Presentation to the NRC Committee to Assess the Current Status and Future Direction of High Magnetic Field Science in the United States

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Guebre X. Tessema,
Program Director of National Facilities
Division of Materials Research

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CMMP 2010:

"For the first time in history, the complexity of CMMP is such that new advances in the field depend on strong support for large facilities, medium scales facilities, interdisciplinary research centers, and individual investigators who actually carry out the research"

NSF Strategic Goal

- The NSF is the primary Federal agency supporting research at the frontiers of knowledge, across all fields of science and engineering (S&E) and all levels of S&E education.

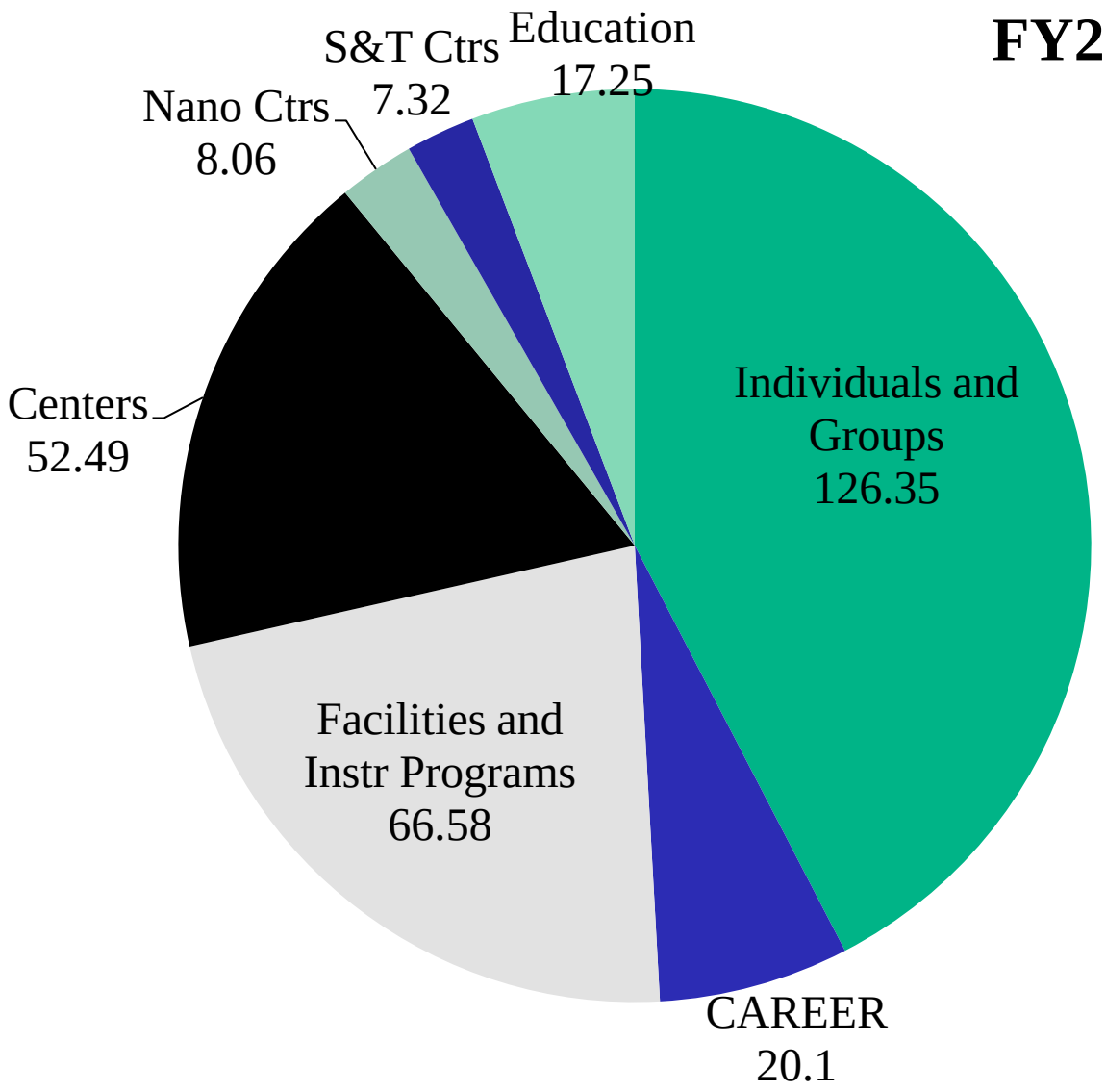
- The NSF strategic goal: to transform the frontiers by providing state-of-the-art infrastructure, by educating and preparing a diverse, world-class STEM workforce, and by partnering with others nationally and internationally. NSF encourages high-risk/high-reward activities and pursues potentially transformative ideas.

The Division Of Materials Research

- Provides the highest support for Materials Research at US universities and colleges.
- Has a highly diversified portfolio.
- Has a tradition to partnering with others.
- Seeks community input in managing its portfolio.

DMR BUDGET

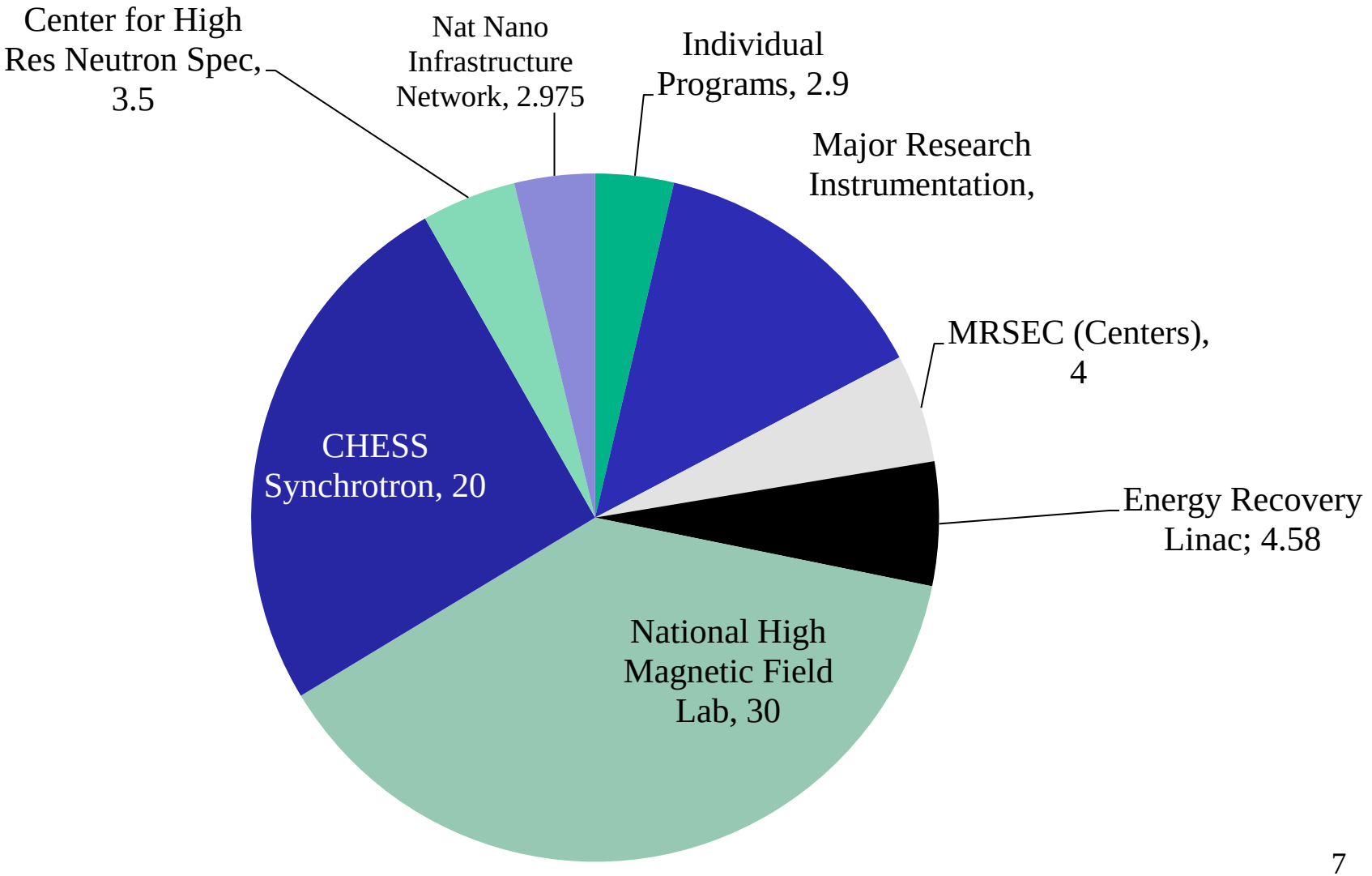
FY2010 $302M



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 Instrumentation and National Facilities Portfolio
Total $78.66 million (26% of total)



Historical Background: 60 Years!

- 1960, Francis Bitter Lab created at MIT funded by the Air Force.
- 1971, the NSF took over support of Francis Bitter National Laboratory (FBNML)
- 1979, NRC Review of High Magnetic Field Research and Facilities: *role of a major high field facility in fostering high field research and extensive analysis the applications of high magnetic fields.*
- 1985, Seitz-Eastman Report: NRC study of all major facilities needed for materials research.
- 1987, NSF commissioned the Seitz Richardson Panel

NHMFL Solicitation: Main Functions & Features

(Solicitation NSF 89-115)

- A user facility open to all qualified scientists and engineers
- Develop future magnet technologies and new materials for high field magnets.
- Create a stimulating in house multidisciplinary research environment in physics, chemistry, materials science, engineering, and biology, requiring high magnetic fields and must lead to improvement of the facilities.
- Must have sufficiently large and dedicated scientific, engineering and technical staff to run the user program as well as the in house research.
- Must be integrated into the academic programs of the educational institution.
- Must provide educational and training opportunities for undergraduate, graduate, and postdocs from within and outside the institution.
- “Must be heavily cost-shared” and the proposing organization provide the required space for the facility.
- **DMR will be responsible for overseeing the management and progress of NHMFL.**

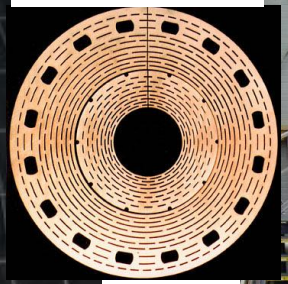
NHMFL Competitive Review

- 1990: 3 Proposals received and reviewed
- 1991: NSB approved award to FSU to create NHMFL
- 1991-95: Transition
  - continued support for FBNML during NHMFL construction
  - NHMFL & FBNML collaborated on 45T hybrid

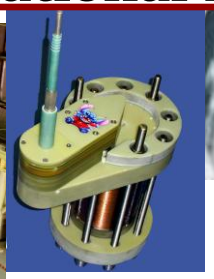
National High Magnetic Field Laboratory

Florida State University

45T Hybrid
DC Magnet



Los Alamos National Laboratory

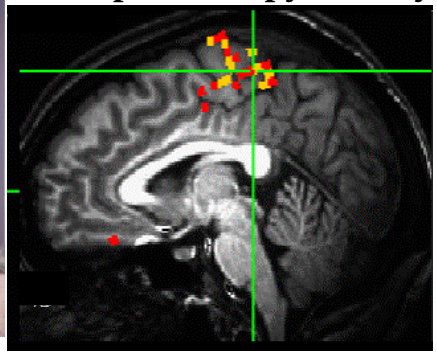


University of Florida

Advanced Magnetic
Resonance Imaging
and Spectroscopy Facility

97T Pulse Magnet
15mm bore

11.4T MRI Magnet
400mm warm bore



High B/T Facility
17T, 6weeks at 1mK

900MHz, 105mm bore
NMR/MRI Magnet

Breadth of Science

Mobile Electrons, Electron Pairs and Spin Excitations –Fermi Surface Studies Magnetic Bose-Einstein Condensation

Electron Moments – Magnetism, Catalysts, Qubits – *electron g-tensor measurements*

Lattice Interactions – Magnetostriction, Resonant Ultrasound – *lattice elastic tensor*

Nuclear Moments – Element-specific local probe, *now with ultra-high sensitivity*

Nanoscale phase separation of electrons in correlated electron systems

Clusters – Mass Spectroscopy of Complex Mixtures, *perhaps useful for magnetic nanoparticles*

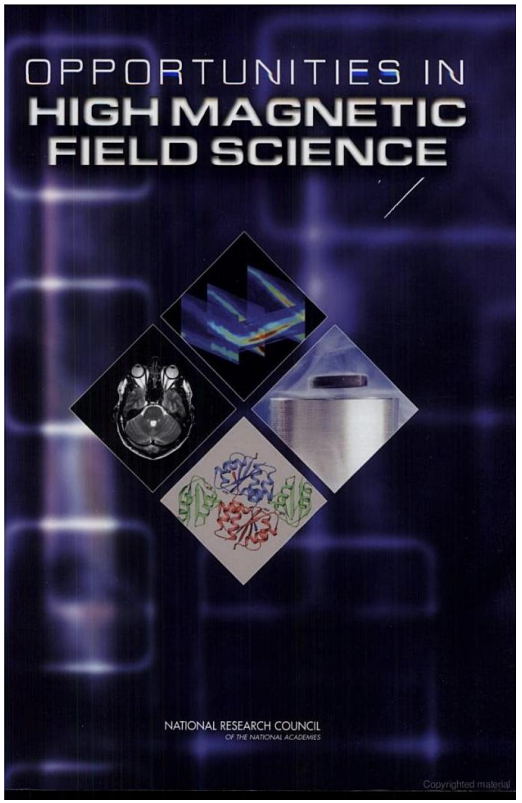
Magnetic Resonance Imaging - Magnetic Quantum Dots for Magnetic Resonance Imaging

NHMFL Renewals

- Renewed NSF support in 1996 and 2001 (2x5 years)
- In 2003-2005, NSF sought community input to address
  - NRC Report on Opportunities in High Magnetic Field Science (COHMAG)
  - NSF Blue Ribbon (Richardson) Panel on recompetition:
- 2008: 5-year renewal award expires on 12/31/2012.

COHMAG Report 2005

- The U.S. should maintain a national laboratory that provides access to magnets operating at the highest possible fields
- New instrument and technology development
  - For studying the neutron and X-ray scattering properties of materials in high magnetic fields
  - Consortium to foster the development of magnet technology
  - Support the development of technology and instrumentation for magnetic resonance and magnetic resonance imaging



Richardson Panel: Recommendation

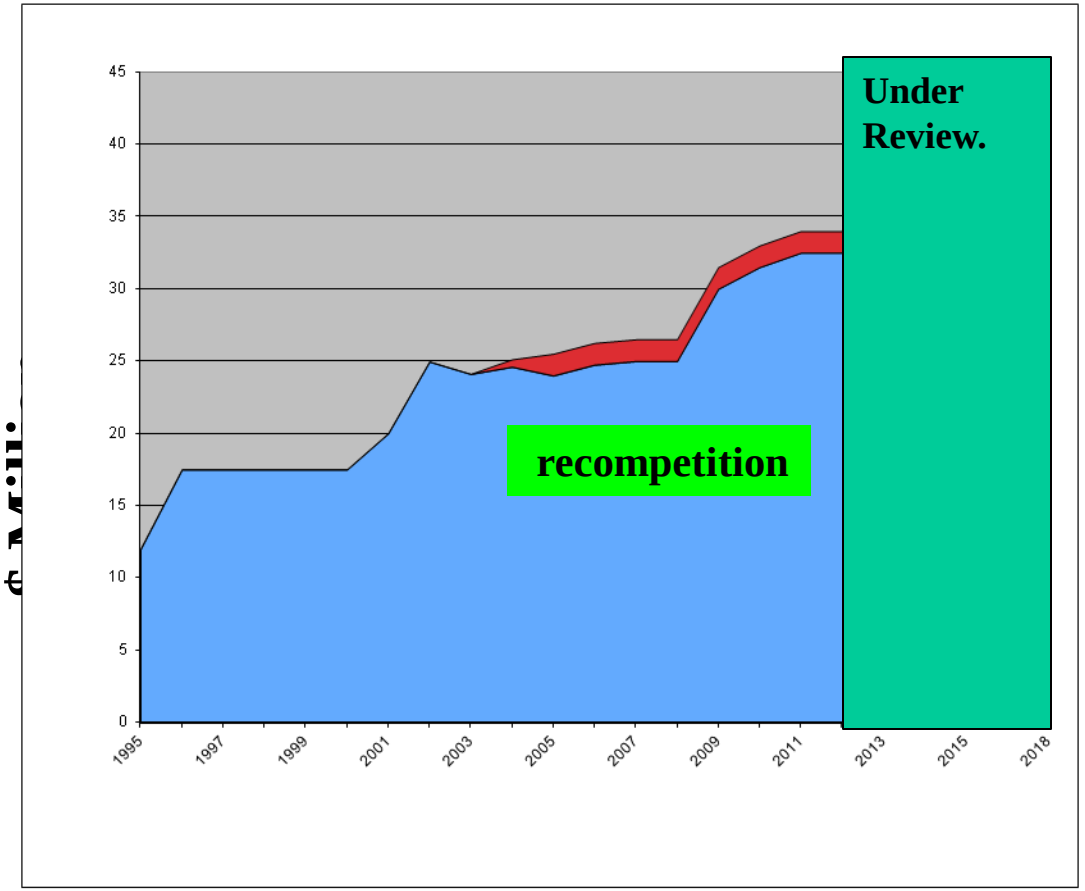
Strongly recommends “renewal review of the NHMFL award, rather than re-competition.”

1. Science remains fertile
2. Infrastructure is magnificent
3. Outstanding performance by present management
4. It is in the best interests of science and engineering

NSF conducted a renewal review resulting in a 5-year award (2008-2012)

NHMFL Budget History

- Renewal: (2008-2012)
  - $156.7 M/5-years
  - $15.7 M cost sharing
- Cumulative budget
  - $482 M NSF
  - $328 M Total State
  - $120 M other competitive grants and contracts (NSF, NIH, DOE, AFSOR….)
    - 36 T SCH (1ppm) $12M
    - 21 T ICR $17 M
    - 32 T HTS $2M
- Lifetime estimate: 10 more years after recompetition.



The Next Decade

- Planning for the US high magnetic field portfolio in the next decade beyond 2018;
- NSB Policy: all expiring awards including facilities must be recompeted;
- Materials 2022: DMR prioritizing its tools portfolio for materials research.

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.

Recompetition of NHMFL Opportunities

- New and transformative science for the next decade;
- Revolutionary, transformative, energy efficient and overall cost effective magnet technologies;
- Novel education and training programs;
- Leadership in broadening participation by women, minorities and people with disabilities;
- Enhanced access and better quality user service for a broad spectrum of science and technology; and
- New approaches to effective organizational and management models;

NSB on NSF: Plan to Recompete the NHMFL

NSB-10-58 August 25-26, 2010, NSB-10-56 , October 4, 2010

- NSF‘s assessment was that there is value in recompetition, but there are complications and risks.
- A National Research Council (NRC) study is needed to advise NSF on future of high magnetic field science in next decade.
- Careful consideration must be given to recompetition actions that consider facility lifetime, value, ownership of facilities, partnerships, and timing.
- Ensure that scientific progress would not be significantly disrupted by a recompetition.

Timeline for NHMFL Recompetition

• **Fall 2011**	**National Academy Study Started**
• **2012**	**Review Renewal of NHMFL Operations (2013-208)**
• **2013**	**Report of NRC study**
• **2013-2014**	**Solicitation and Public Information**
• **2014-2015**	**Start Competition**
• **2015-2016**	**Action Item to NSB**
• **2016-2017**	**New Award**
• **Dec 2018**	**End of NHMFL cooperative agreement.**

Questions?