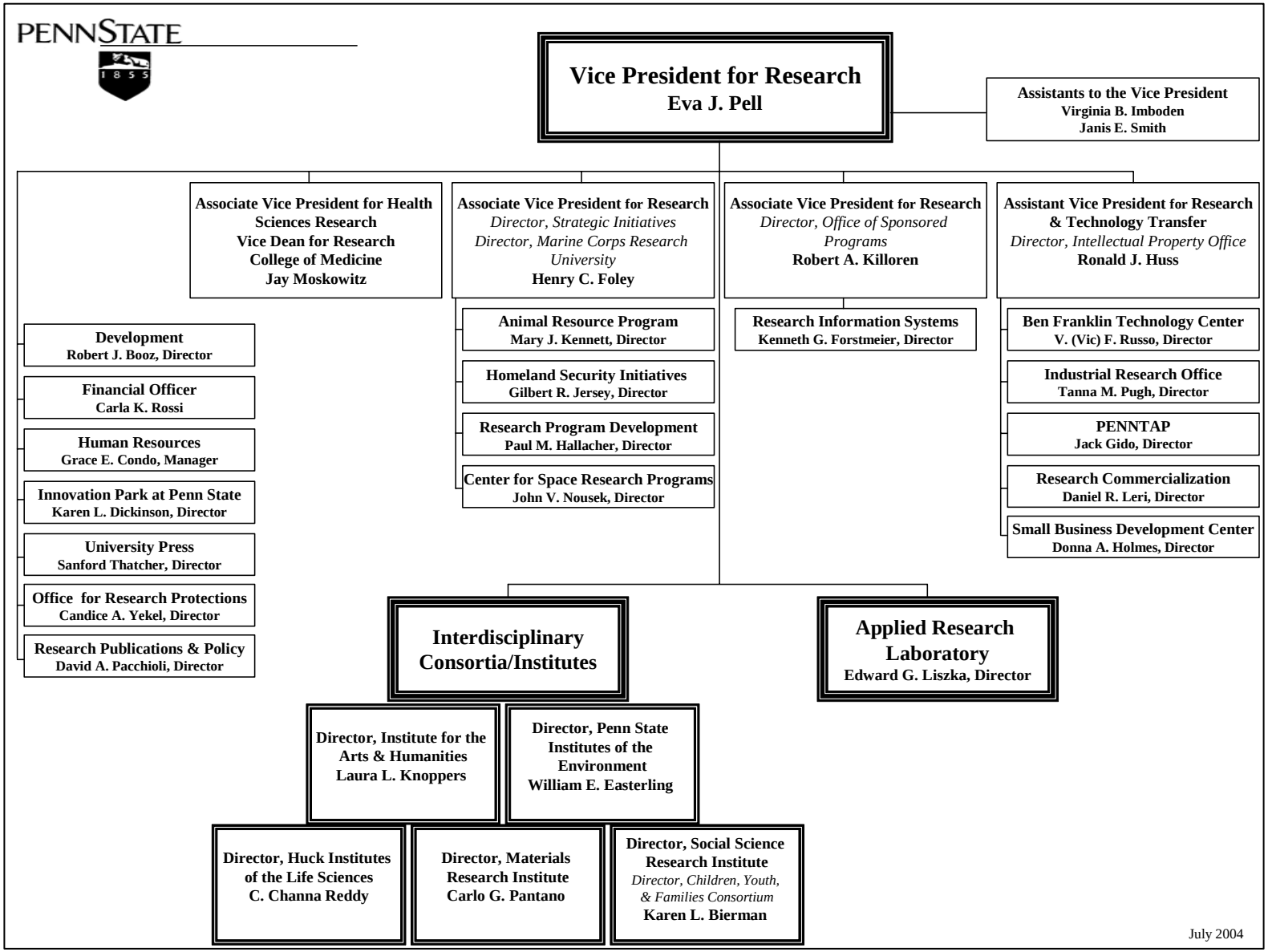
Interdisciplinary Materials Research at Penn State

Carlo G Pantano
Director of the **Materials Research Institute (MRI)**
Distinguished Professor of Materials Science and Engineering
The Pennsylvania State University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July 2004

Penn State Research in the Top 20

national rankings in categories reported by NSF

Materials	#1
Department of Defense Research	#2
Engineering Research	#3
Industry Sponsored Research	#3
Chemistry	#4
Physical Sciences	#10
NASA Research	#10
Physics	#12
Mathematics	#14
Department or Energy Research	#20

Penn State Materials Research Institute (MRI)

- MRI administers, services, supports and/or markets various research organizations to maintain and leverage Penn State's leadership in Materials:
  - Research centers and interdisciplinary teams of faculty
  - Facilities with analytical, computing or processing facilities and permanent research support staff
  - Faculty and Academic Department's materials related activities
  - Graduate students and post-docs interested in interdisciplinary training and career opportunities

Some Background and History

- MatSE department created by merging ceramics, metals, fuels with polymers in the College of Earth and Mineral Sciences
- Materials Research Lab (MRL) established as an intercollege research program (IRP) with a degree program in solid state science (later, Materials)
- University ‘futures committee’ proposed and established consortias and institutes circa 1992-1998….. birth of MRI and MRI Building
- MRI and MRL merged into one unit…. MRI (2000)
- A new building for interdisciplinary materials research will be constructed 2007-2009.

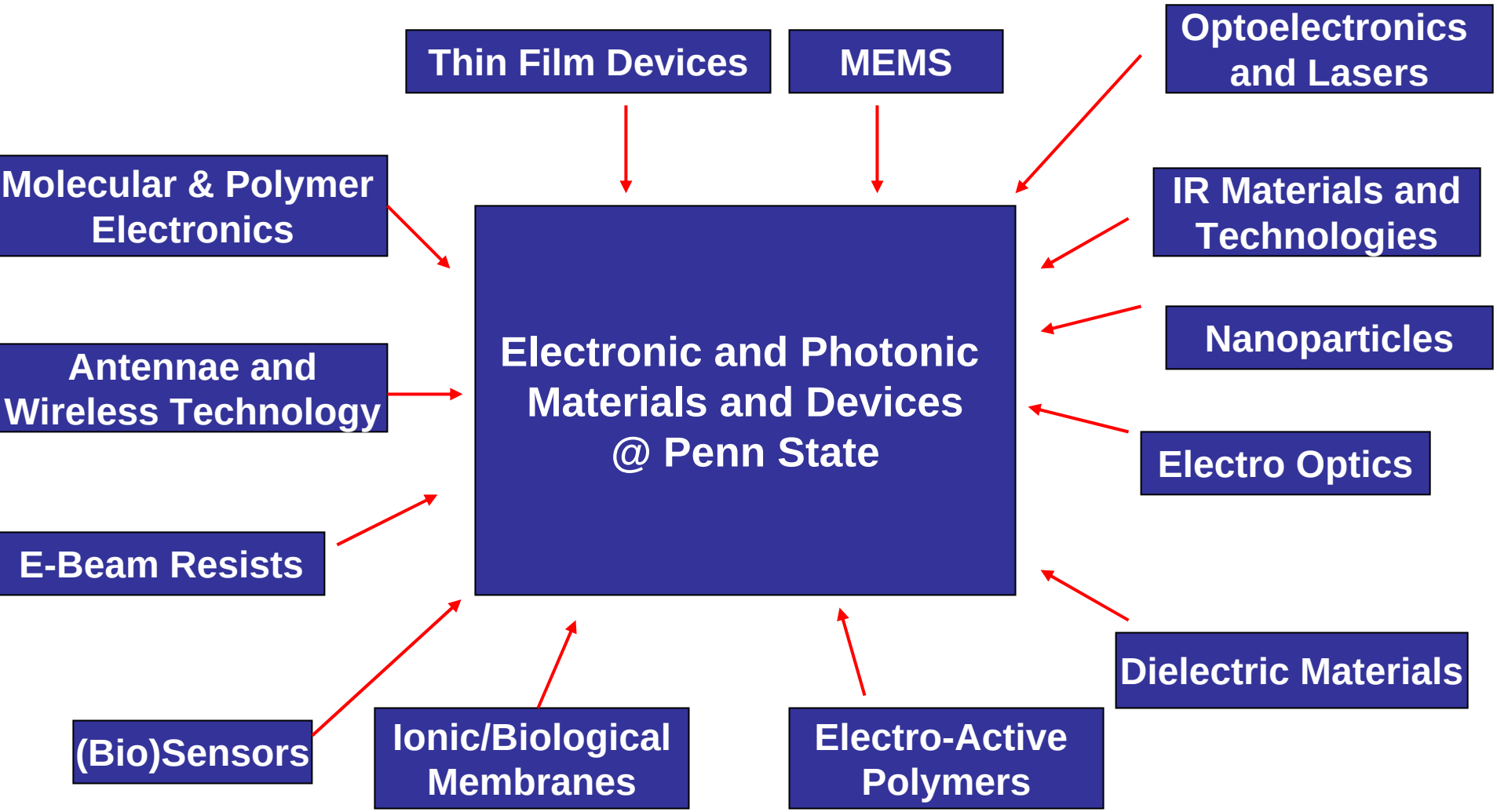
Mission

- MRI promotes interdisciplinary science and engineering
  - by applying its' core competencies to a broad set of technological needs, including those in life science, environmental science, energy and defense.
  - by developing multi-disciplinary research teams to enhance innovation and the competitiveness of our graduates for careers in industry.
  - to drive technology-based economic development in the Commonwealth and in the Nation.

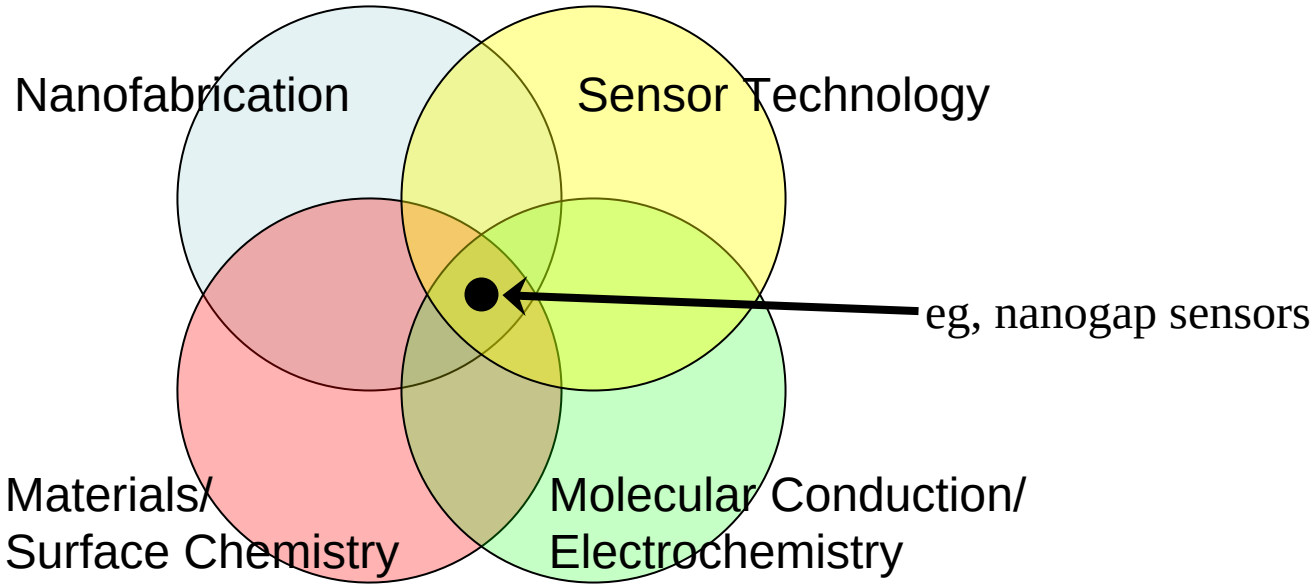
Nanoscale Science and Technology: Interdisciplinary and Multi-Investigator

National Science Foundation Grants

Award Number	PI Name	Email	Phone Number	Proposal Title	Amount Awarded
2002-2009 MRSEC					
	Thomas Mallouk	tom@chem.pus.edu	814-863-9637	Center for Nanoscale Science	$1,500,000/year
2001 - NIRT					
0103585	Henry Foley	hankfoley@engr.psu.edu	814-865-2574	Control of Nanostructures via Metal-Carbon Interactions over Multiple Length Scale via Metal and Metal Carbide Nanojunctions and Nanowelds	$1,125,000
2002 - NIRT					
0210229	Seong Kim	shkim@engr.psu.edu	814-865-2574	Deformation mechanisms and manufacturing of nanostructured mataerials processed by severe plastic deformation (SPD)	$1,100,000
2003 - NIRT					
0303976	Darrell Velegol	velegol@psu.edu	814-865-8739	Bottom Up Assembly of Metal and Semiconductor Nanowires: Fundamental Forces to Nanoelectronic Circuits	$1,000,000
0303981	Thomas Mallouk	tom@chem.pus.edu	814-863-9637	Heterogeneous Integration of Nanowires for Chemical Sensor Arrays	$1,200,000
0304178	Peter Eklund	pce3@psu.edu	814-865-5233	Semiconducting Nanowires: Novel Phenomenon and Nanoscale Sensors	$1,450,000
2005 - NIRT					
0506967	Ayusman Sen	asen@chem.psu.edu	814-865-4700	Nanoscale Motors Powered by Catalytic Reactions	1,000,000
0507146	Darrell Schlom	schlom@ems.psu.edu	814-863-8579	Strain-Enhanced Nanoscale Ferroelectrics	1,200,000
2005 - NER					

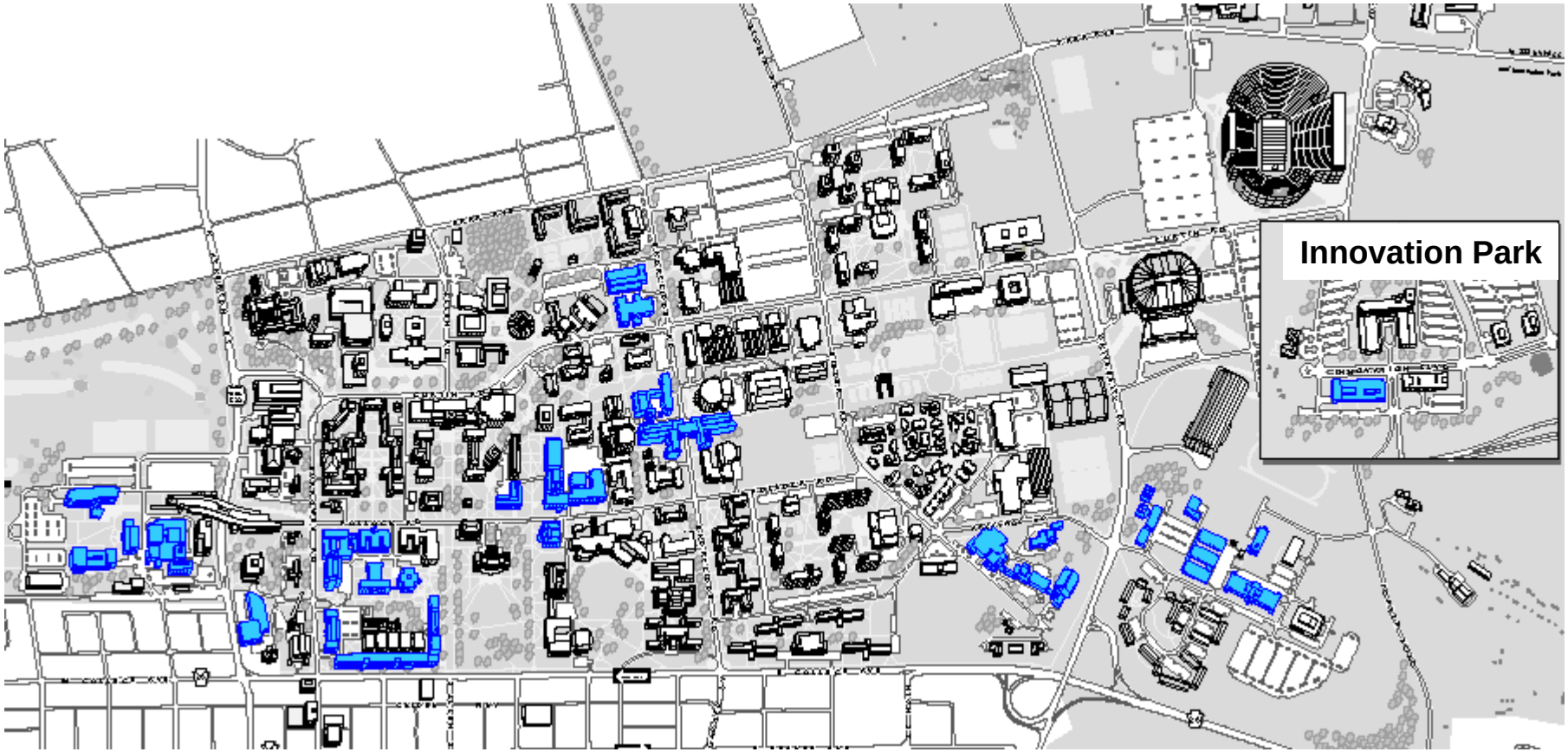

Thin Film Devices
MEMS
Optoelectronics and Lasers
Molecular & Polymer Electronics
IR Materials and Technologies
Electronic and Photonic Materials and Devices @ Penn State
Nanoparticles
Antennae and Wireless Technology
Electro Optics
E-Beam Resists
Dielectric Materials
(Bio)Sensors
Ionic/Biological Membranes
Electro-Active Polymers

Micro- and Nanofabrication Tools for Biological Studies

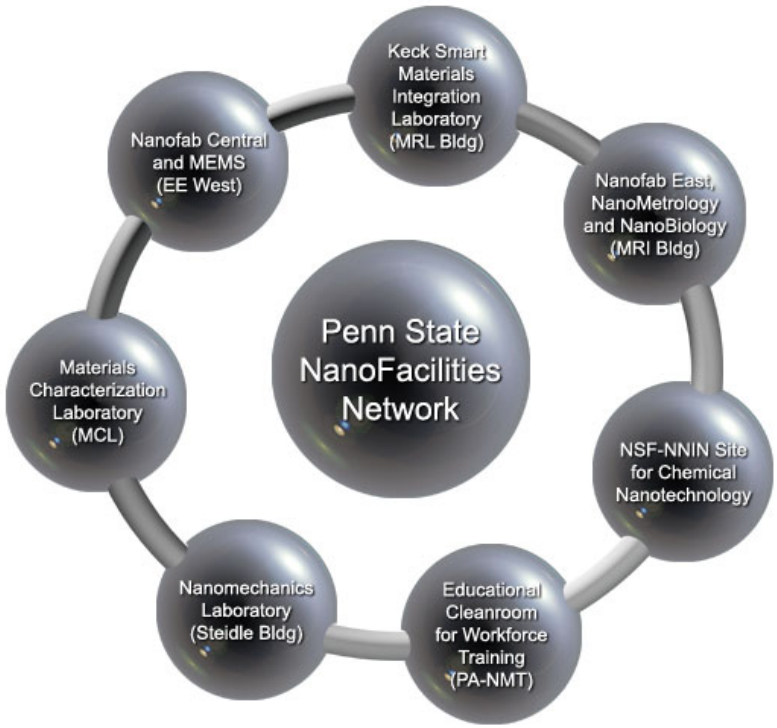


Implement tools and techniques developed for nanofabrication in order to enable/improve biological research

Materials Research Sites



NanoFabrication Facilities and Materials Characterization Labs



Materials Characterization Laboratory

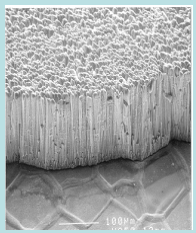
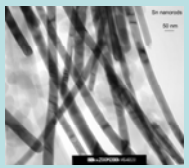
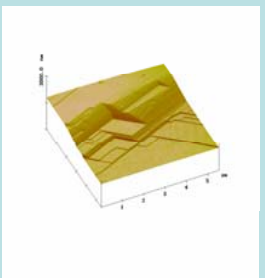
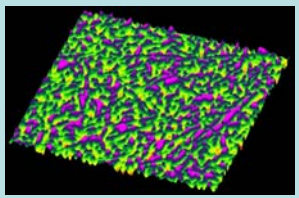
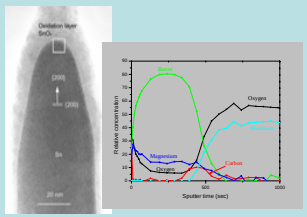
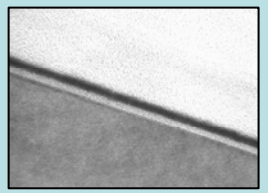
MRI

A user facility supported by the Materials Research Institute to serve analytical needs of the materials community at Penn State

25 analytical techniques (microscopy, chemical analysis, surface, thin film and physical property testing services)

18 professional staff members available for analysis, training, data interpretation and method development

$15 Million worth of specialized analytical equipment


PENNSTATE

Materials Research Institute

strengths in materials and nanotechnology

Materials Research Institute

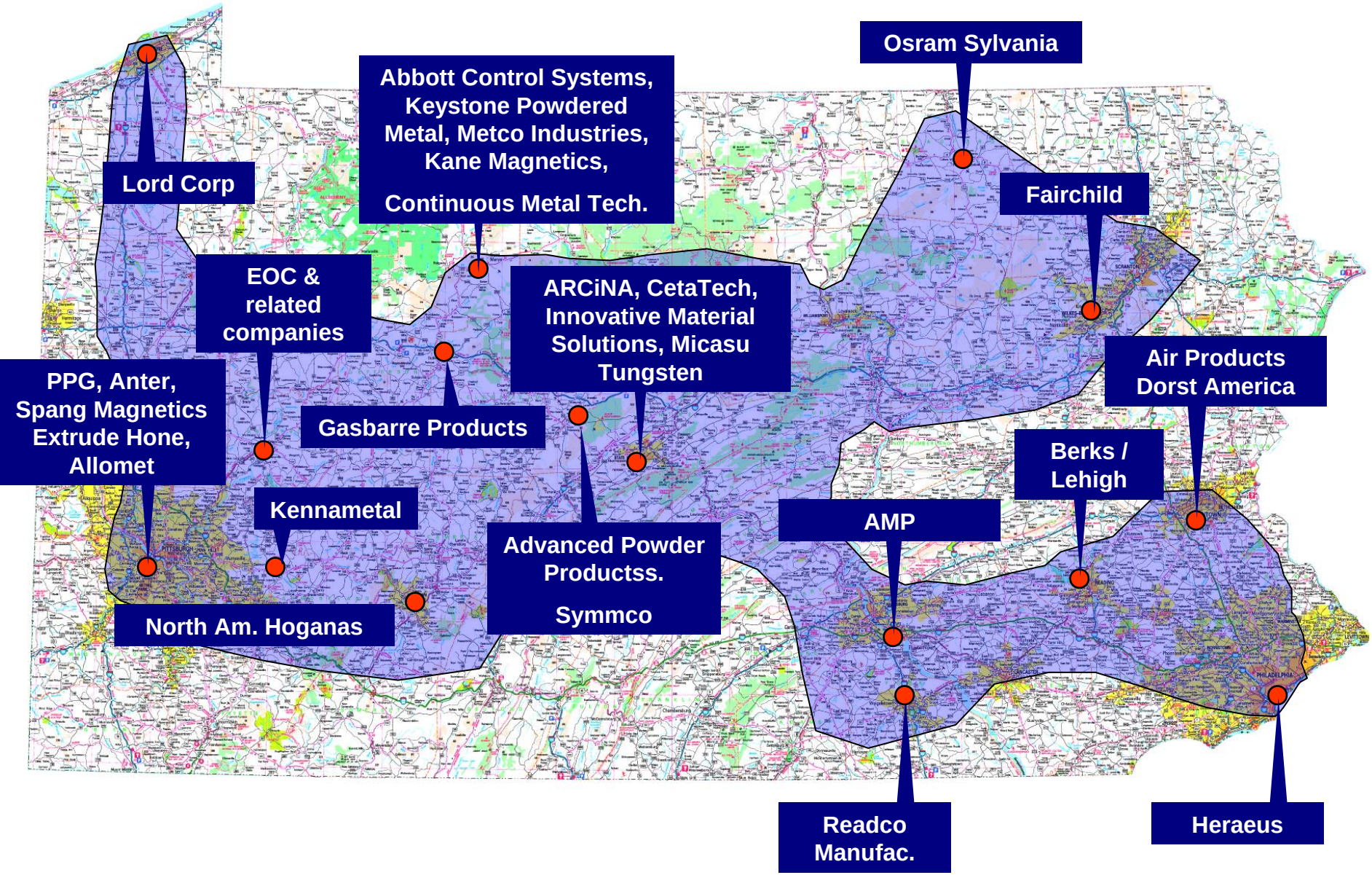
Partnerships and Leveraging in Nanoscale Science

NNIN — **MRI** — **MRSEC**

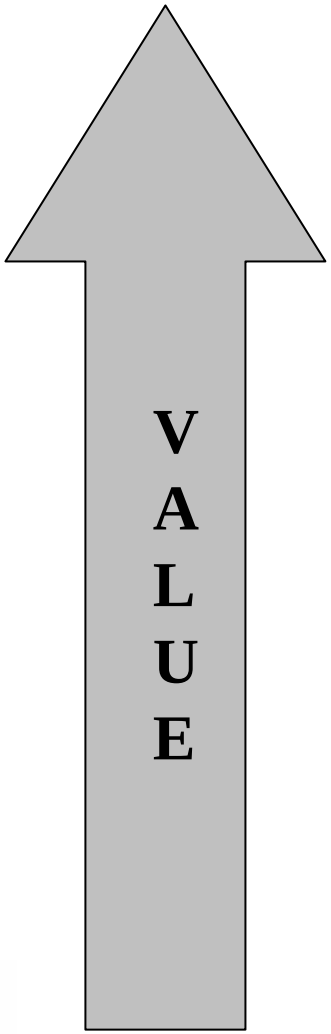
Faculty Co-Funding

- **Nanofab** ↔ **Facilities**: • MCL • Keck ↔ • **CFL**
- • workforce training • commercialization ↔ **Outreach**: • Materials Day • Nano-Portal ↔ • What's in the News • K-12 Students/Teachers
- • Associate Degrees • REU ↔ **Education**: • Graduate Fellowships • Intercollege Degree Program ↔ • RET • REU

A Few of PSU's Manufacturing / Materials Industry Partners



Penn State has the breadth and expertise to vertically-integrate, and transition its fundamental research for commercial applications

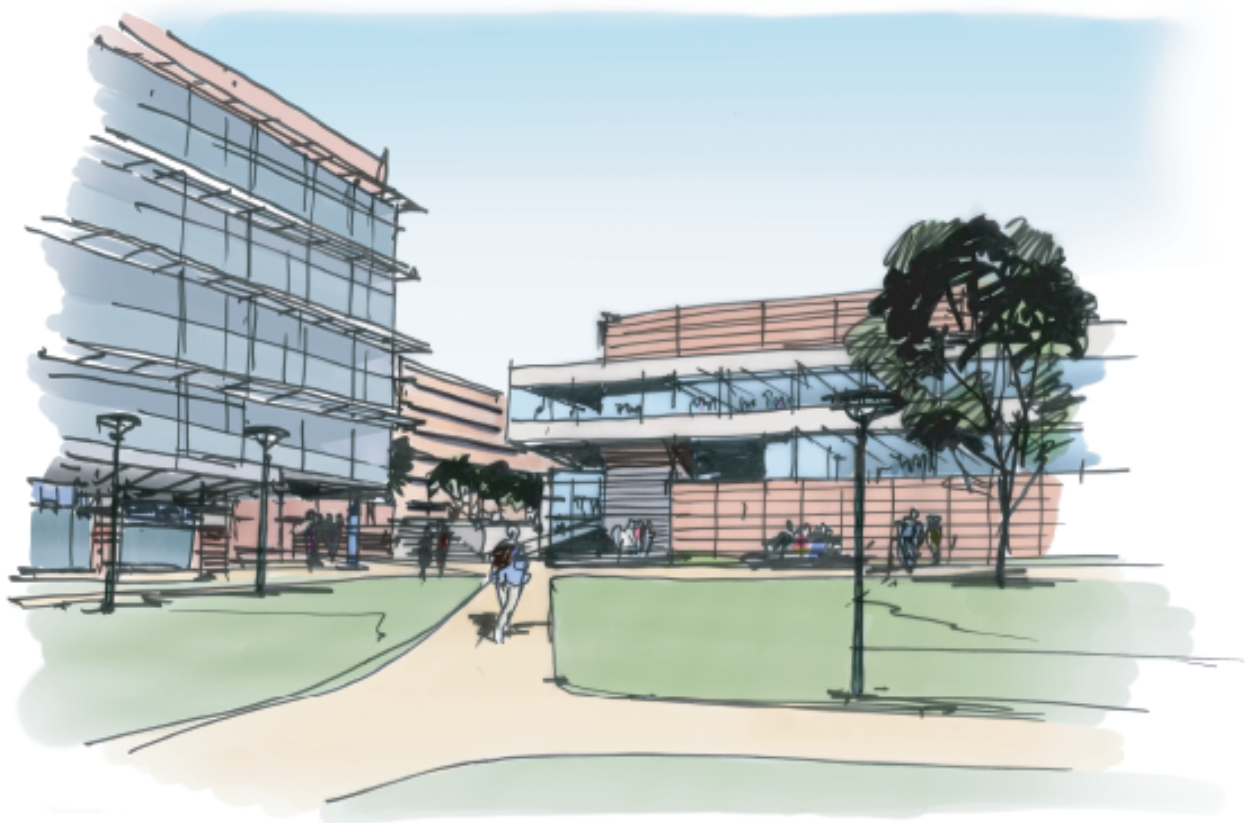


Technologies
Productization processes
Scale-up / optimization
Interface Technologies
Fabrication Methods
Materials Characterization
Materials Synthesis
Modeling / simulation

- **The new materials building is intended to foster and facilitate collaborative, interdisciplinary materials research of the highest quality.**
  Interdisciplinary research is a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice.

- **To maximize space utilization, and flexibility of space utilization for the future, the building will be designed on the basis of function, primarily. This will also increase the number of faculty and graduate students who can occupy and/or use the building.**

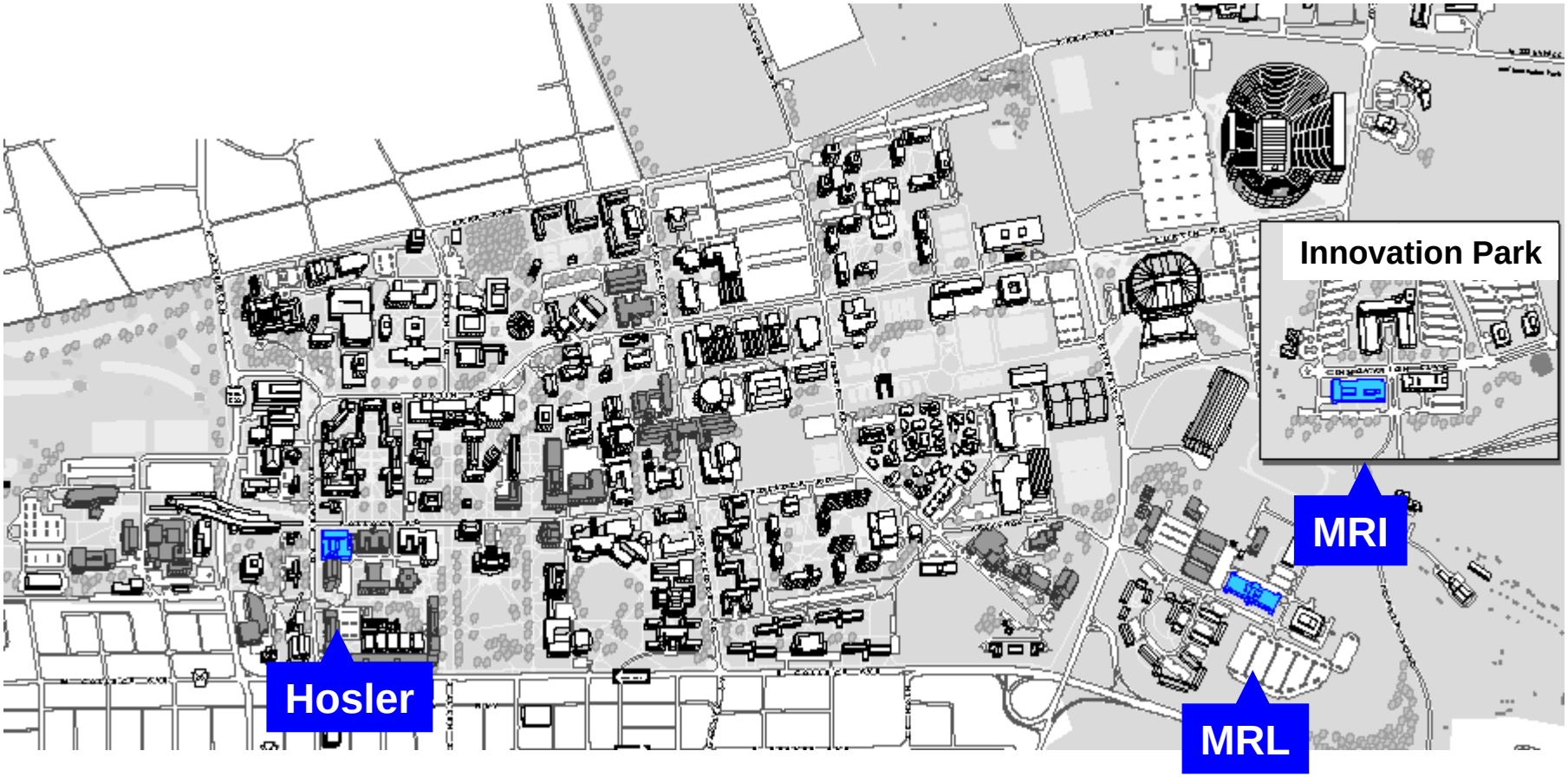
  - Electronic/Photonic Materials and Devices
  - Nanofabrication, Nanostructures and Nanomaterials
  - Biomaterials, Biomemetics and Bionanotechnology



PENN STATE

Life Science II / Materials Science Building Complex; Pollock Field

Distributed Network of User Facilities for Materials Characterization



Office of the Vice President for Research

Nanoscale Science and Technology Steering Committee

MRI Executive Committee

Materials Research Institute (MRI)

MRI Faculty Advisory Board

Industrial Research Office

~200 Faculty in 15 departments

Administration

- MRI/MRL Buildings
- Materials Characterization Lab
- Smart Materials Integration Lab
- Center for Materials Simulation
- Interdisciplinary Centers (5)
- Research Faculty
- Research Support Staff
- Communications and Public Relations

New Initiatives

- faculty co-funding
- equipment matching
- seed grants
- fellowships
- interdisciplinary proposals

internal funding and sponsored research grants

- MRI has an independent budget through the office of the vice president… it adds to department and college resources
- co-funded faculty (not joint appointments); ie, teaching duties, salary release, T&P, etc are managed by the academic departments
- return of overhead to the academic departments of the relevant faculty, independent of who PIs, or where the grant is administered

Summary

- MRI is working for Penn State
- a loose, congenial confederation of faculty
- a formal partnership with departments, facilities and research centers
- MatSE is dominant but not controlling
- funds for facility support, seed grants and discretionary funds are key to success
- '**materials**' is the brand… interdisciplinary research is the mission

Annual ‘Materials Day’ and ‘Crossover’ Events

PENNSTATE

moving at the speed of light

The Huck Institutes of the Life Sciences

www.HILS.psu.edu

Roadmap to Excellence

Penn State
Institutes of the Environment

PSIE

Mission

To facilitate interdisciplinary environmental science and engineering research, teaching, and outreach at Penn State in a set of theme areas of high scientific challenge and societal interest.

Penn State Total Research Expenditures
Twenty Year History