Funding Opportunities in Materials Research & Education

Zakya H. Kafafi
Director, Division of Materials Research (DMR)
National Science Foundation

Where are we?

June 1-2, 2009
UMC Meeting
Arlington, VA

Where are we going?

Outline of Talk

- Overview of DMR
- DMR Staff
- DMR Budget
- DMR Challenges
- DMR Initiatives
- Future of DMR

Division of Materials Research (DMR)

April – May 2009

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Division Director


Ulrich Strom
Executive Officer (Acting)


Lorretta J. Hopkins
Senior Staff Associate


Neila Odom-Jefferson
Operations Specialist

Priya Baliga
STEP Student


Denise Dudley
DMR Student Secretary

Administrative Unit

Manager


Carol Savory-Heflin

Program Support


Denese Logan
Analyst


Bill Daniels
Specialist


Deborah E. Dory

Senior Program Assistants


Renee Ivey

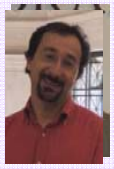

Shirley Millican


Bernie Trumble

Program Directors

Condensed Matter & Materials Theory (CMMT)


Daryl W. Hess


Michael A. Lee
Kent State U.

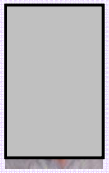
Marco Fornari
Central Michigan U.


Mark R. Pederson

John Mintmire
Oklahoma State

Condensed Matter Physics (CMP)


Wendy Fuller-Mora


Roy Clarke
U. Michigan


Oscar O. Bernal


Udo Pernisz
Dow Corning

Solid-State & Materials Chemistry (SSMC)


Dave L. Nelson


Linda Sapochak
George Washington U.

Polymers (POLY)

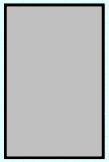

Andrew J. Lovinger


Freddy Khoury

Biomaterials (BMAT)


David A. Brant


Joseph A. Akkara


VACANT
Kent St. U.

Ceramics (CER)


Lynnette D. Madsen

Electronic Materials (EM)


LaVerne D. Hess


Z. Charles Ying

Metals (MET)


Harsh D. Chopra
SUNY


Bruce A. MacDonald

Materials Research Science & Engineering Centers (MRSEC)


William Brittain
Akron U.


Thomas P. Rieker


Rama Bansil
Boston U.

Office of Special Programs (OSP)


Daniele Finotello


Uma Venkateswaran

Instrumentation for Materials Research (IMR)


Charles Bouldin

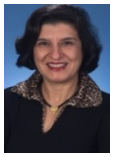
National Facilities (NAF)


Sean L. Jones
Univ. Florida


Guebre X. Tessema

Division of Materials Research (DMR)

OFFICE OF THE DIVISION DIRECTOR


Zakya Kafafi
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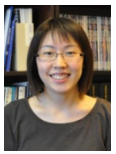
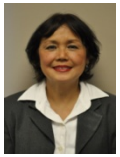
Carmen I. Huber
Executive Officer (Acting)


Neila Odom-Jefferson
Operations Specialist


Judy Chu
STEP Student


My Di Le
STEP Student


Elinor Bruno
Divion Secretary

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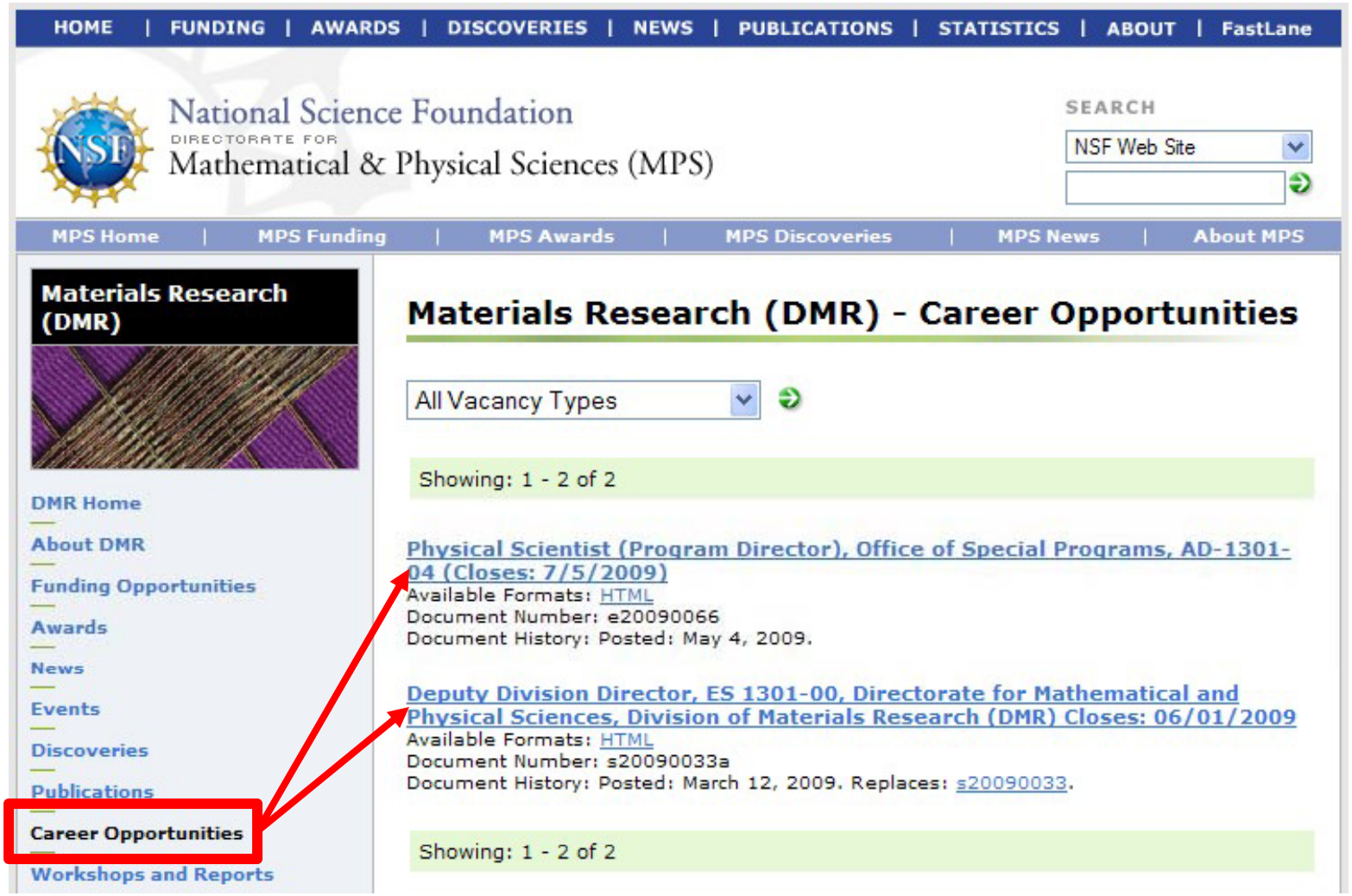
Career Opportunities at DMR



FY 2010 Budget Request by Division

Mathematical and Physical Sciences Directorate

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA	FY 2010 Request	Change over FY 2009 Current Plan Amount	Change over FY 2009 Current Plan Percent
Astronomical Sciences	$217.90	$228.62	$85.80	$250.81	$22.19	9.7%
Chemistry	194.62	211.35	103.00	238.60	27.25	12.9%
Materials Research	**262.55**	**282.13**	**106.90**	**308.97**	**26.84**	**9.5%**
Mathematical Sciences	211.75	226.18	98.00	246.41	20.23	8.9%
Physics	251.64	274.47	96.30	296.08	21.61	7.9%
Office of Multidisciplinary Activities	32.67	33.21	-	39.13	5.92	17.8%
Total, MPS	**$1,171.13**	**$1,255.96**	**$490.00**	**$1,380.00**	**$124.04**	**9.9%**

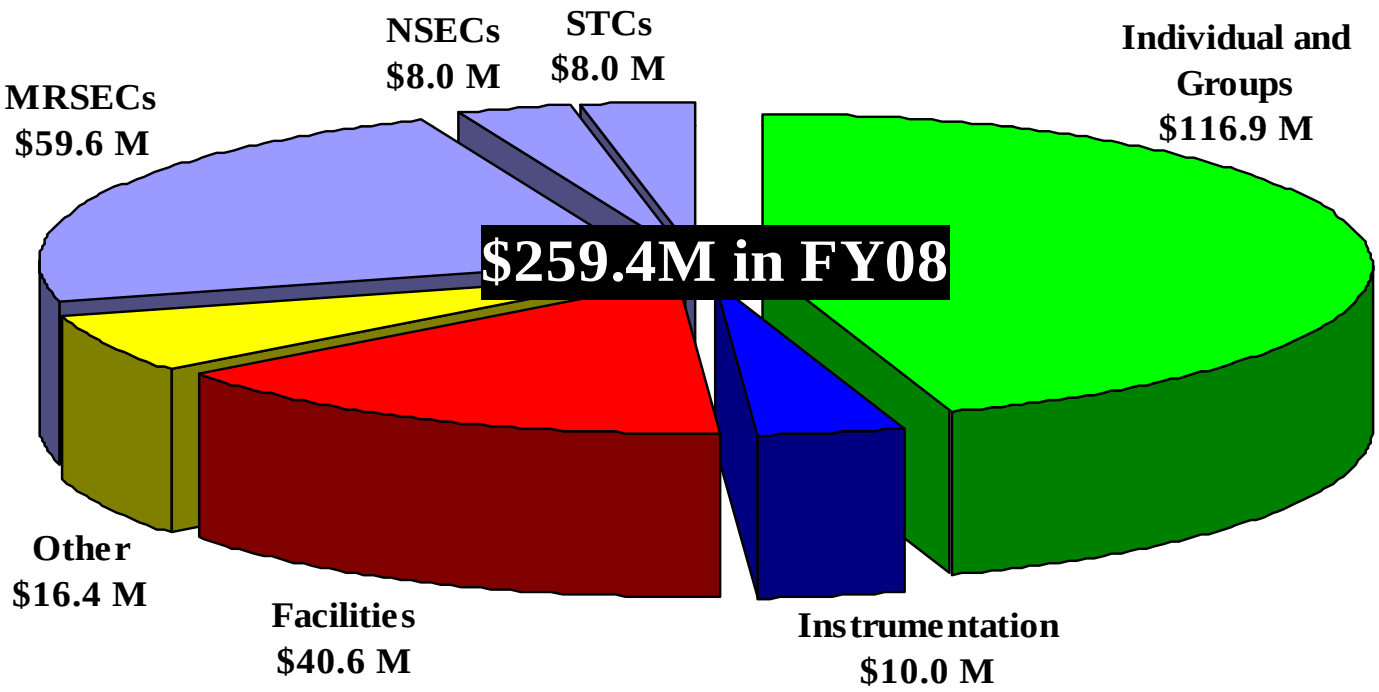
NSF:
$7.045 B, +8.5%

Division of Materials Research Budget

(Dollars in Millions)

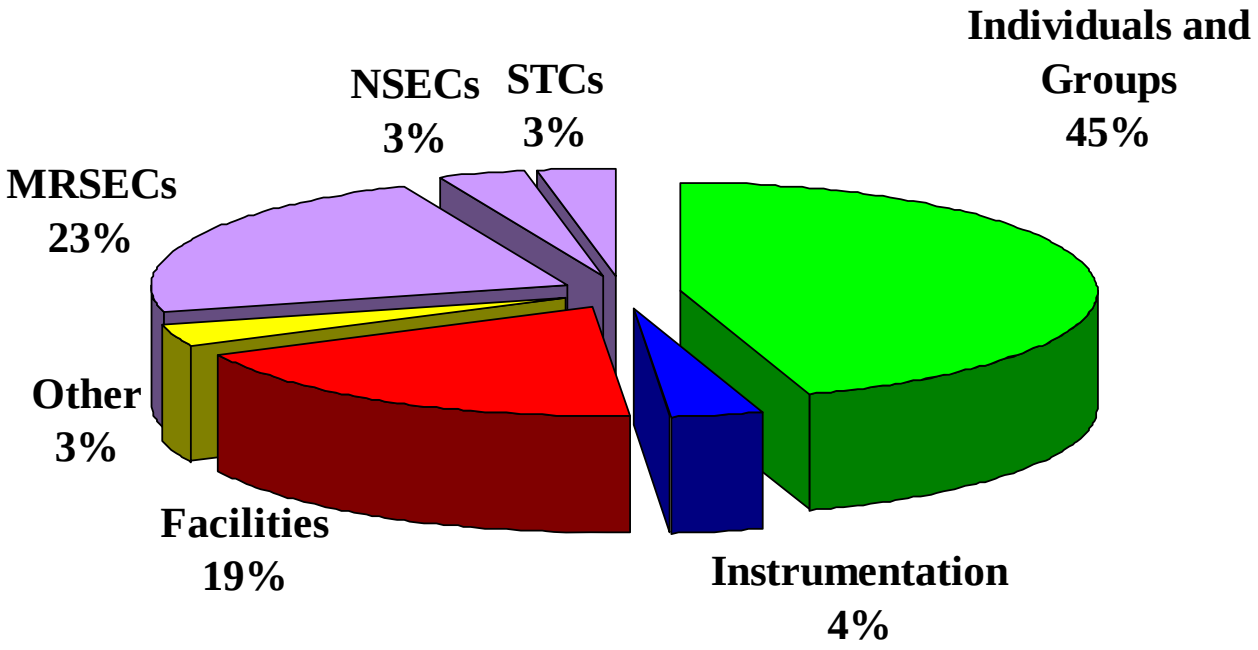
	FY 2007 Actual	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA	FY 2009 Total (includes ARRA)	FY 2010 Request
Budget	**$257.27**	**$262.55**	**$282.13**	**$106.90**	**$389.03**	**$308.97**
Change Over from Previous Year		**$5.28 (2.1%)**	**$19.58 (7.5%)**		**$126.48 (48.2%)**	**$26.84 (9.5%)**

DMR Support for Materials Research & Education in FY08



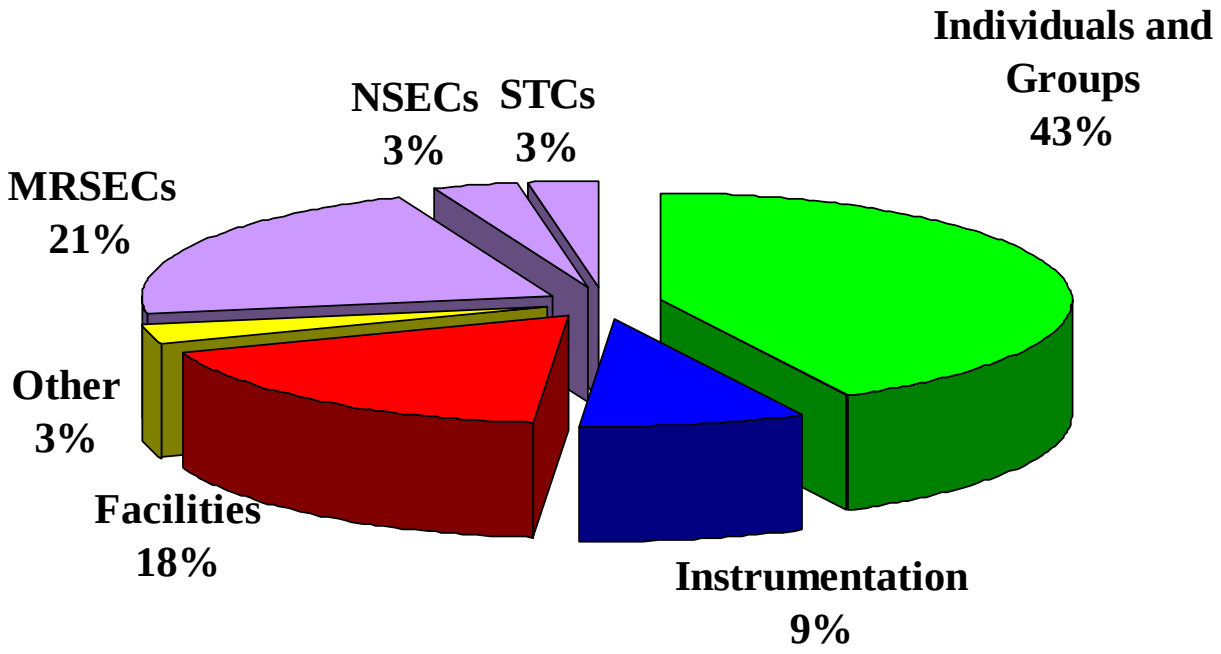
DMR Support for Materials Research & Education

($262.54 M in FY2008)



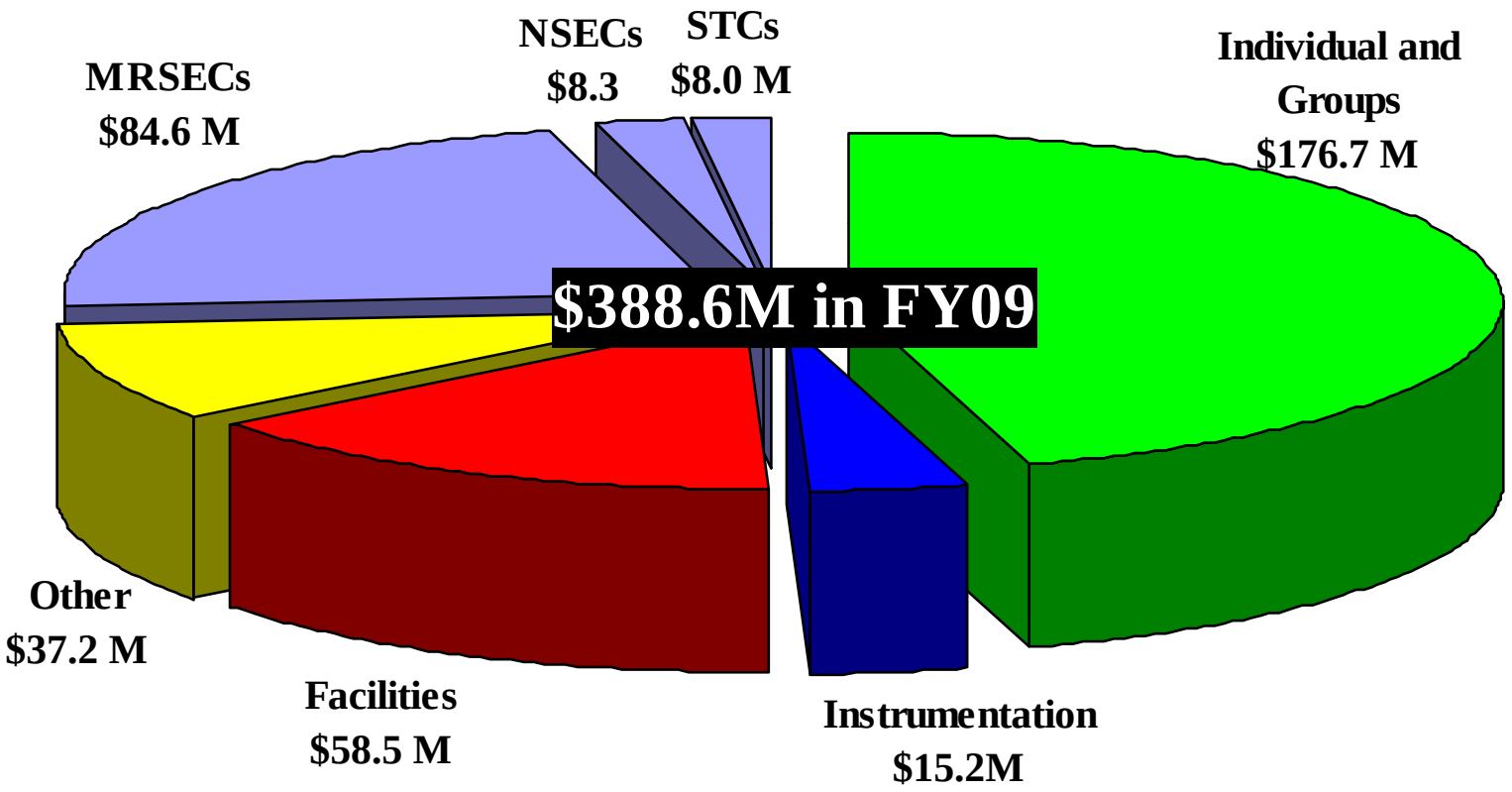
DMR Budget* for Materials Research & Education

($277.14 M in FY 2008)

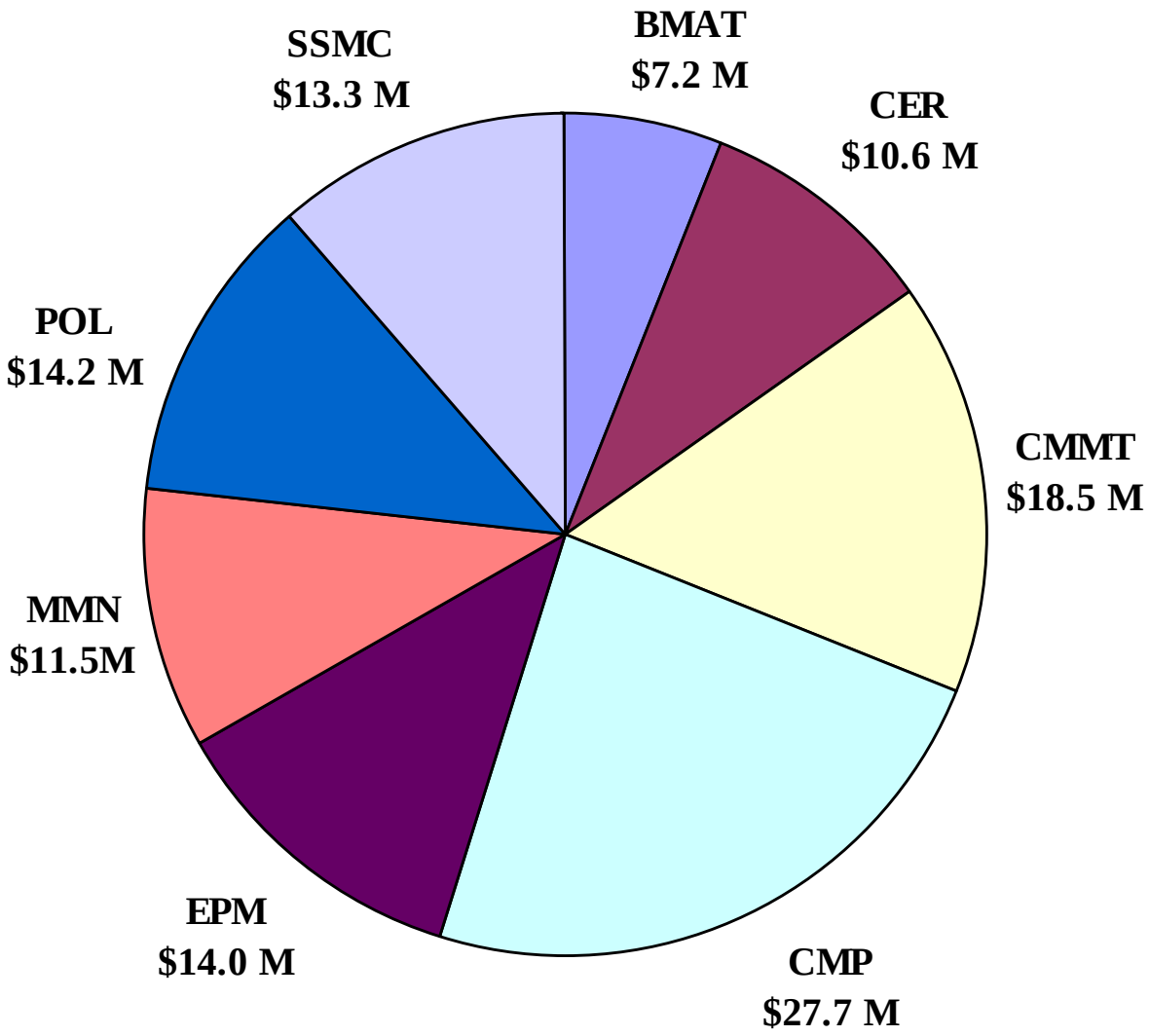


* Includes $14.6 M MRI

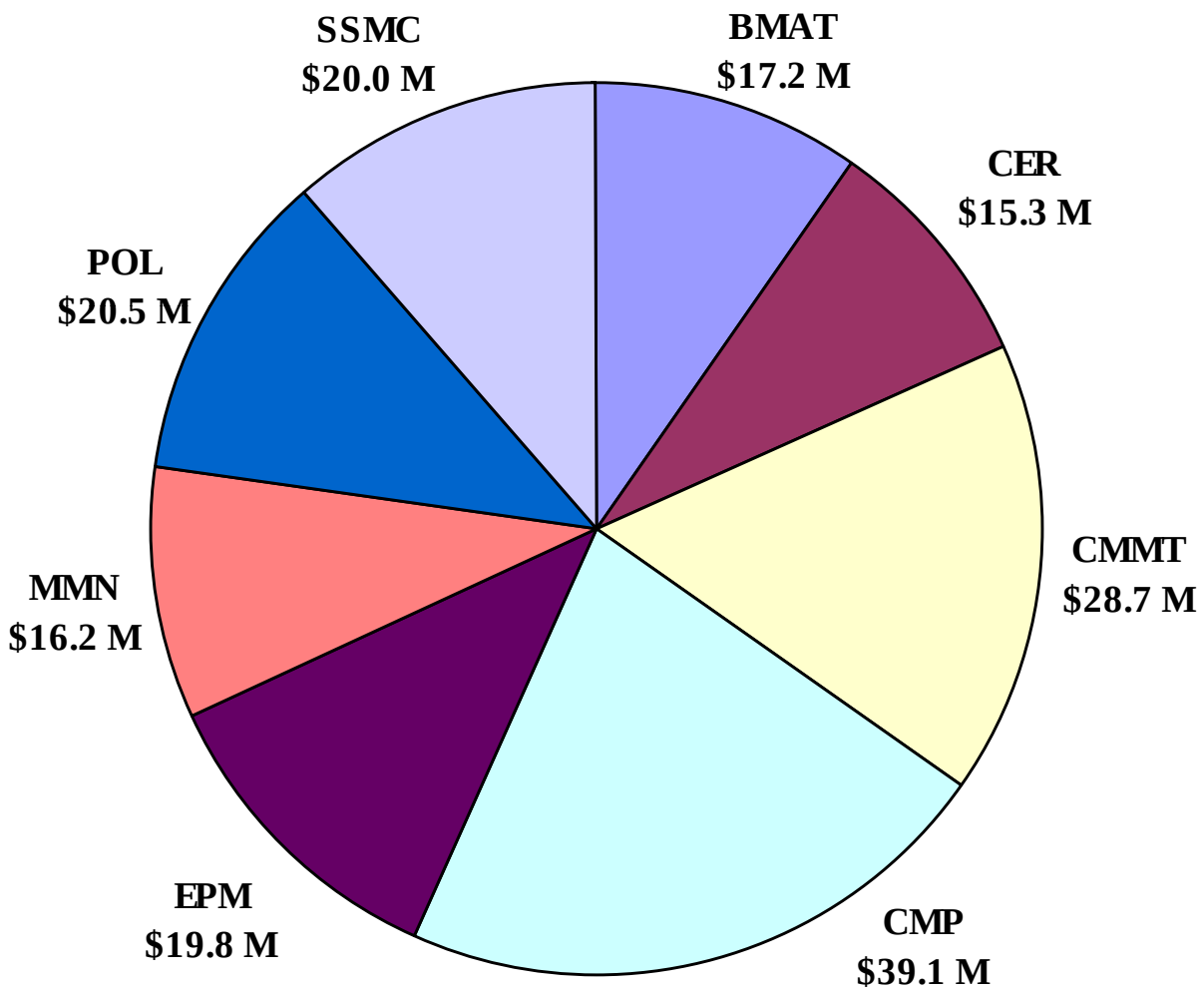
DMR Support for Materials Research & Education in FY09



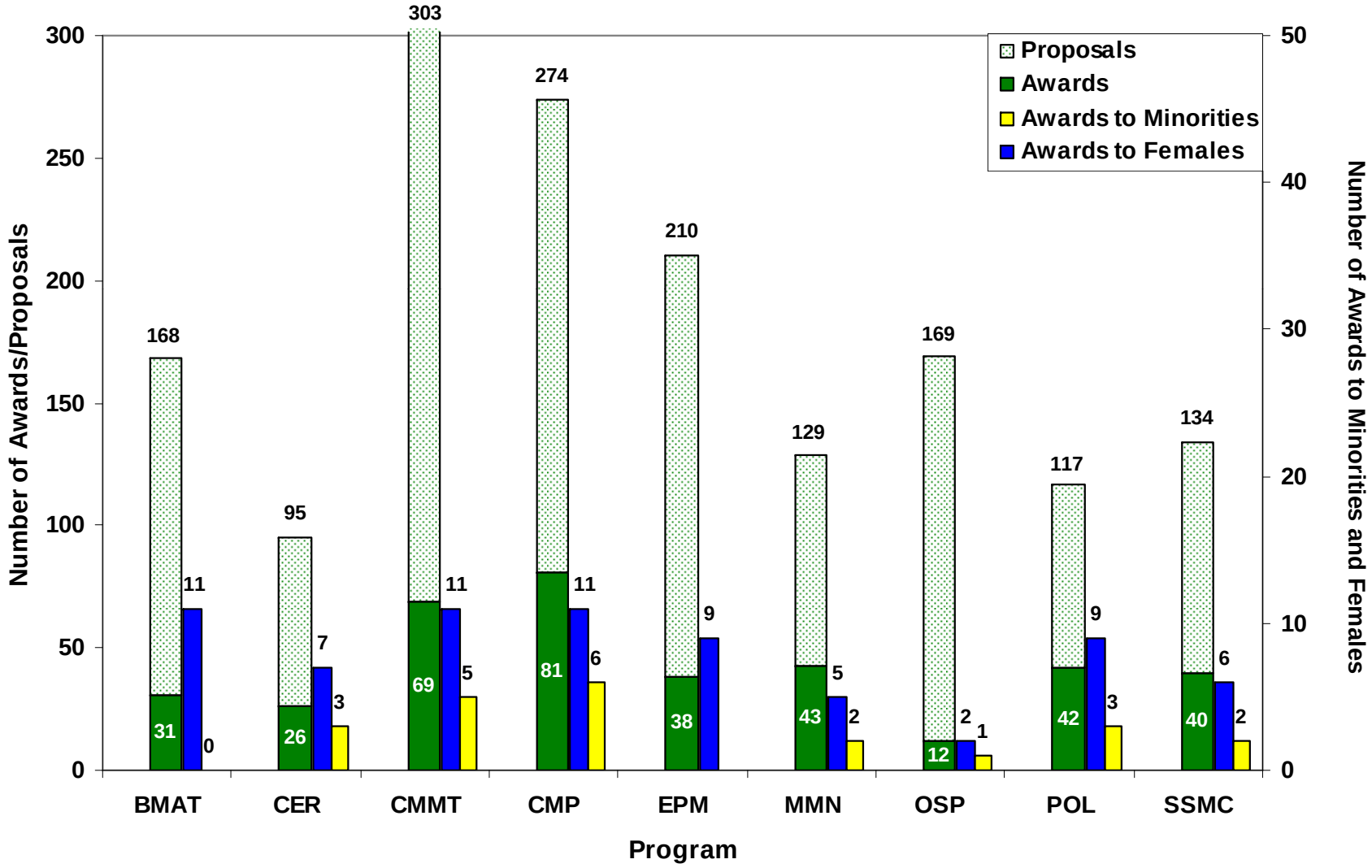
Individual Investigator Programs in FY 2008



Individual Investigator Programs in FY 2009



DMR Awards in FY2008



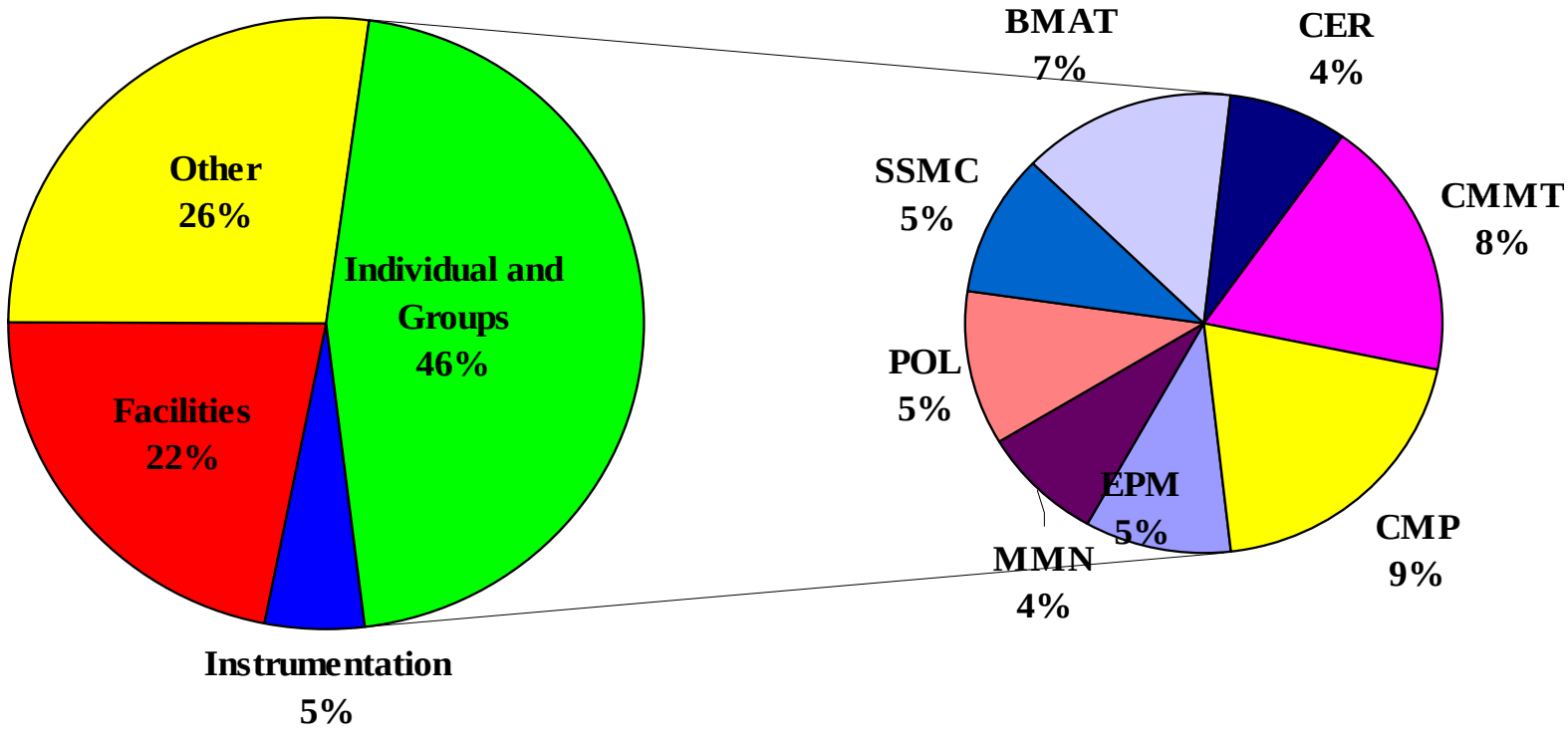
American Recovery and Reinvestment Act (ARRA)

During the ARRA signing ceremony, President Obama said that "this investment will ignite our imagination once more, spurring new discoveries and breakthroughs that will make our economy stronger, our nation more secure and our planet safer for our children."

- **Guiding principles for fund's use:**
  - *** Increase funding rates (and size) of proposals**
  - *** Support investigators early in their careers with focus on "Under-represented Majority"**
  - *** Provide for "shovel ready" projects**

- Goal is quick deployment of funds (spend by the end of FY2009)

ARRA Allocation ($106.9 M)*



*$28.9 M directed to fund NHFML, CHESS, ERL, SRC

Instrumentation for Materials Research (IMR)* and Major Research Instrumentation (MRI)**

- IMR supports instrumentation grants for equipment larger than that in programmatic awards
- MRI supports even larger equipment grants, $100K to $4M
- Both programs support acquisition and development awards for instrumentation
- MRI limited to 2 acquisition and 1 development proposals per institution per year. IMR limited to one per PI and one as co-PI
- *30% cost sharing required in MRI, no cost sharing requirement in IMR.*

* *No solicitation in FY2009 (Division of Materials Research)*

**** Two solicitations in FY2009 (Office of Integrative Activities)**

Major Research Instrumentation Program: Recovery and Reinvestment (MRI-R^2)

Solicitation 09-561

Deadline: August 10, 2009

http://www.nsf.gov/od/oia/programs/mri/

Purpose:

- For instrument development or acquisition of a single instrument or a system of related instruments that share a common or specific research focus
- $100K – $6M from doctorate granting institutions of higher education and non-degree granting organizations
- Up to $6M (no minimum) from non- doctorate granting institutions of higher education or the disciplines of mathematical, social, behavioral, and economic sciences at any eligible organization

Academic Research Infrastructure Program: Recovery and Reinvestment (ARI-R^2)

Solicitation 09-562

Letter of Intent: July 1, 2009

Proposal Deadline: August 24, 2009

http://www.nsf.gov/od/oia/programs/ari/

Purpose:

- To enhance the Nation's existing research facilities where sponsored and/or unsponsored research activities and training take place
- To enable next-generation research infrastructure that integrates shared resources across user communities

Instrumentation for Materials Research
Major Instrumentation Projects:IMR-MIP

Solicitation 09-547 Deadline: June 29, 2009

Two award types:

- **Conceptual and Engineering Design (CED)**
  - Supports development of detailed conceptual and engineering design for new tools for materials preparation and/or characterization at research facilities
  - Funded through continuing or standard grants for a total of up to $2 M per award
- **Construction (CNST)**
  - Provides support for construction of major instruments costing more than $4 M but less than $20 M
  - Funded through 5-year cooperative agreement for $1-4 M per year
  - Operational costs are *not* supported through the solicitation

Materials Research Science and Engineering Centers

FY 2008 Competition

- 31 centers nationwide
- 14 Awards - National investment in timely and important areas such as sustainable energy, bio- and soft-materials, nanotechnology, next-generation electronics and photonics
- Largest turnover in the history of the program
  - 5 awards to institutions that have *not* had a MRSEC
  - 9 MRSECs successfully re-competed
  - 4 existing MRSECs being phased-out

Where are we going?

A Working Group chaired by Bill Brittain was established to look at the future directions of Materials Research & Education Centers

Materials Research Science and Engineering Centers (MRSECs)

Where are we going?*

***Next* MRSECs (> one IRG):**

- Expand activities to international arena
- Develop cyber-enabled infrastructure between MRSECs, PREMs and other centers

MIRACLE Centers

Launch a new type of cyber-enabled centers (one IRG) focused on

Materials Innovative Research and Creative Learning Experience

* Based on the recommendations of the NAS study on MRSECs

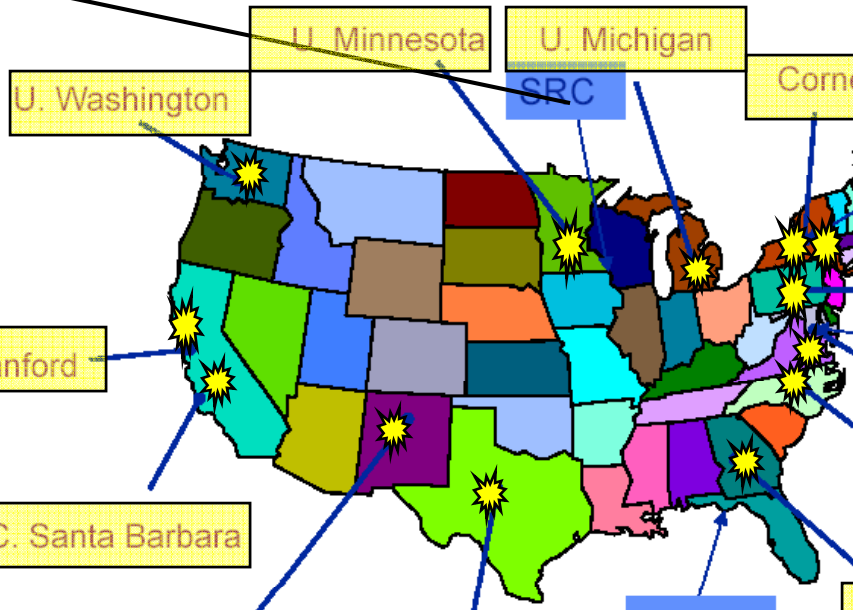
Stewardship: DMR Facilities

$ 42M ~ 6000 users annually

536 users

SRC
Home of Aladdin

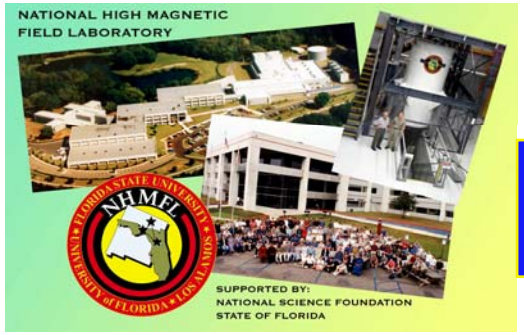
National Facilities & NNIN Sites



~290 Users

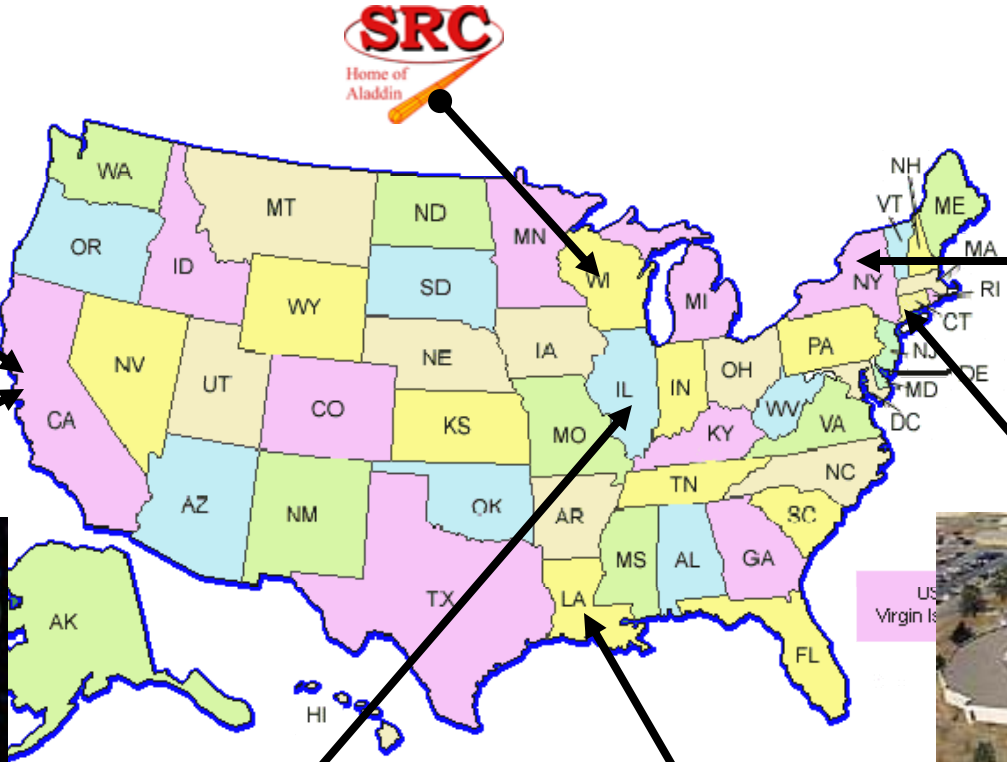
~480 users

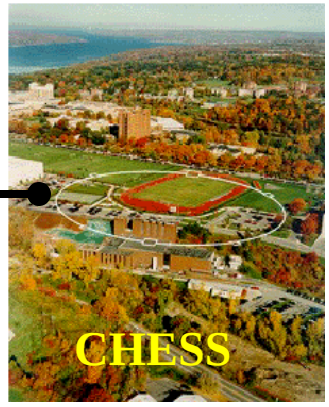
3564 users



~1000 Users

Light Source Facilities





NSF Light Source Panel Report

“The science case for coherent light sources is not debatable” Venky Narayanamurti, Chair of the Light Source Panel

Recommendations

- The United States needs to move more aggressively in this new area
- NSF plays a stewardship role in the design, construction and operation of university-based 4th generation light sources
- NSF stewardship must reflect the breadth of the science and engineering and must therefore involve multiple Directorates and Divisions, and partnership with other agencies
- Continue active user research programs where next-generation light source R&D work is being pursued
- Concurrently support university-based research on advanced concepts (“table top” sources) for light sources

Present and Future Plans for University-based Next Generation Light Source

- Support site-independent and technology-neutral R&D for Coherent Light Sources (CLS)
- Use the expertise and infrastructure at existing facilities as springboards for 4th generation light source technology R&D
- Explore intra- and interagency partnerships/coordination for technology selection
- Possibly conduct an open competition for siting and construction of a CLS

Status of Planning

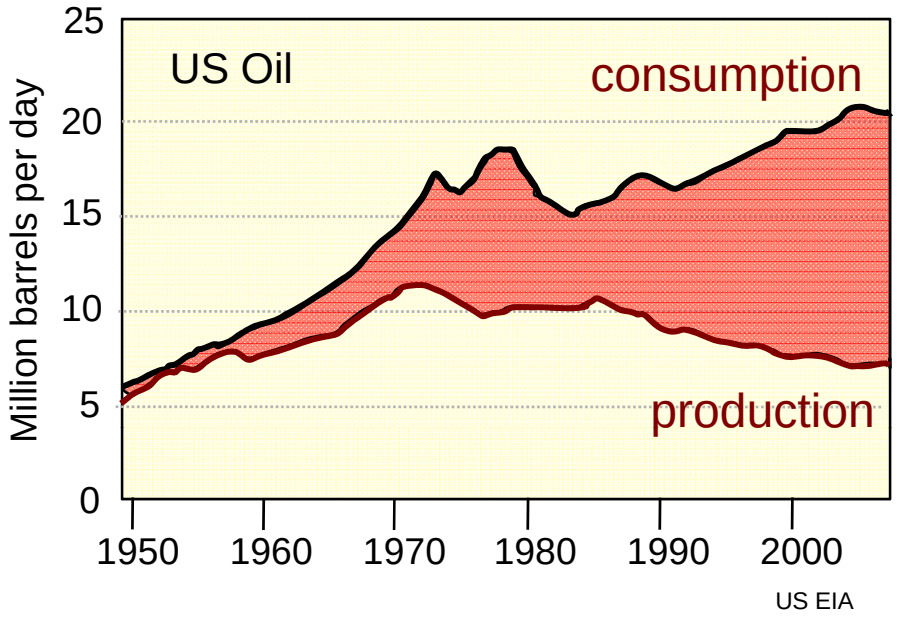
- DMR decision to support site-independent and technology- neutral R&D for Coherent Light Sources (CLS) has been made but is *contingent* upon availability of existing infrastructure

- Proposal renewal review of the existing infrastructure is underway and is expected to be completed very soon

- Action item to the NSB August Meeting: Funding recommendation for facility operation of existing infrastructure (assuming favorable review) starting April 1, 2010

Materials for Sustainable Energy and Clean Environment

The Problem: Dependence on Imported Oil



Unpredictable supply
threatens
economy, lifestyle, national security

find alternatives to imported oil
biofuels, electricity, solar fuels

Cost to economy

$700 B/yr
at recent peak prices

$200 B/yr at current prices

transferred to foreign oil producers

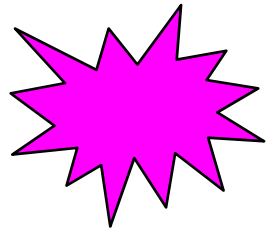
http://tonto.eia.doe.gov/energy_in_brief/foreign_oil_dependence.cfm

The Transition to Sustainable Energy:
Advanced Materials and Chemistry

traditional energy

gas CH_4
oil CH_2
coal $CH_{0.8}$

commodity materials
disposable fuels



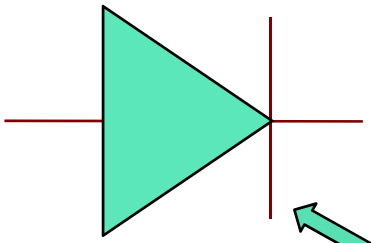
combustion

heat

useful work

sustainable energy

sunlight
wind
water
geothermal
biomass



direct conversion

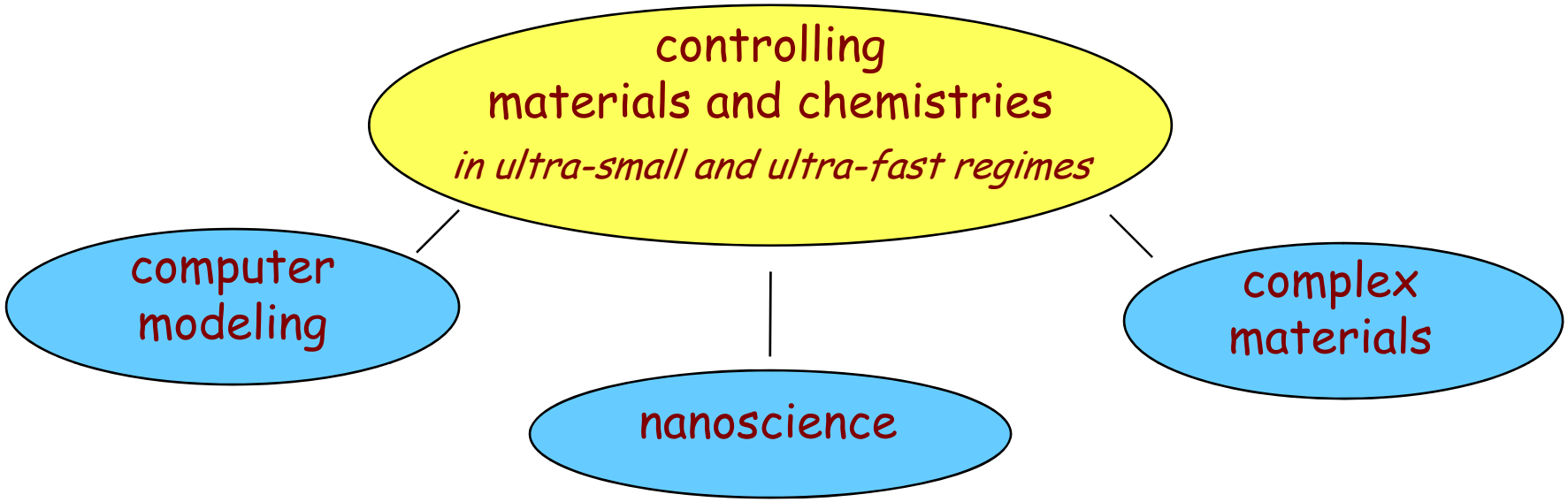
electricity
biofuels
solar chemical
fuel

useful work

Advanced materials and chemistry
e.g., photovoltaics, electrodes,
superconductors, catalysts

sustainable energy requires controlling complex,
functional, novel materials and chemistry

New Science: Controlling Complexity

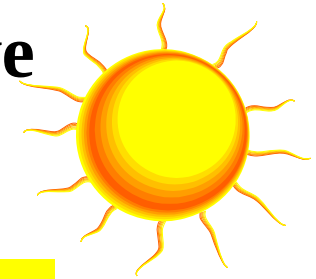


We are at the dawn of a new era

- Build materials with atomic precision
- Predict behavior of materials that have not been made
- Design new materials with specific functionalities

breakthroughs to next-generation sustainable energy technologies are within reach

New CHE-DMR-DMS SOLAR Initiative Launched in FY 2009



Research at the Interface of the Chemical, Material, Mathematical, and Physical Sciences

- At least three co-PIs, providing expertise in chemistry, materials research, and mathematical sciences
- Two-stage proposal preparation and review process to reduce the burden on the communities

What is MPS ROLE?

- Capitalize on the unique strengths of our disciplinary communities
- Use new interdisciplinary modalities by bringing together mathematicians, chemists, and materials researchers, focusing on interdisciplinary synergy and aiming for transformative breakthroughs
- Focus on new fundamental chemical approaches, materials design, physical concepts, and mathematical algorithms

The Energy in Sunlight

1.2×10^5 TW delivered to Earth
36,000 TW on land (world)
2,200 TW on land (US)

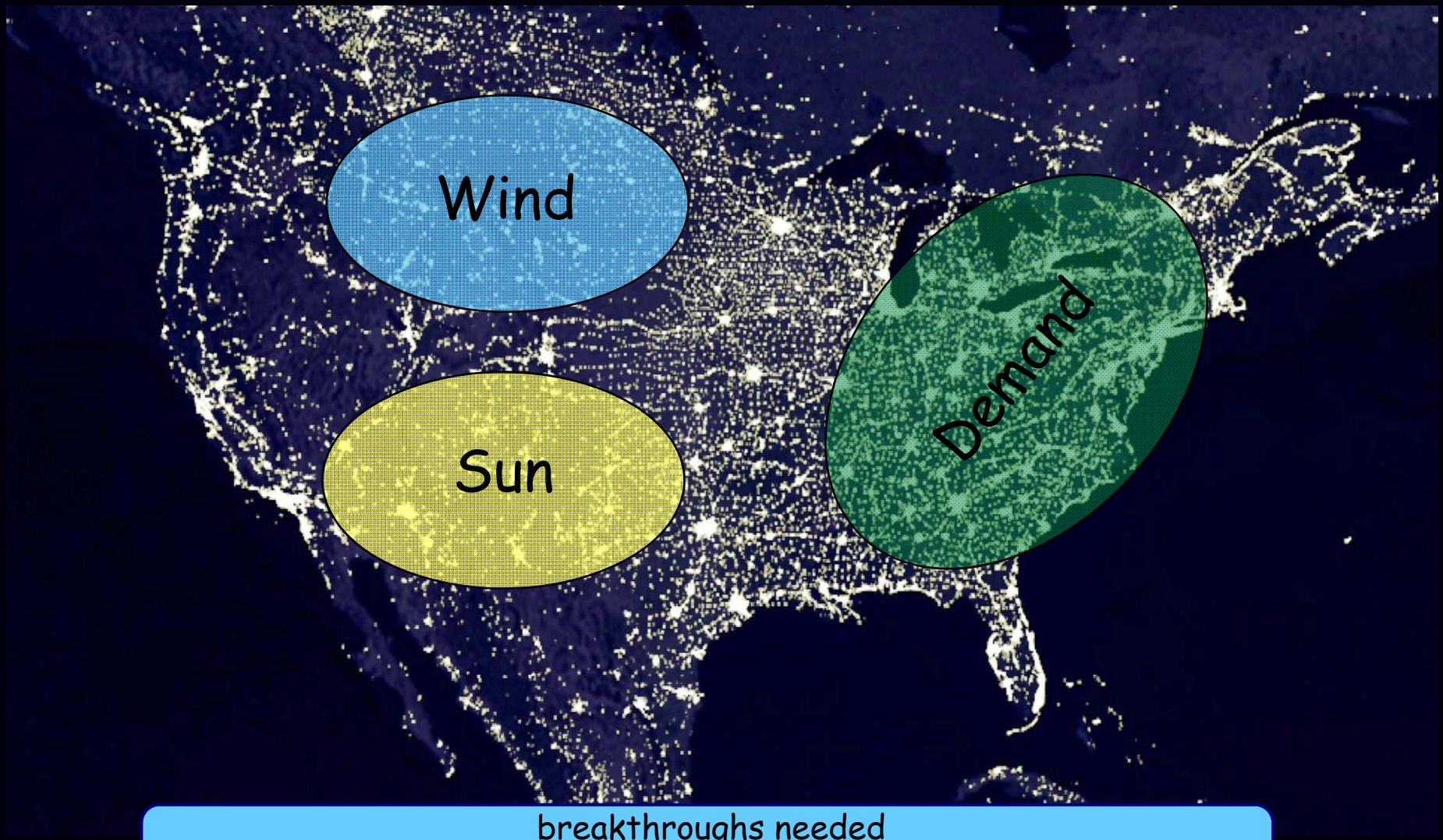
Annual Human Production of Energy
4.6×10^{20} Joules
1 hour of sunlight

Earth's
Ultimate Recoverable Resource
of oil
3 Trillion (=Tera) Barrels
1.7×10^{22} Joules
1.5 days of sunlight

FUNDING POTENTIAL

- Anticipated 3-yr duration (possible renewal for 3 more yrs)
- $5M (+ 2.1 M, ARRA) initial investment in FY2009
- Doubling in FY2010 and tripling in FY2011
- 3-10 awards anticipated in FY2009
- Potential for expansion in future years
- Potential to grow and include other sources of renewable energy in future years

Sustainable Energy Enabling Technologies: The Grid



breakthroughs needed
long distance reliable, efficient delivery of electricity

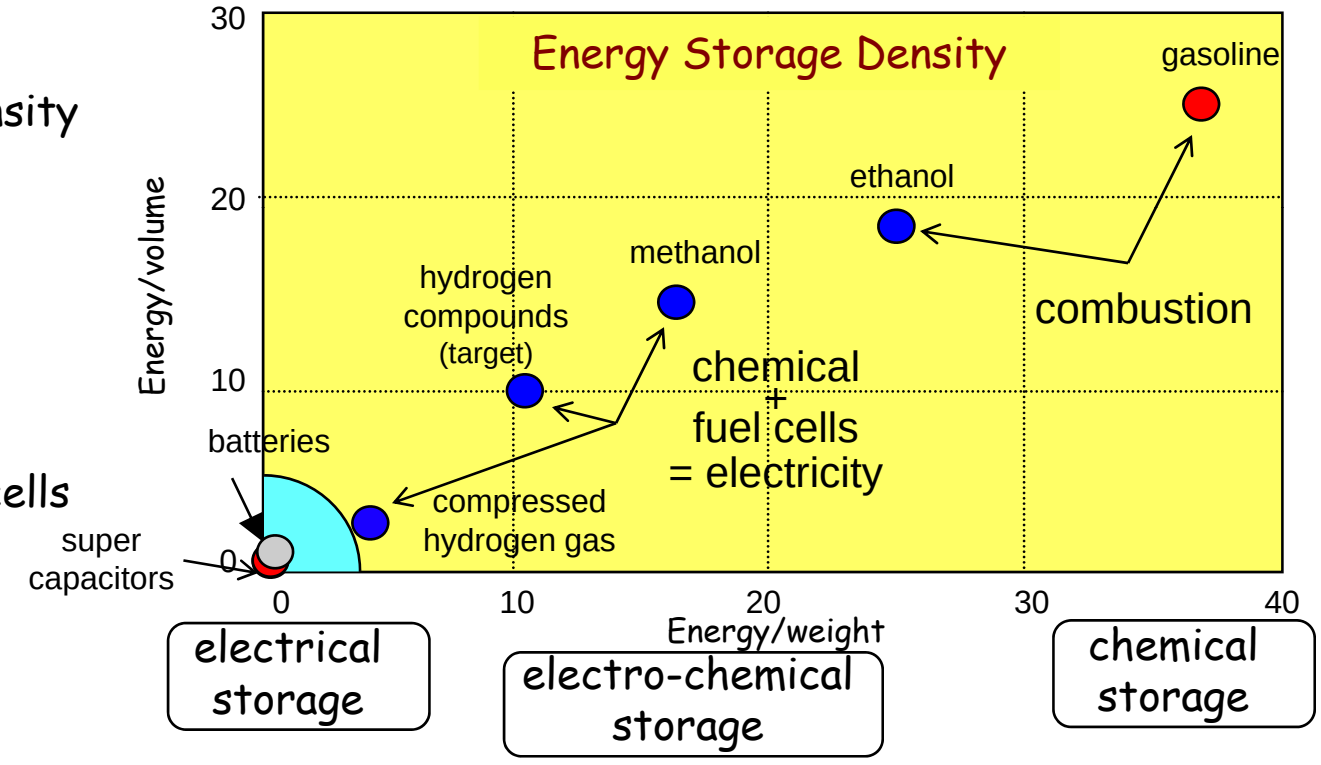
Enabling Technologies: Storing Energy

- Store intermittent solar and wind electricity
- Electrify transportation with plug-in hybrids and electric cars

batteries:
30-50x less energy density than gasoline

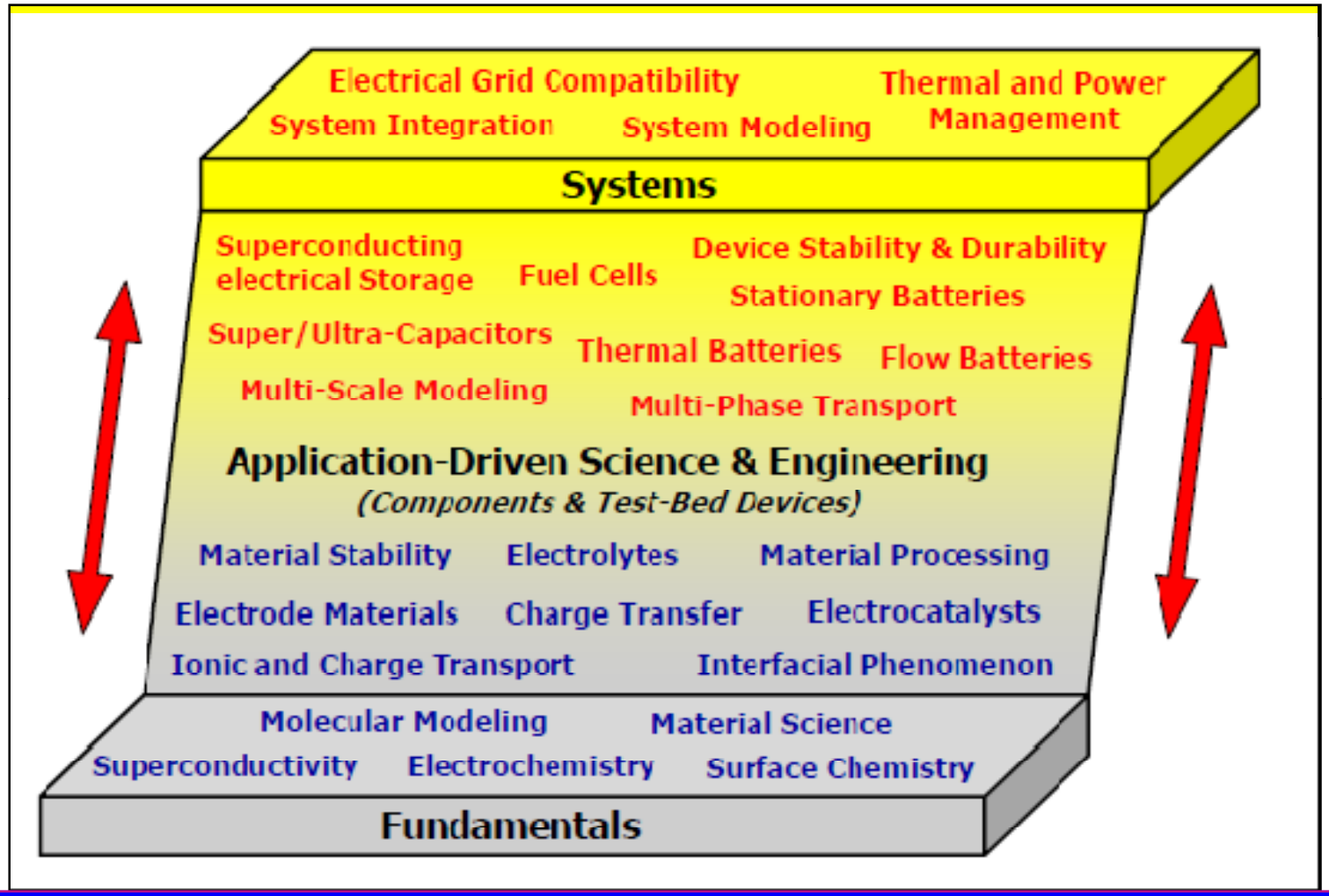
impossible dream: x10 improvement

beyond batteries:
chemical storage + fuel cells = electricity



breakthroughs needed
x2-5 increase in battery energy density
x10-20 increase through chemical storage + fuel cells

Renewable Energy Storage (RESTOR)



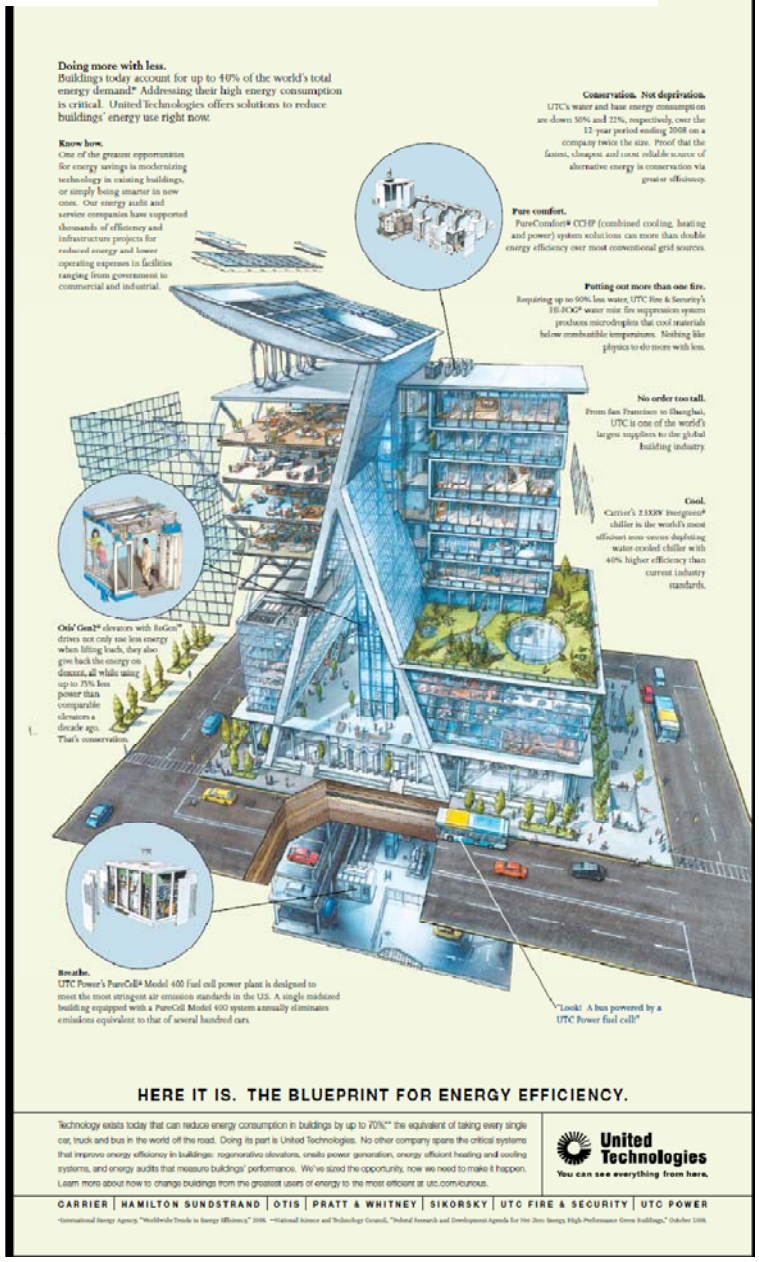
Main theme: Foster breakthroughs in *large scale energy storage* for solar and wind renewable sources

Science in Energy and Environmental Design (SEED): Engineering Sustainable Buildings

- Buildings have significant impact on economy, energy and health.
- Engineering & Science research in building performance at US Universities is negligible.
- Current DOE (EERE) & USGBC initiatives in "High Performance Green Buildings" have a near-term "efficiency" focus & do not integrate science, engineering and systems level research.
- **SEED – design the next generation "green building" of the future. Not restricted by established technologies…..**

Three interrelated research thrusts:

1. Materials & Sensing
2. Modeling & Simulation
3. Concepts for Autonomy & Interdependence



US-China Workshop
中 美 論 壇

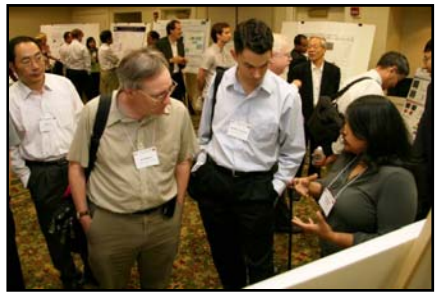
Nanostructured Materials for Global Energy & Environmental Challenges

Evanston, Illinois, September 22-24, 2008

- Held September 22-24, 2008 in Evanston, Illinois
- First in a series of bilateral US-China workshops
- Cosponsored by the NSF and the Natural National Science Foundation of China
- Two major themes: (1) Advanced Solar Cells and (2) Nanomaterials and the Environment
- Primary finding: Transformative approaches and new levels of cooperation are needed to solve global energy and environmental challenges
- Key recommendation: Establishment of a joint US-China global institute
- **Next workshop on New Materials for Renewable Energy to be held in Shanghai, China in October 2009**

Three NSF (DMR, CHE, and DMS) divisions

Zakya Kafafi, Director, Division for Materials Research gives opening remarks.



Graduate student Charusheela Ramanan explains her research to US and Chinese professors.

The Workshop report is available at www.materialsworld.net