



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)

OFFICE of the DIVISION DIRECTOR



Zakya Kafafi
Division Director

Ulrich Strom
Executive Officer (Acting)

Loretta J. Hopkins
Senior Staff Associate

Neila Ogden
Operations Specialist

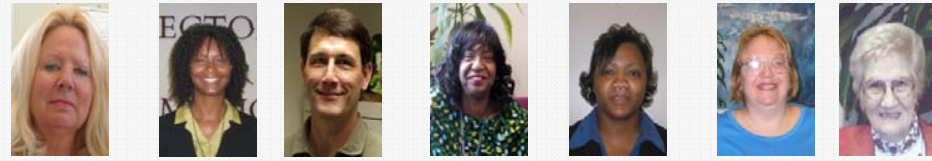
Denise Blumley
STBR Student Secretary

Manager

Program Support

Administrative Unit

Senior Program Assistants



Carol Savory-Heflin
Manager

Denese Logan
Analyst

Bill Daniels
Specialist

Deborah E. Dory
Senior Program Assistant

Renee Ivey
Senior Program Assistant

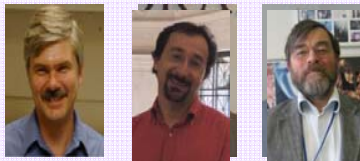
Shirley Millican
Senior Program Assistant

Bernie Trumble
Senior Program Assistant

Program Directors

April - May 2009

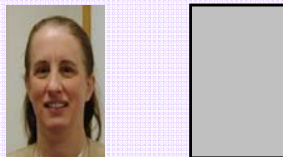
Condensed Matter & Materials Theory (CMMT)



Daryl W. Hess
Central Michigan U.

Michael P. Haefliger
Michigan State U.

Mark R. Anderson
U. Oklahoma State



Wendy Fuller-Mora
CMMT

Roy W. Koch
CMMT



Oscar O. Bernal
CMMT

Udo Pernisz
Dow Corning

Solid-State & Materials Chemistry (SSMC)



Dave L. Nelson
Polymers (POLY)

Wolfgang S. Knapik
George Washington U.



Andrew J. Lovinger
SSMC

Freddy Khoury
SSMC

Biomaterials (BMAT)



David A. Brant
BMAT

Joseph A. Akkara
BMAT

Satyajit Kumar
Kent State U.

Ceramics (CER)



Lynnette D. Madsen
CER

Electronic Materials (EM)



LaVerne D. Hess
EM

Z. Charles Ying
EM

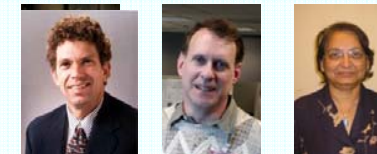
Metals (MET)



Harsh D. Chopra
SUNY

Bruce A. MacDonald
MET

Materials Research Science & Engineering Centers (MRSEC)

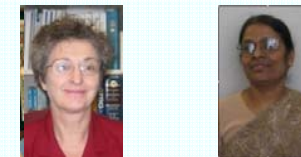


William Brittain
MRSEC

Thomas P. Rieker
MRSEC

Rama Bansil
Boston U.

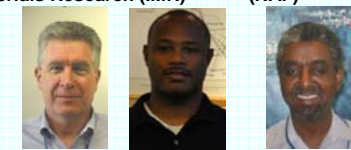
Office of Special Programs (OSP)



Caroline E. Hinkle
OSP

Uma Venkateswaran
OSP

Instrumentation for Materials Research (IMR) National Facilities (NAF)



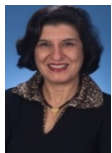
Charles Bouldin
IMR

Sean L. Jones
Univ. Florida

Guebre X. Tessema
NAF

Division of Materials Research (DMR)

OFFICE OF THE DIVISION DIRECTOR



Zakya Kafafi
Division Director



Carmen I. Huber
Executive Officer
(Acting)



Neila Odom-Jefferson
Operations Specialist



Judy Chu
STEP Student



My Di Le
STEP Student



Elinor Bruno
Division Secretary

ADMINISTRATIVE UNIT

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Expert



Denese Logan
Analyst



Bill Daniels
Specialist



Deborah E.
Dory



Renee Ivey



Shirley Millican



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Joseph A. Akkara



David A. Brant

Ceramics (CER)



Lynnette D.
Madsen

Condensed Matter & Materials Theory (CMMT)



Marco Fornari
Central Michigan U.



Daryl W. Hess



John Mintmire
Oklahoma State

Instrumentation for Mat Research (IMR)



Charles Bouldin



Sean L. Jones
Univ. Florida



Guebre X. Tessema

National Facilities (NAF)

Condensed Matter Physics (CMP)



Oscar O. Bernal
Cal State U. L.A.



Wendy Fuller-Mora



Udo Pernisz
Dow Corning

Electronic and Photonic Materials (EPM)



LaVerne D. Hess



Z. Charles Ying

Materials Research Science & Engineering Centers (MRSEC)



Rama Bansil
Boston U.



William Brittain



Thomas P. Rieker

Metallic Materials and Nanostructures (MMN)



Alan J. Ardell



Bruce MacDonald

Polymers (POL)



Freddy Khoury



Andrew J. Lovinger

Solid-State & Materials Chemistry (SSMC)



Linda Sapochak

Office of Special Programs (OSP)



Danielle Finotello
Kent State U.

Career Opportunities at DMR

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 National Science Foundation
DIRECTORATE FOR
Mathematical & Physical Sciences (MPS)

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Materials Research (DMR)

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Materials Research (DMR) - Career Opportunities

All Vacancy Types [v] [→]

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[Physical Scientist \(Program Director\), Office of Special Programs, AD-1301-04 \(Closes: 7/5/2009\)](#)
Available Formats: [HTML](#)
Document Number: e20090066
Document History: Posted: May 4, 2009.

[Deputy Division Director, ES 1301-00, Directorate for Mathematical and Physical Sciences, Division of Materials Research \(DMR\) Closes: 06/01/2009](#)
Available Formats: [HTML](#)
Document Number: s20090033a
Document History: Posted: March 12, 2009. Replaces: [s20090033](#).

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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	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%

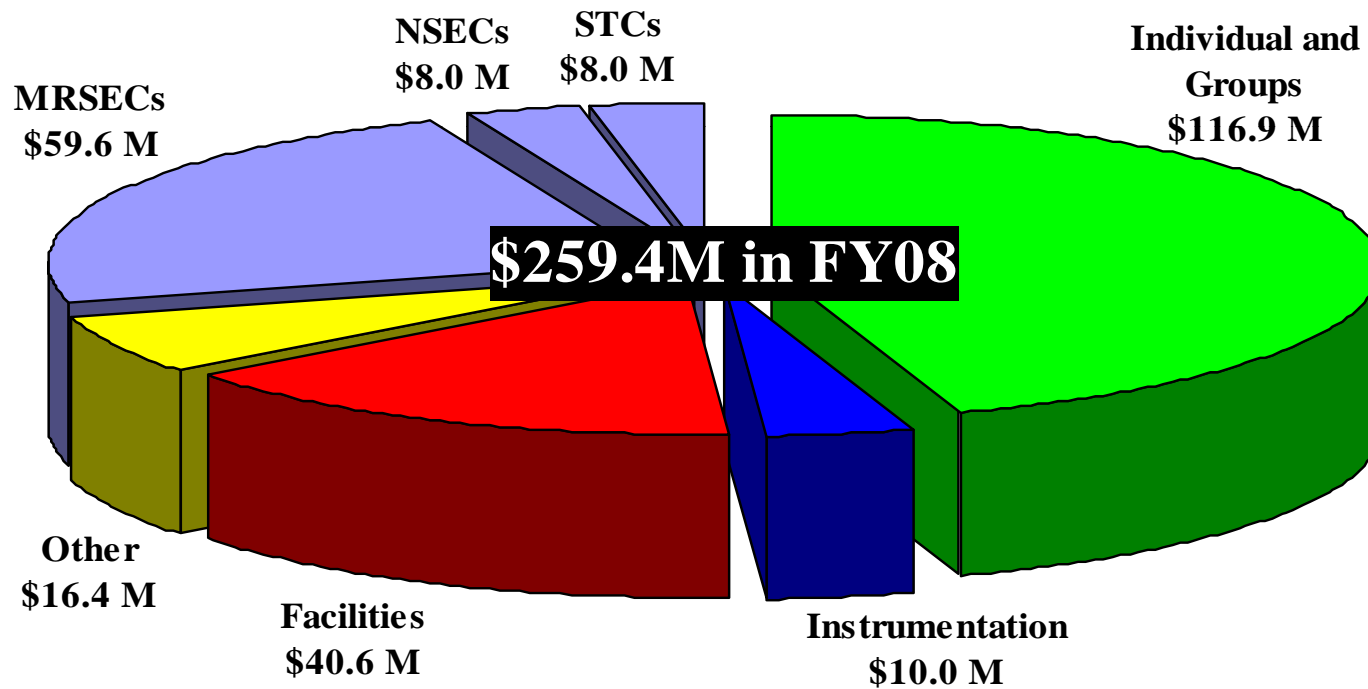
**NSF:
\$7.045 B, +8.5%**

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%)

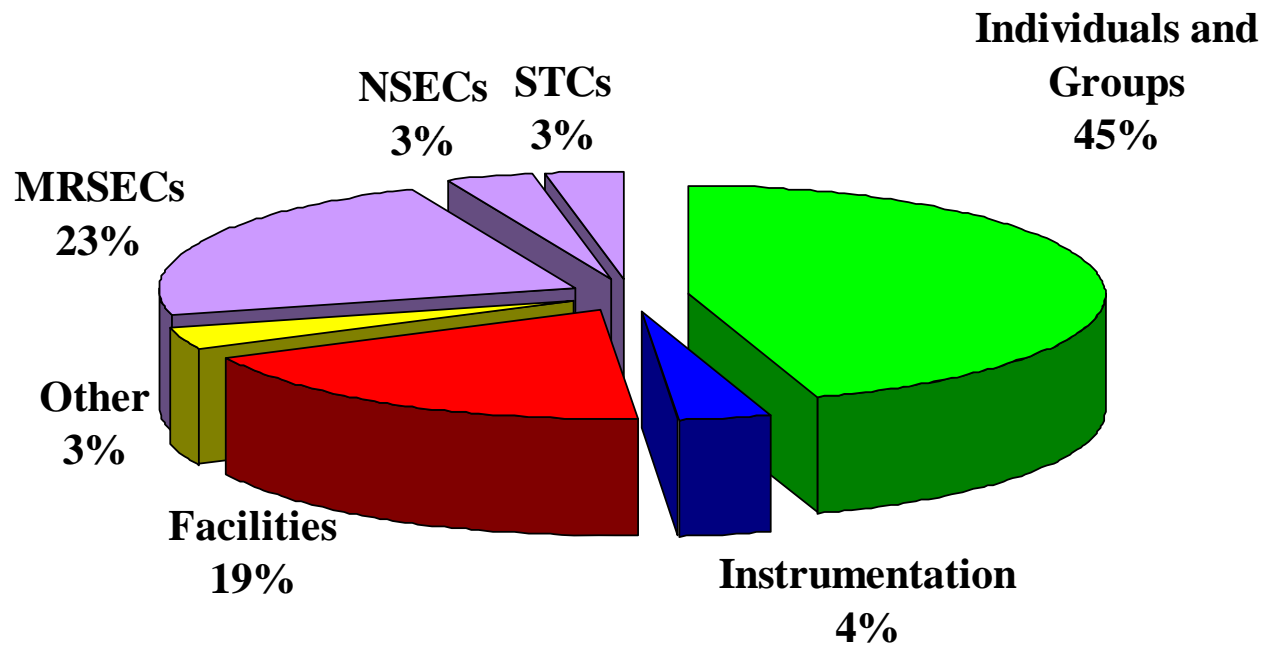
DMR Support for Materials Research & Education in FY08





DMR Support for Materials Research & Education

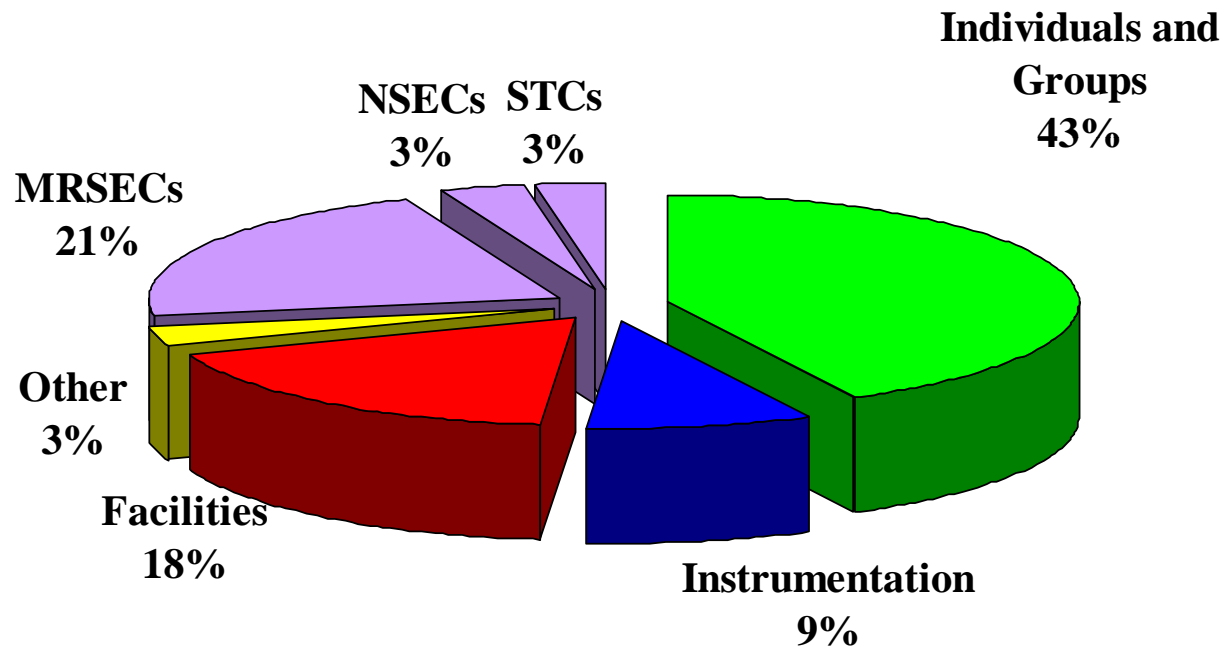
(\$262.54 M in FY2008)





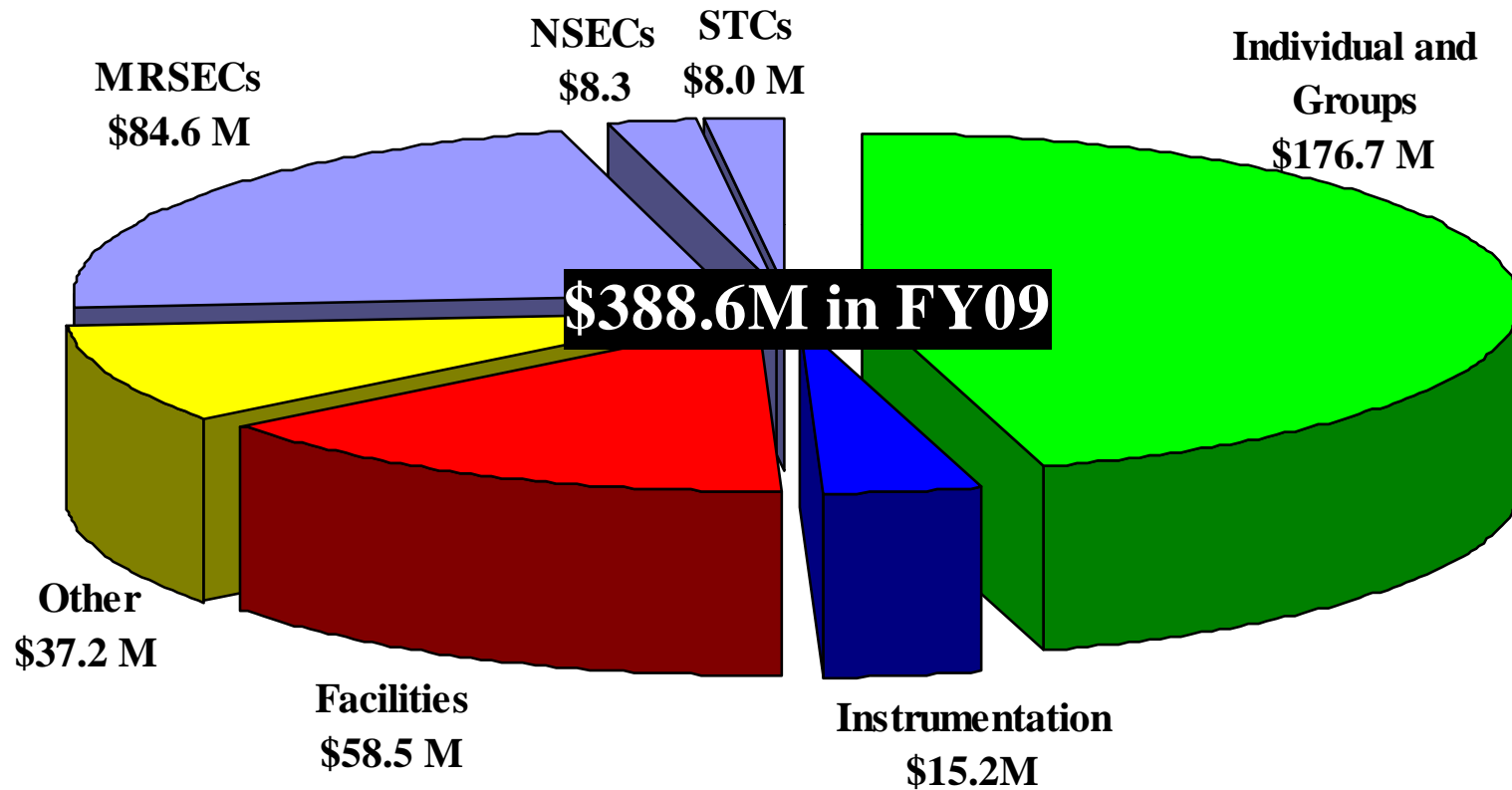
DMR Budget* for Materials Research & Education

(\$277.14 M in FY 2008)

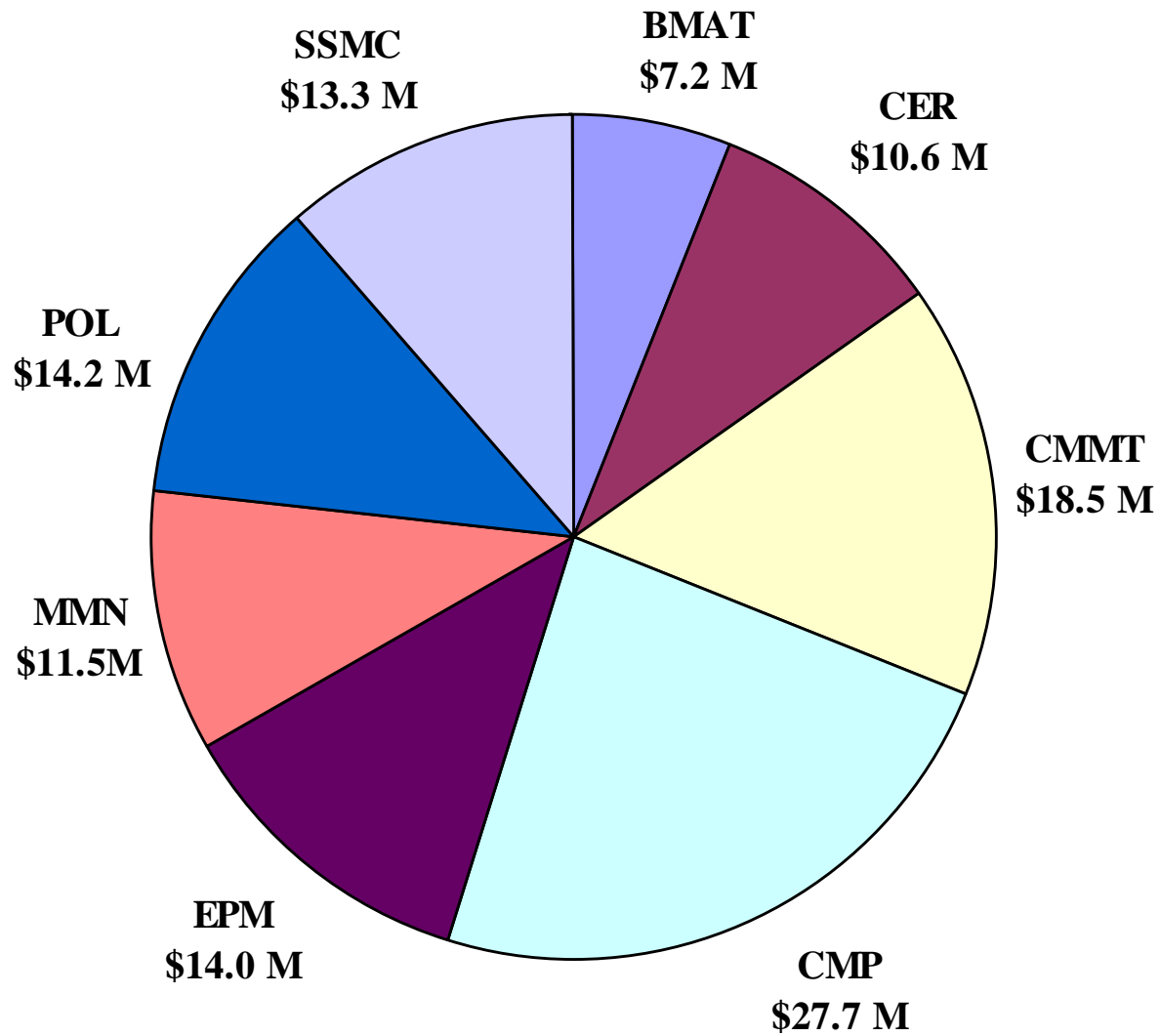


* Includes \$14.6 M MRI

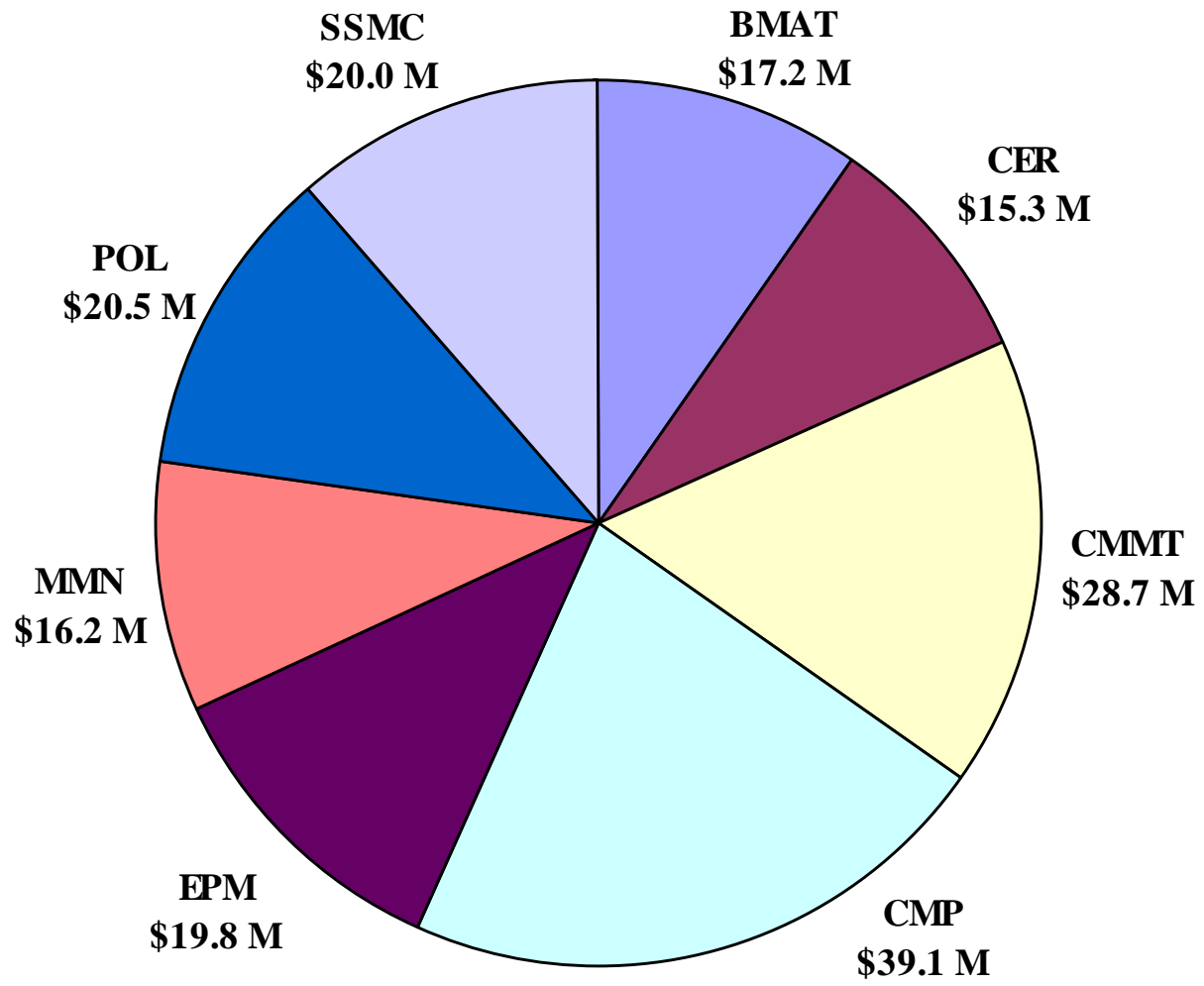
DMR Support for Materials Research & Education in FY09



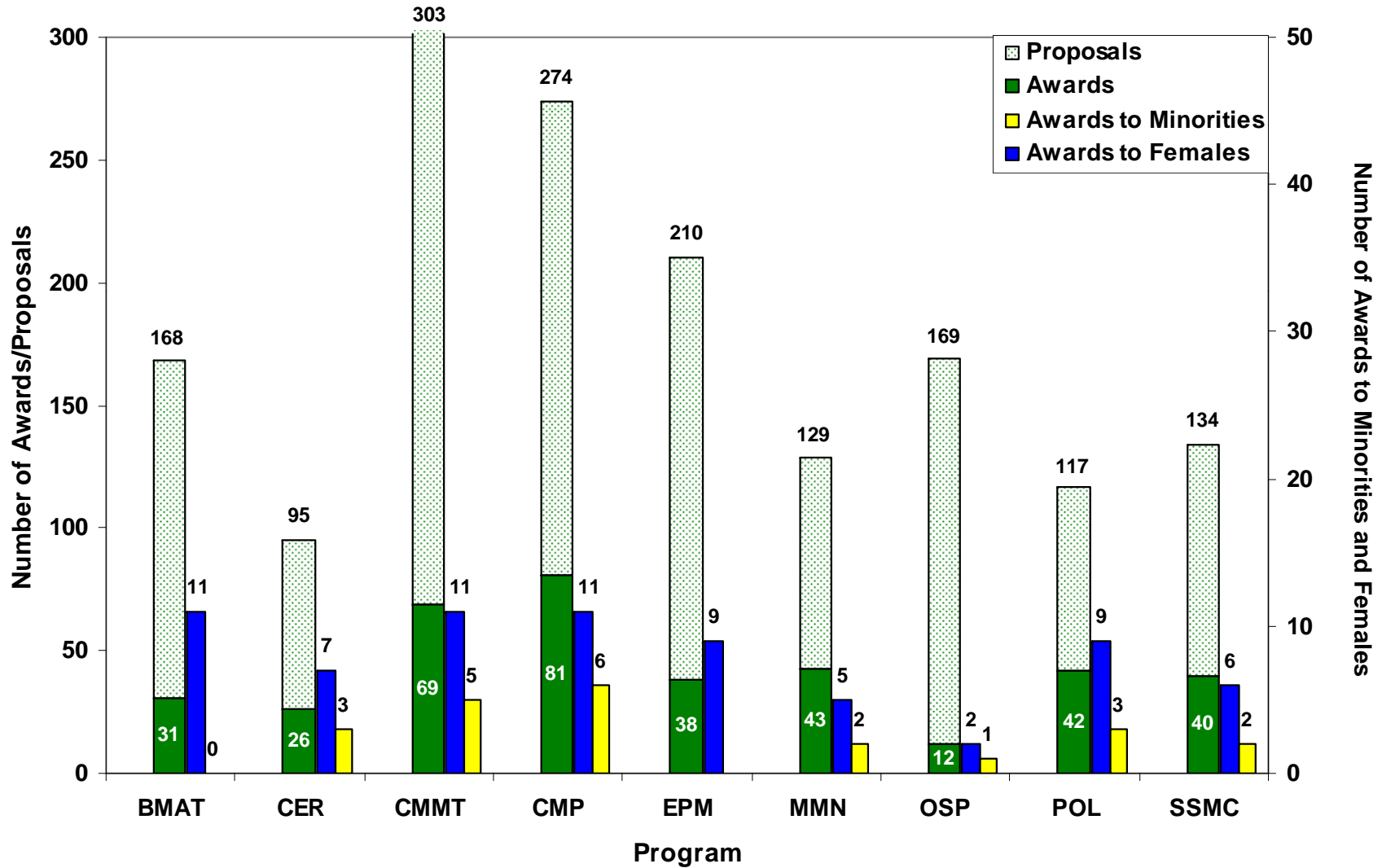
Individual Investigator Programs in FY 2008



Individual Investigator Programs in FY 2009



DMR Awards in FY2008

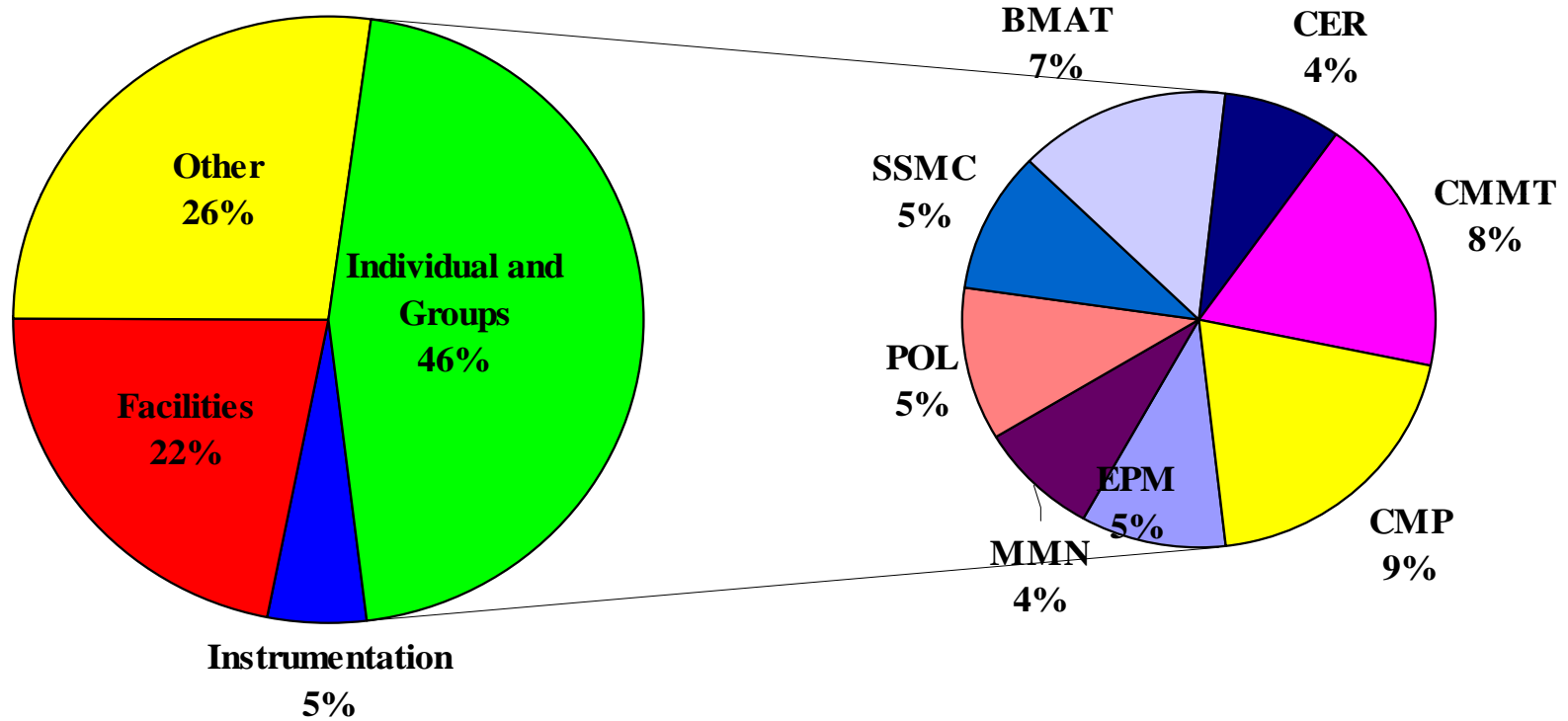


American Recovery and Reinvestment Act (ARRA)

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-R²)

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-R²)

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

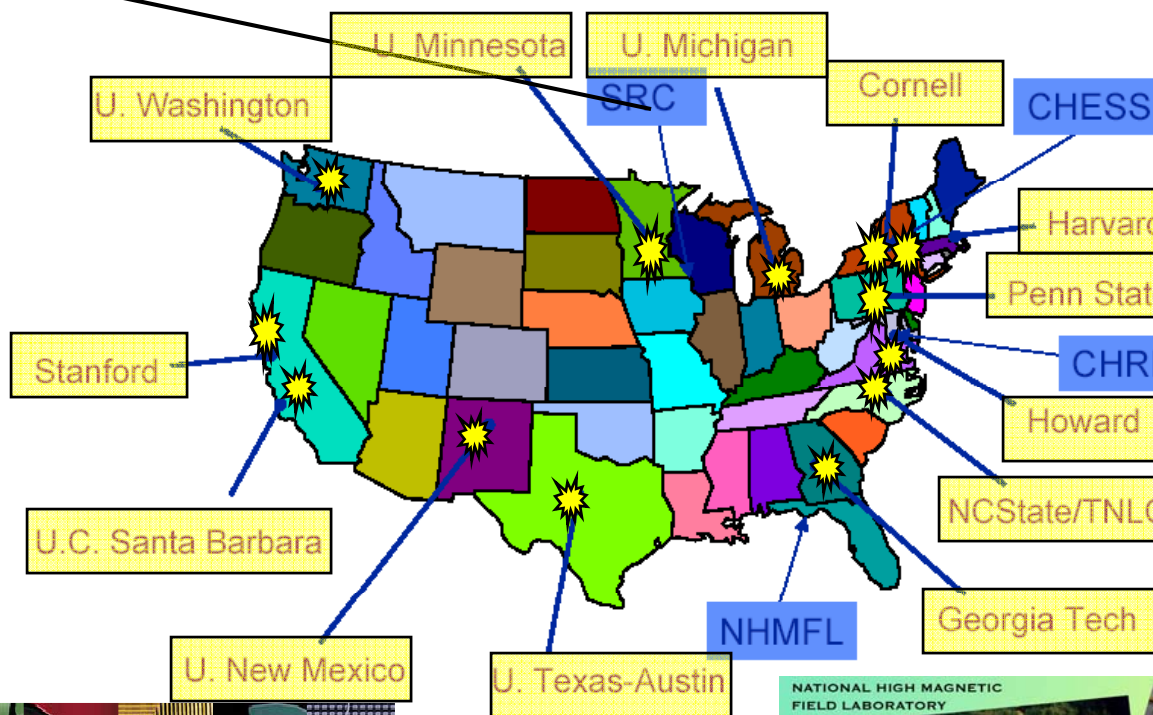
\$ 42M ~ 6000 users annually

536 users



Home of Aladdin

National Facilities & NNIN Sites

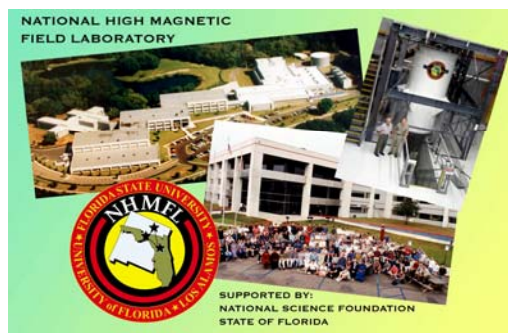


~480 users



~290 Users

3564 users

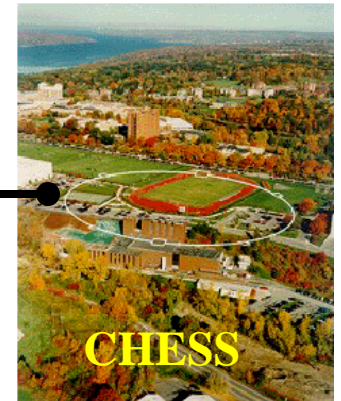


~1000 Users

Light Source Facilities



ALS

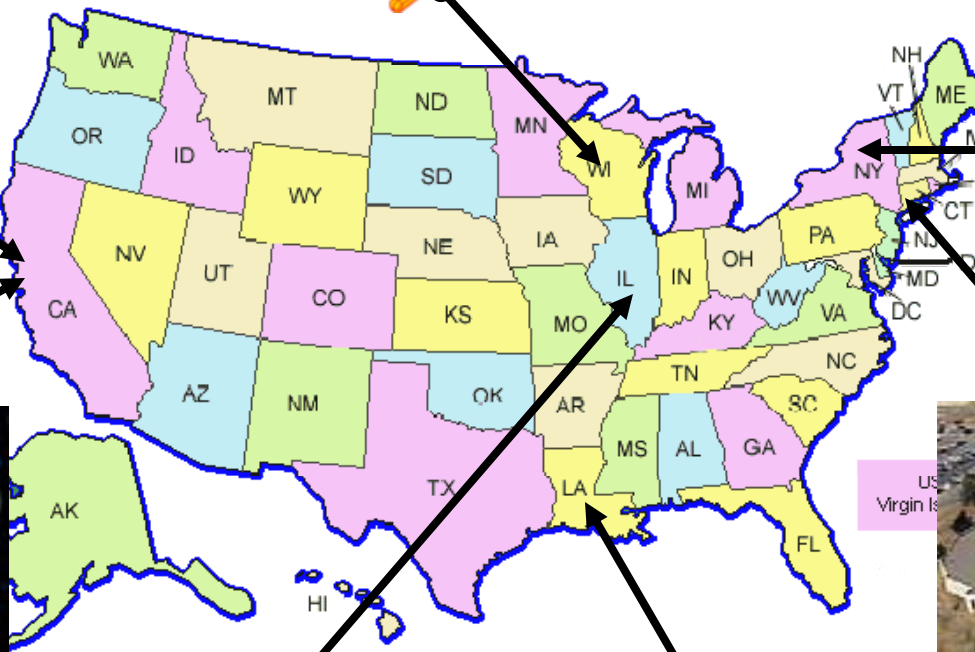


CHESS



SSRL
LCLS

September 28 - October 3, 2007



APS



CAMD



NSLS

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

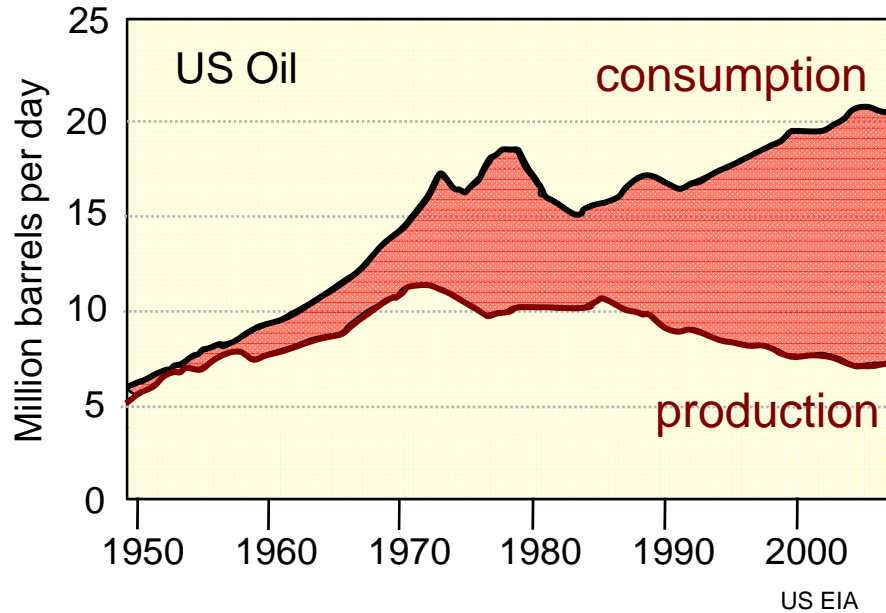


Status of Planning

- 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



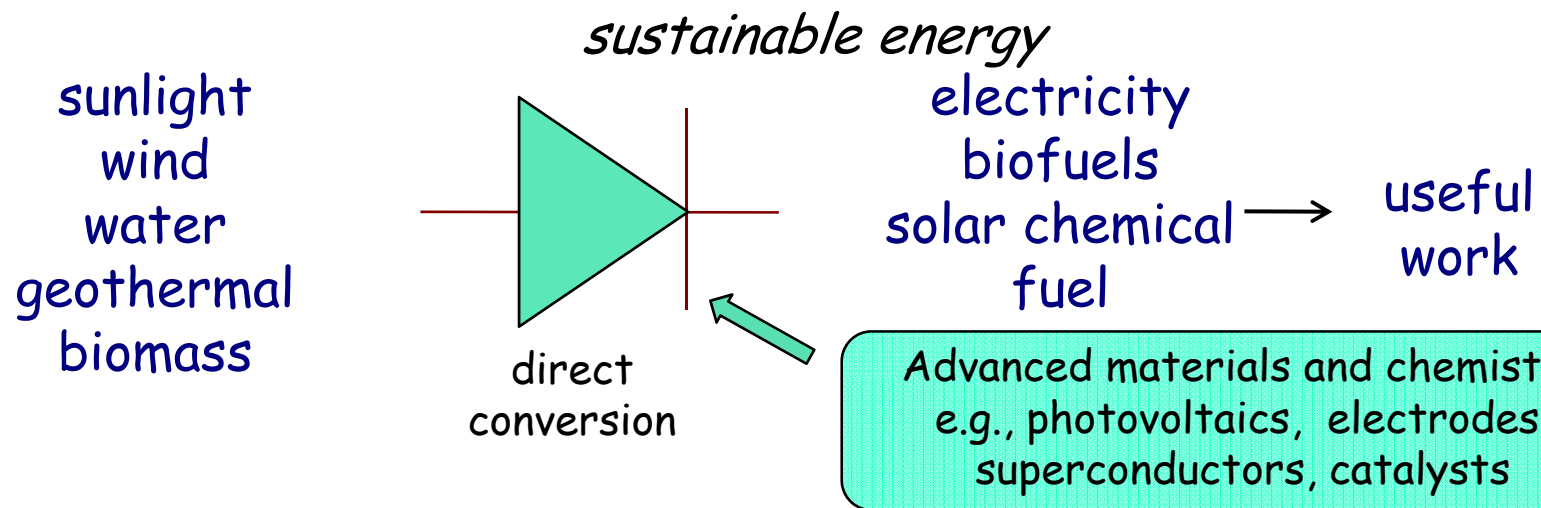
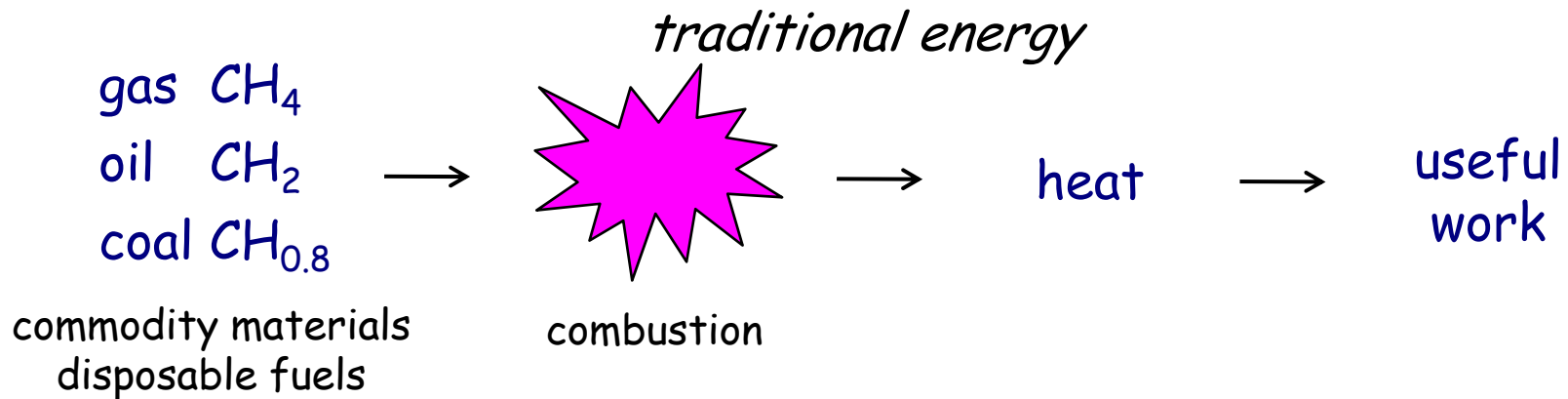
Unpredictable supply
threatens
economy, lifestyle, national security

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

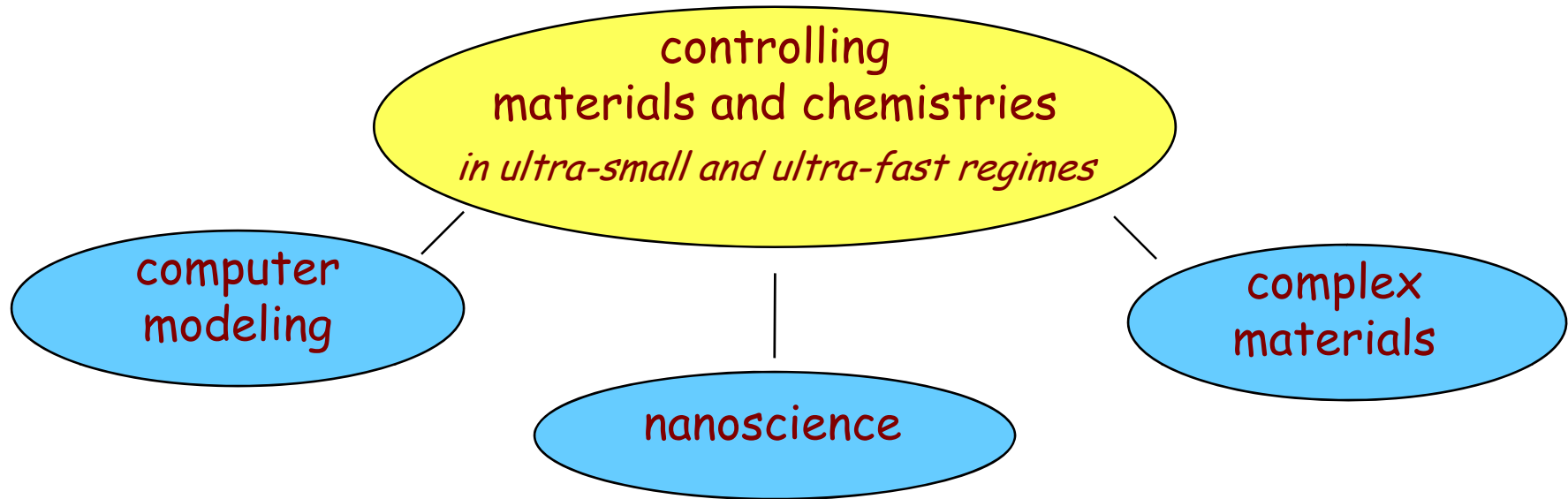


The Transition to Sustainable Energy: Advanced Materials and Chemistry



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

New Science: Controlling Complexity



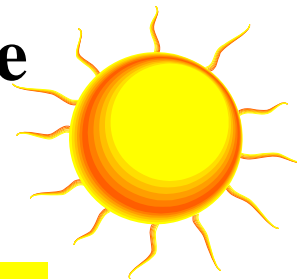
We are at the dawn of a new era

- 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 x 10⁵ TW delivered to Earth
36,000 TW on land (world)
2,200 TW on land (US)

Annual Human Production of Energy

4.6 x 10²⁰ Joules

1 hour of sunlight



Earth's
Ultimate Recoverable Resource
of oil

3 Trillion (=Tera) Barrels

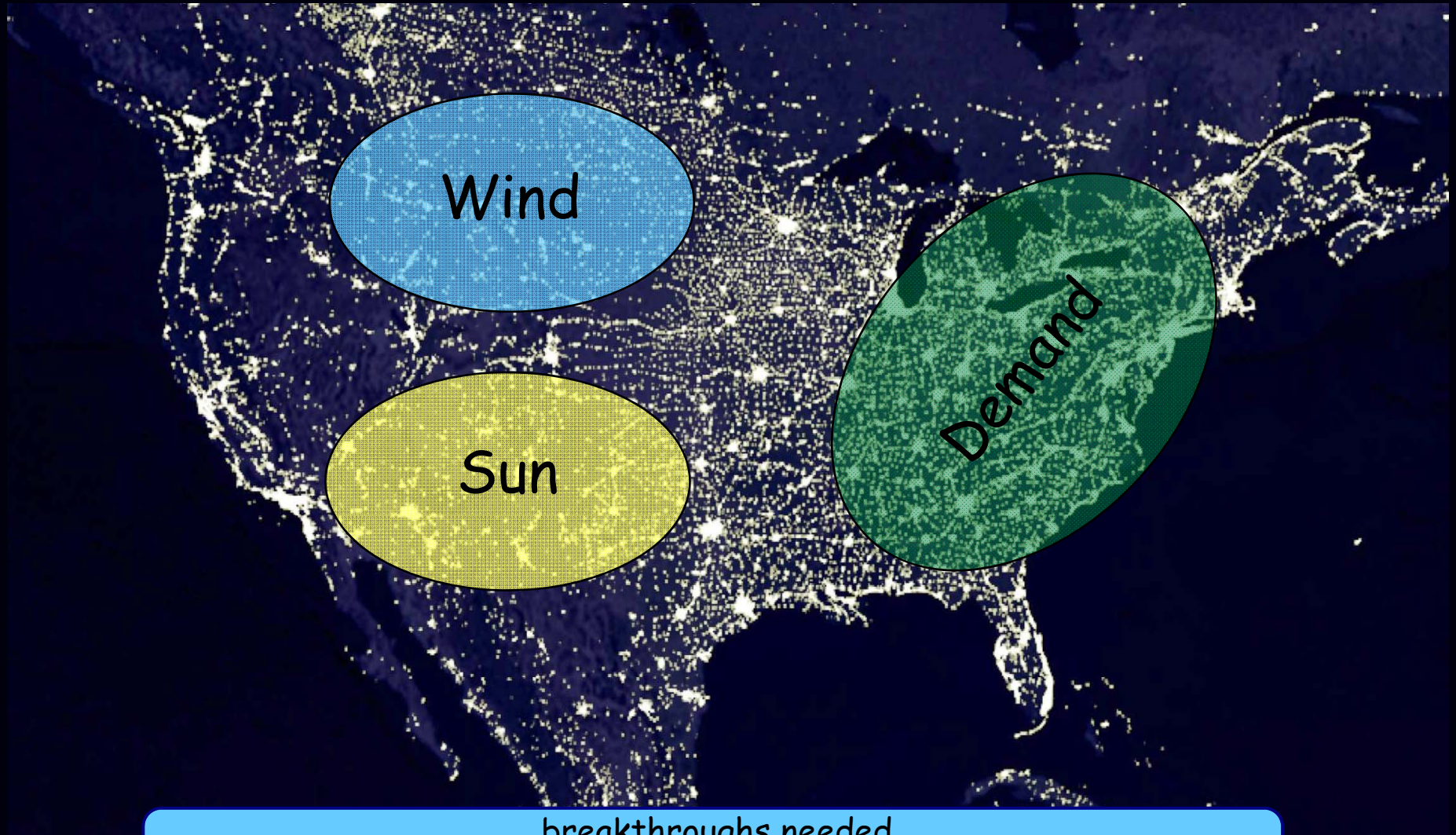
1.7 x 10²² Joules

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

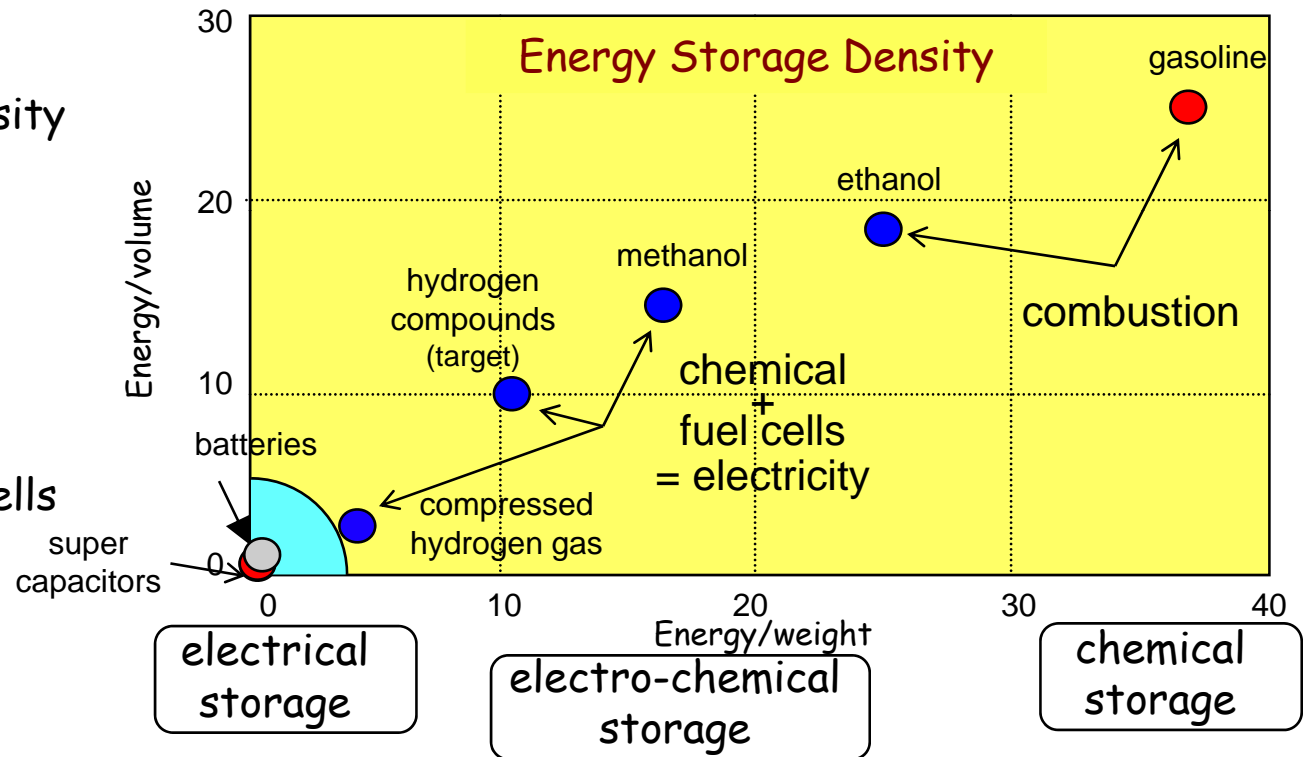
Enabling Technologies: Storing Energy

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

batteries:
30-50x less energy density
than gasoline

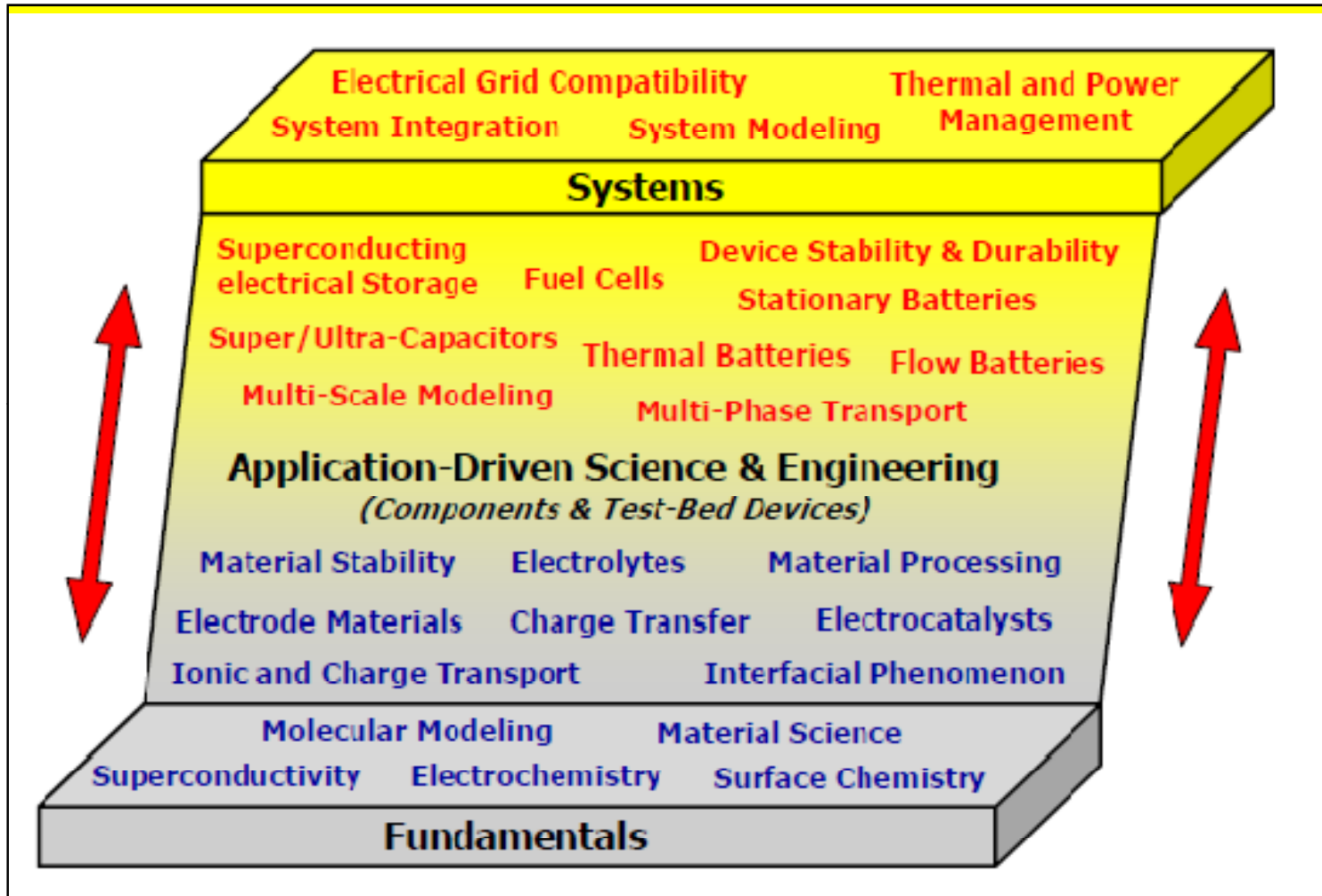
impossible dream: x10
improvement

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

Doing more with less.
Buildings today account for up to 40% of the world's total energy demand.* Addressing their high energy consumption is critical. United Technologies offers solutions to reduce buildings' energy use right now.

Know how.
One of the greatest opportunities for energy savings is modernizing technology in existing buildings, or simply being smarter in new ones. Our energy audits and service companies have supported thousands of efficiency and infrastructure projects for reduced energy and lower operating expenses in facilities ranging from government to commercial and industrial.

Conservation. Not deprivation.
UTC's water and base energy consumption are down 50% and 23%, respectively, over the 11 year period ending 2008 on a company twice the size. Proof that the future, change and cost-effective sources of alternative energy is conservation via greater efficiency.

Pure comfort.
PureComfort® CCHP (combined cooling, heating and power) systems solutions can more than double energy efficiency over most conventional grid sources.

Putting out more than one fire.
Requiring up to 50% less water, UTC Fire & Security's 10-40 KCF water use fire suppression system produces microdroplets that cool materials below combustible temperatures. Nothing like physics to do more with less.

No order too tall.
From San Francisco to Shanghai, UTC is one of the world's largest suppliers to the global building industry.

Cool.
Carrier's ZERON™ Ingersoll® chiller is the world's most efficient zero-ounce halogenating water-cooled chiller with 40% higher efficiency than current industry standards.

Old' Gen® elevators with InGen™
drives not only use less energy when lifting loads, they also give back the energy on descent, all while using up to 75% less power than comparable elevators a decade ago. That's conservation.

Breaks.
UTC Power's PureCell® Model 400 fuel cell power plant is designed to meet the most stringent air emission standards in the US. A single mid-sized building equipped with a PureCell Model 400 system annually eliminates emissions equivalent to that of several hundred cars.

Look! A bus powered by a UTC Power fuel cell!

HERE IT IS. THE BLUEPRINT FOR ENERGY EFFICIENCY.

Technology exists today that can reduce energy consumption in buildings by up to 70%—the equivalent of taking every single car, truck and bus in the world off the road. Doing it part is United Technologies. No other company spans the critical systems that improve energy efficiency in buildings: regenerative elevators, onsite power generation, energy efficient heating and cooling systems, and energy audits that measure buildings' performance. We've seized the opportunity, now we need to make it happen. Learn more about how to change buildings from the greatest users of energy to the most efficient at utcc.com/utccus.

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*International Energy Agency "Worldwide Trends in Energy Efficiency," 2008. **International Science and Technology Council, "Industrial Research and Development Agenda for the Zero Energy High Performance Green Buildings," October 2008.



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 National Natural 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