TESTIMONY

Dr. Arden L. Bement
Director
National Science Foundation

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Introduction

Chairman Baird, Ranking Member Ehlers, and distinguished members of the Subcommittee, thank you for this opportunity to discuss international science and technology (S&T) cooperation and the National Science Foundation's (NSF) current international activities. NSF's combined research and education portfolio provides rich examples of global S&T cooperation. We believe that science collaboration and science diplomacy are essential ingredients for America's future progress and prosperity. I am pleased to testify on this important and timely issue.

Scientists have played an important role on the front-lines of U.S. diplomacy since the end of World War II. They have been the enablers of larger international diplomacy efforts, from the robust scientific exchange with China to renewed and strengthened relations with Egypt, India, and Pakistan—all started with the peaceful beachhead of scientific diplomacy.

For instance, polls indicate that people in the Middle East generally view American S&T more favorably than other aspects of our society. This approving attitude provides for favorable forums to explain other aspects of American policies and actions. Our nation's citizens also benefit directly from S&T cooperation, as it provides our scientists and engineers with greater access to cutting-edge research and allows us to work across geographical boundaries to solve global problems.

In addition, globalization has amplified the worldwide competition for ideas, science and engineering (S&E) talent, and leadership in turning new knowledge into real-world applications. Many nations are accelerating their investments in research and development, education, and infrastructure in order to drive sustained economic growth. To continue being a global leader in S&T, we must ensure that we have access to discoveries being made in every corner of the world.

The National Science Foundation understands the global nature of scientific discovery, and the international character of knowledge creation and research activities are stressed in NSF's FY 2006-2011 Strategic Plan, *Investing in America's Future*. For more than 55 years, NSF has connected S&E researchers and educators in academic organizations, industry and informal science institutions, both nationally and internationally, to leverage intellectual capabilities. NSF has strengthened the nation's collaborative advantage by leading or participating in key interagency initiatives as well as by developing innovative collaborations across all S&E disciplines.

Three categories of activities illustrate NSF's engagement in international S&T: (1) leadership and diplomacy efforts to foster global S&E connectivity; (2) the coordination and support of research projects, both large and small, that have an international component; and (3) the activities of NSF's Office of International Science and Engineering (OISE). The following selected examples underscore the broad influence of NSF activities.

Leadership and Diplomacy Efforts to Foster Global Science and Engineering

The exchange of scientific information and the cooperation in international scientific research activities were identified by the first NSF Director, Alan Waterman, as two of the major responsibilities that Congress had given the agency. NSF embraced those responsibilities in its first cycle of grants, supporting international travel and the dissemination of scientific information originating overseas. NSF recognized that a two-way flow of information and individuals between nations resulted in both better science and improved international goodwill.

In 1955, NSF took a comprehensive look at the role of the federal government in international science, and warned that it was important that "activities of the U.S. Government in the area of science not be tagged internationally as another weapon in our cold war arsenal." NSF concluded that international scientific collaboration, based on considerations of scientific merit and the selflessness of the United States, could help ease international tensions, improve the image of the United States abroad, and help raise the standard of living among less-developed nations.

NSF has long embraced multilateral projects as an essential aspect of its portfolio, beginning with the International Geophysical Year of 1957, and continuing with such activities as the International Biological and Tropical Oceans-Global Atmosphere programs, and, more recently, the International Continental Drilling Program, Gemini Observatory, Rice Genome Sequencing Project, and International Polar Year. The agency has also fostered bilateral partnerships in all parts of the world. These overarching partnerships, most of which involve extensive interagency

collaboration on the U.S. side, have generated thousands of cooperative research projects on multiple scales.

As you know, the Office of Science and Technology Policy (OSTP) guides and oversees the administration's international science and technology strategies and portfolio. Through OSTP, the National Science and Technology Council (NSTC) has a pivotal role in setting priorities for and coordinating interagency collaborations, including those that are international in nature. International cooperation is integrated throughout the four committees of the NSTC, and NSF participates in this work on many levels. I currently co-chair the Committee on Science and serve as the NSF representative on the Committee on Homeland and National Security. NSF Deputy Director Kathie Olsen serves as the NSF representative on the Committee on Environment & Natural Resources and Committee on Technology. NSF is involved in most of NSTC's subcommittees and working groups, and leads many. For example, Dr. Jim Collins, the Assistant Director of the Directorate of Biological Sciences, chairs the Biotechnology Subcommittee, and Dr. Jeannette Wing, the Assistant Director for Computer and Information Sciences and Engineering, co-chairs the Networking and Information Technology Research and Development.

NSF's senior management team also participates in other important international bodies. As NSF Director, I represent the United States at the annual meeting of the Heads of Research Councils (HORCS) for the G-8 countries (Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, and the United States). These meetings provide opportunities for international leaders to meet on a regular basis, to review bilateral issues or problems with individual counterpart agencies, and to propose cooperation on particular topics of common interest. In the last few years, NSF has chaired HORCS working groups on public understanding of science, evaluation of research results, and science and math education in schools.

I also currently serve as a member of the U.S. National Commission for UNESCO and as the vice-chair of the Commission's Natural Sciences and Engineering Committee. As part of the our involvement with US National Committee for UNESCO International Hydrological Programme, NSF is currently working with UNESCO, the U.S. Geological Survey (USGS), the Department of State, and other federal science agencies to organize a high-level Water Science Forum to explore the potential contributions of U.S. science to the challenges of drinking water supply and safety, sanitation, drought, and resource management. The forum, to be held on June 27, 2008, will involve about 80 people, including UNESCO leadership, foreign embassies, and experts from U.S. agencies and academia. A larger meeting, also sponsored by this group and involving hundreds of scientists from around the world, will be held in Irvine, CA, December 1-6, 2008. NSF also actively participates in the OSTP-led Interagency Working Group on Science of UNESCO, which is exploring future collaborative opportunities between the U.S. S&E community and UNESCO.

Additionally, NSF Deputy Director Kathie Olsen serves as vice-chair of the Board of Trustees of the Human Frontier Science Program and as co-chair of the U.S.-EC Biotechnology Task Force. NSF leadership also represents the U.S. government on the International Group of Funding Agencies for Global Change Research, and through multiple roles in the activities of OECD's Global Science Forum. For example, NSF has recently been involved in hosting workshops on

the science of science policy and biocomplexity, and the agency plays a major role in the coordination of the U.S. role in large facilities. NSF also plays significant roles in the consultative meetings of the Antarctic Treaty, in the scientific activities of other United Nations specialized agencies, such as the World Meteorological Organization, and in the activities of the Arctic Council, where we represent the scientific interest of all the Arctic nations. Through these activities, NSF leadership interacts directly with heads of state, ministers, and other principals to discuss forming new multilateral and bilateral agreements, or to alter or extend already existing agreements. Such leadership roles play a critical role in keeping the nation proactively involved in the international S&T arena.

NSF's overseas offices in Beijing, Paris, and Tokyo also proactively promote collaboration between the United States and international S&E communities. Staff headquartered in these offices report on in-country and regional S&T developments and policies, serve as resources of information on current and emerging issues in S&E and policy, and work as liaisons between NSF and foreign organizations and researchers. The offices also regularly support NSF's directorates' and research offices' efforts to expand NSF programs internationally and to finalize implementing agreements. Thus, they play an important role in helping NSF pursue its mission of promoting U.S. research and education excellence in a global context.

Moreover, program officers from NSF's OISE and the heads of its overseas offices have helped establish solid working relationships with counterpart agencies and organizations abroad. Examples are the UK Research Councils, the Japan Society for the Promotion of Science, the National Natural Science Foundation in China, CONACyT in Mexico, the Centre National de la Recherche Scientifique in France, the Deutsche Forschungsgemeinschaft in Germany, the National Research Foundation in South Africa, the Russian Foundation for Basic Research and the Czech Ministry of Education. Over the years, senior officials and program officers from these and other organizations have held numerous discussions, participated in seminars and workshops, and funded cooperative research projects. Since we fund the U.S. portion of international research, these venues provide numerous U.S. S&E researchers, postdoctoral fellows, graduate students, and undergraduates opportunities to gain important international perspectives.

NSF's support of the annual U.S. contribution to the International Institute for Applied Systems Analysis (IIASA) and the International Council for Science (ICSU) via grants to the National Academy of Sciences—the National Member Organization for both IIASA and ICSU—also facilitates involvement of U.S. scientists and engineers in international non-governmental organizations. This support enables U.S. scientists and engineers to participate in global S&E projects. Of particular interest for this hearing, both organizations concentrate on scientific fields of policy importance, including topics focused on the developing world, such as environmental, economic, technological, and social issues in the context of global change.

The Embassy Science Fellows program, administered by the Department of State and coordinated within NSF by OISE, also provides for valuable international experience. Fellows from NSF and certain other U.S. Government agencies spend between one and three months at foreign posts as visiting "scientist/engineer-consultants" to the Embassy, working closely with the Science Counselor and/or other embassy staff involved in S&T issues. The fellows conduct

assessments of in-country S&E institutions, fields, and priorities, and meet with leading scientists and science administrators.

Finally, facilitating the flow of S&E talent to the United States is also a major concern of NSF. OISE continues to serve as a resource on visa policies both to the scientific and engineering community at large and to the Department of State. OISE continues to track the visa situation, providing timely information to NSF senior management and program officers as the policies evolve.

NSF's International Research and Education Portfolio

The U.S portion of international S&E research and education activities is funded by all NSF directorates and research offices. International implications are found throughout all of NSF's activities, from individual research awards and fellowships for students to study abroad, to centers, collaborations, joint projects, and shared networks that demonstrate the value of partnering with the United States.

As a result of its international portfolio encompassing projects in all S&E disciplines, NSF effectively partners with almost every country in the world. The following examples illustrate the international breadth and scope of NSF's international portfolio.

The Research Experiences for Undergraduates program, an NSF-wide activity, gives undergraduate students the opportunity to engage in high-quality research, often at important international sites. One of these sites is CERN, the European Laboratory for Particle Physics in Switzerland, and one of the world's premier international laboratories. Undergraduate students work with faculty mentors and research groups at CERN, where they have access to facilities unavailable anywhere else in the world. NSF also provides support for the Large Hadron Collider housed at CERN.

Collaborations among individual NSF-supported investigators are also common in NSF's portfolio. Recently, scientists at the University of Chicago created a single-molecule diode, a potential building block for nanoelectronics. Theorists at the University of South Florida and the Russian Academy of Sciences then explained the principle of how such a device works. They jointly published their findings.

The Foundation's Division of Materials Research supports the Materials World Network (MWN), a global collaborative aimed at fostering partnerships between materials science and engineering researchers at institutions around the globe, including institutions in Africa, Europe, Asia, and Australia. The MWN was launched in 1995 and further developed via a series of NSF co-sponsored workshops around the world. Through MWN, NSF and international partner agencies jointly solicit proposals for collaborative projects. Since 2001, NSF has participated in funding over 180 awards. Research is targeted at improving medical diagnosis, developing stronger materials for the housing and transportation industries, and more.

At the ends of the world, NSF coordinates nearly all of the U.S. scientific research in the Arctic and Antarctica through its Office of Polar Programs. In fact, NSF was designated as the lead

federal agency for the International Polar Year (IPY) 2007-2008. During this campaign, more than 100 countries undertook projects involving scientists, students, teachers, and the public to increase understanding of the polar region.

Research at NSF supported-centers also has significant international implications. For example, the NSF Center for Sustainability of Semi-Arid Hydrology and Riparian Areas recently won the International Great Man-Made River Prize awarded by UNESCO. The prize "rewards remarkable scientific research work on water usage in arid region as well as areas subject to drought and also for the development of agriculture for the benefit of humanity and the environment." More than three dozen scientists and support staff at another NSF-supported center recently won a different prestigious award for their work on climate change. Researchers and staff at National Center for Atmospheric Research (NCAR), as well as many other NSF-supported researchers, were involved in reports by the U.N. Intergovernmental Panel on Climate Change (IPCC). The U.N. Intergovernmental Panel on Climate Change (IPCC) was awarded the 2007 Nobel Peace Prize along with former Vice President Al Gore.

There are also examples where NSF partners with the United States Agency for International Development (USAID) to support international S&T programs to facilitate capacity building. For example, the U.S.-Pakistan Science and Technology Program, led by a coordinating committee chaired by Dr. Arden Bement, NSF Director, and Dr. Atta-ur-Rahman, Pakistan Minister of Education and Science Advisor to the Prime Minister. USAID funds the U.S. contribution of the joint program and supports other programs in Pakistan involving NIH and other agencies. This US-Pakistan S&T program supports a number of joint research projects peer reviewed by the National Academy of Sciences and approved by the joint S&T committee. Over the past year, the Committee has also established sixteen S&T working groups that involve interagency participation in Pakistan and in the United States to carry out joint research projects of mutual interest (with direct benefit to Pakistan).

Through this collaboration, NSF just completed a network connection of *Internet 2* with Pakistan to facilitate research and education collaborations and data exchanges under the program. This project embodies one of NSF's top priorities, the development of the national science and engineering cyberinfrastructure, enabling a prime role for the United States in global research networks. NSF's goals for the national cyberinfrastructure include the ability to integrate data from diverse disciplines and multiple locations, and to make them widely available to researchers, educators, and students. Already, the Grid Physics Network and the international Virtual Data Grid Laboratory are advancing IT-intensive research in physics, cosmology, and astrophysics.

In today's highly sophisticated, technology-driven science, many international partnerships center around major, high-budget research facilities that are made possible only by combining the resources of more than one nation. For example, NSF's facilities budget includes construction funds for the IceCube neutrino detector, antennas for the Atacama Large Millimeter Array (ALMA), and observation technologies for the Arctic Observing Network (AON).

The IceCube Neutrino Observatory—the world's first high-energy neutrino observatory—offers a powerful example of an international, inter-agency research platform. Agencies in Belgium,

Germany, and Sweden have joined NSF and Department of Energy (DOE) in providing support for IceCube, which will search for neutrinos from deep within the ice cap under the South Pole in Antarctica. Neutrinos are hard-to-detect astronomical messengers that carry information from cosmological events.

The Atacama Large Millimeter Array, currently under construction near San Pedro de Atacama, Chile, will be the world's most sensitive, highest resolution, millimeter wavelength telescope. The array will make it possible to search for planets around hundreds of nearby stars and will provide a testing ground for theories of star birth, galaxy formation, and the evolution of the universe. ALMA has been made possible via an international partnership among North America, Europe, and East Asia, in cooperation with the Republic of Chile. NSF is the U.S. lead on this groundbreaking astronomical facility.

As part of the aforementioned IPY activities, NSF serves as lead contributing agency for the Arctic Observing Network (AON)—an effort to significantly advance our observational capability in the Arctic. AON will help us document the state of the present climate system, and the nature and extent of climate changes occurring in the Arctic regions. The network, organized under the direction of the U.S. Interagency Arctic Research Policy Committee, involves partnerships with the National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration, Department of Interior, Department of Defense, Smithsonian Institution, National Institutes of Health, DOE, and USDA. NSF coordinates AON activities across the U.S. government, as well as with international collaborators, including Canada, Norway, Sweden, Germany, and Russia.

Such international infrastructure projects will continue to play a key role in advancing S&E capacity worldwide. NSF leadership and proactive involvement in large international research projects helps ensure that U.S. S&E stays at the frontier.

The Office of International Science and Engineering

The Office of International Science and Engineering—the centerpiece of NSF's international activities—integrates Foundation-wide activities and manages a broad range of programs that support U.S. scientists and engineers engaged in international research and education. OISE is currently leading the agency's effort to develop a goal-oriented strategic plan that will inform the coordination of international activities across the Foundation. In FY 2009, NSF proposes a budget of $47.44 million for OISE.

Organizationally, OISE is comprised of five regional groups and the three aforementioned international offices. OISE has two programmatic priorities: (1) to enhance research excellence through international collaboration; and (2) to serve as a catalyst for partnerships between the U.S. and the international research community.

OISE works closely with the NSF directorates and other research offices to co-fund innovative awards and supplements that promote research excellence through international collaboration and develop the next generation of globally engaged U.S. scientists and engineers. For example, OISE and NSF's Directorate of Mathematics and Physical Sciences co-fund the "East-West

Collaboration." The East-West Collaboration supports frontier research in elementary particle physics. This scientific interchange between a 20-university collaboration centered at Cornell University and an 18-university collaboration centered at the Institute for High Energy Physics in Beijing, China has enabled a faster start-up for the first superconducting magnet in China, advances in "new physics," and for the direct partnership of U.S. and Chinese scientists. As China continues to invest heavily in science and engineering research, such collaborations will foster necessary intellectual exchange for U.S. scientists and engineers as well lead to greater connectivity between the United States and China.

OISE also serves as an interface for NSF's directorates, offices, divisions, and programs with multi-national organizations, international science organizations, and national funding agencies and ministries in other countries. OISE often works with international counterpart agencies to educate them on the Foundation's peer review process, organizational structure, and funding process, as many, particularly those in developing countries, look to NSF as a model for how to run their programs.. These efforts help align agency procedures close to those of NSF, which can often make collaboration and science funding more effective in these countries.

For example, the United Arab Emirates' (UAE) Ministry of Higher Education has commissioned their scientists to establish a National Research Foundation by early 2008. These scientists visited NSF in January 2008 to learn about NSF procedures for support of research and evaluation of results. Additionally, the King Abdulaziz City for Science and Technology in Riyadh, NSF's counterpart agency in Saudi Arabia, will send its Director of Research in August 2008 to learn about NSF. China is also planning to send a representative to study the NSF model, as they are planning a similar research agency. Additionally, Turkey, France, Japan, and Ireland, among others, are emulating the NSF model.

NSF's international office has implemented specific programs to stimulate innovative international partnerships. The East Asia and Pacific Summer Graduate Research Institutes (EAPSI), International Research Fellowship, and Partnerships for International Research and Education (PIRE) Programs are examples of three OISE-supported programs that facilitate partnership across institutions and countries.

The *East Asia and Pacific Summer Graduate Research Institutes (EAPSI) Program* enables U.S. graduate students to build collaborations with scientists and engineers working in the top research facilities in East Asia and the Pacific region. The eight-week institute programs are held at top research institutions in Japan, Korea, Taiwan, China, Australia, New Zealand, and Singapore. Over 1,600 U.S. graduate students have participated in the program since its inception in 1990. The program fosters a U.S. S&E workforce capable of operating in a global marketplace increasingly impacted by scientific developments in Asia and the Pacific Region.

The research of a behavioral biology student from Texas A&M University offers one example of the resulting increased international connectivity. The student studied the ability of giant pandas to recognize their kin by establishing a live web based "Panda Cam" at China's Wolong Nature Reserve. This student's project not only opened the door for researchers and the broader public to observe the behavior of pandas in their natural habitat, but it helped develop a bridge among China's Forestry Ministry, the Chinese Academy of Sciences, and U.S. researchers.

The *International Research Fellowship Program* supports approximately three dozen U.S. postdoctoral fellows for 9 to 24 months at foreign host institutions annually. The program's objective is to introduce U.S. scientists and engineers to cutting-edge international research opportunities in the early stages of their careers. Fellows' research projects involve international collaboration, the use of overseas instrumentation, and access to unique research environments in a wide range of fields, including biology, physics, engineering, geosciences, computer sciences, and social and behavioral sciences.

In fiscal year 2007, 39 fellowship recipients from 21 states were selected to conduct research in 21 foreign countries. After completion of the fellowship, the researchers return to jobs in academia and industry in the United States. Past fellows attest that their experiences abroad were unparalleled career-enhancers and that the fellowship placed them at the leading-edge of their field of research and positioned them to build new collaborations with colleagues in their host country. These collaborations have also led to foreign hosts of NSF International Research Fellows joining U.S. research teams.

The *Partnerships for International Research and Education (PIRE) Program* is an example of a larger collaborative research activity supported by OISE. PIRE enables U.S. institutions to establish collaborative relationships with international groups or institutions to conduct research dependant upon international collaboration. The program catalyzes a cultural exchange in U.S. institutions by establishing innovative models for international collaborative research and education. PIRE also readies U.S. students to participate in international research collaborations.

To date, the PIRE program has supported the work of 32 institutions in 23 states. Research collaborations with more than 40 countries have resulted. The U.S.-China PIRE project on electron chemistry and catalysis was listed in the Chinese media as one of the top ten S&T developments in China for 2006. The PIRE program supports research projects that nurture U.S. relationships with international counterparts.

Another PIRE project has significantly impacted the developing world. The "AfricaArray" brought together U.S. and African geoscientists, as well as students, to study seismological and volcanic activity in Africa. Collaborators from Penn State University, the University of Witwatersrand (South Africa), the University of Dar Es Salaam (Tanzania), and the National Seismological Network (Uganda) have developed a network of seismic monitoring stations that cross the African continent to study the origins and structure of the African Superplume, an anomalous part of the Earth's mantle that stretches from deep in the mantle to near the surface. To date, the NSF-supported researchers leading AfricaArray have collaborated with more than 20 U.S., African, and European universities, in addition to large cooperations, in order to advance the understanding of Earth's mantle dynamics.

AfricaArray is only one of 15 PIRE projects involving collaboration with scientists in developing countries. Other examples include a project with Indonesia, Malaysia, and the Philippines to transform a biodiversity hotspot into a research and education opportunity as well as a project with Argentina and Mexico to enable cyberinfrastructure applications. In total, the 15 projects represent approximately $36 million in NSF funds, invested in U.S. collaborating institutions.

In recent years, OISE has put greater emphasis on increasing linkages between scientists in the United States and those in developing countries. Specifically, OISE hired a new Program Manager for Developing Countries to expand collaborations with developing countries. Outreach presentations have been given at 12 domestic institutions and 20 international institutions in 10 countries. This OISE program manager and NSF senior leadership are also initiating and continuing dialogue with 12 funding agencies appropriate to co-fund the developing countries' portion of S&E projects, e.g., the International Foundation for Science, the International Rice Research Institute, USAID, and the World Bank.

The progress of humankind will depend increasingly on the new knowledge of science and technology. The collaborative pursuit of new knowledge is a powerful tool for bringing people together, and OISE activities will continue to stimulate global collaboration.

Conclusion

International collaboration in S&E is a necessary foundation for the future. In order for the United States to be competitive in this new global society, we must engage in international research. And, we must proactively develop a workforce that is adept at working on international research teams.

For NSF, this means a continued commitment to foster collaborations of all kinds and to seek new forms of partnership to address today's research challenges and opportunities. The more widely research, data, and new knowledge are shared, the broader the resulting perspectives. As you can see from the numerous examples above, the National Science Foundation is committed to international partnership and collaboration on many levels.

We will continue to leverage our broad mission to catalyze international research endeavors in all disciplines and to train an internationally engaged S&E workforce. We will also continue to leverage science and engineering know-how and the NSF model to catalyze larger diplomatic efforts.

Lastly, we look forward to any new insights that can be garnered from the National Science Board's new report entitled, "International Science and Engineering Partnerships: A Priority for U.S. Foreign Policy and Our Nation's Innovation Enterprise;" we are currently working with the board on their recommendations.

Thank you again for the opportunity to testify, and I would be happy to respond to any questions.