NSF Nuclear Physics Overview

Allena K. Opper

- Announcements
- Budget – focus on PHY
- Announcements
NSF/MPS/Physics Personnel

- France Córdova – Director
- Anne L Kinney – Assistant Director for MPS
- Denise Caldwell – Physics Division Director
- Jean Cottam Allen – Acting Deputy Division Director
- Bogdan Mihaila – Nuclear Theory Program Director
- Jim Thomas – Expt’l Nuclear Physics Program Director
- Allena Opper – Expt’l Nuclear Physics Program Director

NSF FY19 Spending Proposals
(% change from FY18 enacted)
$ in ( ) = FY18 House Marks

NSF Total ($8.18 B)

Research and Related Activities ($6.65 B)

Education and Human Resources ($0.90 B)

Major Research Equipment and Facilities Construction ($0.27 B)
DKIST, LSST, Regional Class Research Vessels (HL LHC Upgrade)

President’s Request*  House Bill  Senate Bill

*The administration submitted the budget request to Congress before the final amounts for fiscal year 2018 were set.
## FY19 PHY $266.73M

<table>
<thead>
<tr>
<th>(Dollars in Millions)</th>
<th>FY 2017 Actual</th>
<th>FY 2018 (TBD)</th>
<th>FY 2019 Request</th>
<th>Change Over FY 2017 Actual Amount</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>$281.43</td>
<td>-</td>
<td>$266.73</td>
<td>-$14.70</td>
<td>-5.2%</td>
</tr>
<tr>
<td><strong>Research</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>178.57</td>
<td>-</td>
<td>159.01</td>
<td>-19.56</td>
<td>-11.0%</td>
</tr>
<tr>
<td>CAREER</td>
<td>10.04</td>
<td>-</td>
<td>7.30</td>
<td>-2.74</td>
<td>-27.3%</td>
</tr>
<tr>
<td>Centers Funding (total)</td>
<td>4.60</td>
<td>-</td>
<td>5.00</td>
<td>0.40</td>
<td>8.7%</td>
</tr>
<tr>
<td>STC: Center for Bright Beams</td>
<td>4.60</td>
<td>-</td>
<td>5.00</td>
<td>0.40</td>
<td>8.7%</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td>5.87</td>
<td>-</td>
<td>4.92</td>
<td>-0.95</td>
<td>-16.2%</td>
</tr>
<tr>
<td><strong>Infrastructure</strong></td>
<td>96.99</td>
<td>-</td>
<td>102.80</td>
<td>5.81</td>
<td>6.0%</td>
</tr>
<tr>
<td>IceCube Neutrino Observatory (IceCube)</td>
<td>3.50</td>
<td>-</td>
<td>3.50</td>
<td>-</td>
<td>0.0%</td>
</tr>
<tr>
<td>Large Hadron Collider (LHC)</td>
<td>16.00</td>
<td>-</td>
<td>16.00</td>
<td>-</td>
<td>0.0%</td>
</tr>
<tr>
<td>Laser Interferometer Gravitational Wave Observatory (LIGO)</td>
<td>41.93</td>
<td>-</td>
<td>45.00</td>
<td>3.07</td>
<td>7.3%</td>
</tr>
<tr>
<td>National Superconoducting Cyclotron Laboratory (NSCL)</td>
<td>24.00</td>
<td>-</td>
<td>24.00</td>
<td>-</td>
<td>0.0%</td>
</tr>
<tr>
<td><strong>Midscale Research Infrastructure</strong></td>
<td>5.85</td>
<td>-</td>
<td>8.00</td>
<td>2.15</td>
<td>36.8%</td>
</tr>
<tr>
<td>Pre-construction Planning:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-Luminosity LHC Upgrade Planning</td>
<td>5.71</td>
<td>-</td>
<td>6.30</td>
<td>0.59</td>
<td>10.3%</td>
</tr>
</tbody>
</table>

1 FY 2017 includes one-time supplemental funding of $2.50 million for a critical vacuum repair.
### Budget Trends – NSF Nuclear Physics
Includes co-funding and other leveraged funds

<table>
<thead>
<tr>
<th>FY</th>
<th>Nucleon &amp; Hadron QCD (k$)</th>
<th>Nuclear Astroph, Reactions, Structure (k$)</th>
<th>Prec Meas’ts &amp; Fund. Symm. (k$)</th>
<th>Total Exp’t Nuclear Physics (k$)</th>
<th>Nuclear Theory (k$)</th>
<th>Nuclear Program Total (k$)</th>
<th>NSCL (k$)</th>
<th>JINA &amp; JINA-CEE (k$)</th>
<th>MRI (K$)</th>
<th>Mid-Scale (K$)</th>
<th>Total Nuclear Physics (k$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>7,969</td>
<td>4,185</td>
<td>6,343</td>
<td>18,497</td>
<td>3,829</td>
<td>22,326</td>
<td>21,500</td>
<td>2,150</td>
<td>2,744</td>
<td>48,720</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>6,183</td>
<td>4,693</td>
<td>5,653</td>
<td>16,509</td>
<td>3,474</td>
<td>20,008</td>
<td>21,500</td>
<td>2,150</td>
<td>2,996</td>
<td>47,144</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>5,826</td>
<td>5,189</td>
<td>5,999</td>
<td>17,014</td>
<td>3,514</td>
<td>20,528</td>
<td>22,500</td>
<td>2,280</td>
<td>1,038</td>
<td>1,188</td>
<td>47,533</td>
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<tr>
<td>2015</td>
<td>6,769</td>
<td>4,702</td>
<td>7,304</td>
<td>18,774</td>
<td>4,183</td>
<td>22,957</td>
<td>23,000</td>
<td>2,280</td>
<td>1,801</td>
<td>1,367</td>
<td>51,406</td>
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<tr>
<td>2016</td>
<td>7,141</td>
<td>5,046</td>
<td>7,391</td>
<td>19,579</td>
<td>4,223</td>
<td>23,802</td>
<td>24,000</td>
<td>2,280</td>
<td>1,869</td>
<td>3,238</td>
<td>55,189</td>
</tr>
<tr>
<td>2017</td>
<td>6,955</td>
<td>6,273</td>
<td>6,692</td>
<td>19,920</td>
<td>4,344</td>
<td>24,264</td>
<td>24,000</td>
<td>2,280</td>
<td>530</td>
<td>2,990</td>
<td>54,064</td>
</tr>
<tr>
<td>2018</td>
<td>7,160</td>
<td>5,058</td>
<td>7,700</td>
<td>19,908 base = 17,800</td>
<td>4,384</td>
<td>24,291</td>
<td>24,000</td>
<td>2,280</td>
<td>3,970</td>
<td>5,249</td>
<td>59,791</td>
</tr>
</tbody>
</table>

FY15 Fundamental Symmetries: + $1.32M for 0νββ
MRI: competes each year; one-time acquisition/development funds
Mid-scale: ad hoc competition; design and construction funds (L-200, MUSE, nEDM)
Experimental Nuclear Physics

**ENP Proposal Trends**

- *2015 - 0vBB added to program*

- Submitted
- Awarded

**ENP Funding Trends**

- New awards only

- Requested funds 1st yr (M$)
- Awarded Funds 1st yr (M$)

**Fiscal Year**

- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018

**Millions $**

0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
19.0
20.0

Proposal pressure

Funding pressure
Experimental Nuclear Physics

Proposal pressure

Funding pressure for new PIs
Experimental Nuclear Physics

Since ~ 2013: $ requested > 2 X $ avail

Since 2016: Proposal funding rate < 40%

Funding rate of new PIs ~ tracks rate of established PIs
Proton Charge Radius “Problem”

Atomic meas’t $\mu$-H $\rightarrow$ p radius 7 $\sigma$ smaller than e-H

$< r_p^2 > = 6 \frac{dG_E^p(Q^2)}{dQ^2} \bigg|_{Q^2 = 0}$

and elastic e-p scattering

CODATA: 0.8775(51) fm
H $\mu_p$: 0.8764(89) fm
$\mu_p$: 0.84087(39) fm

7.9 $\sigma$
Proton Charge Radius “Problem”

Critically important quantity for:

• nuclear physics (QCD, Lattice, ...)
• atomic physics (QED, Lamb shifts, ...)
• directly correlated to the Rydberg constant
  (the most accurately known constant in physics)
• potential for “New Physics”

Two nuclear physics experiments to address this:

• Simultaneous elastic e-p & μ-p scattering
  o MUSE @ PSI – Dec 2018: final commissioning
• Elastic e-p scattering @ low momentum transfer
  o PRad @ JLab – completed
PRad goals:
- large $Q^2$ range in 1 experimental setting
- very low $Q^2$ range ($\sim 10^{-4}$ GeV/C$^2$)
- sub-percent precision in cross section

PRad solutions:
- high resolution, high acceptance calorimeter:
- smaller scattering angles: ($\theta_e = 0.7^0 - 7.0^0$):
  
  \[
  (Q^2 = 2 \times 10^{-4} - 6 \times 10^{-2}) \text{ GeV/c}^2
  \]
- simultaneous detection of $ee \rightarrow ee$ Moller scattering (control of systematics)

Use high density windowless $H_2$ gas flow target:
- beam background under control
- minimize experimental background

\[
< r_p^2 > = 6 \left. \frac{dG_E^p (Q^2)}{dQ^2} \right|_{Q^2 = 0}
\]

Mainz low $Q^2$ data set
Proton Charge Radius “Problem”

Proton Electric Form Factor $G_E$

Plots courtesy of Weizhi Xiong

PRad Preliminary result:
$R_p = 0.830 \pm 0.008$ (stat.) $\pm 0.018$ (syst.) fm

Nilanga Liyanage 2018 DNP Meeting
Proton Charge Radius “Problem”

PRad Preliminary result:
\[ R_p = 0.830 \pm 0.008 \text{ (stat.)} \pm 0.018 \text{ (syst.)} \text{ fm} \]

Nilanga Liyanage 2018 DNP Meeting
Solicitation for NSF Physics Division
Investigator-Initiated Research Projects 18-564

All proposals submitted to the Division of Physics programs must go through this solicitation.

• **Deadlines:**
  – December 4, 2018 for Particle Astrophysics, Elementary Particle Physics, *Experimental & Theoretical Nuclear Physics*

• **Has text on Midscale Instrumentation & Long Duration Efforts**

• **Follow Proposal & Award Policies & Procedures Guide (PAPPG)**
  – Follow the Proposal Preparation checklist

• **Collaborators and Other Affiliations Template**

• **Follow instructions that are specific to this solicitation**
Major Research Instrumentation (MRI) NSF 18-513

- Two tracks:
  - Track 1 $100k < $ from NSF < $1M; max of 2/university
  - Track 2 $1M < $ from NSF < $4M; max of 1/university

- Two types: development and acquisition

- Contact program directors well ahead of submission to discuss (avoid pitfalls)

- Maximum award is $4M; awards above $1M compete across the entire Foundation

- Due date January 22, 2019

FY18

- **Physics: 34 proposals, 10 in ENP (7 for > $1M)**
  - **Nathan Frank:** Development of a Charged Particle Telescope ~ $83k
  - **Zach Meisel:** He Ion Source Upgrade ~ $187k
  - **David DeMille:** Cold molecule Nuclear Time Reversal EXperiment ~ $1.2M
  - **Chen-Yu Liu:** Room Temp nEDM ~ $2.2M
Alliances for Graduate Education and the Professoriate (AGEP)

The AGEP program goal is to increase the number of historically underrepresented minority faculty, in specific STEM disciplines and STEM education research fields, by advancing knowledge about pathways to career success. See NSF 16-662 for details.

AGEP GR Supplements to MPS awards

- Available to PIs at AGEP or AGEP Legacy Institutions
- Graduate Student Eligibility
  - Emphasis placed on under-represented groups
  - *Not currently supported by federal government (NSF, DOE, NIH, …*)
  - US Citizen, US National, or US Permanent Resident
- Stipend, tuition, benefits, and IDC (~$60k)
- Renewable up to two times
  See us and DCL 16-125 for more information
Writing proposals: Mentoring program

GOAL: make the proposal writing expertise of senior researchers available to junior investigators

How does it work?

– The Mentee requests a Mentor (email us at aopper@nsf.gov or jhthomas@nsf.gov).
– We will send a list of Mentor Volunteers to Mentee, who contacts Mentors without identifying them to NSF.
– The Mentor will read the Mentee’s proposal and provide feedback once. Send the proposal early – Mentors are busy people!
– NSF accepts no responsibility on the interaction/outcome of the program!

Needed: Mentors!

email us at aopper@nsf.gov or jhthomas@nsf.gov
For the latest updates, check out

Contact us:

• bpmihaila@nsf.gov
  or call (703)292-8235

• jhthomas@nsf.gov
  or call (703)292-2911

• aopper@nsf.gov
  or call (703)292-8958