NSF Nuclear Physics Overview

Allena K. Opper & Bogdan Mihaila

• New personnel
• 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

Interesting Times

• Launched Mid-scale Research Infrastructure -1 ($6M - $20M) 21-nov-2018
• Launched Mid-scale Research Infrastructure -2 ($20M - $70M) 11-dec-2018
• Lapse in Appropriations:
  – NSF staff not allowed to work even on voluntary basis
  – IPA Rotators (and other essential personnel) ran NSF
  – MRI proposal due date 22-jan-2019
• Onward from January 28th
  – Thank you to reviewers and panelists providing service during compressed review cycle
NSF FY19 Appropriations
% change from FY18 enacted
$ in ( ) = FY19 amounts

NSF Total ($8.08 B)
-4%

Research & Related Activities ($6.52 B)
-3%

Education & Human Resources ($0.91 B)
-3%

Major Research Equipment & Facilities Construction ($0.30 B)
-48%

Trump Request*  House Bill  Senate Bill  Final
47% 36% 62%

* The administration submitted the budget request to Congress before the final amounts for fiscal year 2018 were set.
FY19 & FY20 Budget Process

• Agency budget request → OMB ~ end of summer
• “Pass Back”: OMB provides numbers to agency ~ end of Nov
  – May also include additional instructions
• President’s Budget Request set ~ end of cal year
  – Much activity → NSF Budget Book

• Congress passes appropriation ~ before beginning of FY
  – NSF: Amounts for 6 high-level accounts, occasionally with additional text
• President signs appropriation; budget → agency via OMB
• NSF generates a new Budget Book (“current plan”) and submits to Congress via OMB
• Congress acts within 30 days: “current plan” → “operating plan”
<table>
<thead>
<tr>
<th>Category</th>
<th>FY 2018 Actual</th>
<th>FY 2019 (TBD)</th>
<th>FY 2020 Request</th>
<th>Change over FY 2018 Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>$310.75</td>
<td>-</td>
<td>$247.50</td>
<td>-$63.25</td>
</tr>
<tr>
<td>Research</td>
<td>182.35</td>
<td>-</td>
<td>145.63</td>
<td>-36.72</td>
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<tr>
<td>CAREER</td>
<td>10.14</td>
<td>-</td>
<td>6.78</td>
<td>-3.36</td>
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<tr>
<td>Centers Funding (total)</td>
<td>4.81</td>
<td>-</td>
<td>5.00</td>
<td>0.19</td>
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<tr>
<td>STC: Center for Bright Beams</td>
<td>4.81</td>
<td>-</td>
<td>5.00</td>
<td>0.19</td>
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<tr>
<td>Education</td>
<td>4.50</td>
<td>-</td>
<td>4.70</td>
<td>0.20</td>
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<tr>
<td>Infrastructure</td>
<td>123.90</td>
<td>-</td>
<td>97.17</td>
<td>-26.73</td>
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<tr>
<td>IceCube</td>
<td>3.50</td>
<td>-</td>
<td>3.50</td>
<td>-</td>
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<tr>
<td>LHC</td>
<td>15.86</td>
<td>-</td>
<td>20.00</td>
<td>4.14</td>
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<tr>
<td>LIGO</td>
<td>39.43</td>
<td>-</td>
<td>44.60</td>
<td>5.17</td>
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<tr>
<td>Midscale Research Infrastructure</td>
<td>14.42</td>
<td>-</td>
<td>6.67</td>
<td>-7.75</td>
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<tr>
<td>NSCL</td>
<td>24.00</td>
<td>-</td>
<td>22.00</td>
<td>-2.00</td>
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<tr>
<td>Research Resources</td>
<td>0.09</td>
<td>-</td>
<td>-</td>
<td>-0.09</td>
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<tr>
<td>Facilities Design Stage Activities (total)</td>
<td>26.60</td>
<td>-</td>
<td>0.40</td>
<td>-26.20</td>
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<tr>
<td>High Luminosity-LHC¹</td>
<td>16.60</td>
<td>-</td>
<td>-</td>
<td>-16.60</td>
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<tr>
<td>Advanced LIGO Plus (LIGO A+)</td>
<td>10.00</td>
<td>-</td>
<td>0.40</td>
<td>-9.60</td>
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</tbody>
</table>

¹ FY 2018 Actual reflects $7.50 million of funding for FY 2019 and FY 2020 development and design. No additional funds are expected in these years.
## 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>
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</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></td>
<td>48,720</td>
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<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>490</td>
<td>47,144</td>
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<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>
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<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 base = 3,920</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)
NSF’s Big Ideas for Future Investments

• **Bold questions that will drive NSF’s long-term research agenda**

• **Catalyze investment in fundamental research**

• **Collaborations with industry, private foundations, other agencies, universities**

• **Solve pressing problems and lead to new discoveries**
Career Program

• Solicitation: 17-537
• Must include excellent research proposal as well as excellent educational plan
• There are eligibility requirements: e.g., must be assistant professor, untenured
• 5 year awards, $400,000 minimum
• Proposal deadline: July 19, 2019 ➔
PECASE nominees are chosen from CAREER winners
• Contact program officer for information/advice ahead of time (budget, scope)
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
For the latest updates, check out https://www.nsf.gov/div/index.jsp?div=PHY

Contact us:

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- jhthomas@nsf.gov or call (703)292-2911
- aopper@nsf.gov or call (703)292-8958
IRIS-HEP: Institute for Research and Innovation in Software for High-Energy Physics [OAC/PHY]
- a Software Infrastructure for Sustained Innovation (S2I2) Institute

High-Luminosity Large Hadron Collider (HL-LHC) upgrade:
- order of magnitude increase in data analysis complexity
- order of magnitude increase in store and compute cycles
- solutions needed by: HL-LHC: 2025/2026

- Convergence: HPC & Big Data
- Multi-agency coordination: DoE, +International

IRIS-HEP mission:
- Active center for software R&D
- Intellectual hub for community-wide software R&D
- Transform the operational services and computing model

Note: Complements the NSF MREFC for HL-LHC upgrade
Scalable Cyberinfrastructure for Multi-Messenger Astrophysics [OAC/PHY/AST]

MMA Challenge:
- Detection, Source Identification, Observation, Simulation
- On the Clock: Time lost is Science Lost!

Community building:
- CiMMA Workshop, UMD, May 2018
- Community Planning for Scalable CiMMA

- Convergence: astrophysics, computer science, mathematics, and software engineering
- Multi-agency coordination: NASA, DoE, +International

- Solutions needed by (NSF investment milestones):
  - LSST: 2023
  - Advanced (A) LIGO: 2020
  - A+ LIGO: 2022/2023
  - IceCube Gen2-Phase 1: 2023
  - POSS, ZTF, NOAO, NANOGrav,
  - Veritas, AMON, and many others...
NSF 17-548 Ideas Lab: Practical Fully-Connected Quantum Computer brings together physicists, computer scientists, and engineers to construct a quantum computer capable of showing an advantage over current computer technology.

NSF Award 1818914 PFCQC: STAQ: Software-Tailored Architecture for Quantum co-design

$15 million grant for a multi-institution quantum research collaboration.  [News Release 18-058]

Trapped ions (superimposed) above a fabricated trap to capture and control ion qubits (quantum bits).

Image Credit: K. Hudek, Ion Q&E / E. Edwards, JQI
Solve a challenge problem using quantum computing

- **Convergence**: physical sciences (theory, experiment), engineering, computer science, software engineering
- **Co-design**: architecture, algorithms, software
- **Workforce development**
- **Funding Mechanisms**:
  - *Ideas Lab*: Practical Fully-Connected Quantum Computing challenge (PFCQC)
  - Expeditions in Computing
NSF – DoE Connections in QIS

Superconducting qubits

- Advanced Quantum Testbed
  - Irfan Siddiqi, LBNL
  - Will Oliver, MIT-LL
  - SC circuits & SC 2D-cavities

Trapped Ion qubits

- Quantum Scientific Computing
  - Open User Testbed
  - Peter Maunz, SNL
  - room-temperature and cryogenic trapped ion platforms

EPiQC: Enabling Practical-scale Quantum Computation (NSF/CCF)
- Fred Chong, Chicago
  - Algorithms, Software
  - SC & trapped ion qubit architectures

STAQ: Software-Tailored Architecture for Quantum co-design
- Ken Brow, Jungsang Kim, Duke
  - trapped ion platforms