Division of Materials Research

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Division of Materials Research 2012

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Division Director

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Deputy Division Director

Office of Materials Instrumentation and National Facilities

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Large Facilities office

Office of Special Programs

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Carmiña Londoño

Materials Research Centers and Teams

Sean L. Jones

Mary Galvin

John Snyder

AAAS **Fellow**

Ashley White

Individual investigator programs

Ceramics

Lynnette Madsen

Electronic and Photonic Materials

Nadia El-Masry

Z. Charles Ying

Polymers

Andrew Lovinger

Biomaterials

Joseph Akkara

David Brant

Condensed Matter and Materials Theory

Daryl Hess

Diana Farkas

Serdar Ogut

Metal and Metallic Nanostructures

Eric Taleff

Condensed Matter Physics

Daniele Finotello

Solid State and Materials Chemistry

Linda Sapochak

Job Opportunities in DMR

- Biomaterials
- Electronic and Photonic materials
- Soft Matter Theory
- Condensed Matter Physics

SEND A CV TO THE DIVISION DIRECTOR, iroberts@nsf.gov
And dmr-recruit@nsf.gov
See www.nsf.gov/about/career_opps/rotators/

DMR Members of the Mathematical and Physical Sciences Advisory Committee 2012

Juan dePablo
Wisconsin

Elsa Reichmanis
GA Tech

George Crabtree
Argonne Nat'l Lab

Naomi Halas
Rice

CONTACT WITH YOUR IDEAS AND SUGGESTIONS

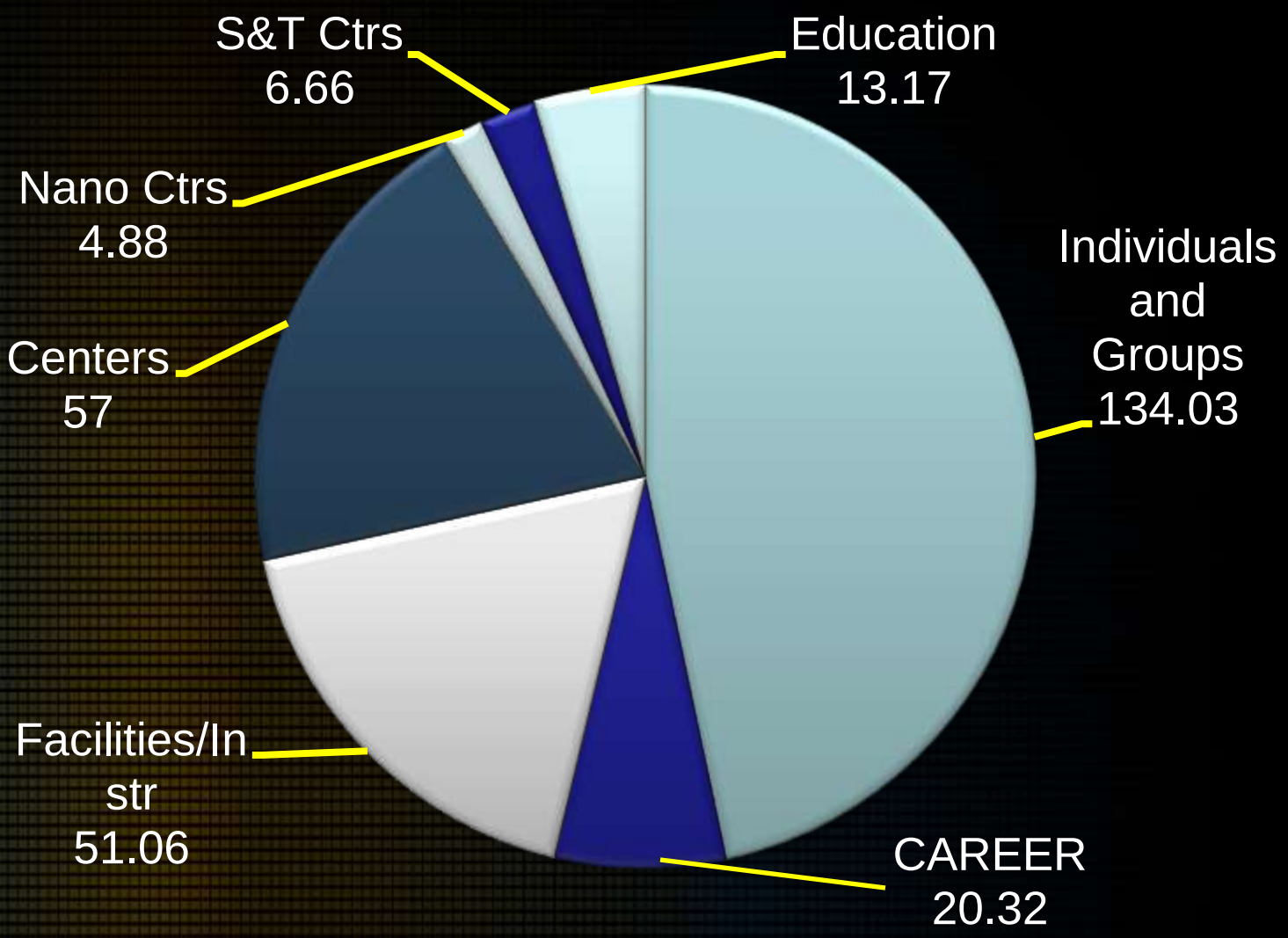
Sharon Glotzer
Michigan

Mathematical and Physical Sciences FY 2013 Budget Request

	FY 2011 Actual	FY 2012 Current Plan	FY 2013 Request	Change FY 2012 to FY 2013
Division of Astronomical Sciences (AST)	$236.78	$234.55	$244.55	4.3%
Division of Chemistry (CHE)	$233.55	$234.06	$243.85	4.2%
Division of Materials Research (DMR)	$294.91	$294.55	$302.63	2.7%
Division of Mathematical Sciences (DMS)	$239.79	$237.77	$245.00	3.0%
Division of Physics (PHY)	$280.34	$277.37	$280.08	1.0%
MPS Total	**$1,312.42**	**$1,308.94**	**$1,345.18**	**2.8%**

FY 2013 NSF Research and related activities 5.2%

DMR BUDGET



FY 2011: $294 M

Division of Materials Research Mission

1. **Discovery**
2. **Interdisciplinarity**
3. **Innovation**
4. **Education and Public Outreach**
5. **Infrastructure**
6. **Stewardship**

Discovery

Spin Liquid in a realistic system (UC Irvine)

Nanoscale Assembly by Algorithmic Design (U. Penn)

Extended Spin Lifetimes in Bilayer Graphene (UC Riverside)

Biodesigning Advanced Nanocomposites (Northwestern)

Topological Insulators (Princeton)

Very Large Magnetoresistance in Graphene
Nanoribbons for High Performance Electronics UCLA

Electrically- and Optically-Controlled
Self-Assembly in Liquid Crystals (Colorado)

OPTICALLY HEALABLE MATERIALS (Case Western)

Quantum Transport in High Mobility Graphene (MIT)

Plasmonic Dye Sensitized Solar Cells (Cornell)

Single-Chirality Single-Walled Carbon Nanotubes (Northwestern)

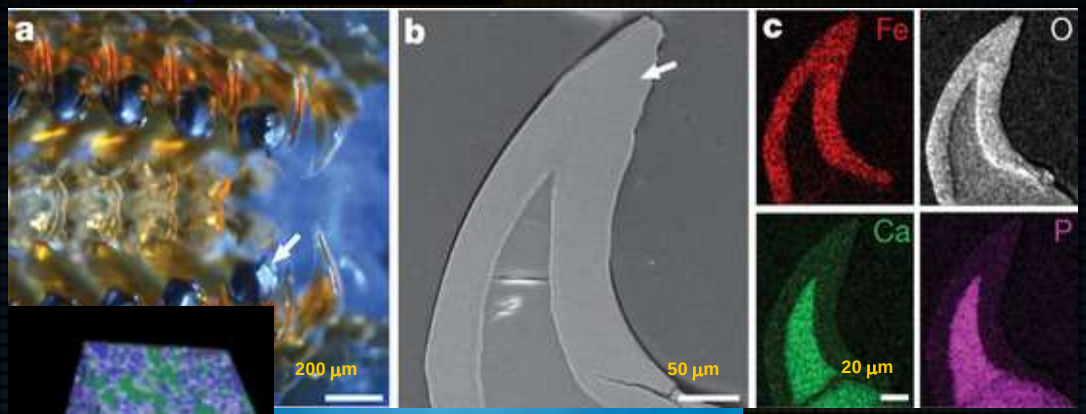
Highly complex 3-D nano-objects
by DNA origami (Arizona State)

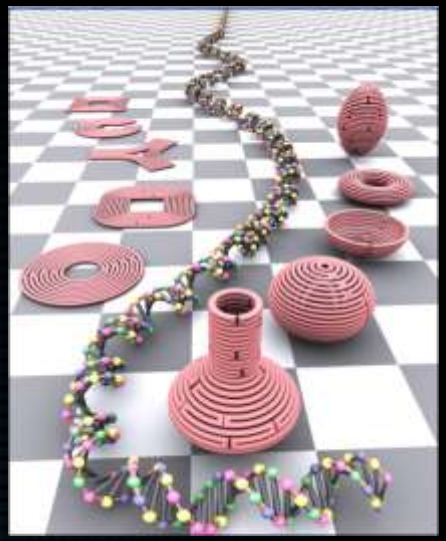
Experimental Investigation of Plasticity at Nanoscale (Cal Tech)

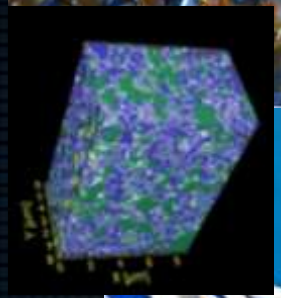
Self-assembly on elastic surfaces (Columbia)

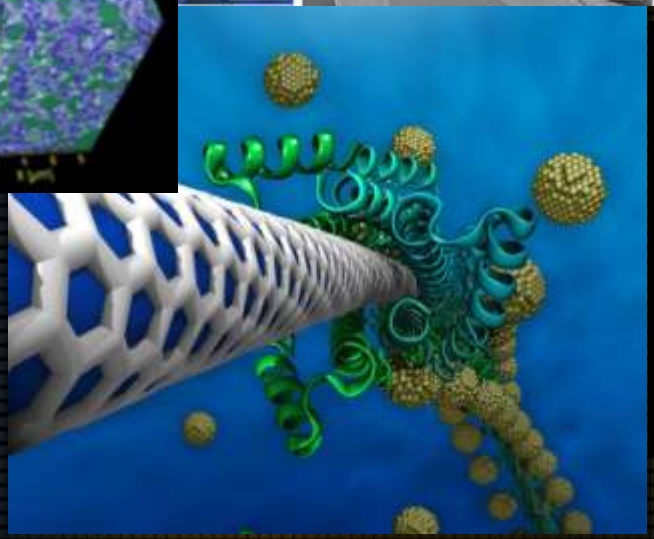
U.S. National Science Foundation:
Division of Materials Research
2012

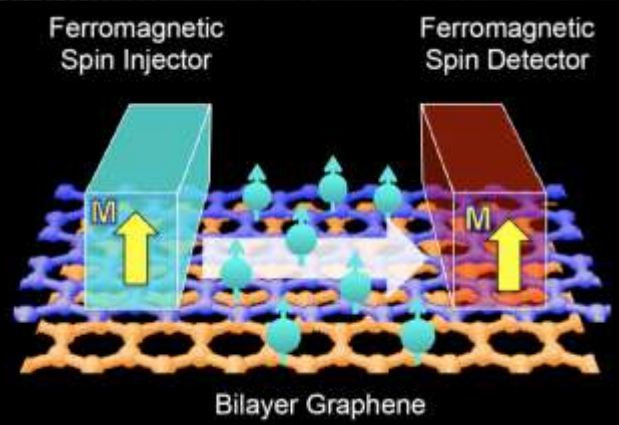
U.S. National Science Foundation: Division of Materials Research

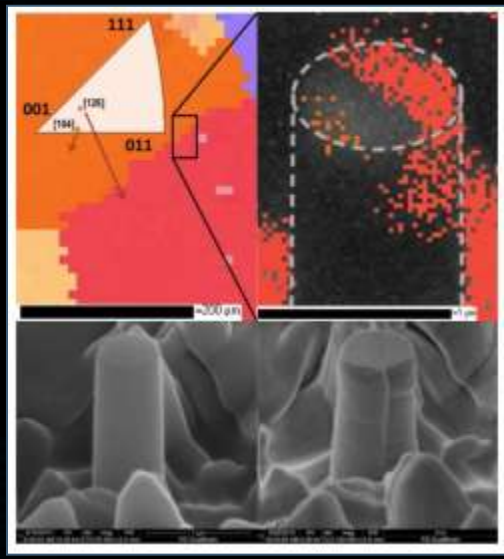


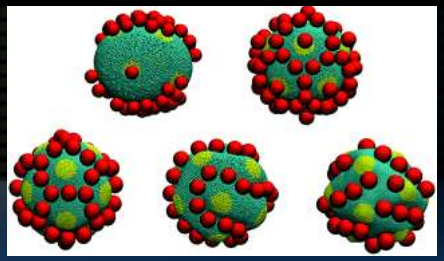








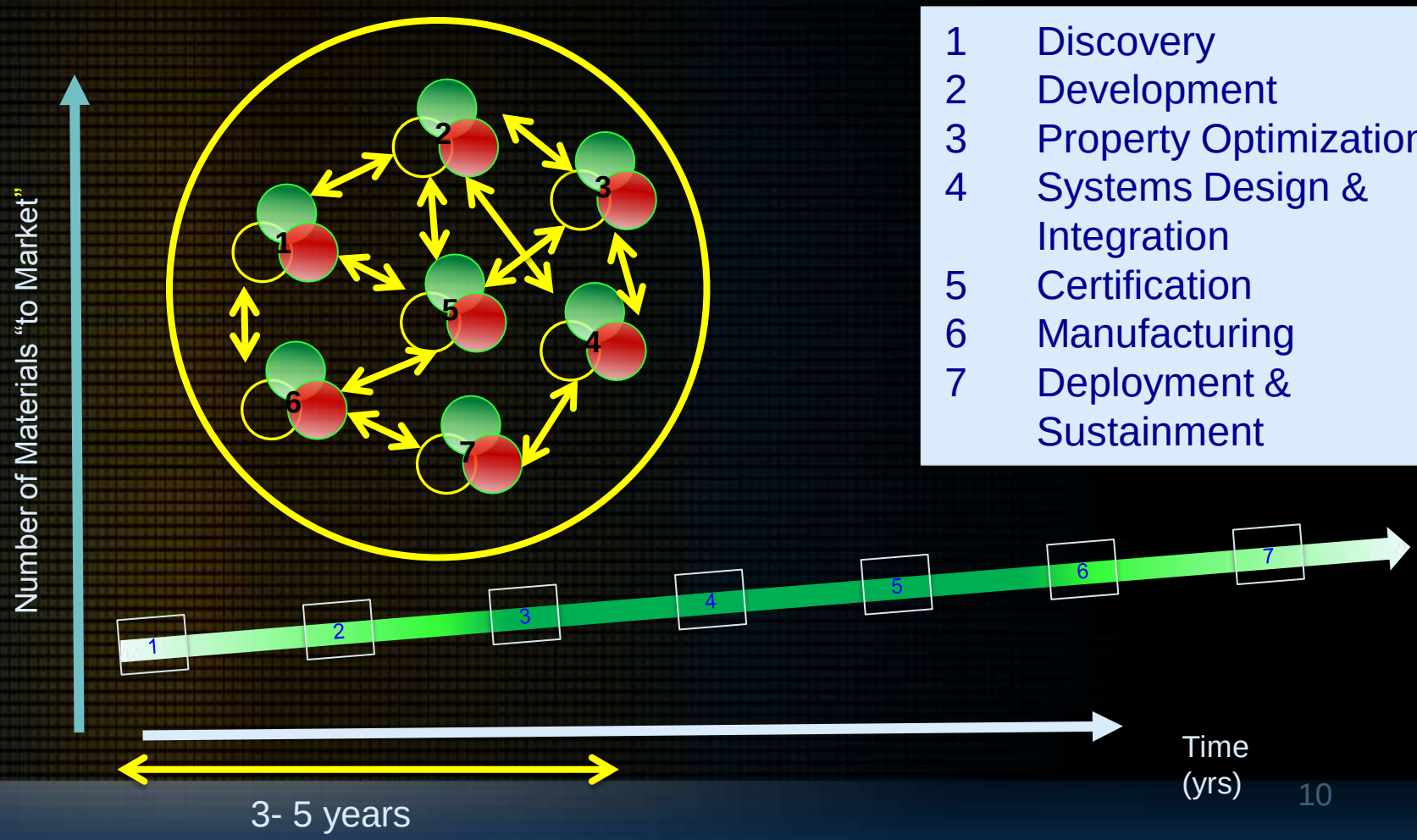




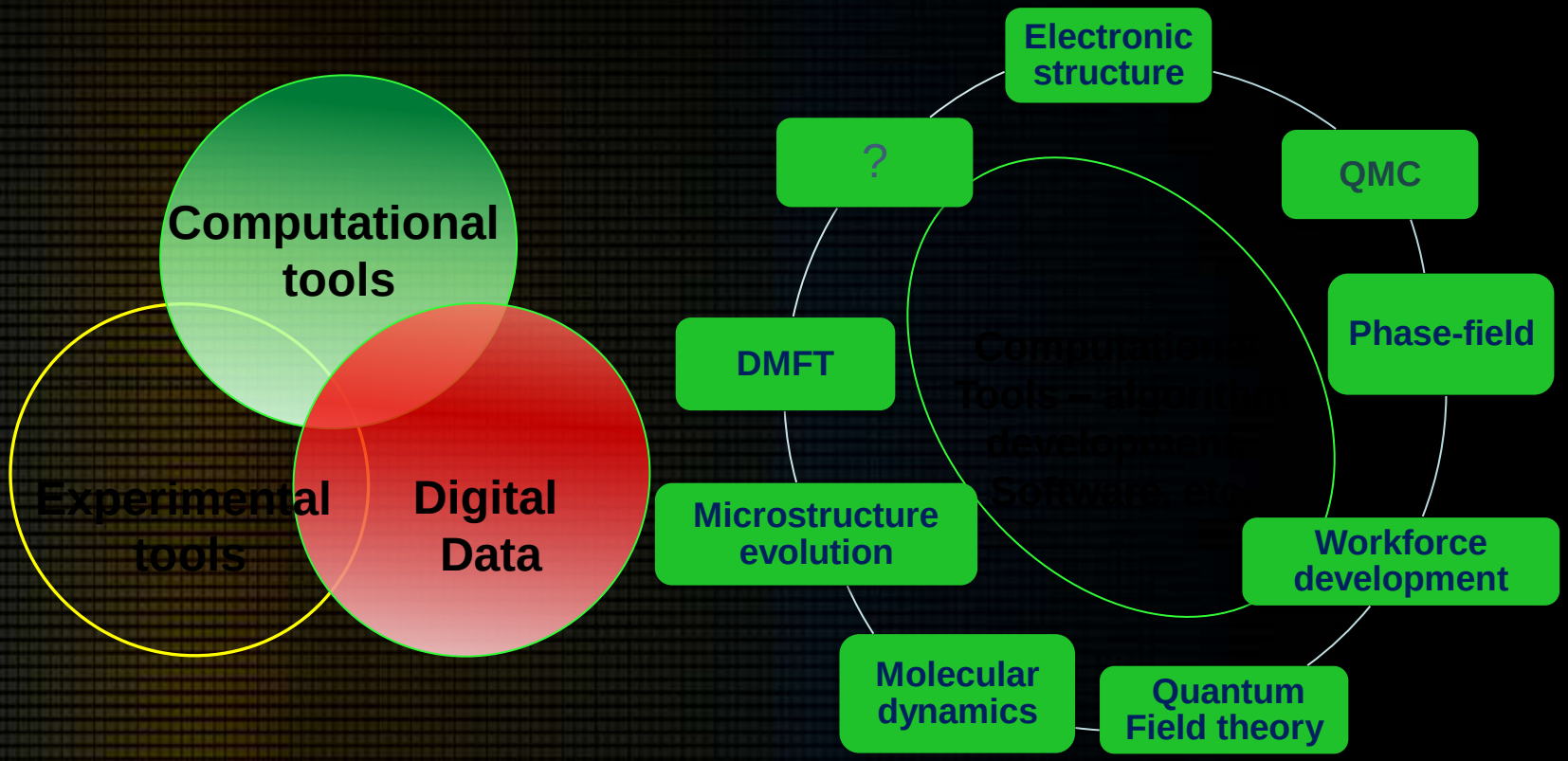
Discovery

Materials Genome Initiative for Global Competitiveness:

"twice as fast, at a fraction of the cost"

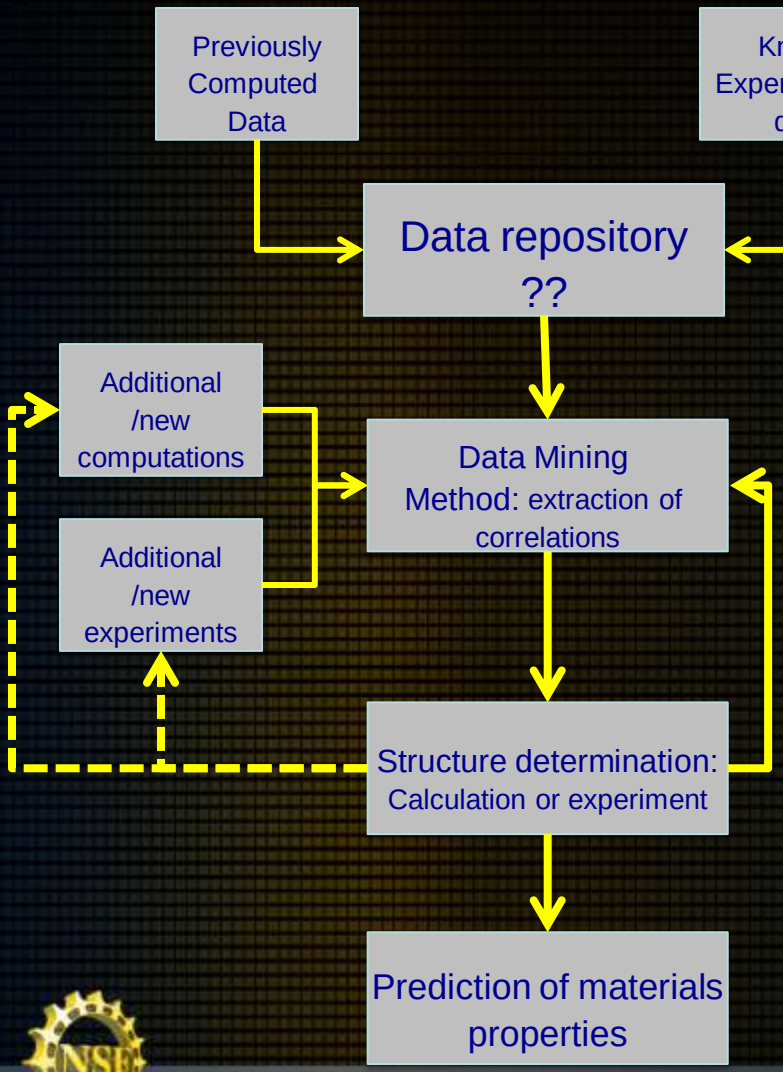


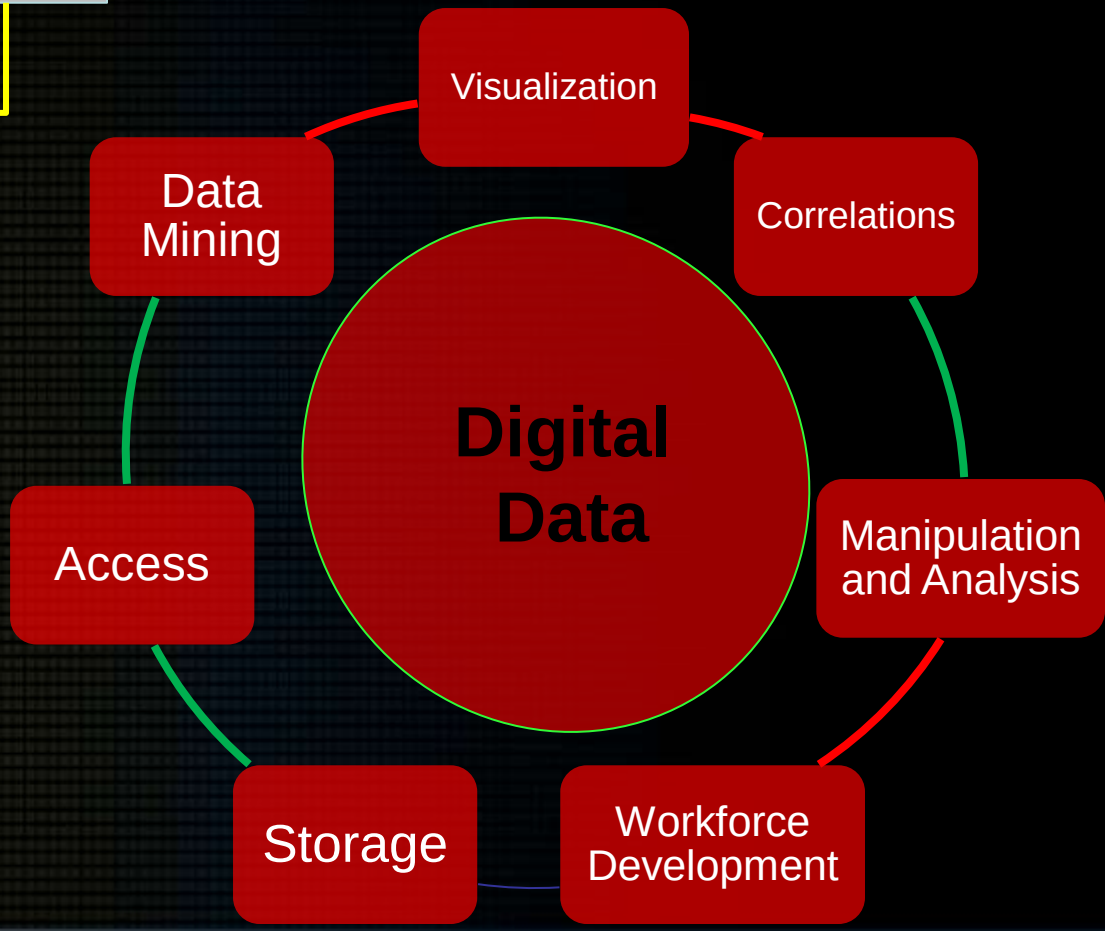
Materials Genome Initiative



Discovery

Data for accelerated discovery of new materials and phenomena – new paradigms?

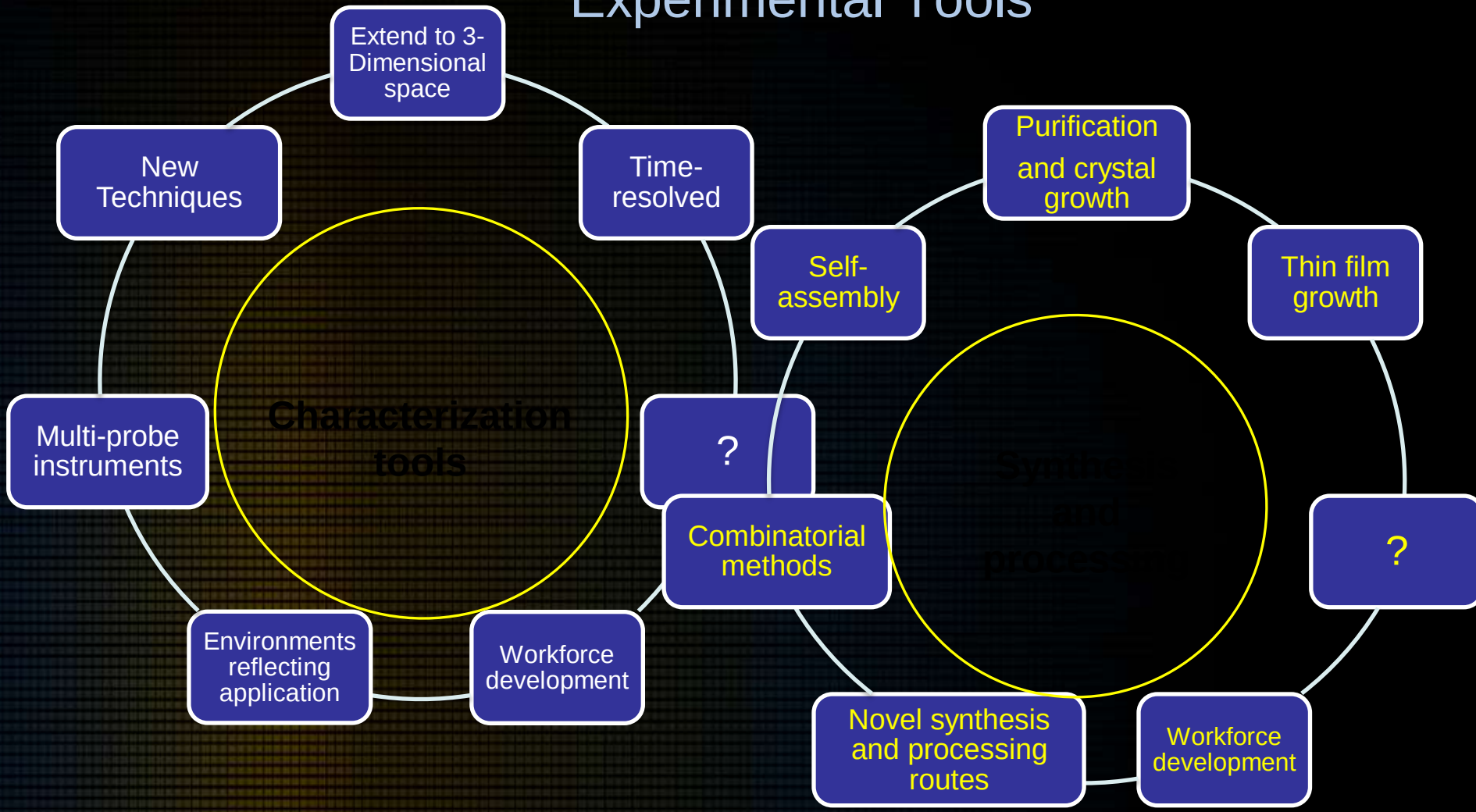




Adapted from Ceder and Morgan

Discovery

Experimental Tools



NSF Response NSF 11—089 DCL DMREF

Designing Materials to Revolutionize and Engineer our Future

Under OneNSF CEMMSS initiative

FY 13 BUDGET REQUEST for DMREF: MPS $20M; ENG $15M

Interdisciplinarity

Science, Engineering, and Education for Sustainability (SEES):

Interdisciplinary basic research in science, engineering and education aimed at meeting present needs without compromising the ability of future generations to meet their own needs.

SusChEM: Sustainability Research in Chemistry, Engineering and Materials -

Discovery of new materials or make materials more sustainable through improved synthesis, enhanced applications, advances in lifecycle management.

Materials for preservation and extension of natural resources

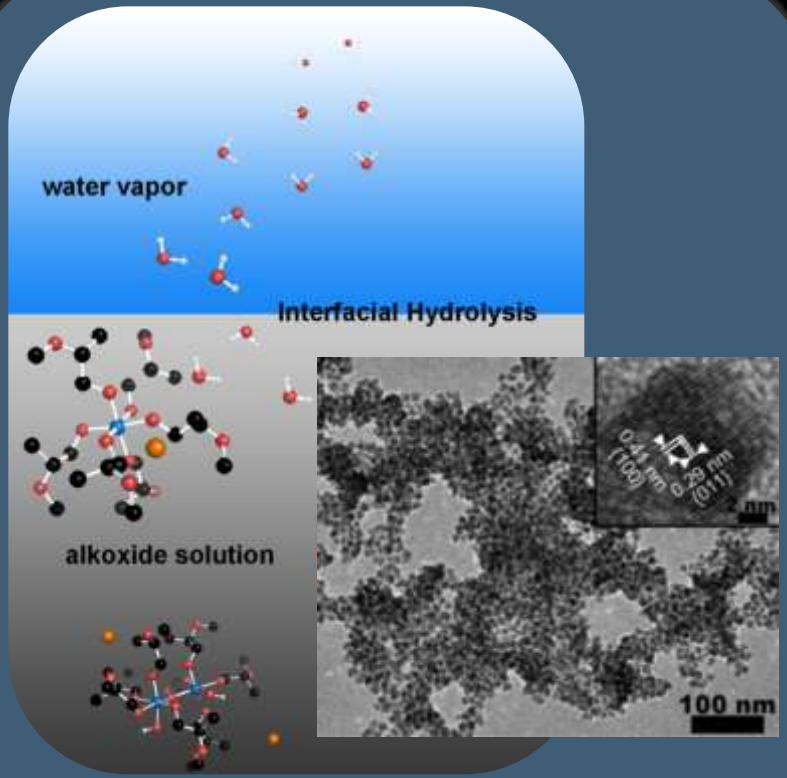
Material replacement for a safer and more secure future

Improved materials during operating conditions

Materials designed for zero waste

PAST SOLICITATIONS

- Sustainable Energy Pathways NSF 11-590 Teams of 3; address 2 main issues; $0.5M/yr for 4 years; due to run every other year
- SEES Post-doc Fellows NSF 11-575 2 mentors in different disciplines, affiliate with a center/ind/international; due to run every year.
- Sustainability Research Networks NSF 11-574 “think tank” $12M over 4-5 years (3-4 awards will be made)



$BaZr_xTi_{1-x}O_3$ nanocrystals can be prepared under ultra-benign conditions from a mixture of bimetallic alkoxides using a kinetically controlled vapor diffusion sol-gel method.

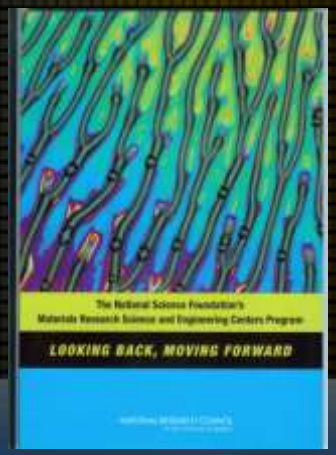
Rabuffetti, F. A.; Brutchey, R. L. *Chemical Communications* DOI:10.1039/C1CC14166J.

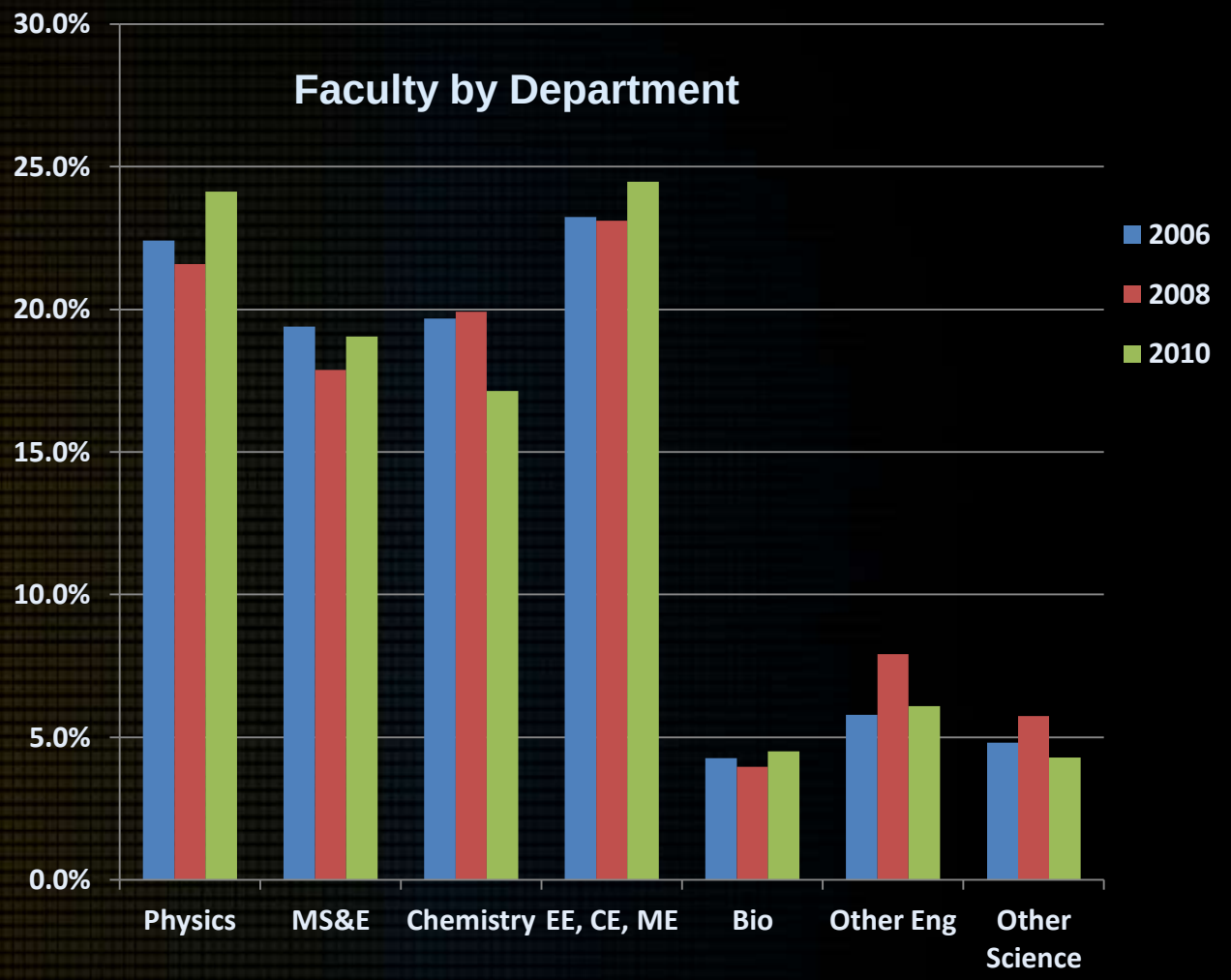
Interdisciplinarity: Materials Research and Engineering Centers (MRSEC)

23 MRSECs & 3 MIRTS
- 58 Interdisciplinary Research Groups

2010-2011 Data for 27 Centers

- 901 Faculty participants
- 224 Ph.D.s awarded
- 129 Post-docs completed
- 1500 publications
- 76 patents issued





Interdisciplinarity:

Scalable Manufacturing

NSF 12-544 due June 4, 2012

Targeted themes

- Novel processes and techniques for continuous and scalable nanomanufacturing;
- Directed (e.g. physical/chemical/biological) self-assembly processes leading to heterogeneous nanostructures with the potential for high-rate production;
- Fundamental scientific research in well-defined areas that are compellingly justified as critical roadblocks to scale-up;
- Principles and design methods to produce machines and processes to manufacture nanoscale structures, devices and systems; and/or
- Long-term societal and educational implications of the large-scale production and use of nanomaterials, devices and systems, including the life-cycle analysis of such nanomaterials, devices and systems.

DMR funded examples

- Lingjie Guo, U. Michigan: jumpstart bulk production and practical large area applications based on graphene and CNTs
- John Marko, Northwestern U.: the application of statistical mechanics to elucidate micromanipulation of DNA molecules, allowing direct statistical-mechanical study of the operation of biomolecular machinery.

Innovation

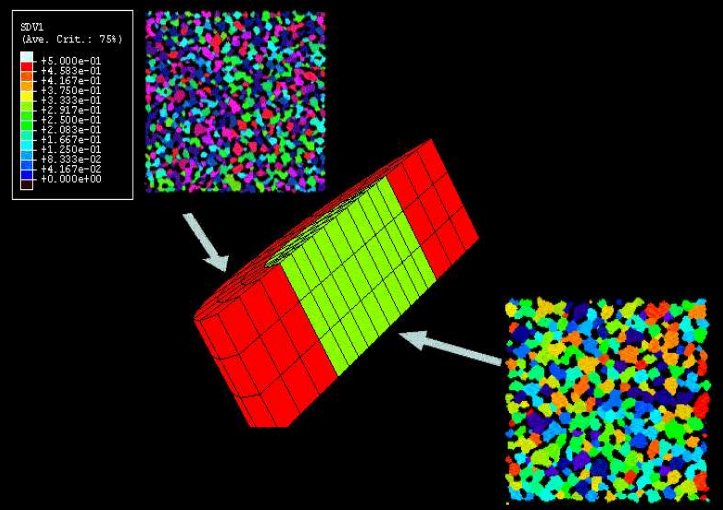
PI, student and mentor learn aspects of developing, organizing and managing a business.
Monthly webinars

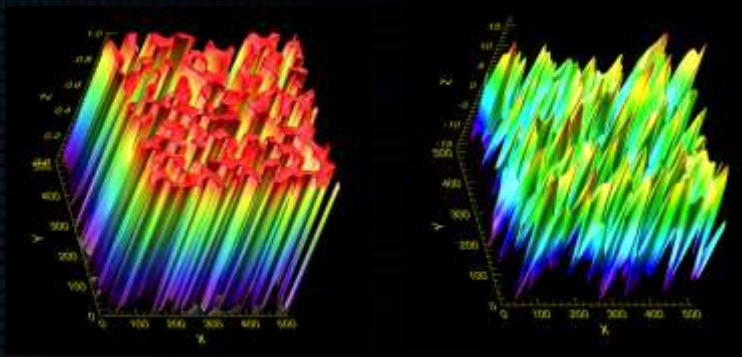
NSF 11-560: I CORPS
5 pages
$50K for 6 mos
4 deadlines/year next:
15 June 2012

Infrastructure

Cyber-Infrastructure Framework for the 21st Century (CIF21)

- Ensure that simulations are able to capture the complexity of nature, and are physically correct, reproducible, and predictive
- Invest in MPS computational sciences, algorithm development, and software
- Provide infrastructure for sustained long-term research efforts.
- Advance data-enabled science, including fundamental mathematical algorithms, software, data services, and network infrastructure





DMR: several choices:

1. Submit to sub-disciplinary programs
2. EAGER - **EArly-concept Grants for Exploratory Research**
3. DMREF
4. Supplements to current awards

MPS FY13 request $19.55M

Infrastructure

National High Magnetic Field Laboratory: Florida State U., U. Florida, Los Alamos

MAGNETS:

- 97.4 T non-destructive pulsed field magnet – world record
- 45 T DC hybrid – highest steady magnetic field in the world
- Split coil 25 T magnet
- 900 Mhz MRI – world's strongest MRI machine
- 21 T Ion Cyclotron Resonance Spectrometer under construction – highest field ICR in the world

USER Programs: https://users.magnet.fsu.edu/

- Advanced Magnetic Resonance Imaging and Spectroscopy
- DC Field
- Electron Magnetic Resonance
- High B/T (magnetic field/temperature)
- Ion Cyclotron Resonance
- Nuclear Magnetic Resonance
- Pulsed Field

Infrastructure

Cornell High Energy Synchrotron Source
Cornell University

11 HIGH ENERGY X-RAY BEAMLINES:

- National High Pressure Facility: High pressure cell allows exploration of utilizing pressure to induce metastable states and studies of nucleation processes.
- Real time observation of materials synthesis discovery of new materials phases and optimization of synthesis conditions. EXAFS, SAXS, fluorescence spectroscopy (including micro-science utilizing focusing capillary optics), single crystal diffraction, scattering experiments using extremely small specimens, and instrumentation development.
- Understand the details of how enzymes work and to be able to mutate, or even *ab initio* predict and synthesize enzymes that catalyze. (2 Nobel Prizes)

To apply for beam time:
http://www.chess.cornell.edu/prposals/index.htm

Infrastructure

Center For High Resolution Neutron Scattering (CHRNS)

National Institute of Standards and Technology

http://www.ncnr.nist.gov/proposal.html

- 30 m high resolution, small-angle neutron scattering instrument
- Diffractometer for ultra-high-resolution small angle scattering
- Cold neutron, triple axis neutron scattering spectrometer
- Multi axis crystal spectrometer
- Very flexible cold-neutron time-of-flight spectrometer
- Backscattering spectrometer with 1 micro eV resolution
- Neutron spin echo spectrometer

National Nanotechnology Infrastructure Network

14 Sites: www.nnin.org

Nanocontacts, quantum dots, break junctions, Superconduction nanostructures;advanced silicon Device structure, process integrations,microwave and mm WaveDevices, gratings couplers,waveguides,lasers, Detectors, photonic crystals, semiconductor LEDs Materials,biocompatible surfaces,sensors,actuators Lab on a chip,nanophase materials,catalysts,self - assembled films

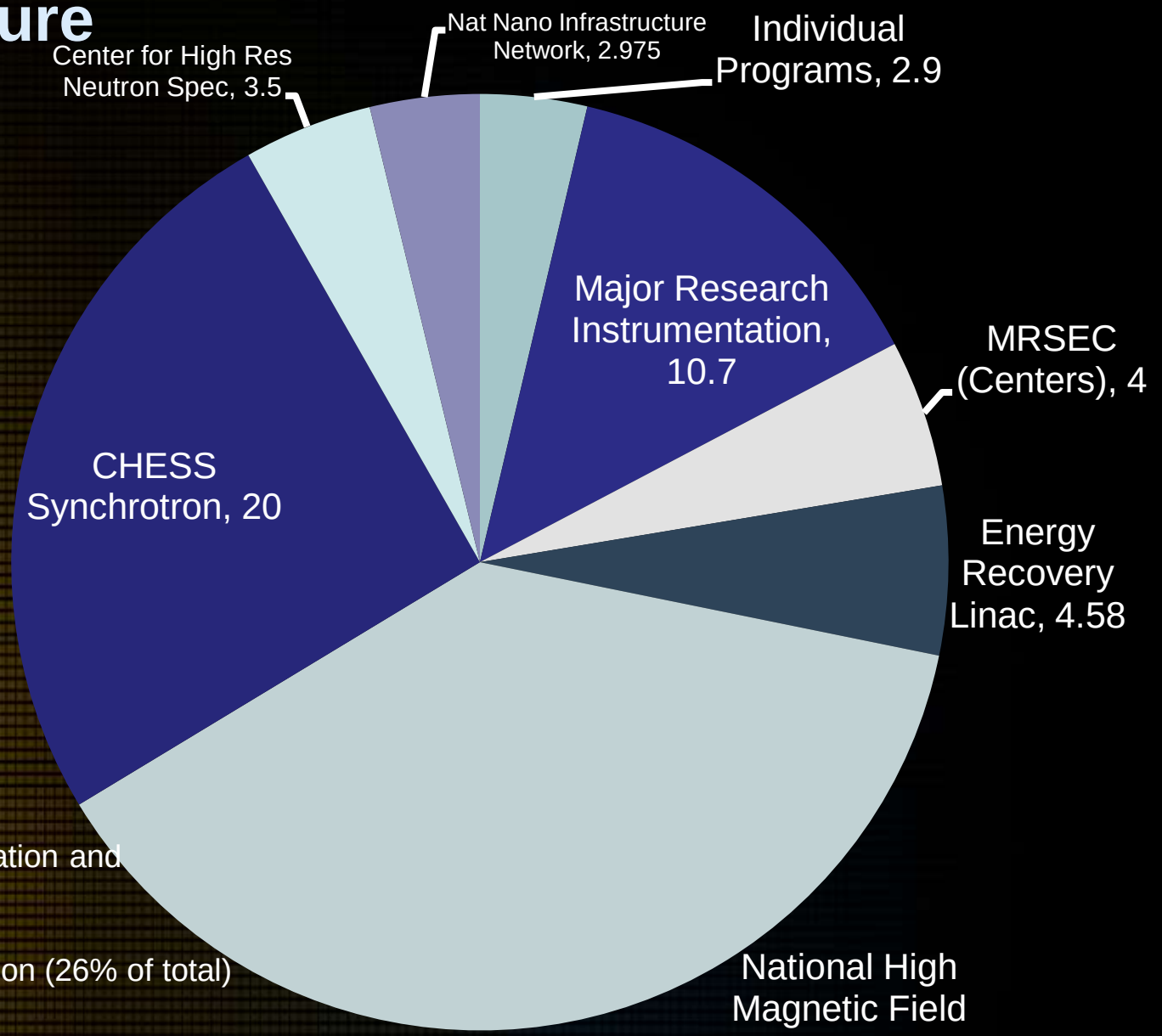
Infrastructure

Major Research Instrumentation Acquisition and Development :

Electron Microscopes
X-ray Diffractometers
X-ray Photoelectron Spectroscopy
X-ray Fluorescence
Ultrafast Lasers
Atomic force microscopes
Surface Plasmon Resonance
Electron beam lithography
Cryo-systems for magnets, etc.
And many others…

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

Infrastructure



DMR Instrumentation and Facilities
($ millions)
Total $78.66 million (26% of total)

Infrastructure

Materials 2022

How can the Division of Materials Research (DMR) best utilize its resources to:

1. meet national needs in instrumentation ?
2. provide access to unique instrumentation capabilities through user programs at national facilities ?
3. support acquisition of multi-user instrumentation for the materials community?
4. develop new instrumentation and facilities?
5. support workforce development?

Constraints:

1. Finite budget of DMR and its distribution with the broad portfolio,
2. Other opportunities for funding for instrumentation, acquisition as well as research and development, and user facilities for materials research,
3. No discussion of current or future individual projects nor will it determine how funds are to be distributed among individual ongoing efforts.

Materials 2022

1. Many telecons and meetings at NSF
2. Community Input: Webinar – 8 February 2012, transcript and recording are online. Email option: materials2022@nsf.gov
3. Preliminary report to MPSAC 5 April 2012
4. Report submitted June 2012
5. Report goes for approval by MPSAC – Fall 2012

Matt Tirrell

Roger Falcone

Materials 2022: Preliminary recommendations

- Increase co-funding for MRI proposals - acquisition and stewardship of equipment $100,000-$500,000.
- Support professional staffing to manage instrumentation and train students.
- Consider a network of centers – to provide a “characterization suite” of instrumentation to the external community or to fulfill a specific need/expertise (i.e. X-ray, microscopy, crystal growth).
- Continue to support acquisition and development of instrumentation at all scales (single-user, institutional, regional, and major facilities) including the development of the infrastructure for instrumentation networks (e.g. clouds), support for instrumentation access (travel costs, users fees), and student training and experience on shared instruments.

DMR Mission

1. **Discovery**
2. **Interdisciplinary**
3. **Innovation**
4. **Education and Public Outreach**
5. **Infrastructure**
6. **Stewardship**

QUESTIONS?

Stewardship

– how we can help you

– how you can help us

Stewardship

NSF CAREER-LIFE Balance Initiative

MPS: Mathematical Sciences, Physics, Chemistry, Astronomy, Materials Research

- Number of women earning MPS doctoral degrees

Year	Number	% of total MPS degrees
2000	1366	23%
2008	2024	28.5%

- In 2008, women occupied 18% of tenured and 29% of tenure track
- 43% of women and 25% of men were 10 years or less from doctorate

Career-Life Balance
MPS DCL-Community Update
NSF 12-015 November 2011

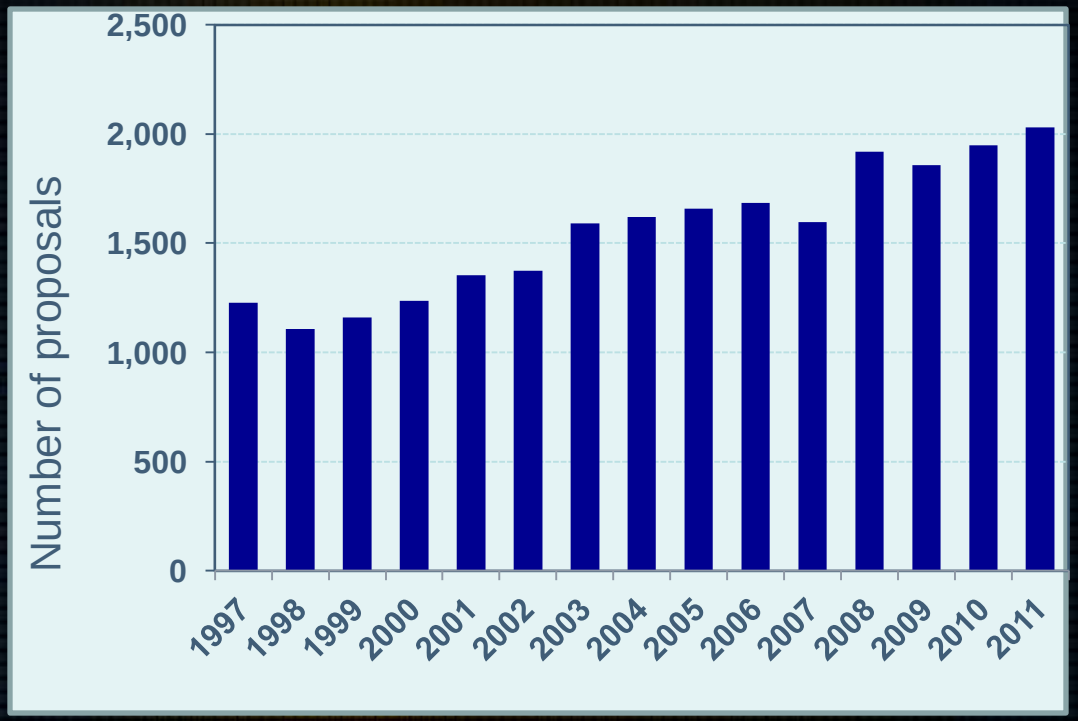
FLEXIBILITY!

- no-cost extensions or temporary suspensions of NSF awards due to family leave
- flexible start dates for NSF awards
- supplements for additional personnel to sustain research when principal investigators are on family leave
- flexible postdoctoral fellowships to accommodate dual-career placements

- options for remote panel participation
- local child care recommendations for panelists
- instructions for panelists describing family-friendly practices.

Stewardship

DMR proposal pressure – internal and external impact



How you can help

- Convey the message to your faculty that one strong proposal has a better chance of success than flooding the system with proposals.
- Think carefully about resubmitting declined proposals. Ask what have you done beyond trying to directly address the comments of a few reviewers. This approach rarely leads to success.
- Consult with the relevant program director.

1. Before you start read the GPG! Follow the instructions on proposal preparation.
2. Any questions make sure to contact the cognizant program officer at the Foundation
3. Work with your sponsored research office to have your proposal submitted prior to the deadline.

Return Without Review

√

The proposal:

1. is inappropriate for funding by the National Science Foundation;
2. is submitted with insufficient lead-time before the activity is scheduled to begin;
3. is a full proposal that was submitted by a proposer that has received a “not invited” response to the submission of a preliminary proposal;
4. is a duplicate of, or substantially similar to, a proposal already under consideration by NSF from the same submitter;
5. does not meet NSF proposal preparation requirements, such as page limitations, formatting instructions, and electronic submission, as specified in the Grant Proposal Guide or program solicitation;
6. is not responsive to the GPG or program announcement/solicitation;
7. does not meet an announced proposal deadline date;
8. was previously reviewed and declined and has not been substantially revised; and
9. duplicates another proposal that was already awarded.

Proposals that do not separately address both merit review criteria within the one-page Project Summary will be returned without review.

Stewardship

How you can help:
Acknowledging your support from the Foundation

Support from the NSF must be appropriately acknowledged in all presentations and publications as well as web sites.

Reporting work supported by multiple agencies or programs within NSF is accepted but the contribution from each funding agency must be acknowledged appropriately.

Centers, institutes and facilities need to display the program name, for example “MRSEC” , should appear on websites, publications, and presentations. The “brand name” must be featured prominently.

We need your support to ensure NSF DMR activities receive appropriate recognition

Stewardship

How you can help. Consider a “Rotation” as a Program Director or as an Executive at the National Science Foundation

- Manage the proposal review process.
- Interact with potential principal investigators.
- Recommend funding decisions.
- Manage post-award activities.
- Collaborate and interact with members of your specific scientific communities.
- Organize/inspire workshops, conferences, and forums.
- Help identify areas of potentially transformative research.
- Liaise with research or research education communities.
- Build new national and international collaborations.
- Play an important role in broadening participation of underrepresented groups in the science and engineering community and the implementation of family friendly policies.
- Create new cross-disciplinary and cross-agency partnerships. Influence new directions in the fields of science, engineering, and education.
- Support cutting-edge interdisciplinary research.
- Mentor future leaders in science and engineering.

- Executives influence the budgets and programs, all hiring in the Divisions, and represent the NSF and the US in all interests in your disciplinary area.

We know many potential candidates have ongoing NSF grants. NSF has mechanisms in place that allow active researchers and educators to continue functioning at their home institution while at NSF on temporary assignment serving the scientific community.

SEND A CV TO THE DIVISION DIRECTOR, see www.nsf.gov/about/career_opps/rotators/

CONDENSED MATTER PHYSICS,SOFT MATTER THEORY, BIOMATERIALS

Interdisciplinarity

INSPIRE: Integrated NSF Support Promoting Interdisciplinary Research and Education

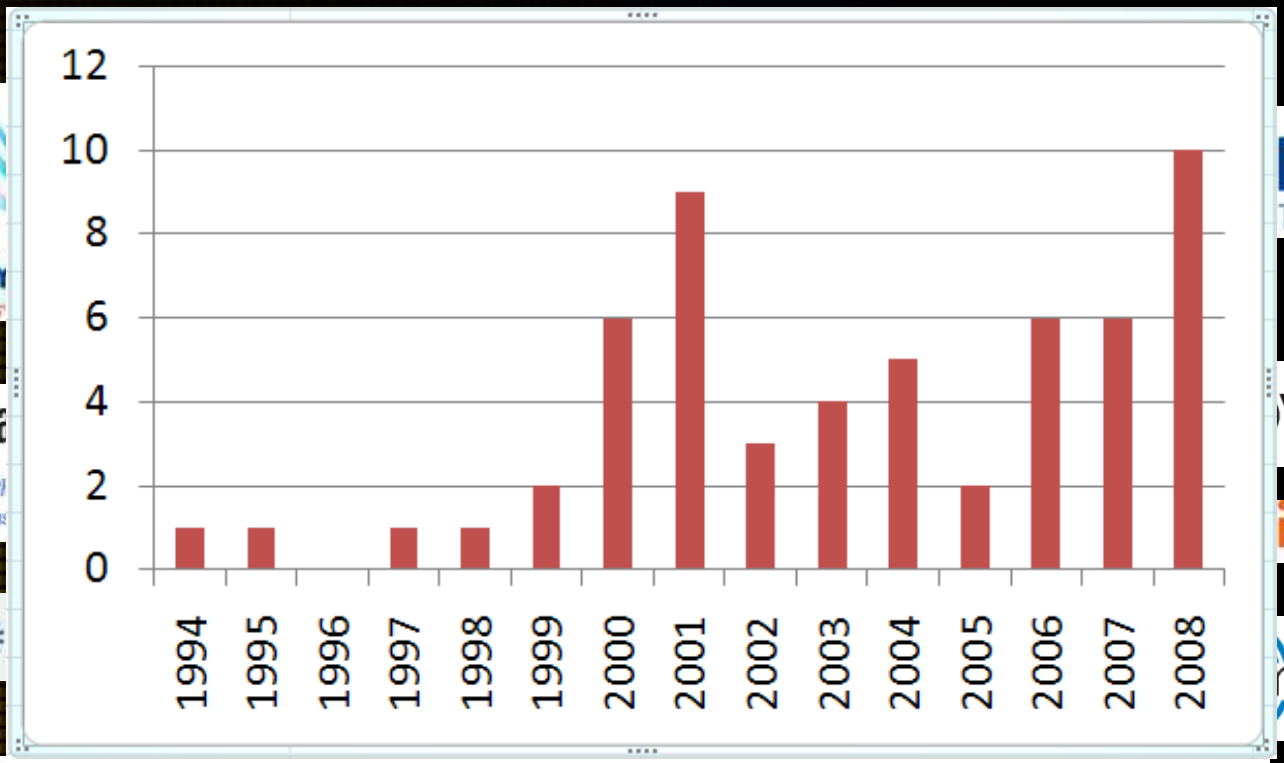
CREATIV: Creative Research Awards for Transformative Interdisciplinary Ventures

a pilot grant mechanism to support bold interdisciplinary projects in all NSF-supported areas of science, engineering, and education research**.**

NSF 12-011

- Only internal merit review is required
- Proposals must be interdisciplinary and potentially transformative
- Requests may be up to $1,000,000 and up to five years duration
- A CREATIV award must be substantially co-funded by at least two intellectually distinct NSF divisions or programs
- YOU MUST CONTACT THE PROGRAM OFFICER(s)
- Submission window: between December 1, 2011, and June15, 2012

MRSEC Startup Companies



60 companies in 13 states, employing more than 1000 people

Education -

Needs in MGI, Sustainability and Interdisciplinarity

Example of a MRSEC Education program:

The Renewable Energy MRSEC –Colorado School of Mines

- an undergraduate Renewable Energy minor
- a Renewable Energy elective course sequence for graduate students
- a Renewable Energy Research Experience for Undergraduates(REU) program.: includes research, seminars on energy topics, field trips to NREL, and interactions with renewable energy companies
- a K-12 Outreach Program: graduate students work directly with minority middle school mathematics and science teachers on classroom presentations and hands-on scientific experiments on Renewable Energy applications.
- a Mentoring Program for postdoctoral research associates

Partnerships for Research and Education in Materials (PREM)
-collaboration between a Minority Serving Institution and a MRSEC
Next competition 2014

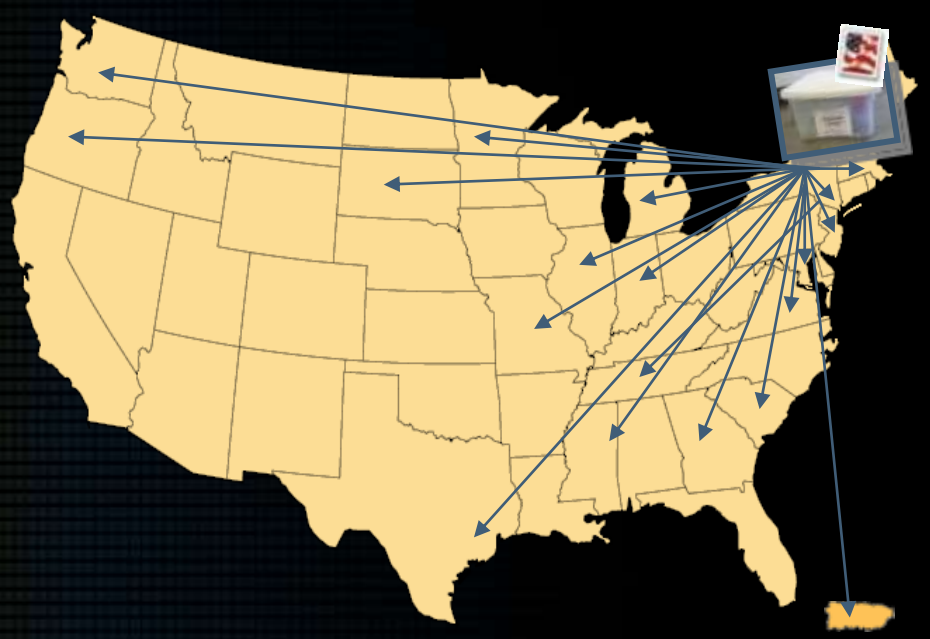
Education

Lending Library of Experiments Available to all K-12 Teachers

Teachers and scientists sharing resources for K-12 science education

- Cornell scientists and a large number of K-12 teachers developed over 37 educational resources and over 100 lesson plans for science education.
- CCMR is loaning these resources to teachers across the country free of charge
- over 1,400 students carried out hands-on experiments with the kits

Visit the Lending Library online at
http://www.ccmr.cornell.edu/education/LendingLibrary/



Arrows indicate schools that have borrowed kits in the past year

Supported by NSF DMR-0520404

Outreach

Episodes

Stronger

Search for the world's strongest stuff—from mollusks, Kevlar®, and carbon nanotubes to the beak of the toucan and spider silk.

Cleaner

Explore clean energy, like bio-based fuels and solar energy, and the alternative ways to generate, store, and distribute it for use in our cars, homes, and industry.

Smaller

Zoom in on nanocircuits and microrobots that may one day hold the key to saving lives and creating materials from the ground up, atom by atom.

Smarter

Learn about "smart" materials that can react and change. Follow materials scientists as they apply principles from the natural world to develop amazing new materials.

pbs.org/nova/education/makingstuff

DMR Materials World Network

Corresponding submissions to NSF and to national/regional funding agencies abroad

Parallel (most cases) or single joint review (UK, Germany)
DMR reviews proposals within programmatic areas

8-10 topical panels, include non-US panelists

NSF standard review criteria (intellectual merit and broader impacts) *and*
value added by international collaboration
balance of intellectual efforts in the US and abroad
participation of junior researchers in international research experiences

Coordination with foreign funding agencies for joint identification of awards

NSF funds US institutions; organizations abroad fund their researchers

NSF supports all costs associated with the research in the US side (not just mobility)

57 Participating Countries FY08-12

DMR International Materials Institutes
(total program $20M over 5 yrs)

University of California Santa Barbara
www.icmr.ucsb.edu

Texas A & M
www.iimec.tamu.edu

University of California Davis
www.i2cam.org

Lehigh University
www.lehigh.edu

Northwestern University
www.imisee.edu

Extends to ~40 countries and leverages ~$40 M of foreign funding.
These started in 2009.

NSF-wide International Programs

SAVI: Science Across Virtual Institutes

NSF 11-087

Provides research and education partnerships ("glue") among NSF funded research centers/institutes (both virtual and real) and their international counterparts.
Teams with active NSF awards are eligible to apply.
Joint workshops, study institutes, student exchanges, etc.
Proposals come into the regular programs according to their target dates.
$50K to $400K per year for up to 5 years.

PEER: Partnerships for Enhanced Engagement in Research

NSF 11-134

For Collaborations with DEVELOPING COUNTRIES
capitalizes on competitively-awarded investments to support and build scientific and technical capacity in the developing world.

NSF pays for the US, USAID pays for the developing country partners
US PI must have an NSF grant already
Applications handled through NAS: http://sites.nationalacademies.org/peer

Activities in 2012

1. Emerging areas in Ceramics, 19 – 21 March 2012
2. Emerging areas in Metals
3. Biomaterials, June 19 -21, 2012
4. Diversity in materials science, Spring 2013
5. Opportunities in Theoretical and Computational Soft Matter – fall 2012
6. Opportunities Enabled by the Materials Innovation Infrastructure (Instrument Development)
7. CAREER workshop

Biomaterials Workshop





- June 19-20, 2012 at NSF headquarters
- Steering committee:
  - David Tirrell (chair), Caltech
  - Kristi Anseth, CU Boulder
  - Dennis Discher, UPenn
  - Lara Estroff, Cornell
  - Paula Hammond, MIT
- 60 invited participants
- Report expected by August 2012
- DMR will use workshop outcomes and report recommendations to identify critical areas of focus for the BMAT program

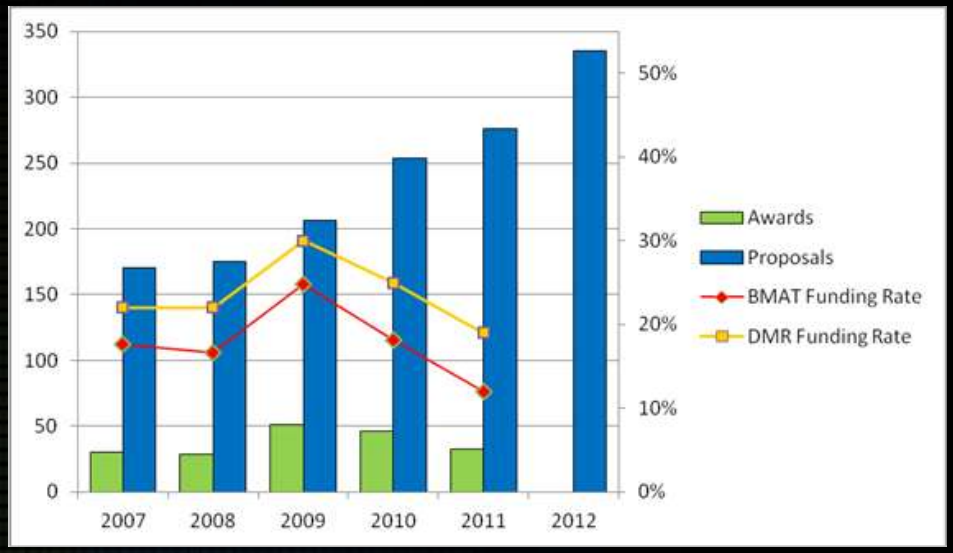
NSF Contacts:

- Ashley White, AAAS S&T Policy Fellow
- David Brant, Program Director

Biomaterials Workshop

Purpose: To help address growing proposal pressure and decreasing funding rate in the BMAT program

Statement of Task: To delineate the components of the biomaterials field and highlight critical areas and outstanding challenges that are ripe for investments in the next 5+ years



Number of BMAT proposals by year and funding rates.

Expected Outcomes:

- Provide a description of the biomaterials field that will help the community identify opportunities in this area
- Guide academia, industry, societies, public and private funders in directing resources towards most critical areas
- Promote discussions about how meeting these responsibilities will be partitioned among the various stakeholders
- Establish robust and durable lines of communication among the stakeholders that support work in biomaterials