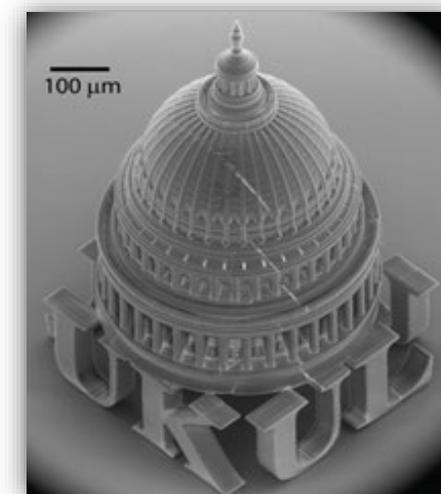


KY MULTISCALE

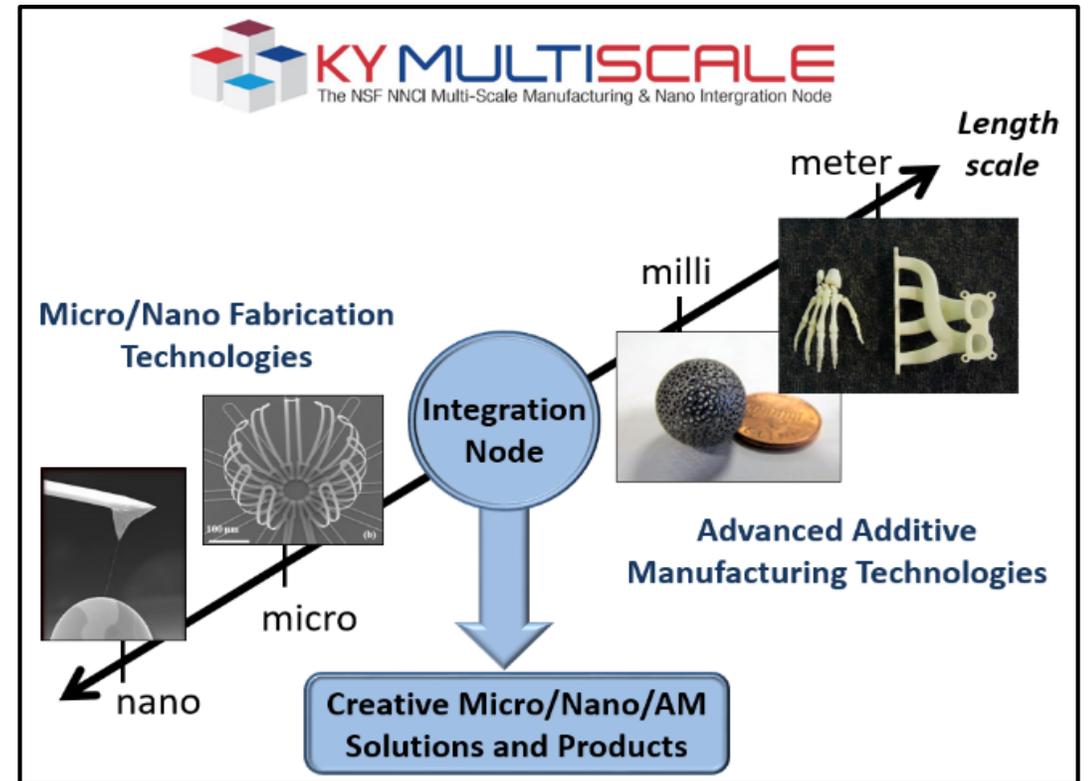
The NSF NNCI Multi-Scale Manufacturing & Nano Integration Node

**NNCI Annual Meeting
Nov 2-3, 2021**





“Converging Nanoscale Science with Emerging Advanced Manufacturing Technologies”



HIGHLIGHTS FOR YEAR 6

1. Expansion of our Imaging Cores
2. New LARRI Robotics Research Facility

KY Multiscale - New Programs and Initiatives for Year 6

Expansion of Electron Microscopy

UofL Medical School TEM Facility Joins NNCI KY Multiscale

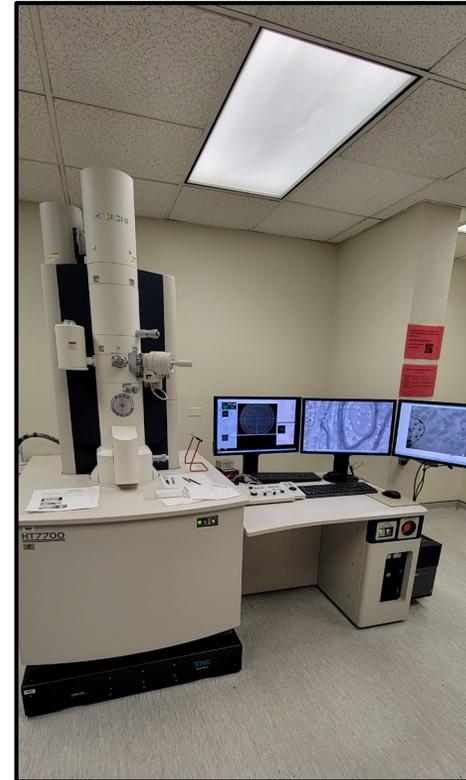
In the Spring of 2021, the MNTC added a Hitachi HT7700 TEM and the Leica UC7 Ultramicrotome into its operations.

RESULTS:

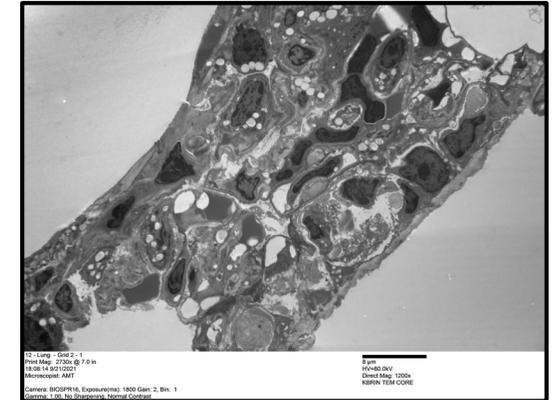
- Increased utilization
- Better data collection
- More interaction between the Eng and Health Science Campuses
- An improved reservation system
- Overlapping applications for both TEM and SEM imaging
- Additional research opportunities with the Health Science Campus
- Inclusion into the NIH IDeA KY INBRE Network and its associated opportunities.



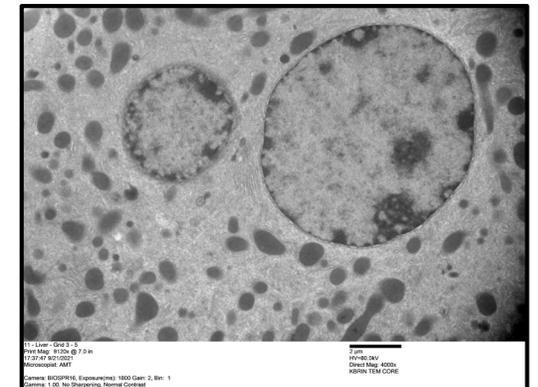
Leica UC7 Ultramicrotome



Hitachi HT7700 TEM



Mouse Lung



Mouse Liver

KY Multiscale - New Programs and Initiatives for Year 6

Expansion of Electron Microscopy

New \$360K SEM Installed and Operational in the UofL MNTC Huson Imaging & Characterization Core

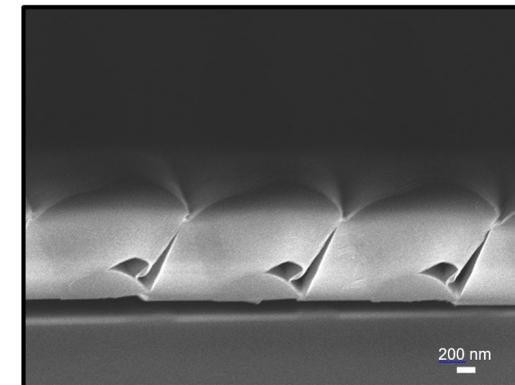
Thermo Fisher Apreo C LoVac Field Emission SEM

- High- and low-voltage ultra-high resolution
- Variable pressure
- Back-scattered detector (BSD)
- Scanning Transmission Electron Microscopy (STEM)
- Energy-dispersive X-ray spectroscopy (EDS)

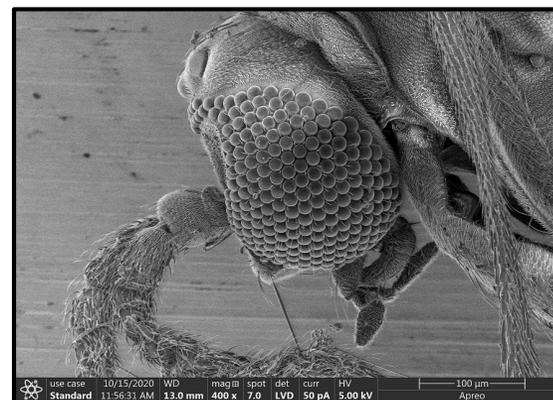
The addition of the instrument has greatly enhanced our relationship with the medical school, bioengineering and biology departments.



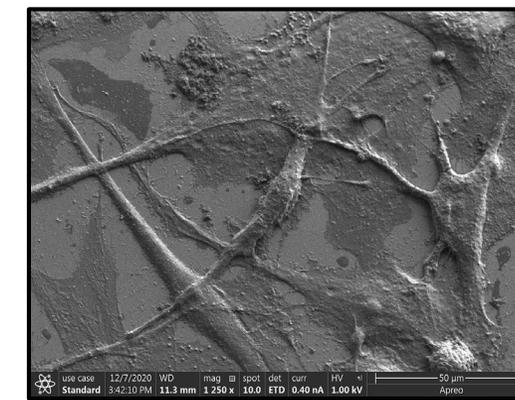
Thermo Fisher Apreo SEM



GLAD nano-channels



Spider



Cultured Glioblastoma without sputter coating

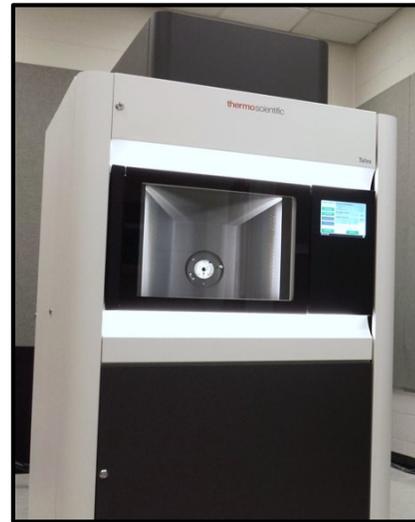
KY Multiscale - New Programs and Initiatives for Year 6

Expansion of Electron Microscopy

Complementary Techniques at UK

Longstanding capabilities with growing usage

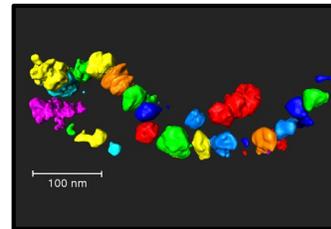
- Talos F200X TEM
 - High-resolution imaging
 - Elemental analysis with EDS and EELS
 - Tomography for nanoscale 3D imaging
- Helios Nanolab G3 FIB-SEM
 - SEM imaging
 - Elemental analysis with EDS
 - Electron backscatter diffraction (EBSD) for grain analysis
 - Focused ion beam cross sectioning and 3D imaging
 - TEM sample preparation



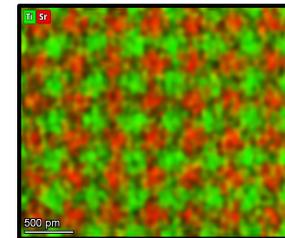
Talos F200X TEM



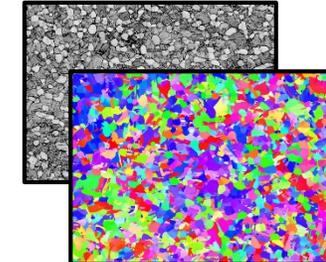
Helios FIB-SEM



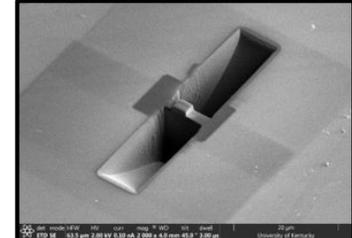
3D reconstruction with
TEM tomography



High-resolution
elemental analysis



Grain analysis with EBSD



TEM sample prep
and cross-sectioning

KY Multiscale - New Programs and Initiatives for Year 6

Expansion of Electron Microscopy

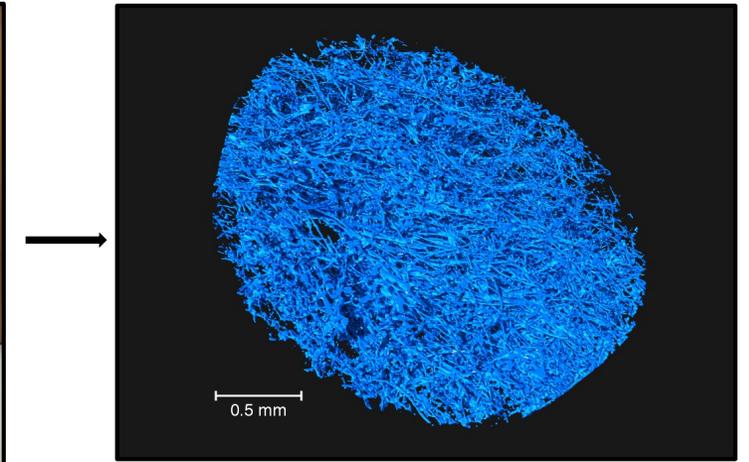
Complementary Techniques at UK

Newly added capabilities

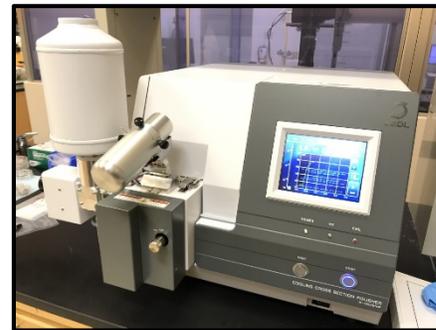
- Micron to millimeter-scale 3D imaging with microCT (Heliscan)
 - Nondestructive 3D imaging for larger samples
- Broad beam ion cross-sectioning with JEOL ion polisher
 - Cross-sections larger areas than the FIB can; useful for later SEM analysis
 - Fewer defects than mechanical polishing and accommodates softer materials
- Benchtop XRD (Equinox 100)



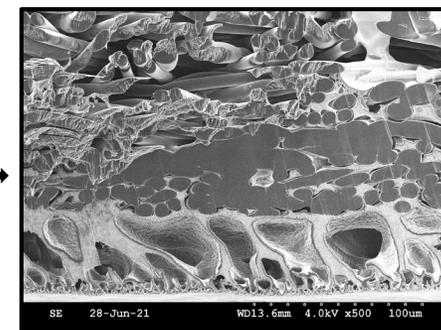
Heliscan microCT



Carbon fiber mesh reconstructed with Heliscan



JEOL Broad Ion Beam Polisher



Cross-sectioned membrane



Equinox 100 Benchtop XRD

KY Multiscale - New Programs and Initiatives for Year 6

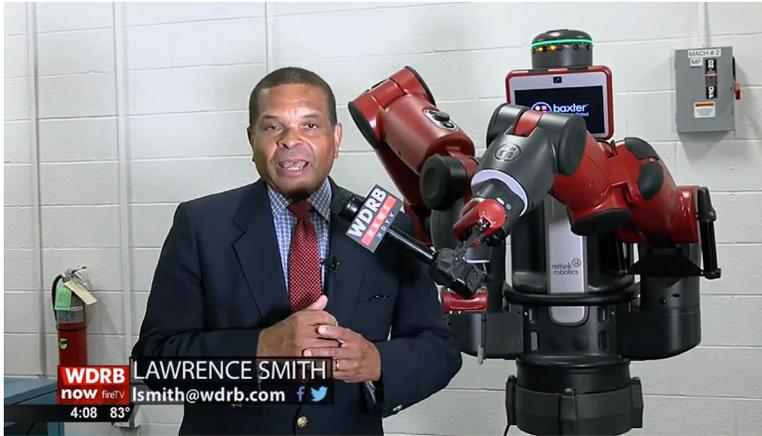
LARRI – Louisville Automation and Robotic Institute

1. New Multi-disciplinary Research Initiative at UofL
2. 12 faculty and 11 research staff from ECE, BE, CE, ME, IE and CSE
3. \$500K investment by the University to renovate 10,000 sq ft of collaborative research space for LARRI
4. Led by Prof. Dan Popa – Endowed Chair of Advanced Manufacturing
5. Special emphasis in human-technology interaction and applications to future manufacturing, healthcare and logistics
6. Areas of research: next generation robots, **sensors**, **artificial skin**, **micro-actuation**, human-robot interaction, automation and robotics for industrial applications, networked robots and autonomous vehicles, planning/control for mechatronic systems, **micro-robotics** and **micro-assembly**



KY Multiscale - New Programs and Initiatives for Year 6

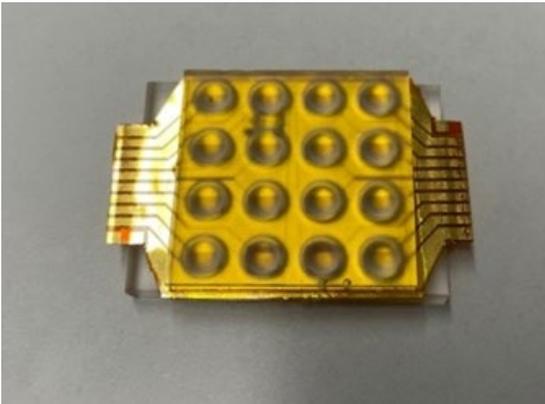
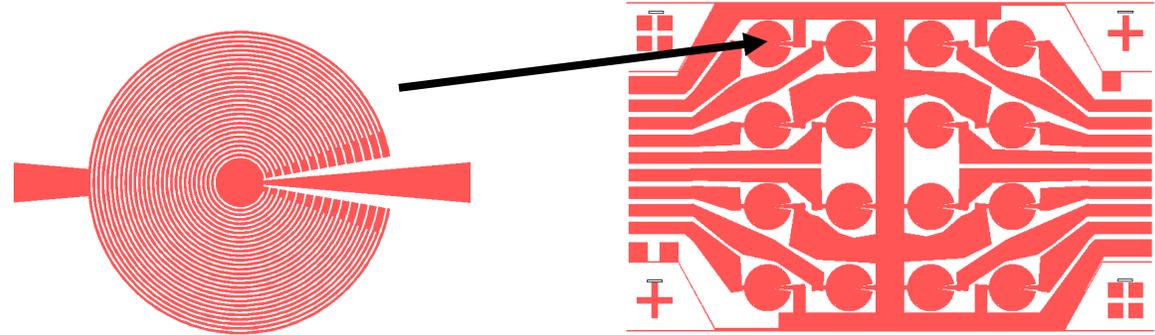
LARRI – Ribbon Cutting (all 5 TV networks attended)



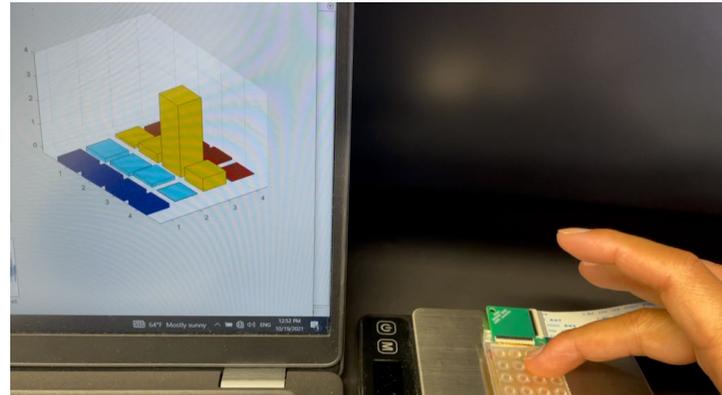
KY Multiscale - New Programs and Initiatives for Year 6

LARRI – Micro/nano Research Example

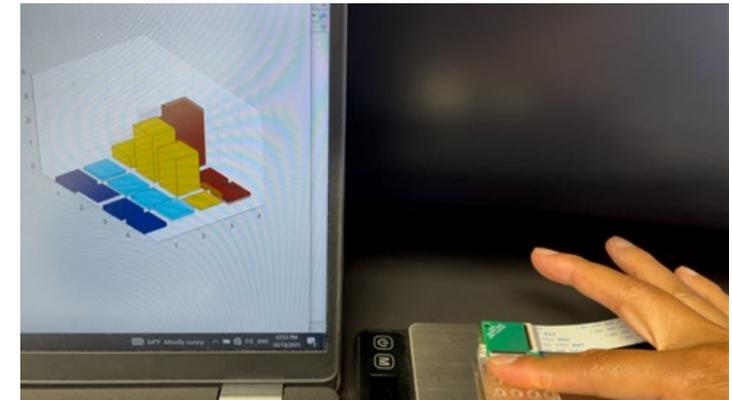
Robotic Skin Tactile Sensors



Skin sensor patch assembly with silicone bedding and cover



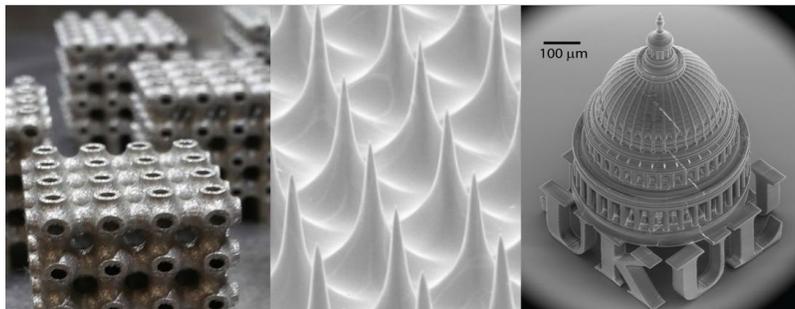
Single point touch with live computer visualizer



Multiple points touch with live computer visualizer

KY Multiscale – Upcoming Annual Symposium

KY Nano+AM Symposia – August 9-10, 2022 in Louisville



Louisville Mayor
Greg Fischer



4 National Keynotes
(Jason Lopes – Carbon)



54 Technical Talks

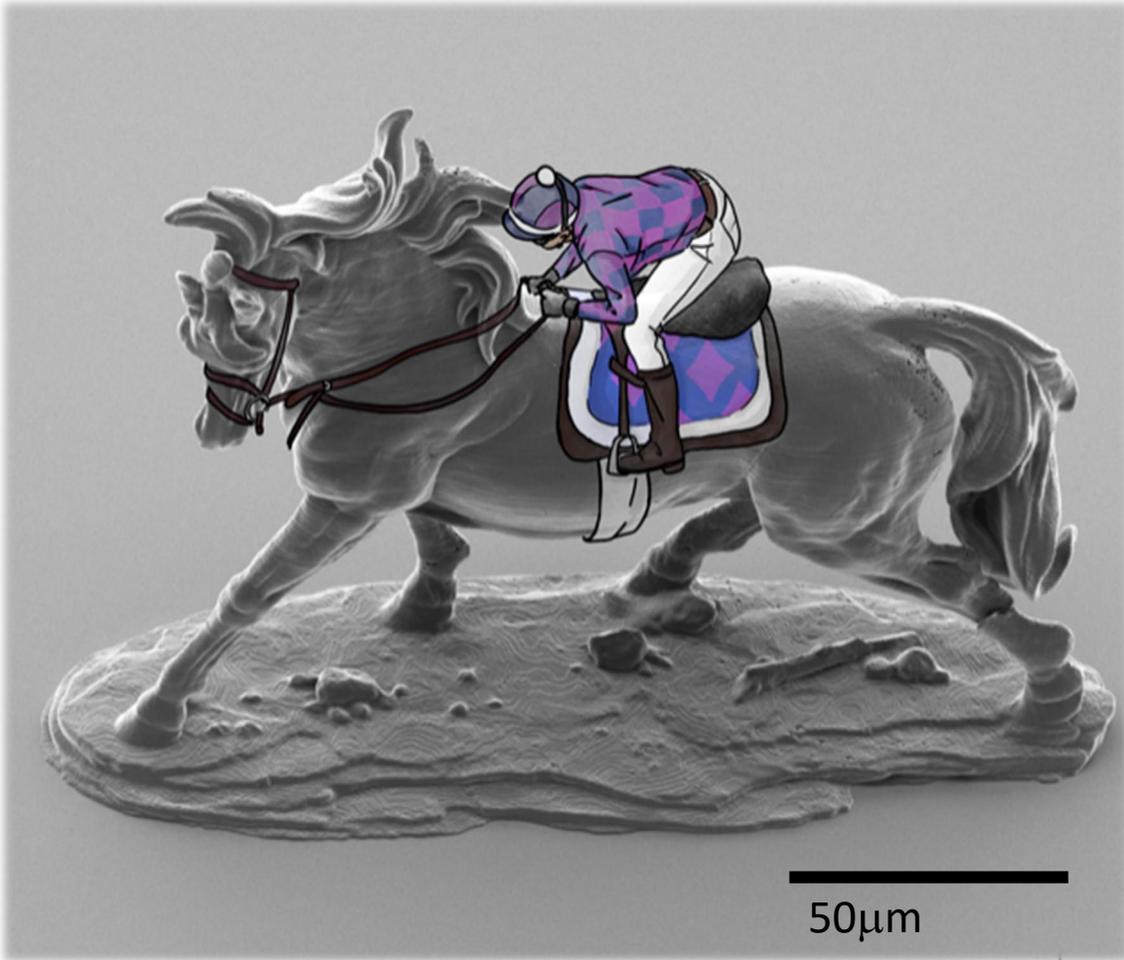


23 Poster Presentations

- Micro/nano plus Additive Manufacturing theme
- Typical attendance of 200
- Industry sponsorship available
- 4 Keynote Speakers (**Dr. Kershed Cooper**, etc)
- Technical Talks and Panel Discussions
- Poster Session and Tours

Survey Results (~50 respondents)

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Need for this Symposium	60%	40%			
Was High Quality	36%	50%	11%	3%	
Well Organized	63%	35%	2%		
Likely to recommend	60%	30%	10%		



Thank You

