



**Argonne**  
NATIONAL  
LABORATORY

*... for a brighter future*



U.S. Department  
of Energy

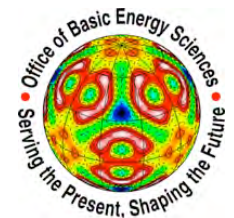
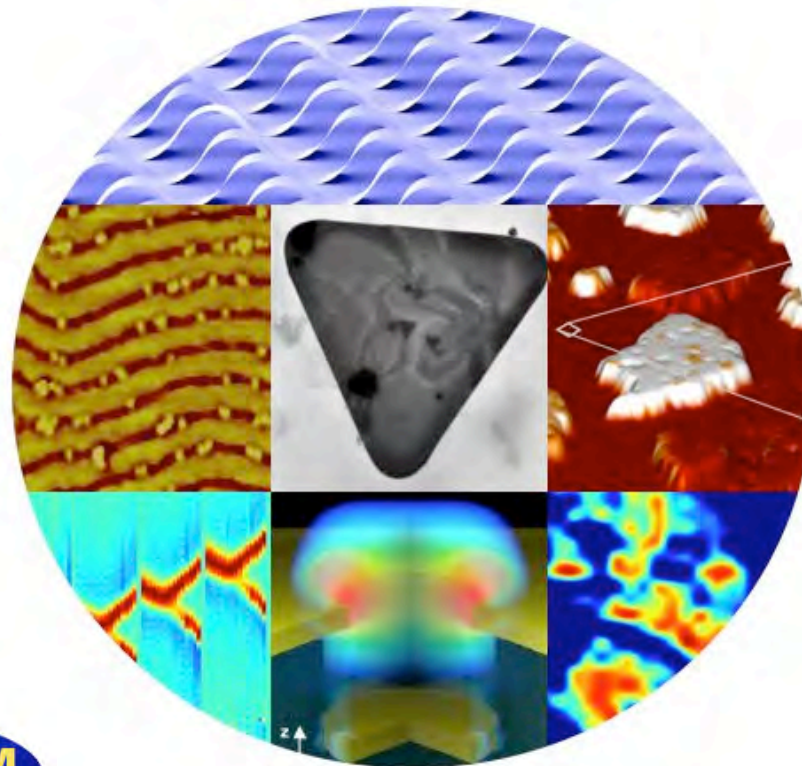
UChicago ►  
Argonne<sub>LLC</sub>



A U.S. Department of Energy laboratory  
managed by UChicago Argonne, LLC

# Center for Nanoscale Materials

Stephen Streiffer  
Acting Director



# Outline

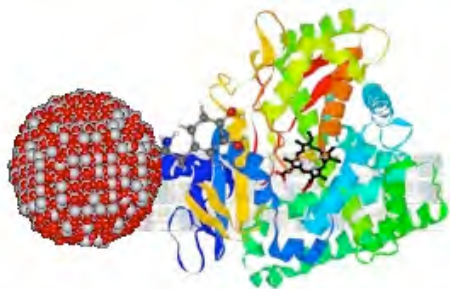
- Introduction to CNM Groups, Facilities and Capabilities; Science Highlights
- Budget and Staffing
- User Access and Statistics
- Interactions with Stakeholders and Partners

# *Introduction to CNM Groups, Facilities & Capabilities; Science Highlights*

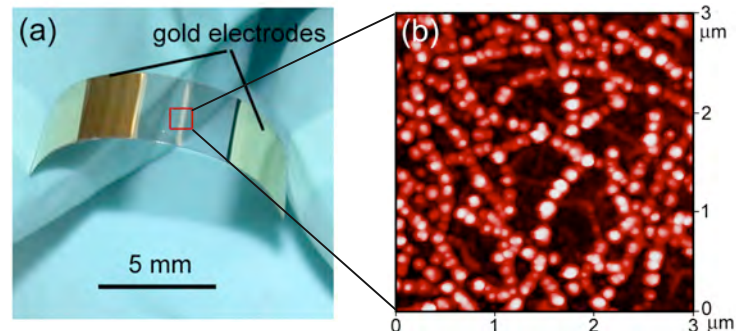
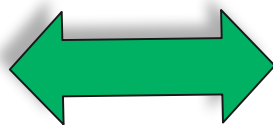




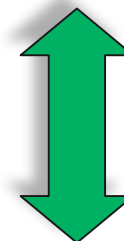
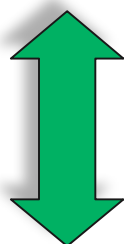
# An Integrated Facility for Nanoscience Research



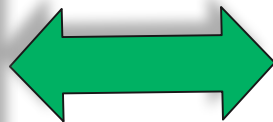
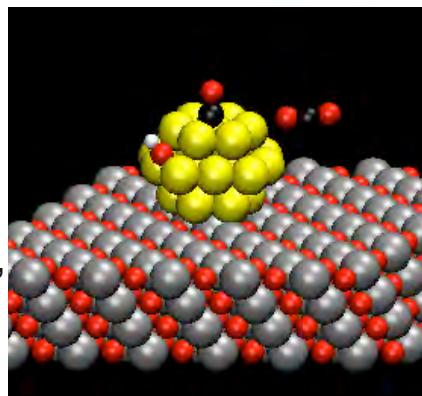
Materials creation:  
Synthesis & assembly for control  
of processes and function



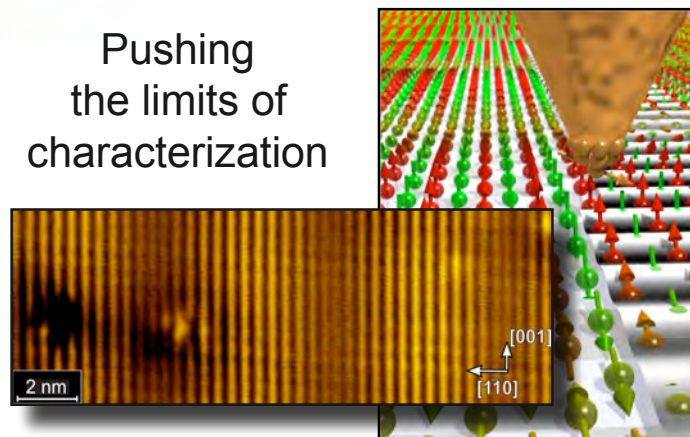
Nanofabrication of novel architectures  
and devices



Virtual Fab Lab  
(theory):  
Guiding the search,  
understanding  
functionality

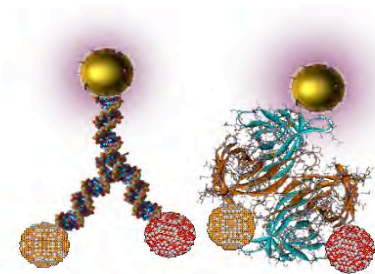


Pushing  
the limits of  
characterization



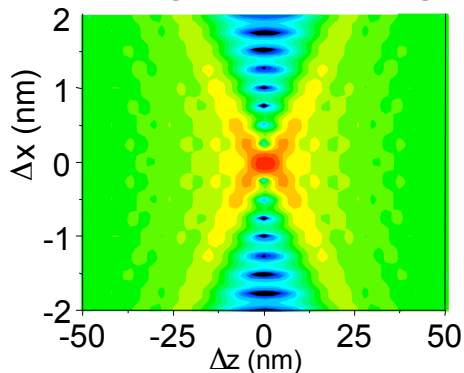
# CNM Groups

## NanoBio Interfaces



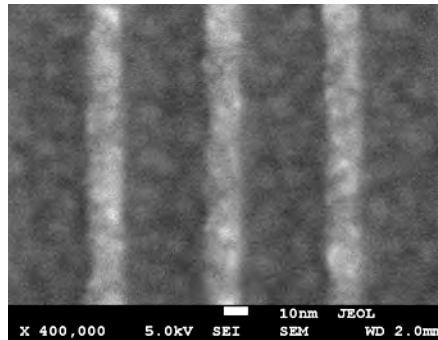
Create bio-inspired materials and processes for energy transduction

## X-ray Microscopy



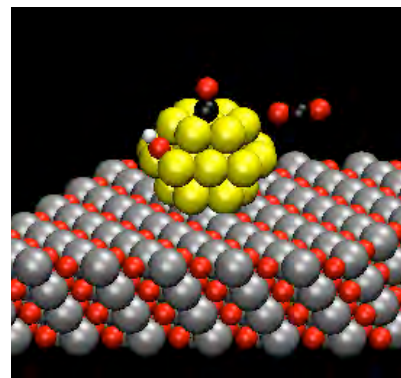
Create images of the nanoworld with hard x-rays

## Nanofabrication & Devices



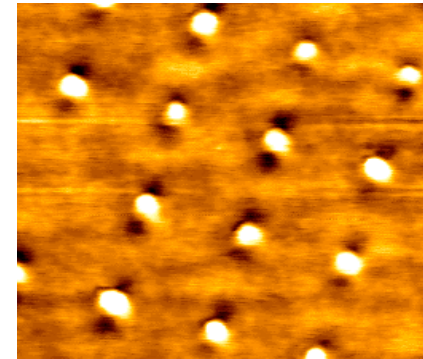
Discover new paths for nanostructured materials, including below 10 nm

## Theory & Modeling



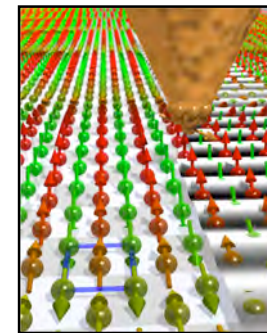
Towards the 'virtual fab lab'

## Nanophotonics



Understand and control optical energy pathways

## Electronic & Magnetic Materials & Devices



Understand and control charge and spin-based materials for energy and information transport

# Center for Nanoscale Materials Facilities

EMMD

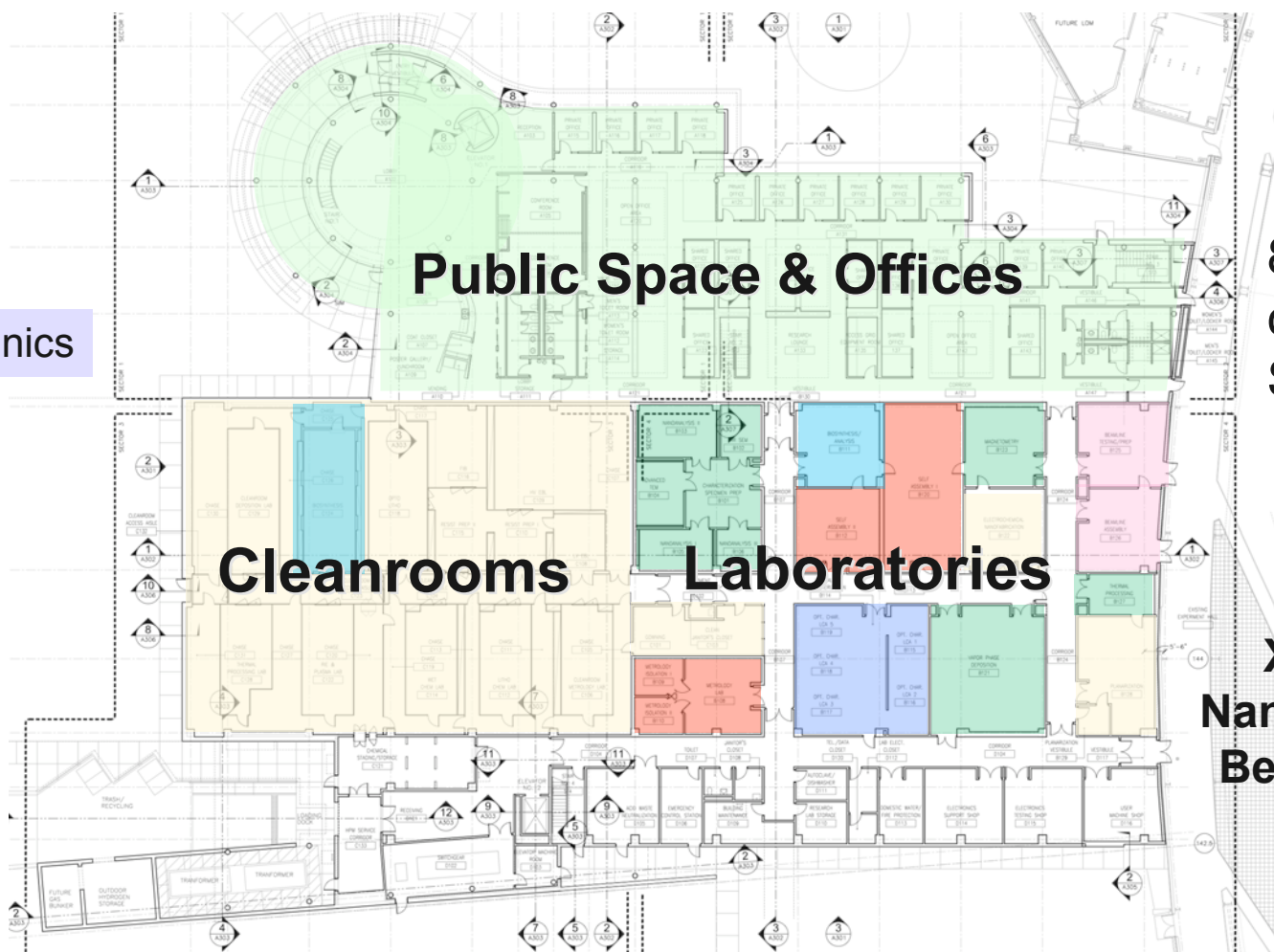
NanoBio

Nanophotonics

X-Ray

NanoFab

Mixed



Public Space & Offices

Cleanrooms Laboratories

88,000 sq.ft.  
completed in  
Sept. '06

X-ray  
Nanoprobe  
Beamline



# Key Facilities and Capabilities

## ■ Materials Synthesis

- Colloidal nanoparticle synthesis using wet methods
- Complex oxide molecular beam epitaxy
- PECVD nanocrystalline diamond
- Polymeric templating
- Spin coating
- Peptide/DNA synthesis methods
- Centrifugation
- Thin films by sputtering and evaporation

## ■ Nanofabrication Research

- Electron-beam lithography (JEOL 9300, Raith 150)
- Focused ion beam processing (FEI Nova 600 )
- Nanoimprint patterning methods (Nanonex NX-3000)
- Reactive ion etching
- Optical lithography
- Wet etching and chemistry
- Metrology

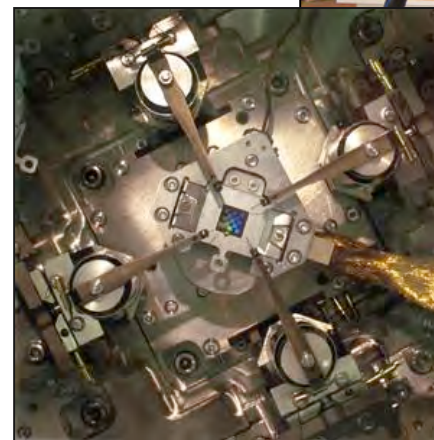
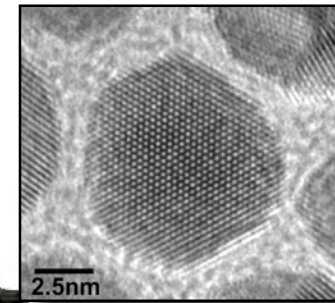
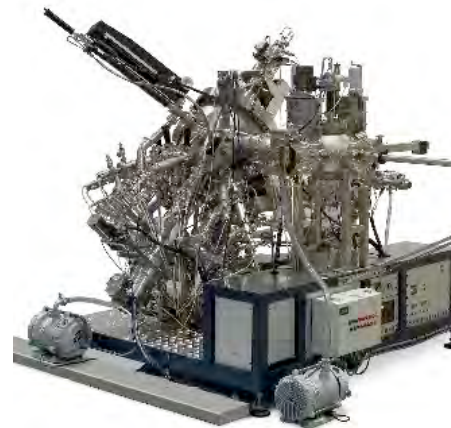
## ■ Characterization

- Proximal Probes: AFM, NSOM, UHV VT-STM
- SEM (JEOL JSM7500F)
- Magnetometry and electrical characterization
- Optical microscopy and spectroscopy
- Thermal analysis (TGA, DSC, rheometry)
- Diffractometry

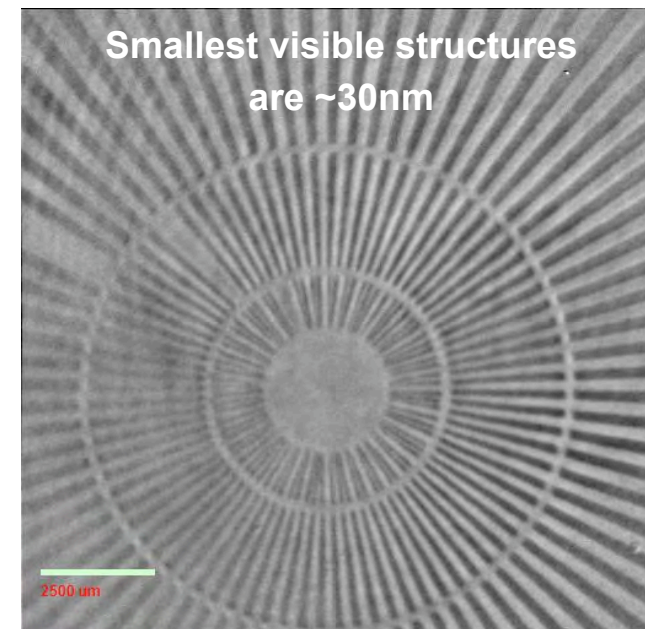
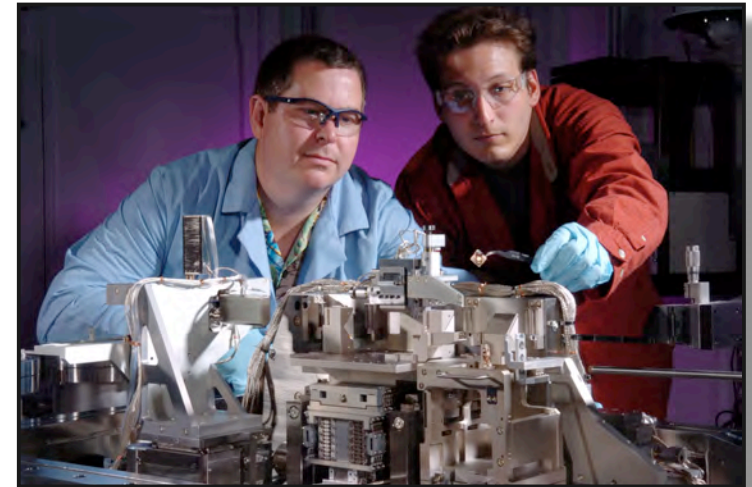
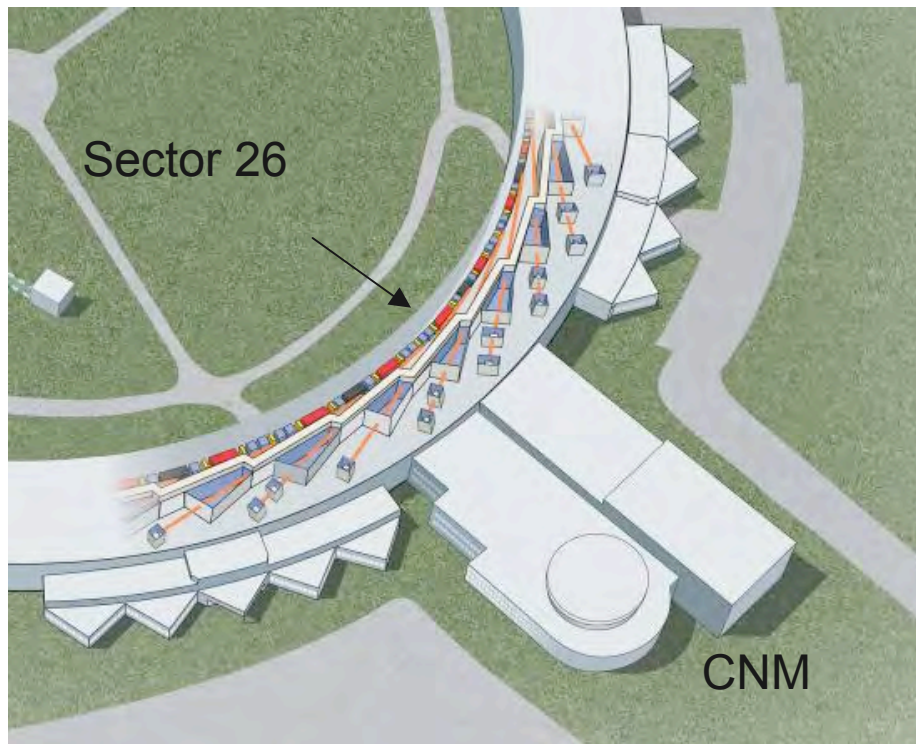
## ■ Dedicated Hard X-Ray Nanoprobe Beamline at the APS

## ■ Computational Nanoscience

- 1152 node cluster with compute capacity of approximately 10 Tflops, ~11M CPU hr/yr



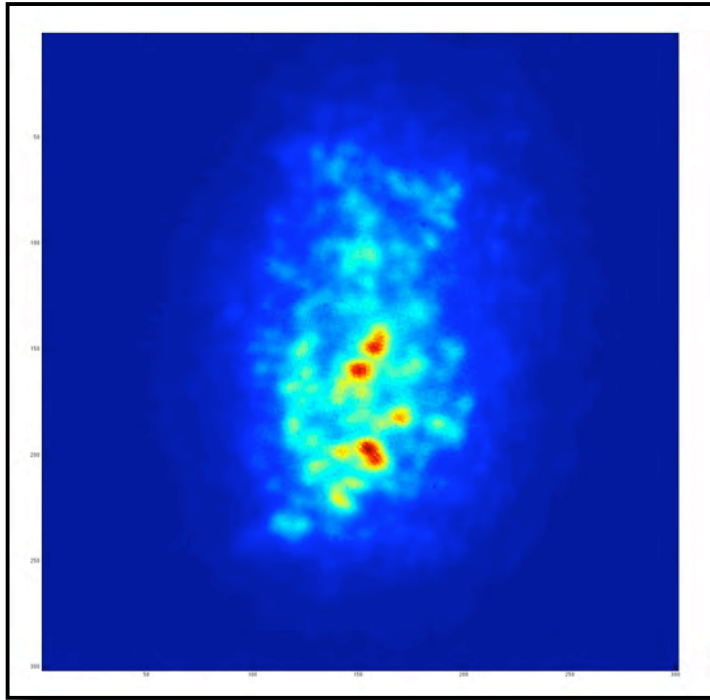
# ***CNM & APS Partnership at Sector 26-ID The Hard X-Ray Nanoprobe***



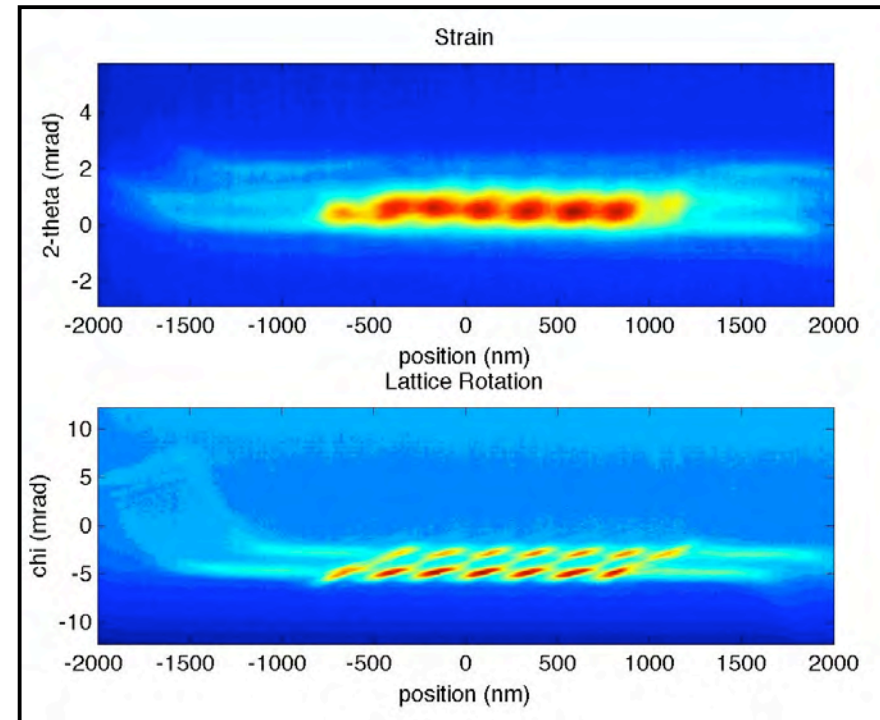
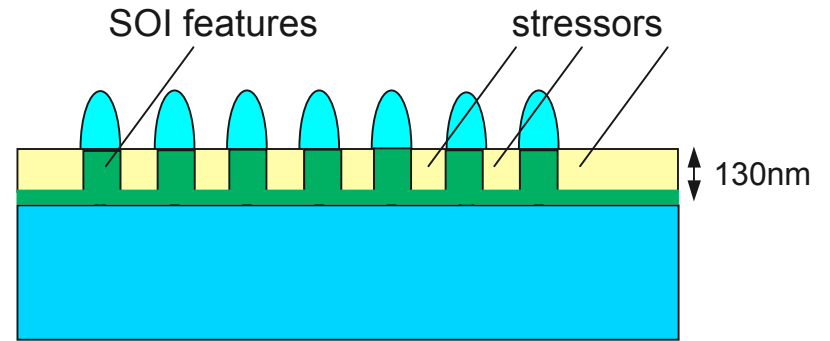
***Jointly staffed and managed by CNM & APS  
(4 CNM staff, 2 APS staff)***



# Early Nanoprobe Results



- Coherent diffraction across nanoscale grains in a Nb thin film (Robinson et al. (UCL))



Photon Energy: 10 keV, Step size: 10 nm

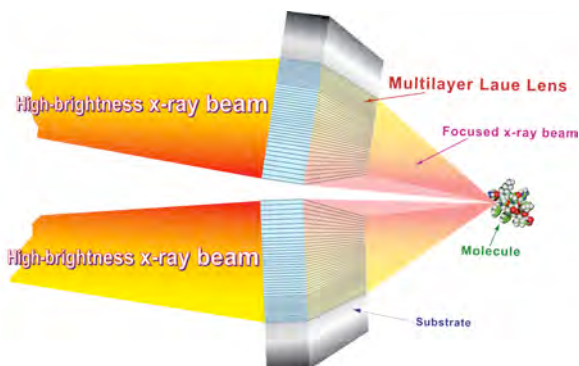
- Diffraction maps across strained SOI (Noyan, Murray, et al. (Columbia, IBM))

# A Path to Nanometer Focusing of X-Rays: Multi-Layer Lens

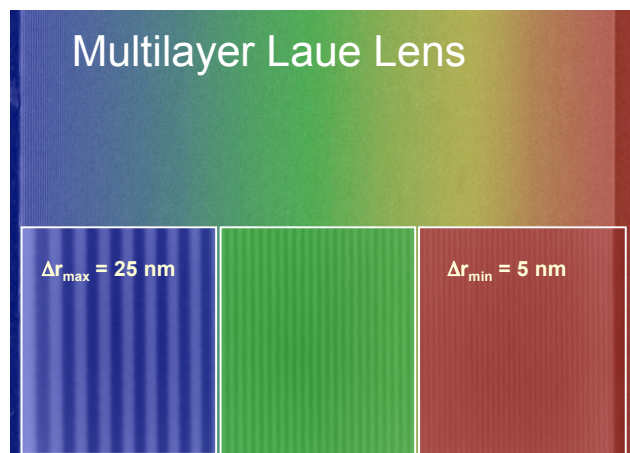
APS/CNM/MSD program

CNM Partner User Proposal submitted by CNM, APS, NSLS-II

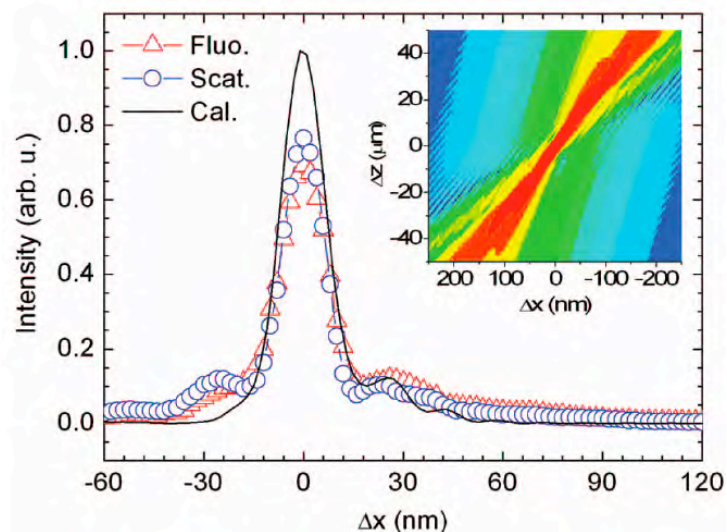
## “Multilayer Laue Lens” Concept



Transmission multilayers



Experiment: 16 nm line focus  
at 20 keV with 31% efficiency

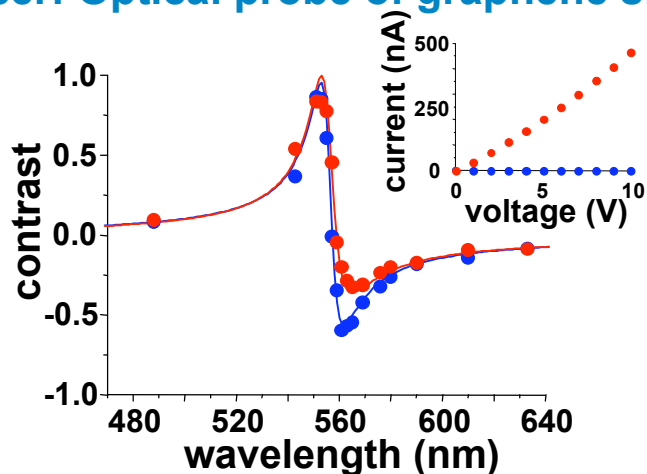


Hyon Chol Kang, et al.,  
*Appl. Phys. Lett.* **92**, 221114 (2008)

Goal: 6 nm with  
complete MLL

# Scientific Highlights

User: Optical probe of graphene sheets



Jung, et al, *Nano Letters*, 7, 3569 (2007)



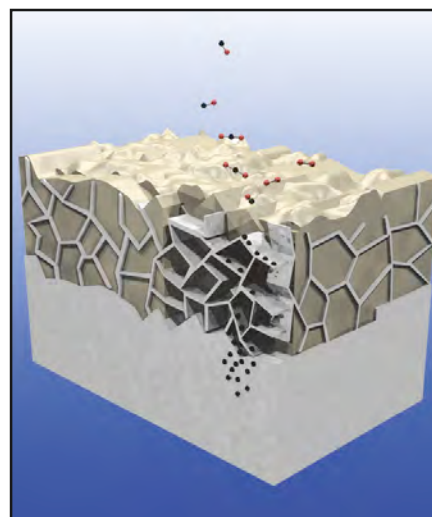
Staff: Ordering in polymer systems

Ramanathan & Darling  
*Wired Magazine* 4•25•08  
[http://www.wired.com/science/discoveries/multimedia/2008/04/gallery\\_nano\\_art](http://www.wired.com/science/discoveries/multimedia/2008/04/gallery_nano_art)



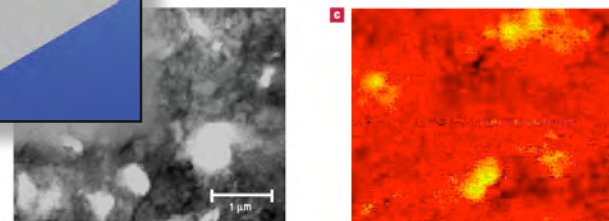
Staff: Novel synthesis of Ag nanoplates

Y-G Sun & Wiederrecht,  
*Small* 3, 1964 (2007)



User: Role of nanoparticles in alloy corrosion

Z. Zheng, et al., *Nature Materials* Published online: 11 July 2008; doi:10.1038/nmat2227





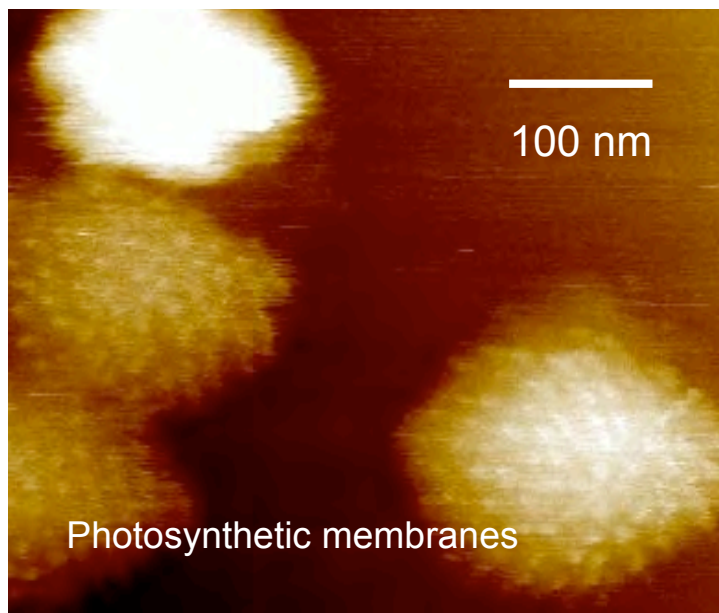
# Recent Awards

**Dr. Libai Huang**

(Joint CNM/CSE Postdoctoral Researcher)

Young Investigator Award,  
Gordon Research Conference on Photosynthesis,  
Mount Holyoke College, MA, June 22-27th, 2008

*Ultrafast imaging of solar energy flow in photosynthesis*

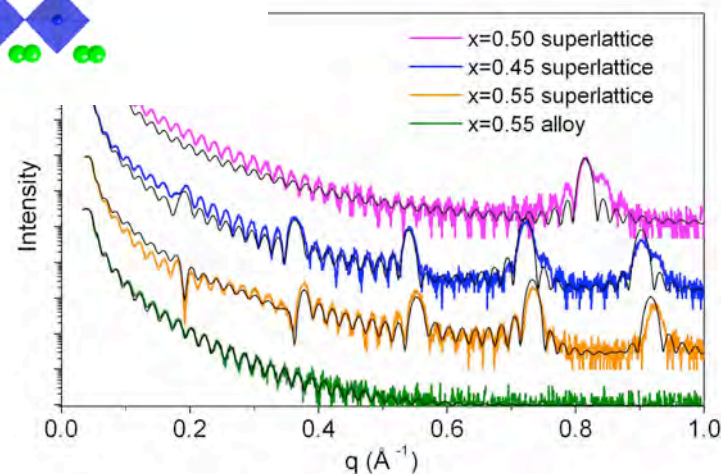
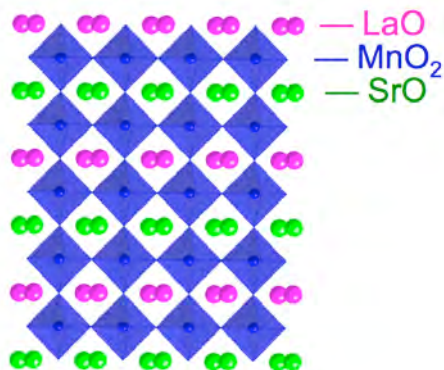


**Dr. Tiffany Santos**

(CNM Postdoctoral Researcher)

Best Poster Award,  
ICMR Frontiers of Complex Oxides Workshop,  
Santa Barbara, CA, July 6-11, 2008

*Creating an Antiferromagnetic Metal in  $La_{1-x}Sr_xMnO_3$  by Digital Synthesis*

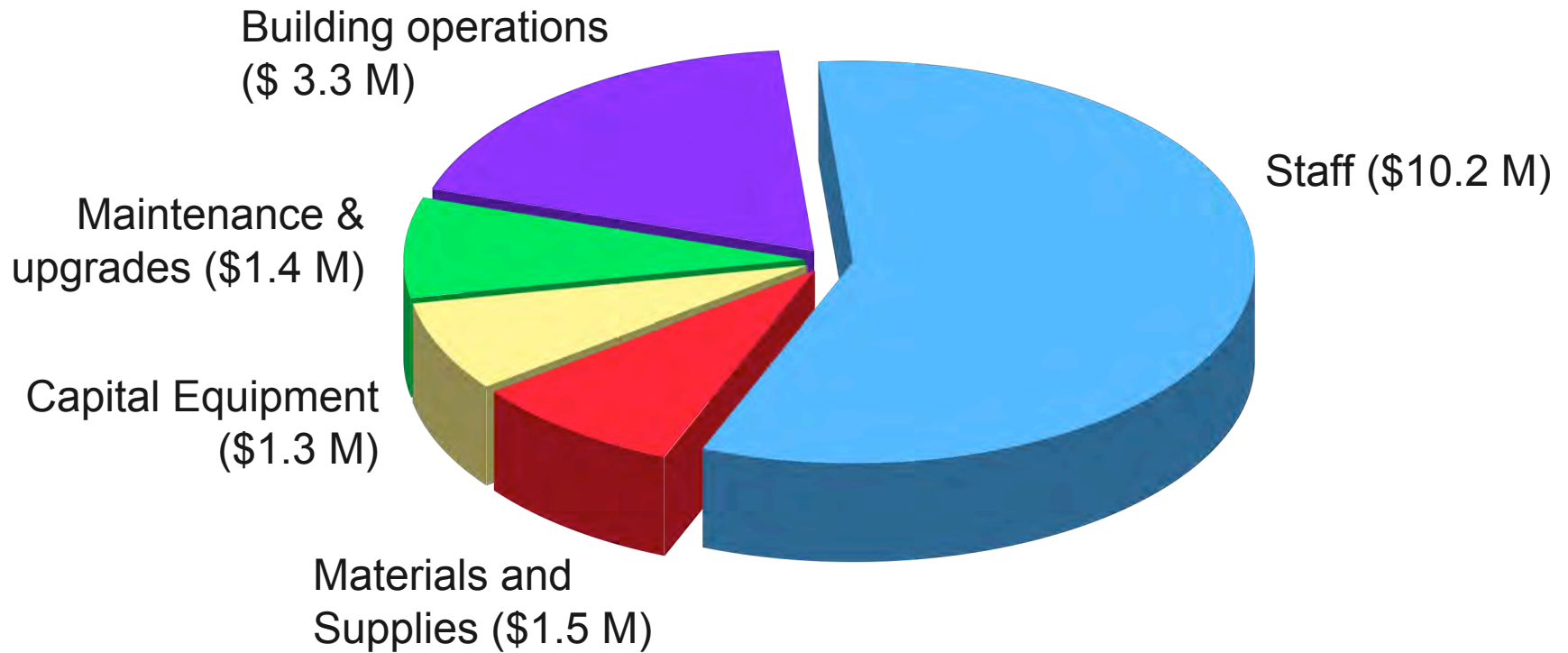


# *Budget and Staffing*

# FY08 CNM Budget

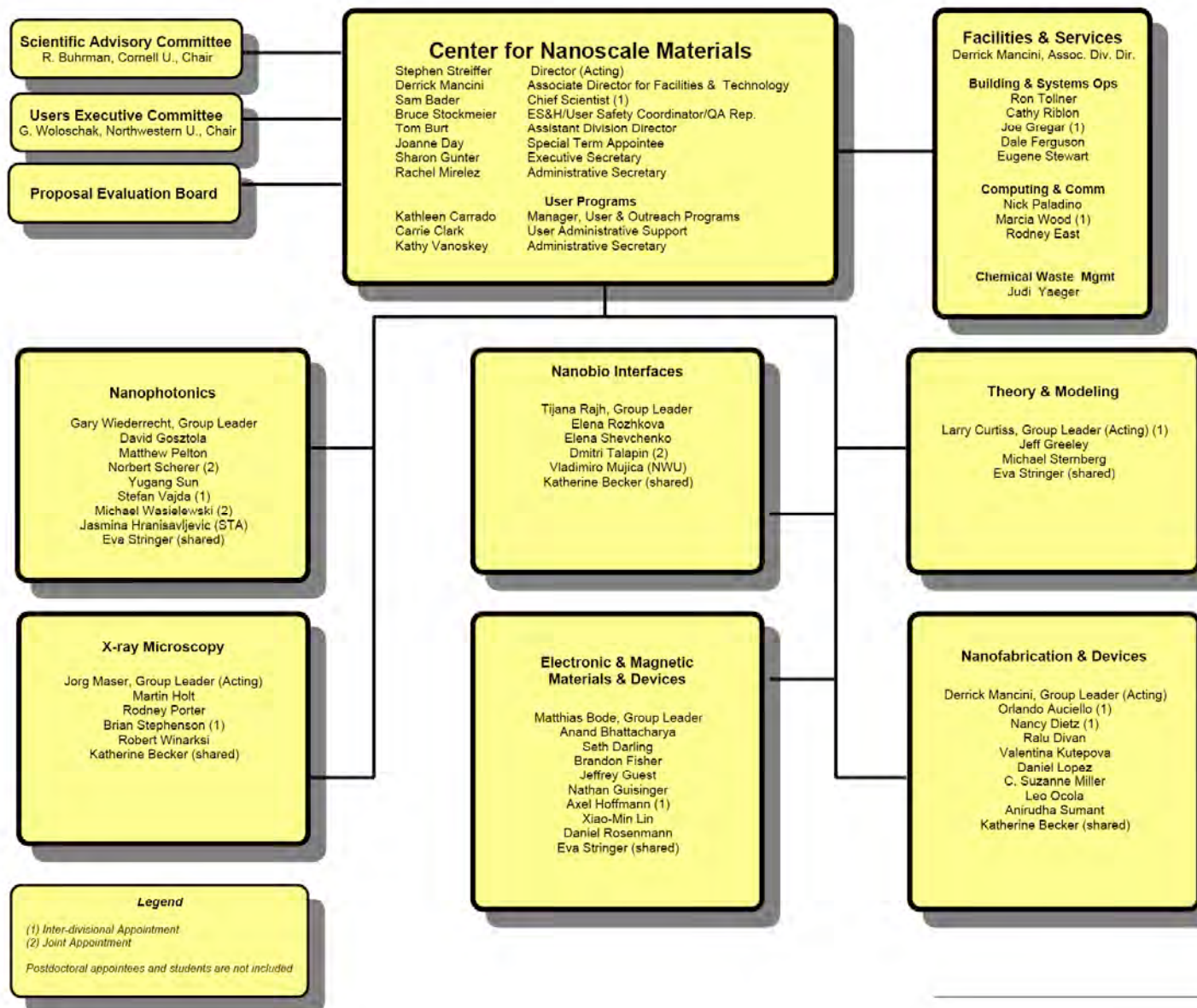
**FY08 Budget Request: \$ 20.8 M**

**FY08 Budget Actual: \$ 17.7 M**





# CNM Organization



# CNM Staff

## ■ Hiring Process

- *Positions are competed*
- *Hiring committees evaluate candidates, make recommendation to Director*

## ■ Staffing Profile

- *23 PI's, 12 post docs, 16 technical & support staff, 10 administrative staff*
- *15 PI's, 3 technical/support staff new to Argonne*
- *All scientific and tech. staff serve as Scientific Contacts responsible for users*
- *PI's spend approximately 50% of their time on users*

## ■ Staffing Progress

- Limited by FY08 budget
- Positions to fill
  - *Group leader, Theory and Modeling (candidates being interviewed)*
  - *Group leader or senior scientist, X-ray Microscopy*
  - *Several positions in Nanofab*
  - *Has limited user access to certain capabilities (nanoimprint, thin film deposition)*

# CNM Staff Criteria

- Ensure user productivity and satisfaction in a safe environment
- Execute innovative, world-leading research in the area of nanoscience
- Develop and implement world-class instrumentation for nanoscience
- Ensure scientific/technical integration within and across groups

Scientific Performance	User Support
<b>* Research quality and impact</b>	<b>* Support of users</b>
- High impact publications	- High number & satisfaction of users
- Citations	- Low unscheduled down time
- Patents/industrial impact	<b>* Outcomes</b>
- Advanced technique development	- Advanced technique deployment
- Speaking invitations	- Impact on quality of user science
- Awards	- Tech Transfer/IP
<b>* Peer review evaluations</b>	<b>* User 'loyalty'</b>
<b>* Proposal accept/reject ratio</b>	- Repeat users & user involvement in user group
<b>* Mentoring &amp; Professional Service</b>	- Referrals
<b>* Safety</b>	<b>* Safety</b>



# *User Access and Statistics*

# User Proposal Process

- Proposals submitted at <http://nano.anl.gov>
- Review & selection are based on scientific & technical quality
  - An external Proposal Evaluation Board (PEB) is used to evaluate proposals
  - Feedback is provided to the user
- Access for non-proprietary work is free
- Cost-recovery charged for proprietary work
- Registration is required to submit a proposal
- Proposals are submitted on-line
  - Abstract, 250-max words
  - Research description is prompted by six standard questions
  - Capabilities, safety issues, timeframe, general contact information
- Nanoprobe proposals may be submitted either through CNM or APS

**Argonne National Laboratory's National User Facilities On-Line Registration System**


For access to any or all of the following Argonne National Laboratory national user facilities, you will need to complete this on-line registration form, even if you have previously registered with one or more of the facilities.

If you are a new user, click the "New User" button. If you are a returning user or have registered previously, enter your Argonne or User badge number, last name, and birth date. The information currently in our database will be automatically entered into the registration form; if needed, please update and correct this information. If you can't remember your badge number or have not previously provided your birthdate, click the "New User" button.

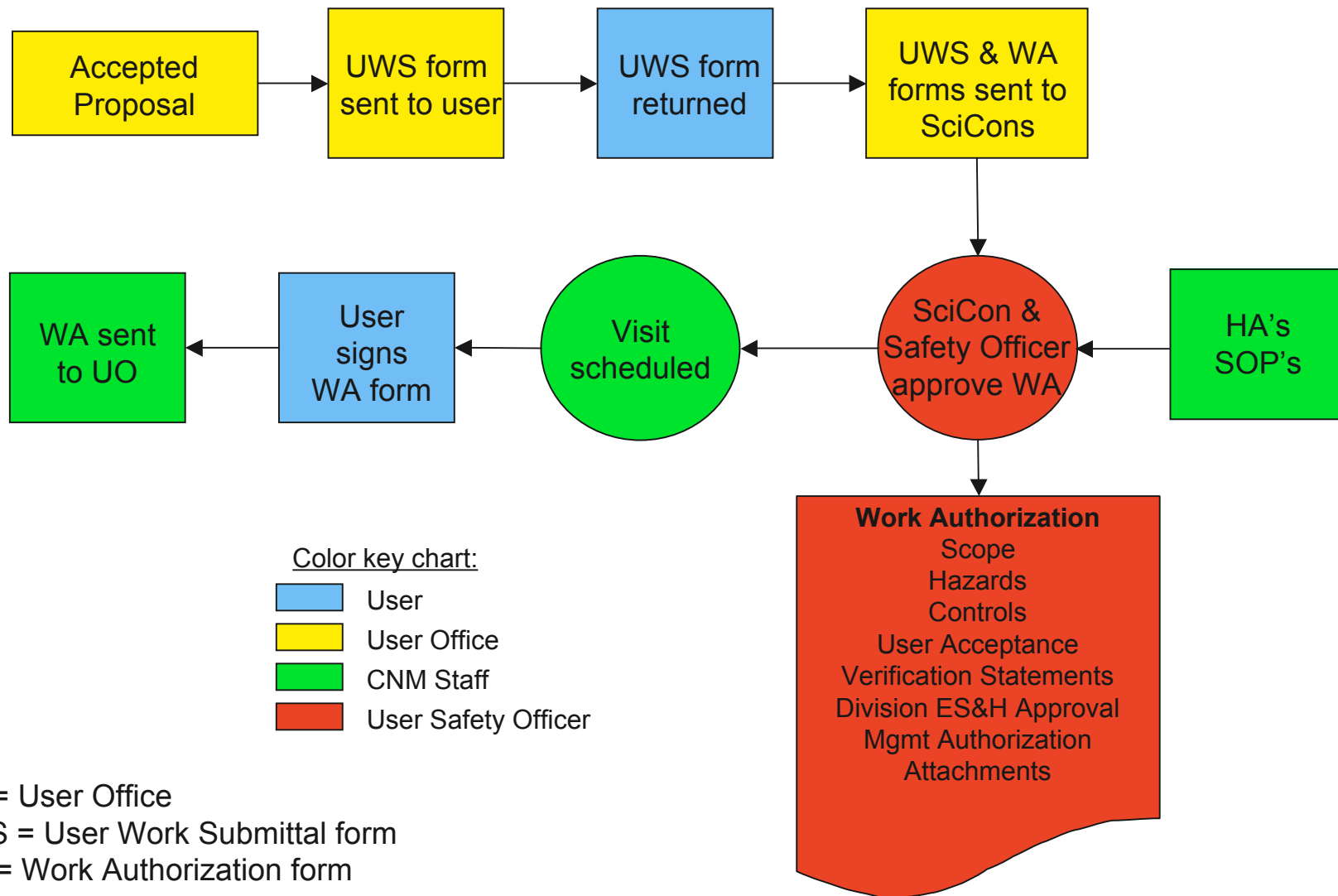
If you need assistance, please send email to [apsuser@aps.anl.gov](mailto:apsuser@aps.anl.gov).

<p><b>New Users</b></p> <p>If you <b>have not</b> been to an ANL DOE-BES User Facility click "New User" below.</p> <p><input type="button" value="New User"/></p>	<p><b>Returning Users</b></p> <p>If you have been to a ANL DOE-BES User Facility, please enter the following information and then click "Returning User" below. (All fields are required)</p> <p>Badge Number*: <input type="text"/></p> <p>Last Name: <input type="text"/></p> <p>Birth Date (e.g. 21-JAN-1985): <input type="text"/></p> <p><input type="button" value="Returning User"/></p>
---	---

\*Your badge number appears on the back of your badge, below and to the right of the magnetic strip. Use the third through seventh digits of this number.



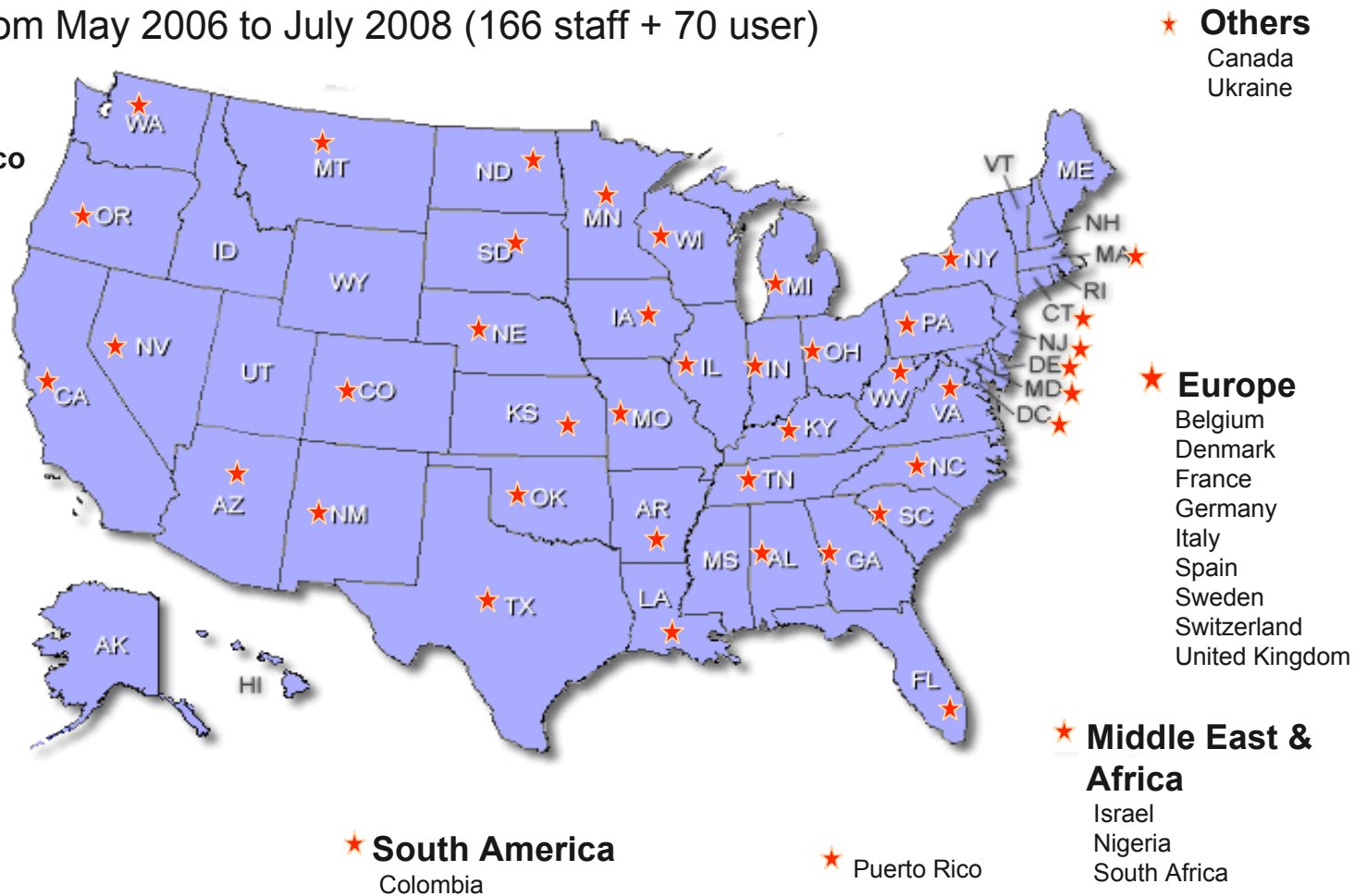
# USER PROPOSAL PROCESS



# Current CNM Users

- Instituting three calls-for-proposals per year synchronized with APS; next deadline Oct. 31, 2008
- 201 accepted proposals since 7/06 (88% acceptance rate), 149 active proposals
- Last CFP 7/11/08: 113 submissions
- 236 publications from May 2006 to July 2008 (166 staff + 70 user)

709 registered users  
42 States and Puerto Rico  
22 Other Countries



as of 7/17/08



# July 11, 2008 CFP

## Total Submissions (tentative assignments)

Group	Primary Theme	Secondary Theme	Tertiary Theme	Quaternary Theme
EMMD	19	8	6	1
Nanobio	11	5	2	1
Nanofab	26	8	1	0
Nanophot	22	6	3	0
T&M	25	2	0	0
X-ray	10	1	0	0

Grand total = 113 submissions

US - Academic 75

US - Host DOE lab - associated with host user facility 8

US - Host DOE lab - not associated with host user facility 18

US - Other DOE labs 1

US - Industry 6

Foreign - Academic 4

(1 unidentified)

Additional 2 proposals submitted through APS for X-Ray Nanoprobe

# *Interactions with Stakeholders and Partners*

# Coupling to Theory and Modeling

## ■ Research Topics

- Chemical Reactivity at the Nanoscale
- Bio-inorganic Nanostructures
- Nanophotonics

## ■ Users: Support for experiment & theory

- Access to CNM resources
- Facilitation of access to INCITE program on Argonne Leadership Computer Facility

- Markovic (ANL MSD)

*The Effect of Nanoislands on CO Electrooxidation on Pt*

- Liu & Guyot-Sionnest (UofC)

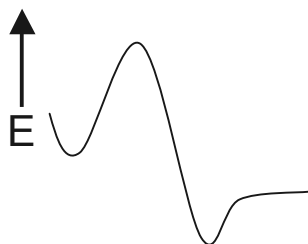
*3D-FDTD Simulation of Plasmonic Nanostructures*

- Stewart, Rogers, Nuzzo et al. (UIUC)

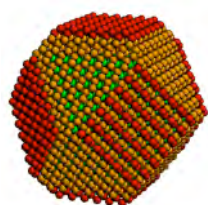
*Biosensing with Plasmonic Crystals*

- Bachelot, Bouhelier (UTT France), Schatz (NU), Novotny (UR)

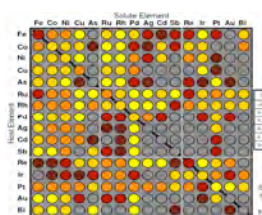
*Manipulating Molecular Motion in Photosensitive Polymers*



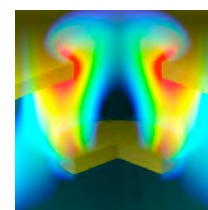
New electronic structure methods for accurate reaction energies



Modeling of structure and stability of nanoparticles



High-throughput screening of materials, e.g., catalysts



Computational nanophotonics



# CNM Oversight and Proposal Evaluation

## ■ Scientific Advisory Committee

- Provides advice to CNM on all matters from science to user policy
- Chair, Prof. Bob Burhman, Prof. Vicki Colvin, Prof. Heinrich Jaeger, Prof. Janos Kirz, Prof. George Schatz, Prof. Michael Therien
- Last meeting April 2007
- Recent discussions with committee in April 2008 (capital equipment proposals)

## ■ User Executive Committee

- Provides advocacy for CNM Users to CNM management, organizes annual users meeting, elected by user community to staggered three-year terms
- Chair, Prof. Gayle Woloschak (NU); Past Chair Prof. Paul Evans (UW, Madison), Prof. Yi Ji (U. Delaware); Dr. Nicolai Moldovan (ADT, Inc.); Prof. Teri Odom (NU); Prof. Greg Wurtz (U. North Florida), Dr. Dillon Fong (Argonne)
- See [http://nano.anl.gov/executive\\_committee.html](http://nano.anl.gov/executive_committee.html)
- Full committee last met February 19, 2008
- Recent discussions with committee in April 2008 (capital equipment proposals); at Users' Meeting in May 2008; June 2008

## ■ Proposal evaluation Board

- External peer reviewers covering CNM themes
- 2 reviews per proposal



# User Engagement, Input & Feedback

- Annual Users' Meetings since 2003
  - Joint with APS
- Workshops - over 40 since 2000
  - Towards 1 nm x-ray beams (06); Nanophotonics (06), Nanomaterials for energy (06); Interfaces and surfaces (05); Modeling the assembling processes of nanomaterials (03); ESPSCoR nanoscience workshop (04)
- Other communications
  - Invited staff lectures - meetings, seminars, ...
  - Partnerships with regional nanocenters, eg, NU International Institute for Nanotechnology, UofC MRSEC, Nanobusiness Alliance, ...
  - Tours
  - Regional industry alliances
- End-of-experiment survey
  - Excellent suggestions on streamlining training, equipment operation, safety processes
- BES Annual Facilities Questionnaire



Notre Dame Students, 2006

**End-of-Experiment Survey**

Research

1. Was your visit to the CNM a success (obtained enough data to move program ahead)?

Highly successful  
 Partially successful  
 Totally unsuccessful

Comments about your research at CNM: This is the part that was absolutely outstanding! We were able to get preliminary data and make connections with experts that made everything happen. We are looking forward to a very productive year based upon just the last experiment.

2. Was the support provided by the scientific staff consistent with your expectations?

Yes  
 No

Comments on scientific support: Everyone went out of their way to make things happen. It was a busy week down there with the nanotechnology high school teachers workshop, but we made great progress. The ideas batted back and forth were helpful and I am hopeful that we develop many collaborations on future applications.

# 2008 Users' Meeting May 7-9

- Joint with APS and EMC
- Wed. Plenary Speakers
  - Nobel Laureate Prof. Rudy Marcus (Cal Tech)
  - Prof. Dmitri Talapin (UofC)
  - Pao Tai Lin (Northwestern)
- Wed. Poster Session (40 posters)
- Wed. & Thurs.: Three CNM-Organized Workshops
  - Nanoscale Heterostructures
  - Emergent States at the Interfaces of Complex Oxides
  - Nanoscale Phenomena Near Phase Transitions
- Friday: Eight Short Courses
  - Confocal Raman Spectroscopy
  - Field Emission Scanning Electron Microscopy
  - Focused Ion Beam Nanofabrication
  - Nanoimprint Lithography
  - Electron-Beam Lithography
  - Introduction to Lithography
  - Nanocrystalline Diamond Synthesis, Fabrication, and Applications
  - Orientation to the Nanoscience Computing Facility



# Recent (and Future) Cross-NSRC Collaborations

- Staff participation in NSRC-Hosted Workshops
  - Bode, CFN Users' Meeting Workshop on Electrical Nanoprobes, May 19, 2008
  - Streiffer, CNMS 3rd International Workshop on Piezoresponse Force Microscopy, Sept 23-25 2008
  
- DOE Experimental Program to Stimulate Competitive Research (EPSCoR) Program Review July 22-24, 2008.
  - Hosted by ORNL, <https://www.ornl.gov/epscor2008/>
  - Presentation on DOE's Nanoscience Centers by Kathleen Carrado Gregar, Manager, User and Outreach Programs, CNM
  
- NSTI Nanotech 2008, Boston, June 1-5, 2008
  - <http://www.nsti.org/Nanotech2008/>
  - All of the NSRCs shared a booth at the Expo:  
<http://www.nsti.org/Nanotech2008/exhibitors.html>
  
- NSRC Brochure: Production through Argonne's Media Services
  
- ESH Working Group
  - NSRC Guidance Document on Safe Handling of Nanomaterials
  - Argonne hosted the *Symposium on Safe Handling of Nanomaterials*, July 7-9, 2008





<http://nano/anl.gov>