KY MULTISCALE
The NSF NNCI Multi-Scale Manufacturing & Nano Integration Node

Micro/Nanotechnology Capabilities and Opportunities within the Commonwealth

Kevin Walsh
Associate Dean of Research and Graduate Studies
Speed School of Engineering
University of Louisville
Feb 23, 2022

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Brief History…
How we got to where we are today?

Brief History

1990s and early 2000s – UofL, UK, and the State of KY (leveraging federal and state programs like NSF and DOE EPSCoR) began investing in the key critical areas of Advanced Manufacturing, Advanced Materials, and Nanotechnology with the goals of…

a) attracting highly productive faculty

b) increasing university research productivity

c) training the STEM workforce of tomorrow

d) catalyzing economic development

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Example of Investment

Shumaker Research Building (SRB)

- $60M, 120,000 sq ft Research Building
- Opened 2006
- Micro/nano/bio Research Theme
- Interdisciplinary Research
  - Engineering
  - Physics and Chemistry
  - Biology and Medicine
- MicroNanoTechnology Core Facilities
  - $30M Cleanroom (10,000 sq ft)
  - Design
  - Fabrication
  - Imaging and Characterization
  - Packaging
  - Prototyping and Small-scale Production
- Top 20 Cleanroom in USA

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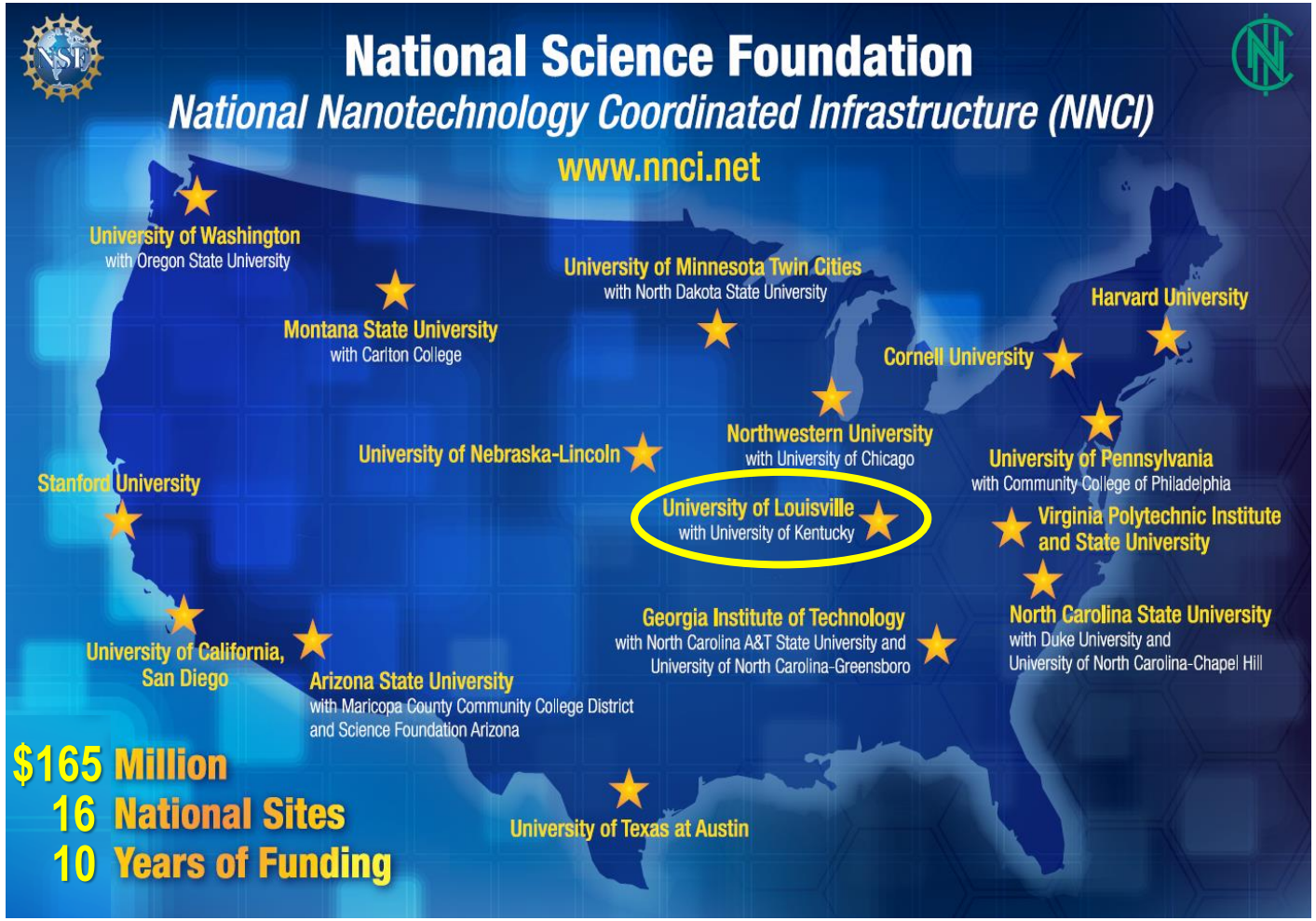
UofL and UK get selected to be part of the NSF NNCI ?

- **NNCI** – National Nanotechnology Coordinated Infrastructure network
- Funded by NSF for 10 years (2015 to 2025)
- Network of 16 premiere nanotechnology core facility sites in the USA
- **Goal of the NNCI** – provide *researchers from academia, small and large companies, and government with access to state-of-the-art university user core facilities* with leading-edge fabrication and characterization tools, instrumentation, and expertise within all disciplines of nanoscale science, engineering and technology.



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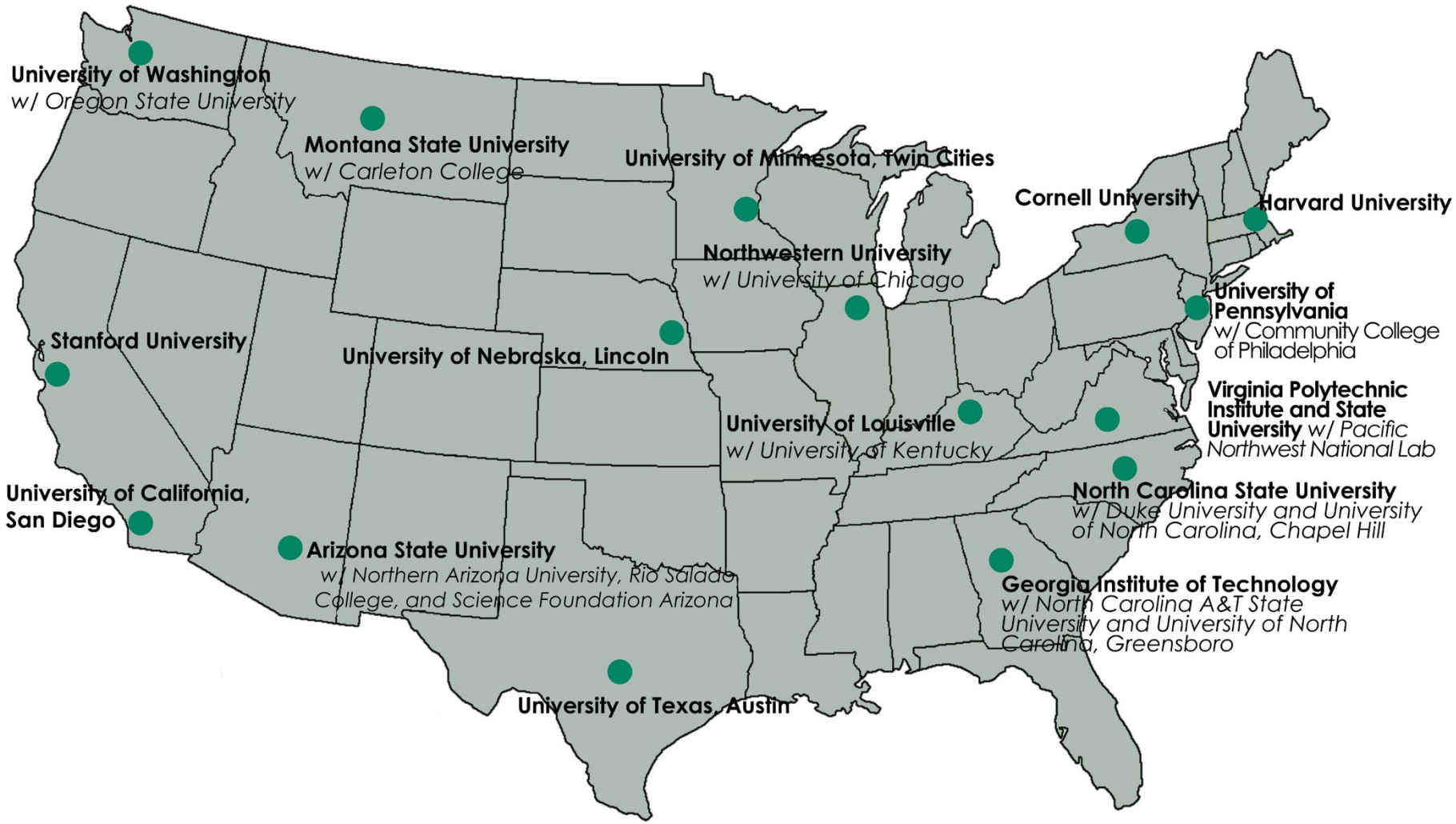
Each of the 16 NNCI Sites have a theme



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

NSF Funded
2015 - 2025
$165M total

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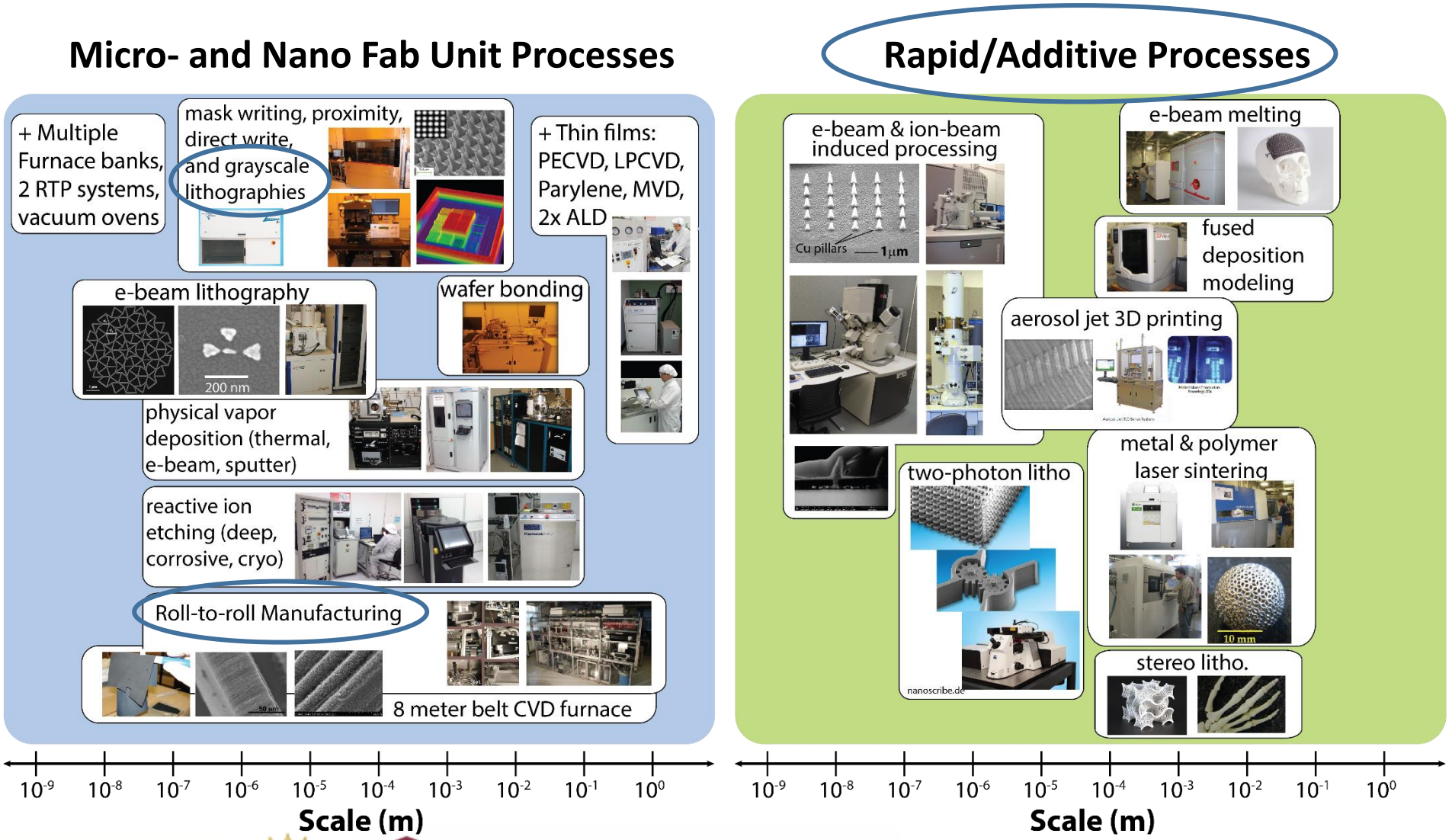
UofL and UK – Fabrication Capabilities over Multiple Lengthscales



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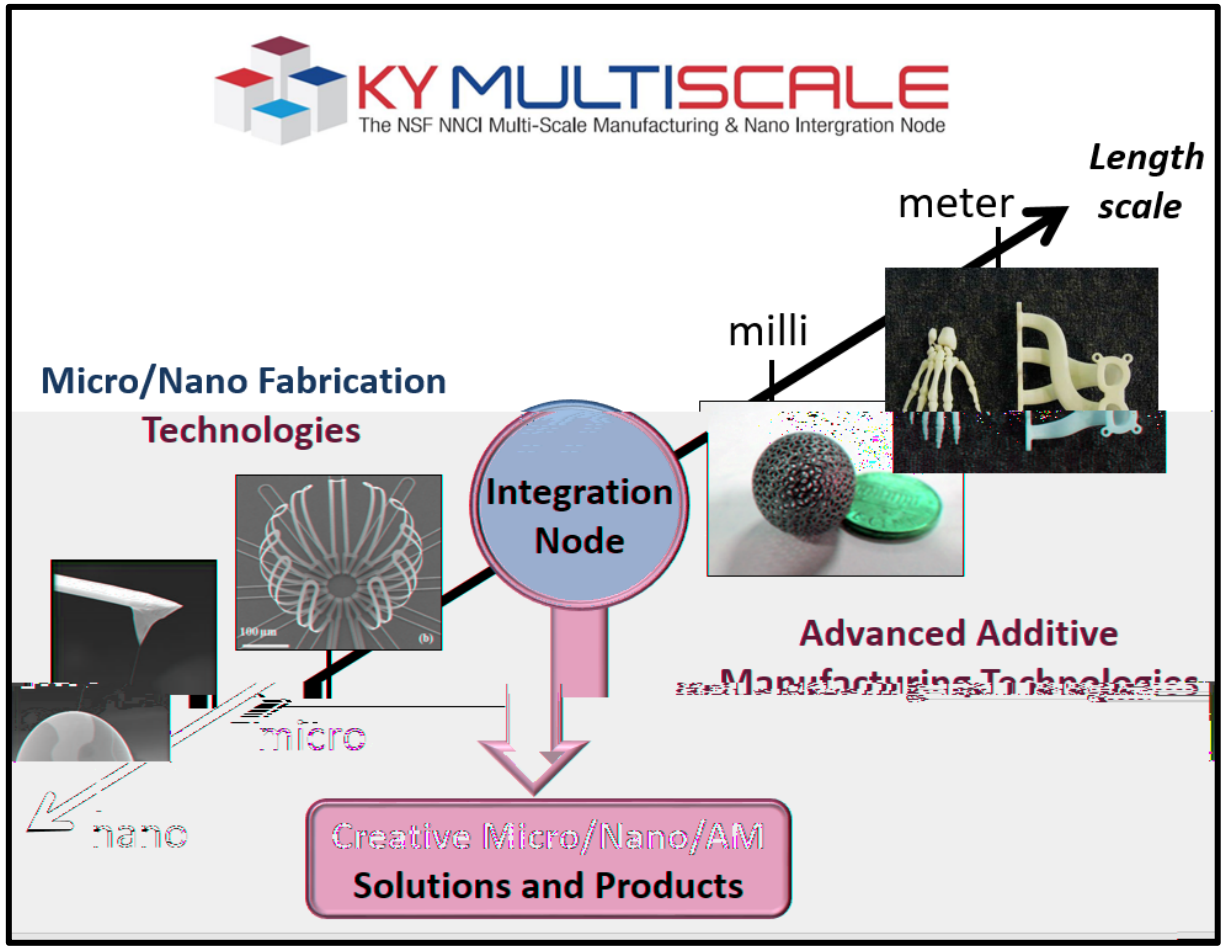
KY Multiscale – focus on Multiscale Advanced Manufacturing

- **"KY Multiscale"** is the name of our NNCI site, which is officially the Kentucky Multiscale Manufacturing and Nanotechnology Integration Node (KYMMNIN).
- Joint collaboration between UofL and UK
- $7M funding from NSF (2015-2025)
- **Theme** – Lead the nation in the convergence of nanoscience and engineering with emerging advanced manufacturing technologies (such as 3D printing, additive manufacturing, roll-to-roll, aerosol jet printing, etc) that span across multiple lengthscales.
- Leverages, engages and promotes 8 key Advanced Manufacturing Core Facilities at UofL and UK

www.kymultiscale.net



KY Multiscale – Core Facilities

Micro/nano fabrication

Imaging and Characterization

MNTC Micro and Nano Technology Center	**CeNSE** Nanoscale Science and Engineering	**AMIST** Additive Man Inst for Science and Tech
EMC Electron Microscopy Center	**KY Multiscale**	**CAM** Center for Advanced Materials
HICL Huson Imaging and Characterization Lab	**CAER** Center for Advanced Energy Research	**CCRER** Conn Center for Renewable Energy Research

Additive Manufacturing

Material Development

Energy Research

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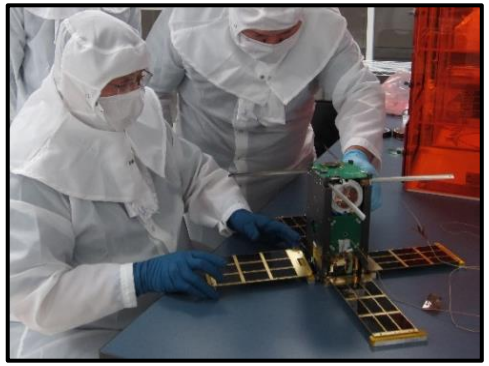
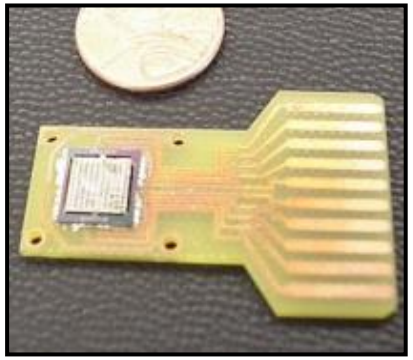
KY Multiscale – Core Facilities

MNTC – Micro Nano Technology Center

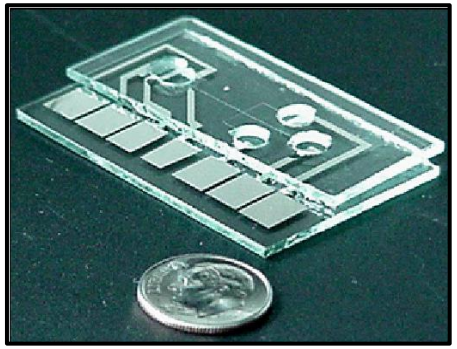
- Located in the UofL Shumaker Research Building
- Designed in 2005 by world renown AGI Associates
- $10M 10,000 sq ft class 100/1000 facility
- ~$20M of state-of-the-art fabrication equipment (over 100 tools)
- Used each year by about 75 unique users (~45 internal, ~30 external)
- **Contact – Dr. Julia Aebersold**



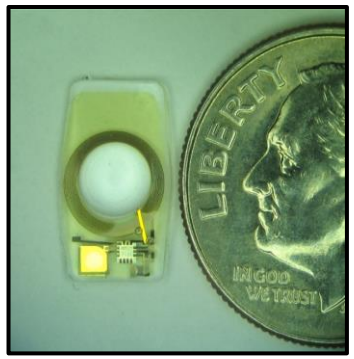
NASA CubeSAT micro-satellite (with Morehead)



Explosive detector

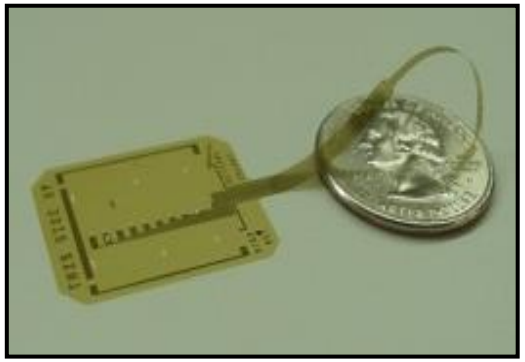


Lab on a chip for bedside diagnostics



Smart IOP lens

Cochlear implant



Retinal implant for the blind

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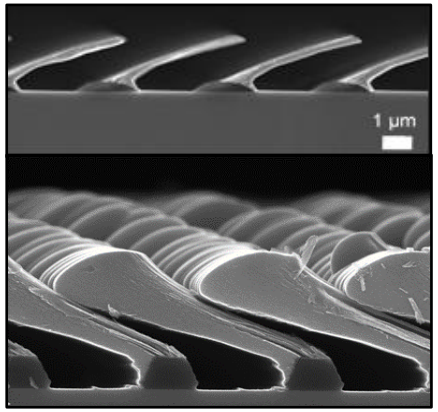
www.louisville.edu/micronano

KY Multiscale – Core Facilities

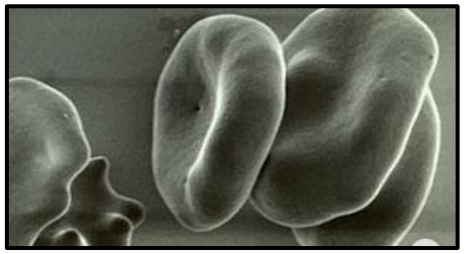
Huson Imaging and Characterization Lab (HICL)

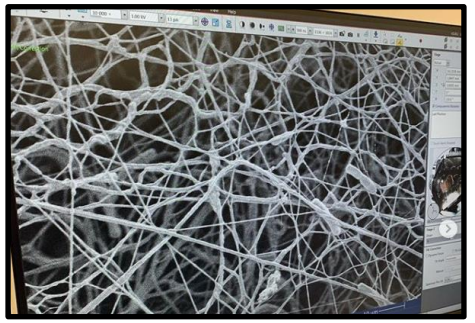
- Located in the UofL Shumaker Research Building
- 1,000 ft^2
- $3M of state-of-the-art imaging and characterization equipment
- Used each year by approximately 50 unique clients (~30 internal, ~20 external)
- SEM, AFM, Thermal Imaging Microscopy, Parylene Coatings
- **Contact – Dr. Julia Aebersold**

Thermo-Scientific Apreo SEM

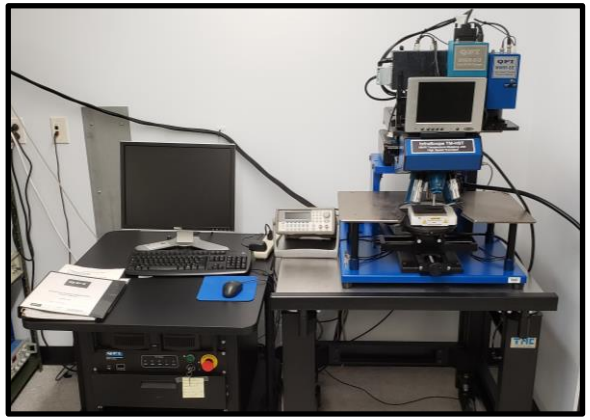


GLAD Nano-structures

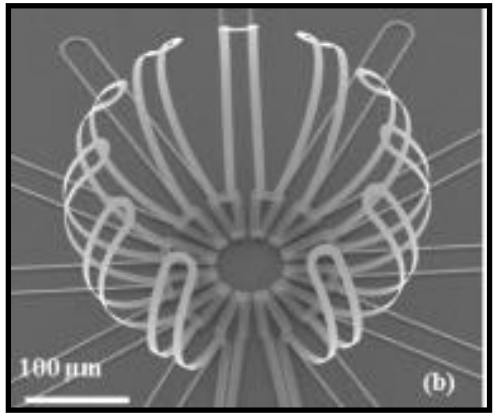




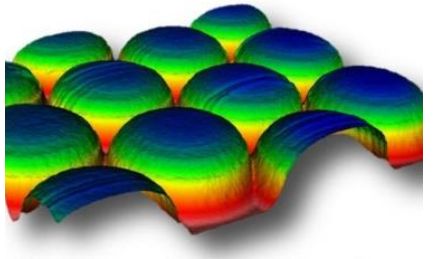
Scanning Electron Microscopy



QFI Thermal imaging Microscopy



Smart Materials



Atomic Force Microscopy

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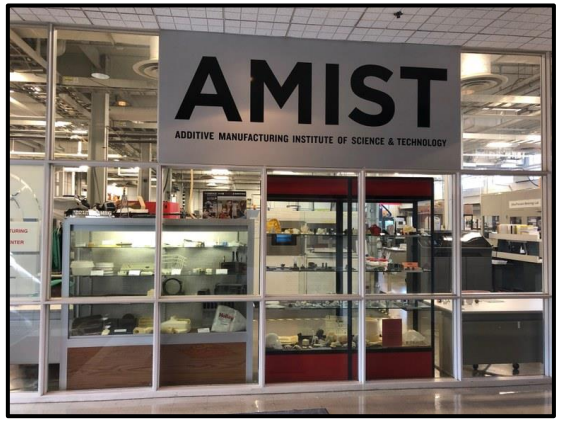
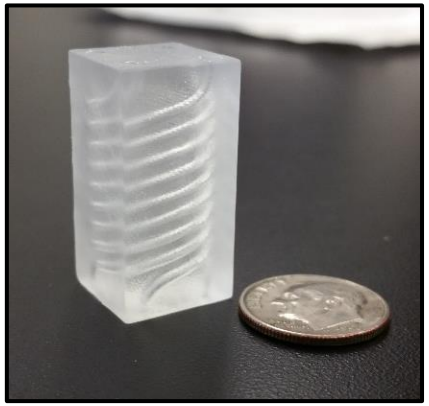
www.louisville.edu/micronano

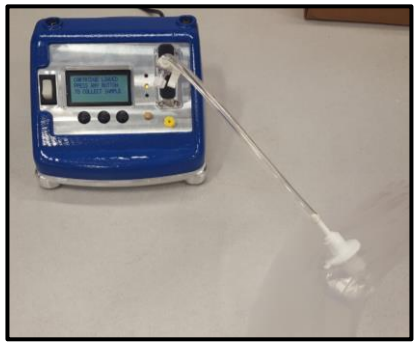
KY Multiscale – Core Facilities

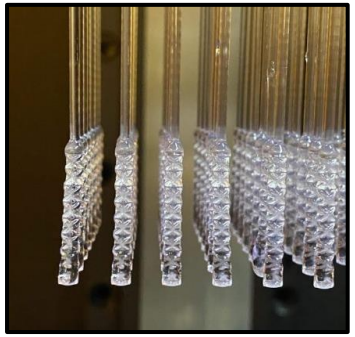
AMIST – Additive Manufacturing Institute for Science and Technology

- Located in the UofL Vogt Bldg and AMIST Training Bldg
- ~20,000 sq ft
- Both a Research Center and a Core Facility
- Over $10M of state-of-the-art 3D printing and characterization tools for AM processing of metals, polymers, and ceramics
- Multiple staff with over 20 years of experience
- Faculty Director – Drs. Li Yang (IE) and Tom Berfield (ME)
- **Contact – Ed Tackett**









www.louisville.edu/amist

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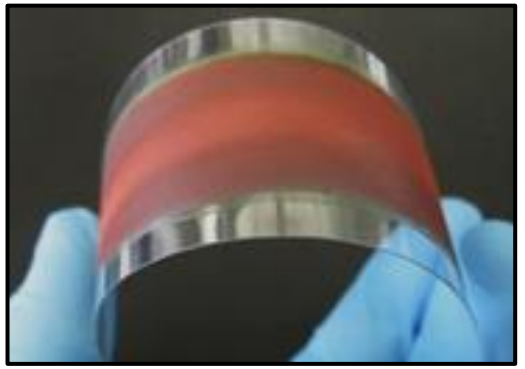
KY Multiscale – Core Facilities

CCRER – Conn Center for Renewable Energy Research

- Multiple locations on the UofL Belknap Campus
- Over 25,000 sq ft
- Both a Research Center and a Core Facility
- Over $15M of state-of-the-art material development and characterization tools
- Focused on solving global energy problems
- Highly interdisciplinary
- Emphasis on scale-up and commercialization
- Faculty Director – Dr. Mahendra Sunkara
- **Contact – Dr. Jacek Jasinski**



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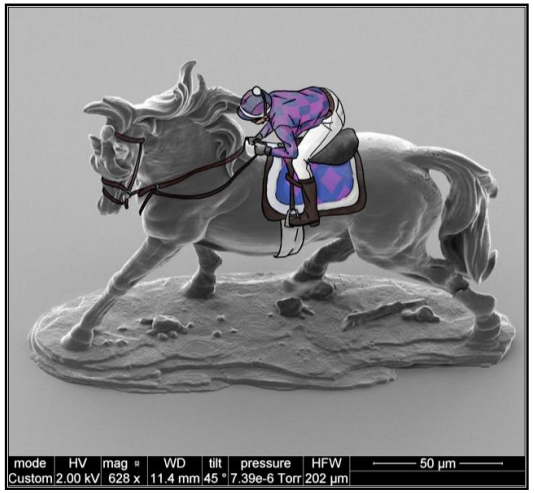
www.conncenter.org

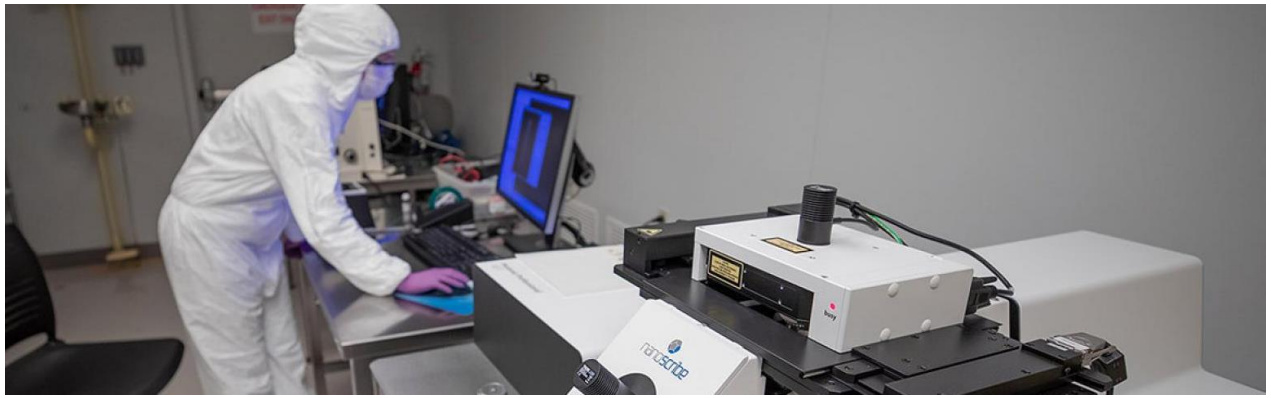
KY Multiscale – Core Facilities

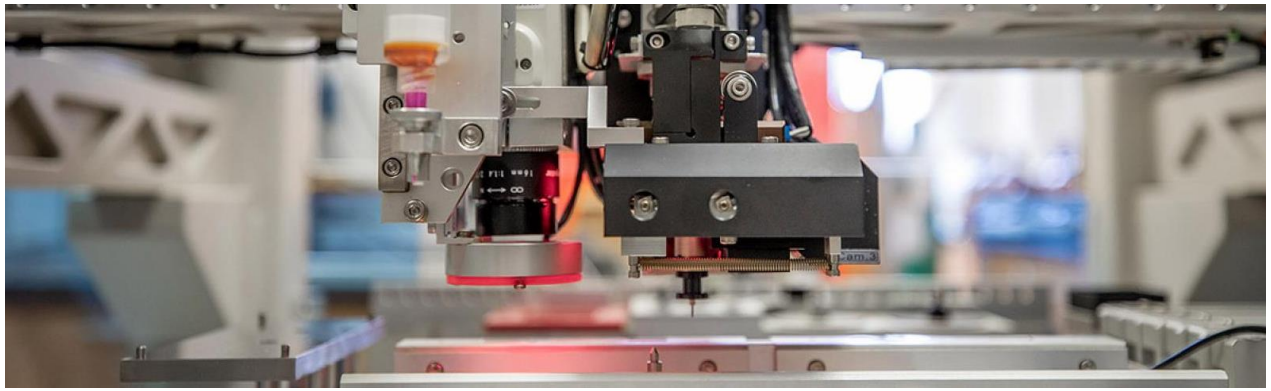
CeNSE – Center for Nanoscale Science and Engineering

- Located in the ASTeCC building on U.K.'s central campus.
- Class 100 cleanroom
- Diverse 2, 2.5, and 3D manufacturing capabilities: From two-photon polymerization 3D Printing to scanning electron beam lithography and traditional photolithography.
- Full suite of etching and depositions tools
- Fundamental Metrology capabilities
- **Contact – Prof. Todd Hastings**



Nano Derby participant





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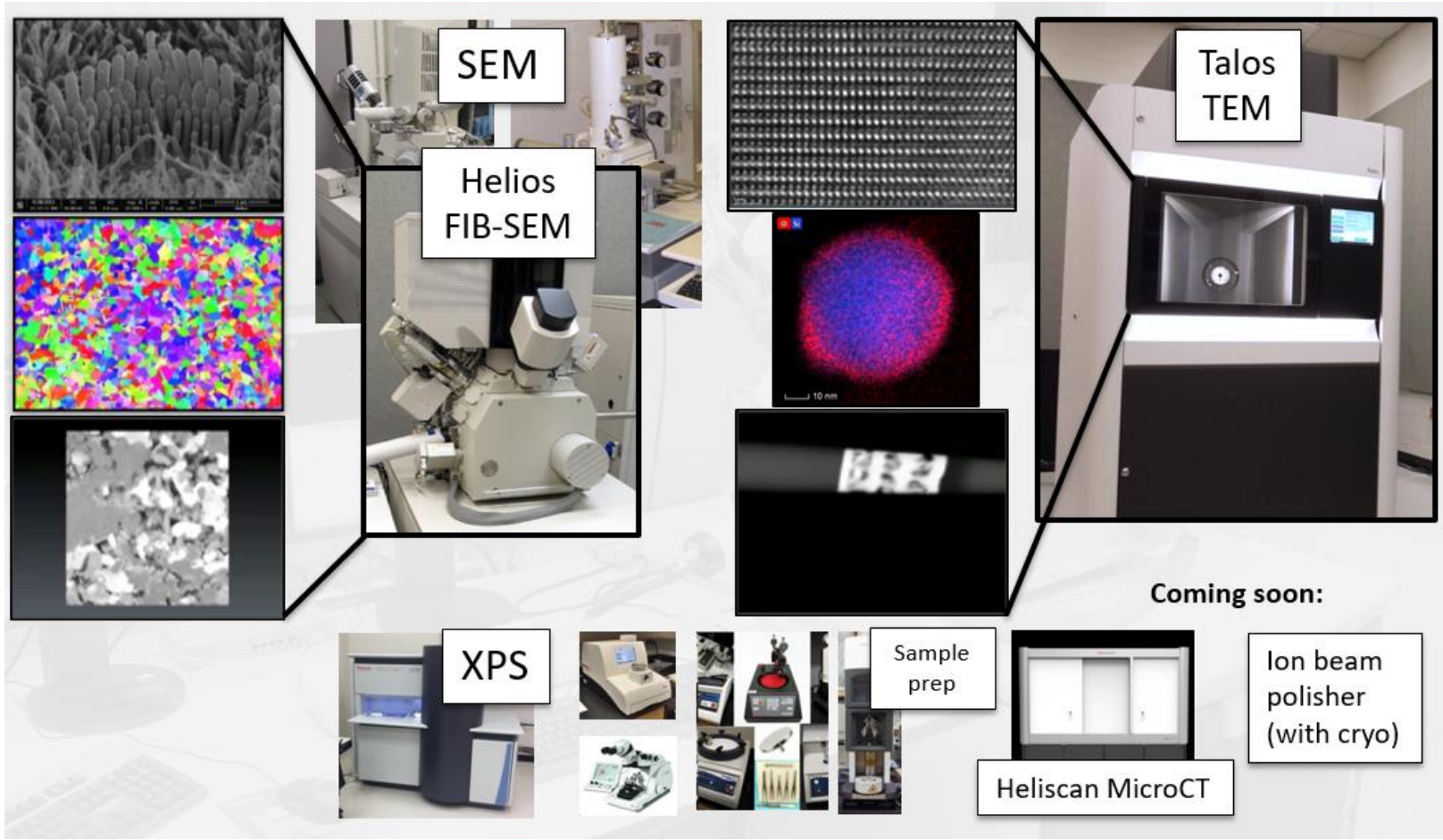
https://cense.engr.uky.edu/

KY Multiscale – Core Facilities

EMC – Electron Microscopy Center

- Located in the UK ASTeCC Building
- Materials, chemical, and biological characterization in SEM, TEM, XPS, microCT, and more
- Fully staffed instruments for assisted work, training, and data analysis
- **Contact – Prof. John Balk**



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http://emc.engr.uky.edu/

KY Multiscale – Core Facilities

CAM – Center for Advanced Materials

- Location: UK Chem./Physics Building (behind ASTeCC)
- **Contact - Prof. Lance De Long**

Cabapilities:

- Helium liquefier
- Multitarget sputtering
- floating-zone furnace for single-crystal growth
- Bruker X-ray diffractometer
- Quantum Designs Physical Properties and Magnetic Properties Measurement Systems, AFM/MFM
- Crystal orientation analyzer, glove box, dicing saw, …

https://pa.as.uky.edu/tag/center-advanced-materials

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KY Multiscale – Core Facilities

CAER – Center for Applied Energy Research

Location: UK Research Park

Capabilities:

- Dry room for battery and organic electronics research
- Growth of large, free-standing vertically aligned MWCNT arrays
- Mixing equipment for composites

Contacts - Prof. Rodney Andrews and Dr. David Eaton

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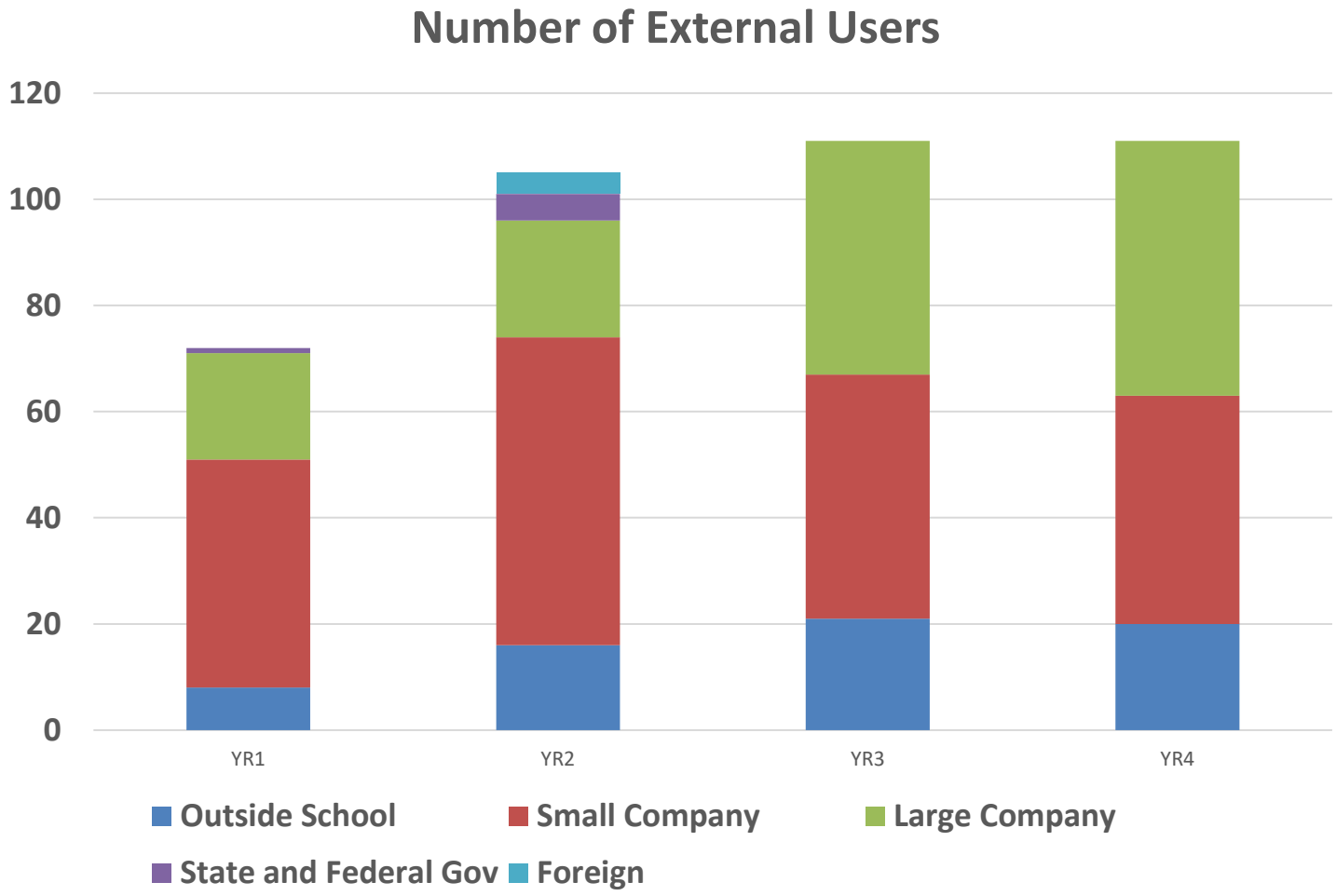
www.caer.uky.edu

KY Multiscale – Growth in External Users



- **Total users have increased 40% (from 278 to 389)**
- **<u>External users</u> have increased 54% (from 72 to 111)**

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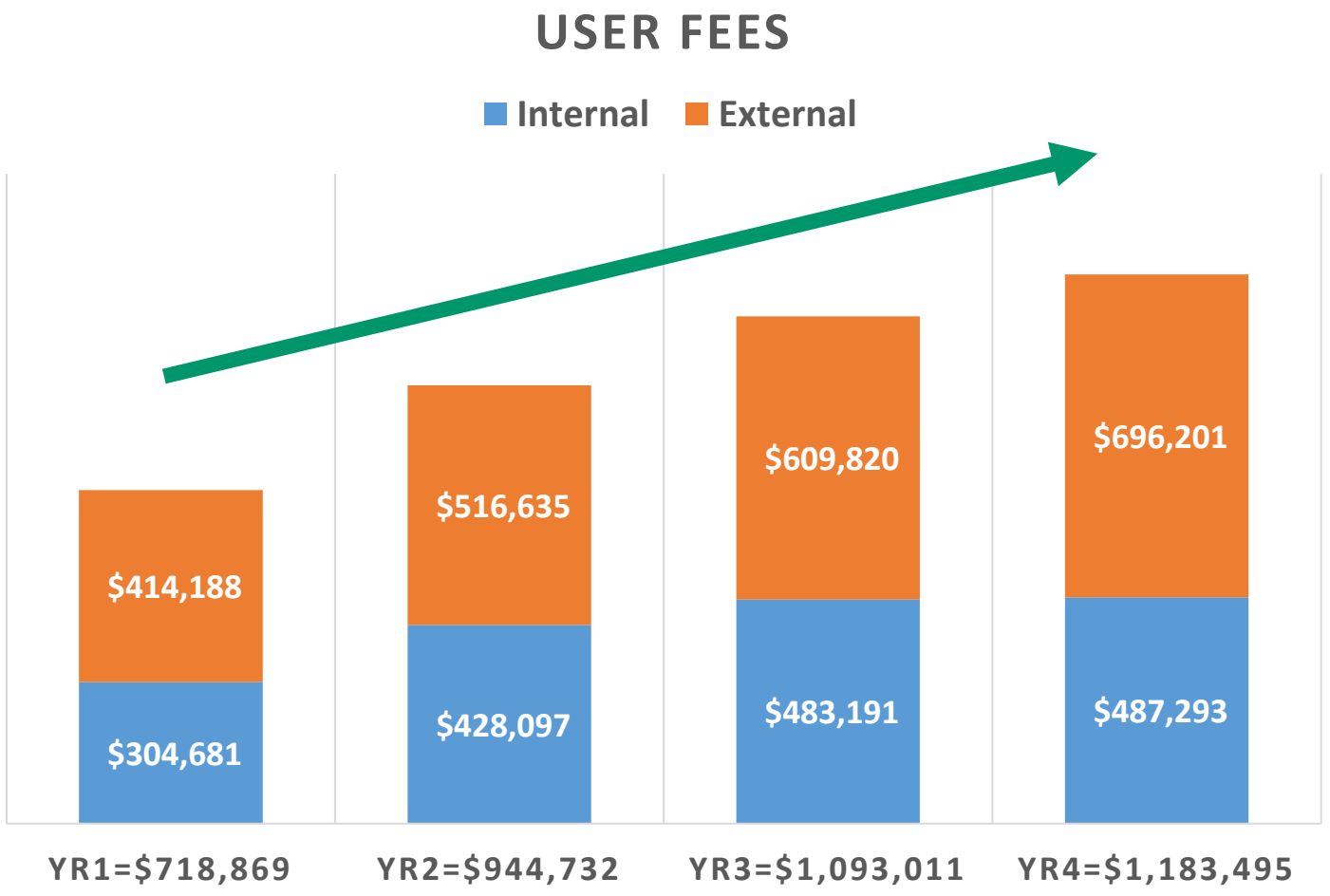
KY Multiscale – Increased Revenue



- **Total generated user fees have increased by 65% since joining the NNCI**
- **60% of our total revenue comes from External users**
- **But our core facilities still remain ~50% subsidized by our universities**

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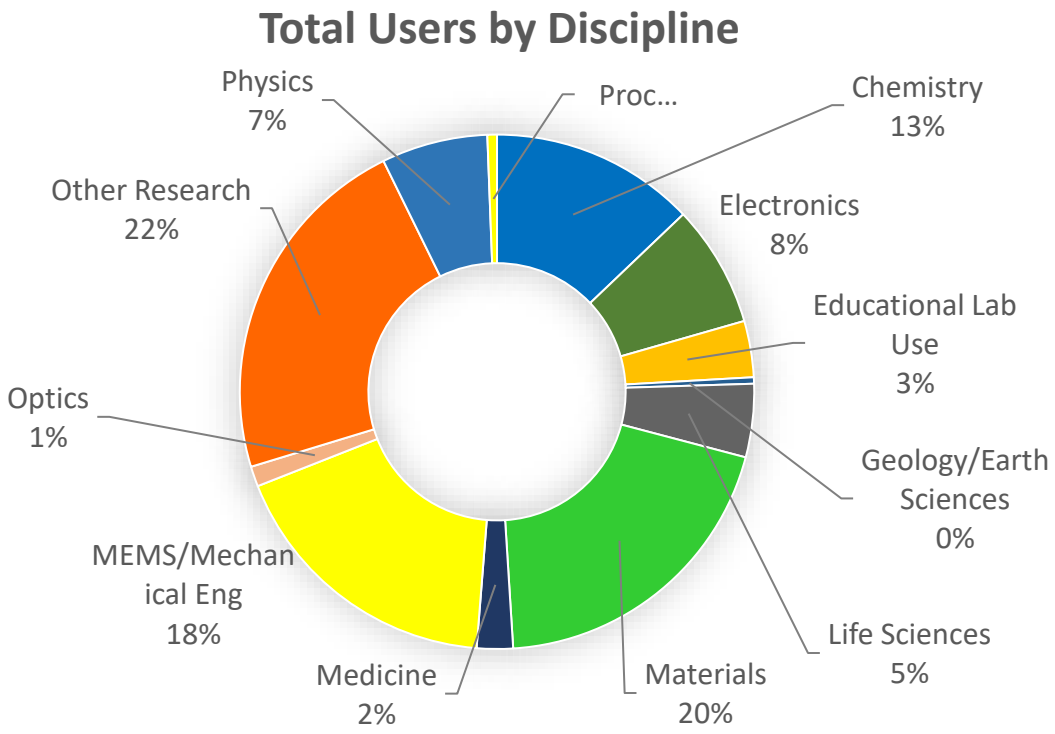
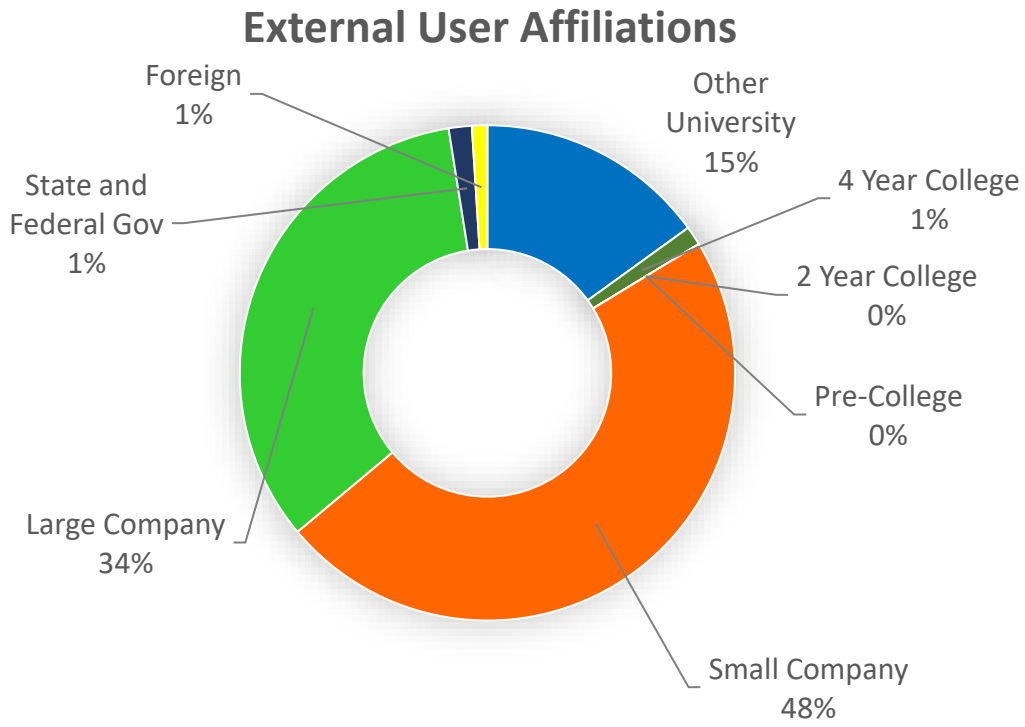
KY Multiscale – Diverse Demographics





We serve a **broad and diverse** technical community.

Largest components are **small companies**, **start-ups**, **large companies** and **other universities**.

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KY Multiscale – Supporting In-state Academic Users

Schools in Kentucky that use our Core Facilities

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KY Multiscale – Supporting Out-of-State Academic Users

Schools around the World that use our Core Facilities

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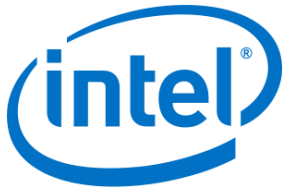
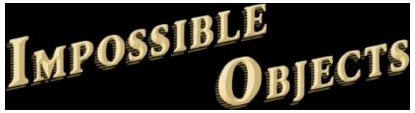
KY Multiscale – Supporting Industry Users





KY Multiscale – Catalyzing Startups

Intellirod Spine
Guiding Innovations for Spinal Surgery

ADEM ADVANCED ENERGY MATERIALS

Science Tomorrow

IOP technologies

Breath Diagnostics

AlphaJet

bluegrass advanced materials

3DSIM

APiQ SEMICONDUCTOR

BERT THIN FILMS LLC

ASSENTI, LLC

NEXT GEN SYSTEMS

NN NAUGANEEDLES

SIMON SOUNDS

Lumenari

Solar IntElect

PowerTech WATER

West Wind Power

COULSENSE, LLC

ULTRATRACE DETECTION, LLC

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KY Multiscale – Seed Programs for New Users

KY Multiscale Seed Programs

KY Multiscale Seed Program Overview

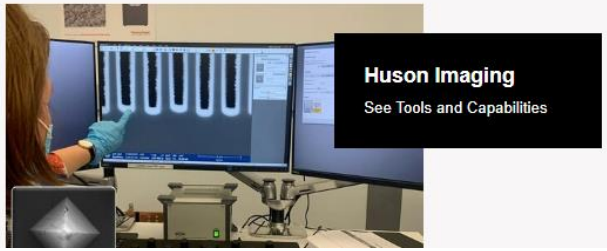
In support of its vision to strengthen and accelerate discovery in micro/nanotechnology and advanced manufacturing across the US, KY Multiscale has established the KY Multiscale Seed Program. This program allows members from the microtechnology, nanotechnology, and larger scientific communities limited free access to the UofL KY Multiscale facilities to aid in research, obtain preliminary data, conduct proof of concept studies, or for educational purposes.

Eligibility

This program is open to new, first-time users of KY Multiscale facilities from both inside and outside the University of Louisville. Consistent with the mission of the National Science Foundation (NSF) to broaden participation, we encourages applications from non-traditional users of micro/nanotechnology and advanced manufacturing (e.g. life and environmental sciences, paper and textiles, biomedical, agriculture, etc.), non-Research I institutions, Primarily Undergraduate Institutions (PUIs), under-represented groups, K-12 schools, and community colleges.

Selection

Supported Facilities



APPLY NOW!

www.kymultiscale.net/seed

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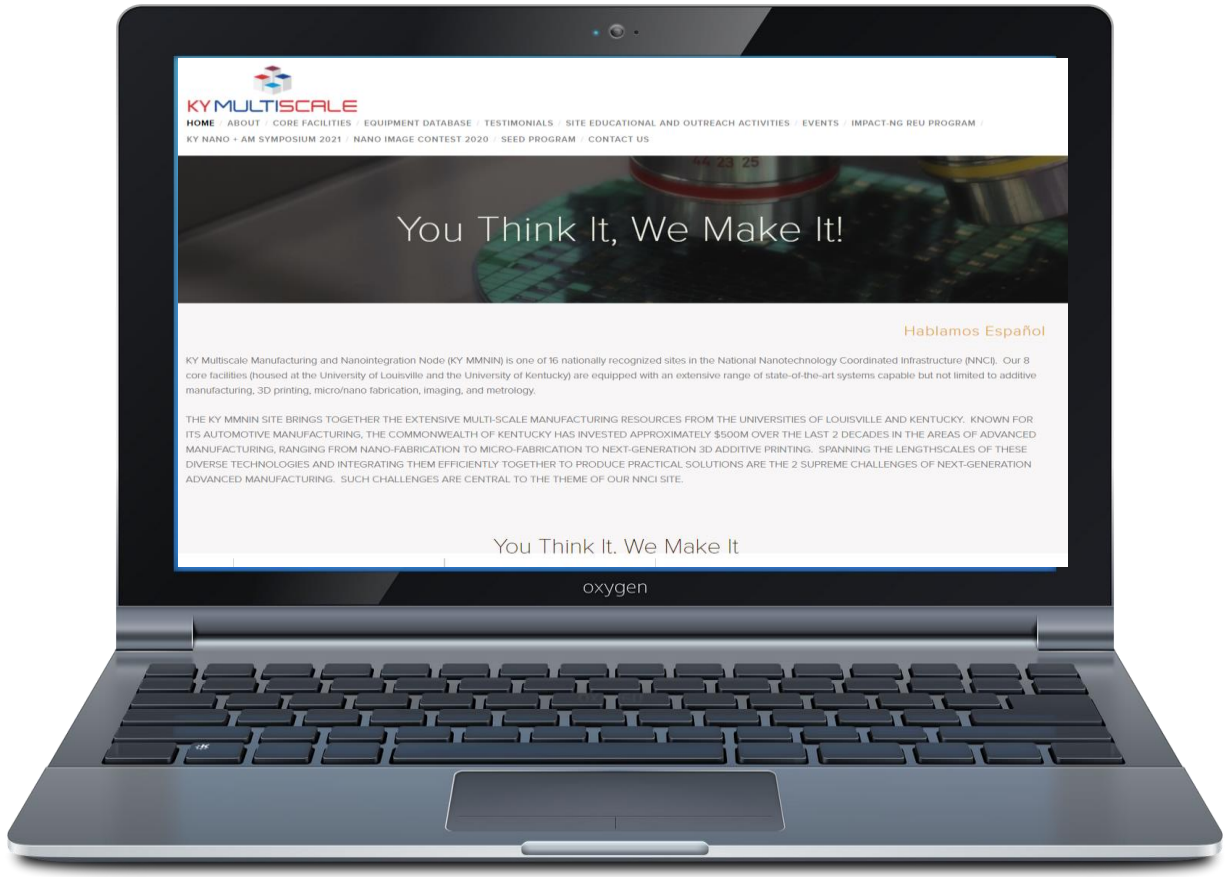
We Offer Other Opportunities to Engage

KY Multiscale – Extensive Web and Social Media Presence

KY Multiscale Website



Find out more…

- About us
- Collaborators
- Core Facilities
- Equipment Database
- User Testimonials
- Site Educational & Outreach Activities
- IMPACT-NG REU Program
- KY NANO + AM Symposium
- Seed Program
- Social Media

…and more

www.kymultiscale.net

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KY Multiscale – Monthly Newsletter to over 8,000 Recipients

Monthly Newsletter

We are eager to spread the news…send us information about your research accomplishments and upcoming events and we will share with our mailing list (over 8,000 industry and academia).

KY Multiscale – REU Summer Program for Undergraduate Training

New NSF REU Program Directly Aligned with our Site's Nano + Additive Manufacturing Theme

Research Experience for Undergraduates Includes:

- Hands on micro/nano/additive training program
- Personalized Independent research project
- Programs to improve oral/written communication skills
- Opportunities to learn about graduate school
- Seminars about entrepreneurship
- Lunch meetings with technical academic & industry, and government leaders
- Tours of industry manufacturing facilitites
- Ethics training
- Social activities
- NNCI Convocation attendance and hosting

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KY Multiscale – Program for Teachers

NanoEducate: Middle School Teachers Training Program

- Summer program with materials and stipends
- Three schools serving primarily underrepresented students already confirmed for recruitment
- Hands on summer professional development workshop about micro/nano/advanced manufacturing technologies
- Duration: 1 weeks
- Number of teachers: 8

GRACE JAMES ACADEMY OF EXCELLENCE

Ronda Cosby, Principle

WES West End School Louisville, KY

Dwight Bransford, Principle

Carol Nord, Ex. Director

NATIVITY ACADEMY AT SAINT BONIFACE

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KY Multiscale – New Regional Network

New Ohio Valley Regional Nano Network

OBJECTIVES

- ***Leverage the recent announcement that Intel plans to build a $20B Semiconductor Manufacturing Facility in Ohio!!!***
- Build network of researchers from facilities throughout the Ohio Valley
- Exchange information on operations and capabilities, host processing seminars
- Accelerate access to KY Multiscale core facilities
- Facility collaborative research

Would you like to be involved in this new initiative?

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KY Multiscale – Annual Conference

Annual Nano+AM Symposium

August 9-10, 2022 in Louisville, KY

Approximately 200-300 participants attend our annual symposium which brings together the converging fields of nanotechnology and additive manufacturing

www.nanoamsummit.com

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KY MULTISCALE
The NSF NNCI Multi-Scale Manufacturing & Nano Integration Node

KY Multiscale – Some Contacts

Contacts

Prof. Kevin Walsh
PI/Director KY Multiscale
Assoc Dean of Research
University of Louisville
Walsh@Louisville.edu

Prof. Todd Hastings
Co-PI/Co-Director KY Multiscale
CENSE Director
University of Kentucky
Todd.Hastings@uky.edu

Ana Sanchez Galiano
KY Multi-Scale Coordinator/
E&O Lead
University of Louisville
Ana.Sanchez@Louisville.edu

Jillian Cramer
UK Coordinator/E&O Lead
University of Kentucky
jillian.cramer@uky.edu

National Nanotechnology Coordinated Infrastructure

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Handoff to Prof. Todd Hastings (UK)

END