OVERVIEW

NUCLEAR PHYSICS

The Nuclear Physics program of the Department of Energy (DOE) has the lead responsibility for Federal support of nuclear physics research and supports fundamental research activities under the mandate provided in Public Law 95-91 which established the Department. The primary goal of the program is to understand the structure of atomic nuclei and the fundamental forces required to hold their constituents in place. Nuclear processes determine the essential physical characteristics of our universe and the composition of the matter which forms it. The science of nuclear physics has spawned many diverse technologies such as nuclear medicine, nuclear power, nuclear fusion and nuclear weapons. These technologies have matured to the point where they now operate almost independently of the fundamental research program. Nevertheless, vital interactions still occur between the development of advanced concepts, the transfer of improved theoretical models, the common development of instrumentation, and the development of more precise nuclear physics data in selected areas. Nuclear Physics accelerators generate many of the radioisotopes used for medical diagnoses and support several cooperative programs in biomedical research and atomic physics. They provide the framework for the training of Health Physicists who are dedicated to the maintenance of a radiation-free environment. Over one-half of the approximately 100 new Ph.D. graduates produced each year in the DOE Nuclear Physics program will find careers in these areas. In addition, the Nuclear Data program within Nuclear Physics generates, evaluates, and disseminates information such as neutron cross-sections and radioactive decay data to support these programs.

The vitality of Nuclear Physics is dependent on continuous advancement of the fundamental understanding of the material and forces of nature. Nuclear Physics activities are an essential component of the nation's scientific and technological base. Over the years, many theoretical models have been developed to describe the structure of the nucleus and its behavior. These models have progressed from simple mechanical models of surface vibrations and rotations to sophisticated descriptions of meson-nucleon interactions. Scientists now know that nucleons (neutrons and protons, the constituents of the nucleus), are composed of smaller constituents called quarks. Based on the ways quarks are confined in groups of three to make nucleons, or groups of two to make mesons, a more fundamental theory of the nuclear force called quantum chromodynamics (QCD) has been formulated. The incorporation of QCD concepts deepens our understanding of nuclear structure and interactions and provides significant new challenges to the experimental program. Many of the characteristics and implications of the new QCD formulation of the nuclear force are addressed by the research programs both of nuclear physics and high energy physics. However, the Nuclear Physics program uniquely approaches problems by testing the theoretical predictions in the medium of extended nuclear matter provided by nuclei composed of many nucleons. Another subfield of Nuclear Physics addresses problems of mutual interest to nuclear physics and astrophysics, including measurements of supernovae, neutron stars, solar neutrinos, composition of cosmic rays, and stellar nuclear abundances. Of special current interest are measurements of the solar neutrino flux which permits the measurement of possible small neutrino masses. Relativistic heavy ion collisions to create a quark-gluon plasma, which simulates a stage of evolution of the universe that ended ten millionths of a second after the initial "big bang", will play an increasing role in the program.

The strategy of the program is to address the most pressing scientific questions in nuclear physics with new theories, equipment, and facilities while maintaining an effective balance between competing and diverse program elements. Essential continuing guidance is provided by the Nuclear Science Advisory Committee (NSAC), based on the 1989 Long Range Plan for Nuclear Science. The program is built on an active experimental research program which is continually evaluated and revised to focus on the most basic scientific questions. Nuclear theory, design and fabrication of sophisticated detectors and the development and training of creative and skilled personnel are necessary for proper conduct of this research. Central to the program are the construction, operation and maintenance of the accelerator facilities which provide the beams of particles with which the experiments are performed. In some areas of nuclear physics, questions are addressed at universities by accelerators dedicated to in-house research, or smaller facilities located at national laboratories. However, many of the newly emerging fundamental problems in nuclear science require large modern facilities that are designed for the research use of the entire nuclear community.

The DOE Nuclear Physics program supports over 85 percent of the U.S. basic research program with the rest being supported by the National Science Foundation (NSF). Scientists supported by the Nuclear Physics program also carry out experiments and conduct research at NSF and High Energy

Physics supported facilities and at foreign accelerator facilities. The university component of the program forms the central core of the facility user activity. University facilities are critical for attracting young scientists, many of whom perform their research at off-campus user facilities. DOE University-based Nuclear Physics research is augmented by NSF supported users of DOE facilities. Emphasis is placed on use of the completed South Hall Ring Experiment at the Massachusetts Institute of Technology and use of the Tandem/AGS high energy heavy ion beams at Brookhaven National Laboratory (BNL) using the recently completed booster. In the Low Energy program, the Holifield Heavy Ion Research Facility will begin a research program based on the existing accelerators which were reconfigured and upgraded to provide a Radioactive Ion Beam (RIB) Facility at Oak Ridge National Laboratory. Operation of other national laboratory facilities at Argonne and Berkeley will continue within the Heavy Ion program. The request provides for preparation of decontamination and decommissioning of LAMPF. However, the Department is currently evaluating new proposed defense uses for LAMPF and may redirect nuclear weapons research and development funds to continue operation of the facility. In this event, funds for preparation of LAMPF decontamination and decommissioning would be redirected to high priority physics research.

Priorities within the program will accommodate students and postdoctoral fellows in nuclear physics and will reflect the highest program priorities. Emphasis will be placed on new scientific areas in physics using electron beams, relativistic heavy ion research, studies of high spin states, and solar neutrino research. Detector projects include completion of the segmented gamma ray detector for nuclear structure physics (Gammasphere) and initial operation of the Sudbury Neutrino Observatory (SNO) project in cooperation with Canada and the United Kingdom. Permanent staffing at the National Institute for Nuclear Theory is completed, and a full program of basic research and study sessions on forefront topics in nuclear physics will be offered.

The Continuous Electron Beam Accelerator Facility (CEBAF) construction project will be complete in FY 1995; the primary activities will be final assembly, commissioning, and completion of design and fabrication of experimental detectors. Already, 325 physicists from 66 institutions have submitted 65 research proposals to the CEBAF. As the facility begins operation, 440 physicists from 105 institutions will carry out approved experiments. About 250 scientists from outside of CEBAF are already actively participating in the design of experiments to be carried out in the three experimental halls. In FY 1995, the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory will enter its fifth year of construction, with procurement of superconducting magnets as a major activity. The present research focus is on the involvement of the user community in equipment fabrication. Letters of intent to design and fabricate detectors have been received representing over 600 scientists from 70 universities and laboratories throughout the world. Two major detectors, STAR and PHENIX, have received approval to begin design and construction, and international teams of scientists are working on each. Two smaller detectors are planned to address specialized scientific questions.

Performance Indicators for the Nuclear Physics program include the discovery of new scientific knowledge, number of scientists supported, accelerator beam hours available for research and percentage completion (cost and schedule milestones) against the approved project plans for CEBAF and RHIC.

In FY 1994, the number of Ph.D-level scientists supported by the program is expected to be about 1100, plus about 450 graduate students. In FY 1995, the level is projected to be 1040 Ph.D.'s, and 425 graduate students. Expected beam hours for research at accelerator user facilities is 14,100 hours in FY 1994, and 13,800 hours in FY 1995, including initial research capability at CEBAF and RIB. CEBAF construction will be complete in the 1st quarter of FY 1995 and operation for commissioning will begin. At the end of FY 1995, the RHIC project will be 55% complete.

DEPARTMENT OF ENERGY
FY 1995 CONGRESSIONAL BUDGET REQUEST
OFFICE OF ENERGY RESEARCH
(Tabular dollars in thousands, narrative in whole dollars)

LEAD TABLE

Nuclear Physics

Activity	FY 1993 Adjusted	FY 1994 Approp.	FY 1994 Adjustment	FY 1995 Request
Operating Expenses				
Medium Energy Nuclear Physics	$56,522	$111,555	-$2,565	$93,686
Heavy Ion Nuclear Physics	67,900	67,400	-1,561	61,560
Low Energy Nuclear Physics	25,400	25,600	-452	24,760
Nuclear Theory	14,500	14,800	-152	14,735
Capital Equipment	31,200	32,000	0	28,000
Construction	111,100	101,990	0	78,100
Subtotal	$306,622	$353,345	-$4,730	$300,841
Adjustment	-9,000 a/	0	0	0
Total Nuclear Physics	$297,622	$353,345	-$4,730	$300,841
Summary				
Operating Expenses	$164,322 b/	$219,355	-$4,730	$194,741
Capital Equipment	31,200	32,000	0	28,000
Construction	111,100	101,990	0	78,100
Total Program	$306,622 c/	$353,345 d/	-$4,730	$300,841
Staffing (FTEs)	(Reference General Science Program Direction)			

Authorization: P.L. 95-91, "Department of Energy Organization Act" (1977)

a/ Amount of general reduction for use of prior year balances assigned to this program. The total reduction will be taken at the Appropriation level.

b/ Total has been reduced by $2,478,000 reprogrammed to Energy Supply for SBIR.

c/ Does not include $53,500,000 in operating expenses and $1,000,000 in capital equipment appropriated within the Atomic Energy Defense Activity for LAMPF operation managed by ER.

d/ Does not include $15,000,000 for LAMPF/LANSCE contained in the Department of Defense Appropriation.

DEPARTMENT OF ENERGY
FY 1995 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
(Tabular dollars in thousands, narrative in whole dollars)

SUMMARY OF CHANGES

Nuclear Physics

FY 1994 Request	$ 353,345
- Adjustment	- 4,730
FY 1994 Adjusted	348,615

Medium Energy Nuclear Physics

- Increase CEBAF to complete commissioning and begin operations. Funds for LAMPF are decreased in preparation for decontamination and decommissioning. Reduce research activity and support for Bates Operations by about 6%	- 15,304

Heavy Ion Nuclear Physics

- Conduct heavy ion research and operations	- 4,279

Low Energy Nuclear Physics

- Continue overall low energy operations and research and nuclear data program, provide operations support for the Radioactive Ion Beam (RIB) project at ORNL	- 388

Nuclear Theory

- Concentrate effort in highest priority areas of nuclear physics with continued support of the Institute of Nuclear Theory	+ 87

Capital Equipment

- Provide Nuclear Physics Instrumentation needed for CLAS Detector at CEBAF, and experimental systems at BNL, LBL, and ANL. The decrease is primarily associated with completion of the Sudbury Neutrino Observatory Detector in FY 1994......................	- 4,000

Construction

- Maintain approximately level effort for AIP and GPP....................................	- 300
- Provide funding for the completion of the Continuous Electron Beam Accelerator Facility (CEBAF) construction project..	- 15,590
- Continue Relativistic Heavy Ion Collider (RHIC) construction project....................	- 8,000
FY 1995 Congressional Budget Request..	$ 300,841

DEPARTMENT OF ENERGY
FY 1995 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

KEY ACTIVITY SUMMARY

NUCLEAR PHYSICS

I. Preface: Medium Energy Nuclear Physics

The Nuclear Physics Program supports the basic research necessary to identify and understand the fundamental features of atomic nuclei and their interactions. The Medium Energy Nuclear Physics subprogram supports academic fundamental research, and operations and research at accelerator facilities with sufficient primary beam energy to produce pi mesons (pions) using projectiles no more massive than alpha particles. In addition, the subprogram supports nuclear physics experiments at accelerators operated by other DOE programs (e.g., High Energy Physics and Basic Energy Sciences) and at other unique domestic or foreign facilities. Two national accelerator facilities have been operated entirely under the Medium Energy subprogram - the Clinton P. Anderson Meson Physics Facility (LAMPF) at Los Alamos National Laboratory and the Bates Linear Accelerator Center operated by the Massachusetts Institute of Technology. These accelerator facilities serve a nationwide community of scientists from over 100 American institutions, of which over 90% are universities. At proton facilities, support is provided for wide-ranging research activities on the scattering of protons and pions, weak interactions, muonic and pionic atoms, selective excitation of proton/neutron states, and giant resonances. At electron facilities, support is provided for high resolution studies of the electric and magnetic structure of nuclei, the motion of pions inside nuclei, and the role of excited states of nucleons in nuclear structure. R&D activities required for the construction of the Continuous Electron Beam Accelerator Facility (CEBAF) and preparation for operation of the laboratory are also carried out under the Medium Energy subprogram.

In FY 1993, $54,500,000 was appropriated in Atomic Energy Defense Activities for LAMPF operations. Due to a major re-structuring of the Los Alamos National Laboratory (LANL), all FY 1995 Medium Energy Nuclear Physics funding is provided to P division under the research program activity. In FY 1995, operation of LAMPF may be primarily supported by Defense Programs.

II. A. Summary Table: Medium Energy Nuclear Physics

Program Activity	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
Research				
CEBAF	$ 11,000	$ 10,580	$ 9,770	- 8
MIT/Bates	3,700	3,700	3,450	- 7
National Laboratories	7,414	16,524	20,730	+ 25
Universities	6,493	11,396	10,836	- 5
Subtotal, Research	$ 28,607	$ 42,200	$ 44,786	+ 6
Operations				
LAMPF	$ 0	$ 23,640	$ 0	-100
Bates	9,900	10,400	8,900	- 14
CEBAF	17,615	32,750	40,000	+ 22
Other	400	0	0	0
Subtotal, Operations	$ 27,915	$ 66,790	$ 48,900	- 27
Total, Medium Energy Nuclear Physics	$ 56,522	$ 108,990	$ 93,686	- 14

II. B. Major Laboratory and Facility Funding

ARGONNE NATIONAL LAB (EAST)	$ 2,900	$ 2,850	$ 2,670	- 6
BROOKHAVEN NATIONAL LAB	$ 2,408	$ 1,930	$ 1,950	+ 1
CONTINUOUS ELECTRON BEAM ACCELERATOR FACILITY	$ 28,615	$ 43,330	$ 49,770	+ 15
LOS ALAMOS NATIONAL LABORATORY	$ 1,700	$ 33,870	$ 14,510	- 57

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1993	FY 1994	FY 1995
Medium Energy Nuclear Physics			
Research			
CEBAF	Utilize data acquisition system for testing of components and systems during accelerator assembly. Expand the Local Area Network (LAN). Modify system to handle inputs from all accelerator components leading to automated operation of the facility.	Utilize data acquisition system for testing of components and systems during accelerator assembly. Bring computer system up to full capability for automated operation and querying of the thousands of inputs monitored for proper operation of the entire facility. Establish the on-line data acquisition capability for automated collection and analysis of data from experiments. Hall C data acquisition and slow controls system will be completed.	The Hall A data acquisition and slow controls system will be completed. The central data replay resources will be upgraded to match the data output of Hall C and the start-up activities in Hall A. Data reduction analysis software and data bases will be supported.
	Assemble and test experimental equipment components. Emphasis will be on completion of Hall C and Hall A detectors to be ready for data taking upon completion of commissioning of the accelerator in early 1995. The CLAS detector in Hall B will be completed as soon as possible thereafter.	Assemble and test experimental equipment components. Emphasis will be on completion of Hall C and Hall A detectors to be ready for data taking upon completion of commissioning of the accelerator in early 1995. The CLAS detector in Hall B will be completed as soon as possible thereafter. In FY 1994, at an intermediate stage of commissioning, the beam will be brought into Hall C. At that time, Hall C equipment will be used to commence the CEBAF experimental research program.	Complete installation of Hall A spectrometer pair and detector packages. Complete installation and testing of beam lines, control systems, data acquisition systems, safety and environmental systems, and other support equipment. Complete final preparations for beginning of physics operations by 4th quarter, FY 1995.
	Continue superconducting research activities and strengthen theoretical efforts. Research by CEBAF scientific staff at other laboratories will be curtailed to concentrate on facility completion and preparation for experiments.	Continue superconducting research activities and strengthen theoretical efforts. CEBAF scientific staff is now almost completely involved in preparation for the CEBAF research program. First experiments get underway.	Continue superconducting research activities. Theoretical efforts will be supported by the Nuclear Theory Program.

Program Activity	FY 1993	FY 1994	FY 1995
CEBAF (Cont'd)	Carry out research at existing facilities on experiments at the MIT/Bates Linear Accelerator Center, the Stanford Linear Accelerator Center, at NIKHEF in the Netherlands, and at Cornell University. Plan for future CEBAF program established through Program Advisory Committee meetings, and CEBAF User's Group meetings.	Participation in outside experiments limited due to pressures of completing CEBAF experimental equipment. Program Advisory Committee will meet in the 4th quarter.	Continue tests for operations in Experimental Hall C. In 4th quarter FY 1995, shake-down for initial operation of Experimental Hall A twin spectrometers will begin.
	$ 11,000	$ 10,580	$ 9,770
MIT/Bates	Continue coincidence measurements with polarized electron beams. Emphasize measurement of spin observables. Begin using new out-of-plane detection techniques, polarized targets, and polarization detection capability.	Continue coincidence measurements with higher intensity polarized electron beams. Begin performing experiments with the new South Hall Ring (SHR). Emphasize measurement of spin observables utilizing the new OHIPS focal plane polarimeter. Carry out measurements "out of the scattering plane" with new detection systems (OOPS) jointly developed with the National Science Foundation (NSF) at the University of Illinois. An important experiment will be a measurement of the charge form factor of the neutron.	Continue coincidence measurements with higher intensity polarized electron beams. Perform experiments with the new South Hall Ring (SHR). Emphasize measurement of spin observables utilizing the new OHIPS focal plane polarimeter. Carry out measurements "out of the scattering plane" with new detection systems (OOPS) jointly developed with the National Science Foundation (NSF) at the University of Illinois. Begin phasing in experiments with the SHR polarized internal targets.
	In the North Hall, put in place and test out all subsystems associated with the SAMPLE experiment to measure parity violation in elastic scattering from the proton and increase level of research in the South Hall as the SHR experiment installation is completed.	Carry out and complete data taking for the SAMPLE experiment to measure parity violation in elastic scattering from the proton. Use high resolution ELSSY spectrometer for measurements of high q magnetic scattering from He-3, and nuclear structure studies of the neon isotopes.	Continue high precision measurements with the ELSSY spectrometer in the North Hall. Consider possibility of extending the SAMPLE experiment to measurements on deuterium.

Program Activity	FY 1993	FY 1994	FY 1995
MIT/Bates (Cont'd)	Continue R&D on behavior of polarized beams in stretcher rings and on design of detector components for use in the South Hall.	Design and implement a polarimeter capability internal to the SHR. Design detection capability for use with internal targets and the cw beam available in the South Hall.	Utilize and improve internal polarimeter capability and new experimental detection capabilities for use with new internal target and high current cw beam available in the South Hall Pulse Stretcher Ring.
	Carry out a program of research at other existing facilities including LAMPF, CEBAF, the Paul Scherrer Institute in Switzerland, and HERA in Germany.	Carry out a program of research at other existing facilities including LAMPF, CEBAF, the Paul Scherrer Institute in Switzerland, and HERA in Germany.	Carry out a program of research at other existing facilities including LAMPF, CEBAF, the Paul Scherrer Institute in Switzerland, and HERA in Germany.
	Include $120,000 for a computer lease for the Laboratory for Nuclear Science Computer Facility Upgrade.	Include $120,000 for a computer lease for the Laboratory for Nuclear Science Computer Facility Upgrade.	Include $120,000 for a computer lease for the Laboratory for Nuclear Science Computer Facility Upgrade.
	$ 3,700	$ 3,700	$ 3,450
National Laboratories	At Brookhaven National Laboratory (BNL), continue data taking phase and continue analysis of the first H-particle search using the Alternating Gradient Synchrotron (AGS). Plan second phase experiment which examines a different mass region. Carry out analysis of experiments on lambda hypernuclei. Build drift chambers for the Short Orbit Spectrometer (SOS) in Hall C at CEBAF.	Continue analysis of H-particle data from first experiment. Begin data accumulation on the second phase H-particle experiment which examines a different mass region. Commence experiment to measure double-lambda hypernuclei. Continue construction and testing of drift chambers for SOS spectrometer at CEBAF.	Continue data accumulation on the second phase H-particle search experiment and the measurement of double-lambda hypernuclei. CEBAF SOS drift chambers are complete and installed. Plan for commencement of strangeness production experiment at CEBAF.

Program Activity	FY 1993	FY 1994	FY 1995
National Laboratories (Cont'd)	At BNL, utilize the Laser Electron Gamma Source (LEGS) Facility. Carry out a broad experimental program of polarized photon scattering looking primarily at few-nucleon targets, and concentrating on measurements of the nuclear tensor force, and polarization observables.	Utilize the LEGS Facility. Carry out a broad experimental program of polarized photon scattering looking primarily at few-nucleon targets, and concentrating on measurements of the nuclear tensor force, and polarization observables. Continue experimental program, and begin studies of hadron polarizabilities, particularly of the proton and the pion. Plan new experimental efforts using the crystal box spectrometer and End Cap upgrade, and a polarized H-D target.	Utilize the LEGS facility. Carry out a broad experimental program of polarized photon scattering looking primarily at few-nucleon targets, and concentrating on measurements of the nuclear tensor force, and polarization observables. Begin new experimental efforts using the crystal box spectrometer and End Cap upgrade, and a polarized H-D target.
	At Argonne National Laboratory (ANL), a program of research is carried out concentrating on the interactions of nuclear constituents and the manner in which they are modified in nuclei. Research is carried out at a number of facilities including Fermilab, SLAC, the VEPP-3 electron storage ring in Russia, HERA in Germany, and CEBAF. Engineering design for the CEBAF Short Orbit Spectrometer is completed. Phase two measurements of the tensor force at VEPP-3 are complete. Data analysis of the Fermilab experiment on deep inelastic muon scattering is well underway.	Construction of the SOS spectrometer will be completed and components of an initial detector system will be installed. Phase three experiment to measure the tensor force in electron deuteron scattering at VEPP-3 will be underway. New initial results from the Fermilab muon scattering experiment will be available. Initial data using CEBAF Hall C spectrometers will be taken.	Plan for commencement of full program of research at CEBAF. Complete work on a cryogenic He-3 target for use in a number of Hall C experiments at CEBAF. Phase three experiment at VEPP-3 will be completed. Begin test measurements on spin structure function of the nucleon in the HERA electron ring.
	At Los Alamos National Laboratory (LANL), a program of research is carried out concentrating on examination of nuclear phenomena at high energies. Work concentrates on achieving an understanding of nuclear behavior at the quark-gluon level. Research is carried primarily at Fermilab, and concepts are being developed to establish a future research program at the AGS, and using the PHENIX detector to be built at RHIC at Brookhaven National Laboratory.	Continue to analyze Fermilab experiment on two prong decays of B and D mesons, and continue to prepare for new Drell-Yan measurements at Fermilab. Continue planning for future use of the PHENIX detector at RHIC for p-N studies.	Prepare for PHENIX detector activities at RHIC, which involve emphasis on the muon subsystem and the overall trigger and data acquisition systems. Begin to carry out Drell-Yan measurements at Fermilab which will yield crucial results on whether the anti-quark asymmetry in the proton is the source of an apparent violation of a sum rule seen in deep inelastic scattering experiments.

III. Medium Energy Nuclear Physics (Cont'd):
Research (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
National Laboratories (Cont'd)	Analyze Fermilab experiment on two prong decay of B and D mesons from nuclear targets.		
	In FY 1993, no research was supported at LAMPF with Nuclear Physics funds.	At LAMPF, high priority experiments are supported such as the rare muon decay search (MEGA), a search for neutrino oscillations using the new LSND detector, and experiments using the new neutral meson spectrometer (NMS).	The request provides for preparation for decontamination and decommissioning of LAMPF. However, the Department is currently evaluating new proposed defense uses for LAMPF and may redirect nuclear weapons research and development funds to continue operations of the facility. In this event, funds for preparation of LAMPF decontamination and decommissioning would be redirected to high priority physics research. Highest priority experiments will continue, such as MEGA, LSND, use of the NMS, and a program of parity and time reversal violation studies using epithermal neutron scattering. Continue analysis of completed LAMPF experiments.
	At the Stanford Linear Accelerator Center (SLAC), support high pressure gas target development for an experiment at the MIT/Bates Linear Accelerator Center.	No activity.	No activity.
	Funding in the amount of $1,478,000 for the SBIR program has been reprogrammed to Energy Supply.	Funding in the amount of $614,000 has been budgeted for the SBIR program.	Funding in the amount of $1,100,000 has been budgeted for the SBIR program.
	$ 7,414	$ 16,524	$ 20,730

III. Medium Energy Nuclear Physics (Cont'd):
Research (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Universities	Support a broad program of university research in Nuclear Physics utilizing not only accelerator facilities supported under the Medium Energy Program, but also using other U.S.and international accelerator laboratories. Also support non-accelerator based research at a number of international sites where major detector systems have been assembled to examine fundamental physical laws such as searches for neutrino oscillations and double beta decay. Conduct program of selected nuclear physics experiments at other facilities including Fermilab, SLAC, TRIUMF (Canada), Saclay (France), PSI (Switzerland), VEPP-3 (Russia), and NIKHEF (Netherlands).	Support a broad program of university research in Nuclear Physics utilizing not only accelerator facilities supported under the Medium Energy Program, but also using other U.S.and international accelerator laboratories. Also support non-accelerator based research at a number of international sites where major detector systems have been assembled to examine fundamental physical laws such as searches for neutrino oscillations and double beta decay. Conduct program of selected nuclear physics experiments at other facilities including Fermilab, SLAC, TRIUMF (Canada), Saclay (France), PSI (Switzerland), VEPP-3 (Russia), and NIKHEF (Netherlands).	Support a broad program of university research in Nuclear Physics utilizing not only accelerator facilities supported under the Medium Energy Program, but also using other U.S.and international accelerator laboratories. Also support non-accelerator based research at a number of international sites where major detector systems have been assembled to examine fundamental physical laws such as searches for neutrino oscillations and double beta decay. Conduct program of selected nuclear physics experiments at other facilities including Fermilab, SLAC, TRIUMF (Canada), Saclay (France), PSI (Switzerland), VEPP-3 (Russia), and NIKHEF (Netherlands).
	$ 6,493	$ 11,396	$ 10,836
Subtotal, Research	$ 28,607	$ 42,200	$ 44,786
Operations			
LAMPF	Operate accelerator and facilities about 1900 hours for nuclear physics research with about seven secondary beams operating simultaneously, using funds appropriated within AEDA ($53,500,000), and managed by ER. Provide beams for approximately 33 nuclear physics experiments involving about 270 scientists.	Operate accelerator and facilities about 1900 hours for nuclear physics research with about seven secondary beams operating simultaneously. Provide beam for approximately 20 nuclear physics experiments involving about 180 scientists.	The request provides for preparation for decontamination and decommissioning of LAMPF. However, the Department is currently evaluating new proposed defense uses for LAMPF and may redirect nuclear weapons research and development funds to continue operation of the facility. In this event, funds for preparation of LAMPF decontamination and decommissioning would be redirected to high priority physics research.

Program Activity	FY 1993	FY 1994	FY 1995
LAMPF (Cont'd)	$ 0	$ 23,640	$ 0
Bates	Operate accelerator and facilities about 1100 hours for nuclear physics research during commissioning of the South Hall Ring.	Operate accelerator and facilities about 2000 hours for nuclear physics research. Begin utilizing the new cw internal target facility on the South Hall Ring, and the new cw extracted electron beam capability.	Operate accelerator and facilities about 1500 hours for nuclear physics research. Utilize the new internal target facility in the South Hall Ring and the cw extracted beams for the experimental nuclear physics program.
	Provide beam for approximately 10 experiments involving about 100 scientists.	Provide beam for approximately 10 experiments involving about 100 scientists.	Provide beam for approximately 10 experiments involving about 100 scientists.
	Operate accelerator at 1 GeV for required experiments during selected operating cycles during the year. Modify electron injector and operate with circulating beam in the South Hall Ring (SHR).	Operate accelerator at 1 GeV for required experiments during selected operating cycles during the year. Routinely inject electron beam into the SHR and operate with circulating electron beams. Extract external cw electron beams for experiments.	Operate accelerator at 1 GeV for required experiments during selected operating cycles during the year. Routinely inject electron beam into the SHR and operate with circulating electron beams. Extract external cw electron beams for experiments. Operate SHR with internal polarimeter capability.
	Complete installation and testing of components for the South Hall Ring Experiment (SHRE). Complete installation of upgrades to the LINAC including a high intensity polarized electron gun.	Complete commissioning of the SHRE.	No activity.
	$ 9,900	$ 10,400	$ 8,900

Program Activity	FY 1993	FY 1994	FY 1995
CEBAF	Carry out testing of North and South Linac components, arc magnets, and associated RF, cryogenic and facility safety systems. Continue commissioning of North Linac and assembly of South Linac. Machine Control Center is staffed around the clock.	Continue final assembly and commissioning of entire accelerator facility and the beam switchyard which channels the electron beam to the three experimental halls. Bring initial beam into Hall C for testing of experimental apparatus. North and South Linac commissioning will be completed. Central Helium Liquefier commissioning will be completed. Beam will be delivered at 800 MeV to Hall C for start of experimental equipment commissioning. Commence the experimental research program.	Complete final assembly and continue commissioning of entire accelerator facility and the beam switchyard which channels the electron beam to the three experimental halls. Make transition from commissioning to operational stage. Achieve 5-pass beam operation and a beam energy of 4 GeV. Establish capability to deliver beam to the three experimental halls simultaneously.
	Provide partial support for startup of laboratory operations and accelerator commissioning. Operate and test major sections of the full injector and the North and South Linacs along with associated systems such as the Central Helium Refrigerator, RF system, safety systems, beam monitors, and computer controls.	Provide partial support for startup of laboratory operations and accelerator commissioning. Operate and test major sections of the full injector and the North and South Linacs along with associated systems such as the Central Helium Refrigerator, RF system, safety systems, beam monitors, and computer controls. Begin testing and operation of experimental equipment. Commence initial experimental research operations in Hall C.	Commence laboratory operations. Continue initial experimental research tests in Hall C and commence testing for initial research operations in Hall A. Operations funding is provided to support commissioning of the accelerator facility only.
	$ 17,615	$ 32,750	$ 40,000
Other	Continue suspension of operation of NPI at SLAC. Provide operation support to the AGS at BNL.	Continue suspension of operation of NPI at SLAC. Terminate other operations support.	Continue suspension of operation of NPI at SLAC.
	$ 400	$ 0	$ 0
Subtotal, Operations	$ 27,915	$ 66,790	$ 48,900

III. Medium Energy Nuclear Physics (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Medium Energy Nuclear Physics	$ 56,522	$ 108,990	$ 93,686

DEPARTMENT OF ENERGY
FY 1995 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

KEY ACTIVITY SUMMARY

NUCLEAR PHYSICS

I. Preface: Heavy Ion Nuclear Physics

The Heavy Ion Research subprogram is aimed at understanding the behavior of nuclei and nuclear matter over an ever increasing range of excitation energy, nuclear density, angular momentum, and deformation. These conditions are created in nucleus-nucleus collisions induced by beams of heavy ions. The heavy ion beams are produced by highly sophisticated accelerators located at three large universities (Texas A&M, Yale, University of Washington) and four National laboratories (Argonne, Brookhaven, Oak Ridge, and Lawrence Berkeley). At low bombarding energies, studies include the high spin behavior of cool nuclear matter leading to severe deformation and eventually fission. Especially intriguing are close encounters of the heaviest nuclei which lead to unexplained spontaneous electron and positron production. The nuclear dynamics of complex phenomena including the evolution of the compound nucleus, deep-inelastic scattering and projectile multifragmentation are studied at intermediate bombarding energies. Radioactive beams are produced to study properties of exotic nuclei out to the very limits of stability. At higher energies, exploration is made of the nuclear matter equation of state for hot dense nuclear matter and the deconfinement of hadronic matter into the quark-gluon plasma.

II. A. Summary Table: Heavy Ion Nuclear Physics

Program Activity	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
Research				
LBL Relativistic Heavy Ion Research...........	$ 4,846	$ 4,655	$ 4,815	+ 3
BNL Tandem/AGS Research.......................	10,462	9,085	8,960	- 1
National Laboratory Research..................	13,197	14,035	13,895	- 1
University Research...........................	10,658	12,420	12,470	0
Subtotal, Research	$ 39,163	$ 40,195	$ 40,140	0
Operations				
LBL Bevalac Operations........................	$ 9,900	$ 5,850	$ 1,810	- 69
BNL Tandem/AGS Operations.....................	7,600	8,670	8,755	+ 1
University Accelerator Operations.............	2,267	2,580	2,555	- 1
Other Operations (including ANL, LBL, ORNL)...	8,970	8,544	8,300	- 3
Subtotal, Operations	$ 28,737	$ 25,644	$ 21,420	- 16
Total, Heavy Ion Nuclear Physics	$ 67,900	$ 65,839	$ 61,560	- 6

II. B. Major Laboratory and Facility Funding

	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
ARGONNE NATIONAL LAB (EAST)	$ 7,205	$ 9,175	$ 9,005	- 2
BROOKHAVEN NATIONAL LAB	$ 18,277	$ 17,755	$ 17,715	0
LAWRENCE BERKELEY LAB	$ 21,685	$ 18,365	$ 14,300	- 22
LAWRENCE LIVERMORE NATIONAL LAB	$ 295	$ 250	$ 240	- 4
LOS ALAMOS NATIONAL LABORATORY	$ 970	$ 1,040	$ 1,000	- 4
OAK RIDGE NATIONAL LAB	$ 6,235	$ 3,510	$ 3,180	- 9

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1993	FY 1994	FY 1995
Heavy Ion Nuclear Physics			
Research			
LBL Relativistic Heavy Ion Research	Conduct a research program appropriate for phaseout of Bevalac Operations. Optimize data acquisition for the Time Projection Chamber (TPC) and the Dilepton Spectrometer (DLS) and analysis of data obtained. Continue involvement in the CERN NA35/NA49 experiment by participation in runs, analysis of data, and design of electronics for a Lead beam experiment in FY 1994. Continue work directed towards development of the STAR experiment at RHIC, including R&D efforts.	Conduct a research program consistent with the FY 1993 phaseout of Bevalac Operations. Work on analysis of Bevalac data, with emphasis on the important data obtained with the TPC and DLS detector systems. Continue involvement in the CERN NA35/NA49 experiment by developing TPC electronics for the FY 1994 Lead (Pb) beam run. Improve support for the core group which provides leadership for the STAR detector at RHIC.	Continue research program focussed on studying the properties of hot, dense nuclear matter produced in relativistic heavy ion collisions. Analysis of data taken in measurements with the DLS and TPC at the Bevalac will be completed. First data will be obtained from the fully instrumented NA49 experiment at CERN, and participation in experiments at the AGS at BNL will continue. Increased effort will be expended for support of the construction of the STAR detector at RHIC. R&D activities on detector instrumentation will continue to be pursued.
	$ 4,846	$ 4,655	$ 4,815

Program Activity	FY 1993	FY 1994	FY 1995
BNL Tandem/AGS Research	Continue the relativistic heavy ion program at the BNL/AGS at about level funding. In the first gold beam experiments, carry out experiments which will provide information about the energy flow, nuclear stopping, strangeness and anti-particle production, limits on strangelet production, and the spatial-time evolution of reaction dynamics in heavier system collisions. Continue R&D directed at RHIC accelerator and detector projects at a level of about $7,200,000. Continue work directed towards designing, and implementing experiments at RHIC.	Continue relativistic heavy ion program at the BNL/AGS to investigate energy flow, nuclear stopping, strangeness and anti-particle production, and spatial-time evolution of reaction dynamics with Gold (Au) beams. Continue R&D directed at RHIC accelerator and detector projects at the level of $5,880,000. Increase support for efforts directed towards designing and implementing experiments at RHIC.	Continue fundamental research program studying energy flow, nuclear stopping, strangeness and anti-particle production, and spatial-time evolution of reaction dynamics with Gold (Au) beams in experiments E866, E877, and E891 at the AGS/BNL. Continue R&D activities which include RHIC R&D at the level of $3,620,000. Increased effort will be devoted to construction of the PHENIX and STAR detectors for RHIC.
	$ 10,462	$ 9,085	$ 8,960
National Laboratory Research	At ANL, continue the experimental program at ATLAS, with emphasis on those classes of studies that exploit the unique beam capabilities and instrumentation available at ATLAS. Continue Fragment Mass Analyzes (FMA) program to address physics of interest. Continue measurements with APEX addressing the question of the origin of the electron-positron peaks observed in heavy nucleus collisions. Continue to provide support in the planning and construction of Gammasphere.	At ANL, continue the ATLAS heavy ion program with emphasis on those studies exploiting the unique beam capabilities and instrumentation at that facility, in particular the measurements being performed with the FMA and APEX detector systems. Continue gamma-ray high-spin spectroscopy program both at ATLAS and with Gammasphere at LBL. Continue R&D activities directed at low-frequency superconducting RF cavities.	At ANL, continue fundamental research studies exploiting the unique massive heavy-ion beam capabilities and instrumentation at ATLAS, and in particular the measurements being performed with the FMA and APEX detector systems. Continue gamma-ray high-spin spectroscopy program both at ATLAS and with Gammasphere at LBL. Continue R&D activities on superconducting RF cavities.

Program Activity	FY 1993	FY 1994	FY 1995
National Laboratory Research (Cont'd)	Continue the experimental program at the LBL 88" Cyclotron, including the high spin and transuranic nuclei studies. Begin measurements with early implementation phase of Gammasphere to address physics questions of high priority. Emphasis will be placed on providing necessary support to keep the Gammasphere Project on schedule. Continue intermediate energy studies investigating energy deposition, multifragmentation and fusion at the 88" cyclotron and elsewhere.	At LBL, continue the experimental program at the 88" cyclotron, including the high spin and transuranic nuclei studies. Continue measurements with the early implementation phase of Gammasphere to address physics questions of high priority. Emphasis will be placed on providing the needed support to assure timely completion of Gammasphere. Continue intermediate energy studies of reaction mechanisms.	At LBL, continue research at the 88" cyclotron, including the high spin and transuranic nuclei studies. Particular emphasis will be placed on the studies being performed with the Gammasphere detector array, and on the development of the auxiliary detectors and computer systems needed to exploit this powerful detector for addressing the highest priority physics. Work will continue on studies of reaction mechanisms at intermediate energies.
	At ORNL, continue experimental program directed at nuclear structure and reaction mechanisms. Continue activities related to fabrication, and installation of Gammasphere. Continue measurements of energetic photons in giant resonance and bremsstrahlung studies. Continue relativistic heavy ion program at CERN by participation in data acquisition and analysis. Continue efforts in R&D directed towards a RHIC detector, and involvement in the development of an experiment for RHIC. Support implementation of a new Radioactive Ion Beam (RIB) facility.	At ORNL, continue the experimental program directed at nuclear structure with emphasis on utilization of large detector arrays, such as Gammasphere and studies with Radioactive Ion Beams (RIB's). Continue reaction mechanism study activities and in particular the measurements of energetic photons from highly excited nuclei. Continue relativistic heavy ion program by participation in the WA98 experiment at CERN using Lead (Pb) beams in FY 1994, and continuing R&D work and planning for the PHENIX detector at RHIC.	At ORNL, continue the research program which includes: nuclear structure studies with emphasis on use of large detector arrays, such as Gammasphere; reaction mechanism studies, in particular the measurements of energetic photons from excited nuclei, and relativistic heavy ion studies at CERN with Lead (Pb) beams in Experiment WA98. Continue activities directed toward construction of the PHENIX detector for RHIC, which includes significant R&D.
	At LANL, continue participation in the CERN experiment NA44. Continue participation in RHIC detector R&D. Take an active role in the development of an experiment at RHIC.	At LANL, continue involvement in the NA44 experiment at CERN, participating in data taking with Lead (Pb) beams in FY 1994 and in the analysis of previous data taken with sulfur and proton beams. Enhanced R&D and planning activities associated with the PHENIX detector for RHIC.	At LANL, continue fundamental research studies at CERN with Lead (Pb) beams in Experiment NA44, and analyses of previous data taken with Silicon and proton beams. Continue activities associated with R&D and construction of the PHENIX detector for RHIC.

Program Activity	FY 1993	FY 1994	FY 1995
National Laboratory Research (Cont'd)	At LLNL, begin data taking in BNL/AGS experiment E866 with gold (Au) beams, and participate in analysis of data from E859. Continue efforts on detector R&D for RHIC, and participate in the development of an experiment at RHIC. Begin effort on nuclear structure studies with Gammasphere.	At LLNL, continue participation in the E866 experiment at the BNL/AGS using Gold (Au) beams in FY 1994, and in the efforts on R&D and planning for the PHENIX detector for RHIC. Continue efforts directed at nuclear structure studies with Gammasphere.	At LLNL, continue research studies at the BNL/AGS with Gold (Au) beams in Experiment E866, and in the analysis of data taken in E859. Continue efforts directed towards construction of the PHENIX detector for RHIC. Continue efforts directed at nuclear structure studies with Gammasphere.
	$ 13,197	$ 14,035	$ 13,895
University Research	Continue university user research at national laboratory facilities, especially where unique capabilities exist. At the upgraded university accelerators at Yale, University of Washington, and Texas A&M the nuclear research programs will continue to carry out nuclear physics studies which are appropriate for the facility and which exploit the inherent strengths of each facility for research and education. Emphasis should continue to be placed on the utilization of the new detectors acquired and on improving instrumentation capabilities at all accelerator facilities.	Continue strengthening university user research at national laboratory facilities where unique instrumentation, such as Gammasphere, and beams, such as relativistic heavy ions at the AGS, exist. At the upgraded university accelerators at Yale, University of Washington, and Texas A&M, the research program will continue to carry out studies which are appropriate for the facility and which exploit the inherent strengths of each facility for research and education. Emphasis should continue to be placed on the utilization of detector systems acquired and on improving the instrumentation available.	Continue strengthening university user fundamental research at national laboratory facilities where unique instrumentation, such as Gammasphere, and beams, such as relativistic heavy ions at the AGS, exist. At the upgraded university accelerators at Yale, University of Washington, and Texas A&M, the research program will continue to carry out studies which are appropriate for and which exploit the inherent strengths of each facility for research and education. Continue emphasis on the utilization of the detector systems acquired and on improving the instrumentation available to address forefront nuclear physics topics. Education of students continues to be of high priority in this activity.
	No activity.	Funding in the amount of $1,000,000 has been budgeted for the SBIR program.	Funding in the amount of $1,330,000 has been budgeted for the SBIR program.
	$ 10,658	$ 12,420	$ 12,470
Subtotal, Research	$ 39,163	$ 40,195	$ 40,140

III. Heavy Ion Nuclear Physics (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Operations			
LBL Bevalac Operations	Funds are provided for specific Bevalac operation to finish highest priority experiments and to initiate decommissioning activities.	Funds at the level of $3,920,000 are provided for activities in preparation of decommissioning of the Bevalac facility. Funds are provided for continued R&D activities in support of the Nuclear Physics program.	Funds are provided for activities to complete preparation for decommissioning of the Bevalac facility, and for R&D activities in support of the Nuclear Physics program.
	$ 9,900	$ 5,850	$ 1,810
BNL Tandem/AGS Operations	Continue Tandem/Booster/AGS operations so as to provide 4 weeks of gold beams for an experimental program. Provide support for implementation and initiation of new gold beam experiments. Continue support of construction of RHIC Test Beamline.	Conduct operations of Tandem/Booster/GAS accelerator facility to provide at least 6 weeks of Gold (Au) beams for an experimental program. Provide support for implementation of gold beam experiments. Support RHIC test beam activities.	Conduct operations of Tandem/Booster/AGS accelerator facility so as to provide at least 5 weeks of Gold (Au) beams for an experimental program. Provide support for implementation and execution of Au beam experiments. Begin RHIC start-up activities for testing accelerator components at the level of $2,200,000 and support RHIC test beam activities.
	$ 7,600	$ 8,670	$ 8,755
University Accelerator Operations	At the three major university accelerator facilities, continue to provide heavy-ion beams and support for carrying out a broad, diverse nuclear physics research program. At the Yale tandem, and the University of Washington superconducting linac booster, provide a broad range of light heavy-ion beams to experiments using an expanded array of detector systems. At the Texas A&M superconducting cyclotron, use the Electron Cyclotron Resonance (ECR) source to provide an expanded range of heavy-ion species at low and intermediate energies for a research program using newly installed experimental instrumentation.	At the Yale tandem facility, provide light heavy-ion beams for nuclear structure, astrophysics, and fundamental interaction studies. Fully support the Texas A&M superconducting cyclotron, with use of the Electron Cyclotron Resonance (ECR) ion source to produce heavy ion beams at low to intermediate energies for a program focussing on the properties of excited nuclei, fundamental interactions, and astrophysics.	The Yale tandem facility will provide beams for conduct of nuclear structure, astrophysics, and fundamental interaction studies. At Texas A&M, the superconducting cyclotron will provide heavy ion beams at low to intermediate energies for a fundamental research program studying the properties of excited nuclei, fundamental interaction, and astrophysics.

III. Heavy Ion Nuclear Physics (Cont'd):
Operations (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
University Accelerator Operations (Cont'd)	$ 2,267	$ 2,580	$ 2,555
Other Operations (including ANL, LBL, ORNL)	Continue improvements of components of the ANL ATLAS facility to optimize the performance and reliability for heavy ion acceleration. Provide beams up to uranium for a research program which includes FMA and APEX measurements. At the LBL 88" Cyclotron, continue R&D on the Advanced ECR source and provide beams for a research program including experiments of the early implementation phase of Gammasphere. At HHIRF at ORNL, complete orderly phase out of user operations and focus effort on the development of a Radioactive Ion Beam (RIB) facility. Continue support of computer and design efforts for Gammasphere.	Support the ANL ATLAS facility to provide beams up to uranium in an enhanced running schedule for a research program which includes FMA and APEX measurements. Continue improvements to optimize the performance and reliability of ATLAS for heavy ion acceleration. At the LBL 88" Cyclotron provide beams in an enhanced running schedule of heavy ion beams for a research program which includes Gammasphere measurements. Continue R&D on the Advanced ECR ion source.	The ANL ATLAS facility will provide heavy ion beams including uranium in a running schedule which includes FMA and APEX measurements. Continue improvements to optimize the performance and reliability of ATLAS for heavy ion acceleration. The LBL 88" Cyclotron will provide beams in a running schedule which emphasizes Gammasphere measurements. R&D will continue on the Advanced ECR ion source.
	$ 8,970	$ 8,544	$ 8,300
Subtotal, Operations	$ 28,737	$ 25,644	$ 21,420
Heavy Ion Nuclear Physics	$ 67,900	$ 65,839	$ 61,560

DEPARTMENT OF ENERGY
FY 1995 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

KEY ACTIVITY SUMMARY

NUCLEAR PHYSICS

I. Preface: Low Energy Nuclear Physics

The basic research part of this subprogram emphasizes experimental investigations at low energies into: the behavior of nucleons at the surface of the nucleus as well as the collective behavior of the entire ensemble of nucleons acting collectively; nuclear reaction mechanisms; and experimental tests of fundamental symmetries. The last of these categories can often be accomplished without the use of accelerators such as in the study of neutrinos from the sun. University-based research is an important feature of the Low Energy Program. Since most of the required facilities are relatively small, they are appropriate for siting on university campuses, where they provide excellent opportunities for hands-on training of nuclear experimentalists, many of whom after obtaining Ph.D.'s, contribute to nuclear technology development of interest to the DOE. The nuclear data part of this subprogram has as its goal the maintenance of an accurate and complete nuclear data information base that is readily accessible and user oriented.

II. A. Summary Table: Low Energy Nuclear Physics

Program Activity	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
Research				
Research at University Facilities............	$ 3,290	$ 3,199	$ 3,083	- 4
Research at National Laboratory Accelerators..	3,425	2,805	3,210	+ 14
Research at Reactors.........................	1,215	1,064	835	- 22
Other Research...............................	4,946	6,022	5,672	- 6
Subtotal, Research	$ 12,876	$ 13,090	$ 12,800	- 2
Operations				
Accelerator Operations.......................	$ 3,559	$ 5,060	$ 5,960	+ 18
Subtotal, Operations	$ 3,559	$ 5,060	$ 5,960	+ 18
Nuclear Data				
Nuclear Data Measurements....................	$ 4,280	$ 2,335	$ 1,850	- 21
Nuclear Data Compilation and Evaluation.......	4,685	4,663	4,150	- 11
Subtotal, Nuclear Data	$ 8,965	$ 6,998	$ 6,000	- 14
Total, Low Energy Nuclear Physics	$ 25,400	$ 25,148	$ 24,760	- 2

II. B. Major Laboratory and Facility Funding

	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
ARGONNE NATIONAL LAB (EAST)	$ 2,545	$ 775	$ 730	- 6
BROOKHAVEN NATIONAL LAB	$ 3,320	$ 3,223	$ 2,450	- 24
IDAHO NATIONAL ENGINEERING LAB	$ 360	$ 345	$ 140	- 59
LAWRENCE BERKELEY LAB	$ 2,930	$ 2,235	$ 2,175	- 3
LAWRENCE LIVERMORE NATIONAL LAB	$ 265	$ 360	$ 395	+ 10
LOS ALAMOS NATIONAL LABORATORY	$ 1,675	$ 1,695	$ 1,475	- 13
OAK RIDGE NATIONAL LAB	$ 3,350	$ 4,958	$ 6,360	+ 28

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1993	FY 1994	FY 1995
Low Energy Nuclear Physics			
Research			
Research at University Facilities	At Texas A&M, emphasis will be on giant resonance studies using new detectors. At Triangle Universities Nuclear Laboratory (TUNL), extend measurements to the higher beam energies provided by new accelerator tubes and charging system; emphasize tests of fundamental symmetries. These include searches for quantum systems which display chaotic behavior, charge symmetry breaking and additional evidence of parity violation in the nucleus. At Washington use the polarized ion source and booster to study a variety of nuclear structure problems and to search for violations of fundamental symmetries.	At TUNL, work emphasizes tests of fundamental symmetries. This includes searches for quantum systems which display chaotic behavior, charge symmetry breaking and additional evidence of parity violation in the nucleus. At the University of Washington use the polarized ion source and booster to study a variety of nuclear structure problems and to search for violations of fundamental symmetries. At Texas A&M University, support is provided for activities associated with giant resonance studies and nuclear astrophysics.	Research at the University of Washington will address issues relating to challenging fundamental problems in symmetries, giant resonances, nucleus-nucleus reactions, and other areas of nuclear physics. This includes the use of the polarized ion source and booster to study a variety of nuclear structure problems and to provide new understanding of possible violations of fundamental symmetries. At TUNL, the fundamental research goal will be to provide new understanding of nuclear astrophysics and fundamental symmetries. In the latter are included searches for quantum systems which display chaotic behavior, charge symmetry breaking and additional evidence of parity violation in the nucleus.
	$ 3,290	$ 3,199	$ 3,083

Program Activity	FY 1993	FY 1994	FY 1995
Research at National Laboratory Accelerators	Continue low energy research at three of the national laboratories. At ANL, low energy heavy ion research will continue; at LBL the main effort will be devoted to the SNO collaboration (described below under Other Research). At the 88-Inch Cyclotron, additional work will be performed in order to evaluate the possible existence of a 17 KeV neutrino, for which some evidence was found in beta decay experiments. At ORNL, assist in development of the RIB facility and study possible transfer of unique detectors, such as the helium dilution refrigerator, to an alternate site.	Continue low energy research at three of the national laboratories. At ORNL, continue development of the Radioactive Ion Beam facility and associated research. At ANL, research into the structure of nuclei far from stability will continue with the use of the recoil mass separator (RMS); at LBL the main effort will be devoted to the Sudbury Neutrino Observatory (SNO) collaboration (described below under Other Research). At BNL and LBL, developmental efforts will address issues associated with producing and handling beams of unstable nuclei.	At ORNL, the intense beams of radioactive ions from the Holifield Radioactive Beam Facility (RIB) will allow, for the first time, access to combinations of proton and neutron configurations at, and beyond, the limits of proton stability. In addition, such beams also will be used to initiate a new and exciting chapter of nuclear astrophysics in which both the structure and the reaction cross sections of nuclei involved in the CNO cycle process and the rapid proton capture process can be studied. At ANL, the objective of low energy research will focus on properties of nuclei far from stability using the Fragment Mass Analyzer. This will include topics in nuclear astrophysics and properties of nuclei with unusual proton to neutron ratios. At LBL, the main effort will be devoted to an international collaboration, described below under Other Research, to measure solar neutrino flux rates.
	$ 3,425	$ 2,805	$ 3,210
Research at Reactors	Continue both the nuclear structure research at BNL and the fundamental neutron measurements at the NIST. The next experimental project proposed at the NIST cold neutron beam facility will be the Time Reversal Symmetry Violation Experiment, with collaborators from Los Alamos National Laboratory and Harvard University. At BNL, use the TRISTAN on-line isotope separator on the HFBR to study isotopes of interest to astrophysics problems. Initiate studies of isotopes important to safety related issues such as emergency core cooling and reactor	Continue both the BNL nuclear structure research and the fundamental neutron measurements at the NIST. At BNL, use the TRISTAN on-line isotope separator at the HFBR to study isotopes of interest to nuclear astrophysics problems. Continue studies of isotopes important to safety related issues such as emergency core cooling and reactor decay heat calculations. Access to isotopes important to both of these categories will be improved with the possible upgrade of the TRISTAN on-line isotope separator by locating the ion source nearer to the reactor core and	The goal of the measurements at NIST, which has the only cold neutron facility in the United States, will use their unique polarized beams to provide an understanding of the fundamental properties of the neutron. These measurements also lead to fundamental answers about the weak interaction and provide insight into the origin of parity violations. Using the High Flux Beam Reactor at BNL, investigations of nuclei with abnormal proton-neutron ratios and development of techniques to identify abnormal nuclear properties will complement experiments using

Program Activity	FY 1993	FY 1994	FY 1995
Research at Reactors (Cont'd)	decay heat calculations.	thereby gaining a factor of thirty in intensity of the separated beams. At the NIST cold neutron beam facility, continue studies of time reversal symmetry violation.	radioactive beams that will initially be available at the ORNL RIB facility. At BNL, discontinue studies of isotopes related to reactor decay heat calculations.
	$ 1,215	$ 1,064	$ 835
Other Research	Continue support for solar neutrino research, chiefly at the Sudbury Neutrino Observatory (SNO), Soviet-American Gallium Experiment (SAGE), and Gallium Experiment (GALLEX) projects. For the SNO project, LANL has major responsibilities for R&D on the large acrylic vessel for the 1,000 tons of heavy water, on data-acquisition codes, and for acquisition of photomultipliers and computer hardware; LBL, for the design and fabrication of the critical radioactivity-free support structure for the many thousands of photomultipliers that will surround the heavy water; and at Penn, for optimization of the photomultipliers and development and acquisition of photomultiplier tube bases, signal processing electronics, and software organization and development. The participation of LANL scientists in the Soviet American Gallium Experiment (SAGE) at the underground lab in the USSR will diminish as the operation of the detection system becomes routine, a calibration using a Cr-51 source is completed, and early results are published.	Continue support for international collaborations in solar neutrino research, the Sudbury Neutrino Observatory (SNO), the Gallium Experiment (GALLEX) and the Soviet-American Gallium Experiment (SAGE) projects. For the SNO project: the Univ. of Penn. has major responsibility for optimization of the many thousands of photomultipliers and the development and acquisition of photomultiplier tube bases, signal processing electronics, and software organization; LANL has major responsibilities for R&D on the large acrylic vessel for the 1,000 tons of heavy water, and for acquisition of photomultipliers and computer hardware; LBL, for fabrication of a critical radioactive-free photomultiplier support structure. At BNL, the nuclear chemistry aspects of GALLEX will be supported by the involvement of their nuclear chemists, including development of a Cr-51 calibration source.	The objective of the solar neutrino research program is to measure the flux of neutrinos from the sun arising from the nuclear processes that drive the sun's energy production. Previous measurements have found neutrino fluxes substantially lower than those predicted by the best current astrophysical models of the sun. The discrepancy between measurements and predictions have two possible explanations; either the solar nuclear processes are not well understood, or the neutrinos themselves, after the initial solar production, are transformed into exotic types which are not detectable by present experiments. If the later case is true, neutrinos would have a small mass and these results provide the first concrete evidence for a change required to the Standard Model of particles and forces which underlies our fundamental understanding of energy and matter. Present experiments use Gallium as the detection material to focus on the primary proton burning process which is not very sensitive to solar models. These international collaborations include a US/European experiment (GALLEX) located in the Gran Sasso tunnel in Italy, the second being a US/Russian (SAGE) experiment located in

III. Low Energy Nuclear Physics (Cont'd):
Research (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Other Research (Cont'd)			a deep cavern in the Russian Caucasus mountains. These will be augmented with a new US/Canadian/UK collaborative experiment (SNO) sited in a very deep nickel mine in Sudbury, Ontario. Use of 1000 tons of heavy water, provided the AECL, will uniquely permit detection of the exotic massive neutrinos if they exist. The responsibilities of the U.S. participants will be: LANL has major responsibilities for R&D on data-acquisition codes, computer hardware, photomultipliers and nuclear chemistry related issues; LBL for fabrication of the background-free photomultiplier support structure; and the University of Pennsylvania for optimization of the photomultipliers.
	Funding fn the amount of $600,000 for the SBIR program has been reprogrammed to Energy Supply.	Funding in the amount of $1,607,000 has been budgeted for the SBIR program.	Funding in the amount of $1,344,000 has been budgeted for the SBIR program.
	$ 4,946	$ 6,022	$ 5,672
Subtotal, Research	$ 12,876	$ 13,090	$ 12,800

III. Low Energy Nuclear Physics (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Operations			
Accelerator Operations	Continue support for the three university accelerator facilities located at Duke University, Texas A&M Univ. and the Univ. of Washington. Provide support for low energy operations at national laboratory facilities, at ANL (ATLAS) and LBL (88-Inch Cyclotron) and development of a Radioactive Ion Beam (RIB) facility at ORNL. These facilities support most of the low energy nuclear physics research activities described in the preceding discussion of the research program.	Fully support two university accelerator facilities located at Duke University and the Univ. of Washington. Operations support of the superconducting cyclotrons at Texas A&M will be provided by the heavy ion program. Provide operations support for the Radioactive Ion Beam (RIB) project at ORNL.	The major objective at ORNL is the completion of a world class accelerator for Radioactive Ion Beams (RIB). This facility will couple the existing ORIC cyclotron and Holifield Tandem facilities into a unique and cost effective facility for producing and accelerating short-lived radioactive nuclides. Additionally, support is provided for two university accelerator facilities located at Duke University and the University of Washington, whose operational goals and objectives are presented above under Research at University Facilities.
	$ 3,559	$ 5,060	$ 5,960
Subtotal, Operations	$ 3,559	$ 5,060	$ 5,960
Nuclear Data			
Nuclear Data Measurements	Using results of DOE's Nuclear Advisory Committee's (NSAC's) study of National Nuclear Data Needs in the 1990's (NNDN-90), strengthen high priority components, such as integrated national cross section modelling capabilities, and phase out or consolidate lower priority components. Continue university based measurements of cross-sections for higher energy neutrons, in particular for (n,p) and (n, alpha) reactions, to derive level density information for use in calculations of cross sections of importance to multiple users such as fusion and nuclear explosion technologies. At ORELA, modify program to accommodate lower funding profile and encourage user support for	Based on priorities set by DOE's Nuclear Advisory Committee's (NSAC's) study of National Nuclear Data Needs in the 1990's (NNDN-90), strengthen high priority components and phase out or consolidate lower priority components. Strengthen the university based measurements of priority cross-sections for higher energy neutrons and charged particles. Address issues important to several segments of the DOE nuclear data user community such as measurements important to the decay heat problem, nuclear reaction cross section measurements important to nuclear astrophysics, and standards used in waste management, and nuclear medicine. Cease activities associated primarily with advanced reactor	The goal of this sub-program is to provide priority measurements coordinated with the testing and improvement of models for use in the prediction of cross sections. These models address critical questions in uses such as nuclear astrophysics. Some of these measurements of reaction cross-sections are for higher energy neutrons, in particular for (n,p) and (n, alpha) reactions, to derive level density information. At INEL, discontinue measurement of radioactive nuclides related to decay heat calculations.

Program Activity	FY 1993	FY 1994	FY 1995
Nuclear Data Measurements (Cont'd)	measurements such as the gamma-ray production from materials incorporated in superconducting magnets of interest to the Office of Fusion Energy (OFE); cease operations and research at the ANL/Fast Neutron Generator. Introduce other cost saving measures to lower funding profile. At LANL, $195,000 of additional funds appropriated within AEDA and managed by ER are provided for neutron induced reactor measurement at WNR/LAMPF.	research. This includes terminating the operation of ORELA at ORNL in support of advanced reactor research.	
	Funding in the amount of $100,000 for the SBIR program has been reprogrammed to Energy Supply.	No activity.	No activity.
	$ 4,280	$ 2,335	$ 1,850
Nuclear Data Compilation and Evaluation	Based on priorities identified in recent reviews, place emphasis on electronic data access and assessment capabilities and increase nuclear cross section modelling activities, restructure aspects of the compilation and evaluation activities to improve nuclear data libraries, their access, and the methods of their production. Continue participation in the Working Group on International Evaluation Cooperation to maintain the coordination of nuclear data evaluation activities and free exchange of the results. Continue support for U.S. contributions to the IAEA International Nuclear Data efforts. Support activities with respect to modernization of the nuclear data information system by replacement with more effective electronic data dissemination techniques to be developed at LBL and prepare for	Using the results of the NNDN-90's review, the National Academy of Science's Nuclear Data Compilation Panel and the Nuclear Structure Evaluation Working Group, strengthen the structure component of the program that is developing electronic data access and assessment capabilities. This will include revising the compilation and evaluation activities to improve nuclear data libraries, and their accessibility. Support activities with respect to modernization and coordination of the nuclear structure data information system including replacement with more effective electronic data dissemination techniques. Continue participation in the Working Group on International Evaluation Cooperation to maintain the coordination of nuclear data evaluation activities and free exchange of the results. Continue support for the IAEA	The goal is to provide a nuclear data base to serve the DOE science and technology base through maintenance of nuclear data activities of compilation, storage and dissemination of evaluated nuclear data files. Cost reductions will be brought about by participation in international data activities such as participation in the international nuclear data effort coordinated by the IAEA nuclear data center, the Nuclear Energy Agency (NEA), and the Working Group on International Evaluation Cooperation. A primary objective will be to modernize the nuclear data information system by replacement of hard copy publications with more effective electronic data dissemination techniques. This includes expansion of electronic data bases as vehicles for timely and cost-effective compilation and dissemination of assessed nuclear properties. This will improve the

III. Low Energy Nuclear Physics (Cont'd):
Nuclear Data (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Nuclear Data Compilation and Evaluation (Cont'd)	discontinuance of hard copy Nuclear Data Sheets. Support expansion of electronic data bases as vehicles for timely and cost effective compilation and dissemination of assessed nuclear properties. Address assessed cross section code files at LLNL.	international Nuclear Data efforts. Address cross section code files and modernization of national data, networking at BNL, LANL, LBL, and LLNL.	interactive and interrogative user-friendly nature of both computer network and personal computer information platforms. Strategic research at LLNL, in cooperation with industry, will address the integration of nuclear physics cross section data bases into interactive programs to provide predictions of dose distributions in radiation oncology patients.
	$ 4,685	$ 4,663	$ 4,150
Subtotal, Nuclear Data	$ 8,965	$ 6,998	$ 6,000
Low Energy Nuclear Physics	$ 25,400	$ 25,148	$ 24,760

DEPARTMENT OF ENERGY
FY 1995 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

KEY ACTIVITY SUMMARY

NUCLEAR PHYSICS

I. Preface: Nuclear Theory

The purpose of fundamental research in theoretical nuclear physics is to provide new insight into the observed behavior of atomic nuclei. The research ranges from relating the description of elementary constituent particles and the fundamental forces connecting them, to accounting for the collective interactions of the nucleus as a whole. The long-range objectives of the Nuclear Theory subprogram are to obtain a comprehensive understanding of the foundations of nuclear matter at the most fundamental level, in terms of the properties of the constituent quarks and gluons, as well as the relation between the nucleons in the environment of the nucleus as a whole. These objectives are approached by interpreting results from nuclear physics experiments and by predicting phenomena and relationships to test this description. The understanding of nuclear phenomena is prerequisite for a description of the material foundations of the universe, including astrophysics phenomena such as the formation of the elements in stars and supernovae. Nuclear theory research at universities and national laboratories entails individual efforts that transcend subcategories of nuclear physics. Much of nuclear theory requires extensive use of supercomputer capabilities. The graduate students and post-docs trained in theoretical nuclear physics will provide technically highly trained people to enhance significantly the nation's scientific literacy.

II. A. Summary Table: Nuclear Theory

Program Activity	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
Nuclear Theory	$ 14,500	$ 14,648	$ 14,735	+ 1
Total, Nuclear Theory	$ 14,500	$ 14,648	$ 14,735	+ 1

II. B. Major Laboratory and Facility Funding

ARGONNE NATIONAL LAB (EAST)	$ 855	$ 925	$ 900	- 3
BROOKHAVEN NATIONAL LAB	$ 1,100	$ 1,100	$ 1,075	- 2
CONTINUOUS ELECTRON BEAM ACCELERATOR FACILITY	$ 135	$ 130	$ 490	+277
LAWRENCE BERKELEY LAB	$ 955	$ 935	$ 880	- 6
LOS ALAMOS NATIONAL LABORATORY	$ 925	$ 775	$ 850	+ 10
OAK RIDGE NATIONAL LAB	$ 800	$ 685	$ 765	+ 12

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1993	FY 1994	FY 1995
Nuclear Theory			
Nuclear Theory	Continue development of forefront research programs at the Institute of Nuclear Theory (INT) at the University of Washington (Seattle). Support interaction with the entire nuclear community by providing such activities as workshops on critical areas. Strengthen the broad range university based program of theoretical research on properties of atomic nuclei particularly aimed at the understanding of nuclear forces. Provide support for theory research that leads to a more fundamental understanding of nuclear forces involved in the interaction between protons and neutrons as well as their further manifestations such as symmetries in nuclei. Continue new theory research efforts aimed at aiding the preparation for future experiments at the Continuous Electron Beam Accelerator Facility (CEBAF), the Relativistic Heavy Ion Collider (RHIC), and provide interpretation of unexpected results from planned experiments. These require the development of theories that address the description of nuclei in terms of their underlying quark-gluon substructure, including the understanding of nuclear forces and phase transitions in nuclear matter. Consolidate national laboratory portion of the program in order to accommodate increased university activity while continuing to give strong theory support to Nuclear Physics highest priorities. $500,000 of additional support for the theory program at LANL is provided by funds appropriated within AEDA and managed by ER.	Operate the Institute for Nuclear Theory at the University of Washington (Seattle) as a focus center for the development of forefront basic research programs in theoretical nuclear physics. Maintain the present level of effort at the institute and continue to support interaction with the nuclear physics community by providing study groups and long-term workshops in critical research areas. Support initiatives which enhance the mutual interaction and stimulation between theory programs at national laboratories and the university programs, (in part in collaboration with the USDOE High Performance Computing and Communications Program). Support those efforts which provide a strong theoretical support to the highest priority programs in Nuclear Physics, including the Continuous Electron Beam Accelerator Facility (CEBAF), the Relativistic Heavy Ion Collider (RHIC), and the Gammasphere multi-detector array. These programs should lead to a more fundamental understanding of nuclear forces involved in the interaction between protons and neutrons as well as their further manifestations such as symmetries in nuclei. They will require the development of theories that address the description of nuclei in terms of the underlying quark-gluon substructure of nuclear matter, and of phase transitions in nuclear matter.	To enhance our understanding of the fundamental structure and governing forces in atomic nuclei, focus highest quality research on top priority areas of nuclear physics research - the physics relevant to the Continuous Electron Beam Accelerator Facility (CEBAF) and the Relativistic Heavy Ion Collider (RHIC), the GAMMASPHERE multi-detector array, and the Radioactive Ion Beam (RIB) programs. Provide full support of the CEBAF theory program from Nuclear Theory as CEBAF changes from construction to operational status. Maintain a balance between university and laboratory programs to develop an appropriate supply of highly trained students and post-docs, and thus providing a highly skilled supply of theoretical physicists for DOE programs. Operate the fully staffed Institute for Nuclear Theory at the University of Washington as a focus center for the development of forefront basic research programs in theoretical nuclear physics. Support interaction between the Institute and the nuclear physics community by providing for study groups and long-term workshops at the Institute in critical research areas, thereby enhancing the transfer of knowledge to the centers across the nation. Support initiatives which enhance the mutual interaction and stimulation between theory programs at national laboratories and the university programs, including collaboration with the USDOE High Performance Computing and Communications Program. These programs should lead to a more fundamental

III. Nuclear Theory (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Nuclear Theory (Cont'd)			understanding of nuclear phenomena, of the role of the underlying quark-gluon substructure of nuclear matter, and of phase transitions in nuclear matter.
	Funding in the amount of $300,000 has been reprogrammed to Energy Supply.	No activity.	Funding in the amount of $121,000 has been budgeted for the SBIR program.
	$ 14,500	$ 14,648	$ 14,735
Nuclear Theory	$ 14,500	$ 14,648	$ 14,735

DEPARTMENT OF ENERGY
FY 1995 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

KEY ACTIVITY SUMMARY

NUCLEAR PHYSICS

I. Preface: Capital Equipment

Capital equipment funds are needed to provide for particle detection systems, for data acquisition and analysis systems, and for instrumentation to improve performance of Nuclear Physics accelerators. These funds are essential for effective utilization of the national accelerator facilities operated by the Nuclear Physics program. In addition, the program has responsibility for providing general purpose capital equipment at the Lawrence Berkeley Laboratory.

II. A. Summary Table: Capital Equipment

Program Activity	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
CEBAF	$ 11,100	$ 11,300	$ 10,200	- 10
BNL	2,170	1,890	2,530	+ 34
LBL	1,553	995	1,050	+ 6
LANL	40	254	1,675	+559
MIT/Bates	1,450	1,675	2,525	+ 51
ANL	870	1,050	1,350	+ 29
ORNL	885	2,235	1,525	- 32
University Laboratories and User Groups	1,974	1,815	1,350	- 26
Sudbury Neutrino Observatory	3,001	3,362	0	-100
Gammasphere	5,000	3,900	2,300	- 41
Lawrence Berkeley Laboratory - GPE	1,870	1,870	1,870	0
Other	1,287	1,654	1,625	- 2
Total, Capital Equipment	$ 31,200	$ 32,000	$ 28,000	- 13

II. B. Major Laboratory and Facility Funding

ARGONNE NATIONAL LAB (EAST)	$ 870	$ 1,050	$ 1,350	+ 29
BROOKHAVEN NATIONAL LAB	$ 2,170	$ 1,890	$ 2,530	+ 34
CONTINUOUS ELECTRON BEAM ACCELERATOR FACILITY	$ 11,100	$ 11,300	$ 10,200	- 10
LAWRENCE BERKELEY LAB	$ 9,023	$ 7,645	$ 5,220	- 32
LOS ALAMOS NATIONAL LABORATORY	$ 2,275	$ 2,374	$ 1,675	- 29
OAK RIDGE NATIONAL LAB	$ 1,885	$ 2,235	$ 1,525	- 32

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1993	FY 1994	FY 1995
Capital Equipment			
CEBAF	Complete procurement of components for the High Resolution Hadron Spectrometer in Hall A, including parts for the detector system. Continue procurement of components for the CEBAF Large Acceptance Spectrometer (CLAS) in Hall B, including the superconducting toroidal magnet, the drift chamber system, and the electromagnetic shower calorimeter. The Hall A and Hall B spectrometers are the largest elements of the CEBAF experimental equipment plan, which was reviewed and strongly endorsed by the DOE/NSF Nuclear Science Advisory Committee (NSAC). These spectrometers will serve a large user community of both DOE and NSF scientists as well as international scientists. The construction of the Hall B spectrometer, in particular, involves a strong, enthusiastic group of university users. Procure general use equipment for the CEBAF facility such as equipment for the computer center, laboratories, offices, and shops. (Effort on this activity was reduced by $2,000,000 as a result of the allocation of the general reduction to prior year balances in the General Science appropriation.)	Continue procurement of components for CLAS in Hall B, including the superconducting toroidal magnet, the drift chamber system, and the electromagnetic shower calorimeter. Procure general use equipment for the CEBAF facility such as equipment for the computer center, laboratories, offices, and shops.	Continue procurement of components for the CEBAF Large Acceptance Spectrometer in Hall B, including major pieces of the drift chamber system and electromagnetic shower calorimeter. This spectrometer will provide angular distribution data on reactions leading to multiple-particle final states, which would be impossible to obtain with any combination of conventional magnetic spectrometers. Procure general use equipment for the CEBAF facility such as equipment for the computer center, laboratories, offices, and shops.
	$ 11,100	$ 11,300	$ 10,200

III. Capital Equipment (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
BNL	Continue improvement of experiments E866, E877 and E878 which are fashioned to utilize the gold beam recently available from the AGS Booster Synchrotron. Experiment E866 utilizes the single-arm magnetic spectrometer system originally built for E802, but adds a second forward spectrometer as well as a new tracking system for the higher rates and multiplicities. Experiments E877, a continuation of E814, is being upgraded with the addition of a new silicon multiplicity detector and a new upstream TOF wall. Complete construction of the AGS test beam for RHIC detector R&D. At LEGS, start construction of the NaI array for the XTAL BOX which is required for experiments on the polarizability of the pion.	Further improve experiments E866, E877 and E878 to take advantage of the unique gold beam from the AGS facility. At LEGS, construct the end cap array for the XTAL BOX which is needed for the measurement of the polarizability of the pion. Provide a tantalum shield for the chromium-51 calibration source for the GALLEX solar neutrino detector.	Continue to construct experimental systems which utilize the gold beam produced by the AGS facility. The study of nuclear reactions with the gold beam offer rewarding and exciting physics opportunities, and provide information that will be useful in interpreting the data from the RHIC facility now under construction. At LEGS, construct new frozen spin target of H-D ice for fundamental measurements of the properties for the proton and neutron. These data are relevant to ongoing studies of the proton spin structure function.
	$ 2,170	$ 1,890	$ 2,530
LBL	Continue fabrication of read-out electronics for the CERN lead beams experiment NA49. This experiment will study the high energy density baryon-rich environment generated by lead beams, which are appreciably stopped in nuclear matter. Begin construction of a high-performance analysis center for processing Time Projection Chamber (TPC) data from the Bevalac EOS experiment and the CERN lead beam experiment. The analysis center (using high-speed, closely-coupled RISC-based computer processors) must be capable of processing large numbers of events that require extensive pattern recognition and 3-dimensional viewing.	Complete fabrication of read-out electronics for the CERN lead beams experiment NA49. This electronics development effort also provides invaluable prototype experience for the design of the TPC system in the STAR experiment at RHIC in which LBL plays a leading role. Continue to develop the analysis center for 3-dimensional TPC data. Begin construction of auxiliary detectors for use with Gammasphere, starting with the Microball detector, a 96 detector minimum-mass array, which provides efficient channel selection based on 4pi detection of charged particles. The combination of the Microball and Gammasphere will be a very powerful tool for spectroscopic and reaction studies.	Continue to acquire and modernize equipment to design and test integrated circuits for STAR electronics. The ongoing endeavor to develop integrated circuits (ICs) requires a continuous effort to stay with state-of-the-art design hardware and software. With each new generation of ICs it is necessary to review the possibility of using more recent and more dense processes, thus further reducing the cost of individual ICs. Continue to develop the analysis center for 3-dimensional TPC data. Continue construction of auxiliary detectors which will fit inside the inner volume of Gammasphere, such as thin x-ray detectors that allow studies of the population of fission shape isomers.

III. Capital Equipment (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
LBL (Cont'd)			
	$ 1,553	$ 995	$ 1,050
LANL	Construct calibration experiment for the SAGE solar neutrino observatory at the Baksan Laboratory in Russia using a chromium-51 source. An additional $1,000,000 is provided for capital equipment needs at LAMPF by funds appropriated within AEDA and managed by ER.	Begin construction of an additional detector system for the Sudbury Neutrino Observatory that will permit simultaneous, real-time measurement of the neutral-current and the charged-current signals. Discrete helium-3 filled neutron detectors made from extremely low radioactivity nickel will be installed within the heavy water volume.	Complete construction of the neutral current detector system for the Sudbury Neutrino Observatory. By adding the neutral current detection capability, the SNO detector can make an accurate determination of whether solar neutrinos change their flavor en route to the earth.
	$ 40	$ 254	$ 1,675
MIT/Bates	Complete procurement of equipment for the South Hall Ring Experiment (SHRE), including control system hardware and beam positioning monitors. Provide funds jointly with the National Science Foundation for construction of the support frame for the Out of Plane Spectrometer (OOPS). The OOPS detector will permit unique measurement of interference structure functions in coincidence electron scattering experiments.	Upgrade existing Bates spectrometers and associated electronics to utilize the extracted, high-duty-cycle beam from the South Hall Ring Experiment. Begin improvement of the Bates electron linac by upgrading various RF, vacuum and control system components. Begin construction of equipment for the HERMES experiment in collaboration with scientists from ANL, University of Colorado and New Mexico State University.	Begin fabrication of a detector system specialized to make optimum use of the internal target capability of the South Hall Ring Experiment. One of the leading research programs envisioned for this detector is the measurement of the electric form factor of the neutron using polarized targets of hydrogen, deuterium and helium-3. Continue improvement of the Bates electron linac by replacing various RF and vacuum system components. Continue construction of equipment for the HERMES experiment. This experiment, which will make complete and precise measurements of the spin-dependent structure functions of the neutron and proton, is being mounted at the DESY laboratory in Hamburg, Germany.
	$ 1,450	$ 1,675	$ 2,525

III. Capital Equipment (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
ANL	Procure additional silicon detectors with multi-guard ring design to improve data rate and precision of measurements with APEX. APEX is studying spontaneous positron production in collisions of very heavy nuclei in order to explore the origin of unexplained sharp lines in the observed spectra. Construct polarized internal gas targets for medium energy research.	For the Fragment Mass Analyzer (FMA), provide double-sided silicon detector and associated electronics to take advantage of its unique capabilities for detecting extremely weak processes, e.g., proton radioactivity. The decay of implanted heavy ions is observed in the silicon detector, which provides both position and time correlation. For APEX, procure improved electronics to obtain better time resolution at lower thresholds and upgrade the heavy-ion detector with increased azimuthal segmentation. For a major program of experiments in CEBAF's Hall C, construct a high-density helium-3 target which operates at 50 atmospheres and 20 degrees Kelvin.	For FMA complete the procurement of a double-sided silicon strip detector system. For APEX provide for replacement of spent silicon detectors. Construct a tritium target polarized with the technique of spin-exchange optical pumping for experiments at CEBAF. The target is essential for study of the those two- and three-body nuclear systems which can be calculated exactly: deuterium, tritium and helium-3.
	$ 870	$ 1,050	$ 1,350
ORNL	In preparation for research using the Radioactive Ion Beam (RIB) facility, procure long lead-time items for construction of beam lines to the experimental apparatus -- the Recoil Mass Separator (RMS) and the Recoil Separator. Procure ORELA facility maintenance items.	Continue preparation for the RIB research program by installing the large Recoil Separator on loan from the Daresbury Laboratory in Great Britain, a device well-suited for nuclear astrophysics studies. The RIB facility presents a long-awaited opportunity to gain further understanding of stellar explosive hydrogen burning by making direct measurements of key processes. Continue installation of the RMS, procuring more beam line components and detector systems. Fabricate ancillary items for RIB research -- target/ion sources, low intensity diagnostic systems, and 300 KeV isobar detectors. Complete construction of a highly-integrated, electronic readout system for lead-glass photon detectors for CERN experiment WA93.	Complete installation of the Recoil Separator and RMS. The proton-rich radioactive beams provided by RIB in conjunction with the RMS experimental system provide an ideal facility for locating the proton drip line in medium-weight elements. Begin acquisition of a large solid angle gamma-ray detector for the RMS, which will make it possible to perform spectroscopic studies with the RMS system.

III. Capital Equipment (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
ORNL (Cont'd)			
	$ 885	$ 2,235	$ 1,525
University Laboratories and User Groups	Continue upgrade of instrumentation at university laboratories. Construct experimental equipment as follows: Texas A&M University (beam analysis system for the magnetic spectrometer), TUNL (upgrade of cryogenic polarized target facility, large HPGe detector for high-energy gamma rays, enhancement of data acquisition system), University of Washington (Pelletron charging system and spiral-field accelerator tubes), Yale University (equipment to search for strange quark matter at the BNL AGS accelerator).	Continue instrumentation at university accelerator laboratories to increase amount of available experimental equipment and improve accelerator facilities. Continue at Yale University the construction of the strangelet experiment E864 at the BNL AGS accelerator. Discovery of strange quark matter systems (strangelets) would have major impact on concepts in physics, astrophysics and cosmology.	Continue instrumentation at university laboratories with construction of particle and gamma-ray detectors, spectrometer systems, and data analysis facilities. Provide funding to replace obsolete and malfunctioning equipment for the accelerators.
	$ 1,974	$ 1,815	$ 1,350
Sudbury Neutrino Observatory	Continue procurement, delivery and testing of the 9,550 photomultiplier tubes (PMTs) needed for the Sudbury Neutrino Observatory (SNO). Complete fabrication of the 55-foot diameter geodesic sphere which supports the PMTs. The SNO detector is located in a cavity excavated at the 6800 foot level of the Creighton mine in Sudbury, Ontario. This unique world class facility for neutrino astrophysics uses heavy water as its principal sensitive medium. SNO is a collaborative Canadian, U.S. and U.K. project. The SNO detector was forcefully endorsed by the DOE/NSF Nuclear Science Advisory Committee as being "an exceptional opportunity to create and work at a unique world class facility. It has a very high potential for fundamental discoveries in solar physics and in the properties of neutrinos." The U.S. share of construction costs for the SNL project is $11,900,000 in actual year	Complete procurement of the photomultiplier tubes, and install support frame and photomultiplier tubes in the SNO cavity at the Creighton mine. The start of the heavy water fill of the SNO detector is scheduled for the summer of 1995.	No activity.

III. Capital Equipment (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Sudbury Neutrino Observatory (Cont'd)	dollars and is provided as capital equipment funds. The entire SNO project has an estimated capital cost of about $53,000,000 and will make use of a valuable store of 1,000 tons of extra pure Canadian heavy water loaned to the project by the Atomic Energy Commission of Canada.		
	$ 3,001	$ 3,362	$ 0
Gammasphere	Continue construction of Gammasphere, receiving from the vendors about 32 detector modules containing Compton-suppressed germanium detectors. Fabricate a temporary support frame for the detectors and begin first physics use with temporary electronics and computer system. (Effort on this activity was reduced by $2,300,000 as a result of the allocation of the general reduction to prior year balances in the General Science appropriation.)	Continue construction of Gammasphere, receiving additional germanium detector modules, final electronics, data acquisition and computer system. Fabricate and install final support frame. Continue physics use of the partially completed Gammasphere detector, upgrading the detector system in stages to maximize physics productivity. Even in its incomplete state, research use of the detector is highly sought after by a large user community.	Complete receiving detector modules and begin full operation. Gammasphere is a world class high-resolution gamma-ray facility for the study of nuclear structure at high angular momentum, finite temperature and large deformation. Gammasphere is designed to observe high-multiplicity coincidence events which are crucially important for the analysis of complex gamma-ray spectra. Up to 110 large Compton-suppressed germanium detectors can be mounted around the target on a spherical support frame. The instrument can address a broad range of nuclear physics such as superdeformed nuclei, damping, giant resonances, symmetries in nuclei, correlations in nuclear reactions, fundamental interactions, and certain astrophysics questions. The Gammasphere detector was highly recommended by the DOE/NSF Nuclear Science Advisory Committee: "this detector represents a huge step forward in the refinement of experimental study of nuclear structure at high angular momentum, finite temperature and large deformation. The proposal has captured the imagination of a large and enthusiastic group of nuclear physics in the U.S. It will provide the major focus for nuclear

III. Capital Equipment (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Gammasphere (Cont'd)			structure research for many years, literally redefining one frontier of the field." Gammasphere has been sited initially at Lawrence Berkeley Laboratory's 88-Inch Cyclotron facility. Gammasphere has a total estimated cost (TEC) of $18,000,000 in actual year dollars.
	$ 5,000	$ 3,900	$ 2,300
Lawrence Berkeley Laboratory - GPE	Provide general purpose equipment at Lawrence Berkeley Laboratory, for which the Nuclear Physics program has landlord responsibility. Typical examples of equipment requested by the various LBL support organizations (Administrative Division; Facilities Department; Information and Computing Science Division; Engineering Division; and Environment, Health and Safety Division) are buses and trucks, data processing equipment used in administrative functions, dedicated computer network file server, cooling towers, emergency generators, mass storage devices for scientific computing, color workstations for illustrations in publications, CAD/CAM workstations and drafting plotters, equipment to develop programmable logic arrays, radioactive waste compactor, solvent recycler, and whole body counter.	Provide general purpose equipment for the needs of these LBL support organizations: Administrative Division; Facilities Department; Information and Computing Science Division; Engineering Division; and Environment, Health and Safety Division.	Provide general purpose equipment for the needs of these LBL support organizations: Administrative Division; Facilities Department; Information and Computing Science Division; Engineering Division; and Environment, Health and Safety Division.
	$ 1,870	$ 1,870	$ 1,870

III. Capital Equipment (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Other	Provide equipment for smaller programs at other national laboratories (INEL and LLNL) which conduct portions of the nuclear data measurements program.	Provide equipment for some participants of the nuclear data measurements program, more rapid completion of selected experimental systems in the medium energy and heavy ion research program.	Provide equipment for some participants of the nuclear data measurements program, more rapid completion of selected experimental systems in the medium energy and heavy ion research program.
	$ 1,287	$ 1,654	$ 1,625
Capital Equipment	$ 31,200	$ 32,000	$ 28,000

DEPARTMENT OF ENERGY
FY 1995 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

KEY ACTIVITY SUMMARY

NUCLEAR PHYSICS

I. Preface: Construction

II. A. Summary Table: Construction

Program Activity	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
Continuous Electron Beam Accelerator Facility (CEBAF)	$ 33,000	$ 16,590	$ 1,000	- 94
Relativistic Heavy Ion Collider (RHIC)	71,400	78,000	70,000	- 10
Accelerator Improvements and Modifications	3,200	3,800	3,200	- 16
General Plant Projects	3,500	3,600	3,900	+ 8
Total, Construction	$ 111,100	$ 101,990	$ 78,100	- 23

II. B. Major Laboratory and Facility Funding

ARGONNE NATIONAL LAB (EAST)	$ 300	$ 300	$ 500	+ 67
BROOKHAVEN NATIONAL LAB	$ 72,700	$ 79,300	$ 71,300	- 10
CONTINUOUS ELECTRON BEAM ACCELERATOR FACILITY	$ 33,000	$ 16,590	$ 1,345	- 92
LAWRENCE BERKELEY LAB	$ 3,655	$ 3,555	$ 3,555	0
OAK RIDGE NATIONAL LAB	$ 800	$ 1,000	$ 200	- 80

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1993	FY 1994	FY 1995
Construction			
Continuous Electron Beam Accelerator Facility (CEBAF)	Continue operational checkout of North linac and assembly of South linac. Complete RF system. Complete installation of beam switchyard magnets and power supplies. Commission cryogenic control system. Continue installation of experimental equipment. A reduction of $1,000,000 associated with the allocation of the general reduction to prior year balances in the General Science appropriation is not included.	Complete civil construction. Complete accelerator and begin commissioning. Start beam delivery to experimental Hall C and physics operation.	Civil construction is complete. Accelerator is operational and ready for commissioning. Complete construction of basic set of experimental equipment in Hall A.
	$ 33,000	$ 16,590	$ 1,000
Relativistic Heavy Ion Collider (RHIC)	Continue construction of superconducting dipole, quadrupole and sextupole magnets for the accelerator arcs. Initiate procurement of components for other accelerator systems including cryogenic piping and power supplies. Start conventional construction work. Initiate detailed design of major detectors and begin procurement of long-lead detectors components such as spectrometer magnets. A reduction of $1,400,000 associated with the allocation of the General Science appropriation general reduction for prior year balances is not included.	Continue installation of first sextant of collider ring magnets. Continue construction and installation of superconducting magnets for the accelerator arcs. Continue procurement of components for cryogenic piping and power supplies. Continue conventional construction work. Continue long-lead procurement activities on detector systems.	Test fully installed sextant of collider ring magnets. Continue construction and installation of superconducting magnets for the accelerator arcs. Continue procurement of components for cryogenic piping and power supplies. Complete conventional construction work. Continue procurement and fabrication activities on detector systems. procurement activities on detector systems.
	$ 71,400	$ 78,000	$ 70,000

III. Construction (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Accelerator Improvements and Modifications	Essential modifications and upgrades are required on an annual basis to maintain and improve the reliability and efficiency of accelerators and experimental facilities. Annual AIP expenditure is less than 1% of total Federal investment in these facilities.	Increased level of activity due to requirements at the Radioactive Ion Beam facility at ORNL and the MIT/Bates Linear Accelerator Center.	Approximately same level of activity as in FY 1994.
	$ 3,200	$ 3,800	$ 3,200
General Plant Projects	Essential additions, modifications, and improvement are required on an annual basis to maintain safety and effectiveness of general laboratory plant and support facilities.	Approximately same level of effort as FY 1993.	Increased level of activity due to requirements at Continuous Electron Beam Accelerator Facility.
	$ 3,500	$ 3,600	$ 3,900
Construction	$ 111,100	$ 101,990	$ 78,100

DEPARTMENT OF ENERGY
FY 1995 CONGRESSIONAL BUDGET REQUEST
(Changes from FY 1994 Congressional Budget Request are denoted with a vertical line in left margin.)

OFFICE OF ENERGY RESEARCH
GENERAL SCIENCE AND RESEARCH
Nuclear Physics
(Tabular dollars in thousands. Narrative material in whole dollars.)

IV. A. Construction Funded Project Summary

Project No.	Project Title	Previous Obligations	FY 1993 Adjusted	FY 1994 Enacted	FY 1995 Request	Unappropriated Balance	TEC
GPE-300	General Plant Projects, Various Locations	$ 38,483	$ 3,500	$ 3,600	$ 3,900	$ 0	$ 3,900
95-G-302	Accelerator Improvements and Modifications, Various Locations	---	---	---	3,200	0	3,200
91-G-300	Relativistic Heavy Ion Collider, BNL	68,850	70,000	78,000	70,000	198,400	477,250
87-R-203	Continuous Electron Beam Accelerator Facility, CEBAF	263,610	32,000	16,590	1,000	0	313,200
Total, Nuclear Physics Construction		$370,943	$108,700	$ 98,190	$ 78,100	$198,400	N/A

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: Project GPE-300, General Plant Projects Various locations

TEC: $3,900
TPC: $3,900

Start Date: 2nd Qtr. FY 1995 Completion Date: 2nd Qtr. FY 1997

2. Financial Schedule (Federal Funds):

Fiscal Year	Appropriation	Obligations	Costs
1995	$ 3,900	$ 3,900	$ 1,600
1996		0	1,800
1997		0	500

3. Narrative: General Plant Projects provide for the many miscellaneous alterations, additions, modifications, replacements, and non-major construction required at the Continuous Electron Beam Accelerator Facility, the Lawrence Berkeley Laboratory and the Massachusetts Institute of Technology (Bates Linear Accelerator Center). GPP projects focus on general laboratory facilities whereas the AIP projects focus on the technical facilities.

These projects are required for the general maintenance, modification and improvement of the overall laboratory plant and include minor new construction, capital alterations and additions, and improvements to buildings and utility systems. These projects are essential for maintaining the productivity, increasing the operational cost effectiveness, and ensuring that necessary support services are available to the research program at the DOE-owned facilities.

A description and listing of the major items of work to be performed at the various locations is contained in the Construction Project Data Sheets. Some of these may be located on non-Government owned property. The following is a list of the proposed FY 1995 funding for the various locations:

Contin. Electron Beam Acc. Facility........	$ 345
Lawrence Berkeley Laboratory	3,355
Massachusetts Institute of Technology (Bates Linear Accelerator Center)	200
Total Estimated Cost....................	$ 3,900

4. Total Project Funding (BA):

	Prior Years	FY 1993	FY 1994 Enacted	FY 1995 Request
Construction	XXXX	$3,500	$3,600	$3,900

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: Project 95-G-302, Accelerator Improvements and Modifications Various locations — TEC: $3,200 TPC: $3,200

Start Date: 2nd Qtr. FY 1995 — Completion Date: 2nd Qtr. FY 1997

2. Financial Schedule (Federal Funds):

Fiscal Year	Appropriation	Obligations	Costs
1995	$ 3,200	$ 3,200	$ 1,200
1996	0	0	1,600
1997	0	0	400

3. Narrative: Accelerator Improvement Projects provide for additions, modifications, and improvements to research accelerators and ancillary experimental facilities. The requested projects are necessary to maintain and improve reliability and efficiency of operations and to provide new experimental capabilities as required for execution of planned nuclear physics research programs. Funds for these projects are needed annually to provide increased performance levels and increased serviceability, thereby decreasing facility downtime, improving the productivity and cost effectiveness of the program.

A description and listing of the major items of work to be performed at the various locations is contained in the Construction Project Data Sheets. Some of these may be located on non-Government owned property. The following is a list of the proposed FY 1995 funding for the various locations:

Argonne National Laboratory	$ 500
Brookhaven National Laboratory (AGS/Tandem)	1,300
Lawrence Berkeley Laboratory	200
Massachusetts Institute of Technology (Bates Linear Accelerator Center)	1,000
Oak Ridge National Laboratory	200
Total Estimated Costs..................	$ 3,200

4. Total Project Funding (BA):

	Prior Years	FY 1993	FY 1994 Enacted	FY 1995 Request
Construction	XXXX	$ 3,200	$ 3,800	$ 3,200

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: Project 91-G-300, Relativistic Heavy Ion Collider
Brookhaven National Laboratory

TEC: $ 475,250
TPC: $ 595,250

Start Date: 2nd Qtr. FY 1991 Completion Date: 2nd Qtr. FY 1999

2. Financial Schedule (Federal Funds):

Fiscal Year	Appropriation	Adjustments	Obligations	Costs
1991	$ 15,000	- 1,500 a/	$ 13,500	$ 6,000
1992	49,350		49,350	23,265
1993	71,400	- 1,400 b/	70,000	60,839
1994	78,000		78,000	92,000
1995	70,000		70,000	90,000
1996	70,000		70,000	70,000
1997	65,000		65,000	61,000
1998	59,400		59,400	59,000
1999	0		0	13,146

a/ Reflects the reduction of funds resulting from the FY 1991 sequester and general reduction.
b/ Application of a portion of the FY 1993 General Science and Research general reduction of $30,000,000 for use of prior year balances.

3. Narrative: The Total Project Cost (TPC) decreased from $597,550,000 to $595,250,000 as a result of the FY 1994 Congressional funding increase. The Total Estimated Cost (TEC) remained unchanged. The project completion date remained unchanged. The Relativistic Heavy Ion Collider (RHIC) facility will be a unique, world-class research facility with opposing colliding beams that provide collision energies of 100 GeV/AMU per beam for heavy ions as massive as gold. RHIC will use the existing Alternating Gradient Synchrotron (AGS) and Tandem Van de Graaff complex as an injector. The new accelerator will be built in the existing Colliding Beam Accelerator (CBA) tunnel (3.8 km circumference) at BNL, and will utilize the experimental halls, support building, and liquid helium refrigerator from the partially completed CBA project.

RHIC will be dedicated to the study of nuclear matter at very high temperatures and densities where the quark-gluon degrees of freedom are expected to be directly revealed. The machine will accelerate ions with atomic masses spanning the periodic table, with the collision energies of 100 GeV/AMU for the heaviest ions, and even higher energies for lighter ions. In such collisions, experimenters will be able to study extended volumes of hadronic matter with energy densities more than ten times that of the nuclear ground state, thus creating in the laboratory conditions that are similar to those of the expanding universe moments after the Big Bang. Ultra-relativistic heavy ion collisions are probably the only means of producing such energy densities under controlled laboratory conditions, and offer a unique avenue for both nuclear and particle physicists to test theories of the strong interaction at the high energy density limit. This is the threshold at which hadronic matter is predicted to lose its identity as a collection of neutrons and protons, and to undergo a phase transition to a plasma of quarks and gluons.

Construction of RHIC will proceed in an expeditious manner, consistent with available funds. FY 1995 construction funds will be used for procurement of superconducting dipole, quadrupole and sextupole magnets for the accelerator arcs, procurement of cryogenic distribution system, magnet electrical system, and accelerator control system. Continue major construction activities on detector systems.

4. Total Project Funding (BA):

	Prior Years	FY 1993	FY 1994	FY 1995 Request	To Complete
Construction	$62,850	$70,000	$78,000	$70,000	$194,400
Capital Equipment	0	0	0	0	0
Operating Expenses	35,064	7,200	5,880	5,820	66,036

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: Project 87-R-203, Continuous Electron Beam Accelerator Facility, Newport News, Virginia — TEC: $313,200; TPC: $513,106

Start Date: 2nd Qtr. FY 1987 — Completion Date: 1st Qtr. FY 1995

2. Financial Schedule (Federal Funds):

Fiscal Year	Appropriation	Adjustments	Obligations	Costs
1987	$ 16,200		$ 16,200	$ 7,842
1988	33,500		33,500	41,858
1989	44,500		44,500	29,086
1990	65,000	- 2,389 a/	62,611	53,441
1991	65,000	- 6,501 b/	58,499	53,595
1992	41,800	+ 6,500 c/	48,300	59,469
1993	33,000	- 1,000 d/	32,000	39,210
1994	16,590		16,590	26,700
1995	1,000		1,000	1,999

a/ Reflects the sequester of funds and distribution of general reduction for FY 1990.
b/ Reflects the sequester of funds and distribution of general reduction for FY 1991.
c/ Reflects reprogramming of $6,500,000 from other project costs (operating expenses) relating to this project to the other construction costs.
d/ Application of a portion of the FY 1993 General Science and Research general reduction of $30,000,000 for use of prior year balances.

3. Narrative: The Total Project Cost (TPC) decreased from $514,946,000 to $513,106,000 as a result of the effects of the general reduction in FY 1994 and FY 1995. The Total Estimated Cost (TEC) remained unchanged. The project completion date remained unchanged. The Continuous Electron Beam Accelerator Facility (CEBAF) is a single purpose, basic nuclear physics research facility based on a four billion electron volt (GeV) electron linear accelerator that is capable of providing high intensity, continuous (i.e., not pulsed) electron beams. The facility will include the experimental areas needed to conduct basic nuclear research, and buildings to house the accelerator complex and its operation and maintenance activities. The facility will possess a complement of equipment for initial experiments and supporting facilities to exploit the capabilities of the accelerator.

CEBAF will be the only facility in the world capable of producing electron beams that simultaneously meet the criteria of high energy, high intensity, and continuous nature necessary to advance the frontiers of nuclear physics. CEBAF's electron accelerator with its capability of providing beams at any energy in the range 0.5 to 4 GeV, is designed to study the largely unexplored transition between the nucleon-meson and the quark-gluon description of nuclear matter.

Construction of CEBAF will continue in an expeditious manner, consistent with available funds. FY 1995 construction funds will be used to complete construction.

4. Total Project Funding (BA):

	Prior Years	FY 1993	FY 1994	FY 1995 Request	To Complete
Construction	$264,577	$32,000	$16,590	$ 1,000	$ 0
Capital Equipment	7,019	1,600	1,600	1,600	0
Operating Expenses	99,843	28,217	43,460	15,600	0