National Science Foundation
Nuclear Physics Overview

Allena K. Opper

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

- France Córdova – Director
- Anne L Kinney – Assistant Director for MPS
- Denise Caldwell – Physics Division Director
- Saúl González – 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

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

- **Deadlines:**
  - **December 3, 2019** 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
- Submission window January 1 – 21, 2020

FY19
- **Physics:** ~25% of the PHY proposals were in ENP
  - Grzywacz, U of TN: Development of a high resolution neutron detector for decay and reaction studies with exotic nuclei; ~$910k
  - Wissink, IU: Development of a forward calorimetry upgrade for STAR; ~$2,150k
  - Voytas, Wittenberg U: Development of a high sensitivity instrument to search for CP violation in positronium decay; ~$292k
  - Lesher, U of WI – LC: Acquisition of Si(Li) detectors and two BGO Compton suppression shields for the development of the La Crosse fIREBall; ~$397k
Permanent Position in PHY

Program Director with expertise in QIS

- [https://www.usajobs.gov/GetJob/ViewDetails/548130300](https://www.usajobs.gov/GetJob/ViewDetails/548130300)

Ref: University of California -- Berkeley

Ref: University of Maryland
The AI Research Institutes program will support the advancement of multidisciplinary, multi-stakeholder research on larger-scale, longer-time-horizon challenges in AI research than are supported in typical research grants

- Joint effort of the NSF, USDA, NIFA, DHS-S&T, DOT, FHWA, & VA to enable AI research
- Two tracks:
  - Institutes in 6 themes (including AI for Discovery in Physics); due date 28-jan-2020
  - Planning; due date 30-jan-2020
Mid-scale Research Infrastructure (Mid-scale RI)

- Track 1 (Mid-scale RI-1): $6-$20 million implementation or design, funded from R&RA account.
  - Solicitation NSF 19-537
  - $60M in FY 2019 projected
  - $30M in FY 2020 Request
  - FY19 awards total $121M

- Track 2 (Mid-scale RI-2): $20-$70 million implementation only, funded from MREFC account.
  - Solicitation NSF 19-542.
  - $60M in FY 2020 Request; $75M in Senate mark
Proposals should be submitted to the PHY Solicitation 18-564

- Design and Construction *or* Acquisition of Instrumentation
  - R & early D, operations *funded by research programs*
- $4M < TPC < $15M; over multiple years
- Selection based on
  - merit review
  - exceptional opportunity
  - research community priorities.
- Currently 6 Midscale projects
  (3 Nuclear Physics: MUSE, nEDM, LEGEND-200)
- For more info, see PHY Solicitation
NSF FY20 Budget Proposals

$ in ( ) = FY19 enacted

-12%  
NSF Total ($8.1 B)
7%  
President’s Request
3%  
House
3%  
Senate

-13%  
Research & Related Activities ($6.5 B)
9%  
President’s Request
4%  
House
4%  
Senate

-10%  
Education & Human Resources ($0.9 B)
7%  
President’s Request
4%  
House
3%  
Senate

-25%  
Major Research Equipment & Facilities Construction ($0.3 B)
25%  
President’s Request

DKIST, HL-LHC det upgrades, LSST, Regional Class Research Vessels
## FY20 PHY $247.50M

President’s Request

(Dollars in Millions)

<table>
<thead>
<tr>
<th></th>
<th>FY 2018 Actual</th>
<th>FY 2019 (TBD)</th>
<th>FY 2020 Request</th>
<th>Change over FY 2018 Actual</th>
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<tbody>
<tr>
<td><strong>Total</strong></td>
<td>$310.75</td>
<td>-</td>
<td>$247.50</td>
<td>-$63.25</td>
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<tr>
<td>Research</td>
<td>182.35</td>
<td>-</td>
<td>145.63</td>
<td>-36.72</td>
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<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><strong>Education</strong></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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<td>LIGO</td>
<td>39.43</td>
<td>-</td>
<td>44.60</td>
<td>5.17</td>
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<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><strong>NSCL</strong></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-LHC</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

~ 25% = Research

~ 75% = Operations

<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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<tbody>
<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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<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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<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>5,048</td>
<td>7,589</td>
<td>19,787</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>
<tr>
<td>2019</td>
<td>6,325</td>
<td>7,322</td>
<td>6,884</td>
<td>20,531</td>
<td>3,921</td>
<td>24,452</td>
<td>24,000</td>
<td>2,280</td>
<td>3,549</td>
<td>5,806</td>
<td>60,086</td>
</tr>
</tbody>
</table>

MRI: competes each year; one-time acquisition/development funds

Mid-scale: ad hoc competition; design and construction funds (L-200, MUSE, nEDM)
**PD 18-5115  July 31, 2018**

**Program Description: Windows on the Universe: The Era of Multi-Messenger Astrophysics**

- Proposals submitted to participating programs in MPS/AST, MPS/PHY and GEO/OPP.
- Proposals funded through “Big Idea” allocation as well as existing programs.
- Criteria: any area of research supported through the participating divisions that address at least one of the following:
  - *Coordination*: Hardware, software, or other infrastructure to coordinate observations involving more than one messenger.
  - *Observations*: Observations of astrophysical objects or phenomena that are potentially sources of more than one messenger, including the use of existing observatories, experiments, and data archives, as well as the development and construction of new capabilities for advancing multi-messenger astrophysics.
  - *Interpretation*: Theory, simulations and other activities to understand or interpret observations of astrophysical objects that are sources of more than one messenger.

MRI: Helium-Jet Ion-Guide System (HJ-IGS) for multi-user operation at NSCL

Rare isotopes caught in stopping cell
- 7 atm He-aerosol mixture
- Off-axis and along A1900
- Some selection of isotopes

Isotopes transported to HJ-IGS
- Decay experiments
- Ionization & transport to other experimental stations

2019: Demonstrated by delivery of $^{70}$As from A1900 $\rightarrow$ HJ enclosure & measurement of its decay; transmission efficiency = 4±1%
Goal: select & collect short-lived isotopes for simultaneous experiments
Complementary to isotope harvesting from beam dump
HBCU Collision Collaboration

• Analysis of UPC data on photo-production of \( J/\Psi \) from PHENIX → x 3 reduction in stat errors

• Develop cosmic test stand → R&D for future colliders (test RPCs & fast TOF systems)

With Mickey Chiu at BNL
Quantifying jet modification in the QGP via $\pi^0$–$h$ correlations with PHENIX data

Jet broadening in Au+Au collisions

Undergraduates presenting summer experience with sPHENIX HCal tile testing
CAREER: Search for CP-Violating Hadronic Physics BSM with Polyatomic Molecules

Nick Hutzler

• Goal: search for Nuclear MQM in cryo beam of $^{173}$YbOH
  – Nuclear MQMs probe hadronic CP-violation
  – Effects amplified by large E fields in polar molecules
  – Yb has quadrupole deformation $\rightarrow$ enhanced MQM

• Order of mag increase in molecule production via cold chemistry
  – Optically excite Yb to metastable $^3P_1$ state
  – Reactive state to overcome chem barriers

Co-funded by NSF AMO and ENP Programs
For the latest updates, check out

Contact us:

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

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

• aopper@nsf.gov or call (703)292-8958
Backup Slides
Experimental Nuclear Physics

**ENP Proposal Trends**
- Submitted
- Awarded

* 2015 - 0vBB added to program

**ENP Funding Trends**
- Requested funds 1st yr (M$)
- Awarded Funds 1st yr (M$)

Fiscal Year: 2010-2019

NSAC: NSF NP Overview
OCT-2019
# FY20 Funding for NSF Big Ideas

**President’s Request**

(Dollars in Millions)

<table>
<thead>
<tr>
<th>Big Ideas</th>
<th>FY 2019 Request</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Research Ideas</strong></td>
<td></td>
</tr>
<tr>
<td>Harnessing the Data Revolution for 21st-Century Science and Engineering - HDR (CISE/ITR)¹</td>
<td>$180.00</td>
</tr>
<tr>
<td>Navigating the New Arctic - NNA (GEO/ICER)</td>
<td>30.00</td>
</tr>
<tr>
<td>The Future of Work at the Human-Technology Frontier - FW-HTF (ENG/EFMA)¹</td>
<td>30.00</td>
</tr>
<tr>
<td>The Quantum Leap - QL (MPS/OMA)</td>
<td>30.00</td>
</tr>
<tr>
<td>Understanding the Rules of Life - URoL (BIO/EF)</td>
<td>30.00</td>
</tr>
<tr>
<td>Windows on the Universe - WoU (MPS/OMA)</td>
<td>30.00</td>
</tr>
<tr>
<td><strong>Process Ideas</strong></td>
<td>$102.50</td>
</tr>
<tr>
<td>Growing Convergence Research - GCR (IA)</td>
<td>16.00</td>
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<tr>
<td>Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science - NSF INCLUDES (EHR)</td>
<td>20.00</td>
</tr>
<tr>
<td>Mid-Scale Research Infrastructure (IA)</td>
<td>60.00</td>
</tr>
<tr>
<td>NSF 2026 Fund (IA)</td>
<td>6.50</td>
</tr>
<tr>
<td><strong>Total, NSF Big Ideas</strong></td>
<td>$282.50</td>
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</table>
Quantum Leap

Exploiting quantum mechanics to observe, manipulate, and control the behavior of particles and energy at atomic and subatomic scales, resulting in next-generation technologies for sensing, computing, modeling, and communicating.

• NSF 18-578 QAMASEI: Foundries for Q. Materials Science, Engineering, and Info. $20M - $25M
• NSF 19-507 QCIS Faculty Fellows; FY’19 and FY’20; $6.7M
• NSF 19-532 QII-TAQS Transformational Advances in Quantum Systems; $26M in FY’19
• NSF 19-559 QLCI Quantum Leap Challenge Institutes; $5M/year for each of several centers