARTIN BOEING SIEMENS intel Honeywell Lam RESEARCH NORTHROP GRUMMAN GE Aviation

Workforce Development Delivering AS, BS, MS, PhD

CENTRAL STATE UNIVERSITY America Makes KENTUCKY STATE UNIVERSITY MEVStim WEST VIRGINIA Community & Technical COLLEGE SYSTEM KENTUCKY Community & Technical COLLEGE SYSTEM

Translation Into SMB

STIFEL America Makes

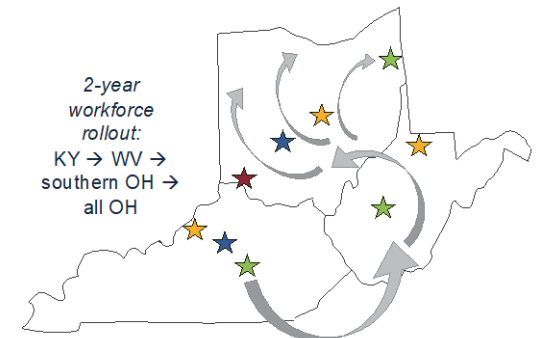
THE REGION

Two EPSCoR states (KY and WV) + one mature economy state (OH)

- > KY is home to major auto manufacturing facilities + logistics hubs for air and ground freight; WV holds wide range of auto, aerospace, and energy suppliers
- > OH has strong auto and aerospace & defense presence plus a growing semiconductor sector
- > Workforce participation below U.S. average in all three states; high need for increased economic resiliency

Tightknit AM research community

- > 3 geographically close R1 institutions (3 hrs X2, 6 hrs X1)
- > Ability to share infrastructure
- > History of cooperation



- ★ R1 Institution
- ★ HBCU Institution
- ★ AMFE Core Partner
- ★ GE Aerospace HQ

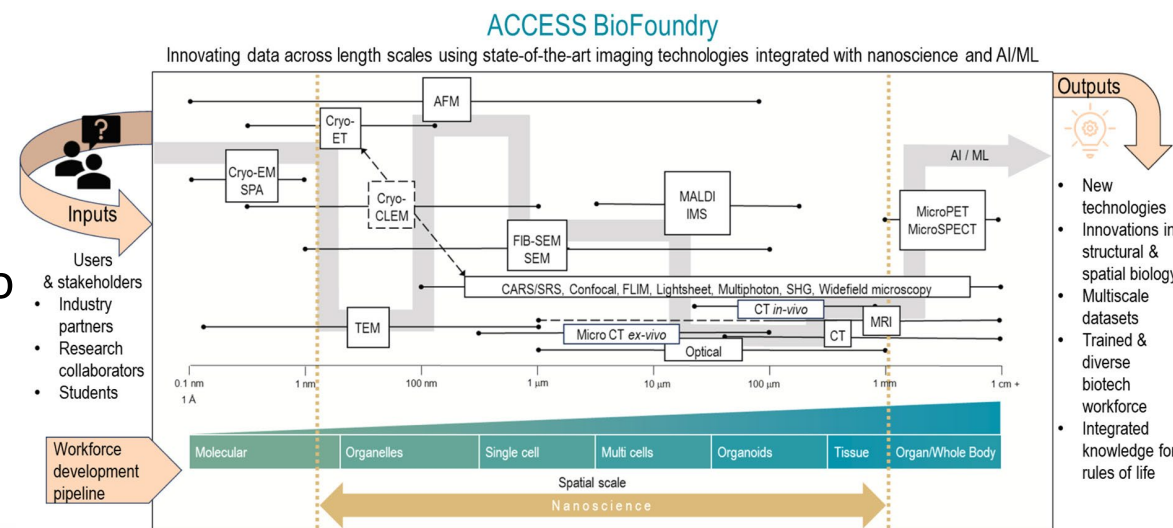
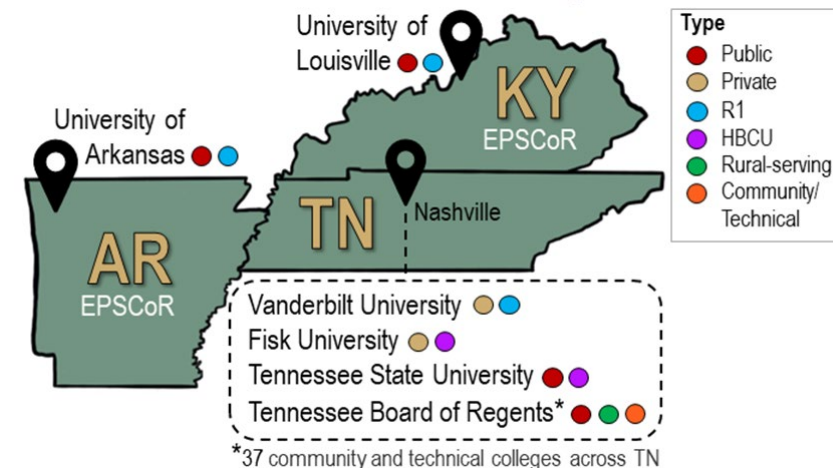
NSF BioFoundry Hub Proposal with Vandy

- **Regional Biofoundry - \$20M for 6 years**
: **ACCESS- Accelerating Discovery of the Rules of Life through Multi-scale Structural and Spatial Biology.**

- Hub-and-spoke, user-facing, comprehensive regional infrastructure for research, innovation, and workforce training
- Integrate advanced imaging technologies across scales, from angstroms to whole organisms
- Convergence of imaging sciences, nanoscience and technology, artificial intelligence (AI), and data science

- **User Facility**

- Knowledge sharing, enabling activities, and training to empower the community
- Equitable and inclusive access of the user facility and expertise to the community.



UofL MNTC is designated as Louisville Research Core (LRC)

- **UofL's new core facility support program by the office of Research and Innovation**
 - ✓ Jewish Heritage Fund (\$3M)+ Executive Vice President for Research and Innovation (\$2M) – investment for 3 years to LRCs
 - ✓ Investment in strategic staff and equipment within UofL LRCs – bolster scientific and Service capabilities in LRCs
 - ✓ Investment in the UofL Coordinated support Infrastructure for Core facilities- Elevate Core Management Ecosystem to best-in-class
 - ✓ Investment to incentivize LRC Use and Engagement



Jewish Heritage Fund

Educational Workshops of a Nanotechnology Paired With Scaled Version

Microfluidics Device Workshops

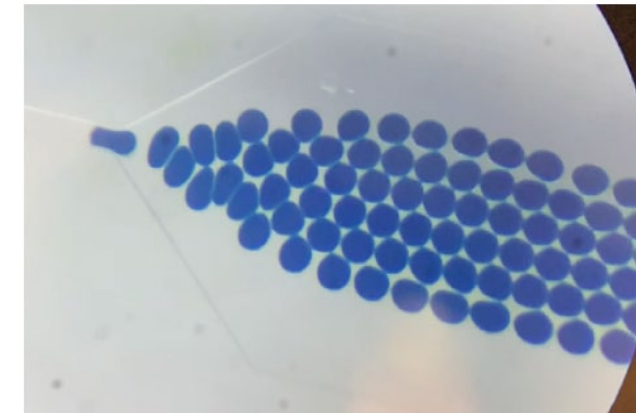
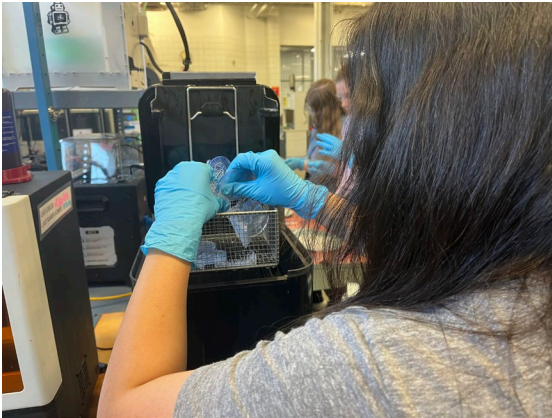
2 Day Workshop in Additive Manufacturing Lab

Followed by

2 Day Workshop in Cleanroom Facility

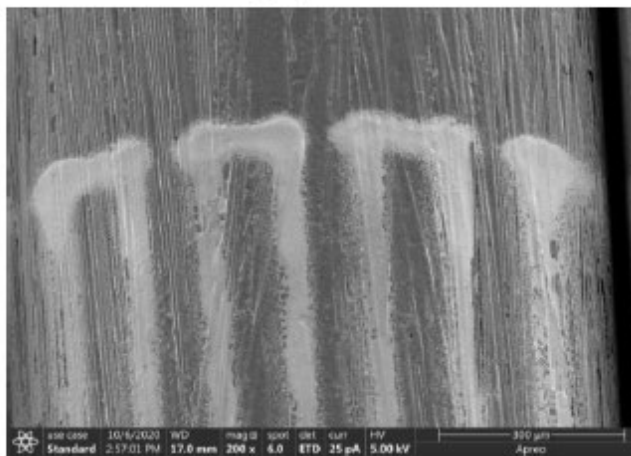
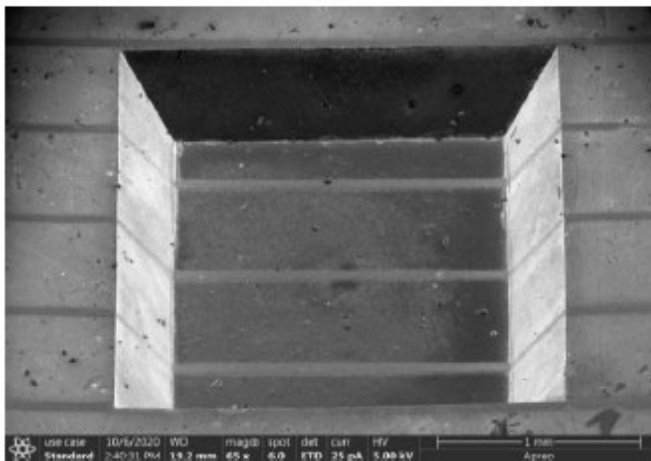
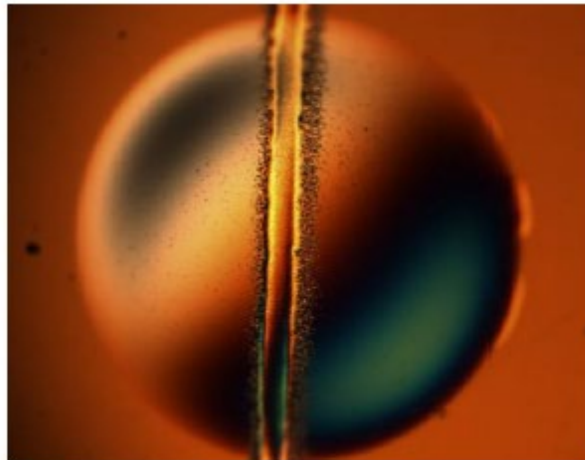
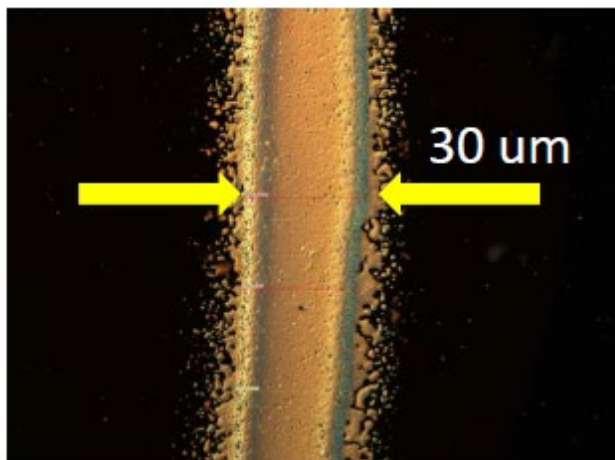
Learn fundamentals, visualize process

Contrast performance with micro/nano-scale versions



Extensions to Other Micro/Nanotechnologies or Devices

- Packaging and Thermal Management
- Design of Folding or Movable Structures (MEMS with hinges, etc.)
- Flexible Electronics
- Transistors/Microelectronics



More Extensive NNCI Tool and Expertise Data Bases - ANA

ANA to work on this slide

- **Wafer size – demand for 8 inch**
- **Each Site should have edit authority for ease of updating**
- **Also Expert Data Base**


More Extensive NNCI Tool and Expertise Data Bases - ANA

Revitalize and Boost the Popularity of the NNCI Tool and Expert Database:

1. Sites have edit authority for entries and updates
2. Comprehensive Template for advanced searches
3. SOPs and Training videos available to entire network


Find a Tool

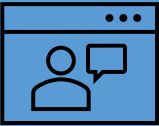
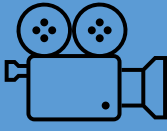

DEEP REACTIVE ION ETCH



Process Area: Etching
Manufacturer: _____
Model: _____
Description: _____

Process Capabilities: _____
Substrate Size: _____
Materials: _____

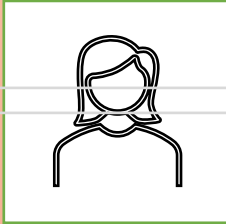
@ NNCI SITE:


 **Contact Expert**  **SOP Video**  **Educational Videos**


Searchable Fields

Find an Expert



JANE DOE, Ph.D.



Research Areas of Expertise:
✓ Microfluidics
✓ DNA Sequencing
✓ Ion Sources
✓ Mass Spectrometry
✓ Chromatography

@ NNCI SITE:


CV
Pubs
Current Grants
Contact Me

 **LinkedIn**
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Experts by Area