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**Before the
Subcommittee on Science and Space
Committee on Commerce, Science, and Transportation
United States Senate**

**on
The President's Fiscal Year 2013 Budget Request
for the National Science Foundation**

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Chairman Nelson, Ranking Member Boozman, and Members of the Subcommittee, it is my privilege to be here with you today to discuss the National Science Foundation's fiscal year (FY) 2013 Budget Request. My name is Subra Suresh, and I am the Director of the National Science Foundation.

I hope to make a clear and compelling case for the continuing vital role NSF's support for science and engineering research and education plays in innovation and economic growth, especially during these times of constrained budgets.

The President's FY 2013 Budget Request reflects wise stewardship of federal funding through innovative, targeted investments. The Request totals \$7.373 billion, an increase of \$340.0 million (4.8 percent) over the FY 2012 Enacted level. The FY 2013 Request provides increased support for core programs in fundamental research and education in all fields of science and engineering. This investment moves our nation forward by connecting the science and engineering enterprise with potential economic, societal, and educational benefits in areas critical to creating high-quality jobs, growing the economy, and ensuring national security. This follows bipartisan support in the FY 2012 budget for a 2.5-percent increase over the 2011 Enacted level.

NSF is the only federal agency with a mandate to support research and education in every discipline. The results of frontier research have a long record of improving lives and meeting national needs. They are the very bedrock of economic growth; the path to sustainability in energy, agricultural, and environmental domains; the seeds of the next technology revolution; and the foundation for advances in medicine. Sustained momentum in NSF's core programs is essential for progress in science and engineering. NSF's broad scope uniquely positions us to

integrate the natural sciences and engineering with social, behavioral, and economic sciences to address the complex societal challenges of today. For all these reasons, the FY 2013 Budget Request provides increased support for the core fundamental research programs across NSF.

NSF: Building a Foundation for Success

NSF has played a significant role in U.S. prosperity, and in the education and development of the nation's science and engineering workforce. For decades, NSF has supported scientists and engineers in their pursuit of world-changing discoveries and innovation that, in turn, created opportunities for private sector growth and for Americans to have good jobs.

Since 1952, the first year that NSF awarded research grants, 196 Nobel Prize recipients have received NSF funding at some point in their careers for their work in physics, chemistry, medicine, and economics. Today, their transformative work addresses society's grand challenges in the areas of energy, environment, and health, as well as national and economic security.

The United States has a long history of investment in and deployment of technological advances derived from advances in basic research facilitated by NSF. For example, research funded by NSF at the National Center for Atmospheric Research and universities was instrumental in the development of Doppler radar, which benefits most Americans regularly through improved weather forecasting. NSF-supported fundamental research in physics, mathematics, and high-flux magnets led to the development of today's magnetic resonance imaging (MRI), employed ubiquitously throughout medicine.

Furthermore, NSF provides a much-needed bridge between research and discovery that would otherwise be neglected and remain untapped by the commercial marketplace. In the 1970s, research on solid modeling by NSF-funded scientists at Carnegie Mellon University led to widespread use of Computer-Aided Design and Computer-Aided Manufacturing, which together have revolutionized much of the U.S. manufacturing industry. NSF was willing to encourage investigations into design problems that neither private firms nor federal mission agencies were willing to address.

While discovery and innovation underpin our global leadership in science and engineering, and consistently provide pathways for entrepreneurs, these activities are also first and foremost human endeavors. Thus, they demand the development of a highly skilled science, technology, engineering, and mathematics (STEM) workforce. NSF strives to ensure that students from diverse backgrounds, including women, underrepresented minorities, and persons with disabilities, have sufficient opportunities to engage in empowering learning experiences and inspiring research, no matter their economic circumstances. Sustaining such a world-class workforce is critical.

Federal investments in fundamental science and engineering and STEM training are increasingly important to help establish U.S. leadership in next-generation technologies, especially as other nations intensify their support of research, development, and education. It is crucial that we

continue to lead in the face of this unprecedented global competition for the world-class talent who generate innovative scientific ideas and comprise the technical workforce.

These federal investment priorities in fundamental science and STEM training align with the *America COMPETES Reauthorization Act of 2010*, which paved the way for increased national attention on STEM research and education. NSF appreciates the Committee's support of this important national policy. The provisions of the *COMPETES Reauthorization Act* cover a wide range of NSF activities. The *Act* has underpinned NSF's development of new partnerships with other agencies (e.g., U.S. Agency for International Development–Partnerships for Enhanced Engagement in Research program, K-16 Math Education effort with the Department of Education).

The *COMPETES Reauthorization Act* also calls for the enhancement of undergraduate research as tools that promote careers in STEM fields. The NSF FY 2013 Budget Request has several new programs tailored to this national need. In particular, we thank the members of the Committee and particularly Chairman Rockefeller for their support of the January 19-20, 2012, EPSCoR 2030 Workshop, and we look forward to the strategic priorities and the recommendations that result from the effort. NSF continues to value the EPSCoR program.

Other NSF priorities in the FY 2013 budget are designed to develop a robust innovation ecosystem in line with the Committee's interest in encouraging technology transfer and commercialization. For example, the Innovation Corps (I-Corps) program, described in more detail later, has the potential to leverage public-private partnerships, through professional mentoring, for technology transfer of fundamental research into useful, commercial technological innovation. At present, the first 21 projects are off to a great start. In fact, four of the awardees have graduated to the SBIR (Small Business Innovation Research) track.

The *COMPETES Reauthorization Act* also directed NSF to implement a policy making the Broader Impacts Review Criterion, one of NSF's two merit review criteria, more clearly understood by reviewers and potential grant recipients. Meanwhile, in May of 2010, the National Science Board (NSB) had initiated a review of NSF's review criteria and developed a Task Force on Merit Review. The task force produced a report (*National Science Foundation's Merit Review Criteria: Review and Revisions*, Jan. 10, 2012) that more clearly defined the two merit review criteria and how they relate to one another. NSF is in full agreement with the recommendations of the task force report. Changes to the descriptions of the criteria and the added principles component are intended to enhance and clarify their function. The agency is currently implementing these changes.

Additionally, the NSB evaluated the needs for mid-scale research instrumentation across all disciplines, in accordance with the *Act*. As the Board noted in its recent report to Congress (*NSB Report to Congress on Mid-Scale Instrumentation at the NSF*, Dec. 14, 2011), NSF's current balance of small, medium, and large instrumentation is sound, and the variety of mechanisms by which NSF prioritizes, solicits, evaluates, and supports mid-scale instrumentation — directly and indirectly through large centers and facilities — provides flexibility and vigor to NSF efforts.

NSF will continue its role as the nation's innovation engine as mandated in the *Act*. The fuel for that engine is fundamental research. Scientific research, with its long-term perspective, strong emphasis on disciplinary excellence, and multi-disciplinary interactions, is a critical foundation for both transformational science and economic competitiveness. For all these reasons, the FY 2013 Budget Request provides increased support for the core fundamental research programs across NSF.

The NSF FY 2013 Budget Request

Budget Rationale

The NSF FY 2013 Budget Request presents a carefully-targeted portfolio of innovative investments that provides increased support for fundamental research in all fields of science and engineering. This core research, which constitutes the largest share of NSF expenditures, lays the foundation for progress in science and technology and enhances our ability to address emerging challenges in areas such as advanced manufacturing, clean energy technologies, cybersecurity, and STEM education.

One NSF Framework

A major emphasis in FY 2013 is the OneNSF Framework, which aims to enable seamless operations across organizational and disciplinary boundaries. OneNSF empowers the Foundation to respond to new challenges in a changing global environment, leverages resources and opportunities for maximum impact, and provides leadership to establish innovative practices, programs, and paradigms that advance scientific knowledge and science, technology, engineering, and mathematics (STEM) education. The OneNSF Framework encompasses a set of investments that create new knowledge, stimulate discovery, address complex societal problems, and promote national prosperity. The OneNSF Framework includes the following investments:

Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMSS) is a \$257.42-million investment that will transform static systems, processes, and edifices into adaptive, pervasive “smart” systems with embedded computational intelligence that can sense, adapt to, and react to changes in the environment. The smart systems of tomorrow, created through CEMMSS, will vastly exceed those of today in terms of adaptability, autonomy, functionality, efficiency, reliability, safety, and usability. CEMMSS brings together researchers and educators from the areas of advanced manufacturing, materials science, cyber-physical systems, and robotics to build an integrated community of interest and stimulate new directions in research.

In the FY 2013 Budget Request, CEMMSS research includes \$148.90 million for advanced manufacturing, which includes NSF participation in areas of national importance such as cyber-physical systems and advanced robotics research; materials processing and manufacturing; and advanced semiconductor and optical device design. Advanced manufacturing research invests in emerging technologies that promise to create high quality manufacturing jobs and enhance our

global competitiveness. NSF is an agency partner in the President's **Advanced Manufacturing Partnership**.

NSF has a long history of investments in cyberinfrastructure. **Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21)** aims to more deeply address a highly science-driven integration of cyberinfrastructure (CI), supporting development of new statistical, mathematical, and computational methods, algorithms, and tools, as well as the cultivation of the next generation of computational and data-enabled researchers who prototype, develop, and use CI in all disciplines. In FY 2013, NSF will invest \$106.08 million in this program.

The **NSF Innovation Corps (I-Corps)** is a public-private partnership to accelerate the movement of research results from the lab to the marketplace by establishing opportunities to assess the readiness of emerging technology concepts for transitioning into valuable new products. I-Corps will bring together technological, entrepreneurial, and business expertise and mentoring to move discoveries toward commercialization, thus facilitating the downstream development of technologies and processes from NSF-sponsored fundamental discoveries. Initially launched in FY 2011, NSF will invest \$18.85 million in FY 2013.

Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE) integrates NSF's existing interdisciplinary efforts with a suite of new Foundation wide activities. INSPIRE encourages research that involves multiple disciplines, connects disciplines, or creates new disciplines. It aims to widen the pool of prospective discoveries that may be overlooked by traditional mechanisms. The NSF Request for INSPIRE in FY 2013 is \$63.0 million.

Cybersecurity vulnerabilities in our government and critical infrastructure are a risk to national security, public safety, and economic prosperity. **Secure and Trustworthy Cyberspace (SaTC)** is a \$110.25 million investment that aligns NSF's cybersecurity investments with the four thrusts outlined in the December 2011 national cybersecurity R&D strategy, *Trustworthy Cyberspace: Strategic Plan for the Federal Cybersecurity Research and Development Program*. SaTC directly addresses the critical Administration priority of cybersecurity issues by supporting research and education that seeks to protect the nation's critical information technology infrastructure, including the Internet, from a wide range of threats to its security, reliability, availability, and overall trustworthiness. SaTC also addresses the social, behavioral and economic aspects of cybersecurity.

In FY 2013, NSF will invest \$355.38 million in **Clean Energy**. NSF's clean energy investments include research related to sustainability science and engineering, such as the conversion, storage, and distribution of diverse power sources (including smart grids), and the science and engineering of energy materials, energy use, and energy efficiency. Some of NSF's investments in clean energy are supported through the FY 2013 NSF investment of \$202.50 million in **Science, Engineering, and Education for Sustainability (SEES)**. SEES focuses on targeted programs that promote innovative interdisciplinary research to address pressing societal issues of clean energy and sustainability. Specifically, SEES will address a wide range of highly complex challenges including sustainable energy pathways; agricultural and environmental sustainability; sustainable chemistry, engineering, and materials; water scarcity; ocean acidification; natural disaster prediction and response, and sustainable coastal and Arctic systems.

The Intersection of Research and Education

Efforts to maintain national science and technology preeminence in a fiercely competitive global environment rest upon a highly educated workforce. The NSF FY 2013 Budget Request continues NSF's long history of support for the next generation of leaders in science, technology, and innovation. The suite of educational investments builds on the recognition that science and engineering talent is the foundation of America's future. Areas of educational investments run the spectrum from early learning to college completion.

K-16 Math Education: As part of the nation's strategic plan in STEM education, NSF is partnering with the Department of Education (ED) to launch an evidence-based effort to improve K-16 mathematics education and knowledge building. This new endeavor will support researchers and educators who have the greatest potential to improve mathematics learning. In FY 2013, NSF's Directorate for Education and Human Resources (EHR) and ED will each contribute \$30.0 million. EHR's contributions will be through support for the Discovery Research K-12 (DR K-12) and Transforming Undergraduate Education in STEM (TUES) programs.

Transforming Undergraduate Education in STEM (TUES) aims to improve the quality of undergraduate STEM education. TUES research will help undergraduate teaching keep pace with advances in disciplinary knowledge, and underpin the creation of new learning materials, teaching strategies, faculty development, and evaluation to directly impact education in practice. In FY 2013, NSF will invest \$61.46 million in TUES.

Expeditions in Education (E²) is a new \$49.0 million interdisciplinary effort that establishes a partnership between the Directorate for Education and Human Resources (EHR) and other research directorates and offices. E² aims to ensure that all of NSF's education and workforce investments are drawing on the latest STEM educational theory, research, and evidence. By incorporating cutting-edge science and engineering education, E² will improve learning in science and engineering disciplines and enhance the preparation of a world-class scientific workforce.

The **Widening Implementation and Demonstration of Evidence-Based Reforms (WIDER)** program, funded at \$20.0 million in FY 2013, is an education research and development program that will modernize the way undergraduate students, including non-STEM majors, are taught and learn general science and mathematics. WIDER will explore how to achieve widespread sustainable implementation of evidence-based undergraduate instructional practices to improve student outcomes.

In FY 2013, NSF will invest \$25.0 million to continue to support the **Federal Cyber Service: Scholarship for Service (SFS)** program to increase the number of qualified students entering the fields of information assurance and computer security. SFS will increase the capacity of the United States higher education enterprise to continue to produce professionals in these fields to meet the needs of our increasingly technological society. SFS directly addresses the Nation's increasing need for innovative solutions to cybersecurity concerns.

The **Advanced Technological Education** program focuses on education for high-technology fields, with an emphasis on two-year colleges to produce well-qualified technicians for existing and emerging high-technology fields. For FY 2013, the NSF Request is \$64.0 million.

Continued Investment in American Innovation and Entrepreneurship:

The Faculty Early Career Development program (CAREER) develops the future scientific and technical workforce through support of young faculty who are dedicated to integrating research with teaching and learning. In FY 2013, NSF will invest \$216.49 million to support approximately 40 more CAREER awards than in FY 2012, for a total of 440 new awards. The CAREER portfolio includes projects that range across all fields of science and engineering supported by the Foundation, including high priority fields such as clean energy, climate change, STEM education, and cybersecurity.

The Graduate Research Fellowship program (GRF), funded at \$242.98 million in FY 2013, supports the development of students and early-career researchers in order to cultivate the next generation of STEM professionals. In FY 2013, 2,000 new fellowships will be awarded, maintaining the doubling of new fellowship awards achieved in FY 2010. To address inflationary pressures on the long-stagnant GRF stipend level, the FY 2013 Request increases the stipend to \$32,000.

Science and Technology Centers (STCs) are funded in FY 2013 at \$74.39 million. In FY 2013, a new cohort of STCs will be initiated (totaling \$25.0 million) that will continue the tradition of conducting world-class research through partnerships among academic institutions, national laboratories, industrial organizations, and/or other public/private entities, and via international collaborations. STCs provide an innovative way for researchers to conduct investigations at the interfaces of disciplines and to invest in high-risk, potentially transformative science.

Experimental Program to Stimulate Competitive Research (EPSCoR) assists NSF in its mandate to promote scientific progress nationwide. EPSCoR effects lasting improvements in the research capacity of institutions in participating jurisdictions to promote broader engagement at the frontiers of discovery and innovation in science and engineering. The FY 2013 investment for EPSCoR is \$158.19 million.

Enhancing Access to the Radio Spectrum (EARS), begun in FY 2012, continues to partner the Directorates for Engineering; Computer and Information Science and Engineering; Mathematical and Physical Sciences; and Social, Behavioral and Economic Sciences in supporting the basic research that funds research and development of spectrum-sharing technologies. NSF proposes an investment of \$50.50 million for FY 2013.

World Class Scientific Infrastructure

The world-class equipment and facilities that NSF supports are essential to the task of discovery. All of the projects in the Major Research Equipment and Facilities Construction account undergo major cost and schedule reviews, as required by NSF guidelines. In FY 2013, NSF will continue support for the construction of the following four projects.

Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO). A planned upgrade of the existing Laser Interferometer Gravitational-Wave Observatory (LIGO), AdvLIGO will be ten times more sensitive, powerful enough to approach the ground-based limit of gravitational-wave detection. The FY 2013 investment is \$15.17 million.

Advanced Technology Solar Telescope (ATST). ATST will enable study of the sun's magnetic fields, which is crucial to our understanding of the types of solar variability and activity that affect Earth's civil life and may impact its climate. The FY 2013 investment is \$25.0 million.

National Ecological Observatory Network (NEON). NEON will consist of geographically distributed field and lab infrastructure networked via cyberotechnology into an integrated research platform for regional to continental scale ecological research. The FY 2013 investment is \$91.0 million.

Ocean Observatories Initiatives (OOI). OOI will enable continuous, interactive access to the ocean via multiple types of sensors linked by cutting-edge cyberinfrastructure, which will produce never-before-seen views of the ocean's depths. The FY 2013 investment is \$65.0 million.

Excellence in Operations

NSF emphasizes the agency's desired outcome of attaining excellence in all aspects of its operations. Thus, performing as a model organization, one of NSF's three strategic goals, underpins NSF programmatic activities and encompasses all the agency's management activities. The Model Organization goal also includes support for the activities of the Office of Inspector General (OIG) and the National Science Board (NSB), which are provided in separate appropriations.

Workforce Development. The FY 2013 budget request includes \$209.47 million, or \$6.56 million over the FY 2012 Estimate, for funding NSF's federal workforce. The Request will support 1,352 full-time equivalents (FTE), an increase of 25 over the FY 2012 Estimate allocation of 1,327 FTE.

iTrak. FY 2013 is the first year of iTRAK implementation. iTRAK will transition NSF from its legacy financial and property management systems to a fully integrated financial management solution. In FY 2013, the total Request for iTRAK is \$11.70 million.

Efficient Management

NSF's FY 2013 Request follows a thorough examination of programs and investments across NSF to determine where the potential exists for more innovative investments. As good stewards of the public trust, we have reduced or eliminated lower priority programs, identified opportunities to leverage resources for maximum impact, and held the line on NSF's operating expenses.

This Request includes several recommended cuts and consolidations.

Computer and Information Science and Engineering Research Programs: Three programs within the Directorate for Computer and Information Science and Engineering (CISE) are eliminated since they have reached their planned endpoints and have achieved their original goals. These programs are: Network Science and Engineering (NetSE); Social-Computational Systems; and the Interface between Computer Science and Economic & Social Sciences (ICES). Support for these research areas will be absorbed into CISE core programs.

Cyber-Enabled Discovery and Innovation (CDI): NSF eliminates funding for the agency-wide CDI program, as the program has reached its planned conclusion and has achieved many of its original goals. Funding in FY 2013 will be redirected to support new efforts in two NSF cross-agency investments (CEMMSS and CIF21) that will build on the accomplishments made in the CDI program.

Mathematical and Physical Sciences Research Programs: Four programs within the Directorate for Mathematical and Physical Sciences (MPS) are eliminated because they overlap with larger core disciplinary programs or they have achieved their original goals. Two programs are eliminated as they are no longer needed as stand-alone programs: Mathematical Physics and Grid Computing. Research conducted under the third program, Cultural Heritage Science, will be funded through regular MPS disciplinary programs. Lastly, the CHE-DMR-DMS Solar Energy Initiative (SOLAR) will be subsumed within the broader framework of NSF's SEES investment through the Sustainable Energy Pathways solicitation.

Nanoscale Science & Engineering Centers (NSECs): NSF reduces support for the NSEC program because the state of the research in this area has matured significantly and the research should advance more rapidly in a different, more use-inspired research center program. Several NSEC grants may transition to the Nanosystems Engineering Research Centers (NERCs) as the nano-devices and processes created at graduating NSECs move to the systems level and potential commercialization. NSF will continue to support eleven continuing NSECs in FY 2013 including the Nanomanufacturing ERC.

Public Outreach terminations: NSF eliminates two small stand-alone public outreach programs because they lack rigorous evaluation and are duplicative of the larger, well-established peer-reviewed Advanced Informal STEM Learning program (formerly, the Informal Science Education program). The eliminated programs are: Communicating Science Broadly and Connecting Researchers with Public Audiences.

Conclusion

With intense global competition for knowledge and talent, we must focus our attention on finding the sophisticated solutions that will ensure a prosperous, secure, and healthy future for the nation and the world. Robust NSF investments in fundamental science and engineering research and education have returned exceptional dividends to the American people, expanding

knowledge, improving lives, and ensuring our security. To keep those benefits flowing, we need to constantly replenish the wellspring of new ideas and train new talent while serving as good stewards of the public trust. That is the fundamental and continuing mission of NSF.

Mr. Chairman and members of the Subcommittee, I hope my testimony explains how the Foundation plays a vital role in ensuring that America remains at the epicenter of the ongoing revolution in research, innovation, and learning that is driving 21st century economies. More than ever, the future prosperity and well being of Americans depend on sustained investments in our science and technology. NSF has been and continues to be central to this endeavor. The FY 2013 Budget Request for NSF clearly acknowledges NSF's pivotal role in ensuring America's future STEM leadership and economic wellbeing.

This concludes my testimony. I thank you for your leadership, and I will be pleased to answer any questions you may have.