Perspective from the National Science Foundation

Community Summer Study 2013
July 29, 2013

Jean Cottam-Allen, Keith Dienes
Saul Gonzalez, Randy Ruchti
Jim Whitmore
Program Directors, Physics Division, NSF
Outline

• NSF mission
• Division of Physics
• Particle physics at the NSF
• Budgets and outlook
• Comments on Snowmass 2013
NSF Perspective

• NSF Mission: “to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes”
  – Empowering university-based investigators
  – Educating and training an exceptional and diverse scientific workforce
  – Adding value through partnerships and broadening participation

• Program Coordination and Execution
  – Programs are coordinated with other U.S. and non-U.S. agencies and organizations
  – We solicit advice on scientific issues and strategic direction from advisory committees such as HEPAP, AAAC, NSAC, National Academy of Sciences, etc.

• The way we work: We fund grant proposals, evaluating them through intrinsic and comparative peer review according to the criteria:
  – What is the Intellectual Merit?
  – What are the Broader Impacts?

• We aim to fund the most compelling scientific research, education, and outreach activities – without preconceived preferences on direction
  – Programs evolve organically as scientific fields evolve and as new scientific opportunities emerge
  – “Proposal pressure” and cross-pollination with other NSF programs are also key elements

July 29, 2013 – Snowmass

Saul Gonzalez
Physics Division: Symmetries

- Test of fundamental theories
  - CPT symmetry
  - Lorentz invariance
  - New physics
- Develop new AMO methodology
  - Clocks, cold atoms and molecules
  - Lasers and optics
  - Ultrasensitive detection

South pole Lorentz invariance test

- ATRAP
  - Trapped Antihydrogen and antiproton expt at CERN

Romalis (Princeton)

Searching for new physics with the electron EDM

Gabrielse (Harvard)
Physics Division: Living Systems

Physics of Living Systems addresses Fundamental Question: Life

Apply Physics approaches to biological problems

Analysis of optical signals from mammalian retina leads to discovery of new light processing unit – Litke et al., UCSC

Diffusion MRI reveals layers within brain as opposed to spaghetti-like structure – Van Weeden, Stanley, MGH, BU
LIGO Scientific Collaboration

- 942 researchers world-wide in 17 countries.
- 528 investigators in the US.
- All GW Observatories: 1488 researchers.

Long Range Experiments
- Lunar laser ranging

Short Range Experiments
(10’s microns)
- Deviations from $1/r^2$ law
- Weak Equivalence Principle
- Lorentz symmetry violations

LIGO

Torsion Balance

Lunar Laser Ranging (APOLLO)
Particle Physics at the NSF

Programs: Elementary Particle Physics (EPP); Particle Astrophysics (PA); Particle Theory, Cosmology (Theory)

• Scientific Frontiers:
  – Energy Frontier – EPP, Theory
  – Intensity Frontier – EPP, PA, Theory
  – Cosmic Frontier – PA, Theory

• Applications and Broader Impacts:
  – Detector R&D
  – Computing / Data
  – Accelerator Science, R&D
  – Education and Outreach
Features of HEP Program at the NSF

<table>
<thead>
<tr>
<th>Supported Personnel</th>
<th>Theory</th>
<th>EPP</th>
<th>PA</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awards</td>
<td>104</td>
<td>60</td>
<td>134</td>
<td>298</td>
</tr>
<tr>
<td>Senior investigators</td>
<td>186</td>
<td>181</td>
<td>63</td>
<td>430</td>
</tr>
<tr>
<td>Postdocs</td>
<td>50</td>
<td>104</td>
<td>64</td>
<td>218</td>
</tr>
<tr>
<td>Graduate Students</td>
<td>50</td>
<td>176</td>
<td>127</td>
<td>353</td>
</tr>
</tbody>
</table>

- Approximate numbers for FY 2012
- Distributed over many types of universities, including research, undergraduate, minority-serving, etc.

- People chase the best science, wherever it might be (US, Europe, Japan, China, Canada, Antarctic…)
- While majority of work is typically carried out at the home institution, many facilities are outside the U.S.

<table>
<thead>
<tr>
<th>US-based physicists working on US/non-US facilities</th>
<th>Domestic</th>
<th>Abroad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Elem. Particle Physics</td>
<td>45%</td>
<td>55%</td>
</tr>
<tr>
<td>Particle Astrophysics</td>
<td>52%</td>
<td>48%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>59%</td>
<td>41%</td>
</tr>
</tbody>
</table>
New in FY 2014: Accelerator Science

- The acceleration and control of charged particle beams are essential tools for discovery science within the Physics Division: from high to low energy beams, high intensity sources for secondary or tertiary beams (e.g., neutrinos), nuclear physics, nuclear astrophysics
- We are starting an accelerator science program with the goal of enabling fundamental discoveries and train students and postdocs across disciplinary boundaries
  - Program Description PD 13-7243
  - Proposal target date: November 29, 2013
- Broader impacts are significant: industrial applications, medical applications, homeland security, light sources
- Program will likely focus on transformational developments that are likely to come from curiosity-driven research with strong interdisciplinary links
- Program will evolve with the community as new challenges are identified
Budgets
## NSF MPS Budget

### National Science Foundation
### Funding Summary Table

(Dollars in Millions)

<table>
<thead>
<tr>
<th>NSF by Account</th>
<th>FY 2012 Actual</th>
<th>FY 2012 Δ</th>
<th>FY 2013 Enacted</th>
<th>FY 2013 Δ</th>
<th>FY 2014 Request</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO</td>
<td>$712.28</td>
<td>-4.7%</td>
<td>$678.93</td>
<td>12.0%</td>
<td>$760.58</td>
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<tr>
<td>CISE</td>
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<td>-8.4%</td>
<td>858.53</td>
<td>10.7%</td>
<td>950.25</td>
</tr>
<tr>
<td>ENG</td>
<td>824.55</td>
<td>-1.3%</td>
<td>813.54</td>
<td>12.0%</td>
<td>911.10</td>
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<tr>
<td>GEO</td>
<td>1,321.37</td>
<td>-4.2%</td>
<td>1,265.84</td>
<td>10.1%</td>
<td>1,393.86</td>
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<tr>
<td><strong>MPS</strong></td>
<td><strong>1,308.70</strong></td>
<td><strong>-4.5%</strong></td>
<td><strong>1,249.50</strong></td>
<td><strong>10.9%</strong></td>
<td><strong>1,386.12</strong></td>
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<tr>
<td>SBE</td>
<td>254.19</td>
<td>-4.6%</td>
<td>242.51</td>
<td>12.3%</td>
<td>272.35</td>
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<tr>
<td>IIA</td>
<td>398.60</td>
<td>8.7%</td>
<td>433.47</td>
<td>23.8%</td>
<td>536.62</td>
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<tr>
<td>US ARCTIC RESEARCH COMMISSION</td>
<td>1.45</td>
<td>-4.1%</td>
<td>1.39</td>
<td>0.4%</td>
<td>1.40</td>
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<tr>
<td>Research &amp; Related Activities</td>
<td>$5,758.30</td>
<td>-3.7%</td>
<td>$5,543.71</td>
<td>12.1%</td>
<td>$6,212.27</td>
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<tr>
<td>Education &amp; Human Resources</td>
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<td>0.3%</td>
<td>$833.31</td>
<td>5.6%</td>
<td>$880.29</td>
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<tr>
<td>Major Research Equipment &amp; Facilities Construction</td>
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<td>$196.17</td>
<td>7.1%</td>
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<td>Agency Operations &amp; Award Management</td>
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<td>$304.29</td>
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<td>National Science Board</td>
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<td>-5.7%</td>
<td>$4.12</td>
<td>8.5%</td>
<td>$4.47</td>
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<tr>
<td>Office of Inspector General</td>
<td>$14.82</td>
<td>-11.0%</td>
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<td>8.6%</td>
<td>$14.32</td>
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<td><strong>Total, NSF</strong></td>
<td><strong>$7,105.41</strong></td>
<td><strong>-3.1%</strong></td>
<td><strong>$6,884.10</strong></td>
<td><strong>10.8%</strong></td>
<td><strong>$7,625.76</strong></td>
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</table>

Totals may not add due to rounding.

In FY 2013, a realignment of offices previously under the Office of the Director was implemented: the Office of Cyberinfrastructure (OCI) is now the Advanced Cyberinfrastructure (ACI) division in the Directorate for Computer and Information Science and Engineering (CISE); the Office of Polar Programs (OPP) is now the Division of Polar Programs (PLR) in the Directorate for Geosciences (GEO); and the Office of International Science and Engineering (OISE) has been merged with Integrative Activities (IA) to form International and Integrative Activities (IIA).
## MPS PHY Budget

### Mathematical and Physical Sciences (MPS) Funding

(Dollars in Millions)

<table>
<thead>
<tr>
<th>Division</th>
<th>FY 2012 Actual</th>
<th>FY 2013 Enacted</th>
<th>FY 2014 Request</th>
</tr>
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<tbody>
<tr>
<td>Division of Astronomical Sciences (AST)</td>
<td>$234.72</td>
<td>$232.52</td>
<td>$243.64</td>
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<tr>
<td>Division of Chemistry (CHE)</td>
<td>234.03</td>
<td>228.97</td>
<td>253.65</td>
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<tr>
<td>Division of Materials Research (DMR)</td>
<td>294.40</td>
<td>290.74</td>
<td>314.63</td>
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<td>Division of Mathematical Sciences (DMS)</td>
<td>237.72</td>
<td>219.19</td>
<td>244.54</td>
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<tr>
<td><strong>Division of Physics (PHY)</strong></td>
<td><strong>277.44</strong></td>
<td><strong>250.72</strong></td>
<td><strong>289.02</strong></td>
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<tr>
<td>Office of Multidisciplinary Activities (OMA)</td>
<td>30.37</td>
<td>27.36</td>
<td>40.64</td>
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<tr>
<td><strong>Total, MPS</strong></td>
<td><strong>$1,308.70</strong></td>
<td><strong>$1,249.50</strong></td>
<td><strong>$1,386.12</strong></td>
</tr>
</tbody>
</table>

Totals may not add due to rounding.

FY 2013 Reduction of -9.6% has serious impacts
FY 2013 Impacts

Instructed to protect ongoing commitments, including facilities

Biggest impact on research grants: approximately -12%

FY 2012 (by activity)

- Other Research: 42%
- Physics Frontier Centers: 7%
- Particle Physics Research: 24%
- Facility Operations: 27%

FY 2013 (by activity)

- Other Research: 39%
- Physics Frontier Centers: 9%
- Particle Physics Research: 23%
- Facility Operations: 29%

$277M

$251M
Impact in FY 2013:
Fewer awards, less faculty, postdocs, students supported
## Particle Physics Funding - Details

<table>
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<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
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</tr>
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<tr>
<td>EPP Research</td>
<td>20.5</td>
<td>18.8</td>
<td>14.0</td>
<td>25.8</td>
<td>25.0</td>
<td>24.7</td>
<td>21.7</td>
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<td>LHC Ops</td>
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<td>18.0</td>
<td>18.0</td>
<td>18.0</td>
<td>18.0</td>
<td>18.0</td>
<td>18.0</td>
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<td>CESR</td>
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<td>8.5</td>
<td>1.3</td>
<td></td>
<td></td>
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<td>Accel/Instrumentation</td>
<td>4.0</td>
<td>2.2</td>
<td>3.0</td>
<td>4.1</td>
<td>11.9</td>
<td>4.5</td>
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<tr>
<td>Particle Astrophysics</td>
<td>15.8</td>
<td>15.9</td>
<td>15.3</td>
<td>17.9</td>
<td>9.7</td>
<td>11.5</td>
<td>10.4</td>
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<td>IceCube Ops</td>
<td>1.5</td>
<td>2.2</td>
<td>2.2</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
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<tr>
<td>DUSEL Planning</td>
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<td>22.0</td>
<td>28.9</td>
<td>10.2</td>
<td></td>
<td></td>
<td>3.2</td>
</tr>
<tr>
<td>Underground R&amp;D</td>
<td>5.0</td>
<td>4.0</td>
<td>5.6</td>
<td>4.6</td>
<td>6.0</td>
<td>11.0</td>
<td>3.4</td>
</tr>
<tr>
<td>Underground Physics</td>
<td></td>
<td></td>
<td>8.4</td>
<td>6.3</td>
<td>5.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>THY (EPP/Astro/Cosmo)</td>
<td>11.7</td>
<td>12.0</td>
<td>6.8</td>
<td>13.2</td>
<td>14.1</td>
<td>13.6</td>
<td>12.1</td>
</tr>
<tr>
<td>Physics Frontier Centers</td>
<td>6.3</td>
<td>5.9</td>
<td>5.9</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
</tr>
<tr>
<td>TOTAL Particle Physics</td>
<td>98.4</td>
<td>109.5</td>
<td>43.0</td>
<td>119.4</td>
<td>104.9</td>
<td>106.4</td>
<td>88.4</td>
</tr>
<tr>
<td>TOTAL Physics Division</td>
<td>285.0</td>
<td>275.5</td>
<td>102.1</td>
<td>307.8</td>
<td>280.3</td>
<td>277.4</td>
<td>250.7</td>
</tr>
<tr>
<td>% of Physics Division</td>
<td>34.5%</td>
<td>39.7%</td>
<td>42.1%</td>
<td>38.8%</td>
<td>37.4%</td>
<td>38.4%</td>
<td>35.2%</td>
</tr>
<tr>
<td>Allied Funding</td>
<td>7.2</td>
<td>4.9</td>
<td>0.5</td>
<td>12.7</td>
<td>12.3</td>
<td>24.7</td>
<td>20.8</td>
</tr>
<tr>
<td>Effective Total</td>
<td>105.5</td>
<td>114.4</td>
<td>43.5</td>
<td>132.1</td>
<td>117.2</td>
<td>131.1</td>
<td>109.2</td>
</tr>
</tbody>
</table>
There is Hope

While the budget climate is not favorable at the moment, the science questions are more compelling than ever. We are therefore:

• Coordinating with DOE on Generation-II DM experiments
• Planning LHC Phase I Upgrades
• Working with DOE and CERN on the next phase of the DOE-NSF-CERN agreement
• Starting an Accelerator Science Program
• Continuing to seek new opportunities and partnerships for funding within and outside the NSF
Comments on Snowmass 2013
NSF view of Snowmass 2013

Captured in two “Dear Colleague” letters by DOE (Siegrist) and NSF (Crim)

Key elements:

• “The DPF-led Snowmass process has been established to identify compelling science opportunities over an approximately 20 year time frame.” → Science

• “Make statements about the sense of the community regarding the importance and impact of these future concepts.” Evaluate “the extent to which each proposed project would address the most important scientific questions, and whether there are other ways to answer these questions” → Make scientific judgments, look at alternative methods.

• Identify “areas which need additional research and/or technology R&D”

• Engage “the entire US community in developing a common vision” → As much as possible organize a common vision. Differing opinions may be expressed.
“It is important to remember that P5 is expected to take the science vision of the HEP community and, together with agency-provided budget profiles, turn that vision into a plan that is both rich in scientific opportunities and executable over a 10 to 20 year timescale. We strongly encourage you to engage in the planning process through the ongoing DPF/Snowmass exercise and by providing input when requested by HEPAP. HEPAP/P5 is the primary mechanism that the agencies have for seeking advice from the scientific community. Broad community participation is essential for developing a long-range plan that captures a shared science vision that can be feasibly implemented.”

James Siegrist
Associate Director for High Energy Physics
DOE Office of Science

F. Fleming Crim
Assistant Director for Mathematical and Physical Sciences
National Science Foundation
NSF’s View of a Successful Snowmass

• A survey of the state of particle physics science
  – The compelling physics opportunities, accompanied by crisp arguments
  – In the U.S. and in the global context
  – Are there other ways to answer the questions?

• We do not expect a consensus, but we do hope for everyone to make a constructive case for the science

• This is the community’s voice. HEPAP and P5 will sort out what we need and can afford from what we want in order to address the important science questions
Final Comments

• We are in the midst of very challenging budgetary climate
• We must plan, focus, and coordinate resources on excellent science with well-defined goals and potential impact
• Past planning is important – we must keep it in mind and chart a rational, defensible path to new opportunities
• Communication is essential to success, including the broader scientific community
• We wish you well as you bring this important exercise to a conclusion
• The NSF is watching with great interest and will continue to engage in all phases of the planning process

• Other NSF Program Directors Attending Snowmass: Keith Dienes, Randy Ruchti, Jim Whitmore – we’re happy to continue the conversation offline
Additional Material
Managing Expectations

• U.S. budgetary climate for fundamental research is very challenging
  – And a lot of competition for research funding
• For the most part, we are not aligned with the National Priorities (climate, energy, etc.)
  – But priorities change – we must be ready
• There is a community-driven roadmap
  – Any significant deviation from this roadmap needs to be very carefully considered
  – Maintaining credibility of the planning process is important
• Problem of long timescales for projects in the field
• Geography – how to tie to other regions’ plans and make them relevant for the U.S.?
Beyond Snowmass

• Funding
  – Need crisp science arguments
  – Need to focus on what is needed to advance the science
  – Seek new partnerships and opportunities

• National Priorities
  – Show relevance and mid-term impacts
  – Articulate broader societal impacts
  – Make alliances with other scientific disciplines

• Planning process
  – Focus on the most important science questions
  – New investments should have well-defined science milestones

• Articulate the Return on Investment
  – What is the added value in terms of science if we build “X”? (even for upgrades!)
  – What is the added value in terms of broader impacts to society?

• All of the above need: Effective Communication