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CRITICAL OUTCOME 1 SUMMARY

1.0 EXCELLENCE IN SCIENCE & TECHNOLOGY

1.1 INTRODUCTION

Brookhaven Science Associates (BSA) rated its overall Science and Technology (S&T) performance for Fiscal Year (FY) 2004 as ***Outstanding*** with a corresponding score of 3.77. The Laboratory achieved noteworthy accomplishments under each of the four Office of Science S&T Objectives and the Nanoscience Initiative Objective as well as demonstrating progress in addressing comments raised by the Department of Energy (DOE) in previews, reviews and evaluations.

The table below shows individual scores for the Office of Science Objectives.

Objective	Weight	Rating	Score
Quality	30%	Outstanding	3.8
Relevance to DOE Mission	10%	Outstanding	3.8
Success in Constructing and Operating Research Facilities	25%	Outstanding	3.8
Research Program Management	30%	Outstanding	3.7
Nanoscience Initiative	5%	Outstanding	3.7
Overall	100%	Outstanding	3.77

The Deputy Director for Science and Technology assigned these scores based on input from the Associate Laboratory Directors (ALD's) of the five BNL Science Directorates. In determining the evaluation scores, the Deputy Director considered many factors including benchmarks from experience and DOE evaluations; major successes; peer review input and research program deficiencies; success in addressing issues to improve research program management both within science and technology organizations, as well as those initiatives taken at the institutional level.

In support of the science mission of the Laboratory senior management has focused on two highly visible areas 1) safety and 2) a new energy contract.
Regarding safety the Laboratory has aggressively initiated a campaign promoting safety at all levels and to help Laboratory staff understand how BNL's Environment, Safety and Health policy commitments apply to all employees. Additionally, three organizations (Collider-Accelerator Department, Plant Engineering Division, and Central Fabrication Services Division) successfully received Occupation, Health, Safety Assessment Series (OHSAS) 18001 Registration.

In FY 04 Laboratory management has been aggressively pursuing the lowest possible electrical power rates to limit the impact any increases would have on the science mission of the Laboratory. This includes negotiating for a new energy contract with local and state officials as well as other potential suppliers.

Highlights of Science & Technology performance are discussed in the following sections.

1.2 INSTITUTIONAL LEVEL PERFORMANCE

1.2.1 Initiatives

1.2.1.1 Scientific Staff

As it was reported in the FY2003 Self Evaluation, a number of key scientific management positions were filled last year. With these appointments, the scientific management at the Laboratory remained stable through FY 2004, except for Dr. Peter Paul's retirement from the position of Deputy Director for Science & Technology on July 2, 2004. Dr. Peter Bond was appointed to the position on an interim basis to replace Dr. Paul.

BSA continues its effort to retain and recruit top-level staff at all levels in order to maintain its core scientific strength. Maintaining a proactive and focused hiring effort, the Science and Technology sector was able to attract many new scientists and technical staff. Examples of some of these appointments are:

- Ivan Bozovic, Sr. Materials Scientist in the Materials Science Department
- Joanna Ingraham, Nuclear Engineer in the Nonproliferation & Nat'l Security Department
- Douglas Wright, Associate Physicist in the Environmental Sciences Department
- Three Goldhaber Fellows, Hua Gen Yu (Chemistry Department), Elena Lynar (Biology Department), and Oleg Gang (Physics Department) were promoted to the Assistant Scientists.
- Kuo-Wei Huang, a Goldhaber Fellow in the Chemistry Department to start on or about 10/1/04
- Adrian Gozar, a Goldhaber Fellow in the Materials Science Department to start on or about 10/1/04
- Dev Chidambaram, a Goldhaber Fellow in Energy Sciences & Technology Department to start on or about 10/1/04.

As a result of the departure of George Hendrey, the leader of the FACE project, the Laboratory is searching for another leader to replace him.

The Laboratory's postdoctoral Research Associate subsidies, the distinguished Goldhaber Fellowship Program established by BSA, and other opportunities made available at the Laboratory have contributed significantly to the increase in the appointments of young scientists. Their number, which was 127 as of 6/30/03, has increased to 131 as of 6/30/04. The total number of scientific staff, including the post doctoral fellows, increased from 556 to 580 in the same period, while the total number of employees at the Laboratory decreased from 2,892 to 2,826.

1.2.1.2 Planning (Long- and Short-term)

The Laboratory engages in several aspects of planning, i.e., strategic planning, facilities initiatives planning, program planning and integration, staff planning, and planning to meet user needs. The Project, Planning, Programming and Budgeting Process (3PBP) process for prioritizing short-term infrastructure/ESH projects, major facility and site master planning, and strategic planning by the Director and ALD's continue to be performed in an outstanding manner. Plans for staff and program realignment and integration are being executed. Bottoms-up planning and integration have improved. Overall organizational planning is excellent; planning across organizations is improving and has been encouraged by Senior Management, especially over the past year. The Laboratory recognizes the ongoing need to improve and to better coordinate the planning process, and established the Integrated Planning Office to assist in pulling it together. Below are examples of institutional planning and execution of that plan.

- Strategic planning by Senior Management for Science and Technology provided a roadmap of ten leadership themes and facilities in support of them, and a long-term vision of how the Laboratory will continue to serve DOE and our national and international communities. The Science and Technology Agenda, BNL's "Future of the Laboratory," and the Institutional Plan flow from these efforts.

- As part of developing the S&T Agenda, the Laboratory assessed the preparatory needs (Laboratory Directed Research and Development [LDRD], program development, infrastructure improvement) of each of the scientific directorates for the next three years and correlated them with projected program growth and the likelihood of success. In parallel, to ensure that LDRD resources are allocated to potential growth areas, for this year, Senior Management agreed to allocate up to 50% of available funds for projects in the Life Sciences and at the Interface of the Life and Physical Sciences, with the stipulation that the projects uphold the required standards of excellence.

- BNL's highest priority, the upgrade of the NSLS (the NSLS-II), will provide the synchrotron user community with cutting edge capabilities well into the future. The determination of the mission need (CD-0) for this third-generation storage ring was submitted during FY04. Such a machine is crucial for the Northeast user community, BNL programs in Basic Energy, Biological and Environmental Sciences, and for the new nanoscale structures to be fabricated in the CFN (that recently passed CD-2). DOE lists this upgrade as one of its priorities in "Facilities for the Future of Science: A Twenty-Year Outlook."

- In Nuclear Physics, evolution of QCD physics and unraveling the spin of the nucleon are the two top science priorities. RHIC is the BNL facility that will ensure these priorities are met. Planning for the next twenty years of research at RHIC also entails a luminosity upgrade and detector upgrade (RHIC II) and adding an energetic electron beam for collisions with RHIC ion beams (eRHIC). These plans will continue to provide world-leading capabilities in Nuclear Physics well into the future. RHIC II and eRHIC are included among SC's priorities in the "Facilities for the Future of Science: A Twenty-Year Outlook."

- For High Energy Physics (HEP), the Laboratory, in partnership with core universities, anticipate funds in the NSF budget for the construction of Rare Symmetry Violating Processes (RSVP) that will look for physics beyond the standard model. Along with the NASA Space Radiation Laboratory, completed in June 2003 that also uses the cutting-edge capabilities of the Alternating Gradient Synchrotron (AGS), it will provide BNL's unique capabilities to another sponsoring agency.

- BNL is developing a plan to construct a "Super Neutrino Beam," using the intensity-upgraded AGS. This HEP project will answer all the remaining questions about neutrino, namely neutrino masses, coupling strength, and CP-violation. DOE lists a Super Neutrino Beam Project in the Future Facilities Plan. As a BNL leadership theme, we coordinate the neutrino working group, a multi-institution collaboration.

- The Large Synoptic Survey Telescope, another HEP project to determine the nature of Dark Energy, was endorsed by three National Academy of Science (NAS) studies and is also a high priority in the Office of Science and Technology Policy's (OSTP) recently published "The Physics of the Universe." BNL requested funds from the SC-OHEP to start a research group that would work on the proposed DOE-funded component of the project, namely the camera. BNL's specific responsibility will be the focal plane assembly. This will pave the way for a new line of fundamental research in astrophysics and cosmology at BNL.

- BNL's long-term strategy positions our BES programs to be leaders in three "Grand Challenge" areas. It relies on integrating our research programs with our facilities, namely the CFN, the NSLS, and the NSLS-II, in pursuit of solving the strongly correlated electron problem, making predictive design of catalysis a reality, and producing materials at the interface of life and physical sciences. The latter is multidisciplinary in nature and will involve collaboration across several directorates.

- In the Life Sciences, we are already world leaders in brain health, another of BNL's leadership themes. Specific initiatives that we will undertake during the next decade to maintain our prominence are a center for radiotracer development and translation, imaging in awake animals, children, and in the developing brain, an imaging institute, and an expanded space biomedical program. To facilitate interaction in carrying out these programs, the Center for Translational Neuroimaging, comprised of all PET and MRI scientists, was created.

- Atmospheric chemistry, particularly aerosols, is another field in which BNL excels. We envision retaining our leadership role by creating an Aerosol Laboratory that will investigate radiative forcing that results from increases in atmospheric greenhouse gases and aerosols. We have already established a group of experts in regional climate models with an emphasis on aerosols whose goal will be to improve climate models and increase our ability to distinguish between natural and human-caused climate change.

- Site Master Planning continues to focus on providing space appropriate for science in the 21st century. The Laboratory is pursuing Third Party Financing as one measure for implementing its plans. Working with the DOE, BNL continues to engage in short and long range plans to maintain and improve the site, including those for our new facilities, such as the Research Support Facility whose construction will start in late 2004. In a related aspect, Senior Management was encouraged to participate in the 3PBP process to ensure that potential infrastructure improvements in support of their leadership themes are addressed and ultimately funded.

1.2.1.3 Overall Integration and Collaborations

As BNL plans for the future, internal and external integration and collaboration activities are essential. BNL has a strong history of collaboration in High Energy and Nuclear Physics and that strength continues. RHIC is the flagship facility of the Laboratory supporting the U.S. nuclear physics program as well as the international nuclear physics community. The NSLS continues to be a major focal point for the Laboratory, industrial and university collaborations, and will be an integrating element of the CFN, which is already operating as a "Jumpstart" user facility, principally in the areas of electron microscopy and nanopatterning. In the Life Sciences, the Biology Department's beamlines at the NSLS, and the STEM and NSRL facilities are critical to the >200 researchers from the U.S. and abroad who use them. Scientists in the Environmental Sciences Dept. have led the FACE program and play a major role in the ARM program. Overall, BNL's large departments are involved in multi-institution collaborations while the small departments participate in a larger number of collaborations comprised of fewer investigators. The following items touch upon the collaborative aspects of major scientific initiatives and leadership themes that occurred during the past year and are not intended to be comprehensive.

- Three of the four RHIC experimental collaborations (BRAHMS, PHOBOS, and STAR) have BNL physicists as spokespersons in FY 2004; these collaborator-elected positions reflect the leadership capabilities of BNL research physicists at RHIC (the BNL facility to maintain a world leading position in QCD physics and Spin of the Nucleon), as it begins to advance toward RHIC II.

- The RIKEN BNL Research Center (RBRC) located in the Physics Department, a collaboration mostly funded by the RIKEN Institute of Japan under the Government-to Government Agreement, plays many important roles in promoting physics with RHIC. Some 30 young researchers supported by the RBRC engage in theoretical and experimental research in relativistic heavy ion collision and spin physics program. In addition, RBRC's 0.6 T-Flop QCDSP super computer in operation and the 10 T-Flop QCDOC under construction at the Center will provide high power lattice gauge computation.

- The collaboration with the High Energy Accelerator Research Organization (KEK) of Japan in the PHENIX Detector program at RHIC, under another Government-to-

Government agreement, continues at a significant level and supported the detector upgrade as well as data taking and analysis operations.

- BNL will play a leading role in the new Large Synoptic Survey Telescope Collaboration, based upon Instrumentation's preeminence in the field of large-scale, low-noise electronic data system capabilities, and our recruitment of scientists for the foundations of an experimental astrophysics/cosmology group.

- The NSLS made a number of significant improvements and upgrades to the existing facility over the past year to accommodate its broad user community. Due to its success in meeting user needs, building a strong scientific program, and fostering collaboration and integration for effective operations, BNL submitted its mission need (CD-0) proposal to DOE for NSLS-II. This upgrade will ensure that the research of its formidable user community will continue to flourish over the next two decades.

- The CFN is the result of internal and external collaborations, and the integration of several BNL internal department staff and external university staff. Recently, it received CD-2 approval from DOE; it will be a focal point for collaboration with nearby universities, NSF nanocenters, and industry. The CFN already held its first annual users' meeting which provided valuable feedback to improve the user and nanoscience programs.

- Internal collaborations continue to grow at BNL. A prime example is our plan to build an Imaging Institute for interdisciplinary and translational research with our world-class radiotracer group at its core. It will incorporate multimodality imaging on length scales from the nanometer to the millimeter, and time scales from nanoseconds to minutes. With strong ties to the NSLS and the CFN, the Institute will operate as a multi-lab partnership and foster needed technology advances through a transfer of knowledge between the physical and life sciences in the field of imaging.

- The BES directorate, comprised of the CFN, Chemistry, and Materials Science Departments, and the Condensed Matter Physics Division, is evolving toward a BES complex where researchers will approach their three Grand Challenges for the future as a team. Among the elements of this "Culture Change" are interdisciplinary collaborations across FWPs, departments and directorates, integration of research programs and facilities, and long term partnerships with universities and industry.

- In EENS, BNL plays a world-leading, as well as a facilitating role in atmospheric chemistry and other technologies. A BNL scientist was named Chief Scientist for the OBER Atmospheric Science Program; another is the site scientist for the ARM program's mobile facility. BNL operates the FACE facility in the Duke Forest and the ARM External Data Center, and coordinated and participated in the North East Aerosol Experiment. With international collaborators, BNL is a vital contributor to advancement of reliable advanced nuclear power generation designs and has developed a thorium-based fuel design which is inherently proliferation resistant.

- Other indicators include our approaches to computation and imaging. DOE plans to fund yet a third QCDOC machine at BNL for lattice gauge theory (LGT) for the U.S. LGT community. BNL et al. have scheduled a workshop to identify areas in computational biology, climate modeling and QCD physics (three BNL leadership themes) where the QCDOC and BlueGene/L architectures will promote collaboration. Likewise, BNL's imaging programs that underpin our brain health initiative interact with research hospitals and clinics; BNL's biomedical engineering laboratory is an exemplary team with participants from five departments/divisions, LBNL and universities.

- In addition, BNL continues to carry a number of research collaborations with domestic and international institutions as follows:

  - HE and NP participate in numerous international collaborations under formal Government-Government agreements. Among them are:
    1) BNL-IHEP (the Institute for High Energy Physics, Beijing) Accelerator Collaboration;
    2) BNL-JPARC Superconducting Magnet Collaboration;
    3) BNL-Riken Collaboration in the Spin Physics Program at RHIC;
    4) BNL-GSI Superconducting Magnet Collaboration;
    5) US-CERN LHC accelerator Collaboration and ATLAS Detector Collaboration

  - In the area of experimental research programs, there are
    1) E949, E962, and; KOPIO Collaborations at AGS;
    2) BRAHMS, PHOBOS, PHENIX, and STAR Collaborations at RHIC;
    3) RIKEN BNL Research Center at BNL
    4) LEGS Research Collaboration at NSLS;
    5) SNO Collaboration at Sudbury; and
    6) The D0 Detector Collaboration at the Tevatron.

  - The BES and EENS directorates are also involved in extensive collaborations. Among them are:
    1) US-Japan Collaboration on Neutron Scattering;
    2) ISIS Postdoctoral fellow program with Rutherford Appleton Laboratory;
    3) Scientific Collaboration on Neutron Scattering;
    4) US-PRC Collaborative Program with IHEP, Beijing;
    5) Complex Materials Consortium;
    6) Global Climate Change and Carbon Management;
    7) International Nuclear Safety Program; and
    8) Initiatives for Proliferation Prevention.

- To support our future leadership in Computational Biology, a user facility here at BNL, letters of support have been received from the BSA Board institutions; Columbia University, Harvard University, Stony Brook University, MIT' Cornell

University, Yale University, and Princeton University, and other local institutions such as Rockefeller University, Cold Spring Harbor Laboratory, and Memorial Sloan-Kettering Cancer Center.

- Collaboration with the State University of New at Stony Brook has resulted in a General Clinical Research Center (GCRC) being established at BNL as an off-site outpatient facility of the GCRC at the University Hospital and Medical Center at Stony Brook. Resources exceeding $730,000 dollars have been allocated by Stony Brook to BNL to support this collaboration.

1.2.1.4 Proposal Process

We break the proposal process into three main categories: the standard Field Work Proposal (FWP) process, new proposals for DOE, and proposals for Work for Others.

- DOE sets the FWP process. To facilitate interaction with DOE, we now post the FWPs on a protected webpage, which is an improvement over the hard copies that we submitted in the past. With the DOE, we are working toward electronic FWP submission.

- Our proposal response to DOE initiatives depends on the DOE program and expectations. During the past year, the most prominent among those submitted was the CD-0 proposal to BES for the NSLS upgrade. In addition, teams from Materials Science, Chemistry, CFN, Biology and Energy, Environment, & National Security (EENS) Departments submitted six pre-proposals to the BES Hydrogen Fuel Initiative call. BES invited full proposals on all six (out of ~700).

- BNL receives significant funding from BER. Since the BER-sponsored Atmospheric Science program is changing direction to address aerosol radiative forcing of climate, scientists in the Environmental Sciences Department submitted proposals totaling more than $3.4 M/yr in response to the Program Announcement for the Atmospheric Sciences Program They also submitted grant applications to BER's NABIR program to expand the DOE-funded Envirosuite Initiative in the newly established Center for Environmental Molecular Science at the NSLS.

- In preparation for a future BER call, scientists from Biology participated in five BER workshops. They also submitted several proposals to the GTL: "Genomes Call for Proposals 03-05" which had a 50% success rate.

- A team from the Center for Data Intensive Computing (CDIC) and Information Technology Division (ITD) responded to Advanced Scientific Computing Research's (ASCR) "Leadership-Class Computation Capability for Science" call. Although the funds (~$25M/yr for five years) were awarded to Oak Ridge National Laboratory (ORNL), BNL's proposal was highly regarded by the DOE. These are significant efforts that have come about as the result of the Lab's strategic planning. In addition to atmospheric chemistry, where we are already a world leader, Computation and

Genomes-to-Life (GTL) represent two areas where we expect to be world leaders in the next two decades.

- In our Work for Others (WFO) proposals, we have been quite successful with NIH and NASA. Our track record with the Department of Homeland Security (DHS) is improving; DHS funds have increased to $ 3.69 M in FY04. The Institutional Plan contains detailed summaries of WFO programs.

- One of our primary goals is to increase BNL's funding from federal agencies other than DOE. The Office of Intellectual Property & Sponsored Research (OIP) has begun to take an active role in providing administrative assistance in preparing NIH proposals. OIP is also posting on their website program announcements of recent funding opportunities and circulating lists of DOD funding opportunities in order to alert researchers about potential sources of non-DOE funds and how to apply for such funding.

1.2.1.5 Laboratory Directed Research and Development

In FY 2004, the LDRD Program continues under the leadership of the Program Director. He continues with the full responsibility for all aspects of the program, and it continues to function efficiently and effectively. A new formal Baldrige type self-assessment was performed in FY 2004; although the results are not yet available we anticipate that it will once again have a positive impact on the administration of the program. Again in FY 2004, the Program Director and a committee, consisting of the Deputy Director for Science and Technology, the five Associate laboratory Directors, and four senior scientific staff, reviewed all proposals, obtained additional information deemed necessary, selected the projects to be funded and the amount of each award.

We continue to emphasize that funding would be made for two years with essentially no likelihood of a third year. This restriction permits us to fund more projects in subsequent years. There was a mid-year review of all projects. This review was a factor in determining whether a project would continue into the next fiscal year. In addition, the Program Director continued the monthly meetings with the DOE Brookhaven Site Office to update the progress of the program and verify that the BNL LDRD Program is meeting the overall LDRD requirements. Congressional inquiries continue to impact the DOE LDRD Program. BNL maintains its support of any new requirements by

- Participating in the DOE SC LDRD working group to develop new guidelines
- Participating in the development of the new Chief Financial Officer (CFO) LDRD database
- Ensuring that all projects support the DOE security missions and missions of other federal agencies
- Identifying potential use/benefits to the DOE security missions for all projects
- Submitting data sheets for all projects to the DOE Operations/Site Office for concurrence
- Including the DOE-BAO LDRD Program Manager in all LDRD selection meetings

In FY 2004, BSA initially approved an $8.5 Million budget, which is beginning to approximate 2 percent of BNL operating funds, which is still far less than the maximum of 6 percent permitted by DOE. However after awarding new projects, financial constraints required that the allocation be reduced to 7.5 million. This was accomplished by delaying the new projects by four months. There continue to be many success stories in the LDRD Program with projects receiving direct funding from DOE, NIH, and CRADA agreements. In addition, several patents were submitted based on LDRD research. We are still planning to increase the LDRD budget, as soon as financial constraints permit, to $9.5 Million. This increase will continue to put us on the road to be more in line with the allocations at the other DOE Science laboratories. The Laboratory continued to assess the accomplishment of the LDRD Projects.

1.2.2 Scientific Recognition

Awards and Accomplishments: Throughout its history, Brookhaven National Laboratory has received numerous recognitions for its contributions to the Technical and Scientific Community. These are the awards and accomplishments received during FY 2004 (October 2003 through September 2004).

Raymond Davis, Jr.
Chemistry Department (retired)

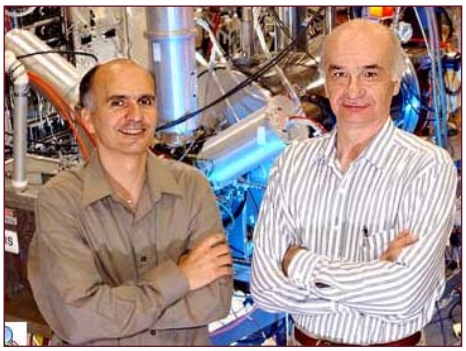
2003 Benjamin Franklin Medal in Physics and 2003 Enrico Fermi Award

Citation: "for detecting solar neutrinos, ghostlike particles produced in the nuclear reactions that power the sun."

Edward Beebe and Alexander Pikin
Collider Accelerator Department

2003 Ion Source Prize, a.k.a. the "Brightness Award"

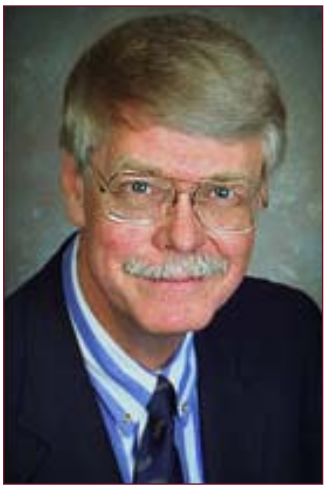
Citation: "for development and testing of a new high-intensity electron beam ion source which is used for production of highly charged heavy ions. This ion source has intensity 20 times higher than predecessors and can be used as a primary source of highly charged gold ions for RHIC."



Joseph Indusi
Nonproliferation and National Security Department

2003 Fellow of the Institute of Nuclear Materials Management

Citation: "for his distinguished contribution to the field of safeguards and nuclear materials management."



Thomas Kirk

Associate Director for High Energy and Nuclear Physics

2003 Fellow of the American Association for the Advancement of Science

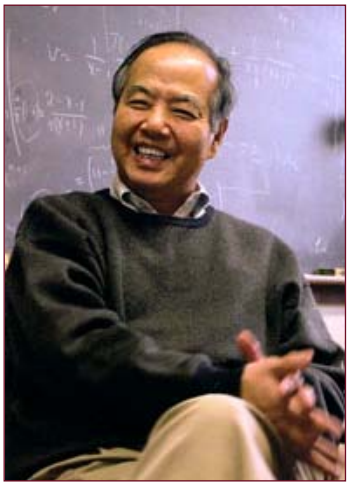
Citation: "for innovative research in particle and nuclear physics across a wide range, for leadership in developing new accelerator facilities and detectors, and for excellence in research administration."

Tsung-Dao (T.D.) Lee

Director Emeritus of RIKEN-BNL Research Center

2003 Pontifical Academy of Science

Chosen on the basis of: "his eminent original scientific studies and acknowledged moral personality, without any ethnic or religious discrimination, and nominated for life by sovereign act of the Holy Father."



Vladimir Litvinenko

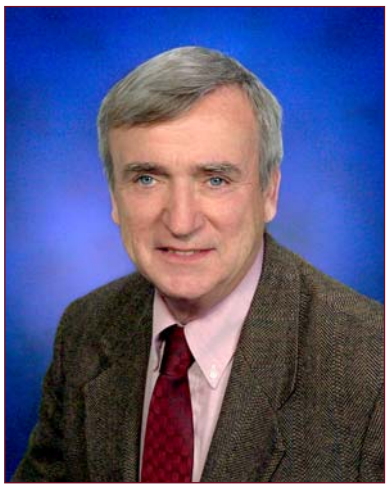
Collider Accelerator Department

2003 Fellow of the American Physical Society (APS)

Citation: "for fundamental and pioneering contributions to the physics of beams in electron storage rings and free-electron lasers, including demonstrating the optical klystron and advancing the short wavelength limit of FEL oscillators."

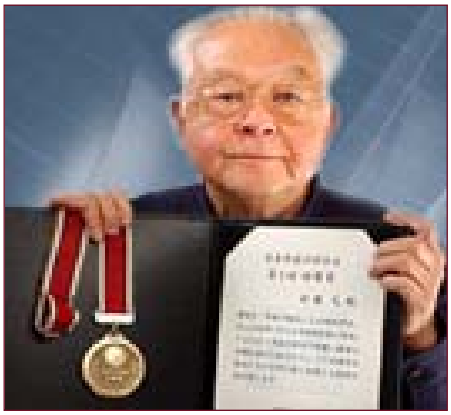
Andrew J. McNerney

Interim Assistant Director for Facilities and Operations



2003 Award for Electrical Engineering Management of the Institute of Electrical and Electronic Engineers Region 1

Citation: "for his managerial excellence in organization, leadership, design, and development of world-class particle accelerator projects."



Gen Shirane

Gen Shirane

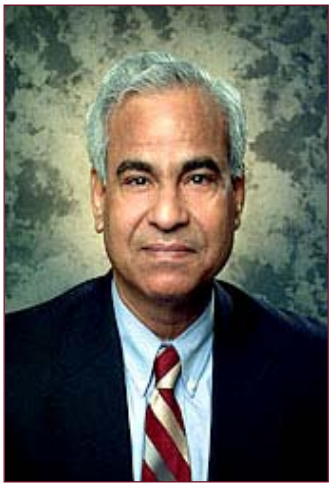
Physics Department

2003 Japanese Society for Neutron Science Medal

Citation: "for his outstanding scientific accomplishments in solid state physics by neutron scattering and his great contribution to the Japanese community by training Japanese scientists at Brookhaven National Laboratory for nearly 40 years."

Suresh Srivastava

Medical Department



2003 Battelle Distinguished Inventor Award

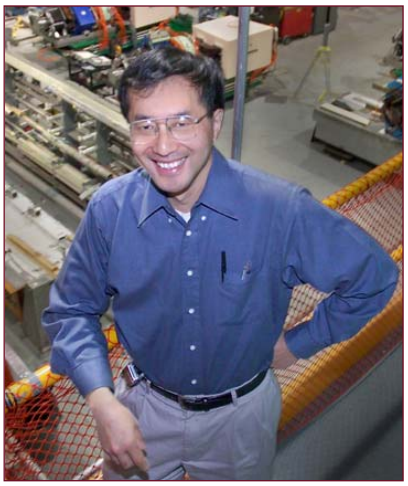
Recognition: "for holding 22 patents in the field of nuclear medicine for diagnostic imaging, bone cancer therapy, and bioengineered monoclonal antibodies radiolabeled using novel bifunctional chelating agents for molecular imaging and radioimmunotherapy of cancer."

Nora Volkow
Medical Department

2003 Paul C. Aebersold Award of the Society of Nuclear Medicine

Citation: "for outstanding achievement in basic science applied to nuclear medicine. Volkow was the first to use imaging to investigate neurochemical changes, particularly in the dopamine system in the brain of addicted, obese, and aging individuals."

Jie Wei
Collider Accelerator Department



2003 Fellow of the American Physical Society

Citation: "for his outstanding and creative contributions to design and development of RHIC and SNS."

Stanislaus Wong
Materials Science Department

2003 National Science Foundation Early Career Award

Citation: "for pioneering contributions in the rational chemical functionalization of carbon nanotubes which have significantly enhanced their purification, exfoliation, and solubilization and for the groundbreaking synthesis of nanoscale forms of perovskite oxide materials."

Li Hua Yu

National Synchrotron Light Source Department

2003 Free Electron Laser Prize

Citation: "in recognition of his outstanding contributions to FEL science and technology (SASE FEL and HGHG FEL)."

Helene Benveniste

Interim Associate Director for Life Sciences

2004 Honored by Brookhaven Town and the American Medical Women's Association "Changing the Face of Medicine: Local Legends"

Recognition: "for her contributions to medicine, her commitment to medicine, and for investigating medical problems of major social impact."

Ivan Bozovic

Materials Science Department

2004 Technology Achievement Award of the International Society for Optical Engineering (SPIE)

Citation: "for constructing a next generation molecular beam epitaxy oxide system, and for developing a technology to deposit atomically smooth films and multilayers of complex oxides."

Mary Daum

Environmental Services Division

2004 Honored by Brookhaven Town

Recognition: "for outstanding service to the community in technology."

Joseph Hendrie

Nonproliferation and National Security Department (retired)

2004 Henry DeWolf Smyth Award of the American Nuclear Society

Citation: "for his outstanding leadership in the development and safe management of nuclear technologies, notably the invention of the High Flux Beam Reactor and for the creation of standard review plans for licensing of nuclear power plants."

Margaret Lynch

Assistant Director for Community, Education, Government and Public Affairs

2004 Honored by Brookhaven Town

Recognition: "for her contributions to the government by successfully directing programs to help rebuild BNL's relationship with neighbors, community groups, and elected officials."

Wu-Tsung (Bill) Weng

Center for Accelerator Physics

2004 Fellow of the Institute of Electrical and Electronics Engineers

Citation: "for his leadership in particle accelerator development."

F. William Studier

Biology Department

2004 R&D 100 Award

Citation: "for developing a new process that simplifies the production of proteins in the widely used T7 gene expression system." The T7 expression system, developed and patented at Brookhaven Lab in the 1980s and 1990s, is used worldwide by academia and industry to produce specific proteins within bacterial cells.

Toshifumi Sugama

Energy Sciences and Technology Department

2003 Federal Laboratory Consortium Award (FLC) and 2003 Battelle Distinguished Inventor Award

FLC citation: "for developing, and transferring to the commercial sector a smart, high-performance polyphenylene coating system for the carbon-steel heat exchangers in geothermal wells

Sergei Maslov
Physics Department

2002 Presidential Early Career Award for Scientists and Engineers

Citation: “for his contributions to the physics of complex systems, with applications ranging from cellular biology to the Internet and economics

1.3 DEPARTMENT OF ENERGY RESEARCH PROGRAMS

1.3.1 Nuclear Physics (NP) Program

1.3.1.1 Quality of Research

- The RHIC experimental program has now published 56 Physical Review Letters (PRL), 14 of them will appear in FY 2004; other, longer publications are appearing in increasing numbers, and a set of four comprehensive review papers is in preparation for 2004 publication, summarizing scientific discoveries in the RHIC experimental program.

- The RHIC theory group at BNL has provided vigorous input to the evolving physics of the RHIC discoveries, including publications, talks and presentations and, most importantly, conducted direct discussions with RHIC experimenters to maximize the connections between the new measurements and their theoretical interpretation.

- Quark Matter 2004, the principal forum for relativistic heavy ion physics, was dominated by new RHIC results presented by all four RHIC experiments; these results were so exciting that they made news in several newspapers across the country, including the New York Times (4 articles), Oakland Tribune, San Francisco Chronicle and Chronicle of Higher Education; the news was also later reported in Science, Nature, Discover Magazine, and the CERN Courier.

- Strong evidence for the observation of a strongly coupled quark gluon plasma (sQGP) was evident in the experimental results shown at QM04 and is now being published in refereed journals; theorists are convinced that the sQGP has been seen but the experimenters are seeking additional confirming evidence before claiming the sQGP discovery.

- Exciting hints for the presence of another theoretically postulated form of matter, the Color Glass Condensate (CGC), were seen in experimental results from the BRAHMS Experiment, also shown at QM04; the BRAHMS results will be published in FY 2004.

- The Riken BNL Research Center (RBRC) at BNL sponsored an important RHIC physics workshop in May 2004 at which theorists and experimenters reviewed and interpreted the new data from RHIC as these results bear on the question of sQGP discovery; no discovery announcement was agreed upon but the whole community made important advances in their understanding of the RHIC data and its interpretation.

- BNL's Instrumentation Division continues to provide support for developing advanced detector technology that is vital for the progress of the NP program at BNL and elsewhere. Of particular importance over the past year has been the

development of the GEM (Gas Electron Multiplication) detector for charged particle tracking, plus a GEM-based Time Projection Chamber.

- The National Nuclear Data Center (NNDC) completed 50 years of providing the Nation's nuclear cross section libraries. The NNDC expanded its research to support homeland security needs.

1.3.1.2 Relevance to DOE Mission

- The Nuclear Physics Program at BNL is strongly dominated by RHIC experimental and theoretical physics; the RHIC physics program is a flagship enterprise of the DOE Office of Nuclear Physics.

- RHIC II, the luminosity upgrade of the RHIC machine entered the NSAC-sponsored scientific competition for DOE Future Facilities in February 2003 and was chosen by the DOE Office of Science as one of 26 agency-wide projects in the long-range plan, "Facilities for the Future of Science," February 2004; the luminosity upgrade for RHIC was favorably noted in the Office of Science and Technology Policy (OSTP) strategic plan, "Physics of the Universe," dated February 2004.

- The future eRHIC project will enable RHIC to develop the capability for studying high energy electron-heavy ion collisions to explore the properties of Color Glass Condensate (CGC); this initiative was also entered in the February 2003 Nuclear Science Advisory Committee (NSAC) competition for DOE Future Facilities and was chosen as 1 of 26 projects adopted for the long-range future facilities plan of the DOE Office of Science.

- A new machine architecture for supercomputing, QCDOC, was accepted by the DOE Office of Nuclear Physics in 2004 as the next computer base for advancing lattice gauge physics in the United States. The DOE-ONP, together with DOE's OHEP and OASCR, are providing funding in FY 2004 and FY 2005 to construct and operate a 10-TFlops QCDOC machine at BNL to advance lattice gauge physics calculations for nuclear physics, in general, and for RHIC physics specifically.

- All of the initiatives noted above, as well as the ongoing RHIC physics program, are proposed and carried out by BNL; these activities are, however, completely aligned with the current and future nuclear physics research program identified by the DOE Office of Science as well as with guidance established by the Nuclear Science Advisory Committee (NSAC).

1.3.1.3 Success in Constructing and Operating Research Facilities

- The FY 2004 RHIC data run exceeded the performance measures set by the DOE ONP and, in fact, exceeded the predicted integrated luminosity for the Au x Au portion of the data run by a factor of two; this performance resulted from a long list

of small and moderate facility improvements, actively pursued in the Collider-Accelerator Department to improve operation of the RHIC facility for research.

- The four RHIC experiments that took data in the FY 2004 data run also performed superbly; the two larger experiments, PHENIX and STAR, each had DOE ONP established performance measures related to the amount of physics data recorded, and each experiment exceeded its performance measure by a large factor (~2.5x), making this run the most successful, by far, for full-energy Au x Au collisions at RHIC; the BNL Physics Department played an important role in the management of these experimental efforts.

- A beam development run for improving the polarized proton beams performance in RHIC and its injectors was successful in reaching the goal of sustained collisions of 100 GeV polarized protons with polarization values of 40% or more in both RHIC rings; this level was achieved in time to allow the four RHIC experiments to take physics data during the last week of the development run, although this bonus run had not been included as a formal performance goal for the FY 2004 RHIC data run.

- Development of the QCDOC supercomputer chip and its massively parallel motherboard and daughterboard implementations were completed by Columbia University, IBM, and BNL during FY 2004. The production of chips, printed circuit boards and electronics cabinets, as well as power and cooling infrastructure for a 10-TFlops supercomputer for lattice gauge physics, were realized in FY 2004. The QCDOC supercomputer itself will be completed and commissioned at BNL in FY 2005.

- BNL's Instrumentation Division (ID) continues to maintain its unique position in the DOE Laboratory system as a preeminent source of advanced instrumentation concepts and innovation for the advance of nuclear physics (and all other science disciplines pursued at BNL); the devices and systems developed in the ID, along with BNL Physics Department collaboration, have kept the RHIC experiments at the cutting edge of technical capability and greatly enhanced their research capability.

1.3.1.4 Effectiveness and Efficiency of Research Program Management

- The RHIC facilities operations managed by BNL's Collider-Accelerator Department (C-AD) performed above expectations in FY 2004 and exceeded the DOE ONP performance measures for this fiscal year; this performance reflects the depth of expertise and facilities management strength of the C-AD leadership.

- The quality and strength of the BNL contingent of the RHIC experimental effort managed by the BNL Physics department, was maintained at a high level in FY 2004 in spite of flat-flat funding for nuclear physics research by DOE; this achievement reflected many-years of buildup of a strong scientific cohort of RHIC physicists that provides much of the scientific leadership in RHIC research efforts.

- The computing support for the RHIC facilities and much of the RHIC scientific analysis effort has been provided and managed by the RHIC Computing Facility (RCF) group in the Physics Department with collaborative involvement by the BNL Information Technology Division (ITD). This management effort has consistently provided excellent availability and carefully tailored resource management to support the successes of the RHIC data acquisition and analysis efforts.

- BNL has continued to build up its nuclear theory program and scientific staff in the Physics Department; we also continue to co-develop our nuclear theory program with the BNL-located Riken BNL Research Center (RBRC); the combined theory operations now rank as the strongest nuclear physics theory group in the world.

- BNL future nuclear physics program efforts and facilities planning has been very successful as demonstrated by the inclusion of two BNL proposed future facilities, RHIC II and eRHIC, by the DOE Office of Science in its priority list of 26 future facilities in February 2004; the first of these, RHIC II is also noted in the February 2004 "Physics of the Universe" strategic plan of the Office of Science and Technology Policy (OSTP).

- BNL is making plans to leverage its host Laboratory management role for U.S. participation in the LHC ATLAS Experiment to develop a strong U.S. capability for research in the ATLAS heavy ion research effort with minimal capital investment by DOE's ONP. This effort will provide a second, complimentary U.S. heavy ion physics capability to the future RHIC II and eRHIC nuclear physics research programs.

- Three of the four RHIC experimental collaborations (BRAHMS, PHOBOS, and STAR) have BNL physicists as spokespersons in FY 2004; these collaborator-elected positions reflect the leadership capabilities of BNL research physicists.

- The BNL Superconducting Magnet Division contributed an important effort to the polarized proton capability of RHIC by designing and constructing in FY 2003 and FY 2004, a superconducting helical dipole magnet to improve beam polarization preservation during AGS acceleration of polarized protons for RHIC; the magnet will be installed and commissioned in FY 2005.

1.3.1.5 Strategic Planning

- In FY 2004, BNL completed and submitted to DOE's ONP, a twenty -year strategic plan for the RHIC physics program, with detailed physics plans for the evolution of the near-term (5-year) physics data runs and goals and a long-term (20-year) plan for evolution of the RHIC facility as it evolves and competes with the LHC heavy ion program; this plan was received with praise by the ONP.

- BNL, in cooperation with the BNL-located Riken BNL Research Center (RBRC), has sponsored many workshops and seminar series to evaluate the ongoing RHIC

physics program and to interpret the data already uncovered; these intellectual forums provide the fundamental physics direction that strategically guides the research program in productive and innovative directions.

- Nuclear physics topics and strategic plans are a prominent part of the annual BNL internal planning forum held each October at the Laboratory; the BNL Director placed the strategic plan for the evolution of QCD physics and the Spin of the Nucleon as the two top strategic science priorities for the Laboratory and identifed RHIC as the BNL facility to maintain a world leading position in these areas.

- RHIC II, the luminosity upgrade of the RHIC machine, entered the NSAC-sponsored scientific competition for DOE Future Facilities in February 2003 and was chosen by the DOE Office of Science as 1 of 26 agency-wide projects in the long-range plan, "Facilities for the Future of Science," February 2004; the luminosity upgrade for RHIC was also favorably noted in the Office of Science and Technology Policy (OSTP) strategic plan, "Physics of the Universe," dated February 2004.

- The future eRHIC project will enable RHIC to develop the capability for studying high-energy, electron-heavy ion collisions to explore the properties of Color Glass Condensate (CGC); this initiative was also entered in the February 2003 NSAC competition for DOE Future Facilities and was chosen as one of 26 projects adopted for the long-range future facilities plan of the DOE Office of Science.

- A new machine architecture for supercomputing, QCDOC, was accepted by the DOE Office of Nuclear Physics in 2004 as the next computer base for advancing lattice gauge physics in the United States as a result of a 3-year planning effort by Columbia University, RBRC, and BNL; longer term planning for lattice gauge computing power is the subject of continuing strategic planning among the same partners.The next strategic goal will target a 1-Petaflop machine at BNL.

1.3.1.6 Response to DOE 2003 Evaluation

- The rating for Objective 1.3, the Success in Constructing and Operating Research Facilities was: 3.5 - Excellent. We are concerned about this evaluation, and this year's performance far exceeded the last year's level in delivering the integrated luminosity in Au-Au collisions.

- The rating for Objective 1.4, the Effectiveness and Efficiency of Research Program Management was: 3.4 - Excellent. The report noted that the FY 2003 planning horizon was too short at three years. This span was supplemented with the twenty-year BNL planning document submitted in December 2003.

1.3.1.7 Alignment towards BNL Related Office of Science FY 2004 Strategic Plan

- BNL had one item for RHIC Facility Performance in FY 2004: "Average achieved operation time of the scientific user facilities as a percentage of the total scheduled

annual operation time will be greater than 80%;" the availability of RHIC was measured to be 80.1% achieved under the defined criteria relative to the baseline of 80%, exceeding the required performance level.

- BNL had two items for Phenix and STAR Detectors Performance in FY 2004: "Weighted average number (within 30% of baseline estimate) of millions of events sampled by the PHENIX (900) and recorded by the STAR (40) detectors, respectively, at the Relativistic Heavy Ion Collider." PHENIX and STAR strongly exceeded their measures: PHENIX – 1583 million events achieved relative to the baseline of 900 million events at 200 GeV Au-Au; STAR – 87 million events achieved relative to the baseline of 40 million events at 200 GeV Au-Au; both experiments also took data at 62 GeV as a result of excellent RHIC machine performance.

1.3.2 Basic Energy Sciences (BES) Program

1.3.2.1 Quality of Research

National Synchrotron Light Source (NSLS)

- The X21 hybrid wiggler x-ray beamline and stations have been substantially upgraded. The two stations have been rebuilt to accommodate new experimental programs that address elastic x-ray scattering studies of materials under high magnetic fields, thin films grown in-situ, and materials studied with small angle x-ray scattering, with appropriate setups permanently installed in the stations. To meet the needs of these programs, the beamline optics have been upgraded.

- A new hard x-ray microprobe beamline, X27A, has been completed to provide additional and enhanced x-ray microspectroscopy capabilities to the NSLS environmental science user community. The beamline can be operated in three different modes: monochromatic, using either silicon (111) or silicon (311) crystals, or white-beam. X-rays are focused to a few microns size spot using a set of 20 cm long Kirkpatrick-Baez (KB) mirrors. A 13-element germanium detector array will enable both elemental mapping as well as fluorescence yield x-ray absorption spectroscopy study of complex environmental samples.

- Grazing incidence infrared spectroscopy is an important tool for corrosion and catalysis studies. A portion of the U4IR surface science beamline was re-built to incorporate a new Bruker 66v infrared spectrometer. This new spectrometer provides improved spectral resolution, spectral range, and increased collection rates over the previous instrument. It also accepts a wider variety of specialized surface measurement techniques such as polarization modulation.

- A state-of-the-art cryogenic Vertical Test Facility was designed and constructed for use in developing superconducting undulators (SCU), allowing precise magnetic field mapping of SCU prototypes at cryogenic temperatures. It incorporates three channels

of liquid helium calorimetric instrumentation to measure thermal performance and quench behavior under realistic operating conditions. We have also developed an SCU design based on the new "APC-type" NbTi superconductor and incorporating a novel cryogenic thermal management system to intercept the high beam heat loads expected in future ultra-high brightness synchrotron light sources.

- The first user experiment was completed at the Deep Ultraviolet Free Electron Laser (DUV-FEL). This chemical science experiment used the third harmonic (89 nm) of the High Gain Harmonic Generation (HGHG) output of the DUV-FEL to study the super excited states of methyl fluoride. The DUV-FEL ion pair imaging experiment helps us understand the specifics of what happens when molecules are excited with energetic ultraviolet light. The experiment also revealed, more generally, how electrons rearrange in molecules in response to light, the nature of chemical bonds, and the dynamics of bond-breaking processes.

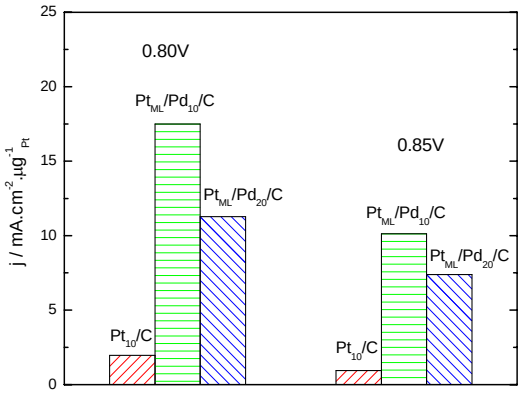
- The X1A1 scanning transmission soft x-ray microscopy beamline has been operated predominantly near the carbon K-edge (~278eV) owing to the strong interest in biological and materials science problems involving carbon. However, it has suffered from sub-optimal performance at this photon energy due to deficiencies in the monochromator. Superior performance has been achieved by implementing a new four-position interchangeable grating chamber with state-of-the-art soft x-ray laminar gratings optimized for specific portions of the X1A1 photon energy range.

- A new insertion device installation was completed on X-29, utilizing a small gap undulator situated between two RF cavities. This installation, the first of its type in the world, provided a source for a state-of-the-art undulator beamline for protein crystallography.

Accelerator and Storage Ring Improvements included: replacement of X-ray Injection Septum Chamber; installation of X29 MGU; installation and Commissioning of X29 Front End and Beamline; installation of Third High Pressure Copper Cooling Water Pump; installation of Full Flow Strainers on Central Chilled Water system; upgrade of X-ray RF Heat Exchangers and Controls; upgrade of X-17 Super Conducting Wiggler Controls; repair of U4IR Mirror System

Catalysis

- The activity of a Pt monolayer on Pd (111) is higher than that of Pt (111) alone. The mass specific activity of a Pt monolayer on Pd nanoparticles is about 8 times that of a standard Pt catalyst.



Pt mass-specific activity for O_2 reduction on three electrocatalysts.

The figure illustrates that the mass-specific activity of a Pt monolayer on Pd nanoparticles is about eight times that of standard Pt electrocatalyst. This high activity is partly due to the reduced OH adsorption compared with bulk Pt.

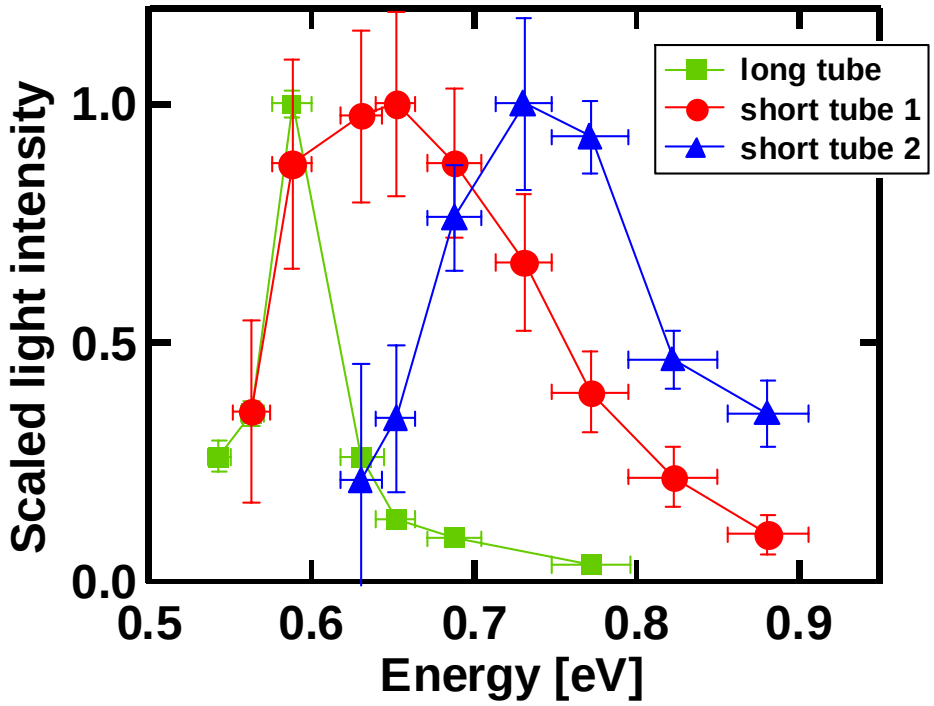
- Mechanistic studies of the reaction of a macrocyclic cobalt (III) hydride complex with water to form dihydrogen revealed a remarkable reaction pathway. These results have implications for the rational design of water photoreduction catalysts and indicate, for example, that very basic metal hydrides should not be effective catalysts for rapid H_2 formation.

- Mo nanoparticles deposited on Au surfaces are encapsulated after thermal treatment. The presence of Au on the Mo nanoparticle surfaces strongly modifies their reactivity toward desulfurization reactions and in some cases can reduce the formation of unwanted carbon deposits.

- The chemical activity of Au nanoparticles supported on MgO(100) and TiO_2(110) surfaces was studied. On MgO, the Au nanoparticles were found to be more reactive than bulk Au but not as active as nanoparticles supported on titanium. These results highlight the importance of Au-oxide interactions in the activation of Au.

Correlated Systems/Material Synthesis

- Individual carbon nanotubes (CNTs) can be used to generate infrared light through the simultaneous injection of electrons and holes into a CNT from opposite ends. This work provides insights into the optical physics of nanotube emission as well as electron-phonon processes.



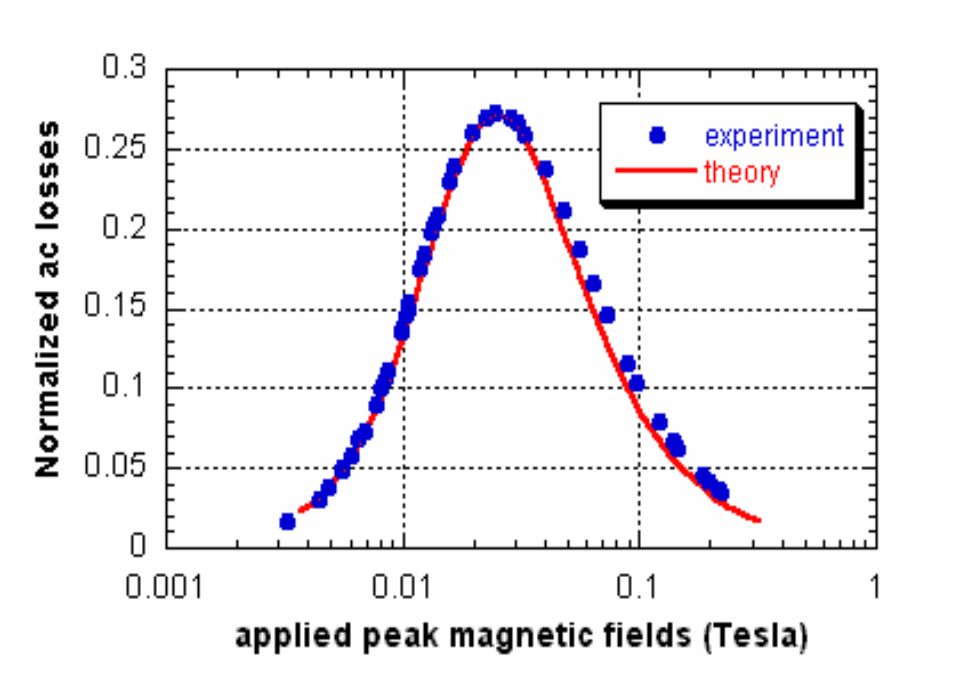
The generation of infrared light in carbon nanotubes has been achieved through the simultaneous injection of electrons and holes. The figure illustrates the results of electron-hole thermalization. The short nanotubes (red and blue spectra) produce broad asymmetric spectra from hot carriers. The long nanotubes (green spectrum) produce narrow symmetric spectrum from thermalized carriers.

- A universal scaling relationship has been discovered for cuprate high-temperature superconductors that relate the superconducting and normal state properties. This unexpected result connects materials with very different structures and compositions, and may provide clues to understanding the mechanism of high Tc superconductivity.

- The dispersion of spin excitations in stripe-ordered La1.875Ba0.125CuO4 is quite similar to that in superconducting YBa2Cu3O6.6. This is the first indication of the existence of a magnetic spectrum that is common to all families of cuprate superconductors.

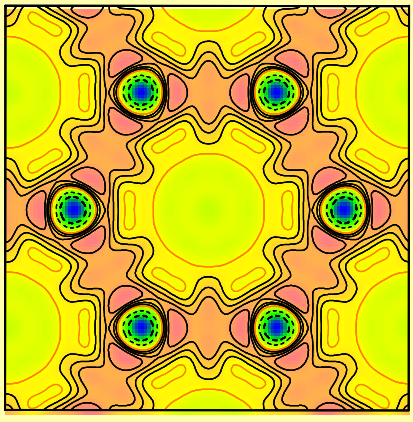
- The spectrum and correlation functions of a carbon nanotube in the Mott insulating regime were calculated.

- Recent inter-laboratory and international collaboration studies verified existing theories of AC losses in YBCO films for the first time. This verification will permit the use of these theories to design more efficient YBCO conductors and power devices.



The figure is an illustration of the first verification of the theories for ac losses in the high crit temperature superconductor, yttrium-barium-copper oxide, YBCO. This confirmation make possible to use the theories to design low ac loss YBCO conductors for electric power applications.

- Researchers have developed a highly sensitive quantitative electron microscopy method, based on small-angle electron scattering to image and measure the distribution of valence electrons in solids. The ability to see valence electrons facilitates the search for stronger materials and better conductors.



The valence electron distribution in MgB_2 was measured using an electron diffraction method developed at BNL, combined with the use of synchrotron x-ray and density functional theory calculations. The figure depicts the valence electron distribution of the (001) B-layer in MgB_2 (yellow slice in the model).

Interface of Life and Physical Sciences

- The existence of a stable adduct between nitric oxide and its one-electron reduced form has been demonstrated. The adduct's energetics, redox potentials, acidity, and stability have been characterized with pulse radiolysis and ab initio techniques.

These findings suggest that the adduct can play a major role in the biological and environmental chemistries of nitric oxide, completely revising the previously accepted point of view.

- A tracer technique was developed to image transport of amino acids in plants, opening a new research area in plant biology.

- Nanometer scale chemical patterns on self-assembled monolayers were prepared using a conducting tip AFM. A model has been proposed to explain the electro-chemical oxidation of the monolayer's terminal methyl groups into carboxyl groups.

Others

- BNL completed the Safety Analysis Study for the NIST reactor located in Gaithersburg, MD. The NIST reactor is considered to be critically important as it is one of the few remaining research reactors in the United States and it is within close proximity to Washington, D.C.

1.3.2.2 Relevance to DOE Mission

- The National Synchrotron Light Source is aligned with the Office of Science Strategic Goal 7.1, to "Provide the discovery-class tools required by the U.S. scientific community to answer the most challenging research questions of our era."

- The three grand challenge problems that have been identified for BES are called out in the DOE strategic plan. They are 1) solving the strongly correlated electron problem, 2) making predictive design of catalysis a reality, and 3) producing materials at the interface of life and physical sciences.

- The Center for Functional Nanomaterials is aligned with the facilities and nanoscience mission of DOE.

Architectural rendering of the BNL Center for Functional Nanomaterials

1.3.2.3 Success in Constructing and Operating Research Facilities

- The NSLS storage rings continue to operate near their theoretical limits of performance. During the year the VUV/IR ring operated well above its scheduled hours, and the x-ray operated with high reliability save for one significant disruption due to failure of a vacuum chamber in the storage ring. During this period a new insertion device installation was completed on X-29, utilizing a small gap undulator situated between two RF cavities. This installation, the first of its type in the world, provided a source for a state-of-the-art undulator for protein crystallography. In the future another insertion device will be located between the cavities on the X-9 straight, providing new capabilities not previously thought possible on our machine.

- The NSLS's own target for reliability is 95% while DOE's performance objective is 90% availability. The VUV/IR ring provided 99.2% of total scheduled operations well exceeding expectations. On the x-ray ring, for two of the quarters in the reporting period the X-ray ring exceeded DOE's 90% expectation, while in one quarter it exceeded the NSLS target of 95% reliability. However, a failure in our injection vacuum chamber resulted in significant down time. Availability for that quarter was only 85%. For the overall reporting period the X-ray ring provided 91.8% of total scheduled operations.

- In FY03, 244 active NSLS users completed a user survey. The percentage of users who were either very satisfied or satisfied with key metrics was: Fraction of the year the facility operates - 81%; timely schedule or service, downtime kept to minimum - 84%; performance (beam or service maintained close to specifications): 86%; user support provided by facility staff: 95%; user support provided by Participating Research Team staff -82%.

- Title I Preliminary Design for the Center for Functional Nanomaterials (CFN) was completed on February 20, 2004. The performance baseline External Independent Review (EIR) was conducted on March 22-26, 2004. The project was found to be appropriately managed within the project scope. It was noted, "the CFN Team is working well together at all observed levels."

- The presentation by the CFN Federal Project Director (J. Eng) to the Department of Energy (DOE) Headquarters' Energy Systems Acquisition Advisory Board (ESAAB) Equivalent Review was held on May 21, 2004. The purpose of the FPD's presentation is to demonstrate that the CFN project is at a level of maturity necessary to define the performance baselines and to proceed with the next phase of the project. CD-2, Approve Performance Baseline was granted by the ESAAB Equivalent Review Board on May 21, 2004.

- Title II, Detail Design for the CFN started on March 1, 2004. Sixty percent Title II drawings and specifications were completed on schedule by the architect engineer HDR on May 28, 2004. HDR is on schedule to complete 100% Title II Detail Design on September 30, 2004.

- A "jumpstart" scientific user program was initiated for the CFN using existing BNL equipment. The first call for user proposals yielded ~30 proposals principally in the areas of electron microscopy and nanopatterning. The first CFN Annual User's meeting was held on May 20, 2004, and valuable feedback was provided to improve the user and nanoscience programs.

- The CFN continued to build its operating staff: two scientists were hired to support the proximal probe and electron microscopy facilities, and a User Administrator and business manager were also hired. Existing BNL electron microscopy and materials synthesis groups were transferred into the Nanoscience Department.

- At the Transmission Electron Microscopes (TEM) facility, electron microscopy tools have been advanced with the development of quantitative methods to study valence electron distribution in strongly correlated electron systems, and phase retrieval methods to study magnetic induction distribution in nanoparticle arrays.

- BNL continues to be an active member of the TEAM project, whose objective is to build the next generation electron microscope with aberration correction.

- Using the LEAF facility, we have achieved ultrafast recombination between electrons and ions in supercritical xenon, have observed electrons being "solvated" in ionic liquids, and investigated rapid transport of holes in molecular wires. A new user plan is being implemented to encourage the broadest collaborative use of LEAF and to initiate user access. LEAF is part of the ultrafast facility group of the CFN.

The Center for Neutron Science (CNS) is leading the design effort to construct a novel neutron instrument (called HYSPEC for HYbrid SPECtrometer) at the Spallation Neutron Source. The transfer and installation of the US-Japan spectrometer from the HFBR to HFIR at Oak Ridge is proceeding and scheduled to operate in FY 2006. The CNS also funds the BNL/NIST Alliance for Neutron Scattering.

1.3.2.4 Effectiveness and Efficiency of Research Program Management

- Each fiscal year, the NSLS updates and revises its Department Strategic Plan, its Annual Operating Plan and Individual Staff Objectives to meet Department goals. During FY 2004, the NSLS required individual plans for all routine operations and proposals for any non-routine work. All plans and proposals were prioritized and operating, capital and AIP funds were allocated to meet the goals. Progress was reviewed monthly and reallocations were made throughout the year as appropriate. This process ensures allocation of department resources in accordance with established priorities, and provides management with ongoing information regarding process and budget.

- An NSLS Stockroom system upgrade was completed over the past year. The new Oracle system replaced an outdated R-base database, provided new bar code scanners

for inventory checkout and upgraded the Stockroom's computer systems. The new stockroom application is integrated with the BNL PeopleSoft system, providing account validation and the capability for users and staff to scan their BNL ID badges to easily gain access to the system.

- The new budget process introduced two years ago at the NSLS that defined and prioritized Department needs was enhanced still further through a Web-Based Budget Planning system that was designed to electronically collect staff project proposals and Section Head requests for additional staffing and funds. The system allows NSLS Management to electronically approve requests and tracks progress on those requests through a monthly electronic tracking system. Further enhancements to this system are expected over the next year

- The Proposal, Access, Safety and Scheduling (PASS) system was brought online in May 2004. PASS was developed to facilitate submission and review of general user and proprietary proposals and the allocation and scheduling of beam time at the NSLS. The safety approval form is also incorporated into the system. Proposal submission, safety approval and the scheduling of general user proposals is complete and online. Proposals are submitted online and routed for beamline review for feasibility and safety purposes, to Proposal Review Panel members for peer review and ratings, to allocation panel members for beam time allocations, to NSLS safety staff for review and approval, and finally for beam time scheduling. Future development will integrate proprietary proposals, safety approval for Participating Research Team experiments, scheduling for all experiments, and incorporation of reduced lead-time for rapid access.

- The BNL Director has established a search committee for the Associate Laboratory Director for Basic Energy Sciences position, and two outstanding candidates have been identified.

- To work towards the goal of developing a science driven nanoscience user center, two existing BNL groups were transferred into the Nanoscience Department: the electron microscopy group and the material synthesis group.

- A vibrant in-house materials synthesis capability continues to be developed via a joint program in the Physics and Materials Science Departments, including PLD thin film and single oxide growth, as well as synthesis of large inorganic molecules, carbon nanotubes, and superconducting materials. Ivan Bosovich, a world-class materials scientist, was hired. Dr. Bosovich's MBE machine was also purchased, and a laboratory is being renovated for installation of this machine. With this new capability, BNL will be able to make ultra pure single crystal films.

- The Laboratory is a partner in the TEAM (Transmission Electron Aberation-corrected Microscope) project, which involves research and development in a collaboration among five BES-sponsored electron micro characterization centers. The BNL emphasis is detector and monochromator development, and development of

techniques such as position sensitive coherent electron detection. The TEAM project is highly collaborative and the BNL program interfaces with the partner laboratories through quarterly meetings of the directors and a program allowing extended exchange visits among researchers at the institutions.

- The Center for Neutron Science continues to develop and maintain the world-class neutron capabilities at BNL and continues to support the major investment in neutron facilities and research at other DOE facilities. Currently the focuses of research activities are at the NIST and HFIR reactors and the ISIS spallation source.

- The "Catalysis and Chemical Transformations" and the "Chemical Energy and Chemical Engineering" programs were favorably reviewed by an external DOE-sponsored scientific panel in May 2004.

1.3.2.5 Strategic Planning

- A thirteen point safety improvement plan was established to improve safety awareness and performance. Elements of the plan included: increased management attention to the on-going self-assessment program; increased management walk-through of facilities; review of qualification process for independent work; promotion of the “safety moment” at meetings; additional work planning training for NSLS scientific and engineering staff; strengthening OSHA expertise; improved worker involvement in ESH issues; review of ESH related personnel performance goals; increased recognition for positive staff ESH performance ; a tracking display for days since the last lost time injury ; two safety suggestion boxes; improving the ESH awareness and supervision of students and post-docs; following a detailed evaluation, requirements for TLDs were modified and most short-term occupants are no longer required to wear a TLD while on the experimental floor

- Substantial progress was made toward defining NSLS-II, a major upgrade of NSLS and the next generation synchrotron facility at BNL; more than 2 dozen workshops in various scientific fields were held to identify the scientific “grand challenges” in the coming decades and the requirements that NSLS-II must meet to enable them; a Machine Advisory Committee was formed and met to review the preliminary conceptual design of NSLS-II; a highly successful workshop with more than 400 attendees convened to discuss the research capabilities of NSLS-II; a major proposal for approval of Conceptual Design (CD-0) of NSLS-II was submitted to DOE; a unique Super Conducting Undulator (SCU) Measurement Test Stand was developed to support R&D on SCUs.

- An outreach program continued this year to increase awareness and understanding of research opportunities and capabilities within the NSLS. This program involves visits to universities for seminars, as well as a number of workshops to train users on specific experimental techniques. The purpose of this program is to identify new opportunities for work at the NSLS and to encourage new collaborations.

- As part of the Lab's planning process, three grand challenge science problems were identified for BES: 1) solving the strongly correlated electron problem, 2) making predictive design of catalysts a reality, and 3) producing materials at the interface of life and physical sciences. In support of solving these grand challenge problems, five initiatives were established for the BES Directorate: Correlated Systems/Materials Synthesis, Catalysis Center, Hydrogen Economy, Center for Functional Nanomaterials, and a strategic hire to work at the LS/PS interface.

- New investments are being made by BNL in the catalysis programs to establish an enhanced interdisciplinary and interactive research environment. These investments will take the following forms: 1) new hires in nanocatalysis theory and CFN facility support, and 2) the development of a Low Energy Electron Microscope for use on an NSLS soft X-ray beam line.

- A multi-disciplinary research committee was established to develop research plans in support of the DOE BES Hydrogen Fuel Initiative. Six pre-proposals were submitted to DOE for consideration. The research subjects were hydrogen storage materials, membranes for separation, catalysis design, and bio-inspired materials.
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1.3.2.6 Response to DOE FY 2003 Evaluation

- The DOE report states, "The Nanoscale Structure and Structural Defects in Advanced Materials Program has a world-class scientist as its leader. It received accolades from the reviewers. BSA should continue its investments in and around the program and the program's close coordination with the BNL Center for Functional Nanomaterials." BNL has invested its own funds in infrastructure development of three new laboratories to house additional microscopes acquired for this program. BNL has also invested funds and considerable time and effort to acquire microscopes from New York State and from Lucent Technologies. Furthermore, this program is being transferred to BNL's Nanoscience Department to enhance coordination between the CFN and the TEM programs.

- The DOE report states, "The Materials-Environment Interactions program has a long and distinguished history of cutting-edge world-class leadership in its field…If BSA management considers this program a high priority, then continuity of leadership is a critical issue." BNL has identified a candidate with the requisite skill, and plans for an offer are being developed.

- The DOE report states, "Encouraging was the continued technical development and science applications of the picosecond Laser-Electron Accelerator Facility (LEAF), an essential resource for the research in this area both for scientists at BNL and for external users. Some concern was expressed over the ultimate nature of the external user community at LEAF." A new user plan has been developed and is being implemented to encourage the broadest collaborative use of LEAF and to initiate user

access in conjunction with LEAF's role as part of the ultrafast facility group of the CFN.

- The DOE report states, "During the past year there have been management changes that should have a positive impact on the BES program…The appointment of a new Associate Laboratory Director for Basic Energy Sciences still remains." The BNL Laboratory has established a search committee to identify qualified candidates to fill the position and has identified two promising candidates.

1.3.2.7 Alignment towards BNL Related Office of Science FY 2004 Strategic Plan

- The NSLS facility supports the objective of the Office of Science 2004 Strategic Plan: Goal 5.7 "Provide the science community access to world-class research facilities."

- The NSLS-II planning efforts, which have involved some 2 dozen workshops in various scientific fields, an in depth proposal submitted to DOE in early 2004 for approval of a Conceptual Design Report (CD-0) and the development of a unique Super Conduction Undulator (SCU) Measurement Test Stand to support R&D on SCU's, support the Office of Science 2004 Strategic Plan initiative "Facilities for the Future of Science" to deliver high-priority facilities over the next twenty years that support DOE's and the nations research.

- The DOE BES program has one program goal which contributes to the DOE Science goals: Program Goal 5.22.00.00, Advance the Basic Science for Energy Independence - Provide the scientific knowledge and tools to achieve energy independence, securing U.S. leadership and essential breakthroughs in basic energy sciences. In the BNL basic energy sciences programs, the Materials Science and Engineering supported programs and the Chemical Sciences, Geosciences, and Energy Biosciences supported programs contribute by producing seminal advances in the core disciplines of the basic energy sciences. Section 1.3.5.1 contains specific examples.

An FY 2004 DOE BES annual construction performance target is to meet the cost and timetables within 10 percent of the baselines given in the construction project data sheets. The CFN construction project is in its first year of PED funding and cost and schedule variances are less than 0.2%.

1.3.3 High-Energy Physics (HEP) Program

1.3.3.1 Quality of Research

- PRL Publication of the first precision results on the negative muon's (g-2) value; this measurement, comparable with the already published positive muon (g-2) value, provided higher precision in confirming the expected CPT invariance of fundamental

processes (mu+ agreed with mu-); this result allows the μ^+ and μ^- results to be combined in a new, ultra-precision measurement of (g-2).

- Publication of a third example of the important rare kaon decay, $K^0 \rightarrow \rightarrow \pi^+ \nu\nu$-bar by the E949 Rare Kaon Decay Experiment in PRL93, 2004, 031801; this is an important measurement for understanding the parameters of CP-violation.

- BNL physicists, led by Bill Marciano and Milind Diwan, have continued to provide leadership in the advancement of the best approaches for the study of neutrino oscillations; their research contributions will be recognized in the top recommendations of the important 2004 APS Neutrino Workshops and Study to be completed in August 2004.

- BNL physicists in the KOPIO and MECO collaborations of RSVP have continued the conceptual development, plus machine and detector R&D, needed for the completion of the baseline design of these experiments. They now plan to obtain an NSF-funded construction project start in FY 2005.

- BNL has been selected for a leading role in the new Large Synoptic Survey Telescope Collaboration, formed to comprehensively study Dark Energy, based upon BNL preeminence in the field of large-scale, low-noise electronic data system capabilities and our initiation of recruitment of scientists interested in experimental astrophysics/cosmology research.

- Significant contributions by the HEP Theory Group to LHC, B-Factory, Neutrino, Tevatron, and LC physics goals and theory methods, including specific phenomenological work of direct benefit to HEP experiments in future DOE programs and facilities; there has also been a growing capability and interest in lattice gauge physics in both HEP and NP subject areas.

- The Muon Collider/Storage Ring Collaboration has made excellent conceptual and R&D progress during the last year, especially in the emerging understanding of innovative applications of FFAG accelerator concepts to the muon-cooling problem that is central to all future muon storage and acceleration applications.

- Advanced instrumentation concepts developed in BNL's Instrumentation Division have contributed to many fields of research pursued at BNL, but have provided especially valuable capability to the ATLAS Experiment under construction at CERN and to many HEP experiments at AGS and Fermilab.

1.3.3.2 Relevance to DOE Mission

- BNL research and management involvement in the LHC ATLAS Experiment, as well as serving as Host Laboratory for U.S. scientist participation in ATLAS, is directly supportive of DOE OHEP's participation in LHC physics, a main goal of the

DOE's Office of Science for the past eight years and one that continues in the coming decade and likely a decade farther into the future.

- BNL's initiative in the current (MINOS) and next phase (Very Long Baseline Neutrino Oscillations) of neutrino oscillations research is fully consistent with plans and priorities published by the DOE Office of Science "Facilities for the Future of Science," the OSTP "The Physics of the Universe," and the HEPAP "Quantum Universe." BNL plans to propose a Super Neutrino Beam to DOE following the success of its white paper in the Future Facilities project list of DOE.

- BNL's lead role in research participation and Laboratory management of the new RSVP Project (KOPIO and MECO Experiments) is a priority for the NSF and has been approved by DOE ONP and OHEP for construction and operation at BNL's AGS; an inter-agency Memorandum of Understanding on RSVP will be signed by DOE and NSF in FY 2004.

- BNL participation in LSST has been informally approved by the OHEP, taking note of BNL's unique capabilities in advanced electronic signal processing and data acquisition capabilities in the Instrumentation Division; BNL has already established its collaborative role with SLAC (the lead DOE Laboratory on LSST) and with LLNL (the other participating DOE Laboratory). This project was very favorably noted in "Physics of the Universe," the 2004 Strategic Plan of the Office of Science and Technology Policy (OSTP).

- BNL's continuing role in D0 research and its contributions to the D0 Upgrade management in 2004 have continued to support DOE's high priority for the operation of the Tevatron for SUSY and Higgs searches.

- BNL's establishment of a Lattice Gauge Computing Facility based upon the QCDOC supercomputer aligns with the DOE OHEP's support for the SciDAC Initiative.

1.3.3.3 Success in Constructing and Operating Research Facilities

- Continuing excellent progress on management of the U.S. ATLAS Construction Project, as well as successful carrying out of BNL technical contributions to this work; Lehman Reviews of the project continue to give it high marks for technical success, on-schedule execution and on or below cost performance relative to the project baseline; this latter performance characteristic has allowed significant scope increases to be added to the project from the scope contingency list.

- Continuing successful progress on management of the U.S. ATLAS Computing Project, as well as important BNL staff contributions to the international ATLAS computing efforts; this includes successful participation in the grid-related ATLAS Data Challenges organized collaboration-wide.

- The Accelerator Test Facility (ATF) continued productive operations for 14 active experiments in FY 2004; recent experiments published in PR/PRL include: Mono-energetic laser accelerator; plasma focusing; surface roughness wake field experiment; Compton Scattering AE22.

- Successful tests were carried out in the AGS machine to demonstrate the necessary inter-bunch proton halo cleanliness needed for the KOPIO Experiment in 2004.

- BNL was successful in obtaining DOE Office of High Energy Physics (OHEP) and Office of Nuclear Physics (ONP) funding support for the installation of a 10-TFlops quantum chromodynamics "on a chip" (QCDOC) supercomputer for the U.S. lattice gauge physics theory community at BNL; the computer design and production was completed in FY 2004. The installation, commissioning, and operations for lattice gauge phyisics at BNL will happen in FY 2005.

- BNL's Instrumentation Division (ID) continues to maintain its unique position in the DOE Laboratory system as a preeminent source of advanced instrumentation concepts and innovation for the advance of particle physics (and all other disciplines pursued at BNL). The devices and systems developed in the ID, with BNL Physics Department collaboration, have helped to establish the Large Hadron Collider (LHC) ATLAS (A Toroidal LHC ApparatuS) experiment at the cutting edge of technical capability and greatly enhance the capabilities of many AGS and Fermilab HEP experiments.

1.3.3.4 Effectiveness and Efficiency of Research Program Management

- Continuing successful progress on management of the U.S. ATLAS Computing Project, as well as important BNL staff contributions to the international ATLAS computing efforts; this includes successful participation in the grid-related ATLAS Data Challenges organized collaboration-wide.

- Professor Bill Willis of Columbia University was appointed the new RSVP Project Director, effective May 1, 2004 and will lead the BNL Laboratory efforts as well as the university-based efforts for RSVP. Bill continued his very successful Project Manager and Research Program Manager roles in the U.S. ATLAS program. Bill is a joint BNL-Columbia University staff member.

- Professor Michael Tuts of Columbia University was appointed the new ATLAS Research Program Manager, effective October 1, 2004.

- Sam Aronson and Howard Gordon continue to manage the HEP Program of the BNL Physics Department sucessfully and effectively; one of the most challenging and difficult management activities has been the several-year need to shrink the size of BNL's research staff as funding for HEP continues to decline.

- Sally Dawson has played a national role in the executive management of the APS Division of Particles and Fields as Chair of the DPF Executive Committee in 2004; Sally has also been appointed vice-chair of the newly commissioned NRC panel, "Elementary Particle Physics in the 21st Century" that will analyze and comment on U.S. particle physics future plans and opportunities.

- Many BNL staff members in the Physics Department have contributed at group levels on up in managing the BNL participation in all of our HEP activities; we received a very positive oral closeout this year in our annual DOE OHEP Program Review for our program here and earned grades of "Outstanding - 3.52" overall and "Excellent - 3.20" for Research Program Management for FY 2003.We hope and expect to do at least as well for FY 2004.

- BNL has managed the Accelerator Test Facility (ATF) successfully for many years; in FY 2004, ATF continued its distinguished record of advancing user experiments in advanced accelerator science and technology areas.

1.3.3.5 Strategic Planning

- BNL is the Host Laboratory and Manager of the LHC ATLAS Upgrade Program and is one of four DOE Laboratory members (Fermilab, BNL, LBNL and SLAC) of the LHC Accelerator Research Program (LARP); these activities support and advance the expected continued U.S. participation in the particle physics program in the LHC Upgrade era after the first years of operation of the LHC for physics.

- BNL has joined the Large Synoptic Survey Telescope (LSST) Collaboration and believes the DOE OHEP intends to go forward with this project; LSST is already identified in the OSTP Strategic Plan "Physics of the Universe", February 2004, as "Ready for Immediate Investment and Direction Known."

- BNL has one intended future HEP facility project, "Super Neutrino Beam," in the "Facilities for the Future of Science" project list from the DOE Office of Science; the associated "Very Long Baseline Neutrino Oscillation Experiment" seeks to combine the Super Neutrino Beam with a large underground detector operated for both neutrino physics and a nucleon decay search in the NSF's "Deep Underground Science and Technology laboratory" (DUSEL) initiative.

- BNL expects to realize the fruits of a 6-year strategic initiative to construct and carry out the Rare Symmetry Violations (RSVP) project, one of the NSF Major Research Equipment and Facility Construction (MRE-FC) projects requested in the President's Budget for FY 2005. RSVP is currently under consideration for funding by the U.S. Congress; the RSVP experiments, KOPIO and MECO, will advance our knowledge in important areas of particle physics.

- BNL currently participates in R&D activity relevant to the "Linear Collider" in the DOE Office of Science's future facilities list and expects to increase its laboratory participation in this work in future years.

1.3.3.6 Response to DOE FY 2003 Evaluation

- The rating for Objective 1.2, the Relevance to DOE Missions and National Needs was: 3.4 - Excellent. DOE made one cautionary observation that "The Lab has been largely successful in redirecting its research efforts and focusing on a few high-quality projects such as D0, ATLAS, MINOS, and LHC accelerator. Maintaining this diversity in the face of budget constraints is a continuing challenge for Lab management." This statement acknowledged a problem area that relates to declining overall funding for HEP work at BNL and the resulting need to decrease overall staff size here. We are aware of this issue and will continue working on it as best we can, taking into account BNL internal policies and rules.

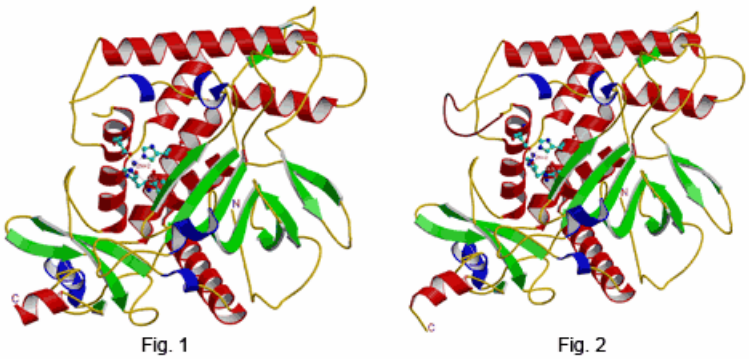
- The rating for Objective 1.4, the Effectiveness and Efficiency of Research Program Management was: 3.2 - Excellent, with one action item: "Lab management needs to develop a solid research plan based on realistic budgets and personnel needs, with various decision points or options based on the outcome of outstanding questions such as Tevatron performance, LHC schedule, AGS role in HEP in future years, and future developments in neutrino physics." We have been working continuously on this and discussed our plan with DOE OHEP.

1.3.4 Biological and Environmental Research (BER) Program

1.3.4.1 Quality of Research

Life Sciences

- The structure of the Type E botulinum toxin was deciphered and altered to create a form of the toxin protein with essentially the same structure but with no toxicity. This achievement brings us closer to developing a vaccine or treatment for the botulinum neurotoxin.



Botulism

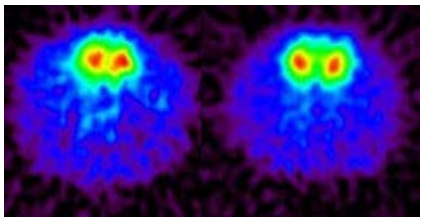
These "ribbon" diagrams illustrate the structures of the catalytic domain for wild type botulinum neurotoxin type E (left, fig. 1) and a related mutant protein (right, fig. 2). The overall conformation for the two proteins is the same; the only difference is that the amino acid gluatamate (GLU) in the wild type protein is changed to glutamine (GLN) in the mutant protein. This causes a loss of hydrogen bonding (shown by a dashed line in fig. 1) to the nearby nucleophilic water molecule, thereby increasing the distance between this water and the zinc atom in the mutant. This subtle change prevents the toxin from cleaving its target, thus abolishing its toxicity.

- In collaboration between BNL, the State University of New York at Stony Brook, and PNNL, the proteomes of three strains of the causative agent of Lyme disease, Borrelia burgdorferi were analyzed. A total of 522 proteins of the B31 strain were identified representing 43% coverage of the theoretical proteome.

- In collaboration with Lawrence Berkeley National Lab and Emory University, the cryo-EM group revealed, by electron crystallography, the interaction of a new anti-mitotic agent epothilone with its target microtubule. This knowledge is critical not only for understanding the pharmacology of the agent, but also for developing the next generation of more potent anticancer drugs.

- New evidence was obtained that brain circuits involved in drug addiction are also activated by the desire for food. The results from this work provide the first evidence that dopamine in the dorsal striatum is involved in food motivation and may lead to a new treatment approach for obesity.

- Gene therapy was found to reduce the desire for alcohol in rats that had a genetic predisposition for heavy alcohol consumption. These results improve our understanding of the genetic mechanisms of alcohol addiction and strengthen the potential for developing a treatment for people addicted to alcohol.



Brain scans showing fewer dopamine receptors (less red) in the nucleus acumbens, or "pleasure center," of alcohol-preferring (P) rats compared to nonpreferring (NP) rats.

Alcoholism Gene Therapy

- A new method for treating head injury-induced cognitive and neurological deficits in a mouse model was discovered. A paper describing the findings was published in PNAS and highlighted in Science News and Nature Neuroscience Reviews.

- The first clinical trials of GVG in the treatment of cocaine and methamphetamine abusers were highly promising.

- A novel and effective method for generating radiolabeled peptide nucleic acids with high-specific activity was developed. The high-specific activity will make these probes suitable for imaging the distribution of low-abundance mRNA in tissues in vitro and/or in vivo.

- The role of the blood brain barrier in water homeostasis and its dependence on gender and disease states were characterized by high-field MRI.

Environmental Research

- A team of BNL's atmospheric scientists are coordinating and participating in the Northeast Aerosol Experiment (NEAX) to help evaluate the effects of aerosol pollutants on Earth's radiation balance and climate. BNL scientists are conducting studies on aerosol formation and growth in plumes from point sources such as power plants and in urban plumes with different characteristics.

- BNL expanded the scope and capabilities of the Center for Environmental Molecular Sciences by establishing a new microprobe end station at the NSLS that is dedicated for use by environmental scientists.

- Dr. Steven Schwartz has been appointed as the Chief Scientist for the DOE OBER Atmospheric Science Program.

- BNL's Atmospheric Radiation Measurement (ARM) program is beginning an analysis of infrared aerosol forcing at North Slope, Alaska to determine how much they change the amount of solar and infrared energy at the surface and how much they alter the clouds.

1.3.4.2 Relevance to DOE Missions and National Needs

Life Sciences

- With funding from DOE, significant advances were made associated with the "Imaging the Awake Animal" project. A prototype "RatCap" was developed which will be further refined to produce the first PET images in 2004. This instrument will allow the imaging of rodents without using anesthesia.

- The Radioisotopes and Radiopharmaceuticals group developed an optimized Ge-68/Ga-68 generator system for PET applications. This generator achieves 5 times higher activity concentration and 15% better activity recovery than a commercially available device. This will allow the use of Ga-68 for the first time for labeling monoclonal antibodies and peptides for cancer diagnosis.

- Using the newly developed technique of Single-Point Genome Signature Tags, BNL scientists have compared the microbial species associated with the roots of Poplar trees grown under ambient and elevated levels of carbon dioxide. Nearly five thousand root-associated microbial species were identified.

- By transferring genes from pollutant-degrading bacteria into bacteria residing in plants, researchers found a method to improve the phytoremediation process used to

extract and degrade environmental pollutants. The method should be applicable to the phytoremediation of a variety of organic compounds that contaminate soils including sites managed by the DOE and DOD. This finding was published and highlighted in Nature Biotechnology – and is now funded by DOE.

1.3.4.3 Success in Constructing and Operating Research Facilities

Life Sciences

- The 9.4-Tesla micro MRI facility was completed. In addition, a micro CT scanner was also obtained and installed to further expand the number of imaging modalities available to BNL researchers and collaborators.

- The NASA Space Radiation Laboratory (NSRL) was commissioned in July 2003. NASA Chief of Staff John Schumacher and DOE Office of Science Director Raymond Orbach attended a ceremony to mark the opening of the NSRL. Since then the NSRL successfully completed its third run in June 2004.

- The Brookhaven National Laboratory Clinical Research Center was aligned with the Stony Brook NIH-sponsored General Clinical Research Center over the past year.

Environmental research

- BNL operates the Forest-Atmosphere-Carbon Transfer and Storage (FACTS-1) experimental facility in Duke Forest, NC, actively participates in the FACTS experiment in Wisconsin and in experiments at other Free Air Carbon dioxide Enrichment (FACE) sites. BNL provides coordination across FACE sites by maintaining collaborations, data management, visualization, and by coordinating data submissions to the Carbon Dioxide Information Analysis Center. FACTS-1 facility was on-line 99% of expected time and attracted 185 users to the facility in FY04.

- BNL has been assigned the responsibility for managing the Atmospheric Radiation Measurement (ARM) Mobil Facility. This portable facility, equipped with standard meteorology instruments, broadband and special radiometer instruments, and remote sensing instruments, will address science questions beyond these addressed by the ARM fixed sites.

1.3.4.4 Effectiveness and Efficiency of Research Program Management

Life Sciences

- The departure of three senior MR scientists prompted Life Sciences management to conduct a review of the MRI program; a world-renowned leader in NMR research at Harvard University and the imaging staff conducted the review. Conclusions: The need to integrate MRI with PET imaging disciplines was viewed as advantageous and necessary for future success.

- The DOE-appointed Bissell Review Team conducted a strategic review of the Life Sciences Programs in February 2004. The Bissell review team expressed serious concern on the lack of life sciences leadership, future direction of the Medical & Imaging Programs, perceived isolation of the group, and the clinical research void with departure of three senior scientists, including poor integration of medical and biology programs.

- All Medical, Chemical & Imaging scientists reconvened in response to the Bissell review to consolidate a strategic plan; The Center for Translational Neuroimaging was created comprising all PET and MRI scientists under the direction of Dr. J. Fowler. Five FWP proposals were submitted in April 2004 to the DOE-OBER as part of this program and a 13-member scientific review committee appointed by DOE-OBER in May 2004 reviewed the proposals and program successfully.

- The Life Sciences Program have been further strengthened by student and clinical fellow recruiting from nearby universities (SBU, Mount Sinai, Columbia, NYU). At this time the center for translational neuroimaging has 13 graduate students, 6 undergrads, 9 post-doctoral fellows, and 3 residents/fellows. Two NIH training grants were submitted.

Environmental Research

- BNL's atmospheric chemistry group has coordinated the DOE portion of the Northeast Aerosol Experiment (NEAX), which will focus on evaluation of the effects of aerosol pollutants on the Earth's radiation balance and climate. BNL is coordinating efforts of several research groups to conduct regional air sampling flights from the Pittsburgh area.

- BNL has coordinated activities to create a new microprobe end station at the NSLS for conducting new environmental research programs under the Center for Environmental Molecular Science (CEMS). CEMS is a unique partnership between BNL, Penn State, Stony Brook, and Temple, and is funded by DOE and EPA. This Center will bring together scientists from a variety of disciplines to tackle major environmental issues, such as cleanup efforts at nuclear waste sites and the behavior of contaminants in soil and water.

1.3.4.5 Strategic Planning

- A significant level of effort has been made to link the Physical Sciences with the Life Sciences. This effort includes planning sessions and technical sessions with other BNL organizations. Laboratory management is supporting various initiatives through the LDRD and program development programs.

- In Biology, Departmental staff has participated in five BER workshops to develop calls for proposals. They included the GTL Roadmap, Contractor Workshop for GTL

programs, and a Deep Dive workshop (to explore capabilities for GTL facilities). In addition, this FY we submitted proposals to the "Genomes to Life: Genomes Call for Proposals 03-05" and had a 50% success rate. We also responded, with collaborators from other institutions, to the DOE computational Biology Call for Proposals.

1.3.4.6 Response to DOE FY 2003 Evaluation

- "BSA management has not provided the leadership necessary to make its scientists competitive in BER research programs." Laboratory management is investing much of its LDRD resources to help strengthen Life Sciences programs and return it to its once preeminent position. Management has increased communication with BER program managers and has been involved in Departmental strategic planning. A BER review stated that "The Committee did not find any obvious institutional reason why the successful competitiveness of this group for individual or program project grants from DOE has thus far been limited, and indeed the total number of all federal grants submitted and actually funded appears to be within the nation-wide average. It is important that DOE funding should not be viewed by the Department or the Laboratory as the only metric for success of individual investigators."

- Biology Department: "The fact that BNL has only one Life Sciences research project (excluding structural biology) does not speak very highly of BSA's ability to respond successfully to BER calls for new Life sciences research." We have been working to align ourselves more with BER as noted in section 1.3.4.7. We also responded, with collaborators from other institutions, to the DOE computational Biology Call for Proposals. Researchers from other National Labs, including ORNL, ANL, PNL, and LBL, were invited to give seminars at BNL and discuss possible joint projects for DOE programs. Likewise, BNL researchers have visited other National Labs.

- Biology Department: "BNL has also not done a very good job overall in submitting Life Sciences proposals that are highly responsive to BER needs. A BER review of life and medical sciences research is planned for FY 2004 in an attempt to help BSA improve its ability to be more responsive to BER needs." BER Review of Biology stated that "It is evident that since the previous Visiting Committee review of three plus years ago, the Biology Department leadership and the Laboratory have invested a considerable effort to better align the Department with the current major emphasis of OBER on the Genomes to Life program, with the clear goal of increasing funding from OBER."

1.3.4.7 Alignment towards Office of Science FY 2004 Strategic Plan

- One of the OS highest priorities is "Scientific Discoveries through Advanced Computing." With BNL's CDIC and ITD and IBM, a workshop on computational biology was organized with over 150 participants. Development of the facility is strongly supported by most outstanding research institutions and universities in the northeast including BNL's core university partners.

- Biology Department staff, to align with the OS “Taming the Microbial World” and OBER Genomes to Life initiative, participated in five BER workshops to develop calls for proposals. This fiscal year two "Genomes to Life: Genomes Call for Proposals 03-05” were funded.

- The DOE/NASA sponsored Space Radiation Facility was fully commissioned this fiscal year.

1.3.5 Energy, Environment, and National Security (EE&NS) Program

1.3.5.1 Energy Resource Mission (EE/FE/NE)

- BNL utilized its MARKAL-based modeling software to develop an energy, environment, and economic model for Central America. This effort, which was jointly supported by DOE and EPA, will be used by the emerging countries of Central America to plan for future energy needs and satisfy global environmental guidelines.

- BNL continues to be a vital contributor to the development of reliable advanced nuclear-based power generation designs and systems, which reduce proliferation concerns. Working with international collaborators, BNL has developed a thorium-based fuel design that is inherently proliferation resistant.

National Security (NNSA/EM)

- BNL maintained a key technical role on transferring technologies and methodologies for upgrading materials protection, control, and accounting (MPC&A) of weapons-usable nuclear materials at Russian facilities. BNL staff is currently leading the MPC&A Education and Awareness project and the MPC&A Operations Monitoring project.

- BNL researchers have designed, built, and tested a proof-of-principle prototype neutron-imaging detector based on a coded aperture and position-sensitive detectors. BNL has also built and tested room temperature high-resolution gamma-ray detectors for homeland security applications.

- BNL has been appointed as the project lead for the Nuclear Materials Consolidation and Conversion (MCC) project that reduces the number of Russian sites that contain weapons-usable nuclear materials and down blends highly enriched uranium.

1.3.5.2 Effectiveness and Efficiency of Research Program Management

- BNL's leadership was instrumental in improving the performance of the MPC&A Technical Survey Team (TST). The TST, which is responsible for verification of security upgrades at Russian facilities, has reduced its cycle-time from 12 weeks to 8 weeks for reviewing upgrades and reporting findings. This improvement will greatly

assist DOE in managing the MPC&A program and in allocating resources for future upgrades.

1.3.6 Advanced Scientific Computing Research (ASCR) Program

1.3.6.1 Quality of Research

- Massively Parallel Computing – Developed detailed algorithms for classical molecular dynamics and fast Fourier transforms on QCDOC (12,000 processors) and on IBM's BlueGene/L (131,000 processor). Began application on adenovirus protease and botulinum neurotoxin.

- Magnetohydrodynamics (MHD) – Developed improved solvers for elliptic problems in complex moving geometries needed for the front tracking-based MHD code, and applied to studies of MHD processes in accelerator targets, and laser- ablated plasma in magnetic fields.

- Cavitating and Bubbly Fluids -- Developed direct numerical simulation techniques for cavitating and bubbly fluids. Applied parallel computing methods to the study of hydrodynamic processes in liquid mercury to understand the target lifetimes in the Spallation Neutron Source and a proposed muon collider.

- Nanoscale Simulation – Developed scalable localizable density functional code for calculations on nanoscale clusters of up to 5000 atoms (~ 5 nanometer diameter). Work in progress to port this code to massively parallel machines such as QCDOC and BlueGene.

- SciDAC -- Scientific Discovery through Advanced Computing. Developed Riemann solver for the phase boundary and applied direct numerical simulation techniques to study experiments on the breakup and atomization of diesel jets in fuel injectors performed at the Advanced Photon Source. Implemented new simulation techniques for wake fields and impedances in accelerators. Studied the influence of wake forces created by resistive and non-smooth accelerator chamber components on the beam dynamics.

- Parallel Maxwell Solver – Developed scalable parallel finite difference time domain code for simulating electrodynamics in photonic crystals and cavities for accelerators.

- Particle Physics Data Grid - Developed a grid user management system capable of importing information from multiple Virtual Organization management servers and mapping them into appropriately authorized sets of user accounts at a particular grid-connected site.

1.3.6.2 Relevance to DOE Mission

- Work on massively parallel computing explores benefits of new computational architectures for the solution of DOE problems.

- Work on magnetohydrodynamics is critical to the fundamental understanding of plasmas for fusion as well as the interaction of target material for advanced accelerators and the Spallation Neutron Source.

- Work in computational biology is important for understanding cellular and molecular processes of importance to the GTL program.

- Work in nanoscale computing is relevant to DOE leadership in the nanoscale revolution, including the scientific mission of the DOE Nanoscale Research Centers.

- Work on grid computing contributes to the collaborative application of wide area distributed computing resources for the analysis of experimental particle physics data with specific benefit to the RHIC and ATLAS programs.

1.3.6.3 Strategic Planning

- Prepared a proposal to the Office of Science call for a Leadership-Class Computing Capability for Science.

1.3.6.4 Alignment towards BNL Related Office of Science FY 2004 Strategic Plan

- Analyzed suitability of new massively parallel architectures to benefit Office of Science research programs.

- Provided computational resources for Nanocenter jumpstart.

- With BNL's CDIC and ITD and IBM, Biology organized a workshop on computational biology with over 150 participants. With input from many workshop participants, a white paper was developed that outlines the case for building a computational biology user facility to support the growing needs of biology researchers in high-end computing and data mining. Development of the facility is strongly supported by most outstanding research institutions and universities in the northeast including BNL's core university partners. Efforts to explore the use of massively parallel computers such as QCDOC and BlueGene/L for predicting protein structure have been initiated with CDIC, SUNY-Stony Brook, and IBM.

1.3.7 Workforce Development (WD) Program

1.3.7.1 Quality of Research

The quality of the science and research experience gained by the undergraduate interns as demonstrated by the high quality of the intern deliverables, including research abstracts and poster presentations, are of outstanding quality. The quality of the student research conducted is reflective of the exceptional quality of the BNL scientific and technical staffs that mentor the students and invite them into their laboratories to share in their passion for discovery.

1.3.7.2 Relevance to DOE Mission

BNL's Office of Educational Programs, and Community Involvement, Education, Government and Public Affairs Directorate (CEGPA) as a whole, continue to align direct and indirect funded educational activities with DOE research initiatives. In addition to the DOE sponsored programs, BNL engages over 20,000 elementary students and teachers per year in the Science Education Museum, and the Community Relations Office brings in thousands of visitors each year to learn about the Laboratory and DOE research.

1.3.7.3 Effectiveness and Efficiency of Research Program Management

BNL's Office of Educational Programs significantly increased leveraging of DOE sponsored programs this year. Approximately 40% more students were brought into the programs in 2004 when compared to 2003. This was achieved by forming collaborations with many institutions, and by working closely with the scientific staff to place National Science Foundation supported students. The DOE programs have served as a solid foundation of programs that have enabled BNL to engage in numerous other collaborative initiatives, thus further leveraging the educational impact attributable to DOE. These collaborations and collective efforts have resulted in a reduced DOE cost per university student internship on the order of 30%.

1.4 WORK FOR OTHERS AND TECHNOLOGY TRANSFER

The WFO program permits the Laboratory to conduct research that is of scientific interest, complements its DOE mission work, and contributes to sustaining its core research capabilities. In June 2004, the Laboratory completed a consolidation of the WFO program in the Office of Intellectual Property and Sponsored Research (OIP).

BNL's technology transfer program enables BNL to enhance our research capabilities and be a resource to U.S. industry, thereby enhancing U.S. competitiveness. Key components of the program are collaborative research projects with industry (CRADAs) and patent licensing.

1.4.1 WFO - Other Federal Agencies

1.4.1.1 National Institutes of Health (NIH)

- Several of our biomedical programs and facilities operate with joint funding from DOE and NIH. These programs/facilities include our Imaging and Neuroscience

Center, which encompasses the PET and MR programs in the Medical and Chemistry Departments, the Scanning Transmission Electron Microscope in the Biology Department, and the Structural Biology beam lines at the NSLS.

- About 1/3 of the users at the NSLS, from Brookhaven, other national laboratories, universities, and pharmaceutical companies use nine of the NSLS experimental stations to study biological structures using x-ray crystallography. Four of these stations are part of a cooperative effort, funded roughly equally by DOE OBER and the National Center for Research Resources (NCRR) of NIH.

- Several important innovations have been made possible by the NCRR/OBER collaborative effort: providing an on-site technical specialist to support users, 20 hours per day, 7 days per week; providing personnel and facilities for a mail-in data collection service ("FedEx Data"); and providing web-based observation of the experiment and the possibility for remote control.

- NIH funds the Regional NIDA Neuroimaging Center at the BNL PET Facility.

- NIH provides substantial support for medical imaging research through grants to individual BNL investigators. Such grants support radiotracer R&D for nuclear medicine, and animal and clinical research at the Imaging and Neuroscience Center.

- NIH supports biomedical research relating to DNA damage and repair, protein structure and folding, viral proteases and receptors, high-resolution labels for electron microscopy, microbeam radiation therapy for tumors, and vaccine development for Lyme disease.

1.4.1.2 National Aeronautics and Space Administration (NASA)

- NASA funds the operation of the NASA Space Radiation Laboratory (NSRL) in the Collider Accelerator Department, representing DOE's partnership with NASA to provide extraordinary facilities and capabilities for research on issues related to the NASA mission. The NSRL takes advantage of heavy-ion beams from the Booster for studies on radiation effects related to the space program.

- NASA provides support for space radiation health research through grants to individual scientists. Investigations are directed to genetic effects of high-energy ions and DNA and brain cell damage due to heavy ion particles.

1.4.1.3 Environmental Protection Agency (EPA)

- BNL has played a major role in a demonstration project in the NY/NJ harbors to identify sediment decontamination technology.

1.4.1.4 Department of Defense (DOD)

- DOD supports diversified R&D at BNL through Program 40 funding and through grants. In both instances, the projects are often in support of Homeland Security.

- Program 40 funds support investigations in six different research departments directed to shipboard accurate Doppler profiles, Raman lidar spectroscopy, and special nuclear materials signature studies.

- Program 40 funds support the operation of the BNL Radiation Detector Testing and Evaluation Center (RADTEC).

- Grant funding supports biotechnology R&D related to structural and molecular biology studies of toxins.

1.4.1.5 Department of State (DOS)

- DOS supports the International Safeguards Project Office (ISPO) in the Nonproliferation and National Security Department. ISPO provides technical support to the International Atomic Energy Agency in Vienna.

1.4.1.6 Department of Homeland Security (DHS)

- BNL's Radiation Detector Test and Evaluation Center (RADTEC), which was designed, constructed, and commissioned in less than two months, has been utilized to conduct over ten thousand individual tests of radiation detectors for probing shipping containers, trucks, and other vehicles.

- BNL's Radiation Detector Test and Evaluation Center (RADTEC), which tests radiation detectors prior to field deployment by the Port Authority of New York and New Jersey, was designed, constructed, and commissioned in less than two months. Since becoming operational, RADTEC's staff has conducted over ten thousand individual tests of radiation detectors for probing shipping containers, trucks, and other vehicles.

1.4.2 WFO - Non-Federal Agencies

1.4.2.1 Private Firms

- The utilities fund work in the energy sciences field related to pipeline leak detection, power reactor control room improvements, and new materials for insulating storage facilities.

- Biotechnology companies support R&D at BNL related to structural biology and protein structure determination.

- Defense contractors, such as ITT and Raytheon, support work related to Raman lidar spectroscopy and aircraft component degradation.

- The National Space Biomedical Research Institute (NSBRI) is a non-profit institution funded by NASA that supports the majority of research conducted by BNL at the NSRL. Studies, conducted by three research departments, address effects of deep space radiation on human stem cells, CNS damage and countermeasures, and microbeam detectors.

- Non-profit R&D institutions, such as the National Oilheat Research Alliance and the Energy Research Center, which support R&D in the energy sector, fund work at BNL related to fuel oil burner design, low-sulfur fuels, and maximizing fuel performance.

- BNL was awarded U.S. Patent No. 6,608,677 for a portable instrument that detects and identifies unknown chemical and biological substances in real time from safe distances.

1.4.2.2 Non-Profit Organizations/Institutions

- The largest segment of our work for non-profit organizations/institutions is for hospitals and biomedical research institutions. These studies, funded by sponsors such as the Multiple Sclerosis Society, NYU Medical Center, and St. Luke's – Roosevelt Hospital, utilize BNL's capabilities in PET and MRI. Investigations are directed to neutron activation, MS lesion development, and Alzheimer's disease.

1.4.2.3 Universities

- BNL's atmospheric chemistry group is involved in a research program with the University of Minnesota involving CO2 studies at a FACE facility.

- The University of Rochester, with funding from NSF, supports a major U.S. Atlas program in the Physics Department.

- Yale University, Stony Brook University, and the University of California at Irvine, all with NSF funding, support the R&D effort at BNL in anticipation of the two major detectors that will be installed at the AGS as part of the RSVP program.

- The University of Connecticut supports a program in the Medical Department on the development of new radiotracers for nuclear medicine.

1.4.2.4 State Agencies

- The majority of funding from state agencies comes from the New York State Energy Research and Development Authority (NYSERDA). Current work for NYSERDA is directed to improving electric efficiency in heating equipment, heating with low sulfur oil, and efficient oil burners.

- The Texas Natural Resource Conservation Commission, through the Houston Advanced Research Center, continues to fund R&D to analyze different aspects of contributors to the poor air quality in Houston.

1.4.2.5 Foreign Sponsors

- BNL's expertise in conducting risk-assessment studies and other work for the Nuclear Regulatory Commission has resulted in a significant amount of foreign-sponsored research, for which we perform similar studies at foreign nuclear power plants. BNL conducts such work for NATO and for sponsors in Sweden, Spain, and Austria.

- The University of Tokyo funds the U.S. – Japan cooperative program in neutron scattering.

- The Australian Nuclear Science and Technology Organization, recognizing the unique capabilities in BNL's Instrumentation Division, is funding BNL to design and construct an advanced neutron detector for their new research reactor.

1.4.3 Technology Transfer

1.4.3.1 Intellectual Property Program

- The Laboratory's intellectual property protection program continues to be effective. OIP received 29 invention disclosures in FY 2003 and 23 through July 2004; OIP filed 17 U.S. patent applications in FY 2003 and 15 through July 2004, and BSA received 24 U.S. patents in FY2003 and 10 through July 2004.

- Inventions arising from BNL's biotechnology research programs continue to be of particular licensing interest to industry. Technologies related to medical imaging, radiopharmaceuticals, nuclear medicine, molecular genetics, genomics, structural biology, and protein engineering are licensed to industry.

- Technology based on the T7 gene expression system continues to evolve with new commercial licenses granted. In FY 2003 over 50 new licenses were granted covering the T7 technology.

- The Laboratory entered into 63 new licenses in FY 2003. There are over 150 technologies in BSA's Patent Licensing Portfolio; more than half these technologies are licensed to industry; and seventeen of the technologies licensed by the Laboratory are the basis for new products on the market.

- The net revenue generated by the licensing program available for re-investment in the Laboratory's research programs has risen from $1.1M in FY01 to $1.9M in FY03. The licensing program continues to be very cost effective, with the costs of patent

prosecution, patent maintenance, and licensing being 17% of the gross revenue in FY 2003.

1.4.3.2 CRADA Program

- BNL's participation in CRADAs is being funded from two sources: DOE's Initiative for Proliferation Prevention Program for the Newly Independent States of the former Soviet Union (IPP-NIS); and, industrial partners who fully fund BNL's CRADA research activities.

- The IPP-NIS program supports research partnerships, which take advantage of the research capabilities of established scientific institutions in the NIS and the commercialization expertise of U.S. industry. DOE supports the research conducted by BNL and the NIS institute. BNL is currently a participant in seventeen IPP-NIS CRADAs.

- The Laboratory receives funding from industry to support research collaborations. BNL is working with Dow Corporation to create environmentally beneficial agricultural plants with applications for human health and nutrition; with Acceleron on electron beam welding; with AES on development of a superconducting gun; and with J&J on development of new radiotracers.

1.5 ALIGNMENT WITH DOE STRATEGIC GOALS

DOE Office of Fossil Energy - Program Title: Coal Research and Development		
Approximate Dollar Value: $444K		
Sub Program: $(K)		**DOE Energy Strategic Goal Alignment**
AA2025200 Environmental Technology	$277k	**Energy Security**: *Exploring advanced technologies that make a fundamental improvement in our mix of energy options*
AA3010000 Green House Gas Control	$167k	

DOE Office of Fossil Energy - Program Title: Gas Research and Development		
Approximate Dollar Value: $198K		
Sub Program: $(K)		**DOE Energy Strategic Goal Alignment**
AB0540000 Exploration and Production	$198K	**Energy Security**: *Exploring advanced technologies that make a fundamental improvement in our mix of energy options*

DOE Office of Fossil Energy - Program Title: Petroleum Research and Development		
Approximate Dollar Value: $131K		
Sub Program: $(K)		**DOE Energy Strategic Goal Alignment**
AC1005000 Exploration & Production Support Research	$19k	**Energy Security**: *Exploring advanced technologies that make a fundamental improvement in our mix of energy options*
AC1015000 Effective Environmental Protection	$112K	

DOE Office of Energy, Efficiency and Renewable Energy - Program Title: Building Technologies		
Approximate Dollar Value: $1,121K		
Sub Program: $(K)		**DOE Energy Strategic Goal Alignment**
BT0101000 Research and Development	$595k	**Energy Security:** *Improving energy efficiency*
BT0302000 Space Conditioning and Refrigeration R&D	$526k	

DOE Office of Nuclear Energy Science and Technology - Program Title: Nuclear Energy Research and Development		
Approximate Dollar Value: $1,301K		
Sub Program: $(K)		**DOE Energy Strategic Goal Alignment**
AF3710000 Next Generation Nuclear Energy Systems	$265k	**Energy Security**: *Exploring advanced technologies that make a fundamental improvement in our mix of energy options*
AF4530000 Nuclear Energy Plant Optimization Research and Development	$310K	
AF5710000 Experimental Breeder Reactor - II (EBR II) Shutdown	$725k	

DOE Office of Counterintelligence - Program Title: Counterintelligence		
Approximate Dollar Value: $734K		
Sub Program: $(K)		**DOE Defense Strategic Goal Alignment**
CN0400000 Program Activities	$734k	**Nuclear Nonproliferation**: *Provide technical leadership to limit or prevent the spread of materials, technology, and expertise relating to weapons of mass destruction*

DOE Office of National Nuclear Security Administration - Program Title: Weapons Activities		
Approximate Dollar Value: $28K		
Sub Program: $(K)		**DOE Defense Strategic Goal Alignment**
DP0901190 Intersite Stockpile Stewardship Institutional Requirements	$10K	**Nuclear Nonproliferation**: *Provide technical leadership to limit or prevent the spread of materials, technology, and expertise relating to weapons of mass destruction*
DP0909012 Technical Integration	$19K	

DOE Office of Energy Efficiency & Renewable Energy - Program Title: Solar & Renewable Resource Technology		
Approximate Dollar Value: $1,052K		
Sub Program: $(K)		**DOE Energy Strategic Goal Alignment**
EB2102010 Fundamental Research	$495K	**Energy Security**: *Exploring advanced technologies that make a fundamental improvement in our mix of energy options*
EB4001000 Geothermal Electric R&D and Deployment	$558K	

DOE Office of Energy Efficiency & Renewable Energy - Program Title: Policy and Management		
Approximate Dollar Value: $267K		
Sub Program: $(K)		**DOE Energy Strategic Goal Alignment**
EH0120060 Policy and Management Other Services	$267K	**Energy Security**: *Exploring advanced technologies that make a fundamental improvement in our mix of energy options*

DOE Office of Science - Program Title: Safeguards and Security - Science		
Total Available Funding: $11,187K		
Sub Program: $(K)		**DOE Office of Science Strategic Plan Alignment**
FS1001000 Protective Forces	$6,851K	**Provide the Resource Foundations that Enable Great Science**: *Provide the discovery-class tools required by the U.S. scientific community to answer the most challenging research questions of our era*
FS1002000 Security Systems	$845K	
FS1004000 Information Security	$119K	
FS1005000 Cyber Security	$2,279K	
FS1006000 Personnel Security (excluding Security Investigations)	$100K	
FS1007000 Material Control and Accountability	$399K	
FS1009000 Program Management	$595K	

DOE Office of Environment Safety & Health - Program Title: Environment Safety & Health (Defense)		
Total Available Funding: $187K		
Sub Program: $(K)		**DOE Defense Strategic Goal Alignment**
HD2006200 Epidemiologic Studies	$128K	**NUCLEAR NONPROLIFERATION:** *Advance the technologies to detect the proliferation of weapons of mass destruction worldwide*
HD6000000 Worker Safety	$59K	

DOE Office of Energy Efficiency and Renewable Energy - Program Title: Hydrogen, Fuel Cells and Infra-Structure Technologies		
Total Available Funding: $303K		
Sub Program: $(K)		**DOE Energy Strategic Goal Alignment**
HI0300000 Stack Component R&D	$303K	**Energy Security**: *Improve energy security by developing technologies that foster a diverse supply of reliable, affordable, and environmentally sound energy by providing for reliable delivery of energy*

DOE Office of Science - Program Title: High Energy Physics		
Approximate Dollar Value: $26,076K		
Sub Program: $(K)		**DOE Office of Science Strategic Plan Alignment**
KA1101020 National Laboratory Research	$8,227K	**Explore the Fundamental Interactions of Energy, Matter, Time, and Space**: *Understand the unification of fundamental particles and forces and the mysterious forms of unseen energy and matter that dominate the universe, search for possible new dimensions of space, and investigate the nature of time itself*
KA1102041 Accelerator	$1,079K	
KA1102043 ATLAS Detector	$4,928K	
KA1102051 LHC Software and Computing	$1,676K	
KA1102052 LHC Experimental Support (M&O)	$1,358K	
KA1102053 LHC Accelerator R&D	$334K	
KA1102070 AGS Support	$641K	

KA1401020 National Laboratory Research	$2,597K	
KA1501020 National Laboratory Research	$3,081K	
KA1502010 General Accelerator Development	$1,029K	
KA1502020 Linear Collider	$250K	
KA1503020 Detector Development	$870K	

DOE Office of Science - Program Title: Nuclear Physics		
Approximate Dollar Value: $129,331K		
Sub Program: $(K)		**DOE Office of Science Strategic Plan Alignment**
KB0101022 Other National Laboratory Research	$3,835K	**Explore Nuclear Matter - from Quarks to Stars**: *Understand the evolution and structure of nuclear matter, from the smallest building blocks, quarks and gluons; to the elements in the universe created by stars; to unique isotopes created in the laboratory that exist at the limits of stability, possessing radically different properties from known matter*
KB0201021 RHIC Research	$6,401K	
KB0202011 RHIC Accelerator Operations	$85,555K	
KB0202012 RHIC Experimental Report	$26,670K	
KB0301020 National Laboratory Research	$2,256K	
KB0301020 National Laboratory Research	$498K	
KB0301042 National Laboratory Research	$3,008K	
KB0401022 Other National Laboratory Research	$806K	

KB0401052 National Laboratory Research	$301K	

DOE Office of Science - Program Title: Basic Energy Sciences		
Approximate Dollar Value: $64,073K		
Sub Program: $(K)		**DOE Office of Science Strategic Plan Alignment**
KC0201010 Structure of Materials	$3,829K	**Advance the Basic Sciences for Energy Independence**: *Provide the scientific knowledge and tools to achieve energy independence, securing U.S. leadership and essential breakthroughs in basic energy sciences*
KC0201030 Physical Properties	$1,374K	
KC0201050 Engineering Materials	$226K	
KC0202010 Neutron Scattering	$4,743K	
KC0202020 Experimental Research	$2,747K	
KC0202030 Theoretical Research	$1,536K	
KC0203010 Synthesis & Chemical Structure	$1,637K	
KC0204011 National Synchrotron Light Source	$36,508K	**Provide the Resource Foundations that Enable Great Science**: *Provide the discovery-class tools required by the U.S. scientific community to answer the most challenging research questions of our era*
KC0301010 Photochemical & Radiation Sciences	$4,570K	**Advance the Basic Sciences for Energy Independence**: *Provide the scientific knowledge and tools to achieve energy independence, securing U.S. leadership and essential breakthroughs in basic energy sciences*
KC0301020 Chemical Physics	$3,294K	
KC0302010 Chemical Energy	$2,042K	
KC0302020 Separation & Analysis	$22K	
KC0302040 Chemical Engineering Sciences	$766K	

KC0303010 Geology, Geophysics and Earth Dynamics	$8K	
KC0304000 Energy Biosciences	$769K	

DOE Office of Science – Program Title: Computational & Technology Research		
Approximate Dollar Value: $1,896K		
Sub Program: $(K)		**DOE Office of Science Strategic Plan Alignment**
KJ0101010 Basic Research & Human Resources	$721K	**Deliver Computing for the Frontiers of Science**: *Deliver forefront computational and networking capabilities to scientists nationwide that enable them to extend the frontiers of science, answering critical questions that range from the function of living cells to the power of fusion energy*
KJ0101030 Advanced Software Technology & Algorithams Research	$72K	
KJ0102000 Advanced Computational Communications Research	$479K	
KJ0200000 Laboratory Technology Research	$625K	

DOE Office of Science - Program Title: Science Education		
Total Available Funding: $774K		
Sub Program: $(K)		**DOE Office of Science Strategic Plan Alignment**
KL0101000 Science Undergraduate Laboratory Internship (SULI)	$774K	**Provide the Resource Foundations that Enable Great Science:** *Contribute to a vital and diverse national scientific workforce by providing national laboratory research opportunities to students and teachers*

DOE Office of Science - Program Title: Biological and Environmental Research		
Approximate Dollar Value: $20,555K		
Sub Program: $(K)		**DOE Office of Science Strategic Plan Alignment**
KP1101 Structural Biology	$4,276K	**Provide the Resource Foundations that Enable Great Science**: *Create and sustain the discovery-class tools, 21st Century scientific and technical workforce, research partnerships, and management systems that support the foundations for a highly productive, world-class national science enterprise. Provide the discovery-class tools required by the U.S. scientific community to answer the most challenging research questions of our era*
KP1102 Molecular Biology	$1,527K	**Harness the Power of Our Living World**: *Provide the biological and environmental discoveries necessary to clean and protect our environment, offer new energy alternatives, and fundamentally alter the future of medical care and human health. Master the convergence of the physical and the life sciences to deliver revolutionary technologies for health and medical applications.*
KP1102 Cellular Biology	$600K	
KP1103 Genome	$22K	
KP1201 Atmospheric Radiation Measurement	$944K	
KP1202 Atmospheric Science	$2,003K	
KP1202 Terrestrial Carbon Processes	$2,014K	
KP1203 Vegetation	$880K	
KP1301 Bioremediation Research	$357K	
KP1301 Clean Up Research	$305	
KP1401 Radiopharmaceuticals	$3,555K	
KP1401 Instrumentation	$1,793K	

KP1401 Clinical Feasibility	$1,043K	
KP1401 Baron Neutron Capture Therapy	$662K	
KP1401 Molecular Nuclear Medicine	$563K	

DOE Office of National Nuclear Security Administration - Program Title: Nonproliferation and National Security Program Direction		
Approximate Dollar Value: $7,453K		
Sub Program: $(K)		**DOE Defense Strategic Goal Alignment**
NN4101010 Initiatives for Proliferation Prevention (US)	$5,409K	**Nuclear Nonproliferation**: *Provide technical leadership to limit or prevent the spread of materials, technology, and expertise relating to weapons of mass destruction*
NN4102020 Nuclear Cities Initiatives (Russian Federation)	$2,044K	

DOE Office of Nuclear Energy- Program Title: Radiopharmaceuticals		
Approximate Dollar Value: $2,700K		
Sub Program: $(K)		**DOE Office of Science Strategic Plan Alignment**
ST3002000	$2,700K	**Provide the Resource Foundations that Enable Great Science**: *Create and sustain the discovery-class tools, 21st Century scientific and technical workforce, research partnerships, and management systems that support the foundations for a highly productive, world-class national science enterprise. Provide the discovery-class tools required by the U.S. scientific community to answer the most challenging research questions of our era*

DOE Energy Information Administration - Program Title: National Energy Information System		
Approximate Dollar Value: $497K		
Sub Program: $(K)		**DOE Energy Strategic Goal Alignment**

TA0100000 National Energy Information System-NEIS	$497K	**Energy Security**: *Exploring advanced technologies that make a fundamental improvement in our mix of energy options*

DOE Office of Electric Transmission and Distribution - Program Title: Office of Electric Transmission and Distribution		
Approximate Dollar Value: $498K		
Sub Program: $(K)		**DOE Energy Strategic Goal Alignment**
TD5001130 Strategic Research	$498K	**Energy Security**: *Improve energy security by developing technologies that foster a diverse supply of reliable, affordable, and environmentally sound energy by providing for reliable delivery of energy*

DOE Office of Energy Efficiency and Renewable Energy - Program Title: Vehicle Technology		
Approximate Dollar Value: $1,953K		
Sub Program: $(K)		**DOE Energy Strategic Goal Alignment**
VT0301010 Hybrid Systems - High Power Energy Storage	$165K	**Energy Security***: Exploring advanced technologies that make a fundamental improvement in our mix of energy options*
VT0406000 Health Impacts	$1,788	

DOE Office of Energy Efficiency and Renewable Energy - Program Title: In-House Energy Management		
Total Available Funding: $70K		
Sub Program: $(K)		**DOE Energy Strategic Goal Alignment**
WB0100000 IHEM Program Operations	$70K	**ENERGY SECURITY:** *Exploring advanced technologies that make a fundamental improvement in our mix of energy options*