Nuclear Science Advisory Committee

National Science Foundation
Directorate for Mathematical and Physical Sciences

F. Fleming Crim
Assistant Director for
Mathematical and Physical Sciences

October 15, 2015
Nuclear Science Advisory Committee

National Science Foundation
Directorate for Mathematical and Physical Sciences

Budget

Mid-scale Instrumentation

Long Range Plan
Nuclear Science Advisory Committee

National Science Foundation
Directorate for Mathematical and Physical Sciences

Budget

Mid-scale Instrumentation Comments on Long Range Plan

Mathematical and Physical Sciences
NSF Supports Academic Basic Research

<table>
<thead>
<tr>
<th>Field</th>
<th>Fraction of Federal Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Science and Engineering Fields</td>
<td>25%</td>
</tr>
<tr>
<td>Engineering</td>
<td>41%</td>
</tr>
<tr>
<td>Physical Sciences</td>
<td>44%</td>
</tr>
<tr>
<td>Environmental Sciences</td>
<td>61%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>62%</td>
</tr>
<tr>
<td>Environmental Sciences</td>
<td>65%</td>
</tr>
<tr>
<td>Biology (excluding NIH)</td>
<td>66%</td>
</tr>
<tr>
<td>Computer Science</td>
<td>89%</td>
</tr>
</tbody>
</table>

Source: NSF/ Center for National Science and Engineering Statistics, FY 2013
The National Science Foundation

- National Science Board (NSB)
  - Office of the Director (OD)
    - FY 2015
      - Mathematical and Physical Sciences (MPS)
        - Geosciences (GEO)
          - $1304 M
        - Mathematical and Physical Sciences (MPS)
          - $1337 M
        - Engineering (ENG)
          - $892 M
        - Education & Human Resources (EHR)
          - $866 M
        - Computer and Information Science and Engineering (CISE)
          - $922 M
        - Social, Behavioral, and Economic Sciences (SBE)
          - $272 M

Mathematical and Physical Sciences
<table>
<thead>
<tr>
<th></th>
<th>FY 2015</th>
<th>FY 2016 (request)</th>
<th>Increase</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSF</td>
<td>$ 7344 M</td>
<td>$ 7724 M</td>
<td>$ 380 M</td>
<td>5.2%</td>
</tr>
<tr>
<td>R&amp;RA</td>
<td>$ 5934 M</td>
<td>$ 6186 M</td>
<td>$ 252 M</td>
<td>4.2%</td>
</tr>
</tbody>
</table>
## FY 2016 Budget Request

### NSF Budget by Appropriation

($ in millions)

<table>
<thead>
<tr>
<th>Category</th>
<th>FY 2015</th>
<th>FY 2016 Request</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research &amp; Related Activities</td>
<td>$ 5934</td>
<td>$ 6186</td>
<td>4%</td>
</tr>
<tr>
<td>Education &amp; Human Resources</td>
<td>866</td>
<td>963</td>
<td>11%</td>
</tr>
<tr>
<td>Major Research Equipment &amp; Facilities Construction</td>
<td>201</td>
<td>200</td>
<td>-0.2%</td>
</tr>
<tr>
<td>Agency Operations &amp; Award Management</td>
<td>325</td>
<td>355</td>
<td>9%</td>
</tr>
<tr>
<td>National Science Board</td>
<td>4</td>
<td>4</td>
<td>--</td>
</tr>
<tr>
<td>Office of Inspector General</td>
<td>14</td>
<td>15</td>
<td>5%</td>
</tr>
<tr>
<td><strong>Total NSF</strong></td>
<td><strong>$ 7344</strong></td>
<td><strong>$ 7724</strong></td>
<td><strong>5%</strong></td>
</tr>
</tbody>
</table>
MPS Budgets

FY 2013 $1250M + 4.0% FY 2014 $1300M + 2.8% FY 2015 $1337M + 2.2% FY 2016 $1366M (request)
Selected MPS Major Investments

<table>
<thead>
<tr>
<th>Project</th>
<th>FY 2015</th>
<th>FY 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INFEWS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DMREF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BioMaPS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UtB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIF21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Midscale*</td>
<td></td>
<td>$86 M</td>
</tr>
<tr>
<td>OP</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*$MPS only
Selected MPS Major Investments

Mid-Scale Research Infrastructure

Amount ($ Millions)

<table>
<thead>
<tr>
<th>Program</th>
<th>FY 2015</th>
<th>FY 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEES</td>
<td></td>
<td></td>
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<tr>
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*MPS only
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Mid-scale Instrumentation

Long Range Plan
Examples of Community Calls

NSB, 2002
NSAS, 2006
NAS, 2010
NSB, 2002
NAS, 2006
NAS, 2010

Building for Discovery
Strategic Plan for U.S. Particle Physics in the Global Context
HEPAP, 2014
NSAC, 2014

Mathematical and Physical Sciences
Mid-Scale Infrastructure

Projects larger than the Major Research Instrumentation (MRI) limit of $4M and smaller than the MREFC threshold (10% of a Directorate’s budget)

We have a gap

$4M

$130M

Photo Credit: Nathan D. Holmes

Mathematical and Physical Sciences
Mid-Scale Infrastructure

Projects larger than the Major Research Instrumentation (MRI) limit of $4M and smaller than the MREFC threshold (10% of a Directorate’s budget)

AST (FY 2014)
PHY (FY 2014)
DMR (FY 2015)

$4M
$130M

AST received 38 pre-proposals totaling $398 M in FY 2014

Photo Credit: Nathan D. Holmes
PHY Mid-Scale Infrastructure
Approach and Examples

Selection: Merit review, great opportunity, community priorities
Cost: Up to $15M over several years (see NSF 14-116)
Currently: Five projects receiving about $2M/yr

Phase 1 LHC Upgrades

Liquid Ar Calorimeter Trigger
CMS
L1 Trigger
(muon, calorimeter)
HCAL (muon, calorimeter)
FPIX

ATLAS
Upstream tracker
LHCb

Phy Mid-Scale Infrastructure
Approach and Examples
Selection: Merit review, great opportunity, community priorities
Cost: Up to $15M over several years (see NSF 14-116)
Currently: Five projects receiving about $2M/yr

Phase 1 LHC Upgrades

Liquid Ar Calorimeter Trigger
CMS
L1 Trigger
(muon, calorimeter)
HCAL (muon, calorimeter)
FPIX

ATLAS
Upstream tracker
LHCb
PHY Mid-Scale Infrastructure

G2 Dark Matter

Large Underground Xenon – Zeplin (LZ)
www.lbnl.gov

Super Cryogenic Dark Matter Search (Super CDMS)
http://cdms.berkeley.edu/scdmsnolab.html
PHY Mid-Scale Infrastructure
Neutron Electric Dipole Moment (nEDM)

- Prepare polarized 3He
- Isotopically purify 4He each measurement cycle

- Generate electric field
- Store 3He, neutrons
- Monitor 3He, neutron precession frequencies

- Generate uniform B-field

Brad Filippone (Caltech) and Doug Beck (UIUC)
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Long Range Plan
Long Range Plan

The 2015 LONG RANGE PLAN for NUCLEAR SCIENCE

REACHING FOR THE HORIZON

The Site of the Wright Brothers' First Airplane Flight

Mathematical and Physical Sciences
Long Range Plan

Recommendation I: Capitalize on investments of 2007 plan
CEBAF upgrade, FRIB, fundamental symmetries, neutrinos, RHIC
MPS supports through IIA, MRI, midscale

Recommendation II: Ton-scale neutrinoless $\beta\beta$ decay
NSAC subcommittee report at this meeting

Recommendation III: Polarized electron-ion collider after FRIB
JLab and RHIC planning

Recommendation IV: Small-scale and mid-scale projects
MPS priority – budget constraints
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