HIGH ENERGY PHYSICS

PROGRAM MISSION

The High Energy Physics (HEP) program is a major component of the Department's fundamental research mission. It 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. Fundamental research provides the necessary foundation that ultimately enables the Nation to progress in its science and technology capabilities, to advance its industrial competitiveness, and to discover new and innovative approaches to our energy future.

The GOAL of the HEP program is to:

Provide new insights into the nature of energy and matter to better understand the natural world.

The OBJECTIVES related to this goal are:

1. TO CONTINUE TO SUPPORT HIGH QUALITY RESEARCH - Support high quality university and laboratory based high energy physics research, both theoretical and experimental. Experimental research in HEP is primarily performed by university scientists using particle accelerators located at major laboratories in the U.S. and abroad.

2. TO EFFECTIVELY OPERATE THE DEPARTMENT'S HIGH ENERGY PHYSICS ACCELERATOR FACILITIES - Provide optimal and cost effective operation of the Fermi National Accelerator Laboratory, the Stanford Linear Accelerator Center, and the Alternating Gradient Synchrotron complex at the Brookhaven National Laboratory.

3. TO CONTINUE TO PROVIDE WORLD CLASS RESEARCH FACILITIES - Plan for and build new, state-of-the-art research facilities that allow researchers to advance the forefront of the science of high energy physics. Support essential improvements and upgrades at the major accelerator laboratories. Manage the completion of the Fermilab Main Injector project, the commissioning of the B-factory at SLAC and the design work for a new experimental facility at Fermilab called Neutrinos at the Main Injector (NuMI).

PROGRAM MISSION - HIGH ENERGY PHYSICS (Cont'd)

4. TO CONTINUE TO PROVIDE THE PROGRAM'S TECHNOLOGICAL BASE - Support long-range accelerator and detector R&D in order to develop the advanced concepts and technologies which are critical to the long-range viability of high energy physics research.

5. TO CONTINUE TO PURSUE INTERNATIONAL COLLABORATION ON LARGE HIGH ENERGY PHYSICS PROJECTS - Continue to champion U.S. participation in the Large Hadron Collider (LHC) program at CERN. Recommend and defend funding for U.S. participation on the LHC project as recommended by the High Energy Physics Advisory Panel's "Subpanel on the Vision for the Future of High Energy Physics" Subpanel. Negotiations with CERN leading to a formal agreement on U.S. participation in the LHC accelerator and major detector projects are expected to be completed early in 1997.

SCIENTIFIC FACILITIES UTILIZATION:

The High Energy Physics request includes $421,290,000 to maintain support of the Department's scientific user facilities. This investment will provide significant research time for thousands of scientists in universities, and other Federal laboratories. It will also leverage both Federally and privately sponsored research, consistent with the Administration's strategy for enhancing the U.S. National science investment. This level supports users at FY 1997 levels. The proposed funding will support operations at all three of the Department's major high energy physics facilities: the Tevatron at Fermilab, the Stanford Linear Collider at SLAC, and the Alternating Gradient Synchrotron at BNL.

PERFORMANCE MEASURES:

Performance measures related to basic science activities are primarily qualitative rather than quantitative. The scientific excellence of the HEP program is continually reevaluated through the peer review process. Some specific performance measures are:

1. Quality of scientific results and plans as indicated by expert advisory committees, peer reviews of the research, sustained progress, recognition by the scientific community, and awards received by DOE-supported HEP researchers. The results of these reviews and other quality measures will be used to determine programmatic decisions aimed at maintaining the world leadership position of the U.S. high energy physics program.

2. Sustained achievement in advancing knowledge, as measured by the quantity and quality of research results published in refereed scientific journals, and by the degree of invited participation at national and international conferences and workshops.

PROGRAM MISSION - HIGH ENERGY PHYSICS (Cont'd)

3. Operation of research facilities in a manner that meets user requirements, as indicated by achieving performance specifications while protecting the safety of the workers and the environment, and by the level of endorsement by user organizations; operating facilities that are used for research at the forefront of science; operating facilities reliably and according to planned schedules; and maintaining and improving facilities at reasonable costs.

4. Progress on the Fermilab Main Injector Project as measured by accomplishment of scheduled milestones; luminosity and operational efficiency achieved in B-factory commissioning measured by comparison with stated project goals.

SIGNIFICANT ACCOMPLISHMENTS AND PROGRAM SHIFTS:

1. Discovery and verification, by a team of university and laboratory scientists working at Fermilab, of the top quark. This is the last, and by far the heaviest, of the fundamental building blocks of matter (quarks) whose existence was predicted by the Standard Model of elementary particles.

2. Measurement, by a team of university and laboratory scientists working at Fermilab, of the mass and production properties of the recently discovered top quark.

3. Fermilab continues to increase the beam intensity delivered from the Tevatron to the fixed target area reaching a new world record of 2.5×10^{13} protons per beam pulse.

4. The world's most precise measurement, by a team of university and laboratory scientists working at Fermilab, of the mass of the W boson.

5. The world's highest precision single measurement was made, by a group of university and laboratory scientists working at SLAC, of the weak mixing angle, a fundamental parameter of the Standard Model.

6. A collaboration of university scientists working at the observatory at Mt. Hopkins in Arizona observed, for the first time, gamma rays coming from active galactic nuclei with energies in excess of 1 TeV.

7. A major advance in theoretical physics was achieved when it was shown and verified that all of the known "string" theories are equivalent. This greatly reduces the number of possible theories which describe all of the known forces including gravity.

PROGRAM MISSION - HIGH ENERGY PHYSICS (Cont'd)

8. Production for the first time, at Fermilab, of anti-hydrogen atoms. These consist of an anti-proton and an anti-electron (positron).

9. The final data collection with the Stanford Large Detector will occur during FY 1998 and the prime focus of the SLAC program will turn to research with the B-factory.

10. The Fermilab Main Injector Project is proceeding well and is within the planned cost and schedule profiles. All relevant milestones have been met. At the end of FY 1998 the construction phase of the project will be nearly complete and commissioning will be about to start.

11. The C-Zero Experimental Hall project at Fermilab will provide a new underground experimental area at the C-Zero location on the Tevatron ring. This will provide space for a new program of fixed target and modest sized collider experiments now being planned at Fermilab.

12. The B-factory Project at SLAC is proceeding well and is within the planned cost and schedule profiles. All relevant milestones have been met. At the end of FY 1998 the project will be complete and commissioning will be underway.

13. Waste Management activities at Fermilab and SLAC are included as a new (beginning in FY 1998) responsibility transferred from the Environmental Management (EM) program. Funding in the amount of $4,960,000 is included in the Facility Operations subprogram as a transfer from the EM budget. The Department has initiated a pilot program intended to evaluate opportunities to reduce the volume of newly generated waste and its associated management and disposal costs resulting from Departmental mission activities. Beginning in FY 1998, the Department will implement the Pilot Waste Management Re-Engineering Program at a limited number of sites, at which the responsibility for the newly generated waste management programs will be transferred from the Office of Environmental Management to the generating program. Throughout the implementation of the FY 1998 pilot, the regulatory accountability will remain with the program that currently holds the regulatory permits. In addition, the Office of Environmental Management will be responsible for any unavoidable funding shortfalls due to underestimates for FY 1998 waste generation.

    The Department expects that this re-engineered waste management structure will result in increased awareness on the waste generating organizations' part, thereby creating a financial incentive to minimize waste generation. Waste generating programs will be able to clearly track the true cost of their waste generation, as well as incorporate the associated costs within the formulation of the outyear budgets. To the extent that the programs minimize waste generation, the savings will be available to support increased mission activity. The impacts of this pilot arrangement will be carefully evaluated throughout FY 1998, and will provide the basis of the Administration's decision regarding the continuation and/or expansion of the effort in FY 1999 and beyond. The Pilot Waste Management Re-Engineering Program was initiated in response to several recommendations received from several Departmental stakeholders, including the National Academy of Sciences and the Environmental Management Advisory Board.

PROGRAM MISSION - HIGH ENERGY PHYSICS (Cont'd)

14. Large Hadron Collider (LHC) at CERN

The European Center for Nuclear Research (CERN) in Geneva, Switzerland has initiated the Large Hadron Collider (LHC) project. This will consist of a 7 on 7 TeV proton-proton colliding beams facility to be constructed in the existing Large Electron-Positron Collider (LEP) machine tunnel (LEP will be removed). The LHC will have an energy 7 times that of the Tevatron at Fermilab. Thus the LHC will open up substantial new frontiers for scientific discovery.

Participation by the U.S. in the LHC program is extremely important to U.S. High Energy Physics program goals. The LHC will become the foremost high energy physics research facility in the world around the middle of the next decade. With the LHC at the next energy frontier, American scientific research on that frontier depends on participation in LHC. The HEPAP Subpanel on Vision for the Future of High-Energy Physics (Drell) strongly endorsed participation in the LHC, and this endorsement has been restated by HEPAP on several occasions.

The physics goals of the LHC are outstanding; they include a search for the origin of mass as represented by the "Higgs" particle, exploration in detail of the structure and interactions of the top quark, and the search for totally unanticipated new phenomena. Although LHC will have a lower energy than the SSC (cancelled in 1993), it has strong potential for answering the question of the origin of mass. The LHC energies are sufficient to test theoretical arguments for a totally new type of matter. In addition, history shows that major increases in the energy provided nearly always yield unexpected discoveries.

DOE and NSF are negotiating with CERN about contributions to the LHC accelerator and detectors as part of the U.S. participation in the LHC program to provide access for U.S. scientists to the next decade's premier high energy physics facility. The Director of the Office of Energy Research and other U.S. representatives met with the Director-General of CERN in January 1996 to begin negotiations. The Administration anticipates signing the agreement in the summer of 1997.

Participation in the LHC project (accelerator and detectors) at CERN will primarily take the form of the U.S. accepting responsibility for designing and fabricating particular subsystems of the accelerator and of the two large detectors. Thus, much of the funding will go to U.S. laboratories, university groups, and industry for fabrication of subsystems and components which will become part of the LHC accelerator or detectors. A portion of the funds will be used to pay for purchases by CERN of material needed for construction of the accelerator. As a result of the negotiations CERN has agreed to make these purchases from U.S. vendors.

PROGRAM MISSION - HIGH ENERGY PHYSICS (Cont'd)

Preliminary agreement has been reached for a U.S. DOE contribution of $450,000,000 to the LHC accelerator and detectors over the period FY 1996 through FY 2004 (With approximately $80,000,000 being planned by the NSF). The DOE contribution is tentatively broken down as follows: detectors $250,000,000; accelerator $200,000,000 (including $90,000,000 for direct purchases by CERN from U.S. vendors and $110,000,000 for fabrication of components by U.S. laboratories).

The total cost of the LHC on a basis comparable to that used for U.S. projects is estimated at about $6,000,000,000. Thus the U.S. contribution represents less than 10% of the total. (The LHC cost estimates prepared by CERN, in general, do not include the cost of permanent laboratory staff and other laboratory resources used to construct the project). Neither the proposed U.S. $450,000,000 contribution nor the estimated total cost of $6,000,000,000 include support for the European and U.S. research physicists working on the LHC program.

The agreement being negotiated with CERN will provide for U.S. involvement in the management of the project through participation in key management committees (CERN Council, CERN Committee of Council, LHC Board, etc.). This will provide an effective base from which to monitor the progress of the project, and will help ensure that U.S. scientists have full access to the physics opportunities available at the LHC. The Office of Energy Research has conducted a cost and schedule review of the entire LHC project and similar reviews of the several proposed U.S. funded components of the LHC. All of these reviews concluded the costs are properly estimated and that the schedule is feasible.

In addition to the proposed U.S. DOE $450,000,000 contribution to the LHC accelerator and detector hardware fabrication, U.S. participation in the LHC will involve a significant portion of the U.S. High Energy Physics community in the research program at the LHC. This physicist involvement has already begun. Over 500 U.S. scientists have joined the U.S.-ATLAS detector collaboration, the U.S.-CMS detector collaboration, or the U.S.-LHC accelerator consortium, and are hard at work helping to design the initial physics research program to be carried out at the LHC and helping to design the planned physics capabilities of the LHC accelerator and detectors.

Fabrication of LHC subsystems and components by U.S. participants will begin in FY 1998. Funding was provided in FY 1996 ($6,000,000) and FY 1997 ($15,000,000) for preliminary R&D, design and engineering work on the subsystems and components being proposed for inclusion in the agreement with CERN. This funding was essential in order to provide the cost and technical bases for the proposed U.S. responsibilities in LHC, and to be ready for rapid start to satisfy the anticipated timetable for the project. Funding in the amount of $35,000,000 is being requested for FY 1998 to support continuation of these R&D and design efforts, and the initiation of fabrication of those subsystems and components which will be provided for under the anticipated agreement with CERN. The remaining $394,000,000 is being requested as an advance appropriation, with $65,000,000 available in FY 1999; $70,000,000 available in FY 2000; $70,000,000 available in FY 2001; $70,000,000 available in FY 2002; $65,000,000 available in FY 2003; and $54,000,000 available in FY 2004. This advance appropriation affirms the Administration's commitment to the U.S. contribution to the LHC project and caps the level of the total DOE contribution to LHC component fabrication at $450,000,000. While limiting U.S.

liability for any future project over runs, the advance appropriation facilitates effective project management. The inherent funding stability this provides is viewed by the administration as a pilot for possible future large scale international collaborative projects and thus is expected to enhance international collaboration.

The proposed U.S. funding for the LHC project is summarized below.

U.S. LHC ACCELERATOR AND DETECTOR FUNDING
(Dollars in thousands)

	US Contribution	FY 1996*	FY 1997*	FY 1998	FY 1999	FY 2000	FY 2001
Accelerator	$200,000**	$ 2,000	$ 6,700	$ 15,600	$ 29,000	$ 31,200	$ 31,200
Detector	$250,000	$ 4,000	$ 8,300	$ 19,400	$ 36,000	$ 38,800	$ 38,800
Total DOE	$450,000	$ 6,000	$ 15,000	$ 35,000	$ 65,000	$ 70,000	$ 70,000
NSF***	$ 80,000	The annual profile for the anticipated NSF funding is not available at this time.					

	FY 2002	FY 2003	FY 2004
Accelerator	$ 31,200	$ 29,000	$ 24,100
Detector	$ 38,800	$ 36,000	$ 29,900
Total DOE	$ 70,000	$ 65,000	$ 54,000

This estimated annual funding profile is based on the needs of the LHC project and is consistent with flat out year funding for the HEP program. The profile is subject to change as additional planning detail is derived. The total of $450,000,000 from DOE for the project is firm.

* The FY 1996 and FY 1997 funding was for R&D, design and engineering work in support of the proposed U.S. participation in LHC.

** Includes $110,000,000 for LHC accelerator components to be fabricated by U.S. laboratories and supporting R&D and $90,000,000 for purchases by CERN from U.S. vendors.

*** The NSF funding is estimated and is awaiting approval by the National Science Board.

HIGH ENERGY PHYSICS

PROGRAM FUNDING PROFILE

(Dollars in thousands)

Subprogram	FY 1996 Enacted Appropriation	FY 1997 Original Appropriation	FY 1997 Adjustments	FY 1997 Current Appropriation	FY 1998 Budget Request
Physics Research	$141;000	$0	$0	$0	$0
High Energy Technology	63,476	0	0	0	0
Research and Technology	0	210,000	0	210,000	205,240
Facility Operations	347,927	360,075	0	360,075	418,945 a/
Subtotal	552,403	570,075	0	570,075	624,185
Construction	104,000	100,000	0	100,000	50,850
Subtotal, High Energy Physics	656,403	670,075	0	670,075	
Adjustment	0	0	0	0	
TOTAL, HEP	$656,403 b/	$670,075	$0	$670,075	

a/ Includes $4,960,000 in FY 1998 for Waste Management activities at Fermilab and SLAC which was previously budgeted in FY 1996 and FY 1997 by the Environmental Management Program.

b/ Excludes $9,532,000 which was transferred to the SBIR program and $715,000 which was transferred to the STTR program.

Public Law Authorization:

Pub. Law 95-91, DOE Organization Act

HIGH ENERGY PHYSICS

(Dollars in thousands)

PROGRAM FUNDING BY SITE

Field Offices/Sites	FY 1996 Current Appropriation	FY 1997 Original Appropriation	FY 1997 Adjustments	FY 1997 Current Appropriation	FY 1998 Request
Albuquerque Operations Office					
Los Alamos National Laboratory	$916	$725	$0	$725	$736
Chicago Operations Office					
Argonne National Laboratory	8,930	8,669	0	8,669	8,525
Brookhaven National Laboratory	75,325	72,704	0	72,704	71,765
Fermi National Accelerator Laboratory	260,270	260,811	0	260,811	264,341
Oakland Operations Office					
Lawrence Berkeley National Laboratory	25,487	22,504	0	22,504	21,100
Lawrence Livermore National Laboratory	1,836	380	0	380	388
Stanford Linear Accelerator Center	169,008	170,934	0	170,934	140,994
Oak Ridge Operations Office					
Thomas Jefferson National Accelerator Facility	230	0	0	0	0
Oak Ridge National Laboratory	342	335	0	335	342
Richland Operations Office					
Pacific Northwest Laboratory	45	0	0	0	0
All Other Sites a/	114,014	133,013	0	133,013	166,844
Subtotal	656,403	670,075	0	670,075	675,035
Adjustment	0	0	0	0	0
TOTAL	$656,403	$670,075	$0	$670,075	$675,035

a/ Funding provided to universities, industry, other federal agencies and other miscellaneous contractors.

HIGH ENERGY PHYSICS

PHYSICS RESEARCH

(Tabular dollars in thousands, narrative in whole dollars)

I. **Mission Supporting Goals and Objectives:** Beginning in FY 1997, Physics Research is funded as an activity under the new Research and Technology subprogram consistent with FY 1997 Congressional direction. The Physics Research subprogram 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 studies 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 publication of results. Theoretical physics research provides the framework for interpreting and understanding observed phenomena and, through predictions and extrapolations based on current understanding, identifies key questions for future experimental explorations. This subprogram supports research groups at more than 100 major universities and at 8 DOE laboratories.

II. **Funding Schedule:**

Program Activity	FY 1996	FY 1997	FY 1998	Change	% Change
Fermilab	$ 10,344	$ 0	$ 0	$0	0
SLAC	10,542	0	0	0	0
BNL	7,922	0	0	0	0
LBNL	10,265	0	0	0	0
ANL	5,715	0	0	0	0
Universities and Other Laboratories	96,212	0	0	0	0
Total	$ 141,000	$0	$0	$ 0	0

III. Performance Summary- Accomplishments

	FY 1996	FY 1997	FY 1998
Fermilab—Provided support primarily for Fermilab research physicists working on CDF, D-Zero, and several fixed target experiments, on the CMS detector for LHC, on particle astrophysics experiments, and on theoretical analyses.	$ 10,344	$ 0	$ 0
SLAC—Provided support primarily for SLAC research physicists working on the B-factory, on the SLD at SLC, on the Beijing Electron Synchrotron detector at the accelerator in Beijing, China, on fixed target experiments at SLAC, and on theoretical analyses.	10,542	0	0
BNL—Provided support primarily for BNL research physicists working on the high priority Rare k-decay experiments at the AGS at BNL, on the D-Zero detector at Fermilab, on the experiment to make a precision measurement of the muon's magnetic properties, on the Atlas detector for LHC, and on theoretical analyses.	7,922	0	0
LBNL—Provided support primarily for LBNL research physicists working on the CDF and D-Zero detectors at Fermilab, on the BaBar detector for the B-factory at SLAC, on the Atlas detector for the LHC, on the SLD at the SLC at SLAC, on an underground experiment to search for cosmic dark matter, and on theoretical analyses. Also provided for the Particle Data Group which serves as a clearing house and archivist for data on elementary particles.	10,265	0	0
ANL—Provided support primarily for ANL research physicists working on the CDF detector at Fermilab, on the ZEUS detector at DESY, on the underground Soudan-2 detector, on the MINOS detector for the planned NuMI project at Fermilab, and on theoretical analyses.	5,715	0	0
Universities and Other Laboratories—Provided support for research physicists at over 100 U.S. universities working at all of the U.S. and at many foreign accelerator laboratories, on a number of non-accelerator experiments, and performing theoretical analyses. Provided support for similar research scientists at LANL, ORNL, and PNL.	96,212	0	0
TOTAL PHYSICS RESEARCH	$141,000	$0	$0

HIGH ENERGY PHYSICS

HIGH ENERGY TECHNOLOGY

(Tabular dollars in thousands, narrative in whole dollars)

I. **Mission Supporting Goals and Objectives:** Beginning in FY 1997, High Energy Technology is funded as an Activity under the new Research and Technology subprogram consistent with FY 1997 Congressional direction. The High Energy Technology subprogram provides the specialized advanced technology R&D required to sustain and extend the technology base and provide operational support for the highly specialized accelerators, colliding beams facilities, and detector facilities which are essential to the overall high energy physics program goal of carrying out forefront research. The objectives of this subprogram include: 1) carry out R&D in support of existing accelerator and detector facilities aimed at maintaining and improving their performance parameters and cost effectiveness; 2) carry out R&D in support of planned and proposed projects to maximize their performance goals and cost effectiveness; 3) carry out R&D to transfer new concepts and technologies into practical application in the HEP context; and 4) carry out R&D to search for and develop new concepts and ideas which could lead to significant enhancements of research capabilities or to significant cost savings in the construction and operation of new facilities. This subprogram supports work primarily at the DOE labs, but also at universities, other federal labs, and in industry.

In FY 1996 the High Energy Technology subprogram included funding for a major portion of the LHC related R&D effort; the other FY 1996 LHC funds were provided as capital equipment in the Facility Operations subprogram. In FY 1997 this was continued in the High Energy Physics Technology activity in the Research and Technology subprogram. Beginning in FY 1998, when fabrication by U.S. groups of LHC hardware components begins, all of the LHC project funding is budgeted as a separate LHC activity in the Facility Operations subprogram. This provides improved visibility of LHC component funding and will simplify DOE management by consolidating all funding in a single subprogram. For clarity, the details of LHC funding for FY 1996-FY 1998 are displayed in a table entitled "LHC Accelerator and Detector Funding" displayed within the Facility Operations subprogram presentation later in this budget.

II. Funding Schedule:

Program Activity	FY 1996	FY 1997	FY 1998	Change	% Change
Fermilab	$ 13,925	$ 0	$ 0	$0	0
SLAC	15,255	0	0	0	0
BNL	6,433	0	0	0	0
LBNL	9,828	0	0	0	0
LHC	5,221	0	0	0	0
Universities, Other Laboratories and Other	12,814	0	0	0	0
Total	$ 63,476	$ 0	$ 0	$ 0	0

III. Performance Summary- Accomplishments

	FY 1996	FY 1997	FY 1998
Fermilab—Provided support primarily for technology R&D in support of the Fermilab Main Injector project, for technology R&D aimed at improving the performance and reliability of the Fermilab accelerator complex and the detectors used in Fermilab research program, and for technology R&D of general benefit to the HEP program.	$ 13,925	$ 0	$ 0
SLAC—Provided support primarily for technology R&D in support of the B-factory project and the BaBar detectors, for technology R&D aimed at improving the performance and reliability of the SLC and the other parts of the SLAC accelerator complex. Also provides for R&D in key technical areas related to a possible future large linear collider project, and for technology R&D of general benefit to the HEP program.	15,255	0	0
BNL—Provided support primarily for technology R&D in support of the AGS and the AGS experimental program, for a program of experiment exploring novel accelerator techniques using the Accelerator Test Facility, R&D aimed at developing an operational free electron laser, and for technology R&D of general benefit to the HEP program.	6,433	0	0

HIGH ENERGY TECHNOLOGY (Cont'd)	FY 1996	FY 1997	FY 1998
LBNL—Provided support primarily for technology R&D in the areas of superconducting magnets for accelerators, high performance RF power systems, plasma lenses using the accelerator R&D beam at the Advanced Light Source, R&D in support of the joint SLAC/LBNL/LLNL B-factory project, and for technology R&D of general benefit to the HEP program.	9,828	0	0
Large Hadron Collider—Provides support for the R&D and planning necessary to provide an informed basis on which to negotiate an agreement with CERN relative to U.S. participation in the LHC Project. In FY 1996, an additional $779,000 was budgeted as capital equipment under the Facility Operations subprogram. Beginning in FY 1998, when fabrication of LHC subsystems and components will begin, all LHC funds for component fabrication are budgeted under the Facility Operations subprogram.	5,221	0	0
Universities, Other Laboratories, and Other Contractors—Provided support for relevant, high priority technology R&D at universities, other DOE laboratories, and in private industry. Areas being studied included improved superconductor, laser, and collective effect accelerator techniques, non-linear dynamics and theoretical studies.	12,814	0	0
SBIR/STTR - In FY 1996 $4,632,000 and $715,000 were transferred to the SBIR and STTR programs respectively.	0	0	0
TOTAL HIGH ENERGY TECHNOLOGY	$ 63,476	$ 0	$ 0

HIGH ENERGY PHYSICS

RESEARCH AND TECHNOLOGY

(Tabular dollars in thousands, narrative in whole dollars)

I. **Mission Supporting Goals and Objectives:** The High Energy Physics Program has two major subprograms. The Research and Technology subprogram provides support for the scientists who perform the research and technology R&D which is the core of the Program. The Facility Operations subprogram, described later, provides the large facilities - accelerators, detectors, etc. - needed for the research program.

The Physics Research activity in the Research and Technology subprogram 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 publication of results. Theoretical physics research provides the framework for interpreting and understanding observed phenomena and, through predictions and extrapolations based on current understanding, identifies key questions for future experimental explorations. This subprogram supports research groups at more than 100 major universities and at 8 DOE laboratories. In FY 1996 and prior years, this activity was funded as a separate Physics Research subprogram.

The High Energy Technology activity in the Research and Technology subprogram provides the specialized advanced technology R&D required to sustain and extend the technology base and provide operational support for the highly specialized accelerators, colliding beams facilities, and detector facilities which are essential to the overall high energy physics program goal of carrying out forefront research. The objectives of this activity include: 1) carry out R&D in support of existing accelerator and detector facilities aimed at maintaining and improving their performance parameters and cost effectiveness; 2) carry out R&D in support of planned and proposed projects to maximize their performance goals and cost effectiveness; 3) carry out R&D to transfer new concepts and technologies into practical application in the HEP context; and 4) carry out R&D to search for and develop new concepts and ideas which could lead to significant enhancements of research capabilities or to significant cost savings in the construction and operation of new facilities. This activity supports work primarily at the DOE labs, but also at universities, other federal labs, and in industry. In FY 1996 and prior years, this activity was funded as a separate High Energy Technology subprogram.

In FY 1997, the Research and Technology subprogram included funding for a major portion of the LHC related R&D effort; the other portion was provided as capital equipment in the Facility Operations subprogram. In FY 1996, this effort was funded in the High Energy Technology subprogram. Beginning in FY 1998, when fabrication by U.S. groups of LHC hardware components begins, all of the LHC project funding is budgeted as a separate activity in the Facility Operations subprogram. This provides improved visibility of LHC component funding and will facilitate DOE management by consolidating all funding in a single subprogram.

II. Funding Schedule:

Program Activity	FY 1996*	FY 1997	FY 1998	$ Change	% Change
Physics Research	$ 0	$ 140,592	$ 140,800	$+ 208	+ 0.1%
High Energy Technology	0	66,694	62,436	-4,258	- 6.4%
SBIR/STTR	0	2,714	2,004	- 710	-26.2%
Total	$ 0	$210,000	$205,240	$-4,760	- 2.3%

*In FY 1996, funding for these activities was provided in the Physics Research subprogram and the High Energy Technology subprogram.

III. Performance Summary- Accomplishments

PHYSICS RESEARCH	FY 1996	FY 1997	FY 1998
Fermilab—Provides support primarily for Fermilab research physicists working on CDF, D-Zero, and several fixed target experiments, on the CMS detector for LHC, on particle astrophysics experiments, and on theoretical analyses.	$ 0	$ 9,880	$ 10,010
SLAC—Provides support primarily for SLAC research physicists working on the B-factory, on the SLD at SLC, on the Beijing Electron Synchrotron detector at the accelerator in Beijing, China, on fixed target experiments at SLAC, and on theoretical analyses.	0	10,123	10,283

PHYSICS RESEARCH (Cont'd)	FY 1996	FY 1997	FY 1998
BNL—Provides support primarily for BNL research physicists working on the high priority Rare k-decay experiments at the AGS at BNL, on the D-Zero detector at Fermilab, on the experiment to make a precision measurement of the muon's magnetic properties, on the Atlas detector for LHC, and on theoretical analyses.	0	7,585	7,705
LBNL—Provides support primarily for LBNL research physicists working on the CDF and D-Zero detectors at Fermilab, on the BaBar detector for the B-factory at SLAC, on the Atlas detector for the LHC, on the SLD at the SLC at SLAC, on an underground experiment to search for cosmic dark matter, and on theoretical analyses. Also provides for the Particle Data Group which serves as a clearing house and archivist for data on elementary particles.	0	9,935	10,085
ANL—Provides support primarily for ANL research physicists working on the CDF detector at Fermilab, on the ZEUS detector at DESY, on the underground Soudan-2 detector, on the MINOS detector for the planned NuMI project at Fermilab, and on theoretical analyses.	0	5,504	5,584
Universities and Other Laboratories—Provides support for research physicists at over 100 U.S. universities working at all of the U.S. and at many foreign accelerator laboratories, on a number of non-accelerator experiments, and performing theoretical analyses. Provides support for similar research scientists at LANL, ORNL, and PNL.	0	97,565	97,133
TOTAL PHYSICS RESEARCH	$ 0	$140,592	$140,800
HIGH ENERGY TECHNOLOGY			
Fermilab—Provides funding primarily for technology R&D in support of the Fermilab Main Injector project, for technology R&D aimed at improving the performance and reliability of the Fermilab accelerator complex and the detectors used in Fermilab research program, and for technology R&D of general benefit to the HEP program.	$ 0	$ 13,236	$ 13,436

HIGH ENERGY TECHNOLOGY (Cont'd)	FY 1996	FY 1997	FY 1998
SLAC—Provides funding primarily for technology R&D support of the B-factory project and the BaBar detectors, for technology R&D aimed at improving the performance and reliability of the SLC and the other parts of the SLAC accelerator complex. Also provides for R&D in key technical areas related to a possible future large linear collider project, and for technology R&D of general benefit to the HEP program.	0	14,850	15,080
BNL—Provides funding primarily for technology R&D in support of the AGS and the AGS experimental program, experiments exploring novel accelerator techniques using the Accelerator Test Facility, R&D aimed at developing an operational free electron laser, and for technology R&D of general benefit to the HEP program.	0	6,145	6,255
LBNL—Provides support primarily for technology R&D in the areas of superconducting magnets for accelerators, high performance RF power systems, plasma lenses using the accelerator R&D beam at the Advanced Light Source, R&D in support of the joint SLAC/LBNL/LLNL B-factory project, and for technology R&D of general benefit to the HEP program.	0	9,095	9,225
Large Hadron Collider—Provides support for the R&D and planning necessary to provide an informed basis on which to negotiate an agreement with CERN relative to U.S. participation in the LHC Project. In FY 1997 an additional $3,000,000 is budgeted as capital equipment under the Facility Operations subprogram. Beginning in FY 1998, when fabrication of LHC subsystems and components will begin, all LHC funds for component fabrication and supporting R&D are budgeted under the Facility Operations subprogram.	0	12,000	0
Universities, Other Laboratories, and Other Contractors—Provides support for relevant, high priority technology R&D at universities, other DOE laboratories, and private industry. Areas being studied include improved superconductor, laser, and collective effect accelerator techniques, non-linear dynamics and theoretical studies.	0	11,368	18,440

The FY 1998 request includes $4,500,000 for an expansion of advanced accelerator R&D aimed at technologies which will be needed in the era after the completion of the LHC.

HIGH ENERGY TECHNOLOGY (Cont'd)	FY 1996	FY 1997	FY 1998
Possible areas for exploration include high field superconducting magnets, large electron-positron linear colliders and new particle acceleration techniques.			
TOTAL HIGH ENERGY TECHNOLOGY	$ 0	$66,694	$62,436
SBIR/STTR - Provides funding for the mandated SBIR and STTR programs. Additional funding for the SBIR program is contained in the Facility Operations subprogram. The FY 1997 estimate is for both SBIR and STTR. The FY 1998 estimate is for SBIR only since Part D, Section 110 of P.L. 104-208, making Omnibus Consolidated Appropriations for FY 1997 reauthorized STTR for FY 1997 only."	0	2,714	2,004
TOTAL RESEARCH AND TECHNOLOGY	$ 0	$ 210,000	$ 205,240

EXPLANATION OF FUNDING CHANGES FY 1997 TO FY 1998:

Partial allowances for the impact of inflation.	+$3,450,000
Funding for expanded effort in the search for new and innovative accelerator technologies.	+$4,500,000
Transfer of LHC funding to Facility Operations subprogram.	-$12,000,000
SBIR/STTR assessment.	-$710,000
Total Funding Change, Research and Technology	-$4,760,000

HIGH ENERGY PHYSICS

FACILITY OPERATIONS

(Tabular dollars in thousands, narrative in whole dollars)

I. **Mission Supporting Goals and Objectives:** The Facility Operations subprogram includes the provision and operation of the large accelerator and detector facilities which are the essential tools that enable scientists in university and laboratory based research groups to perform experimental research in high energy physics. This subprogram includes funding for the operation and maintenance of the national laboratory research facilities including accelerators, colliders, secondary beam lines, detector facilities for experiments, experimental areas, computing, and computing networking facilities. It includes the costs of detector and accelerator components, personnel, electric power, expendable supplies, replacement parts and subsystems, and inventories. General purpose projects (GPP) funding will be provided for minor new construction, other capital alterations and additions, and for buildings and utility systems. General purpose equipment (GPE) funding for Brookhaven National Laboratory and landlord GPP funding for Brookhaven National Laboratory, Fermi National Accelerator Laboratory and Stanford Linear Accelerator Center are also included. Accelerator Improvement Projects (AIP) funding support for additions and modifications to accelerator facilities which are supported by the HEP research program is also included. As discussed in the preceding program mission statement, funding for a pilot program concerning transfer from EM to ER of waste management responsibility at Fermilab and SLAC is also included beginning in FY 1998.

Beginning in FY 1998, when fabrication of hardware for the LHC project begins, this subprogram includes all of the U.S. DOE funding for machine and detector hardware.

The principal objective of the Facility Operations subprogram is to maximize the quantity and quality of data collected for approved experiments being conducted at the HEP facilities. The ultimate measure for success in the Facility Operations subprogram is whether the research scientists have data of sufficient quantity and quality to do their planned measurements or to discover new phenomena. The quality of the data is dependent on the accelerator and detector capabilities, and on the degree to which those capabilities are achieved during a particular operating period. The quantity of the data relates primarily to the beam intensity, the length of the operating period, and the operational availability of the accelerator and detector facilities.

Planned Accelerator Operations
(in weeks)

		FY 1996	FY 1997	FY 1998
Fermilab	Fixed Target	15	44	a/
	Collider	16		
	Commissioning	—	—	13
	Total	31	44	13
SLAC	SLC	24	22	16 b/
	Fixed Target	8	10	0
	Commissioning	0	0	16
	Total	32	32	32
BNL	AGS-HEP c/	18	12	15

a/ Operation of the Tevatron in collider or fixed target mode in FY 1998 is precluded by the long shutdown needed for completion of the Fermilab Main Injector project.

b/ Operation of the SLC at SLAC in FY 1998 is severely constrained by the long shutdown needed for the completion of the B-factory project.

c/ The AGS is also funded and operated by the Nuclear Physics program for operation with heavy ions.

II. Funding Schedule:

Program Activity	FY 1996	FY 1997	FY 1998	$ Change	% Change
Fermilab National Accelerator Laboratory ...	$ 182,865	$ 182,425	$ 197,235	$ +14,810	+ 8.1%
Stanford Linear Accelerator Center	91,211	97,961	103,481	+ 5,520	+ 5.6%
Brookhaven National Laboratory	59,723	56,135	57,805	+ 1,670	+ 3.0%
Universities and Other Laboratories	13,349	10,303	9,539	-764	- 7.4%
Large Hadron Collider	779a/	3,000a/	35,000	+32,000	+1,066.7%
Waste Management	0b/	0b/	4,960	+4,960	
SBIR	0	10,251	10,925	+674	+ 6.6%
Total	$347,927	$360,075	$418,945	$+58,870	+ 16.3%

a/ As previously discussed, $5,221,000 in FY 1996 was budgeted for LHC R&D in the High Energy Technology subprogram and $12,000,000 in FY 1997 was budgeted for LHC R&D in the High Energy Technology activity within the Research and Technology subprogram.
b/ Waste Management activities in FY 1996 and FY 1997 were funded by the Environmental Management Program.

III. Performance Summary- Accomplishments

	FY 1996	FY 1997	FY 1998
Fermilab—Provides support for operation, maintenance, improvement, and enhancement of the Tevatron accelerator complex, the large detector facilities (CDF and D-Zero), the smaller fixed target experiments, and the on-site computing resources required to design the detectors and analyze the experimental data. Also provides for maintenance of the laboratory physical plant.	$ 182,865	$ 182,425	$ 197,235

- Tevatron operation
  - --FY 1996 - operation in collider mode for 16 weeks; together with 15 weeks in fixed target mode.
  - --FY 1997 - operation in fixed target mode for about 44 weeks.
  - --FY 1998 - a nine month long shutdown required to complete construction and install components of the Main Injector followed by 13 weeks of Main Injector commissioning and Tevatron startup.

	FY 1996	FY 1997	FY 1998
SLAC—Provides for the operation, maintenance, improvement and enhancement of the accelerator and detector complex on the SLAC site. The accelerators include the electron linac and the SLC. To these is being added the B-factory. The detector facilities include the SLD, the End Station A experimental set-ups, and BaBar, the detector which is being constructed for use with the B-factory. Also provides for maintenance of the laboratory physical plant.	91,211	97,961	103,481

- SLAC operation
  - --FY 1996 - operation of the SLC with the SLD for about 22 weeks; followed by 2 weeks of accelerator operations for R&D studies relating to a future Large Linear collider; then 8 weeks of running of fixed target facilities for End Station A.
  - --FY 1997 - operation of the linac for fixed target experiments in End Station A for about 10 weeks followed by 22 weeks of operation of the SLC with SLD that includes about 2 weeks of operation for R&D studies related to a future large linear collider.
  - --FY 1998 - operation of the SLC with the SLD for about 16 weeks followed by a long shutdown to complete the B-factory. Commissioning will require about 16 weeks of linac operation.

FACILITY OPERATIONS (Cont'd)	FY 1996	FY 1997	FY 1998
BNL—Provides support for the operation, maintenance, improvement, and enhancement of the accelerator and detector complex on the BNL site. The principal facility is the AGS and its complement of experimental set ups. Also provides for maintenance of the laboratory physical plant. • AGS operation --FY 1996 - operation of the AGS for HEP for 18 weeks. --FY 1997 - operation of the AGS for HEP for about 12 weeks. --FY 1998 - operation of the AGS for HEP for about 15 weeks. The AGS is also operated by the Nuclear Physics program for heavy ion research.	59,723	56,135	57,805
Universities and other labs - Provides for capital equipment funding at ANL, LBNL, some smaller DOE labs, and for university based researchers. Provides for certain computer networking expenses.	13,349	10,303	9,539
Large Hadron Collider - Beginning in FY 1998, includes funding for: fabrication of machine and detector hardware, for supporting R&D, and for purchases by CERN from U.S. vendors. Funding in FY 1996 and FY 1997 was for R&D activities in preparation for the U.S. participation in the project. These R&D activities were budgeted, in part, in the High Energy Technology subprogram ($5,221,000) in FY 1996 and the Research and Technology subprogram ($12,000,000) in FY 1997 presented earlier and, in part, in this subprogram. An advance appropriation of $394,000,000 has been requested for the years FY 1999 to FY 2004. Bringing total DOE funding for the project to $450,000,000. The work is being performed at various locations including 4 major DOE labs and more than 55 universities.	779	3,000	35,000

In addition to the $6,000,000 in FY 1996, $15,000,000 in FY 1997 and $35,000,000 in FY 1998, an advance appropriation is being proposed by the administration as discussed earlier. This advance appropriation provides $65,000,000 in FY 1999; $70,000,000 in FY 2000; $70,000,000 in FY 2001; $70,000,000 in FY 2002; $65,000,000 in FY 2003; and $54,000,000 in FY 2004.

The DOE funding for LHC hardware fabrication (which begins in FY 1998) and supporting R&D is displayed below for completeness and clarity:

LHC Accelerator and Detector Funding
(B/A in thousands)

		FY 1996	FY 1997	FY 1998
Facility Operations Subprogram				
LHC				
accelerator	- Operating Expenses	$ 0	$ 0	$ 7,800
	- Capital Equipment	0	400	7,800
detectors	- Operating Expenses	0	0	12,600
	- Capital Equipment	779	2,600	6,800
Total Facility Operations		779	3,000	35,000
High Energy Technology a/		5,221	0	0
Research and Technology b/				
High Energy Technology		0	12,000	0
Total LHC		$6,000	$15,000	$35,000

a/ These R&D funds are displayed here for comparability purposes only. These FY 1996 funds were budgeted in the High Energy Technology subprogram.

b/ These R&D funds are displayed here for comparability purposes only. These FY 1997 funds are budgeted in the Research and Technology subprogram.

FACILITY OPERATIONS (Cont'd)	FY 1996	FY 1997	FY 1998
Waste Management - Provides for a pilot program concerning packaging, shipment and disposition of hazardous, radioactive or mixed waste generated in the course of normal operations at Fermilab and SLAC. This pilot program is intended to evaluate opportunities to reduce the volume of newly generated waste and its associated management and disposal costs.	0	0	4,960
SBIR - Additional funding for the SBIR program and all funding for the STTR program is contained in the Research and Technology subprogram. In FY 1996 $4,900,000 was transferred to the SBIR program. The FY 1997 estimate is for SBIR. The FY 1998 estimate is for SBIR only since Part D, Section 110 of P.L. 104-208, making Omnibus Consolidated Appropriations for FY 1997 reauthorized STTR for FY 1997 only.	0	10,251	10,925
TOTAL FACILITY OPERATIONS	$347,927	$360,075	$418,945

MAJOR ISSUES:

The Administration supports U.S. participation in the LHC project and, as an indication of its support for the LHC, has requested an advance appropriation of $394,000,000 for the DOE High Energy Physics program contribution to LHC hardware component fabrication through the year 2004. DOE participation in LHC is possible at currently projected funding levels for the High Energy Physics program. The advance appropriation demonstrates the Administration's commitment to the LHC project and provides for improved project management since the project will not be dependent on future uncertain incremental appropriations. Thus, project management is enhanced and international collaboration is facilitated.

EXPLANATION OF FUNDING CHANGES FY 1997 TO FY 1998:

Increase for CDF and D-Zero detector upgrades at Fermilab.	+$20,600,000
Expanded maintenance activities during long shutdown for Fermilab Main Injector completion.	+$1,000,000
Preoperating for Fermilab Main Injector Project.	+$1,400,000
Partial allowance for impact of inflation at Fermilab.	+$1,810,000
Savings due to shortened Fermilab running schedule.	-$5,000,000
Reduction at Fermilab in AIP under $2,000,000. This is offset by the C-Zero Hall Project.	-$5,000,000
Partial allowance for impact of inflation at SLAC.	+$1,520,000
Increase in funding for infrastructure problems at SLAC.	+$1,000,000
Preoperating costs for B-factory project.	+$3,000,000
Partial allowance for impact of inflation at BNL.	+$870,000
Additional operation of AGS at BNL.	+$800,000
Partial allowance for impact of inflation in universities and other laboratories.	+$150,000
Planned program reduction in universities and other laboratories.	-$914,000
Net increase for LHC.	+$20,000,000
Transfer of LHC funding from Research and Technology subprogram. This is offset by a $12,000,000 decrease in that subprogram.	+$12,000,000

FACILITY OPERATIONS (Cont'd)

Transfer of Waste Management responsibilities at Fermilab and SLAC from EM to HEP as part of pilot program.	+$4,960,000
SBIR	+$674,000
Total Funding Change, Facility Operations	$58,870,000

HIGH ENERGY PHYSICS

CONSTRUCTION

I. **Mission Supporting Goals and Objectives:** This provides for the construction of major new facilities needed to meet the overall objectives of the HEP Program.

II. **Funding Schedule:**

Program Activity	FY 1996	FY 1997	FY 1998	$ Change	% Change
Construction	$104,000	$100,000	$50,850	$-49,150	-49.1%
Total	$104,000	$100,000	$50,850	$-49,150	-49.1%

III. Performance Summary- Accomplishments	FY 1996	FY 1997	FY 1998
Fermilab Main Injector Project - This project provides for a new accelerator to replace the injector accelerator for the Tevatron complex. The present injector for the Tevatron is the original Fermilab main ring which is less than fully adequate and nearing the end of its useful lifetime. By the end of FY 1997, the project will be about 80% complete. The FY 1998 funding will provide for completion of all civil construction except the required modifications to the Tevatron tunnel, for completion of all the ring magnets for the new accelerator, and for refurbishment of components from the old main ring which are being reused. Commissioning will begin late in FY 1998.	$52,000	$52,000	$30,950
B-factory Project - This project provides for the construction of a B-factory in the PEP storage ring tunnel at SLAC. At the end of FY 1997, the construction phase of the SLAC B-factory Project will be about 90% complete. During FY 1998, the project will be completed, and by the end of FY 1998 commissioning will be well advanced.	52,000	45,000	0

	FY 1996	FY 1997	FY 1998
SLAC Master Substation Upgrade - This project provides for an upgrade and reconfiguration of the main electric power substation on the SLAC site. Obsolete (and hazardous) switch gear will be replaced and load balancing will be implemented thus extending the useful life of the existing main 230kv transformers. Procurement of long lead switch gear items will be initiated in FY 1997, and the project will be completed by the end of FY 1998.	0	3,000	9,400
Neutrinos at the Main Injector (NuMI) - The FY 1998 funding will provide for an Architect-Engineer firm to accomplish detailed design of the several parts of the project. This project provides for the construction of new facilities at Fermilab and at the Soudan Underground Laboratory in Soudan, Minnesota which are especially designed for the study of the properties of the neutrino and in particular to search for neutrino oscillations.	0	0	5,500
C-Zero Area Experimental Hall - This project provides for the construction of a new experiment hall at the C-Zero location on the Fermilab Tevatron ring. This will be used to house modest sized collider and fixed target experiments in a new experimental program being planned at Fermilab.	0	0	5,000
TOTAL CONSTRUCTION	$104,000	$100,000	$50,850

CONSTRUCTION (Cont'd)

EXPLANATION OF FUNDING CHANGES FY 1997 TO FY 1998:

Maintain the Fermilab Main Injector project on the approved funding profile.	-$21,050,000
The SLAC B-factory funding was completed in FY 1997.	-$45,000,000
Maintain the SLAC Master Substation Upgrade project on the approved funding profile.	+$6,400,000
Initiation of the Fermilab NuMI project.	+$5,500,000
C-Zero Area Experimental Hall project at Fermilab.	+$5,000,000
Total Funding Change, Construction	$-49,150,000

HIGH ENERGY PHYSICS
CAPITAL OPERATING EXPENSES & CONSTRUCTION SUMMARY
(Dollars in thousands)

	FY 1996	FY 1997	FY 1998	$ Change	% Change
Capital Operating Expenses					
General Plant Projects (total)	$14,825	$11,775	$12,955	$+ 1,180	+10.0%
Accelerator Improvement Projects (total)	5,060	8,740	3,880	- 4,860	- 55.6%
Capital Equipment (total)	63,339	60,325	85,215	+24,890	+41.3%

Construction Project Summary (both Operating and Construction Funded)

Project Number	Project Title	TEC	Previous Approp.	FY 1996 Approp.	FY 1997 Approp.	FY 1998 Request	Unapprop. Balance
92-G-302	Fermilab Main Injector	$229,600	$94,650	$52,000	$52,000	$30,950	$ 0
94-G-304	B-factory	177,000	80,000	52,000	45,000	0	0
97-G-303	SLAC Master Substation Upgrade	12,400	0	0	3,000	9,400	0
98-G-304	Neutrinos at the Main Injector	5,500	0	0	0	5,500	0
98-G-305	C-Zero Area Experimental Hall	5,000	0	0	0	5,000	0
Total High Energy Physics		--	$174,650	$104,000	$100,000	$50,850	$ 0

Major Items of Equipment (CE $2 Million and Above)

	TEC	Previous Approp.	FY 1996 Approp.	FY 1997 Approp.	FY 1998 Request	Acceptance Date
1. g-2 Experiment	$ 17,685	$ 14,393	$ 2,500	$ 792	$ 0	FY 1997
2. Rare k-decay Experiment	9,864	7,864	1,000	1,000	0	FY 1997
3. KTeV Experiment	18,125	16,600	1,525	0	0	FY 1996
4. D-Zero Upgrade	55,270	12,937	7,625	7,200	17,500	FY 1999
5. CDF Upgrade	57,940	14,407	7,625	7,200	17,500	FY 1999
6. B-factory detector (BaBar)*	67,000	8,500	14,200	20,340	20,000	FY 1999
7. Next Linear Collider Test Facility	13,002	11,400	1,602	0	0	FY 1997

CAPITAL OPERATING EXPENSES & CONSTRUCTION SUMMARY HEP (Cont'd)

Major Items of Equipment (CE $2 Million and Above)	TEC	Previous Approp.	FY 1996 Approp.	FY 1997 Approp.	FY 1998 Request	Acceptance Date
8. Antimatter in Space	2,625	0	2,125	500	0	FY 1997
9. Super-Kamiokande	3,584	1,380	1,080	593	531	FY 1998
10. Large Hadron Collider - Machine**	96,000	0	0	0	7,800	FY 2005
11. Large Hadron Collider - Detectors**	85,000	0	0	0	6,800	FY 2005

* The funding for the B-factory detector reflects cost savings of about $20,000,000 resulting from contributions of components and subsystems by non-U.S. collaborating institutions.

** The FY 1998 funding and the TEC in both cases are based on preliminary estimates and will need to be revised in future years as additional detailed planning is completed. Substantial additional LHC funding is being provided as operating expenses. The overall DOE contribution to LHC fabrication is capped at $450,000,000.

Department of Energy
FY 1998 Congressional Budget Request
Science Assets Acquisition

Project Data Sheets
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DEPARTMENT OF ENERGY
FY 1998 CONGRESSIONAL BUDGET REQUEST
(Changes from FY 1997 Congressional Budget Request are denoted with a vertical line in left margin.)

(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	5.	Previous Construction Estimate: Total Estimated Cost (TEC) -- $229,600
3b.	A-E Work (Title I & Title II) Duration: 30 months		Total Project Cost (TPC) -- $259,300
4a.	Date Physical Construction Starts: 4th Qtr. FY 1992	6.	Current Cost Estimate: TEC -- $229,600
4b.	Date Construction Ends: 3rd Qtr. FY 1999		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	36,517
1996	52,000		52,000	50,435
1997	52,000		52,000	53,000
1998	30,950		30,950	46,500
1999	0		0	4,903

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. Project Description, Justification and Scope

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 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. The project also includes an 8 GeV ring and associated beam transfer lines capable of collecting, refocussing, and storing antiprotons from previous collider cycles. To these, are added the beam from the Antiprotron Source, thus increasing the overall antiproton intensity available for acceleration in the Tevatron. Antiprotons from the storage ring will be accelerated to 150 GeV in the Main Injector for use in the Tevatron collider. Located directly above the Main Injector ring magnets, the storage ring will employ permanent magnets, thus reducing power costs. The project also provides 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 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 as needed for a 150 GeV proton synchrotron injector accelerator.

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. Fabrication of new technical components including magnets, vacuum and RF systems as needed to provide an antiproton capture and recycling capability.

8. Project Description, Justification and Scope (Continued)

d. Construction of the technical components required to implement the delivery of 120 GeV beam from the Main Injector to 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.

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

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

The primary purpose of this project is to significantly 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 energies to produce the top quark, which is the highest mass 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 at least $5x10^{31}cm^{-2}sec^{-1}$ will assure meaningful determination of the properties of the top quark, which was recently discovered at Fermilab. 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 a new capability of 120 GeV proton beams which can be used for fixed target physics research, and to provide beams year-round for the testing and collaboration of detector components and subsystems simultaneously with collider operations for 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. In addition, the Main Injector will be able to capture and "recycle" the antiprotons remaining at the end of each Tevatron collider operating cycle, thus increasing the number of antiprotons available for use in the next cycle. 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

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

8. Project Description, Justification and Scope (Continued)

be achieved with the old Main Ring. The Tevatron antiproton-proton colliding beam luminosity will be increased to at least 5 x 10^{31} $cm^{-2}sec^{-1}$. These performance goals are expected to be achieved after months of operational experience with the new accelerator.

9. Details of Cost Estimate*

		Item Cost	Total Cost
a.	Engineering Design Inspection and assembly		$43,025
b.	Main Injector construction costs		171,875
	1. Conventional construction	78,367	
	2. Special facilities	93,508	
c.	Contingencies		14,700
	Total line item cost		$229,600

* The annual escalation rates assumed for FY 1994 through FY 1998 are 3.6, 4.2, 4.3, 4.6, and 5.0 percent respectively.

10. 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

11. 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	$ 36,517
Total facility costs.....	$ 0	$ 990	$ 9,937	$ 27,318	$ 36,517
2. Other project costs					
(a) R&D costs necessary to complete construction.....	$ 5,400	$ 4,300	$ 6,000	$ 1,700	$ 1,000
(b) Pre-operating costs.....	0	0	0	0	0
(c) Capital equipment.....	0	100	110	50	350
(d) Inventories and Spares....	0	0	0	0	0
Total other project costs.	5,400	4,400	6,110	1,750	1,350
Total project costs.....	$ 5,400	$ 5,390	$ 16,047	$ 29,068	$ 37,867

a. Total project funding (cont.)	FY 1996	FY 1997	FY 1998	FY 1999	Total
1. Total facility costs					
(a) Line item.....	$ 50,435	$ 53,000	$ 46,500	$ 4,903	$229,600
	$ 50,435	$ 53,000	$ 46,500	$ 4,903	$229,600
2. Other project costs					
(a) R&D costs necessary to complete construction.....	$ 300	$ 0	$ 0	$ 0	$ 18,700
(b) Pre-operating costs.....	0	0	1,400	500	1,900
(c) Capital equipment.....	140	150	100	0	1,000
(d) Inventories and Spares....	1,000	3,500	3,600	0	8,100
Total other project costs.	1,440	3,650	5,100	500	29,700
Total project costs.....	$ 51,875	$ 56,650	$ 51,600	$5,403	$259,300

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

1. Power costs for Main Injector slow spill operations	$5,400
2. Experimental areas operating costs for 120 GeV slow spill beam	1,200
Total related annual costs (in FY 1997 dollars)	$6,600

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

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

a. Total project funding

1. Total facility costs

(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 costs for a several month commissioning period.

(c) Capital equipment - Includes test instruments, electronics, and other general equipment to support 12.a.1 and 12.a.2.a.

(d) 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.

b. Related annual costs

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 extracted beam operations simultaneously with Tevatron operations for physics research will require an average increase in power plus other operating costs by about $6,600,000 annually. The operating costs in 12.b reflect the incremental demands of delivering 120 GeV protons to the fixed target experimental areas during Tevatron collider operations.

DEPARTMENT OF ENERGY
FY 1998 OMB BUDGET REQUEST

(Tabular dollars in thousands. Narrative material in whole dollars.)

HIGH ENERGY PHYSICS

1. Title and location of project: Master Substation Upgrade Stanford Linear Accelerator Center	2a. Project No. 97-G-303 2b. Construction Funded
3a Date A-E Work Initiated: 1st Qtr. FY 1997 3b. A-E Work (Title I & Title II) Duration: 6 months	5. Previous Construction Estimate: Total Estimated Cost (TEC) -- 12,400 Total Project Cost (TPC) -- 12,430
4a. Date Physical Construction Starts: 3rd Qtr. FY 1997 4b. Date Construction Ends: 4th Qtr. FY 1998	6. Current Cost Estimate: TEC -- $12,400 TPC -- $12,430

7. Financial Schedule (Federal Funds):

Fiscal Year	Appropriations	Obligations	Costs
1997	3,000	3,000	3,000
1998	9,400	9,400	9,400

8. Project Description, Justification and Scope

This project replaces obsolete equipment and reconfigures the master substation to optimize the reliability and operational flexibility of this primary site substation.

The present substation configuration requires the primary transformers to operate with a significantly unbalanced loading, reducing the life of one while underutilizing the other. The new configuration will allow the balancing of load between the two primary transformers, effectively lengthening their service life indefinitely.

1. Title and location of project: Master Substation Upgrade Stanford Linear Accelerator Center	2a. Project No. 97-G-303 2b. Construction Funded

8. Project Description, Justification and Scope (Continued)

Existing switchgear was built by several different manufacturers, some of which have been out of business for more than 15 years. The switchgear is 30 years old and approaching the end of its useful life. Spare parts are not available and we must rely on overhauled or used parts to repair this equipment. New switchgear will be in compliance with current OSHA safety regulations, improving worker safety.

Present 230kV distribution to the two primary transformers consists of a combination of exposed overhead buss to one primary transformer and SF_6, insulated buss to the other primary transformer. The SF_6 buss requires continuous monitoring and frequent maintenance due to SF_6 leaks and overtemperature problems. Safety disconnects for the SF_6 buss cannot be visually verified in the open position due to the discoloration of their windows requiring the electricians to verify their status by making voltage measurements. This SF_6 buss and disconnects will be replaced by exposed overhead buss and open disconnects to match the other primary transformer configuration.

Obsolete 12.47kV switchgear will be replaced by new switchgear capacity to operate the two 230kV primary site transformers in parallel rather than separately, as presently done. The two primary site transformers will be relocated next to each other and provided with new overhead buss and open frame disconnect switches to eliminate the troublesome SF_6 buss and disconnect switches currently in use.

Backup power is provided through a separate 69kV source which is reduced by two transformers to 12.47kV that is out of phase with the 12.47kV from the two primary transformers. The phase difference prevents parallel operation of a primary and backup transformer. In order to utilize the backup source, the entire site load must be turned off and then restarted to prevent damage due to the out-of-phase incompatibility. This project will replace the two 69kV transformers by a single transformer that is in-phase with the primary 230kV transformers. In-phase backup power will allow transfers between primary and backup sources without the time lost in turning off and restarting all the connected loads.

Relocating one of the 230kV primary transformers and placing the new 69kV transformer in new locations will reduce the installation costs for the buss replacements and allow construction of new concrete secondary containment for these two transformers, which will bring them into compliance with environmental regulations for oil filled equipment.

The activities in the first year of this project will consist of initial procurements, detailed engineering, and installation of those portions of this project that do not require site power outages.

Procurement and installation of the remainder of the project will be completed in the second year.

1. Title and location of project: Master Substation Upgrade
Stanford Linear Accelerator Center

2a. Project No. 97-G-303
2b. Construction Funded

9. Details of Cost Estimate*

The following dollar distribution represents the new obligation authority necessary beginning in FY 1997 for the construction project described herein:

	Item Cost	Total Cost
a. Engineering Design and Inspection		$ 1,640
1. Engineering Design and Inspection at approximately 13% of Construction	$ 1,170	
2. Project Management at approximately 5% of Construction	470	
b. Construction Cost		9,330
1. Equipment and Materials	6,820	
2. Removal and Installation	2,510	
c. Subtotal Engineering Design and Inspection, Construction and Project Management		10,970
d. Contingency at 13% of Item C		1,430
e. Total estimated project cost		$ 12,400

* All costs are escalated to the mid-point of construction. The rates used are 4.0, 3.9, and 3.8 percent for the years FY 1995, FY 1996, and FY 1997 respectively, as shown in the "DOE Department Price Change Index," dated January 1995.

A conceptual design report titled "Master Substation Upgrade" is completed for an estimated cost of $30,000.

10. Method of Performance

Engineering, design and inspection will be accomplished by SLAC Plant Engineering personnel. To the extent feasible, equipment and materials, removal and installation will be accomplished by fixed-price procurements or subcontracts awarded on the basis of competitive bidding.

1. Title and location of project: Master Substation Upgrade
Stanford Linear Accelerator Center

2a. Project No. 97-G-303
2b. Construction Funded

11. Schedule of Project Funding and Other Related Funding Requirements

	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	Total
a. Total project costs							
1. Total facility costs							
(a) Line item	$ 0	$ 0	$ 0	$ 0	$ 3,000	$ 9,400	$12,400
	0	0	0	0	3,000	9,400	12,400
2. Other project costs							
(a) Conceptual Design Cost	0	0	30	0	0	0	30
Total Project Costs (TPC) ...	$ 0	$ 0	$ 30	$ 0	$ 3,000	$ 9,400	$12,430

12. Narrative Explanation of Project Funding

a. Total project funding
   1. Total facility costs
      a. Line Item - Narrative not required.
      b. Expense - Funded Equipment - None.
      c. Inventories - None.
      d. Non-Federal Contribution - None.
   2. Other project costs
      a. R&D Necessary to Complete Construction - None.
      b. Conceptual Design - Narrative not required.
      c. Non-Federal Contribution - None.

b. Related annual costs
   Annual operating cost will be reduced as a result of improved system reliability and high efficiencies.

(Tabular dollars in thousands. Narrative material in whole dollars.)

HIGH ENERGY PHYSICS

1. Title and Location of Project: Fermilab C-Zero Area Experimental Hall
Fermi National Accelerator Laboratory

2a. Project No. 98-G-305
2b. Construction Funded

3a. Date A-E Work Initiated: 1st Qtr. FY 1998

3b. A-E Work Duration: 15 months

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

4a. Date Physical Construction Starts: 1st Qtr. FY 1998

4b. Date Construction Ends: 1st Qtr. FY 1999

6. Current Cost Estimate:
TEC -- 5,000
TPC -- 5,700

7. Financial Schedule (Federal Funds):

Fiscal Year	Appropriations	Obligations	Costs
1998	$ 5,000	$ 5,000	$4,500
1999			500
Totals			$5,000

1. Title and Location of Project:	Fermilab C-Zero Area Experimental Hall Fermi National Accelerator Laboratory	2a. Project No.: 98-G-305 2b. Construction Funded

8. Project Description, Justification and Scope

The project provides for the design, engineering and construction of an underground experimental enclosure and above ground assembly building located at the C-Zero straight section in the Tevatron collider at the Fermi National Accelerator Laboratory in Batavia, Illinois. It replaces the existing C-Zero spectrometer room and the Tevatron enclosure at C-Zero, which has been used for experiments since 1972. The purpose of this project is to provide an enclosure which can be used for fixed target and modest colliding beams experiments. The experiments will be primarily directed toward the testing of prototypes for the next generation of colliding beam experiments at Fermilab. It will also provide an opportunity to mount a medium scale experiment which could investigate the properties of hadrons containing heavy quarks, particularly charmed hadrons. Existing equipment taken from the 800 GeV Fixed Target experiments, now in their last running period, will be used to mount the experiments. This area will make it possible to equip a third region to be used for colliding beams in the future.

These experiments will evaluate several proposed techniques to detect and measure heavy quarks in the forward direction, close to the beam direction. Additional physics topics, such as diffractive and other very forward production studies, could also be accommodated in this enclosure at a later date.

This project will include the demolition of the existing Tevatron enclosure at C-Zero, and the partial demolition of the C-Zero spectrometer room. It also includes civil construction of the below ground experimental hall at C-Zero, an above ground assembly area, and an equipment access. The construction will occur during the long Tevatron down period in FY 1998 required for completion of the Main Injector project.

1. Title and Location of Project: Fermilab C-Zero Area Experimental Hall
Fermi National Accelerator Laboratory

2a. Project No.: 98-G-305
2b. Construction Funded

9. Details of Cost Estimate

		Item Cost	Total Cost
a.	Engineering Design Inspection and assembly at approximately 15 percent of construction costs (including value engineering)		$ 500
b.	C-Zero Construction Costs		3,250
c.	Contingencies at approximately 33 percent of above costs		1,250
d.	Total line item		$5,000

10. Method of Performance

Engineering, design and inspection will be performed by Laboratory personnel, aided by outside A&E firms as appropriated. Construction and procurement will be accomplished by a fixed price contract awarded on the basis of competitive bidding.

11. Schedule of Project Funding and Other Related Funding Requirements

Total project costs	FY 1997	FY 1998	FY 1999	Total
1. Total facility costs				
(a) Line item	$ 0	$4,500	$ 500	$5,000
2. Other project costs				
(a) Design costs	600	0	0	600
(b) Commissioning costs	0	0	100	100
Total other project costs	600	0	100	700
Total project costs	$ 600	$4,500	$ 600	$5,700

1. Title and Location of Project:	Fermilab C-Zero Area Experimental Hall Fermi National Accelerator Laboratory	2a. Project No.: 98-G-305 2b. Construction Funded

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

Total project costs

1. Total facility cost

Funds are being requested at this time because construction can be carried out in the Tevatron enclosure while the Fermilab Accelerator Complex will be shut down for at least nine months, beginning on October 1, 1997. It will not be possible to carry out this work after FY 1998 without a major disruption to the physics program. The FY 1998 budget request includes funding for design, engineering, and construction of the experimental hall, equipment access, and above ground assembly building.

2. Total other project cost

FY 1997 other project cost

The FY 1997 other project costs provide for design work, including project trade off studies, and value engineering studies for engineering cost optimization that must be completed before starting the final engineering design work. Architectural/Engineering firms will be selected in FY 1997 to carry out the design and engineering that will begin when line-item funds become available for construction.

13. Design and Construction of Federal Facilities

All DOE facilities are designed and constructed in accordance with applicable Public Laws, Executive Orders, OMB Circulars, Federal Property Management Regulations and DOE Orders. The total estimated cost of the project will include the cost of measures necessary to assure compliance with Executive Order 12088, "Federal Compliance with Pollution Control Standards;" section 19 of the Occupational Safety and Health Act of 1970, the provision of Executive Order 12196, and the related Safety and Health provisions for Federal Employees (CFR Title 29, Chapter XVII, Part 1960); and the Architectural Barriers Act, Public Law 90-480, and implementing instructions in 41 CFR 101-19.6.

1. The project will be located in an area not subject to flooding determined in accordance with Executive Order 11988.

2. DOE has reviewed the GSA inventory of Federal Scientific Laboratories and found insufficient space available, as reported by the GSA inventory.

3. This project will fall under the categorical exclusion for accelerator facilities 10CFR 1021 Categorical Exclusion B 3.10.

DEPARTMENT OF ENERGY
FY 1998 OMB BUDGET REQUEST

(Tabular dollars in thousands. Narrative material in whole dollars.)

HIGH ENERGY PHYSICS

1. Title and Location of Project: Neutrinos at the Main Injector (NuMI) (engineering only)
Fermi National Accelerator Laboratory

2a. Project No.: 98-G-304
2b. Construction Funded

3a. Date A-E Work Initiated: 1st Qtr. FY 1998

3b. A-E Work Duration: 12 months a/

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

4a. Date Physical Construction Starts: not applicable

4b. Date Construction Ends: not applicable

6. Current Cost Estimate: a/ b/
TEC -- 5,500
TPC -- 6,300

7. Financial Schedule (Federal Funds):

Fiscal Year	Appropriations	Obligations	Costs
1998	$ 5,500	$ 5,500	$5,500

a/ This cost and schedule is based on Architectural Engineering and technical design work only for FY 1998.
b/ The Total Project Cost is estimated to be in the range of $100M - $120M. Total Project Cost and schedule will be determined after a project review in 1998. The FY 1998 request provides only for architect-engineering and technical design work for the facility construction and technical systems.

1. Title and Location of Project:	Neutrinos at the Main Injector (NuMI) (engineering only) Fermi National Accelerator Laboratory	2a. Project No.: 98-G-304 2b. Construction Funded

8. Project Description, Justification and Scope

The project provides for the design, engineering and construction of new experimental facilities at Fermi National Accelerator Laboratory in Batavia, Illinois and at the Soudan Underground Laboratory at Soudan, Minnesota. The project is called NuMI which stands for Neutrinos at the Main Injector. The purpose of the project is to provide facilities which will be used by particle physicists to study the properties of neutrinos, which are fundamental elementary particles. In the Standard Model of elementary particle physics there are three types of neutrinos which are postulated to be massless and to date, no direct experimental observation of neutrino mass has been made. However, there are compelling hints from experiments which study neutrinos produced in the sun and in the earth's atmosphere that indicate that if neutrinos were capable of changing their type it could provide a credible explanation for observed neutrino deficits in these experiments.

The primary element of the project is a high flux beam of neutrinos in the energy range of 1 to 40 GeV. The technical components required to produce such a beam will be located on the southwest side of the Fermilab site, tangent to the new Main Injector accelerator at the MI-60 extraction region. The beam components will be installed in a tunnel of approximately 1 km in length and 6.5 m diameter. The beam is aimed at detectors which will be constructed in experimental caverns located along the trajectory of the neutrino beam. Two such detectors will be located on the Fermilab site, while the third will be located in the Soudan Underground Laboratory.

The experiments which are being designed to use these facilities will be able to search for neutrino oscillations occurring in an accelerator produced neutrino beam and hence determine if neutrinos do have mass. Fermilab is the only operational high energy physics facility in the U.S. with sufficiently high energy to produce neutrinos which have enough energy to produce tau leptons. This gives Fermilab the unique opportunity to search for neutrino oscillations occurring between the muon and the tau neutrino. Additionally, the NuMI facility is designed to accommodate future enhancements to the physics program that could push the search for neutrino mass well beyond the initial goals established for this project.

1. Title and Location of Project:	Neutrinos at the Main Injector (NuMI) Fermi National Accelerator Laboratory	2a. Project No.: 98-G-304 2b. Construction Funded

9. Details of Cost Estimate

The initial project provides funds for an Architect-Engineer to accomplish detailed design of the conventional construction of the facility as well as engineering and design work for the technical components of the beam. Also included are funds for engineering and design related to the systems and structures required for the detectors of the long baseline oscillation search.

10. Method of Performance

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

11. Schedule of Project Funding and Other Related Funding Requirements

a. Total project costs	Prior Years	FY 1998	Total
1. Total facility costs			
(a) Line item	$ 0	$5,500	$5,500
	0	5,500	5,500
2. Other project costs			
(a) Conceptual Design Cost	800	0	800
Total	$ 800	$5,500	$6,300 d/

d/ This cost and schedule is for Architectural Engineering and technical design work in FY 1998. The Total Project Cost which will be refined during the FY 1998 design effort is estimated to be in the range of $100M-$120M.

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

Funding for the Architectural and Engineering design of the conventional facilities which will be required for the NuMI Project.