DEPARTMENT OF ENERGY
FY 1996 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 and new, highly sophisticated approaches to data reduction and analysis. Such technologies often find near-term as well as long-term applications in other fields.

The U.S. HEP program is widely acclaimed as being a world forefront program. Fermilab has the highest energy particle beams available anywhere, and the SLC at SLAC has the highest energy polarized electron-positron collisions available anywhere. Further, U.S. scientists are substantially involved in forefront research in all areas in this field. Thus, the HEP program is a strong contributor to the President's goal of "World leadership in basic science...."

Research in high energy physics is an important part of the Department of Energy's (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, as well as in industry.

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 research 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). 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.

SCIENCE FACILITIES UTILIZATION ENHANCEMENT: The High Energy Physics request includes $15,000,000 to enhance the utilization of the Department's fundamental science and user facilities. This investment will significantly increase research time available to thousands of scientists in universities, Federal agencies, and U.S. companies. It will also leverage both Federally and privately sponsored research, consistent with the Administration's strategy for enhancing the U.S. National science investment. The purpose of this targeted science initiative is to increase the utilization of the Department's large state-of-the-art science facilities. The proposed increase will support an enhanced level of operations at all three of the Department's major high energy physics facilities: the Tevatron, the Stanford Linear Collider, and the Alternating Gradient Synchrotron. In addition, approximately twenty percent of funds provided through the initiative will be administered directly to users through competitive grants. The proposed increase is consistent with the recommendations of the High Energy Physics Advisory Panel expert subpanel that advised the Department on the appropriate future path for the Department's High Energy Physics program in the wake of the cancellation of the Superconducting Super Collider project in 1993.

The budget presented herein is divided into five 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 the large accelerator and detector facilities which are essential to perform the research. The High Energy Physics Technology section of the budget provides for the advanced R&D necessary for the U.S. to have 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 budget categories support a balanced program of excellent research in high energy physics.

DEPARTMENT OF ENERGY
FY 1996 CONGRESSIONAL BUDGET REQUEST
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(Tabular dollars in thousands, narrative in whole dollars)

LEAD TABLE

High Energy Physics

Activity	FY 1994 Adjusted	FY 1995 Appropriation b/	FY 1995 Adjustment	FY 1995 Adjusted	FY 1996 Request
Operating Expenses					
Physics Research..............................	$144,717	$139,940	$0	$139,940	$147,155
Facility Operations............................	262,474	279,399	−2,836	276,563	280,152
High Energy Technology.....................	56,651	58,190	0	58,190	67,370
Subtotal Operating Expenses...........	463,842	477,529	−2,836	474,693	494,677
Capital Equipment.............................	60,100	57,700	0	57,700	63,230
Construction..	86,254	111,661	−1,925	109,736	127,645
TOTAL..	610,196	646,890	−4,761	642,129	685,552
Summary					
Operating Expenses............................	$463,842	$477,529	−$2,836	$474,693	$494,677
Capital Equipment..............................	60,100	57,700	0	57,700	63,230
Construction..	86,254	111,661	−1,925	109,736	127,645
Total Program.....................................	$610,196 a/	$646,890	−$4,761 b/	$642,129	$685,552
Staffing (FTEs)..................................	(Reference General Science Program Direction)				

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

a/ Excludes $7,067,000 for the SBIR program and $236,000 for the STTR program which has been reprogrammed to Energy Supply R&D.
b/ Amount of General Reduction and Procurement Reform ($2,836,000 in operating and $1,925,000 in Construction

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

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 utilize accelerators, but instead take advantage of processes that occur in the natural environment and involve experimental apparatus located 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 both at home and abroad 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 Tevatron complex.

The strategy for the overall High Energy Physics program for FY 1996 revolves around the following key factors:

o Careful planning to optimize the physics output of the program. The report of the 1994 High Energy Physics Advisory Panel Subpanel on the Vision for the Future of High Energy Physics is available and provides recommendations for structuring the program to optimize current assets and to pursue opportunities for international cooperation.

o Tevatron operation in FY 1996 will be in the fixed target mode providing beam to six new experiments. 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 Stanford Linear Collider (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, thus, the ability for confirmation of the top quark's existence and the ability to study the properties in detail.

o Construction of the B-Factory at SLAC will be continued. 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 make possible a significant series of tests of the Standard Model, and will advance our understanding 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 Significant involvement of U.S. high energy physicists in the Large Hadron Collider (LHC) project at CERN in Geneva, Switzerland is planned. We anticipate that a satisfactory agreement will be reached with CERN which enables this involvement. When completed in the first part of the next decade, the LHC will be the world's highest energy hadron collider. To conduct research on the high energy frontier in this time period, U.S. physicists must be participants in the design and construction of the LHC and its associated detectors, activities which are already underway in Europe.

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. The performance of the HEP program in FY 1994 was measured by an ensemble of reviews of identified aspects of the program. These included: annual program reviews of the major participating DOE laboratories (ANL, BNL, Fermilab, LBL, and SLAC); semiannual reviews of the Fermilab Main Injector Project, and the B-factory Project at SLAC; review of 305 proposals for renewals of grants and contracts supporting university-based research work; reviews of 94 proposals for new work and site visits to over one hundred university locations for review and discussion of work in progress during the course of multiyear grants or contracts. All of the lab and university reviews and some portion of the site visits included outside peer reviewers. It is planned that a similar set of reviews will be undertaken in FY 1995 and beyond. In FY 1996, reviews of the U.S. involvement in LHC will be initiated.

In FY 1994, the lab and project reviews described above led, in many cases, to program office directions for significant corrective actions by the relevant contractors. The reviews of renewal proposals for university-based work also often resulted in directions for corrective actions. Of the 94 proposals for new work received during FY 1994, there were 18 acceptances and 39 rejections. Thirty seven were received in the latter part of the year and are still being processed.

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(Tabular dollars in thousands, narrative in whole dollars)

SUMMARY OF CHANGES

High Energy Physics

FY 1995 Appropriation	$ 646,890
- Adjustment	- 4,761
FY 1995 Adjusted	$ 642,129
Operating and Capital Equipment	
- Increase in funding for Fermilab to support a full operating program and upgrades of the collider detector	+ 8,101
- Increase in funding SLAC to support additional running and fabrication of the detector for the B-factory	+ 6,420
- Increase in operating funding for BNL to support additional running of the AGS	+ 2,854
- Decrease in capital equipment funding for BNL reflecting completion of planned upgrades to the experimental apparatus	- 3,109
- Increase for initial U.S. participation in Large Hadron Collider related R&D	+ 6,000
- Increase in funding for other parts of the HEP program (primarily universities) in accord with the increased accelerator operations	+ 5,248
Construction	
- Continuation of Fermilab Main Injector construction project	+ 9,000
- Continuation of SLAC B-Factory construction project	+ 8,000
- Reduction in funding for AIP	- 790
- Increase in GPP funding for high priority ES&H activities	+ 1,699
FY 1996 OMB Budget Request	$ 685,552

DEPARTMENT OF ENERGY
FY 1996 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 nine 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, BNL, Fermilab, and SLAC. These facilities are made available to qualified scientists as determined by peer review 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), BEPC (China), 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 1996 will be a year of strong research output as the researchers analyze data collected in FY 1995 and previous years from the SLC collider at SLAC with the Stanford Large Detector (SLD), and from the world unique Tevatron collider at Fermilab with its CDF and D-Zero collider detector facilities, and from fixed target facilities at BNL, SLAC, and Fermilab. Priority will be given to 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 modest level. Many of the researchers supported by this funding will also be participating in R&D related to possible LHC involvement (as described in the High Energy Technology section of this budget).

II. A. **Summary Table: Physics Research**

Program Activity	FY 1994 Adjusted	FY 1995 Adjusted	FY 1996 Request	$ Change
Fermi National Accelerator Laboratory............	$ 11,160	$ 10,049	$ 10,130	$ 81
Stanford Linear Accelerator Center...............	12,368	9,875	10,105	230
Brookhaven National Laboratory...................	8,227	7,931	8,175	244
Argonne National Laboratory (East)...............	5,957	5,640	5,750	110
Lawrence Berkeley Laboratory.....................	10,640	10,220	10,450	230
Universities and Other Labs......................	96,365	96,225	102,545	6,320
Total, Physics Research	$ 144,717	$ 139,940	$ 147,155	$ 7,215

II. B. **Laboratory and Facility Funding Table: Physics Research**

Argonne National Lab (East)	$ 5,957	$ 5,640	$ 5,750	$ 110
Brookhaven National Lab	8,227	7,931	8,175	244
Fermi National Accelerator Lab	11,160	10,049	10,130	81
Lawrence Berkeley Lab	10,640	10,220	10,450	230
Stanford Linear Accelerator Center	12,368	9,875	10,105	230
All Other	96,365	96,225	102,545	6,320
Total, Physics Research	$ 144,717	$ 139,940	$ 147,155	$ 7,215

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

Program Activity	FY 1994	FY 1995	FY 1996
Physics Research			
Fermi National Accelerator Laboratory	The extended Tevatron antiproton-proton collider operating period for research, which began in FY 1993, continued. The CDF and D-Zero colliding beam detector facilities continued to collect data in FY 1994, and continued 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 their next data taking. 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.	FY 1996 will be the first year of an extended two-year operating period for the fixed-target research program. Six major new experiments will be commissioned and operated in the Fermilab Neutrino and Proton Research areas. Two new experiments will use the circulating Antiproton Accumulator beam. The Meson Research Area will be mothballed for potential future test beams. The collider physicists will continue analyses of data, and upgrade both detector facilities for the higher beam intensities expected from the Main Injector. Theoretical physics and particle astrophysics research efforts will continue.
	$ 11,160	$ 10,049	$ 10,130
Stanford Linear Accelerator Center	Research in High Energy Physics at SLAC involves experiments with the 2-mile 50 GeV linac in e+e- collider mode (SLC) using the SLD detector or in Fixed target mode using the End Station A polarized target. The large sample of Z0 decays produced by the 60% polarized electron beam in FY 1993 and FY 1994 have allowed the SLC/SLD experiment to be more than competitive with the European LEP experiments. For example, the single most-precise measurement of sine-squared theta-w now belongs to SLAC and will be improved significantly as more data are accumulated with the recently achieved 80% polarization capability of the electron linac. Detailed study of charm and tau physics continue in collaboration with the Institute of High Energy Physics in Beijing. The SLAC theoretical Physics	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.	Results from the SLC/SLD runs of FY 1994 and FY 1995 will guide the specific objectives for data runs in FY 1996. Extended studies of systematic errors, motivated in part by the complementary results from LEP experiments, may be required. Improvements to the detector, such as the vertex chambers, will improve the quality of the additional data to be collected in FY 1996. Charm and tau physics studies at the BES detector in Beijing continue. End Station A studies of polarized electrons on a polarized target will continue. Theoretical physics efforts will continue.

III. Physics Research (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Stanford Linear Accelerator Center (Cont'd)	Group provides interpretation and insight on experimental results and works with experimentalists to provide direction to future investigation.		
	$ 12,368	$ 9,875	$ 10,105
Brookhaven National Laboratory	Priority was given to exploitation of the radiation-hardened high intensity beam lines and the upgraded kaon-decay detectors. These experiments were designed to accumulate data challenging specific Standard Model predictions and testing laws of conservation of lepton flavors. Major components of the muon (g-2) detector were ready for testing. Analysis of data from the D-Zero experiment at Fermilab continued as D-Zero continued to run through most of FY 1994. Theoretical efforts continued.	The BNL Physics Department will be emphasizing data collection by three of the major High Energy Physics 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.	Experimental research will focus on operation of experiments at the AGS, especially two of the rare Kaon decay experiments and the search for exotic Meson states. The muon "g-2" experiment will have its initial engineering shakedown run. Analysis of D-Zero data from the recently completed run at the Fermilab Tevatron will be intensive. The theory program will continue at a constant level-of-effort. The HEP research group will be developing other initiatives, possibly including studies for using the Large Hadron Collider at CERN.
	$ 8,227	$ 7,931	$ 8,175
Argonne National Laboratory (East)	The ANL program continued 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 was in its second year of steady-state running. The theoretical research effort continued at about the same level of effort.	ANL experimental groups will continue as major collaborators on two world-class colliding beam experiments: 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.	Argonne groups will continue to play important roles in the CDF experiment at Fermilab and the ZEUS experiment at DESY in Hamburg, Germany. By the end of 1996 the underground Soudan detector in Minnesota will have recorded 75% of its planned data in search of proton decay. Plans for participation in an experiment at the Large Hadron Collider at CERN will be under development. Theoretical research, including lattice gauge calculations, will continue at about the same level of effort.
	$ 5,957	$ 5,640	$ 5,750

Program Activity	FY 1994	FY 1995	FY 1996
Lawrence Berkeley Laboratory	The CDF and D-zero groups concentrated on analysis of the Tevatron collider data gathered this year. Evidence for the top quark, determination of electroweak parameters, and B meson results have been obtained. A new silicon vertex detector was installed in CDF and the design and building of a silicon tracker for D-zero continues. Detector development for SLAC's B-factory has started. LBL also participated in the unique polarized electron study now underway with the SLD detector at SLAC. LBL is involved in the termination process for SSCL's SDC detector project. The completion and documentation of some aspects of previous SDC work is being done. The astrophysics supernova search discovered several distant supernovas. LBL finished the fabrication and preliminary assembly of the "icebox" electrical systems for the cryogenic detectors being prepared for a dark matter search experiment. The experimental program to detect and then map anisotropies in the Cosmic Microwave Background (CMB) continues. Data from the Cosmic Background Explorer (COBE) satellite is being received and analyzed. In addition, work on follow - on experiments is being done. The strong theory program continued their efforts in particle theory, particle astrophysics, and formal theory. The theory group contributed to the planning of experiments at future hadron colliders. The Particle Data Group, which serves as the archivists of measurements of particle properties, also is an active member of the Contemporary Physics Education Project.	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.	The CDF and D-zero groups will continue data analysis and participation in the planned upgrades to these detectors. Final designs for the B-factory detector subsystems will be developed and preparations made for production. Work will continue on the ATLAS project at CERN. The SLD effort will continue. The supernova search group plans to complete the analysis of first data from the new 4-chip camera and to begin work on the next generation of astronomical detectors and cameras. The initial physics results from the dark matter pilot experiment is anticipated. Data analysis from other instruments will continue and potential new experiments will be studied. The theory group and the Particle Data Group will continue their efforts.

Program Activity	FY 1994	FY 1995	FY 1996
Lawrence Berkeley Laboratory (Cont'd)	$ 10,640	$ 10,220	$ 10,450
Universities and Other Labs	University-based scientists and staff from other DOE laboratories have participated in preparation for, execution of, and data analysis for major experiments at U.S. and foreign laboratories and have conducted theoretical investigations into the fundamental properties of matter and energy. Preparation for and execution of physics research has included colliding beam experiments with the D-Zero and Collider Detector at Fermilab (CDF) detectors at the Tevatron, with the Stanford Large Detector (SLD) at SLAC, with the L3, ALEPH, OPAL, and DELPHI detectors at the Large Electron Positron (LEP) accelerator complex at CERN, and with the ZEUS detector at the Hadron Electron Ring Accelerator (HERA) complex at DESY. University-based data analysis activities have made essential contributions to evidence for the existence of the top quark and to high precision knowledge of the parameters of the electroweak interaction. Installation of scintillator material and electronics for the second half of the MACRO detector (Gran Sasso, Italy) was completed, and data taking with the full detector is scheduled for FY 1995. Fixed target experiments were reinstrumented at BNL in preparation for improved sensitivity rare kaon decay measurements. To optimize support for the highest priority activities, reviews of university-based grant programs and other DOE laboratory programs were conducted. When indicated, new work was initiated and ongoing work was brought to conclusion. Included is $120,000 for a computer	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 mesons, 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.	Groups at universities and other DOE laboratories will continue to exercise leadership in major experiments at U.S. and foreign laboratories and to conduct advanced theoretical investigations. Many of the physicists in the universities will be planning for possible involvement at the LHC, and in detector R&D for LHC as described in the High Energy Technology section of this budget. Important experiments include fixed target experiments at the Tevatron and SLAC and colliding beam experiments at LEP and DESY. Preparation for the next cycle of colliding beam experiments at D-Zero and CDF will be a major effort. University participation in the high luminosity, high polarization electron beam collider experiments at SLD and in preparation for research with the B-Factory at SLAC will be important aspects of the program. Emphasis will be given to analysis of SLD, D-Zero and CDF data. The underground MACRO and Soudan experiments will continue data taking with fully instrumented detectors. Also, some upgraded experiments at BNL for rare K-decays will be running, as will the search for exotic mesons, the search for highly strange nuclei, and the precision measurement of the muon anomalous magnetic moment will have its initial run. Redirection and optimization of university-based and other DOE laboratory programs will continue to meet emerging needs and opportunities. Includes $287,000 for computer leases at the Laboratory for Nuclear Science (LNS) at MIT.

III. Physics Research (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Universities and Other Labs (Cont'd)	lease at the Laboratory for Nuclear Science at the Massachusetts Institute of Technology.		
	Funding in the amount of $2,648,000 has been transferred to the SBIR program.	Funding in the amount of $329,000 and $475,000 has been budgeted for the SBIR program and the STTR program, respectively.	Funding in the amount of $3,305,000 and $262,000 has been budgeted for the SBIR program and the STTR program, respectively.
	$ 96,365	$ 96,225	$ 102,545
Physics Research	$ 144,717	$ 139,940	$ 147,155

DEPARTMENT OF ENERGY
FY 1996 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 1996 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, 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 1996.

II. A. Summary Table: Facility Operations

Program Activity	FY 1994 Adjusted	FY 1995 Adjusted	FY 1996 Request	$ Change
Fermi National Accelerator Laboratory............	$ 138,163	$ 141,640	$ 146,420	$ 4,780
Stanford Linear Accelerator Center Operations....	78,370	78,205	80,810	2,605
Brookhaven National Laboratory-AGS Operations....	41,810	43,115	45,545	2,430
Other Operations................................	4,131	13,603	7,377	-6,226
Total, Facility Operations	$ 262,474	$ 276,563	$ 280,152	$ 3,589

II. B. Laboratory and Facility Funding Table: Facility Operations

	FY 1994 Adjusted	FY 1995 Adjusted	FY 1996 Request	$ Change
Brookhaven National Lab	$ 41,810	$ 43,115	$ 45,545	$ 2,430
Fermi National Accelerator Lab	138,163	141,640	146,420	4,780
Stanford Linear Accelerator Center	78,370	78,205	80,810	2,605
All Other	4,131	13,603	7,377	-6,226
Total, Facility Operations	$ 262,474	$ 276,563	$ 280,152	$ 3,589

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

Program Activity	FY 1994	FY 1995	FY 1996
Facility Operations			
Fermi National Accelerator Laboratory	For most of FY 1994, the D-Zero and CDF detectors will be taking data using the significantly higher Tevatron luminosity which the upgraded Linac capabilities made possible. The Tevatron is anticipated to be in operation for physics research in its antiproton-proton collider mode for as many as 45 weeks during FY 1994.	The extended period of operations for data-taking for the antiproton-proton collider program will continue through most of FY 1995. Both the CDF and the D-Zero collider detector facilities are expected to collect data for most of the year. Preparations will also be ongoing for the major fixed target experimental program scheduled to begin by the second quarter of FY 1996. Tevatron operations for research are expected for 39 weeks during FY 1995, all in the antiproton-proton collider mode.	The fiscal year begins with a 9 week period of colliding beam data-taking. After a 3 month changeover and maintenance shutdown, the Tevatron is scheduled to be in operation for fixed target physics research for about 28 weeks during FY 1996. Eight major experiments are scheduled to take data: three in the Neutrino Experimental Area, three in the Proton Experimental Area, and two using the Antiproton Accumulator. The Tevatron will operate for research for a total of 37 weeks in FY 1996.
	$ 138,163	$ 141,640	$ 146,420
Stanford Linear Accelerator Center Operations	SLAC will operate in the SLC/SLD collider mode for much of the year (22 weeks) to accumulate data with electron polarization approaching 80%. The greater analyzing power which this unique capability affords will be exploited to determine the cause of the possible discrepancies with LEP experiments to reassure the electro-weak mixing angle, theta-w, as more data are accumulated. The Linac will also serve the fixed target program with beam to End Station A (11 weeks) and also the Linear collider R&D program, including the Final Focus Test Beam.	The SLC will operate for about 25 weeks and with near 80% 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. The polarized target experiments in End Station A using polarized electron beams from the SLAC linac will be upgraded and begin running at the beginning of FY 1996. Short runs will be made in parallel with SLC operation with Final Focus Test Beam as appropriate.	The SLC/SLD will operate for about 25 weeks with polarization near 80%. The fixed target operation in End Station A will run for about to 10 weeks. Additional Linac running at lower rep rates which reduces costs will provide beams for high energy Linear collider R&D studies and for Final Focus Test Beam studies.
	$ 78,370	$ 78,205	$ 80,810

III. Facility Operations (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Brookhaven National Laboratory-AGS Operations	The AGS operated 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 were operated simultaneously greatly enhancing the experimental program. The AGS is also ran for 6 weeks for nuclear physics.	The accelerator complex will deliver about 17 weeks of slow-extracted proton beam for HEP data-taking. 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 5 weeks of nuclear physics. This additional running is funded by the Nuclear Physics program.	The Booster/AGS accelerator complex will deliver about 19 weeks of slow-extracted proton beam to the 5 HEP experiments. A test beam for R&D on components for detectors at RHIC will also operate. The g-2 experiment will use about 2 weeks of beam for engineering shakedown, and there may be about 2 weeks for studies of polarized protons in the AGS. The Booster/AGS will operate for at least 4 weeks accelerating heavy ions. This additional running is funded by the Nuclear Physics program.
	$ 41,810	$ 43,115	$ 45,545
Other Operations	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 and $236,000 has been transferred to the SBIR program and the STTR program, respectively.	Continuation of FY 1994 program for program specific computer networking activities at about the same level of effort. Funding in the amount of $8,588,000 has been budgeted for the SBIR program.	Continuation of FY 1995 program for program specific computer networking activities at about the same level of effort. Funding in the amount of $3,234,000 and $230,000 has been budgeted for the SBIR program and the STTR program, respectively.
	$ 4,131	$ 13,603	$ 7,377
Facility Operations	$ 262,474	$ 276,563	$ 280,152

DEPARTMENT OF ENERGY
FY 1996 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
(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 1994 Adjusted	FY 1995 Adjusted	FY 1996 Request	$ Change
Fermi National Accelerator Laboratory............	$ 14,393	$ 14,375	$ 14,775	$ 400
Stanford Linear Accelerator Center..............	14,368	13,490	13,820	330
Brookhaven National Laboratory..................	6,232	5,838	6,018	180
Lawrence Berkeley Laboratory....................	8,999	8,929	9,140	211
Universities, Other Laboratories, and Other Contractors..................................	12,659	15,558	23,617	8,059
Total, High Energy Technology	$ 56,651	$ 58,190	$ 67,370	$ 9,180

II. B. Laboratory and Facility Funding Table: High Energy Technology

	FY 1994 Adjusted	FY 1995 Adjusted	FY 1996 Request	$ Change
Brookhaven National Lab	$ 6,232	$ 5,838	$ 6,018	$ 180
Fermi National Accelerator Lab	14,393	14,375	14,775	400
Lawrence Berkeley Lab	8,999	8,929	9,140	211
Stanford Linear Accelerator Center	14,368	13,490	13,820	330
All Other	12,659	15,558	23,617	8,059
Total, High Energy Technology	$ 56,651	$ 58,190	$ 67,370	$ 9,180

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

Program Activity	FY 1994	FY 1995	FY 1996
High Energy Technology			
Fermi National Accelerator Laboratory	R&D was continued in support of the Main Injector construction project. Calculations of the machine impedance and thresholds for associated beam instabilities were done, as were theoretical studies of beam behavior during injection and extraction. R&D was completed on the dipole, quadrupole, and sextupole magnets, and production of these magnets began. R&D on the dipole power supplies and rf power amplifier was also completed. R&D also continued in support of improving the existing accelerator complex and detectors.	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.	R&D will be ongoing with the goal of further increasing the luminosity of the collider and the intensity of the fixed-target beams. This will be accomplished by improving the intensity of the proton and antiproton sources, and by studying (and seeking remedies for) instabilities in the Main Ring and the Tevatron that limit their ability to accelerate beams from these sources with minimal losses and phase-space dilution. R&D on future linear colliders will continue. As part of the FY 1996 fixed-target run, improvements that will have been made to the CDF and D-Zero detector facilities (to accommodate Collider Run II luminosities) will be tested. Fixed-target beam lines for the Main Injector era will be designed, and high-performance computing systems will be developed to meet the increased demands of high energy physics data acquisition, analysis, and theoretical calculations.
	$ 14,393	$ 14,375	$ 14,775
Stanford Linear Accelerator Center	A strong R&D program supported the operation of the SLC for physics. Rebuilt damping rings were brought on-line and an improved strained lattice photocathode electron source brought polarization from about 60% to over 80%. R&D for these and other improvements has boosted physics productivity for the SLD detector. R&D in support of the B-factory construction project continued to focus on broad band, multibunch feedback systems; the elimination of higher	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	R&D in support of B-factory construction will be concluded in FY 1996 with final effort on the radiofrequency systems and in support of the detector fabrication. R&D will continue, but at a reduced level, in support of improved operation of the SLC and the SLD detector for physics with a focus on higher luminosity and electron beam polarization. Experiments using the Final Focus Test Beam will continue to explore improved optics, beam based self-alignment, and

III. High Energy Technology (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Stanford Linear Accelerator Center (Cont'd)	order modes in the high power radiofrequency cavities; high power microwave tube development; and the development of vacuum chambers capable of handling the high heat load resulting from the high power levels of synchrotron radiation. Long range R&D in support of the technology for next linear colliders continued at a level reduced from FY 1993. Experiments using the recently completed Final Focus Test Beam began with achievement of a 73 nanometer vertical beam dimension and the successful demonstration of two new types of beam profile monitors to measure these tiny beam sizes. Development of a 1 GeV accelerator module to study new linear accelerator structures and radiofrequency power sources operating at 11.4 GHz continued. R&D to develop technology and prepare a conceptual design report for the B-factory detector proceeded on schedule.	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.	innovative instrumentation for the purpose of achieving precision control over the small beam size needed for linear colliders. This facility will also be exploring very high peak power laser beam back scattering of the 50 GeV electron beam which is relevant to the gamma-gamma collider concept. A continuing activity will be the assembly and commissioning of portions of the Next Linear Collider Test Accelerator which will explore questions about radiofrequency power sources operating at 11.4 GHz, acceleration structures operating at gradients above 50 MeV per meter, and new instrumentation and diagnostics systems.
	$ 14,368	$ 13,490	$ 13,820
Brookhaven National Laboratory	This activity supports R&D programs to improve reliability of AGS operation and for improvement of particle detectors, beam lines, and targets for AGS experiments. R&D for advanced accelerator concepts is also supported. Priority was given to R&D in support of AGS operation. Components such as the multi-pulsing fast kicker and the new ejector septum for the new, fast AGS extraction system to deliver beam to the g-2 experiment have been fabricated. A Partial Siberian Snake to eliminate the imperfection spin depolarization resonances was installed in the AGS and tested successfully.	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.	Priority will be given to R&D activities of the Accelerator Test Facility (ATF), the Center for Accelerator Physics, and the Instrumentation Division. The ATF user program, including the laser grating accelerator, Inverse Cerenkov, and Inverse Free Electron Laser experiments, will continue using the upgraded 100 gigawatt laser system. Work for the muon g-2 experiment including the muon kicker will continue.

III. High Energy Technology (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Brookhaven National Laboratory (Cont'd)	Improvements at the Accelerator Test Facility (ATF) including upgrades of the linac, laser system, and electron gun to provide a higher brightness beam, have been completed and the experimental program commenced. Novel accelerator concepts are being experimentally tested at the ATF.		
	$ 6,232	$ 5,838	$ 6,018
Lawrence Berkeley Laboratory	The R&D programs to improve the performance of accelerator and storage ring subsystems were continued. This included support of very advanced superconducting material and magnet technology needed for the future national program. Activities in very advanced, exploratory accelerator R&D has continued to 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. This year the ALS test beam line was completed and experimental studies on plasma lens concepts were begun. R&D in support of Fermilab's upgrade of the DO detector subsystems has been proceeding. Accelerator and detector R&D in support of the B-Factory project at SLAC has been in progress.	Progress continues on technology R&D with priority as described in FY 1994. Advanced accelerator studies will include radiofrequency characterization of vacuum hardware and radiofrequency feedback designs. Experiments using the Advanced Light Source 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.	Technology R&D will continue on very advanced accelerator and detector concepts. Superconducting magnet R&D will emphasize even higher magnetic fields (about 16 Tesla) as a goal. Studies on advanced accelerator and beam concepts using the Advanced Light Source Beam Test Facility will include new experiments recommended by the Experimental Program Committee and further studies of novel rf structures. R&D for the Fermilab D-Zero detector upgrade includes preparations for the replacement of the vertex chamber with a new silicon tracking system that is based on LBL-developed technology. Also, R&D on the upgrade of the silicon vertex detector, part of the highly successful CDF detector at Fermilab, will be in progress. General studies of very advanced detector concepts will continue. B-Factory accelerator R&D will focus on rf and other components for the low-energy ring. R&D on the new detector for the B-Factory will include work on front-end electronics, silicon vertex detector, data acquisition and trigger electronics and on-line monitor and control systems.

Program Activity	FY 1994	FY 1995	FY 1996
Lawrence Berkeley Laboratory (Cont'd)	$ 8,999	$ 8,929	$ 9,140
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. Experimental tests of advanced accelerator concepts continued on the laser wakefield accelerator, inverse Cerenkov accelerator, and inverse free electron laser accelerator advanced the physics plausibility of those devices achieving in one case of about 36ev per meter. 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 concepts. It should be noted that the principal funding for graduate student training in accelerator physics is in this subprogram.	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 supported.	The broad range of physics and technology R&D studies supported in FY 1995 in universities, industry, and Federal laboratories will continue. The work is aimed at improved high energy physics related technology which can make possible future accelerators and detectors with enhanced capabilities, improved efficiencies and possibly reduced costs. Much of the technology developed here spins off eventually to American industry, some in the short term and some in the very long term. The mix of very practical, for example support for standards maintenance and development, to the esoteric and theoretical, exemplified by laser acceleration of charged particles in plasmas and research in nonlinear dynamics, will continue. Program activities of special interest in FY 1996 will include startup of a new wakefield accelerator experiment at ANL, continued high-power microwave testing at LLNL, and a variety of new accelerator concept tests at the accelerator test-bed at BNL. 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, with a specific target of going above 15 Tesla. R&D also continues on generic technology for future particle physics detectors.

III. High Energy Technology (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Universities, Other Laboratories, and Other Contractors (Cont'd)	No LHC activity.	LHC activity at a low level and not separately identified.	Funding in the amount of $4,800,000 is also included for the initiation of collaborative activities with CERN on the LHC. This funding is requested in anticipation that a satisfactory agreement will be reached with CERN for significant U.S. participation in the LHC project. The activities that would be supported have not been identified in detail, but would be associated with both the accelerator and the detectors. Specific efforts associated with the accelerator might include: superconductor wire testing and R&D; superconducting magnet R&D and design, including the intersection regions; design, modeling, and prototype development of beam transfer lines; and beam vacuum chamber screening R&D. Detector R&D efforts might be focused on muon chambers, tracking detectors, and hadron and electromagnetic calorimetry.
	Funding in the amount of $2,764,000 has been transferred to the SBIR program.	Funding in the amount of $577,000 has been budgeted for the SBIR program.	Funding in the amount of $3,355,000 and $250,000 has been budgeted for the SBIR program and the STTR program, respectively.
	$ 12,659	$ 15,558	$ 23,617
High Energy Technology	$ 56,651	$ 58,190	$ 67,370

DEPARTMENT OF ENERGY
FY 1996 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 1994 Adjusted	FY 1995 Adjusted	FY 1996 Request	$ Change
Fermi National Accelerator Laboratory............	$ 27,015	$ 26,745	$ 29,585	$ 2,840
Stanford Linear Accelerator Center...............	11,690	12,475	15,730	3,255
Brookhaven National Laboratory...................	8,380	5,299	2,190	-3,109
Universities and Other Laboratories..............	9,090	9,256	11,800	2,544
Brookhaven National Laboratory- General Purpose Equipment..............................	3,925	3,925	3,925	0
Total, Capital Equipment	$ 60,100	$ 57,700	$ 63,230	$ 5,530

II. B. Laboratory and Facility Funding Table: Capital Equipment

Brookhaven National Lab	$ 12,305	$ 9,224	$ 6,115	$ -3,109
Fermi National Accelerator Lab	27,015	26,745	29,585	2,840
Stanford Linear Accelerator Center	11,690	12,475	15,730	3,255

II. B. Laboratory and Facility Funding Table: Capital Equipment

	FY 1994 Adjusted	FY 1995 Estimate	FY 1996 Request	$ Change
All Other	9,090	9,256	11,800	2,544
Total, Capital Equipment	$ 60,100	$ 57,700	$ 63,230	$ 5,530

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

Program Activity	FY 1994	FY 1995	FY 1996
Capital Equipment			
Fermi National Accelerator Laboratory	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 a fast and radiation hard scintillating fiber tracking system. 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. Preparation of the new major fixed target experiments scheduled to begin research operation in FY 1995 will be supported at $6,100,000. A major fraction of that sum will be needed to complete a major 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	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	The Fermilab Main Injector project will become operational late in FY 1998. Improvement programs for both the CDF and the D-Zero detector facilities will be continued in FY 1996 in order to prepare for the significantly higher colliding beam luminosities which will result. The CDF facility will require $9,800,000 with emphasis on improvements to the Silicon Vertex Detector systems, upgrades to the muon detection system and faster front end electronics modules. D-Zero improvements will center on a silicon-based central tracking system and faster trigger system electronics, and will require in total $8,700,000. The Tevatron fixed target experiments will need $6,500,000 with a major emphasis on electronics and data acquisition systems, and the completion of the new KTeV detector facility. Improvements to the Massively Parallel data and computing systems in the central facility and at the experiments will total $3,200,000. Equipment in support of the accelerator complex, R&D programs and general site needs will be $1,385,000.

III. Capital Equipment (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Fermi National Accelerator Laboratory (Cont'd)	extensions to the central computing facility ($3,680,000) are required. Equipment is required in support of R&D programs, the accelerator complex, and for general site requirements ($2,900,000).	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 $2,545,000.	
	$ 27,015	$ 26,745	$ 29,585
Stanford Linear Accelerator Center	Funds were be provided to initiate the B-Factory detector ($2,500,000) and for the highest priority needs of the SLC/SLD research program ($2,320,000). Funds were 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 was also 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 ($7,515,000). 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).	Funds will be provided for the B-Factory detector ($9,000,000). Funds will be provided in support of other physics research ($1,800,000) and for the Mass Storage System Upgrade ($1,200,000). Funds for equipment in support of advanced accelerator R&D leading to high energy linear colliders will also be provided (2,200,000). Capital equipment in support of the fixed target program in End Station A will be funded ($780,000). Support will also be provided for general laboratory equipment including high voltage gear, Computer Aided Design/Computer Aided Manufacturing systems, and new machine tools ($750,000).
	$ 11,690	$ 12,475	$ 15,730

III. Capital Equipment (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Brookhaven National Laboratory	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 ($2,540,000); beamline components, including radiation-hardened magnets and new shielding ($2,545,000); accelerator R&D ($710,000); and general AGS support ($585,000).	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 ($1,649,000); preparation of the experiments for high intensities ($2,000,000); beamline components and shielding ($1,000,000); accelerator R&D ($580,000).	Capital equipment funding is provided in support of the Physics Research and Accelerator R&D groups, and in support of the ongoing operation of the AGS ($2,190,000).
	$ 8,380	$ 5,299	$ 2,190
Universities and Other Laboratories	University-based scientists' participation in data analysis and in preparation for new and upgraded experiments required computer equipment for data analysis, event reconstruction, and detector simulation and required instrumentation for R&D in support of upgrade of components of detectors at the accelerator laboratories. In addition, equipment for the actual fabrication of components was provided. Hardware for advanced accelerator concept experiments at the Advanced Test Facility at BNL and the ANL Wakefield Test Facility was included. Ongoing university program detector component fabrication efforts included: preparation for high sensitivity rare decay experiments and precision measurement of the muon's anomalous magnetic moment at BNL; upgraded muon and silicon vertex systems at the Tevatron's collider detectors; improved polarized beam intensity and polarization determination capability at SLAC; and increase in the muon detection capability of the L3 detector at CERN. Work also included	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	University-based scientists are expected to be intellectual leaders and principal participants in major detector design and component fabrication efforts at the SLAC B-Factory, in planning for LHC detectors, and in upgrade of the D-Zero and CDF detectors at the Tevatron. This work requires on-campus computer equipment and other instrumentation for detector simulation activities and construction and test of prototype modules. Advanced computer systems will be needed for analysis of the data sets coming from uniquely high luminosity collider running at SLAC, Fermilab, and LEP. It is anticipated that there will be other new efforts -- for example, Super Kamiokande (Japan), and MILAGRO (Los Alamos National Laboratory). Experiments for investigation of neutrino oscillation phenomena and for high intensity study of the properties of B mesons are under active consideration. Hardware for advanced accelerator concept experiments at the Advanced Test Facility at BNL and the ANL Wakefield Test Facility are included. Modest

III. Capital Equipment (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Universities and Other Laboratories (Cont'd)	fabrication and test of a polarized proton target use in the NEPTUN-A experiment (Russia). Capital equipment funds were provided to LBL for support of ongoing experiments at Fermilab and SLAC, for advanced detector prototypes, for equipment in support of superconducting magnet R&D, and for equipment in support of advanced accelerator R&D.	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.	upgrades of components at the ZEUS collider detector at DESY and the LEP collider detectors at CERN are planned. 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 magnet R&D, and advanced accelerator R&D.
	No LHC activity.	LHC activity at a low level and not separately identified.	Funding in the amount of $1,200,000 is also included for the initiation of collaborative activities with CERN on the LHC. This funding is requested in anticipation that a satisfactory agreement will be reached with CERN for significant U.S. participation in the LHC project. The funds would be used for test and fabrication equipment and R&D prototypes in support of the R&D activities described in the High Energy Technology section of this budget.
	$ 9,090	$ 9,256	$ 11,800
Brookhaven National Laboratory- General Purpose Equipment	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)	Provides general purpose equipment for the entire laboratory.
	$ 3,925	$ 3,925	$ 3,925
Capital Equipment	$ 60,100	$ 57,700	$ 63,230

DEPARTMENT OF ENERGY
FY 1996 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 1994 Adjusted	FY 1995 Adjusted	FY 1996 Request	$ Change
Construction....................................	$ 86,254	$ 109,736	$ 127,645	$ 17,909
Total, Construction	$ 86,254	$ 109,736	$ 127,645	$ 17,909

II. B. Laboratory and Facility Funding Table: Construction

	FY 1994 Adjusted	FY 1995 Adjusted	FY 1996 Request	$ Change
Brookhaven National Lab	$ 8,425	$ 8,225	$ 7,595	$ -630
Fermi National Accelerator Lab	34,935	52,720	62,440	9,720
Stanford Linear Accelerator Center	42,894	48,791	57,610	8,819
Total, Construction	$ 86,254	$ 109,736	$ 127,645	$ 17,909

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

Program Activity	FY 1994	FY 1995	FY 1996
Construction			
Construction	AIP funding was used to support continuing large need for modifications to maintain and improve the technical capability and operational efficiency of the accelerator complexes.	The level of effort for AIP is reduced relative to FY 1994, reflecting consideration of the laboratories changing needs.	The level of effort for AIP is reduced relative to FY 1995, reflecting consideration of the laboratories changing needs.
	GPP funding was used for small general purpose projects, e.g. roads, utilities, and environmental, safety, health and security needs.	GPP activity continues with about the same level of effort as in FY 1994.	The level of effort for GPP is increased relative to FY 1995 in order to provide for increased emphasis on ES&H concerns.
	The following paragraph describes FY 1994 activities supported by the Main Injector construction funding. Engineering design work on the civil construction was completed by mid-year. By year's end, about one quarter of the ring enclosure construction was complete, and beneficial occupancy of the largest service building was gained. About five percent of the dipole magnets were completely assembled and tested, and one of the nine 9000 ampere power supplies was completed. Fabrication work on most of the other major technical components began by the end of the fiscal year. At the end of FY 1994, the project was about 22% complete.	The following paragraph describes FY 1995 activities supported by the Main Injector construction funding. 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. 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.	The following paragraph describes FY 1996 activities supported by the Main Injector construction funding. Civil construction of the ring enclosure and service buildings will be completed and beneficial occupancy will be realized. Approximately 70% of the dipole magnets will be completed by the end of FY 1996, and the dipole power supplies, solid-state microwave drivers, 200-kW microwave amplifiers, magnet support stands, and ring vacuum pumps will all be in hand. By the end of FY 1996, about half of the technical components will be installed. The requested funding will provide for an additional 26% of the total project and at the end of FY 1996, the project will be about 60% complete.

III. Construction (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Construction (Cont'd)	The following paragraph describes FY 1994 activities supported by the B-factory construction funding. 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. At the end of FY 1994, the project will be about 15% complete.	The following paragraph describes FY 1995 activities supported by the B-factory construction funding. 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. 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.	The following paragraph describes FY 1996 activities supported by the B-factory construction funding. In FY 1996 most of the new magnets and vacuum system components for the high energy ring will be fabricated and installed, and all rf components will be in fabrication. Delivery and installation of magnets and vacuum elements for the low energy ring will also begin. The injector bypass beam lines and the system for extracting electrons from the linac, having been completed in FY 1995, will be tested in FY 1996, and all components will be completed for the positron extraction system and the beam lines connecting the bypass lines to the rings. The control system will be in final implementation and testing. At the end of FY 1996, the project will be about 65% complete.
	$ 86,254	$ 109,736	$ 127,645
Construction	$ 86,254	$ 109,736	$ 127,645

DEPARTMENT OF ENERGY
FY 1996 OMB BUDGET REQUEST
(Changes from FY 1995 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	TEC	Previous Appropriated	FY 1994 Appropriated	FY 1995 Appropriated	FY 1996 Request	Unappropriated Balance
GPE-103	General Plant Projects, Various Locations	$ ---	$ ---	$ 12,149	$ 12,146	$ 13,845	$ ---
96-G-301	Accelerator Improvements and Modifications, Various Locations	9,800	---	---	---	9,800	---
94-G-304	B-Factory, Stanford Linear Accelerator Center	177,000	---	36,000	44,000	52,000	45,000
92-G-302	Fermilab Main Injector, Fermilab	229,600	26,650	25,000	43,000	52,000	82,950
Subtotal Line Item Projects		406,600	26,650	61,000	87,000	104,000	127,950
Total, High Energy Physics		$ ---	$ ---	$ 73,149	$ 99,146	$127,645	$ ---

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: Project GPE-103 General Plant Projects Various locations — TEC: $13,845 TPC: $13,845

Start Date: 3rd. Qtr. FY 1996 Completion Date: 2nd Qtr. FY 1998

2. Financial Schedule (Federal Funds):

Fiscal Year	Appropriation	Obligations	Costs
1996	$13,845	$13,845	$4,465
1997	0	0	6,465
1998	0	0	2,915

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.

The FY 1996 General Plant Projects funding will also support high priority ES&H activities identified in the Department's ES&H Five Year Plan.

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	$ 6,015
Fermi National Accelerator Laboratory	4,260
Stanford Linear Accelerator Center	3,570
Total Estimated Cost...............	$13,845

4. Total Project Funding (BA):

	Prior Years	FY 1994	FY 1995	FY 1996 Request
Construction........................	XXXX	$12,149	$12,146	$13,845

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: Project 96-G-301 Accelerator Improvements and Modifications, Various Locations

TEC: $ 9,800
TPC: $ 9,800

Start Date: 3rd. Qtr. FY 1996 Completion Date: 2nd Qtr. FY 1998

2. Financial Schedule (Federal Funds):

Fiscal Year	Appropriation	Obligations	Costs
1996	$ 9,800	$ 9,800	$ 2,300
1997	0	0	4,530
1998	0	0	2,970

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	$ 1,580
Fermi National Accelerator Laboratory	6,180
Stanford Linear Accelerator Center	2,040
Total Estimated Cost...............	$ 9,800

4. Total Project Funding (BA):

	Prior Years	FY 1994	FY 1995	FY 1996
Construction........................	XXXX	$ 0	$ 0	$ 9,800

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: 1st. Qtr. FY 1994 — Completion Date: 4th Qtr. FY 1998

2. Financial Schedule (Federal Funds):

Fiscal Year	Appropriation	Obligations	Costs
1994	$ 36,000	$ 36,000	$ 13,385
1995	44,000	44,000	42,000
1996	52,000	52,000	50,000
1997	45,000	45,000	47,000
1998	0	0	24,615

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 1995 Request	FY 1996 Request	To Complete
Construction........................	$36,000	$44,000	$52,000	$45,000
Capital Equipment....................	1,900	8,500	19,000	38,500
Operating Expenses...................	24,900	5,200	4,800	13,400

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	27,318
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	15,855

3. Narrative: 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.

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 almost guarantee sufficient evidence to firmly establish the discovery at Fermilab of the top quark. (First evidence has recently been announced of discovery 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 1994	FY 1995 Request	FY 1996 Request	To Complete
Construction........................	$26,650	$25,000	$43,000	$52,000	$ 82,950
Capital Equipment...................	300	100	100	100	400
Operating Expenses..................	15,700	2,700	0	0	10,300

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.

DEPARTMENT OF ENERGY
FY 1996 CONGRESSIONAL BUDGET REVIEW BUDGET
(Changes from FY 1995 Congressional Budget Request are denoted with a vertical line in left margin.)

GENERAL SCIENCE AND RESEARCH - PLANT AND CAPITAL EQUIPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

HIGH ENERGY PHYSICS

1. Title and Location of Project: General plant projects
Various locations

2a. Project No.: GPE-103
2b. Construction Funded

3a. Date A-E Work Initiated: 2nd Qtr. FY 1996

3b. A-E Work Duration: Various

5. Previous Cost Estimate:
Total Estimated Cost (TEC) -- None
Total Project Cost (TPC) -- None

4a. Date Physical Construction Starts: 3rd Qtr. FY 1996

4. Date Construction Ends: 2nd Qtr. FY 1998

6. Current cost estimate:
TEC -- $13,845
TPC -- $13,845

7. Financial Schedule (Federal Funds):

Fiscal Year	Appropriations	Obligations	Costs
1996	$ 13,845	$ 13,845	$ 4,465
1997	0	0	6,465
1998	0	0	2,915

8. Brief Physical Description of Project

These projects provide for the many miscellaneous alterations, additions, modifications, replacements, and non-major construction required at Brookhaven National Laboratory the Fermi National Accelerator Laboratory and the Stanford Linear Accelerator Center facilities. The FY 1996 General Plant Projects funding will also support high priority ES&H activities identified in the Department's ES&H Five Year Plan.

1. Title and Location of Project: General plant projects Various locations	2a. Project No.: GPE-103 2b. Construction Funded

8. Brief Physical Description of Project (Continued)

The following are examples of the major items of work to be performed at the various locations:

Brookhaven National Laboratory		$ 6,015
Waste Crusher for Radioactive Material	$ 235	
Spray Shop Replacement - Building Maintenance Shop	400	
Ductbank for Fiber Optics Network	500	
Retrofit Existing R-12 Refrigeration Machines	600	
Sanitary System Extension North	310	
Inner Ring Power Supply Rooms	830	
Upgrade Old Theater Building for Science Museum	900	
Phase II Building Addition - Physics Department	680	
Storage Building - National Synchrotron Light Source	600	
Building 555 - Extension of Exhaust Stacks	450	
West Gate Lighting	30	
Apartment Area Electric Upgrades	250	
Alternate Power for Network and Telecommunication Equipment	100	
Brookhaven Center North Room Air Conditioning Installation	130	
Fermi National Accelerator Laboratory		$ 4,260
Storage Building for Flammable and Combustible Materials at Industrial Center	$ 120	
Life Safety Improvements for IB1-4	375	
FCC Insulation/Condensation Upgrade	360	
Monitoring Well Network	288	
New Muon Lab Refurbishment	870	
Class 2 Repair Facility	810	
Main Ring Service Building Electrical Compliance	85	
Antiproton Source Service Building Electrical Compliance	70	
WHFW Sprinkler Modifications	70	
IMAC Addition to Calibration Laboratory	264	
Wilson Hall West Entrance	708	
TV Group Laboratory	240	

1. Title and Location of Project:	General plant projects Various locations	2a. Project No.: GPE-103 2b. Construction Funded

8. Brief Physical Description of Project (Continued)

Stanford Linear Accelerator Center		$ 3,570
Fire Alarm Upgrades	$ 370	
Sitewide High Voltage Feeders	250	
Linac 480 Volt Panel Upgrades	500	
Disconnect Switches	310	
Roof Replacement - Central Laboratory Addition	250	
Roof Replacement - SLC City Office and PEP Region 8	420	
Chilled Water Plant Upgrade	1,100	
Gallery Pump Motor Control Center Switchboards	370	

9. Purpose, Justification of Need For, and Scope of Project

General plant 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 are short-term projects whose timely accomplishment is 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. Since it is difficult to detail the most urgently needed items in advance, a continuing evaluation of requirements and priorities may result in additions, deletions, and changes to the currently planned subprojects. No significant R&D program is anticipated as a prerequisite for design and construction of the subprojects under consideration.

The funds requested for FY 1996 are estimated as follows:

Brookhaven National Laboratory	$ 6,015
Fermi National Accelerator Laboratory	4,260
Stanford Linear Accelerator Center	3,570
Total line item cost	$13,845

Since needs and priorities may change, other subprojects may be substituted for those listed and some of these may be located on non-Government owned property.

1. Title and Location of Project: General plant projects Various locations	2a. Project No.: GPE-103 2b. Construction Funded

10. Details of Cost Estimate

See description, item 8. The estimated costs are preliminary and, in general, indicate the magnitude of each program. These costs include engineering, design and inspection.

11. Method of Performance

Design will be by contractor staff or on the basis of negotiated architect-engineer contracts. To the extent feasible, construction and procurement will be accomplished by firm fixed-price contracts and subcontracts on the basis of competitive bidding.

DEPARTMENT OF ENERGY
FY 1996 CONGRESSIONAL BUDGET REQUEST
(Changes from FY 1995 Congressional Budget Request are denoted with a vertical line in left margin.)

GENERAL SCIENCE AND RESEARCH - PLANT AND CAPITAL EQUIPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

HIGH ENERGY PHYSICS

1. Title and Location of Project: Accelerator improvements and modifications, Various Locations	2a. Project No.: 96-G-301 2b. Construction Funded
3a. Date A-E Work Initiated: 2nd Qtr. FY 1996 3b. A-E Work Duration: Various	5. Previous Cost Estimate: Total Estimated Cost (TEC): None Total Project Cost (TPC): None
4a. Date Physical Construction Starts: 3rd Qtr. FY 1996 4b. Date Construction Ends: 2nd Qtr. FY 1998	6. Current Cost Estimate: TEC -- $ 9,800 TPC -- $ 9,800

7. Financial Schedule (Federal Funds):

Fiscal Year	Appropriations	Obligations	Costs
1996	$ 9,800	$ 9,800	$ 2,300
1997	0	0	4,530
1998	0	0	2,970

8. Brief Physical Description of Project

This project provides 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 effectiveness of these facilities. In addition to the replacement of components for improved reliability and cost effectiveness of operation, it is often necessary to modify the facility to accommodate changes required by the research program. The funds requested, which represent less than 1 percent of the present value of the government's investment in these facilities, produce a large return in terms of more cost effective operation and greater research productivity.

1.	Title and Location of Project: Accelerator improvements and modifications, Various Locations	2a. Project No.: 96-G-301 2b. Construction Funded

8. Brief Physical Description of Project (Continued)

The following are examples of the major items of work to be performed at the various locations:

Brookhaven National Laboratory.. $1,580

Funds are requested for modifications, improvements, and additions to the Alternating Gradient Synchrotron (AGS) and its related experimental facilities. Items planned include: Booster power supply reactive stabilization, AGS ring equipment overhaul, and Linac-to-Booster (LTB) line beam position monitor (BPM) upgrade.

Fermi National Accelerator Laboratory...................................... $6,180

Funds requested are for modifications, improvements and additions to the Fermilab accelerator facilities (which include the linear accelerator, booster synchrotron, antiproton accumulator, debuncher rings, main ring, and superconducting Tevatron ring) and to the switchyard, beamlines, target facilities and experimental areas.

Modifications to the accelerator facilities are expected to include: Pbar Target Sweeping, Pbar Kicker and Septa Improvements, Accumulator Stacktail Upgrade, and Magnet Database Improvements.

Modifications to the experimental facilities are expected to include: New Beryllium Beampipe for CDF and D0, Replacement of P01 Pipe with Larger Diameter Pipe, and Experimental Areas Controls Upgrade.

Stanford Linear Accelerator Center (SLAC)................................. $2,040

Funds are requested for modifications, improvements and additions to the SLAC linear accelerator, the SLC colliding beam facilities, and to the associated experimental facilities. Items now planned for FY 1995 include: Replacement of Relay Controls in 245 Klystron Gallery Modulators, Linac Instrumentation and Control Upgrades, Personnel and Machine Protection, and Beam Containment Upgrades, Replacement of Blumlein by Cable Pulse Forming Networks in South Damping Ring Kicker System, Power Supply Interlock Upgrades, Beam Switchyard Vacuum Upgrade, and Positron Girder Upgrades.

1. Title and Location of Project: Accelerator improvements and modifications, Various Locations	2a. Project No.: 96-G-301 2b. Construction Funded

9. Purpose, Justification of Need For, and Scope of Project

Accelerator improvements are essential on an annual basis to maintain 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. Research advances and facility requirements in high energy physics occur at a rapid pace; further, each research facility is a unique assemblage of very specialized, high technology components. Consequently, there is a continuing need to modify facilities, frequently on a short time scale, in response to research needs and to respond to problems that can affect the reliability, efficiency and economy of operation on a time scale shorter than the normal two-year budget cycle. The requested accelerator improvements and modifications will provide greater flexibility for experimental setups, increased performance levels, and increased serviceability, thereby decreasing facility downtime, improving the productivity, scientific effectiveness and cost effectiveness of the U.S. program in High Energy Physics.

Since needs and priorities may change, other subprojects may be substituted for those listed. Some of these will be located on non-Government owned property.

10. Details of Cost Estimate

a. Engineering, design and inspection and component assembly and installation............	$ 9,800
Total line item cost..	$ 9,800

The estimated costs of the program at each laboratory are preliminary and, in general, indicate the magnitude of each program.

11. Method of Performance

Design will be primarily by contractor staff. To the extent feasible, construction and procurement will be accomplished by fixed-price subcontracts awarded on the basis of competitive bidding.

DEPARTMENT OF ENERGY
FY 1996 CONGRESSIONAL BUDGET REQUEST
(Changes from FY 1995 Congressional Budget Request are denoted with a vertical line in left margin.)

GENERAL SCIENCE AND RESEARCH
(Tabular dollars in thousands. Narrative material in whole dollars.)

HIGH ENERGY PHYSICS

1. Title and Location of Project: B-Factory
Stanford Linear Accelerator Center (SLAC)

2a. Project No.: 94-G-304
2b. Construction Funded

3a. Date A-E Work Initiated: 1st Qtr. FY 1994

3b. A-E Work (Titles I & II) Duration: 30 months

5. Previous cost estimate:
Total Estimated Cost (TEC) -- $177,000
Total Project Cost(TPC) -- $293,200

4a. Date Physical Construction Starts: 1st Qtr. FY 1994

4b. Date Construction Ends: 4th Qtr. FY 1998

6. Current cost estimate:
TEC -- $177,000
TPC -- $293,200

7. Financial Schedule

Fiscal Year	Appropriations	Obligations	Costs
1994	$ 36,000	$ 36,000	$ 13,385
1995	44,000	44,000	42,000
1996	52,000	52,000	50,000
1997	45,000	45,000	47,000
1998	0	0	24,615

8. Brief Physical Description of Project

The project involves the modification of the SLAC linac and Positron-Electron Project (PEP) storage ring to provide for collisions of 9-GeV electrons with 3-GeV positrons at high luminosity. The existing PEP ring will be upgraded and used for the electrons. A new, separate, lower energy ring for the positrons will be provided

8. Brief Physical Description of Project (Continued)

in the PEP tunnel. The two rings will intersect in one of the existing PEP interaction regions, where a particle detector will be installed. At the completion of the project it will be possible to accelerate electrons to 9 GeV and positrons to 3 GeV in the linac, inject them into the storage rings, bring them into collision at a luminosity in the range of 10^{33} $cm^{-2}s^{-1}$, and detect the products of the collisions.

Specifically provided for in the scope of the project are the following actions:

- o The linac, which can accelerate both electrons and positrons to 50 GeV over its full length of 2 miles, will be modified to permit the extraction of 9-GeV electrons and 3-GeV positrons at the appropriate points.
- o Two bypass lines, including appropriate magnetic optical elements, will be installed alongside the linac in the existing linac enclosure to permit the 9-GeV and 3-GeV extracted beams to be transported to the end of the linac.
- o The PEP storage ring, which has a circumference of 2.2 km, will be refurbished.
  - The existing PEP storage ring magnet system will be removed from the tunnel, refurbished for storing electrons at 9 GeV with increased luminosity, and reinstalled in the tunnel.
  - A new, 3-GeV positron storage ring will be constructed and installed in the PEP tunnel along with the electron storage ring.
  - The beam lines that now connect the linac to the PEP ring will be modified to allow electron and positron beams of different energies to be transported from the ends of the new bypass lines to the storage rings.
  - The existing PEP cooling water system and electrical power distribution system will be modified for the B-Factory.
  - New microwave power and control systems will be constructed for the storage rings.

The project requires no conventional construction. The project will be housed in the existing Linac and PEP ring enclosures.

9. Purpose, Justification of Need For, and Scope of Project

The primary purpose of this project is to provide a facility for observing colliding beams of electrons and positrons at a center-of-mass collision energy of 10 GeV to 11 GeV with sufficient luminosity, and with electrons and positrons having sufficiently different energies, to measure the extent to which charge/parity conservation is violated in the B meson system and thereby test the predictions of the Standard Model of particle physics in this important area. A second important purpose is to provide a facility for pursuing a

9. Purpose, Justification of Need For, and Scope of Project (Continued)

broad program of experimental studies of bottom quark, charm quark, tau lepton, and two-photon physics with large numbers of events and thus high precision. This broad-based program of experiments will directly confront a number of crucial questions about the Standard Model and, consequently, will provide possibly the best window to new physics understanding of any currently proposed facility.

Violation of charge/parity conservation, or CP violation, is a fundamental, symmetry-breaking process that is believed to be responsible for our very existence - without it the equal amounts of matter and antimatter that it is thought were formed at the origin of the universe might by now have come together and been annihilated. The Standard Model, which is the embodiment of our most basic understanding of particle physics, predicts that CP violation is manifested in significantly different decay rates for neutral B mesons and antimesons. Yet, because no existing accelerator can produce enough pairs of B mesons and antimesons to observe the effect, this important prediction has never been confronted with experimental data.

In the B-Factory, the collision energy and luminosity are optimized for copious production of B meson pairs, and the energy asymmetry of the electron and positron beams is chosen to optimize the detection of different decay rates for B mesons and antimesons. Execution of this project will permit the very important first experimental test of the Standard Model's explanation of CP violation.

While the primary goal of this project is to study CP violation experimentally as a means of testing the validity of the Standard Model, the B-Factory will also provide an opportunity to pursue a rich program of experiments in a large number of other areas of intense interest in high energy physics. For example, studies of rare decay modes of B mesons will be possible with unprecedented sensitivity, as will measurements of transitions in the bound $b^{-}b^{+}$ (quark-antiquark) system. Charmed mesons and baryons will be produced in abundance, and their decays can be studied in great detail. Copious production of tau/anti-tau pairs will permit a wealth of new and precise measurements of the tau system, including the tau lifetime and a substantial reduction in the upper limit on the tau-neutrino mass. Its high luminosity will also make the B-Factory an ideal place to study final states that can only be reached by two-photon exchange; for example, exotic meson states containing more than two quarks might be discovered. The impact of this broad experimental program will be an exceptionally broad and fundamental test of the validity of the Standard Model.

1. Title and Location of Project:	B-Factory Stanford Linear Accelerator Center (SLAC)	2a. Project No.: 94-G-304 2b. Construction Funded

9. Purpose, Justification of Need For, and Scope of Project (Continued)

A B-Factory was considered by and endorsed in 1990 and 1992 by HEPAP Subpanels on the U.S. High Energy Physics Research Program. A DOE Office of Energy Research Committee reviewed the present proposal in March 1991, and found it to be technically sound. The project was also reviewed by the Joint DOE and NSF B-Factory Review Committee in July 1993 as part of the B-Factory site selection process. The report indicated that the cost estimate is credible and that construction could begin in FY 1994.

10. Detail of Cost Estimate

	Item Cost	Total Cost
a. Design and Management Costs		$ 33,000
1. Engineering design and inspection at 26 percent of construction costs, Item c	$ 29,100	
2. Project Management at 3 percent of Construction Costs, Item c	3,900	
b. Land and land rights	0	
c. Construction Costs		111,000
1. Accelerator Facilities	106,200	
2. Utilities	4,800	
d. Contingencies at approximately 23 percent of above costs		33,000
e. Total line item cost (Section 12.a. 1. (a))		177,000
f. Non-Federal Contribution		0*
Net Federal line item cost		$177,000

* Non-Federal contribution: Discussions have taken place and are continuing between SLAC and a number of potential foreign collaborators in the detector part of the project. It is anticipated that substantial non-Federal contributions to the detector may be realized. When these have been definitized, the cost estimates will be revised accordingly to display the Federal share.

1. Title and Location of Project:	B-Factory Stanford Linear Accelerator Center (SLAC)	2a. Project No.: 94-G-304 2b. Construction Funded

11. Method of Performance

The B-Factory project is a collaboration of SLAC, Lawrence Berkeley Laboratory (LBL) and Lawrence Livermore National Laboratory (LLNL). It is possible that other laboratories (both U.S. and foreign) may join the project prior to construction especially in the detector area. Design of the technical components will be by the operating contractors, at this time SLAC, LBL, and LLNL. To the extent feasible, construction procurement and installation will be accomplished by fixed-price subcontracts awarded on the basis of competitive bidding.

12. Schedule of Project Funding and Other Related Funding Requirements

	Prior Years	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	TOTAL
a. Total project costs							
1. Total facility costs							
(a) Line Item..................	$ 0	$13,385	$42,000	$50,000	$47,000	$24,615	$177,000
2. Other project costs							
(a) R&D........................	19,700	5,200	5,200	4,800	0	0	34,900
(b) Pre-operations.............	0	0	0	0	1,300	11,200	12,500
(c) Capital Equipment for R&D..	100	800	0	0	0	0	900
(d) Detector (Capital Equip.)..	0	1,000	8,500	19,000	20,500	18,000	67,000
(e) Spares.....................	0	0	0	0	0	900	900
Total other project costs..	19,800	7,000	13,700	23,800	21,800	30,100	116,200
Total project cost.........	19,800	20,385	55,700	73,800	68,800	54,715	293,200
(f) Non-Federal contribution...	0	0	0	0	0	0	0
(g) Net Federal total project cost......................	$19,800	$20,385	$55,700	$73,800	$68,800	$54,715	$293,200

b. Related annual funding (estimated life of project = 20 years)

1. Power costs for B-Factory	$ 8,800
2. Other operating costs for B-Factory	18,500
Total annual funding (in FY 1998 dollars)	$27,300

1. Title and Location of Project:	B-Factory Stanford Linear Accelerator Center (SLAC)	2a. Project No.: 94-G-304 2b. Construction Funded

13. Narrative Explanation of Total Project Funding and Other Related Funding Requirements

a. Total project funding
1. Total facility costs
(a) Construction Line Item - explained in line items 8, 9, and 10.
2. Other project costs
(a) R&D Necessary to Complete: This will provide for the design and development of new components and for the fabrication and testing of prototypes. Includes R&D efforts at SLAC, LBL, LLNL, and for the detector, other potential collaborators. Significant foreign contributions are anticipated at the completion of discussions presently underway.
(b) Pre-operations: This will include costs for systems checkout, operator training, and a several month commissioning period.
(c) Capital Equipment: This will include test instruments and other general equipment to support the associated R&D.
(d) Detector: This includes capital equipment funds for the initial B-Factory detector. The estimates are preliminary, are based on a preliminary conceptual design, and are expected to change when a detailed detector design has been developed and agreed to. Significant foreign contributions are anticipated at the completion of discussions presently underway.
(e) Spares: Provides for spares of critical technical components with significant delivery times.
(f) Non-Federal contribution: Discussions have taken place and are continuing between SLAC and a number of potential foreign collaborators in the detector part of the project. It is anticipated that substantial non-Federal contributions to the detector may be realized. When these have been definitized, the cost estimates will be revised accordingly to display the Federal share.

b. Related annual funding

1. Includes power costs to operate the B-Factory.

2. Includes costs for operations staff, materials, supplies, etc., to operate the B-Factory.

We assume that when the B-Factory project construction is complete, the SLC based particle physics program will be discontinued. We estimate that when the B-Factory is operational, the overall operating costs at SLAC will be roughly the same as at present (inflation adjusted); therefore, no incremental annual funding is anticipated.

DEPARTMENT OF ENERGY
FY 1996 CONGRESSIONAL BUDGET REQUEST
(Changes from FY 1995 Congressional Budget Request are denoted with a vertical line in left margin.)

GENERAL SCIENCE AND RESEARCH - PLANT AND CAPITAL EQUIPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

HIGH ENERGY PHYSICS

1. Title and Location of Project: Fermilab Main Injector
Fermi National Accelerator Laboratory

2a. Project No.: 92-G-302
2b. Construction Funded

3a. Date A-E Work Initiated: 3rd Qtr. FY 1992

3b. A-E Work (Title I & Title II) Duration: 18 months

5. Previous Construction Estimate:
Total Estimated Cost (TEC) -- $229,600
Total Project Cost (TPC) -- $259,300

4a. Date Physical Construction Starts: 4th Qtr. FY 1992

4b. Date Construction Ends: 3rd Qtr. FY 1999

6. Current Cost Estimate:
TEC -- $229,600
TPC -- $259,300

7. Financial Schedule (Federal Funds):

Fiscal Year	Appropriations	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	27,318
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	15,855

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

1. Title and Location of Project: Fermilab Main Injector
Fermi National Accelerator Laboratory

2a. Project No.: 92-G-302
2b. Construction Funded

8. Brief Physical Description of Project

This project provides for the construction of a new accelerator, called the Fermilab Main Injector, which will replace the aging Fermilab Main Ring in all of its functions. It will provide particles for injection into the existing superconducting Tevatron accelerator, as well as for direct delivery to the existing fixed target experimental and test beam areas. The accelerator is 3.3 km in circumference and it is capable of accelerating either protons or antiprotons to 150 GeV. It employs conventional iron core magnets. Also provided are five new beam transport lines which connect the Main Injector into the existing Fermilab accelerator complex, transport 120 GeV proton beam to the fixed target experimental areas, and provide particle beams for the testing and calibration of SSC detector components and subsystems.

Many technical components will be recycled from the existing Main Ring, including quadrupole magnets, some power supplies and correction magnets, radiofrequency accelerating systems, controls system components, and diagnostic devices.

The Main Injector will be located in the southwest corner of the Fermilab site, and will be connected to the existing Tevatron ring enclosure at its F-Zero straight section.

Specifically provided for in the scope of the project are:

a. Construction of a 3.3 km ring enclosure with ancillary service buildings, and utilities; and the fabrication of new technical components including dipole magnets, high current power supplies, and vacuum systems.

b. Construction of beamline enclosures, service buildings, utilities, and technical components which are required to implement an 8 GeV Booster-to-Main Injector beamline, the 150 GeV proton and antiproton Main Injector-to-Tevatron transfer lines, and a 120 GeV Main Injector-to-Antiproton Production Target beamline.

c. Construction of the technical components required to implement the delivery of 120 GeV beam from the Main Injector to the existing external fixed target and test beam experimental areas, and the construction of a new sub-station and 345KV power lines for distribution of electrical power to the Main Injector location.

8. Brief Physical Description of Project (Continued)

d. Modifications to the Tevatron ring enclosure at the F-Zero straight section, for installation of the 150 GeV proton and antiproton transfer lines.

e. Refurbishment and reinstallation in the Main Injector ring enclosure of those technical components which will be reused from the old Main Ring accelerator.

9. Purpose, Justification of Need For, and Scope of Project

The primary purpose of this project is to greatly increase the Tevatron collider luminosity which can be delivered to the two existing collider detector experimental facilities at Fermilab. Fermilab is the only operational high energy physics facility in the world with sufficiently high energy to produce the top quark, which is the last unobserved (first evidence of discovery of the top quark has recently been announced) fundamental particle building block according to our current understanding of the basic structure of matter. Increasing the luminosity of the Fermilab proton-antiproton collider to as much as $5x10^{31}cm^{-2}sec^{-1}$ will almost guarantee sufficient evidence to firmly establish the discovery of the top quark at Fermilab, so long as its mass lies within the range defined by all known data. The project will also significantly increase the number of protons which can be injected into the Tevatron for subsequent acceleration to 800 GeV and then extraction into the existing fixed target and test beam experimental areas, will replace or refurbish the 20 year old components of the existing main ring accelerator, and will eliminate the significant operational problems resulting from the main ring in the same tunnel with the superconducting Tevatron. Other important purposes are to provide an expanded capability of 120 GeV proton beams which can be used for fixed target physics research.

Increasing the collider luminosity requires increasing both the numbers of protons and of antiprotons injected into the Tevatron. The substantial increases in injection intensities result from the large effective aperture of the Main Injector accelerator and from its high repetition rate capability. These are achieved through tight beam focussing, high magnetic field quality, and elimination of the two vertical overpasses which had to be installed in the Main Ring during the 1980's in order to provide the collider interaction regions. The Main Injector will be capable of accelerating an intense beam of protons to 120 GeV every 1.5 seconds for the purpose of antiproton production, as compared to a 2.4 second cycle for the present Main Ring. The beam intensity which can be injected into the Tevatron by the Main Injector will approach 6×10^{13} protons each 60 second cycle, which is about two times greater than could be achieved with the old Main Ring. The Tevatron antiproton-proton colliding beam

1. Title and Location of Project: Fermilab Main Injector Fermi National Accelerator Laboratory	2a. Project No.: 92-G-302 2b. Construction Funded

9. Purpose, Justification of Need For, and Scope of Project (Continued)

luminosity will be increased to about 5×10^{31} $cm^{-2}sec^{-1}$, which is five times greater than can be achieved using the Main Ring as injector. These performance goals are expected to be achieved after months of operational experience with the new accelerator.

10. Details of Cost Estimate*

	Item Cost	Total Cost
a. Engineering Design Inspection and assembly at 16 percent of construction costs..................		$ 26,300
b. Main Injector construction costs..................		165,000
1. Conventional construction..................	$ 79,200	
2. Special facilities..................	85,800	
c. Contingencies at 20 percent of above costs..................		38,300
Total line item cost..................		$229,600

* The annual escalation rates assumed for FY 1994 through FY 1998 are 3.3, 3.6, 3.7, 3.7, and 3.6 percent respectively.

11. Method of Performance

Design of facilities will be by the operating contractor and subcontractors as appropriate. To the extent feasible, construction and procurement will be accomplished by fixed-price contracts awarded on the basis of competitive bids.

1. Title and Location of Project: Fermilab Main Injector
Fermi National Accelerator Laboratory

2a. Project No.: 92-G-302
2b. Construction Funded

12. Schedule of Project Funding and Other Related Funding Requirements

a. Total project funding	Prior Year	FY 1992	FY 1993	FY 1994	FY 1995
1. Total facility costs					
(a) Line item..................	$ 0	$ 990	$ 9,937	$27,318	$38,800
	$ 0	$ 990	$ 9,937	$27,318	$38,800
2. Other project costs					
(a) R&D costs necessary to complete construction.......	$ 5,400	$ 4,300	$ 6,000	$ 2,700	$ 0
(b) Pre-operating costs..........	0	0	0	0	0
(c) Capital equipment............	0	200	100	100	100
(d) Inventories and Spares.......	0	0	0	0	0
Total other project costs	5,400	4,500	6,100	2,800	100
Total project costs	$ 5,400	$ 5,490	$16,037	$30,118	$38,900

a. Total project funding (cont.)	FY 1996	FY 1997	FY 1998	FY 1999	Total
1. Total facility costs					
(a) Line item..................	$48,400	$52,000	$36,300	$15,855	$229,600
	$48,400	$52,000	$36,300	$15,855	$229,600
2. Other project costs					
(a) R&D costs necessary to complete construction.......	$ 0	$ 0	$ 0	$ 0	$ 18,400
(b) Pre-operating costs..........	0	0	2,000	0	2,000
(c) Capital equipment............	100	200	200	0	1,000
(d) Inventories and Spares.......	0	2,600	5,700	0	8,300
Total other project costs	100	2,800	7,900	0	29,700
Total project costs	$48,500	$54,800	$44,200	$ 15,855	$259,300

b. Related annual funding (estimated life of project: 20 years)

1. Power costs for Main Injector test beam operations	$5,800
2. Experimental areas operating costs for test beams	1,300
Total incremental annual funding (in FY 1997 dollars)	$7,100

1. Title and Location of Project:	Fermilab Main Injector Fermi National Accelerator Laboratory	2a. Project No.: 92-G-302 2b. Construction Funded

13. Narrative Explanation of Total Project Funding and Other Related Funding Requirements

a. Total project funding
   1. Total facility cost
      (a) Line item - explained in items 8,9,10

   2. Other project costs
      (a) Direct R&D operating costs - This will provide for the design and development of new components and for the fabrication and testing of prototypes. R&D on all elements of the project, in order to optimize performance and minimize costs, is concentrated in the early years. Specifically included are the development of the high current dipole magnets and associated power supplies. A small number of Main Injector dipole magnets and power supplies will be fabricated and tested using R&D operating funds.
      (b) Pre-operating costs - Includes personnel and power costs for a 6 month commissioning period.
      (c) Spares and inventories - Provides for special process spares for the major technical components, primarily magnets and power supplies, and for an increase in common use inventories for Main Injector related items.
      (d) Capital equipment - Includes test instruments, electronics, and other general equipment to support 12.a.1 and 12.a.2.a.

b. Total incremental funding requirements - We assume that the Fermilab Tevatron complex will continue both its fixed target and its colliding beam research programs, with each running about 40% of the time on the average. The Main Injector replaces the present Main Ring in all of its functional roles, and it is designed to require about the same amount of power to operate for those purposes. The new Main Injector capability for test beam operations simultaneously with Tevatron operations for physics research will require an average increase in power plus other operating costs by about $7.1M annually. The operating costs in 12.b reflect the incremental demands of delivering 120 GeV protons to the test beam areas during Tevatron colliding beam and fixed target operating periods for physics research.