

Center for Nanophase Materials Sciences

Oak Ridge National Laboratory

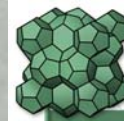
2007 National Polymer Graduate Research Conference

*Linda Horton
Division Director
June 5, 2007*



**Office of
Science**

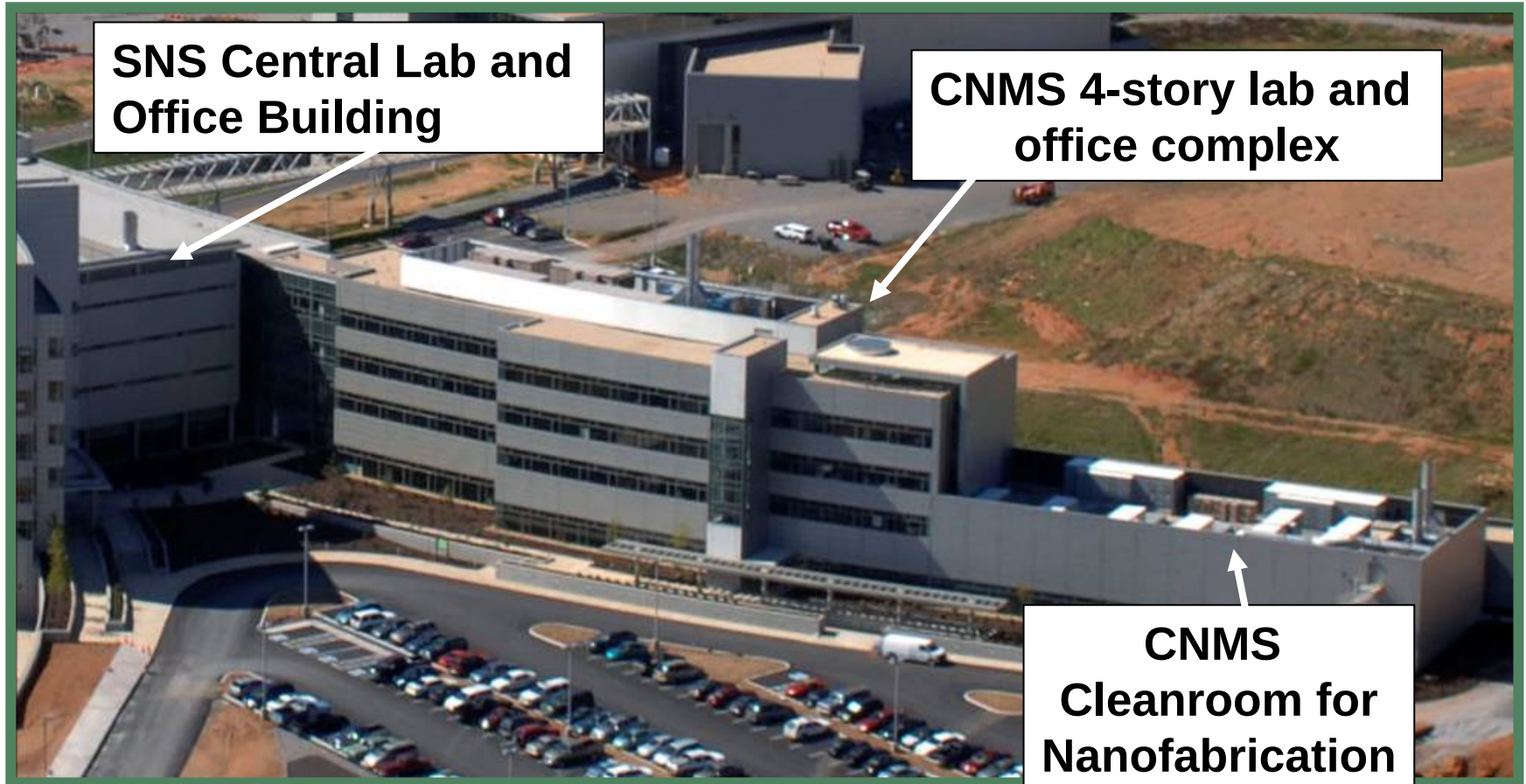
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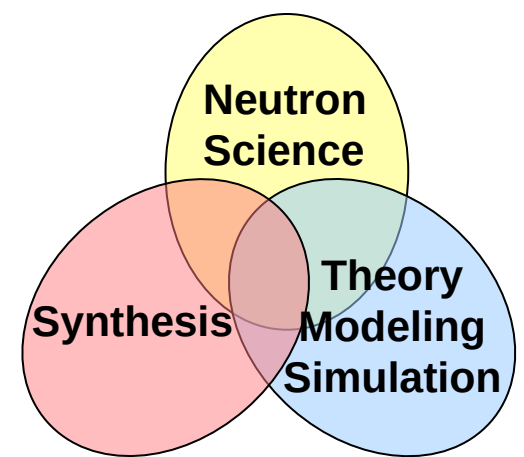
**Center for Nanophase
Materials Sciences**

Center for Nanophase Materials Sciences

An 80,000 sq ft laboratory and office facility
for nanoscience and technology research



CNMS Integrates Nanoscale Science with 3 Synergistic Research Needs



- Neutron Science
 - Opportunity for world leadership using unique capabilities of neutron scattering
- Synthesis Science
 - *Science-driven* synthesis: synthesis as enabler; evolution of synthesis via theory, modeling, and simulation
- Theory / Modeling / Simulation
 - Stimulate U.S. leadership in using theory, modeling and simulation to design new nanomaterials
 - Investigate new pathways for materials synthesis



CNMS Scientific Themes

Macromolecular Complex Systems

Synthetic (polymeric) and bio-inspired materials

Functional Nanomaterials

Nano- tubes, wires, dots, composites; artificial oxide film structures

NanoPhysics: Magnetism, Transport, and Scanning Probes

Reduced and variable dimensionality; quantum transport

Catalysis and Nano-Building Blocks

Highly selective catalysts; nanoscale synthesis & organization

Nanomaterials Theory Institute: Theory, Modeling, Simulation

Grand challenges of “computational nanoscience”

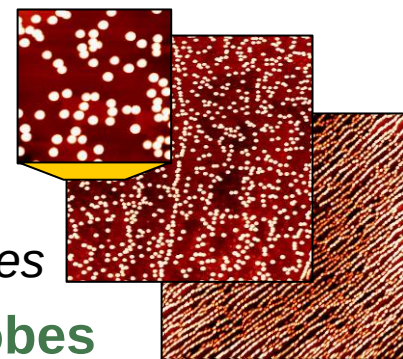
Nanofabrication Research Laboratory and Bio-Inspired Nanomaterials

Controlled synthesis & directed assembly; functional integration of “soft” and “hard” materials

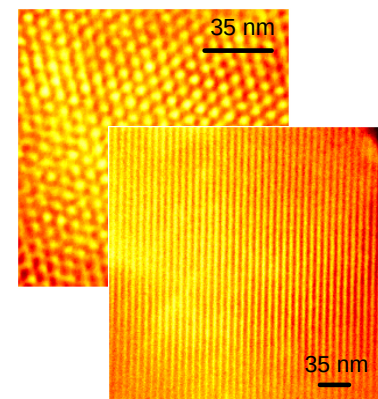
Nanoscale Structure and Dynamics

Neutrons, Electron, and X-ray Characterization

Unique instruments to characterize and manipulate nanostructures; simultaneous imaging and environmental control



AFM images of Fe nanodots and nanowires on flat and stepped NaCl surfaces
(edge length 750 nanometers)

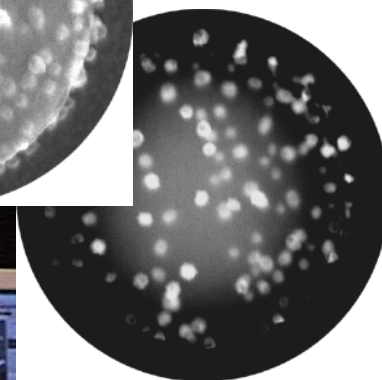
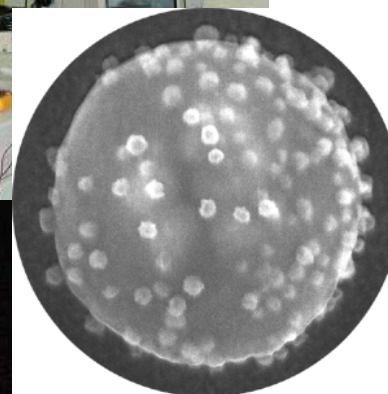
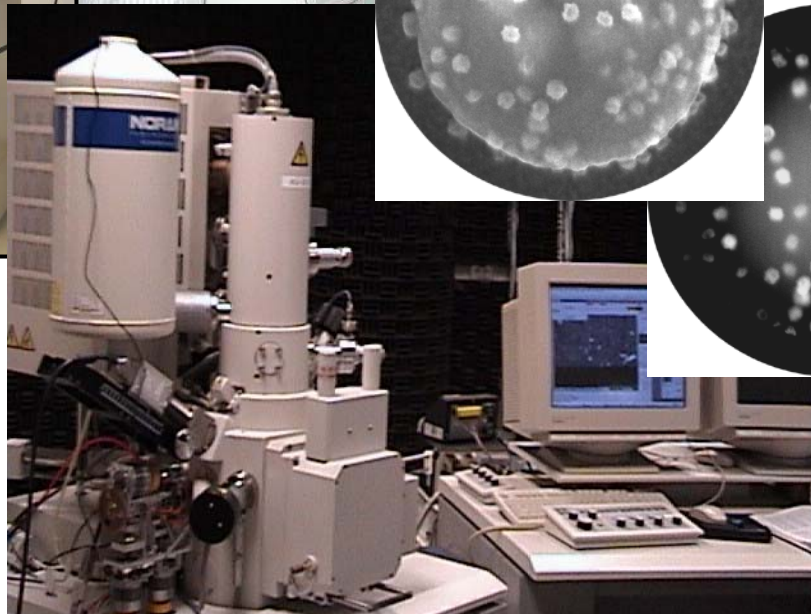
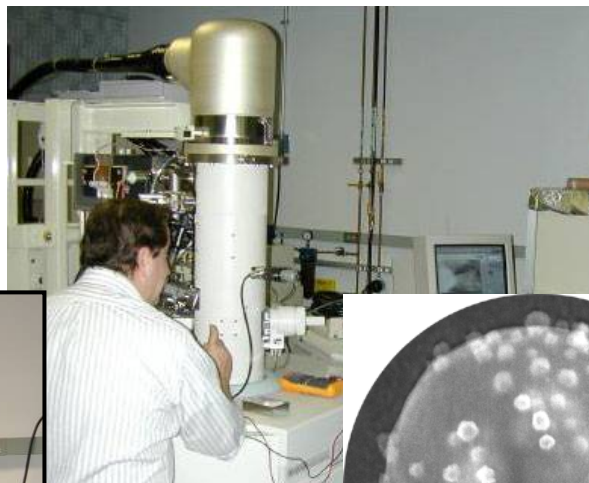
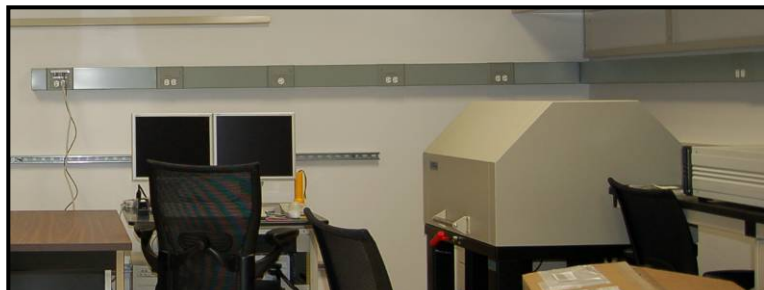


Ordered nanoporous silica synthesized using an organic template

Nanofabrication Research Laboratory



Key Characterization Equipment



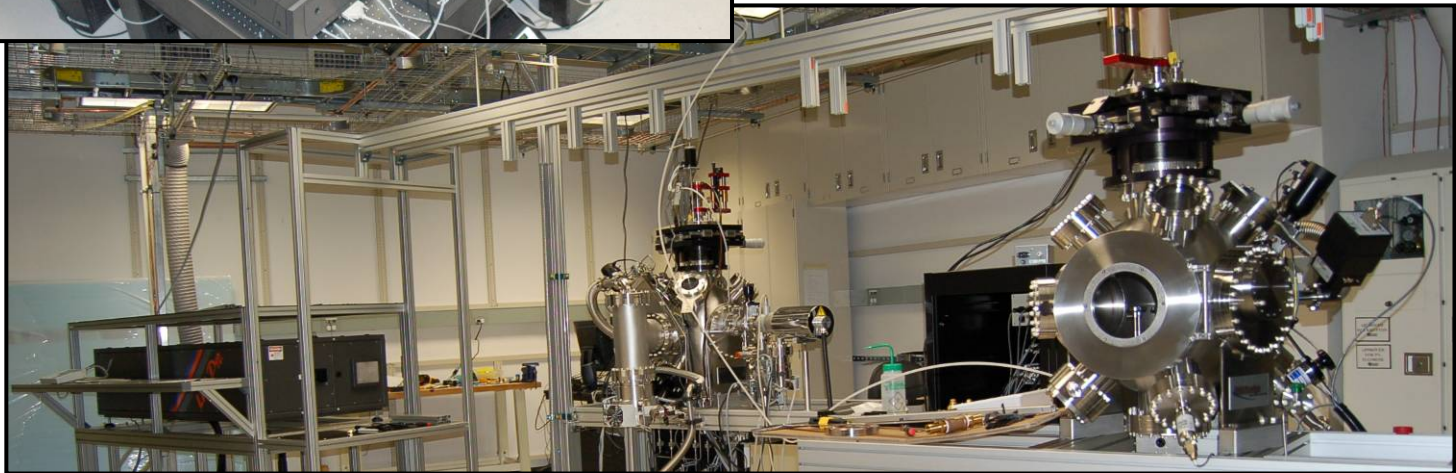
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Functional Nanomaterials: Laser-based Synthesis and Characterization



**Nanotubes, nanowires,
nanoparticles
Oxide thin films and multilayers**

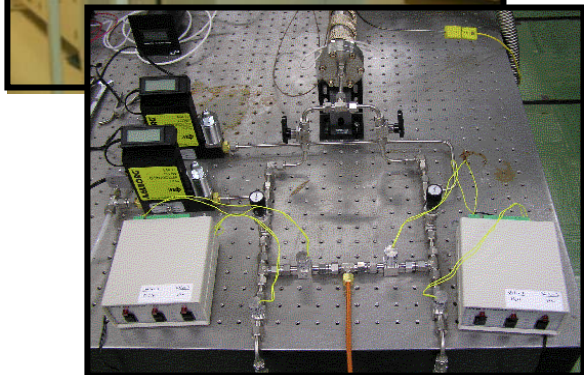


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Nanocatalysis: Synthesis and Catalytic Characterization

Synthesis capabilities

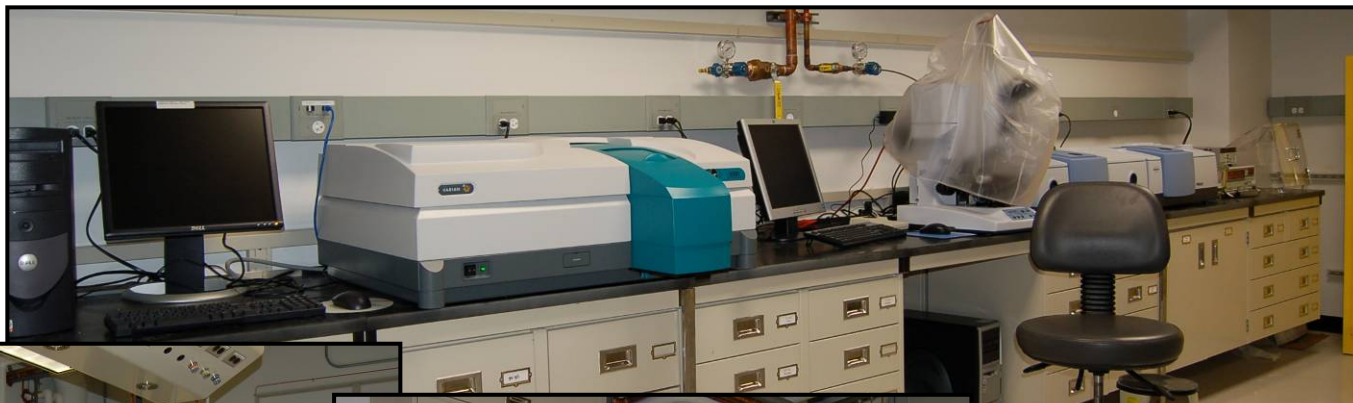


Atomic layer deposition

Characterization resources:
instruments for volumetric
gas adsorption, temperature
programmed reaction, and
dynamic FTIR spectroscopy



Macromolecular: Synthesis and Characterization



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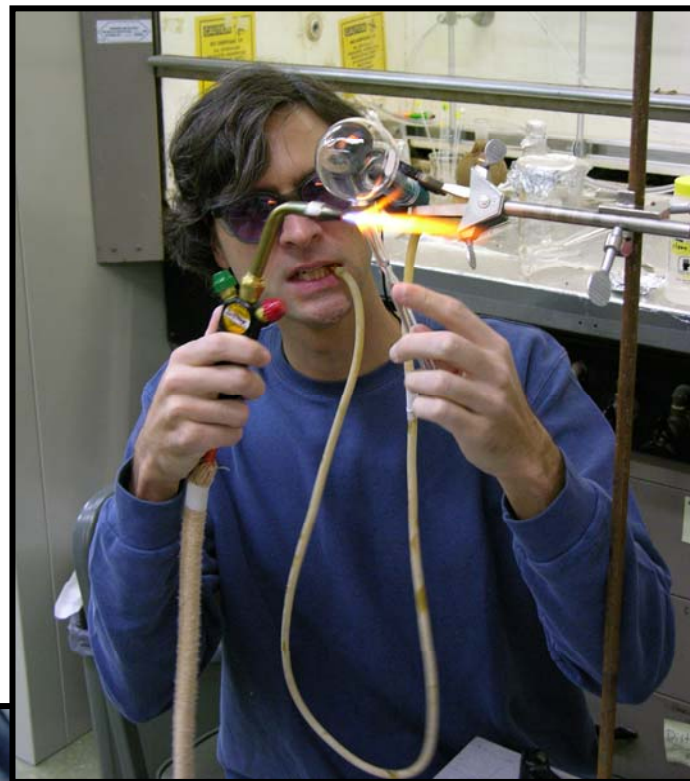
Unique and State-of-the-Art Capabilities in Macromolecular Science

- “One-stop-shopping” for all polymer needs
 - Synthesis, characterization, **deuteration**
- State-of-the-art synthetic techniques to prepare complex polymer architectures
 - Stars, combs, hyper-branched polymers
 - Specialists in anionic synthesis, available in only ~ dozen labs world-wide
 - Anionic: Precise control of polymer molecular weight (MW) and narrow MW distribution
- Emerging synthetic capabilities to prepare novel polymer architectures
 - Based solely or partially on amino acids
- Unique new capabilities to prepare and characterize polymer-carbon nanotube composites



*Users from Cal Tech
doing polymer synthesis*

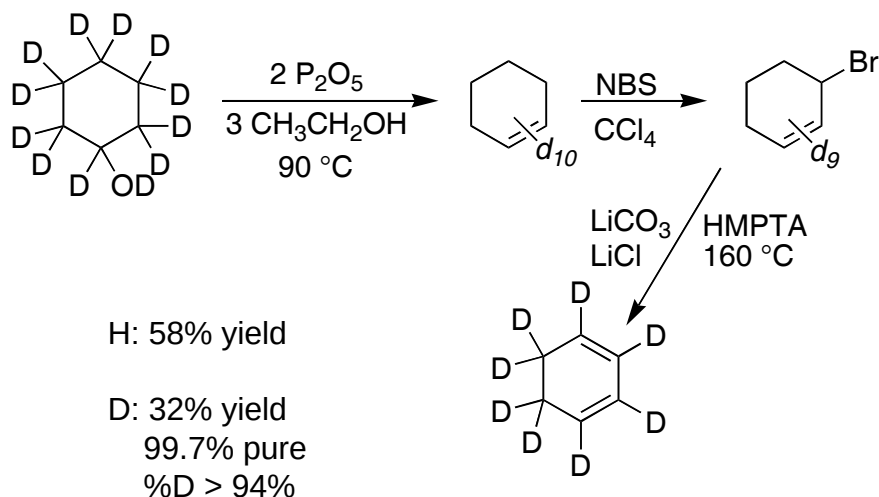
All-Glass Reactors and Vacuum Line Approach



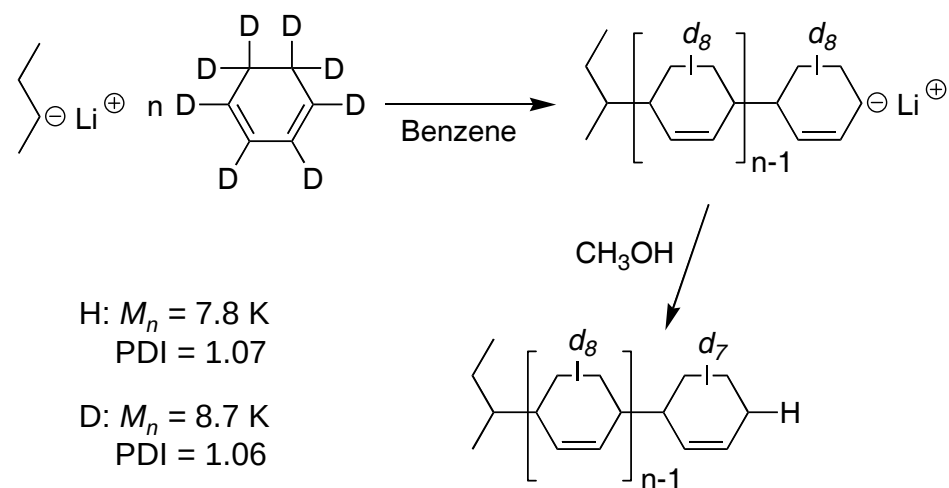
Unique Deuteration Capabilities Available

- Two NSF Workshops (2003) recommended deuteration facilities convenient to the beam line
- CNMS provides synthetic staff trained in organic and polymer synthesis (for preparation of well defined deuterated small molecules, monomers, and polymers)

Synthesis of deuterated monomer



Synthesis of deuterated polymer



- Results of SANS studies using CNMS polymers published in *Macromolecules* (2006)
- First neutron reflectivity experiments at SNS performed recently using CNMS polymers

CNMS has Synergistic Relationships with other ORNL Capabilities

- **Neutron Scattering**
 - High Flux Isotope Reactor Center for Neutron Scattering
 - Spallation Neutron Source
 - Joint Institute for Neutron Scattering (future)
- **Computational Resources**
 - National Center for Computational Sciences (OASCR) – 119 TFlops
- **Electron Microscopy**
 - Shared Research Equipment (SHaRE) User Program
 - High Temperature Materials Laboratory (EERE)
- Shared and Affiliated resources with ORNL's BES Materials and Chemical Sciences Programs
- Integrated Proposal under development for ORNL's BES User Facilities



User Access Policy

- **Open access based on scientific and technical quality**
 - All Users submit proposals
 - External, peer-review required
 - Proposal Review Committee entirely external to ORNL
 - Review guidelines and process described on CNMS Web site
- **Flexibility to accommodate spectrum of user needs**
 - General Users: Access to existing tools / support / collaboration
 - Partner Users: Enhance CNMS capabilities
 - Proprietary Users: Access at full cost recovery for sensitive research
 - Internal ORNL peer-review for proprietary research
- **Free of charge**
 - No fees if results published in open, peer-reviewed scientific journals
- **Full cost recovery charged for proprietary access**

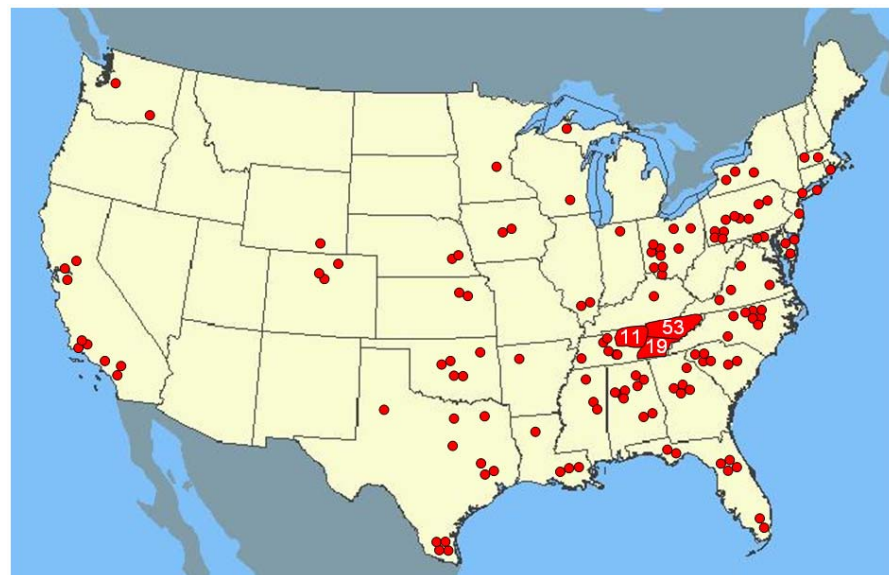
Where are the proposals coming from?

based on home institution of PI



- FY07: >160 users to date
- FY06 users by type of institution

US ACADEMIC	83
CNMS	12
ORNL (non-CNMS)	36
OTHER FEDERAL	8
US INDUSTRY	1
FOREIGN	5

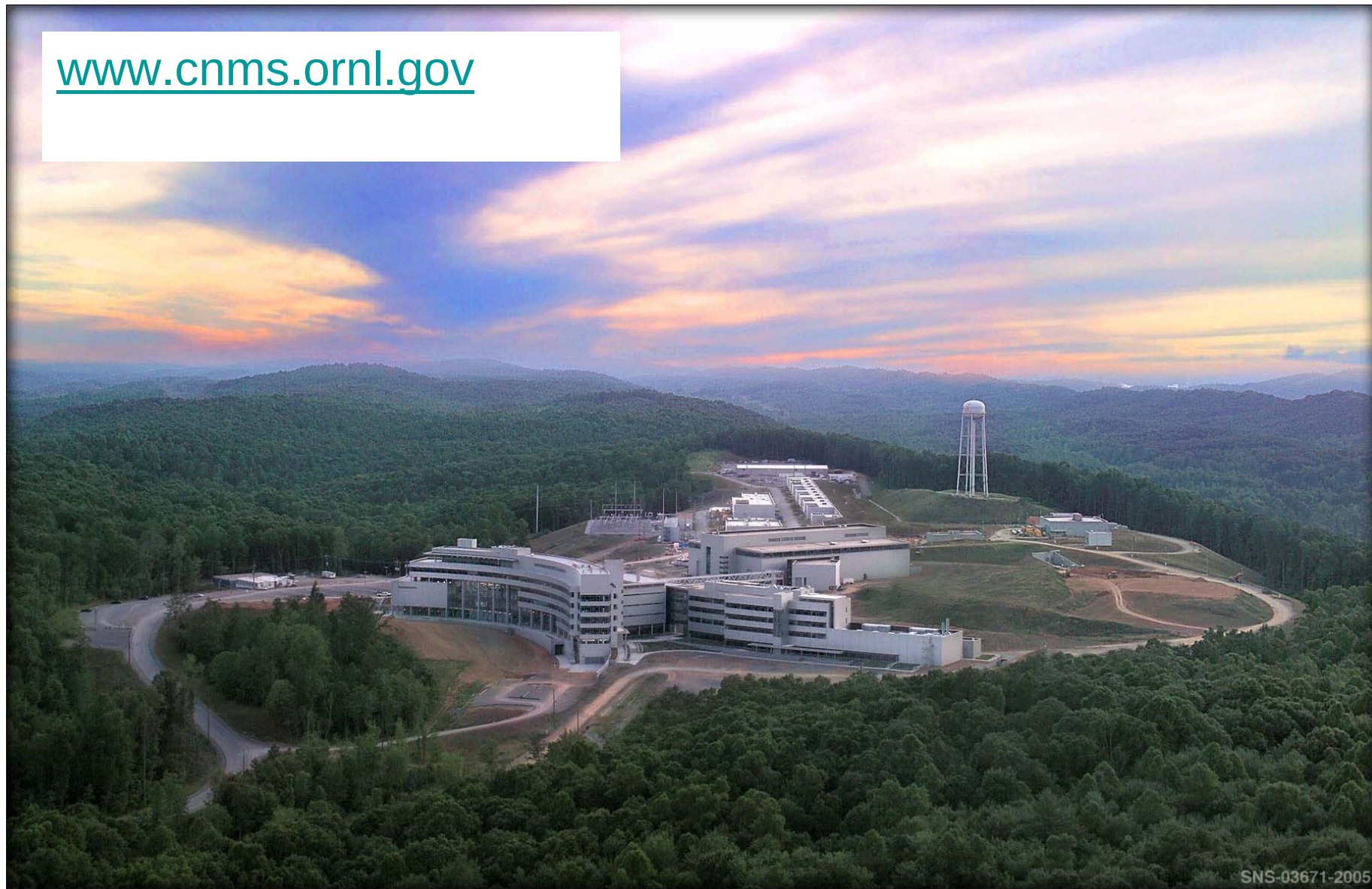


Belgium (1), Canada (1), China (3),
France (2), Germany (1), Israel (2), Mexico (1),
Spain (1) , U.K. (3), Ukraine (1)

CNMS – Options for Your Research

- **User projects**
 - Days, weeks, or months
- **Summer and semester research**
- **Workshops**
 - First scheduled for this Fall during the CNMS Users' Meeting: October 10-12, 2007
- **Postdoctoral Fellowships**
- **Sabbatical visits**

www.cnms.ornl.gov



SNS-03671-2005

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