DEPARTMENT OF ENERGY
FY 1995 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH

OVERVIEW

HIGH ENERGY PHYSICS

Research in high energy physics is directed at understanding the nature of matter and energy at the most fundamental level, and the basic forces which govern all processes in nature. The primary goal of the program is to acquire new knowledge and understanding. To carry out this forefront basic research, the program develops advanced technologies for application to accelerators and detectors. Such technologies often find near-term as well as long-term applications in other fields.

Research in high energy physics is an important part of the DOE mission and the DOE serves as the Executive Agent for the U.S. High Energy Physics Program. High Energy Physics has proven to be an extremely challenging and fruitful intellectual activity. It attracts some of the best minds in the nation, and provides substantial input to the intellectual ferment which fuels the nation's science and engineering enterprise. High energy physics is an excellent discipline for the training of physicists, and many high energy physics Ph.D. graduates go on to highly productive careers in other scientific disciplines.

High energy physics contributes to the nation's economic competitiveness. The accelerators and detectors needed for the pursuit of high energy physics research require state-of-the-art technology in many areas such as fast electronics, high speed computing, superconducting magnets, and high power radio-frequency devices. In these areas, high energy physics often pushes the technology, and in some areas provides a major component of the civilian marketplace. Further, high energy physics continues to make major contributions to accelerator technology and provides a major portion of the expertise needed to support the substantial recent expansion of applications of accelerators to other scientific disciplines and to industrial processes (e.g. synchrotron light sources, medical diagnostics and treatment, etc).

Both the Fermi National Accelerator Laboratory (Fermilab) and the Stanford Linear Accelerator Center (SLAC) are outstanding scientific institutions. Thus, high energy physics research activities contribute in a major way to the world preeminence of the nation's scientific and technical enterprise both now and in the future.

The budget presented herein is divided into major categories. The Physics Research section of the budget provides support for the scientists who plan and perform research. The Facility Operations section of the budget provides support for large accelerator and detector facilities essential to perform the research. The High Energy Physics Technology section of the budget provides for the R&D necessary to maintain the accelerator and detector facilities at the required forefront of the science. The Capital Equipment and Construction sections of the budget provide for the hardware and facilities required for ongoing progress of the research programs. Taken together, these comprise a balanced program of excellent research in high energy physics.

There are three DOE high energy physics accelerator centers: Fermi National Accelerator Laboratory (Fermilab), the Stanford Linear Accelerator Center (SLAC), and the Alternating Gradient Synchrotron (AGS) complex at Brookhaven National Laboratory (BNL), each of which provide unique research capabilities. All three centers are operated as national facilities that are available to qualified experimenters on the basis of the scientific merit of their research proposals.

Experiments by U.S. scientists are also carried out at the Cornell Electron Storage Ring (CESR) facility, which is largely supported by the National Science Foundation, and at foreign accelerators that offer unique capabilities not available in the United States. Some important high energy physics experiments do not require accelerators, but instead take advantage of processes that occur in the natural environment, sometimes deep underground, deep underwater, or on mountain tops.

More than 65 percent of the U.S. high energy physics research at accelerator facilities is performed by university-based scientists, and their participation is critical to the strength and vitality of the U.S. program. It is essential to maintain the capability of university scientists to participate effectively in world forefront experiments and to maintain the technical capabilities of the major university laboratories.

The Tevatron at Fermilab is the world's highest energy particle accelerator and is distinguished as the first one to use superconducting magnets. The Tevatron will ensure that the U.S. program remains highly competitive and at the cutting edge for the next several years. The Fermilab Main Injector, presently under construction, will greatly increase the research capabilities of the Fermilab and Tevatron complex.

The strategy for the overall High Energy Physics program for FY 1995 revolves around the following key factors:

o Careful planning to optimize the physics output of the program. The report of the 1994 Subpanel on the Future Vision for High Energy Physics will be available before the beginning of FY 1995. This report will provide recommendations for structuring the program to optimize current assets and opportunities for international cooperation.

o Tevatron collider operations in FY 1995 will utilize both the mature Collider Detector at Fermilab (CDF) and the complementary new D-Zero detector facility. The SLAC linac will be operated for fixed target experiments in End Station A, for high energy linear collider R&D, and for physics research with the SLC. With its new booster, research at BNL's Alternating Gradient Synchrotron (AGS) will improve direct tests of the Standard Model via detailed study of rare decay modes of kaons.

o Construction of the Main Injector at Fermilab will be continued. This project will greatly enhance the physics capabilities of the existing Tevatron accelerator and its detector facilities by the end of the decade. The project will provide a much higher beam intensity and, hence, the capability for major new scientific discoveries such as the top quark.

o Construction of a B-Factory will be continued at SLAC. The B-Factory will be an asymmetric, very high intensity electron-positron colliding beam facility optimized for the study of charge parity violation in the B meson system. This will provide for a significant series of tests of the Standard Model and will advance our knowledge of why matter dominated over anti-matter in the early moments of the big bang. This project is part of the President's FY 1994 Investment Package.

o Continued effective participation of university scientists is critical to the ongoing vitality of High Energy Physics. Universities have a leading role in providing intellectual leadership for the field of high energy physics and in training graduate and post-doctoral scientists and engineers for many fields of physics.

o Long-range accelerator and detector R&D studies to develop advanced concepts and technologies is critical to the long-range vitality of High Energy Physics. Priority will be given to advancing the most promising concepts.

The performance indicators for the High Energy Physics program supported by this budget request are: the attainment of new scientific knowledge; effectiveness of facility operations (done separately for each facility and mode of operation); number of scientists supported for research; and percent completion (cost and schedule milestones) against the approved project plans for the Fermilab Main Injector and the B-Factory.

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

LEAD TABLE

High Energy Physics

Activity	FY 1993 Adjusted		FY 1994 Approp.	FY 1994 Adjustment	FY 1995 Request
Operating Expenses					
Physics Research	$144,415		$148,560	-$1,195	$139,940
Facility Operations	279,799		268,455	-4,090	254,399
High Energy Technology	65,755		59,415	0	58,190
Subtotal Operating Expenses	489,969	a/	476,430	-5,285	452,529
Capital Equipment	73,220		65,085	-4,985	57,700
Construction	42,930		86,254	0	111,661
Subtotal	606,119		627,769	-10,270	621,890
Adjustment	-18,500	b/	0	0	0
Total High Energy Physics	$587,619		$627,769	-$10,270	$621,890
Summary					
Operating Expenses	$477,049	a/	$476,430	-$5,285	$452,529
Capital Equipment	67,640		65,085	-4,985	57,700
Construction	42,930		86,254	0	111,661
Total Program	$587,619		$627,769	-$10,270	$621,890
Staffing (FTEs)	(Reference General Science Program Direction)				

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

a/ Excludes $7,265,000 which has been transferred to the SBIR program.
b/ Amount of general reduction for use of prior year balances assigned to this program. The total will be taken at the Appropriation level.

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

SUMMARY OF CHANGES

High Energy Physics

FY 1994 Appropriation	$ 627,769
- Adjustment	- 10,270
FY 1994 Adjusted	617,499
Operating and Capital Equipment	
- Reduction in funding for Fermilab	- 4,475
- Reduction in funding for SLAC	- 5,755
- Reduction in funding for BNL	- 4,336
- Decrease in funding for High Energy Physics research activities at the SSC Laboratory resulting from termination of the SSC	- 750
- Reduction in funding for other parts of the HEP program	- 7,923
- Increase in funding for SBIR program	+ 2,223
Construction	
- Continuation of Fermilab Main Injector construction project	+ 18,000
- Continuation of SLAC B-Factory construction project	+ 8,000
- Reduction in funding for AIP and GPP	- 593
FY 1995 Congressional Budget Request	$ 621,890

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

KEY ACTIVITY SUMMARY

HIGH ENERGY PHYSICS

I. Preface: Physics Research

This activity provides support for university and laboratory based research groups conducting experimental and theoretical research in high energy physics. This research probes the nature of matter and energy at the most fundamental level, and the characteristics of the basic forces in nature. Experimental research activities include: planning, design, fabrication and installation of experiments; conduct of experiments; analysis and interpretation of data; and dissemination of results. Theoretical physics research provides the framework for interpreting and understanding observed phenomena and, through predictions and extrapolations based on existing theories, identifies key questions for future experimental explorations. This subprogram supports research groups at more than 100 universities as well as at the 9 DOE laboratories which participate in high energy physics research.

Experiments in high energy physics require the use of large particle accelerators, together with complex detection apparatus, to study the results of the collisions of particles at high energies. The DOE-supported operating high energy physics accelerators are located at three existing central laboratories, Fermilab, SLAC, and BNL. These three are made available to qualified scientists on the basis of the scientific merit and promise of their research proposals. Detectors and experimental facilities are located at the DOE accelerator laboratories, at other accelerators around the world, and at a number of sites not associated with accelerators. More than 65 percent of the research done with these facilities is performed by university-based physicists. The balance of the research is done by scientists at the accelerator laboratories and certain other DOE laboratories. Because of the size and complexity of a typical high energy physics experiment, users from a number of institutions frequently collaborate on a given experiment. These research teams typically include a mix of physicists, engineers, technicians, and graduate students. After a research proposal to the laboratory is approved, the research teams participate in the design and fabrication of the experimental apparatus and provide manpower for the experiment during the data-taking phase at the laboratory. There is significant interaction and participation from laboratory staff and use of laboratory support facilities for each experiment. The entire process, from conception of the experiment to publication of results, typically takes up to five years if no major new detector is involved; if major detector design and fabrication is involved, the total duration can be several years longer. U.S. user groups also participate in experiments which take advantage of unique accelerator capabilities and opportunities at other laboratories; for example, the Cornell Electron Storage Ring (CESR), supported by the U.S. National Science Foundation, and at foreign laboratories such as DESY (Germany), CERN (Western Europe), KEK (Japan), and IHEP (Protvino, Russia). There is also a program of experiments not requiring beams from accelerators, of which experiments to search for proton decay and magnetic monopoles are presently the major component.

FY 1995 will be a year of strong research output as the researchers proceed with the analysis of data collected in FY 1994 and previous years from the SLC collider at SLAC with the Stanford Linear Collider (SLC) detector and from the world unique Tevatron collider at Fermilab with its CDF and D-Zero collider detector facilities and fixed target facilities at SLAC, Fermilab, and BNL. Priority will be given on analysis of existing data and data collection at the operating facilities. The ongoing enhancement of the technical capabilities of the major university laboratories will proceed at a very modest level.

II. A. Summary Table: Physics Research

Program Activity	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
Fermi National Accelerator Laboratory	$ 11,242	$ 10,137	$ 10,945	+ 8
Stanford Linear Accelerator Center	12,585	11,120	10,765	- 3
Brookhaven National Laboratory	7,785	7,802	7,620	- 2
Argonne National Laboratory (East)	5,653	5,712	5,550	- 3
Lawrence Berkeley Laboratory	10,320	10,540	10,370	- 2
Universities and Other Labs	96,830	102,054	94,690	- 7
Total, Physics Research	$ 144,415	$ 147,365	$ 139,940	- 5

II. B. Major Laboratory and Facility Funding

ARGONNE NATIONAL LAB (EAST)	$ 5,653	$ 5,712	$ 5,550	- 3
BROOKHAVEN NATIONAL LAB	$ 7,785	$ 7,802	$ 7,620	- 2
FERMI NATIONAL ACCELERATOR LAB	$ 11,242	$ 10,137	$ 10,945	+ 8
LAWRENCE BERKELEY LAB	$ 10,320	$ 10,540	$ 10,370	- 2
STANFORD LINEAR ACCELERATOR CENTER	$ 12,585	$ 11,120	$ 10,765	- 3

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

Program Activity	FY 1993	FY 1994	FY 1995
Physics Research			
Fermi National Accelerator Laboratory	The Tevatron collider run, which began in FY 1992, will continue through most of FY 1993. The collider research groups will continue data collection, while the fixed target research groups will continue their physics analysis activities of last year, as well as preparations for a data collection period starting in FY 1995. The SDC participants expect to begin fabrication work on components and subsystems of that future SSC detector facility, and to begin preparations for putting components into test beams. Particle astrophysics and theoretical physics will continue.	The CDF and D-Zero colliding beam detector facilities will continue to collect data for most of FY 1994, and continue to work on data analysis and the next round of detector facility upgrade projects. The Fermilab research physicists collaborating on fixed target experiments will design, fabricate and test detector components in preparation for data taking next year. Theoretical physics, particle astrophysics and other physics research efforts will be ongoing.	Researchers working on the CDF and D-Zero colliding beam detector facilities will conclude their long data-taking run early in FY 1995 and turn their efforts to data analysis and then preparation of papers for publication. Those involved in the fixed target research program will install their apparatus and commission it for data-taking, scheduled to begin in the last quarter of FY 1995. Theoretical physics and particle astrophysics research efforts will continue.
	$ 11,242	$ 10,137	$ 10,945
Stanford Linear Accelerator Center	Research in High Energy Physics at SLAC involves experiments carried out with the Stanford Linear Collider (SLC) and the SLAC 2-mile Linac. The linac serves a unique fixed target facility at End Station A and accelerates both electrons and positrons to 50 GeV for SLC. The Stanford Large Detector (SLD) was operated with the SLC to study the production and properties of Z bosons. Polarized electrons, producing polarized Z's, have been available since mid-1992. In FY 1993, there was an accumulation of good measurements on at least 50,000 polarized Z's from a greater than 60% polarized beam. Data taking and analysis of fixed target experiments in End Station A using the 2-mile Linac polarized electron beam will continue. Detailed study of charm and tau physics in collaboration with the Institute of High Energy Physics in Beijing, China will continue. The	The highest priority will be to operate the SLC with the SLD with the highest possible beam luminosity and polarization. It is anticipated that about 100,000 polarized Z's will be recorded. Effort will be concentrated on completely analyzing all of the data. Data taking and analysis of polarized target experiments in End Station A using the 2-mile Linac polarized electron beam will continue. Detailed study of charm and tau physics in collaboration with the Institute of High Energy Physics in Beijing, China will continue. Theoretical physics efforts will continue.	The highest priority will be to operate the SLC with the SLD with the highest possible beam luminosity and polarization. It is expected that moderate increases in both luminosity and polarization will enable more than an additional 100,000 polarized Z's to be measured. Complete analysis of the total accumulated Z's should, by the end of FY 1995, afford the world's best measurement of important properties of these particles. Detailed study of charm and tau physics with the recently upgraded BES detector in collaboration with the Institute of High Energy Physics in Beijing, China will continue. Data taking and analysis of experiments in End Station A using polarized beams on polarized targets will continue. Theoretical physics efforts will continue.

III. Physics Research (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Stanford Linear Accelerator Center (Cont'd)	theoretical physics group provides interpretation and insights on experimental results.		
	$ 12,585	$ 11,120	$ 10,765
Brookhaven National Laboratory	The BNL program includes research using unique capabilities of the AGS for studies of certain extremely rare decays of the kaon. These experiments are considered to be very important in that they will test and challenge certain specific predictions of the Standard Model of particle interactions. One such experiment is taking data and two others are being upgraded for the higher beam intensities planned for the FY 1994 running. An additional high priority effort at the AGS is the "(g-2)" experiment which is designed to make an extremely precise measurement of the magnetic moment of the mu meson. This experiment will provide an extremely valuable new measurement of this fundamental quantity. Fabrication of the apparatus for this experiment will continue. Work on the GEM detector for the SSC continued, with the BNL group as a major contributor to the project leadership and the GEM Technical Design Report.	Priority will be given to exploitation of the radiation-hardened high intensity beam lines and the upgraded kaon-decay detectors. These experiments should accumulate data challenging specific Standard Model predictions and testing laws of conservation of lepton flavors. Major components of the muon (g-2) detector will be ready for testing. Analysis of data from the D-Zero experiment at Fermilab will continue as D-Zero continues to run through most of FY 1994. Theoretical efforts will continue.	There will be a strong emphasis on data collection by the five major HEP experiments using the high intensity slow-extracted proton beam. A new fast extraction system and beamline will begin to deliver beam to the muon g-2 experiment for commissioning of the magnet ring and detectors. There will be heavy analysis work on the large data set accumulated by the D-Zero experiment. Theoretical efforts will continue.
	$ 7,785	$ 7,802	$ 7,620

III. Physics Research (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Argonne National Laboratory (East)	Experimental groups continued to concentrate on taking data from detectors at colliding beam facilities with beams of energies and intensities previously unattainable. The ANL program included the ZEUS electron-proton detector at DESY in Hamburg and CDF at Fermilab. The SOUDAN-2 detector, with leadership from ANL, is completed and taking data. An increasing fraction of the effort is being given to detector development focussed on the large SDC detector which has been selected to be one of the two first experiments at the SSC lab.	The ANL program will continue its strong participation in the operation of the CDF detector at Fermilab and in the operation of the ZEUS detector at DESY. The SOUDAN-2 detector will be in its second year of steady-state running. The theoretical research effort will continue at about the same level of effort.	ANL experimental groups will continue as major collaborators on three world-class colliding beam experiments, including the CDF experiment at Fermilab and the ZEUS electron-proton experiment at DESY. The SOUDAN-2 detector will be progressing to its goal of 5 kiloton-years of proton-decay data. The theory group will continue at about the same level of effort.
	$ 5,653	$ 5,712	$ 5,550
Lawrence Berkeley Laboratory	CDF and D-zero detectors groups concentrated on taking data during the very successful run at the Fermilab Tevatron. Detector development continued on the large SDC detector which has been selected as one of the first experiments at the SSC. LBL also collaborated on the unique polarized electron study now underway with the SLD detector at SLAC. The astrophysics supernova search detected and analyzed the furthest supernova yet found. The strong theory program continued with successes such as the development by Hall and his collaborators of a predictive ansatz for Fermion mass matrices in supersymmetric theories. The Particle Data Group, which serves as the archivist of particle data properties, also broadened their general educational activities.	The lab will continue with the activities described for FY 1993. Experimental groups will complete the present data taking phase at Fermilab with the D-Zero and CDF detectors and concentrate on analysis of this data. The theory and astrophysics group will remain strong and active and the Particle Data Group will continue its essential activities as the archivists on particle properties.	The CDF and D-zero teams will complete the analysis of the Tevatron collider data gathered in FY 1994, thereby extending the search for the top quark to 180 GeV. The D-zero group will install the new silicon detector system. Analysis will go forward on the large polarized e-e+ sample gathered in the SLD detector at SLAC. The astrophysics supernova search will have two extensive periods of observations while the dark matter detector will move to a deep underground location and have its first major run. The theory and astrophysics groups will continue and the Particle Data Group will continue its efforts on particle properties.
	$ 10,320	$ 10,540	$ 10,370

III. Physics Research (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Universities and Other Labs	Groups at universities and other DOE laboratories participated in major experiments at U.S. and foreign laboratories. Also, many of the groups engaged in planning and R&D activities in preparation for experiments at the SSC. Important new experiments continued running, including: the SLD experiment at the SLC (SLAC); the D-Zero and CDF experiments at the Tevatron (Fermilab); the ZEUS experiment at HERA (DESY); the MACRO Experiment (Italy); and the SOUDAN-2 experiment (Minnesota). Also, the experiment to make a precision measurement of the muon's anomalous magnetic moment is in preparation at BNL, as are some upgraded experiments at BNL for rare K-decays. Preparations are underway for fixed target experiments at Fermilab, and the DUMAND experiment (Hawaii). Included $120,000 for a computer lease at the Laboratory for Nuclear Science (LNS) Facility Upgrade, MIT and $2,140,000 for research activities at the SSCL.	Groups at universities and other DOE laboratories will participate in major experiments at U.S. and foreign laboratories. Important new experiments will continue running, including: the D-Zero and CDF experiments at the Tevatron (Fermilab); the L3, ALEPH, OPAL and DELPHI experiments at LEP (CERN); the ZEUS experiment at HERA (DESY); the MACRO experiment (Italy); the SOUDAN-2 experiment (Minnesota); and the GRANITE experiment (Arizona). Also, some upgraded experiments at BNL for rare K-decays will be in the final stages of preparation, as will the precision measurement of the muon anomalous magnetic moment, and the search for highly strange nuclei. Preparations for fixed target experiments at Fermilab will continue. To optimize support for the highest priority activities, a small number of university groups will be dropped or substantially reduced. Includes $120,000 for a computer lease at the Laboratory for Nuclear Science (LNS) Facility Upgrade, MIT.	Groups at universities and other DOE laboratories will participate in major experiments at U.S. and foreign laboratories. Important new experiments will continue running, including: fixed target experiments at the Tevatron (Fermilab); the L3, ALEPH, OPAL and DELPHI experiments at LEP (CERN); the ZEUS experiment at HERA (DESY); the MACRO experiment (Italy); the SOUDAN-2 experiment (Minnesota); and the GRANITE experiment (Arizona). Also, some upgraded experiments at BNL for rare K-decays will be running, as will the search for exotic muons, the search for highly strange nuclei, and the precision measurement of the muon anomalous magnetic moment will be in final steps of preparation. An extensive effort to analyze D-Zero and CDF data will continue. To optimize support for the highest priority activities, a small number of university groups will be dropped or substantially reduced. Includes $120,000 for a computer lease at the Laboratory for Nuclear Science (LNS) at MIT.
	Funding in the amount of $1,485,000 for the SBIR program has been reprogrammed to Energy Supply.	Funding in the amount of $2,648,000 has been budgeted for the SBIR program.	Funding in the amount of $3,793,000 has been budgeted for the SBIR program.
	$ 96,830	$ 102,054	$ 94,690
Physics Research	$ 144,415	$ 147,365	$ 139,940

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

KEY ACTIVITY SUMMARY

HIGH ENERGY PHYSICS

I. Preface: Facility Operations

This activity includes funding for the operation and maintenance of the national laboratory research facilities including accelerators, colliders, secondary beam lines, detectors for experiments, experimental areas, computing, and computer networking facilities. It includes the costs of manpower, electric power, expendable supplies, replacement parts and subsystems, and inventories. The major DOE supported facilities to be operated in FY 1995 are the Fermilab Tevatron (800 GeV proton fixed target and 900 GeV antiproton-proton colliding beams); SLAC (50 GeV linear accelerator) and the SLC (50 GeV, GeV electron-positron collider); and the BNL AGS (25 GeV proton fixed target program) with the recently commissioned AGS booster. The BNL AGS, the SLC and the linac at SLAC, and the Fermilab Tevatron, along with their associated research detector facilities, will be operated for physics for most of FY 1995.

II. A. Summary Table: Facility Operations

Program Activity	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
Fermi National Accelerator Laboratory.....	$ 144,612	$ 138,993	$ 134,296	- 3
Stanford Linear Accelerator Center Operations...	88,947	78,895	73,890	- 6
Brookhaven National Laboratory-AGS Operations...	45,012	41,810	41,570	- 1
Other Operations.....	1,228	4,667	4,643	- 1
Total, Facility Operations	$ 279,799	$ 264,365	$ 254,399	- 4

II. B. Major Laboratory and Facility Funding

BROOKHAVEN NATIONAL LAB	$ 45,012	$ 41,810	$ 41,570	- 1
FERMI NATIONAL ACCELERATOR LAB	$ 144,612	$ 138,993	$ 134,296	- 3
STANFORD LINEAR ACCELERATOR CENTER	$ 88,947	$ 78,895	$ 73,890	- 6

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

Program Activity	FY 1993	FY 1994	FY 1995
Facility Operations			
Fermi National Accelerator Laboratory	The Tevatron will operate for physics research for about 34 weeks in FY 1993 in the collider mode. Final installation of the Linac Upgrade construction project, and of upgrades to the Tevatron refrigeration system, will be accomplished during a 4 month shutdown at the end of the fiscal year. Maintenance on the accelerator facilities, as well as the installation of upgraded CDF and D-Zero detector components, will also be done while the Tevatron is off.	After a brief Tevatron and Linac commissioning period, the D-Zero and CDF detectors will resume data taking with the significantly higher Tevatron luminosity which the upgraded Linac capabilities will make possible. The Tevatron colliding beam operating period begun in mid-FY 1992 will continue through most of FY 1994. The Tevatron is anticipated to be in operation for physics research in its antiproton-proton collider mode for as many as 30 weeks during FY 1994.	The extended period of operations for collider research program data-taking will be concluded with a final 13 weeks of operation early in FY 1995. The CDF and D-Zero detector facilities will be moved into their assembly halls for maintenance and installation of upgraded components and subsystems. During the Tevatron shutdown and change over period, 6 major fixed target experiments will be readied for data taking operations. The shutdown is expected to last about 5 months. The fixed target research program is scheduled to be in operation during the last 13 weeks of FY 1995. Thus Tevatron operations for research should total about 26 weeks in FY 1995.
	$ 144,612	$ 138,993	$ 134,296
Stanford Linear Accelerator Center Operations	SLAC will operate SLC and SLD for about 26 weeks with polarized beam. With significantly improved luminosity, and the polarized beam of very small size, the modern SLD detector is expected to provide important new physics results. The first two months of FY 1993 were dedicated to running 6-sectors of the linac at 120 pps for experiments in End Station A. Over a three month period, short runs with the linac will be devoted to commissioning SLAC's Final Focus Test Beam (FFTB) which is important for understanding the extension of linear colliders to much higher energies.	The SLC will operate for about 22 weeks and with greater than 50% beam polarization. With the unique capabilities of the SLC beams, the state-of-the-art SLD is expected to provide additional important new physics results. About 2 weeks of SLC running will be used for high energy linear collider R&D studies. It is expected that the polarized target experiments in End Station A using polarized electron beams from the SLAC linac will run about 5 weeks. Short runs will be made with Final Focus Test Beam as appropriate.	The SLC will operate for about 18 weeks and with greater than 60% beam polarization. With this polarization and the extremely small size of the beams, the state-of-the-art SLD detector is expected to continue to provide important new research results. About 2 weeks of SLC running will be used for high energy linear collider R&D studies. It is expected that the polarized target experiments in End Station A using polarized electron beams from the SLAC linac will run about 5 weeks. Short runs will be made with Final Focus Test Beam as appropriate.
	$ 88,947	$ 78,895	$ 73,890

III. Facility Operations (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Brookhaven National Laboratory-AGS Operations	The Booster/AGS complex will operate for about 12 weeks of high energy physics, including 4 weeks of polarized proton tests. In addition there will be 4 weeks for nuclear physics. Installation of the upgrade to the AGS RF system, required by both the heavy ions for RHIC and the high proton intensities for slow extraction, will continue. The RF upgrade, to be completed in FY 1994, includes 10 refurbished cavities, 10 new power amplifiers, and a new beam control system. The AGS extraction system, as well as the external beamlines and detectors, will be readied for high-intensity data-taking in FY 1994.	The AGS is expected to operate for about 14 weeks with a slow extracted beam so as to optimize the exploitation of the more intense beams and the upgraded detectors used to study the rare K-decays. In total five or six experiments will be operated simultaneously greatly enhancing the experimental program. The AGS is also expected to run for at least 6 weeks for nuclear physics.	The accelerator complex will deliver about 12 weeks of slow-extracted proton beam for HEP data-taking, plus about 2 weeks of fast-extracted beam for tests of the g-2 experiment. Emphasis will be on maintaining the operational readiness and efficiency of the external beamlines and the 5 major HEP experiments. There may be some further tests of polarized protons in the Booster/AGS complex. The complex is expected to accelerate heavy ions for at least 4 weeks of nuclear physics.
	$ 45,012	$ 41,810	$ 41,570
Other Operations	Continuation of FY 1992 program at about the same level of effort. Includes program specific computer networking activities. Funding in the amount of $2,110,000 for the SBIR program has been reprogrammed to Energy Supply.	Continuation of FY 1993 program at about the same level of effort for program specific computer networking activities. Funding in the amount of $1,655,000 has been budgeted for the SBIR program.	Continuation of FY 1994 program for program specific computer networking activities at about the same level of effort. Funding in the amount of $2,285,000 has been budgeted for the SBIR program.
	$ 1,228	$ 4,667	$ 4,643
Facility Operations	$ 279,799	$ 264,365	$ 254,399

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(dollars in thousands)

KEY ACTIVITY SUMMARY

HIGH ENERGY PHYSICS

I. Preface: High Energy Technology

This activity provides funding to maintain and develop the technological base that supports the scientific effectiveness, reliability, and efficiency of existing High Energy Physics research facilities and that is essential for extending the capabilities of accelerators, colliders, and detectors by developing and proving new concepts and technologies. It includes R&D with a near term focus in support of current, ongoing construction projects, fabrication of major detectors, and improving existing research capabilities. There is also a strong longer-term focus on development of advanced concepts leading to greater performance capability and more cost effective operation of accelerator and detector facilities. It also includes theoretical studies of accelerator physics; exploration of new concepts for particle acceleration, storage, and transport; and fabrication and testing of apparatus based on these studies. This activity also includes studies of new types of detectors and improved detector performance, for example: improved particle identification, improved precision in delineating tracks and locating vertices, decrease in susceptibility to degradation of performance caused by nuclear radiation, etc. The High Energy Physics Technology program is carried out primarily in the DOE laboratories, but with a significant program of advanced concept development in universities and industry. Since the limits of present accelerator technology are being reached by present generations of existing and planned machines, a strong effort has focused on a search for new accelerator technologies applicable to the long-term needs for physics research.

II. A. Summary Table: High Energy Technology

Program Activity	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
Fermi National Accelerator Laboratory	$ 16,805	$ 14,470	$ 14,260	- 1
Stanford Linear Accelerator Center	19,120	13,420	12,745	- 5
Brookhaven National Laboratory	4,808	6,069	5,735	- 6
Lawrence Berkeley Laboratory	8,600	8,705	8,420	- 3
Universities, Other Laboratories, and Other Contractors	16,422	16,751	17,030	+ 2
Total, High Energy Technology	$ 65,755	$ 59,415	$ 58,190	- 2

II. B. Major Laboratory and Facility Funding

BROOKHAVEN NATIONAL LAB	$ 4,808	$ 6,069	$ 5,735	- 6
FERMI NATIONAL ACCELERATOR LAB	$ 16,805	$ 14,470	$ 14,260	- 1
LAWRENCE BERKELEY LAB	$ 8,600	$ 8,705	$ 8,420	- 3
STANFORD LINEAR ACCELERATOR CENTER	$ 19,120	$ 13,420	$ 12,745	- 5

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

Program Activity	FY 1993	FY 1994	FY 1995
High Energy Technology			
Fermi National Accelerator Laboratory	This activity supports R&D programs to improve the performance of the accelerator and storage ring subsystems. Priority was given to support of the Main Injector construction project. R&D was directed toward final engineering design of the accelerator components. R&D efforts directed at dipole magnets were completed while the design and prototyping work on power supplies, rf amplifiers and instrumentation and controls systems was continued. Priority was also given to support of collider operations and the continuing luminosity upgrades. R&D directed at increasing the beam intensity for the fixed target program and a proton beam sweeping magnet for the antiproton production system was begun. Development of transverse dampers needed at injection into the Main Ring and the Tevatron to restrict emittance growth, continued as did studies for improvements to the CDF and D-Zero collider detectors. Commissioning of the newly completed Linac Upgrade Project began.	R&D in support of the Main Injector construction project will continue. In preparation for the future Main Injector commissioning, R&D effort on the design for upgrades of beam diagnostic equipment will be started. R&D work for the Main Injector also includes work on extraction and debunching the beam. Other R&D includes a beamline to link the 120 GeV extracted beam to the existing switchyard for test beams during collider runs, a new dedicated high intensity beamline for a new generation of high flux experiments, development of a power amplifier, and continued development and testing of higher order mode damper for the existing Main Ring cavity. Studies for future improvements to the CDF and D-Zero detectors will also continue.	R&D in support of the Main Injector construction project will continue, as the design work on the last of its technical components is finalized. R&D in support of efforts to increase the energy, the extracted beam intensity and the colliding beam luminosity of the Tevatron and the beam intensity of all of the other existing accelerators, including aperture enhancements for the antiproton source, will be undertaken. Priority will be given for R&D to improve the reliability of all accelerator systems and for R&D activities associated with the Fermilab colliding beam experimental programs using the CDF and D-Zero detector facilities.
	$ 16,805	$ 14,470	$ 14,260

III. High Energy Technology (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Stanford Linear Accelerator Center	A strong R&D program supported the operation of the SLC for physics research. Developments in feedback systems, in new diagnostics and tuning techniques and tests with flat beams yielded greatly increased luminosities. Studies showed higher levels are possible with modifications to Damping Ring vacuum chambers. R&D placed particular emphasis on improved performance of the SLC with polarized electrons. Over 60 percent polarization at the interaction point has been achieved. Work on very high intensity electron-positron colliders has focused on magnetic optics designs, interaction region background reduction, and space charge driven beam instabilities. Long range R&D in support of TeV linear colliders continued. Experiments to study nonlinear beam optics and methods for achieving small focal spots began on the newly completed Final Focus Test Beam line. The fabrication of a prototype accelerator module and beam line system, planned to study new linear collider accelerator structures and radiofrequency power sources, was begun. R&D to develop the detector technology required to do physics at high luminosity electron-positron colliders continued.	R&D includes work on broad band, multibunch feedback systems; very low impedance radiofrequency cavities; high power microwave tube windows; and vacuum chambers capable of handling the high heat load resulting from the very high power levels of synchrotron radiation all of which are essential to reaching B-Factory goals. R&D necessary to support the operation of the SLC/SLD for physics research is continuing. Long range R&D in support of high energy linear colliders continues at a reduced level. Experiments using the Final Focus Test Beam are in their first year. The development of a 1 GeV accelerator module to study new linear accelerator structures and test new radiofrequency power sources continues. R&D to develop detector technology required to do physics at the B-Factory is underway, as is design of the B-Factory detector.	R&D continues for higher beam intensity and polarization capabilities for future high energy electron-positron linear colliders at an increased level over FY 1994. Better cathodes and other polarized source improvements, combined with tests on spin manipulation techniques, should result in beam polarization capability approaching 80 percent. Experimental and theoretical work on very high current beams and high luminosity detectors will continue. Experiments using the Final Focus Test Beam needed for the development of linear colliders in the TeV range will continue. Fabrication of the accelerator test module and beam line to study new linear collider accelerator structures and test new radiofrequency power sources and other microwave components will continue. R&D in support of the B-Factory and the B-Factory detector will continue.
	$ 19,120	$ 13,420	$ 12,745

III. High Energy Technology (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Brookhaven National Laboratory	This activity supports R&D programs to improve flexibility and reliability of AGS operation and to reduce radiation levels and maintenance requirements; and for improvement of particle detectors, beam lines and targets for AGS experiments. A program of experiments on new acceleration concepts at the Accelerator Test Facility (ATF) and on ultra bright radiation sources was carried out, including initial studies on switched power technology for improved high brightness electron sources and high gradient acceleration. Detector R&D supported BNL participation in GEM collaboration for the design of the GEM detector for the SSC Laboratory and work on improvements to detectors for AGS experiments.	Priority is being given to R&D in support of AGS operations. Particle detectors, beam lines and targets will be improved only as necessary to maintain the existing capability for AGS experiments. The new, fast AGS extraction system to extract beam for the muon g-2 experiment is being installed. Promising novel accelerator concepts are being tested experimentally at the ATF.	Priority will be given to R&D activities in support of AGS operations. Existing capabilities of particle detectors, beam lines and targets for AGS experiments will be maintained. Work on the beam line for the muon g-2 experiment will be continued. The laser system at the ATF will be upgraded to 100 gigawatts for use in testing novel acceleration techniques. The experimental program at the ATF aimed at testing novel acceleration concepts will continue.
	$ 4,808	$ 6,069	$ 5,735
Lawrence Berkeley Laboratory	This activity included R&D on high-field superconducting materials and magnet technology; R&D on beam instrumentation and cooling; advanced research into the generation of very high energy particle beams, including advanced high-power microwave sources and the two-beam accelerator concept in collaboration with LLNL and MIT. It also included studies of accelerator and charged-particle beam physics and technology issues central to achieving very high luminosities in colliding beam machines. Studies included the production of low-emittance, high-brightness beams, the physics of intense, ultra-short, highly focused beams and measurement and control of the phenomena associated with such beams. R&D on advanced detector systems was also carried out. R&D	Support of very advanced superconducting material and magnet technology needed for the future national program is continuing. Activities in very advanced, exploratory accelerator R&D continues and will focus on radio-frequency (rf) power systems, methods of vacuum improvement, beam dynamics, magnet design, and studies of new accelerator and beam concepts, including tests using the beam from the Advanced Light Source (ALS) linac. Accelerator R&D and detector R&D in support of the B-Factory are in progress.	Progress continues on technology R&D with priority described for FY 1994. Advanced accelerator studies will include radiofrequency characterization of vacuum hardware and radiofrequency feedback designs. Experiments using the ALS Beam Test Facility will continue. Completion of plasma lens tests for focusing relativistic electron beams is expected, and there will be initiation of experiments on laser-electron beam interactions, novel radiofrequency structures, and novel diagnostic techniques. R&D in support of the B-Factory and its detector will continue.

III. High Energy Technology (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Lawrence Berkeley Laboratory (Cont'd)	activities on high current effects in accelerator systems focused on beam loading, active dampers, beam-beam interaction, and improved magnetic optical design. Preparations continued for experimental tests on accelerator physics innovations using beam from the ALS linac with detailed measurements of ALS beam characteristics.		
	$ 8,600	$ 8,705	$ 8,420
Universities, Other Laboratories, and Other Contractors	This subprogram supported a broad range of topics in very advanced accelerator and detector technologies needed to ensure a strong future experimental research capability in high energy physics. Research carried out in universities, industry, research institutes, and government research centers (e.g. NIST, NRL, etc.) addressed topics ranging from development of improved superconductors through new and advanced accelerator concepts, such as the use of lasers and collective effect phenomenon to accelerate charged particles, to new theoretical concepts in non-linear charged particle beam dynamics. The first demonstration of plasma beat-wave acceleration was achieved in a proof-of-principle experiment at UCLA. However, much more work is needed to prove that this can be scaled to future needs. The focus of this set of activities is on technologies applicable beyond the year 2000. Some exploratory work on the development and potential application of very high critical field superconducting magnets continued in progress. A concerted effort was made to search for promising new charged particle beam acceleration	Program activities include wakefield accelerator experiments at ANL, high-power microwave testing at LLNL, a variety of new accelerator concept tests at the accelerator test-bed at BNL, and full operation of the high brightness source at UCLA. Work will continue on superconducting materials for very high field superconducting magnets and on new and innovative approaches to designing and building magnets which are beyond the current state-of-the-art. R&D also continues on generic technology for future particle physics detectors.	The program will continue the focus on utilization of the special resources of universities, industry, not for profit research institutes, and government laboratories to address a broad spectrum of technology development important to the long term future productivity of the physics research. Tests will continue on a variety of new charged particle acceleration concepts using the facilities at universities and at ANL and BNL. Acceleration schemes include ideas based on lasers, plasmas, and collective beam effects. Particle-beam physics studies will be in progress at the UCLA 20-MeV linac using the new high brightness source. Alternate concepts for microwave power and high gradient accelerator structures for future linear colliders will continue. Studies will also continue on conductor materials for very high field superconducting magnets with increased current-carrying capability and on very-high field magnets. There will be continued application of theoretical concepts such as nonlinear beam dynamics to particle accelerators. Work on advanced, generic technologies for future particle detectors will also be

III. High Energy Technology (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Universities, Other Laboratories, and Other Contractors (Cont'd)	concepts. First major tests of advanced accelerator concepts identified as feasible in prior year R&D were undertaken at the advanced accelerator test-bed (ATF) established as a user center at BNL. It should be noted that the principal funding for graduate student training in accelerator physics is in this subprogram.		supported.
	Funding in the amount of $3,670,000 for the SBIR program has been reprogrammed to Energy Supply.	Funding in the amount of $2,764,000 has been budgeted for the SBIR program.	Funding in the amount of $2,973,000 has been budgeted for the SBIR program. This amount will be reduced upon allocation of the productivity savings reflected in the lead table.
	$ 16,422	$ 16,751	$ 17,030
High Energy Technology	$ 65,755	$ 59,415	$ 58,190

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

KEY ACTIVITY SUMMARY

HIGH ENERGY PHYSICS

I. Preface: Capital Equipment

Capital Equipment funding provides the secondary beam line components, particle detection apparatus, and data analysis systems essential to do high quality, forefront high energy physics experiments. It also provides for replacement of accelerator and detector facility components that have worn out or become obsolete. A proper complement of detectors and secondary beams is essential for effective utilization and operation of the high energy physics accelerator and colliding beam facilities.

Timely introduction of new beam and detector capabilities, and the regular upgrading and modification of existing capabilities, is essential. The large scale of the equipment required for high energy physics research systems is illustrated by a few examples: a typical secondary beam line can range from several hundred feet to a mile or more in length, and requires many beam transport, beam shaping and control elements; the portable shielding required around detectors and targets can involve arrays of hundreds of shielding blocks weighing as much as 10 tons each; the analysis magnets incorporated in detection systems weigh many tons; large calorimeters of 300 tons or more are not uncommon; and electronics systems with hundreds of thousands of data channels are typically required for major detectors. A time span of as much as five years is often involved from design, through fabrication, to installation, checkout, and operation of these large systems. Examples of specific items of equipment needed include: beam transport magnets; large spectrometer magnets for detector systems; precision regulated power supplies; particle beam diagnostic and control systems; electronic and optical detectors with precision spatial and time resolution; high precision calorimeters and tracking chambers for colliding beam detectors; high speed and large volume data processing systems; special cryogenic components for liquid hydrogen targets and superconducting devices; and a host of specialized electronics and other items of laboratory support equipment.

II. A. Summary Table: Capital Equipment

Program Activity	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
Fermi National Accelerator Laboratory	$ 32,355	$ 27,015	$ 26,550	- 2
Stanford Linear Accelerator Center	14,850	10,690	11,210	+ 5
Brookhaven National Laboratory	6,397	8,780	5,200	- 41
Universities and Other Laboratories	15,488	9,690	10,815	+ 12
Brookhaven National Laboratory- General Purpose Equipment	4,130	3,925	3,925	0
Total, Capital Equipment	$ 73,220	$ 60,100	$ 57,700	- 4

II. B. Major Laboratory and Facility Funding

BROOKHAVEN NATIONAL LAB	$ 6,397	$ 8,780	$ 5,200	- 41
FERMI NATIONAL ACCELERATOR LAB	$ 32,355	$ 27,015	$ 26,550	- 2
STANFORD LINEAR ACCELERATOR CENTER	$ 14,850	$ 10,690	$ 11,210	+ 5

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

Program Activity	FY 1993	FY 1994	FY 1995
Capital Equipment			
Fermi National Accelerator Laboratory	Design and fabrication of new electronics and other subsystems for CDF D-Zero was underway in order to accommodate the greatly increased proton and anti-proton bunch crossing frequency planned to be instituted during FY 1994. Both facilities will require faster triggering capabilities as well as increased on-line computing and data collection electronics capacities. CDF obtained a much improved Silicon vertex detector system as well, and D-Zero replaced its central tracking and electron identification systems. The equipment funding allocated for these major Fermilab collider detector facilities in FY 1993 totaled $7,800,000 for D-Zero and $7,900,000 for CDF. During the Tevatron shutdown for the installation of the final Linac Upgrade Project components in late FY 1993, new and upgraded components for both the CDF and the D-Zero detector facilities will be installed. The fixed target research program and the test beams received modifications to beam lines and detectors in preparation for the next fixed target run in FY 1995 ($7,100,000). Continuing extensions to the computing facilities in order to be able to match the steadily increasing data collection rates of the major experimental facilities were made ($4,250,000); equipment was provided for the sequence of accelerators and their control systems, instrumentation, and general site-related needs ($5,305,000).	Steadily increasing colliding beam luminosity and shorter beam crossing time make it essential to replace the original CDF calorimeter readouts based on a gaseous ionization collection medium with a system using fast scintillating materials. This also makes possible removal of the forward calorimeters, such that the forward and backward muon toroids can be moved closer to the central detector. The solid angle for muon detection would thereby be significantly increased. The same effects will render the D-Zero central tracking systems marginal, and they are to be replaced with fast and radiation hard scintillating fibers inside a new central magnetic solenoid. The equipment funding required for improvements to these two Fermilab collider detector facilities in FY 1994 totals $7,335,000 for CDF and $7,000,000 for D-Zero. Final preparation of the new major fixed target experiments scheduled to begin research operation early in FY 1995 will be supported at $6,100,000. A major fraction of that sum will be needed to complete the new detector for the precision study of neutral K meson decay modes. Data acquisition electronics and additional computing capabilities in the experimental areas, as well as extensions to the central computing facility ($3,680,000) is required. Equipment is required in support of R&D programs, the accelerator complex, and for general site requirements ($2,900,000).	Upgrades and improvements to the CDF detector facility will require $6,800,000 in FY 1995. Emphasis will be on modifications needed to operate with a very short time interval between triggers, which include major changes to the data acquisition electronic systems. Final testing calibration and installation of the new scintillator based forward and backward calorimeter systems will be completed. The D-Zero detector facility will need $7,400,000 for its upgrade program. As for CDF, priority will be given to the electronics required for short trigger interval times. The pulse shaping electronics for the calorimeters will require major improvements, as will the trigger system overall. Signal processing for the muon detection system will also have to be made faster. The Tevatron fixed target research programs will require $6,500,000 in FY 1995. The purchase of much of the commercially available data acquisition electronics for the fixed target experiments will be made early in the fiscal year, so that it can be installed for the scheduled data taking towards the end of the fiscal year. Improvements to beam line diagnostics, vacuum systems and particle detectors will also be supported. General purpose data acquisition electronics and improvements to both online and central computing equipment capabilities will require $3,500,000. Equipment in support of R&D programs, the accelerator complex and general site requirements will need $2,350,000.

III. Capital Equipment (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Fermi National Accelerator Laboratory (Cont'd)	$ 32,355	$ 27,015	$ 26,550
Stanford Linear Accelerator Center	Funds were provided for support of the high priority research with SLD ($2,000,000), and the SLC ($2,000,000) and its polarized beam ($2,600,000). Funds were provided in support of physics research including computer equipment ($1,350,000) and to meet needs in advanced accelerator R&D including the Final Focus Test Beam ($3,190,000). Support was also provided for general laboratory equipment including new machine tools, Computer Aided Design/Computer Aided Manufacturing, and heating, ventilation and air conditioning upgrades ($3,710,000).	Funds will be provided to initiate the B-Factory detector ($2,500,000) and for the highest priority needs of the SLC/SLD research program ($1,320,000). Funds will be provided in support of other physics research including computer equipment ($2,300,000) and to meet needs in advanced accelerator R&D including the Final Focus Test Beam ($3,500,000). Support will also be provided for general laboratory equipment including new machine tools, Computer Aided Design/Computer Aided Manufacturing, and heating, ventilation and air conditioning upgrades ($1,070,000).	Funds will be provided for the B-Factory detector ($6,250,000). Funds will be provided in support of other physics research including computing equipment ($1,500,000). Funds for equipment in support of advanced accelerator R&D leading to high energy linear colliders will also be provided ($2,100,000). Capital equipment in support of the fixed target program in End Station A will be funded ($550,000). Support will also be provided for general laboratory equipment including high voltage gear, Computer Aided Design/Computer Aided Manufacturing systems, new machine tools, and heating, ventilation, and air conditioning upgrade ($810,000).
	$ 14,850	$ 10,690	$ 11,210
Brookhaven National Laboratory	Continued fabrication of the muon anomalous magnetic moment (g-2) experiment ($1,920,000); support for upgrades to the experiments to handle the new higher Booster intensities ($2,450,000); beamline components, including radiation-hardened magnets and new shielding ($1,000,000); accelerator R&D ($620,000); general AGS support ($407,000).	The level of funding for this effort is increased to continue support for the muon anomalous magnetic moment (g-2) experiment ($2,000,000); support for upgrades to the experiments to handle the new higher AGS intensities ($2,900,000); beamline components, including radiation-hardened magnets and new shielding ($2,910,000); accelerator R&D ($710,000); and general AGS support ($260,000).	Capital equipment funding is reduced, following the 5-year profile developed in 1992 in coordination with BNL management as part of the upgrade/run/terminate planning for the HEP program at the AGS. Continued fabrication of the muon g-2 experiment ($1,800,000); preparation of the experiments for high intensities ($2,000,000); beamline components and shielding ($1,000,000); accelerator R&D ($400,000).
	$ 6,397	$ 8,780	$ 5,200

III. Capital Equipment (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Universities and Other Laboratories	The U.S. ZEUS Collaboration continues its initial program of research at HERA (Hamburg), as will other U.S. groups at MACRO (Italy) and SOUDAN (Minnesota). DUMAND (Hawaii) is in the final steps of preparation. Some funding has been provided to meet, in part, ongoing needs for upgrade of computer and other data analysis equipment, as well as advanced equipment for design and fabrication of experimental equipment, in order that university-based physicists can contribute to high energy physics research on campus. Hardware for advanced accelerator concept experiments at the BNL-ATF and the ANL wakefield test facility is included. Includes funding for the MIT-LEPICS computer upgrade ($900,000). Preparations for data taking in FY 1994 of some upgraded rare K-decay experiments at BNL and fixed target experiments at Fermilab and SLAC will be in progress. Capital equipment funds are needed at LBL for equipment to support ongoing experiments at Fermilab and SLAC, equipment for advanced detector prototypes, for equipment in support of the superconducting R&D magnet work, advanced accelerator research and development studies and related test and support equipment.	It is anticipated that there will be a few new experiments beginning their fabrication effort. Some funding will be provided to meet, in part, ongoing needs for upgrade of computer and other data analysis equipment, as well as for design and fabrication of experimental equipment, in order that university-based physicists can fully and actively contribute to high energy physics research on campus. Hardware for advanced accelerator concept experiments at the BNL-ATF and the ANL wakefield test facility is included. Ongoing university program fabrication efforts include upgraded rare K-decay experiments and search for highly strange nuclei at BNL, L3, and OPAL, upgrades at CERN, DUMAND (Hawaii), GRANITE (Arizona), NEPTUN-A (Russia), ZEUS (HERA), and Super-Kamiokande (Japan). Capital equipment funds are needed at LBL for equipment to support ongoing experiments at Fermilab and SLAC, equipment for advanced detector prototypes, for equipment in support of the superconducting R&D magnet work, advanced accelerator research and development studies and related test and support equipment.	University-based scientists will participate in new experiments in the major fixed target run planned at Fermilab, on rare K-decays, neutrino interactions, neutrino oscillations, hyperons and B-particles. It is anticipated that there will be a few other new experiments, including for example, Super-Kamiokande (Japan). Some funding will be provided to meet, in part, ongoing needs for upgrade of computer and other data analysis equipment, as well as advanced equipment for design and fabrication of experimental equipment, in order that university-based physicists can fully and actively contribute to high energy physics research on campus. Hardware for advanced accelerator concept experiments at the BNL-ATF and the ANL wakefield test facility is included. Data taking in FY 1994 of some upgraded rare K-decay experiments and searches at BNL will be in progress. Capital equipment funds are needed at LBL for equipment to support ongoing experiments at Fermilab and SLAC, equipment for advanced detector prototypes, for equipment in support of the superconducting R&D magnet work, advanced accelerator research and development studies and related test and support equipment. New non-accelerator experiments and upgrades to experiments at foreign accelerators will be undertaken only in cases with exceptional importance. The funding level will impact proposed new experiments and significant enhancements of existing detectors.
	$ 15,488	$ 9,690	$ 10,815

III. Capital Equipment (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Brookhaven National Laboratory- General Purpose Equipment	Provides general purpose equipment for the entire laboratory.	Provides general purpose equipment for the entire laboratory.	Provides general purpose equipment for the entire laboratory. Includes purchase of massively parallel computer. ($1,000,000)
	$ 4,130	$ 3,925	$ 3,925
Capital Equipment	$ 73,220	$ 60,100	$ 57,700

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

KEY ACTIVITY SUMMARY

HIGH ENERGY PHYSICS

I. Preface: Construction

II. A. Summary Table: Construction

Program Activity	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
Accelerator Improvements and Modifications	$ 15,095	$ 13,105	$ 12,515	- 5
General Plant Projects	12,835	12,149	12,146	0
Fermilab Main Injector	15,000	25,000	43,000	+ 72
B-Factory	0	36,000	44,000	+ 22
Total, Construction	$ 42,930	$ 86,254	$ 111,661	+ 29

II. B. Major Laboratory and Facility Funding

BROOKHAVEN NATIONAL LAB	$ 8,545	$ 8,425	$ 8,225	- 2
FERMI NATIONAL ACCELERATOR LAB	$ 26,955	$ 34,935	$ 52,720	+ 51
STANFORD LINEAR ACCELERATOR CENTER	$ 7,430	$ 42,894	$ 50,716	+ 18

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

Program Activity	FY 1993	FY 1994	FY 1995
Construction			
Accelerator Improvements and Modifications	This funding was used to support continuing large need for modifications to maintain and improve the technical capability and operational efficiency of the accelerator complexes.	Level of effort reduced relative to FY 1993. Fermilab and SLAC will delay improvements for efficiency and sacrifice performance enhancement of aging facilities. Approximately constant level maintained at BNL to improve AGS for completion of HEP experiments at high luminosity enabled by Booster.	The level of effort is reduced relative to FY 1994. Fermilab and SLAC will delay some improvements for efficiency and sacrifice some performance enhancements for aging facilities. Approximately constant level maintained at BNL to improve AGS for completion of HEP experiments at high luminosity enabled by Booster.
	$ 15,095	$ 13,105	$ 12,515
General Plant Projects	Funding was used for small general purpose construction projects, e.g. roads, utilities, and environmental, safety, health and security needs.	This activity continues at a level of effort reduced by about 10% relative to FY 1993.	This activity continues with about the same level of effort as in FY 1994.
	$ 12,835	$ 12,149	$ 12,146
Fermilab Main Injector	Engineering design work continued on all aspects of the projects. Civil construction of the largest service building began. Fabrication of major components and subassemblies for technical components was started. Emphasis was put on the completion of R&D dipole magnets and for the R&D for design and fabrication of high-current power supplies.	Engineering design work on the unit construction will be completed by mid-year. By year's end, about one quarter of the ring enclosure construction will be complete, and beneficial occupancy of the largest service building will be gained. About five percent of the dipole magnets will be completely assembled and tested, and one of the nine 9000 ampere power supplies will be in assembly. Fabrication work on most of the other major technical components will have begun by the end of the fiscal year.	Civil construction work on the ring enclosure will continue with about three quarters of the ring enclosure completed. Emphasis will be on procurement of the dipole magnets and high-current power supplies. About one-third of the dipole magnets will be completed and tested and three of the high current power supplies will be operational. Fabrication of the remaining technical components will have started.
	At the end of FY 1993, the project will be about 6% complete.	At the end of FY 1994, the project will be about 17% complete.	The requested funding will provide for an additional 17% of the total project and at the end of FY 1995, the project will be about 34% complete.

III. Construction (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Fermilab Main Injector (Cont'd)	$ 15,000	$ 25,000	$ 43,000
B-Factory	No activity.	FY 1994 is the first year of construction for the SLAC B-Factory. The project, an extensive upgrade of the PEP storage ring, includes the design, modification, fabrication, and assembly of storage ring components; there is no conventional construction. Prominent activities in FY 1994 include startup of most important engineering and design activities, clearing of PEP tunnel of existing equipment scheduled for refurbishing or not required for the B-Factory, and initiation of those long lead-time procurements that most seriously impact the project's critical schedule path.	Detailed engineering design will continue. Tunnel clearing will be complete and refurbishing of PEP components (particularly ring magnets for the high energy ring) will be in full swing. Fabrication of low energy ring magnets, and injection system components will begin. High energy ring magnet support and vacuum chamber components will be under construction.
	No activity.	At the end of FY 1994, the project will be about 15% complete.	The requested funding will provide for an additional 25% of the project and at the end of FY 1995, the project will be about 40% complete.
	$ 0	$ 36,000	$ 44,000
Construction	$ 42,930	$ 86,254	$ 111,661

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
High Energy 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 Request	FY 1995 Request	Unappropriated Balance	TEC
GPE-103	General Plant Projects, Various Locations	$ ---	$ ---	$ 12,149	$ 12,146	$ 0	$ 12,146
95-G-301	Accelerator Improvements and Modifications, Various Locations	---	---	13,105	12,515	0	12,515
94-G-304	B-Factory, Stanford Linear Accelerator Center	---	---	36,000	44,000	97,000	177,000
92-G-302	Fermilab Main Injector, Fermilab	11,650	15,000	25,000	43,000	134,950	229,600
Total, High Energy Physics		$ 11,650	$ 15,000	$ 86,254	$111,661	$231,950	$431,261

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: Project GPE-103 General Plant Projects — TEC: $12,146
Various locations — TPC: $12,146

Start Date: 3rd. Qtr. FY 1995 Completion Date: 2nd Qtr. FY 1997

2. Financial Schedule (Federal Funds):

Fiscal Year	Appropriation	Obligations	Costs
1995	$12,146	$12,146	$3,900
1996	0	0	5,900
1997	0	0	2,346

3. Narrative: General Plant Projects provide for the many miscellaneous alterations, additions, modifications, replacements, and non-major construction required for general purpose, non-programmatic facilities at the Brookhaven National Laboratory, Fermi National Accelerator Laboratory and the Stanford Linear Accelerator Center facilities. High Energy Physics has the responsibility to provide funding for all GPP needs at BNL, Fermilab, and SLAC.

These projects are required for the general maintenance, modifications and improvement of the overall laboratory plant remediation of environmental problems and include minor new construction, capital alterations and additions, and improvements to buildings and utility systems. These are short-term projects whose timely accomplishment is essential for timely response to environmental and safety needs, maintaining the productivity, increasing the operational cost effectiveness, and ensuring that necessary support services are available to the research program.

A description and listing of examples of the major items of work to be performed at the various locations is contained in the Construction Project Data Sheet. Some of these may be located on non-government owned property. Following is a listing of the funding proposed for the various locations:

Brookhaven National Laboratory	$ 5,695
Fermi National Accelerator Laboratory	3,660
Stanford Linear Accelerator Center	2,791
Total Estimated Cost.....	$12,146

4. Total Project Funding (BA):

	Prior Years	FY 1993	FY 1994	FY 1995 Request
Construction.....	XXXX	$12,835	$12,149	$12,146

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: Project 95-G-301 Accelerator Improvements and Modifications, Various Locations — TEC: $12,515, TPC: $12,515

Start Date: 3rd. Qtr. FY 1995 Completion Date: 2nd Qtr. FY 1997

2. Financial Schedule (Federal Funds):

Fiscal Year	Appropriation	Obligations	Costs
1995	$ 12,515	$ 12,515	$ 3,100
1996	0	0	5,500
1997	0	0	3,915

3. Narrative: Accelerator Improvement projects provide for a variety of minor modifications, improvements and additions to the major high energy particle accelerators, colliding beam devices and experimental facilities. Funds of this type are necessary on an annual basis to maintain and improve the scientific effectiveness of these facilities as well as their operating reliability and cost effectiveness. The funds requested, which represent less than 1 percent of the present value of the government's investment in these facilities, produce a substantial return in terms of more cost effective operation and greater research productivity.

These projects are essential on an annual basis to maintain the short term operating efficiency and reliability, and the research flexibility of the high energy accelerators, colliding beam systems and related experimental facilities, thereby maintaining or enhancing their level of scientific effectiveness and productivity.

A description and listing of examples of the major items of work to be performed at the various locations is contained in the Construction Project Data Sheet. Some of these may be located on non-government owned property. Following is a listing of the funding proposed for the various locations:

Brookhaven National Laboratory	$ 2,530
Fermi National Accelerator Laboratory	6,060
Stanford Linear Accelerator Center	3,925
Total Estimated Cost.....	$12,515

4. Total Project Funding (BA):

	Prior Years	FY 1993	FY 1994	FY 1995
Construction.....	XXXX	$15,095	$13,105	$12,515

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: Project 94-G-304, B-Factory
Stanford Linear Accelerator Center

TEC: $177,000
TPC: $293,200

Start Date: 2nd. Qtr. FY 1994 Completion Date: 2nd Qtr. FY 1998

2. Financial Schedule (Federal Funds):

Fiscal Year	Appropriation	Obligations	Costs
1994	$ 36,000	$ 36,000	$ 27,000
1995	44,000	44,000	42,000
1996	52,000	52,000	50,000
1997	45,000	45,000	47,000
1998	0	0	11,000

3. Narrative: This project will provide two rings of magnets for storage of electrons at about 9 GeV and of positrons at about 3 GeV. The counter rotating beams of electrons and positrons will be brought into collision in an intersection area. A key element of the project will be the incorporation of design elements which will allow the very high collision luminosity required for effective studies of the B-meson system.

4. Total Project Funding (BA):

	Prior Years	FY 1994 Request	FY 1995 Request	To Complete
Construction.....	$ ---	$36,000	$44,000	$97,000
Capital Equipment.....	100	3,300	8,500	69,400
Operating Expenses.....	21,200	6,500	5,600	1,600

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: Project 92-G-302 Fermilab Main Injector, Batavia, Illinois — TEC: $ 229,600, TPC: $ 259,300

Start Date: 3rd. Qtr. FY 1992 — Completion Date: 3rd. Qtr. FY 1999

2. Financial Schedule (Federal Funds):

Fiscal Year	Appropriation	Adjustments	Obligations	Costs
1992	$ 15,000	- 3,350 a/	$ 11,650	$ 990
1993	15,000 b/		15,000	9,937
1994	25,000		25,000	27,600
1995	43,000		43,000	38,800
1996	52,000		52,000	48,400
1997	52,000		52,000	52,000
1998	30,950		30,950	36,300
1999	0		0	15,573

3. Narrative: ~~Due primarily to a combination of enhanced ES&H criteria and re-estimates due to design advances, this project has been stretched out from the 4th Quarter of FY 1997 to the 3rd Quarter of FY 1999 resulting in an attendant increase in TEC and TPC. The TEC has been increased from $185,000,000 to $229,600,000. The TPC has been increased from $215,200,000 to $259,300,000.~~

This project provides for the construction of a new replacement accelerator to provide particles for injection into the existing Fermilab superconducting Tevatron accelerator, and also for direct delivery to the existing fixed target experimental and test beam areas.

The primary programmatic goal of this project is to greatly increase the luminosity delivered to the two existing collider detector facilities at Fermilab. ~~It will also make it possible to provide particle beams for the testing and calibration of SSC detector components and subsystems, and create an expanded capability for 120 GeV beams for physics research, without interference with operation of the ongoing Fermilab Tevatron collider or fixed target research programs.~~

Purpose of this project is to greatly increase the data rate for the two existing Tevatron collider detector facilities, thereby enhancing significantly their efficiencies and physics research capabilities. This will in particular maximize the likelihood of the discovery at Fermilab of the top quark; the last unobserved fundamental particle forming the basis of our current understanding of the structure of matter.

4. Total Project Funding (BA):

	Prior Years	FY 1993	FY 1994 Request	FY 1995 Request	To Complete
Construction.....	$11,650	$15,000	$25,000	$43,000	$134,950
Capital Equipment.....	200	200	200	200	200
Operating Expenses.....	9,100	4,100	3,200	500	11,800

a/ Reflects Congressional Rescission of $3,350,000 in FY 1992.
b/ Congressional request for $30,000,000 changed to $15,000,000 by Congressional action on FY 1993 request.