DEPARTMENT OF ENERGY
FY 1997 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
(Tabular dollars in thousands, Narrative in whole dollars)

HIGH ENERGY PHYSICS

PROGRAM MISSION

The High Energy Physics (HEP) Program, a major component of the Department's fundamental research mission, 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 underpinning that enables the Nation to maintain 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 so as 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. Support essential improvements and upgrades at the major accelerator laboratories. Champion the construction of the Fermilab Main Injector project and the B-factory project at SLAC.

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.

PROGRAM MISSION - HIGH ENERGY PHYSICS (Cont'd)

5. TO CONTINUE TO PURSUE INTERNATIONAL COLLABORATION ON LARGE SCIENCE 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 "Future Vision" Subpanel. Continue negotiations with CERN leading to a formal agreement on U.S. participation in the LHC accelerator and major detector projects.

The 1994 HEPAP "Subpanel on the Vision for the Future of High Energy Physics" (Drell Subpanel) provided guidance on the future course of the HEP program. The above objectives strongly reflect that guidance.

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.

2. Sustained achievement in advancing knowledge, as indicated by the publication of research results in refereed scientific journals, and by invited participation at national and international conferences and workshops.

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; meeting schedule and cost milestones; operating facilities that are used for research at the forefront of science; operating facilities reliably and according to planned schedules; maintaining and improving facilities at reasonable costs; and obtaining strong and enthusiastic endorsement by user organizations.

4. Accomplishment of all Fermilab Main Injector project and SLAC B-factory project cost and schedule milestones.

SIGNIFICANT ACCOMPLISHMENTS AND PROGRAM SHIFTS:

1. Discovery at Fermilab of the top quark, the last of the fundamental building blocks of matter (quarks) predicted by the Standard Model of elementary particles.

2. The Tevatron accelerator at Fermilab continued to set world records for particle beam intensity (luminosity) by achieving a luminosity of 2.3×10^{31} $cm^{-2}sec^{-1}$, greatly exceeding its original 1981 design luminosity of 0.2×10^{31}

3. The world's most precise measurement of the mass of the W boson at Fermilab.

4. The world's most precise measurement was made at SLAC of the weak mixing angle; a fundamental parameter of the Standard Model.

5. 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 1997 the project will be about 80% complete.

6. 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 1997 the project will be about 90% complete.

7. 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 for the U.S. to join the CERN Large Hadron Collider project. A second negotiation meeting occurred in February. The negotiations are going well and a satisfactory agreement is expected by the end of 1996. Over 500 U.S. scientists have already shown their enthusiasm for participation in the LHC by joining the U.S.-ATLAS detector collaboration, the U.S.-CMS detector collaboration, or the U.S.-LHC accelerator consortium.

8. Participation in the LHC project at CERN will primarily take the form of U.S. accepting responsibility for providing particular subsystems of the accelerator and of the two large detectors. Thus much of the funding will go to U.S. groups for fabrication of components which will become part of the project. Funding is being provided in FY 1996 for preliminary design and engineering work needed to identify and clarify what subsystems should be considered for inclusion in the agreement with CERN. This funding is important 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 $15,000,000 is being requested for FY 1997 to support the initiation of those activities provided for in the anticipated agreement with CERN.

SIGNIFICANT ACCOMPLISHMENTS AND PROGRAM SHIFTS (Cont'd):

9. The High Energy Physics request includes $403,975,000 to maintain support of the Department's scientific user facilities. Approximately 4% of this amount is associated with the continuation of the science user facilities initiative contained in the FY 1996 budget request. This investment will provide significant research time for 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. This level supports users at FY 1996 levels. The proposed funding will support operations at all three of the Department's major high energy physics facilities: the Tevatron, the Stanford Linear Collider, and the Alternating Gradient Synchrotron. The proposed funding 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 in 1993.

HIGH ENERGY PHYSICS

PROGRAM FUNDING PROFILE

(Dollars in thousands)

	FY 1995 Comparable Appropriation	FY 1996 Original Appropriation	FY 1996 Real & Comp Adjustments	FY 1996 Comparable Adjusted	FY 1997 Budget Request
Research					
Physics Research	$139,139	$141,000	$0	$141,000	$141,290
Facility Operations	267,975	353,077	-86,505 a/	266,572	271,210
High Energy Technology	57,613	68,923	0	68,923	74,880
Related Capital Funding	80,436	0	86,505	86,505	91,745
Subtotal Research	545,163	563,000	0	563,000	579,125
Construction	87,000	104,000	0	104,000	100,000
Subtotal, High Energy Physics	632,163	667,000	0	667,000	679,125
Adjustment	-3 b/	0	0	0	0
Total, High Energy Physics	$632,160 c/	$667,000	$0	$667,000	$679,125

a/ Comparability transfer to Related Capital Funding ($86,505,000).

b/ Share of General Science and Research general reduction for use of prior year balances assigned to this program.

c/ Excludes $9,494,000 which has been transferred to the SBIR program and $475,000 which has been transferred to the STTR program.

Public Law Authorization:

Pub. Law 95-91, DOE Organization Act (1977)

HIGH ENERGY PHYSICS
(Dollars in thousands)

PROGRAM FUNDING BY SITE

Field Offices/Sites	FY 1995 Comparable Appropriation	FY 1996 Original Appropriation	FY 1996 Real & Comp Adjustments	FY 1996 Comparable Appropriation	FY 1997 Budget Request
Albuquerque Operations Office					
Los Alamos National Laboratory	$1,005	$806	$0	$806	$913
Chicago Operations Office					
Argonne National Laboratory	8,918	8,580	0	8,580	8,410
Brookhaven National Laboratory	76,347	73,712	0	73,712	70,782
Fermi National Accelerator Laboratory	248,631	256,213	0	256,213	259,743
Oakland Operations Office					
Lawrence Berkeley National Laboratory	23,111	21,393	0	21,393	20,983
Lawrence Livermore National Laboratory	1,445	490	0	490	490
Stanford Linear Accelerator Center	162,663	174,070	0	174,070	173,450
Oak Ridge Operations Office					
Continuous Electron Beam Accelerator Facility	211	220	0	220	211
Oak Ridge National Laboratory	470	250	0	250	406
Richland Operations Office					
Pacific Northwest Laboratory	45	45	0	45	52
All Other Sites a/	109,317	131,221	0	131,221	143,685
Subtotal	632,163	667,000	0	667,000	679,125
Adjustment	(3) b/	0	0	0	0
TOTAL	$632,160	$667,000	$0	$667,000	$679,125

a/ Funding provided to universities, industry, other federal agencies and other miscellaneous contractors.
b/ Share of General Science and Research general reduction for use of prior year balances assigned to this program.

HIGH ENERGY PHYSICS
PROGRAM OBJECT CLASS SUMMARY
(Dollars in thousands)

		FY 1995		FY 1996		
		Comparable	Non-Comp	Comparable	Non-Comp	FY 1997
	Direct Funding:					
	Personnel compensation:					
11.1	Full-time permanent					
11.3	Other than full-time permanent					
11.5	Other personnel compensation					
11.8	Special personal services payments					
11.9	Total personnel compensation	0	0	0	0	0
12.1	Civilian personnel benefits					
13.0	Benefits for former personnel					
21.0	Travel and transportation of persons					
22.0	Transportation of things					
23.1	Rental payments to GSA					
23.2	Rental payments to others					
23.3	Communications, utilities, and miscellaneous charges					
24.0	Printing and reproduction					
25.1	Advisory and assistance services					
25.2	Other services					
25.3	Purchases of goods and services from Government accounts	1,028	1,028	725	725	646
25.4	Operation and maintenance of facilities	360,067	360,067	353,007	353,007	350,973
25.5	Research and development contracts	12,266	12,266	39,417	39,417	54,140
25.7	Operation and maintenance of equipment					
26.0	Supplies and materials					
31.0	Equipment	57,727	57,727	65,123	65,123	70,780
32.0	Land and structures	109,735	109,735	125,479	125,479	120,965
41.0	Grants, subsidies and contributions	91,375	91,375	83,427	83,427	81,621
99.0	Subtotal, obligations	632,198	632,198	667,178	667,178	679,125
	Reimbursable Obligations	-	-	-	-	-
99.9	Total Obligations	632,198	632,198	667,178	667,178	679,125
	Recovery of prior year obligations	-118	-118			
	Unobligated balance avail, start of year	-98	-98	-178	-178	0
	Unobligated balance avail, end of year	178	178			
	Budget Authority	$632,160	$632,160	$667,000	$667,000	$679,125

HIGH ENERGY PHYSICS

PHYSICS RESEARCH
(Tabular dollars in thousands, Narrative in whole dollars)

I. Mission Supporting Goals and Objectives:

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 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 more than 100 research groups at major universities as well as research groups at 9 DOE laboratories.

II. Funding Schedule:

Program Activity	FY 1995	FY 1996	FY 1997	$ Change	% Change
Fermilab National Accelerator Laboratory . .	$ 10,469	$ 10,158	$ 9,978	$ -180	-1.8%
Stanford Linear Accelerator Center	9,494	10,545	10,335	-210	-2.0%
Brookhaven National Laboratory	7,999	7,915	7,755	-160	-2.0%
Lawrence Berkeley Laboratory	10,370	10,265	10,065	-200	-2.0%
Argonne National Laboratory	5,791	5,625	5,515	-110	-2.0%
Universities and Other Labs	95,016	96,492	97,642	+1,150	+1.2%
Total, Physics Research	$139,139	$141,000	$141,290	$+ 290	+0.2%

III. Performance Summary:

FY 1995 Accomplishments:

- The conduct of experiments and the ongoing analysis of data collected in FY 1995 and previous years from the Tevatron Collider at Fermilab utilizing its CDF and D-Zero detector facilities.

III. Performance Summary: PHYSICS RESEARCH

- Discovery of the top quark by the CDF and D-Zero detector collaborations in experiments performed at Fermilab, and preliminary measurement of its mass.

- Conduct of experiments and the ongoing analysis of data collected in FY 1995 and previous years utilizing the SLD detector with the SLC collider at SLAC, and using the fixed target facilities in End Station A.

- The world's most precise measurement, at SLAC, of the weak mixing angle; a fundamental parameter of the Standard Model.

- Recorded extensive data using the kaon beams at the AGS at BNL in experiments searching for exceedingly rare decays of the kaon. These experiments are providing a stringent test of the presently accepted Standard Model of elementary particles.

- Participation in advanced R&D and design work related to the CMS and ATLAS detector facilities to be fabricated for future research at the LHC accelerator project at CERN.

- Conduct of experiments and the ongoing analysis of data collected earlier using four major detector facilities at the LEP collider at CERN.

- Major collaborator in a large international detector facility (ZEUS) at the DESY laboratory in Hamburg, Germany, recording collisions of high-energy positrons with high-energy protons in order to map the internal structure of the proton with unprecedented sensitivity.

- The world's most precise measurement of the mass of the W boson using the CDF detector at Fermilab. This measurement, combined with the measurement of the top quark mass, yields a rough prediction of the Higgs mass.

- Formulation of the research program and detailed design of the BaBar detector for the B-factory at SLAC.

- Major breakthrough at Rutgers and Princeton in the discovery of a solvable realistic quantum field theory.

- The discovery of several distant supernovas using particle-astrophysics techniques.

- Data collection using a highly instrumented 1000 ton detector deep underground in the Soudan mine in Minnesota, searching for the spontaneous decay of a nucleon and measuring the fluxes of background cosmic ray muons and neutrinos.

- Funding in the amount of $329,000 and $475,000 has been transferred to the SBIR and STTR programs, respectively.

III. *Performance Summary:* PHYSICS RESEARCH (Cont'd)

FY 1996 Accomplishments (to date and planned):

- o Completion of fabrication and initial operation of ten major new fixed target experiments at Fermilab.
- o Completion of a year-long period of data collection using the CDF and D-Zero detectors facilities at Fermilab, including significant upgrades of certain detector subsystems.
- o Analysis of data collected at CDF and D-Zero during the FY 1995 operation of the Tevatron accelerator facility.
- o Collect data using the SLD detector at the SLC at SLAC using the new vertex detector. Obtain important new understanding of B mesons.
- o Continue analysis of data recorded by experiments at the AGS at BNL which are searching for rare kaon decays.
- o Continue operation of 5 fixed target experiments at the AGS at BNL.
- o Commission the beam line which will deliver beams to an experiment intended to measure very precisely the magnetic properties of the muon. This is at the AGS at BNL.
- o Participation in design, engineering and R&D on CMS and ATLAS detectors for the LHC at CERN.
- o Conduct experiments and analysis of data collected using four major detectors at the LEP collider at CERN.
- o Continue work on the design and fabrication of the BaBar detector for use at the SLAC B-factory facility to be completed in FY 1998.
- o Further development of theoretical approaches to understanding and interpreting the most recent experimental results.
- o Continue operation of the Soudan underground detector searching for proton decay.
- o Complete fabrication and start initial operation of the Super-Kamiokande detector in Japan.

III. Performance Summary: PHYSICS RESEARCH (Cont'd)

- Continue collaboration in the ZEUS positron-proton detector facility at DESY.

FY 1997 Planned Accomplishments:

- Completion of a two year long period of data collection for ten major fixed target experiments at Fermilab, which were installed and brought into operation in FY 1996.
- Analysis of the data collected during FY 1996 with the collider detectors and the fixed target experiments at Fermilab.
- Initial operation at the AGS at BNL of an experiment intended to measure very precisely the magnetic properties of the muon.
- Continue analysis of data recorded by the experiments at the AGS at BNL searching for rare kaon decays.
- Continue operation of 5 fixed target experiments at the AGS at BNL.
- Participate in design, engineering, and R&D on both the CMS and the ATLAS detector facilities for the LHC at CERN.
- Conduct experiments and analyze data collected earlier using four major detectors at the LEP collider at CERN.
- Continue work on the design and fabrication of the BaBar detector for use at the B-factory at SLAC.
- Major data collection using the Super-Kamiokande underground detector in Japan.
- Continue operation of the Soudan underground detector searching for proton decay.
- Continue collaboration in the ZEUS positron-proton experiment in Hamburg.

III. Performance Summary: PHYSICS RESEARCH (Cont'd)

Explanation of funding changes FY 1996 to FY 1997:

The decrease of $180,000 at Fermilab results from the programmatic shifts to provide funding for the involvement in the LHC and for the three major detector fabrication programs.

The decrease of $210,000 at SLAC results from the programmatic shifts to provide funding for the involvement in the LHC and for the three major detector fabrication programs.

The decrease of $160,000 at BNL results from the programmatic shifts to provide funding for the involvement in the LHC and for the three major detector fabrication programs.

The decrease of $200,000 at LBNL results from the programmatic shifts to provide funding for the involvement in the LHC and for the three major detector fabrication programs.

The decrease of $110,000 at ANL results from the programmatic shifts to provide funding for the involvement in the LHC and results from programmatic shifts to provide funding for the involvement in the LHC and for the three major detector fabrication programs.

The increase of $1,150,000 in the University and Other Laboratories activity reflects continued strong support for the university based component of the HEP program.

HIGH ENERGY PHYSICS

FACILITY OPERATIONS
(Tabular dollars in thousands, Narrative in whole dollars)

I. Mission Supporting Goals and Objectives:

This activity provides for the 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 personnel, electric power, expendable supplies, replacement parts and subsystems, and inventories. The ultimate measure for success in this activity 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.

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.

II. Funding Schedule:

Program Activity	FY 1995	FY 1996	FY 1997	$ Change	% Change
Fermilab National Accelerator Laboratory	$143,542	$143,095	$142,815	$- 280	- 0.2%
Stanford Linear Accelerator Center	79,400	73,045	72,905	- 140	- 0.2%
Brookhaven National Laboratory	44,755	43,625	43,535	- 90	- 0.2%
Universities and Other Laboratories	278	6,807	11,955	+5,148	+75.6%
Total, Facility Operations	$267,975	$266,572	$271,210	$+4,638	+ 1.7%

III. Performance Summary: FACILITY OPERATIONS

FY 1995 Accomplishments:

- Operation of the Tevatron colliding beams facility at Fermilab for an extended period and with strong utilization of its CDF and D-Zero detector facilities. There were 40 weeks of operation with 70% availability, and 130 luminosity units of beam were delivered.
- Completion and installation of nine major new fixed target experiments at Fermilab in preparation for the planned 1996 fixed target run.
- Operation of the SLC Collider at SLAC utilizing the SLD detector facility for 25 weeks.
- Operation of the SLAC accelerator for 2 weeks for End Station A (fixed target) experiments.
- Operation of the SLAC accelerator for about 4 weeks for R&D studies relating to a future large linear collider.
- Operation of AGS at BNL for 5 major HEP experiments for 25 weeks.
- Preparation for fixed target operations at SLAC in FY 1996, including the upgrade of the polarized target for the experiments.
- Funding in the amount of $8,588,000 has been transferred to the SBIR program.

FY 1996 Accomplishments (to date and planned):

- Operation of the Tevatron Collider at Fermilab for utilization of the CDF and D-Zero detector facilities during the first four months of FY 1996. This will provide 15 weeks of operation.
- Transition from collider operation to fixed target operation of the Tevatron at Fermilab by the end of the third quarter of FY 1996.
- Operation for research of the Tevatron fixed target facilities at Fermilab for 12 weeks.
- Operation of the SLC Collider at SLAC utilizing the SLD detector facility for 25 weeks.
- Operation of fixed target facilities at SLAC for End Station A for 10 weeks.

III. Performance Summary: FACILITY OPERATIONS (Cont'd)

- o Operation of the SLAC accelerator for about 4 weeks for R&D studies relating to a future large linear collider.
- o Operation of the AGS at BNL for 5 major HEP experiments for 14 weeks providing the world's highest intensity Kaon beams for experiments probing the boundaries of known physics.
- o Operation of the AGS at BNL for 2 weeks for the initial engineering shakedown of the experiment intended to measure very precisely the magnetic properties of the muon.
- o Funding in the amount of $4,598,000 has been budgeted for the SBIR program.

FY 1997 Planned Accomplishments:

- o Operation of the fixed target capabilities of the Tevatron at Fermilab for about 29 weeks.
- o Operation of the SLC Collider at SLAC utilizing the SLD detector facility for 26 weeks.
- o Operation of fixed target facilities at SLAC for End Station A for 6 weeks.
- o Operation of the SLAC accelerator for about 4 weeks for R&D studies relating to the a future large linear collider.
- o Operation of the AGS at BNL for 5 major HEP experiments for 15 weeks providing the world's highest intensity Kaon beams for experiments probing the boundaries of known physics and for the experiment to measure the magnetic properties of the muon.
- o Funding in the amount of $7,954,000 has been budgeted for the SBIR program.

Explanation of funding changes FY 1996 to FY 1997:

The decrease of $280,000 at Fermilab results from programmatic shifts to provide funding for the involvement in the LHC and for the three major detector fabrication programs.

The decrease of $140,000 at SLAC results from programmatic shifts to provide funding for the involvement in the LHC and for the three major detector fabrication programs.

III. Performance Summary: FACILITY OPERATIONS (Cont'd)

The decrease of $90,000 at BNL results from programmatic shifts to provide funding for the involvement in the LHC and for the three major detector fabrication programs.

The increase of $5,148,000 in Universities and Other Labs reflects an increase of $3,356,000 in the SBIR allocation and an increase of $1,792,000 in other programmatic activities.

HIGH ENERGY TECHNOLOGY
(Tabular dollars in thousands, Narrative in whole dollars)

I. Mission Supporting Goals and Objectives:

This 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.

II. Funding Schedule:

Program Activity	FY 1995	FY 1996	FY 1997	$ Change	% Change
Fermilab National Accelerator Laboratory . .	$14,394	$13,785	$13,515	$- 270	- 2.0%
Stanford Linear Accelerator Center	13,367	15,480	15,170	- 310	- 2.0%
Brookhaven National Laboratory	6,329	6,415	6,285	- 130	- 2.0%
Lawrence Berkeley National Laboratory . . .	9,585	9,313	9,133	- 180	- 1.9%
Universities and Other Labs	13,938	23,930	30,777	+ 6,847	+28.6%
Total, High Energy Technology	$57,613	$68,923	$74,880	$+ 5,957	+ 8.6%

III. Performance Summary:

FY 1995 Accomplishments:

- Produced beams of ultra short electron bunches in the Argonne Wakefield Accelerator with 100 nanoCoulombs in each bunch. This exceeds, by a factor of about 10, the previous world's record.

III. Performance Summary: HIGH ENERGY TECHNOLOGY (Cont'd)

- Completed preparations for new experiments on the LBNL Advanced Light Source test beam line.
- Developed, at LBNL, radiation-hard, high-speed silicon readout chips for use at Fermilab.
- Carried out R&D in support of upgrading the two Tevatron collider detectors to exploit the increased data rates that the Fermilab Main Injector will provide beginning in FY 1999.
- Tested, at BNL, superconducting wire and cable produced for use in several projects. This included critical current measurements, and stability tests on special cable prepared at CERN.
- The BNL Accelerator Test Facility (ATF) set a world record brightness for electron accelerators of 60 amperes per square millimeter. Using a CO_2 laser synchronized to the beam pulses of an electron linear accelerator, the ATF achieved a laser acceleration record of 3.7 million electron volts over 12 centimeters.
- Continued R&D on the feasibility of a high energy linear collider including work on beam optics, high gradient accelerating structures, and the RF system.
- Continued development of advanced detector technology for the B-factory detector.
- Upgraded the optics in End Station A at SLAC to handle a linac energy of 55 GeV for the experimental program.
- Upgraded the SLC to produce a performance level of 100,000 Z^* particles per year at an average electron polarization of 80%.
- Demonstrated improved capability for accelerating polarized protons in the AGS at BNL.
- Performed R&D in support of the B-factory Project. This was done at SLAC, LBNL and LLNL.
- Funding in the amount of $577,000 has been transferred to the SBIR program.

III. Performance Summary: HIGH ENERGY TECHNOLOGY (Cont'd)

FY 1996 Accomplishments (to date and planned):

- o Develop, at the Argonne Wakefield Accelerator, a laser beam with a hemispherical wavefront to produce higher intensity electron bunches.
- o Develop and test, at LBNL, new superconducting wire coatings and materials to improve accelerator magnet performance.
- o Complete testing at LBNL of a magnet built using brittle superconductors capable of producing a much higher magnetic field than is available in accelerator magnets in present use.
- o Complete tests of plasma lens at LBNL, perform studies of the interactions of laser beams and electron beams, and initiate laser acceleration studies at the Advanced Light Source test beam line.
- o Perform, at LBNL, R&D on damping rings for a future linear collider.
- o Test the increased data-rate capability of the two upgraded Tevatron collider detectors using the proton beam extracted from the Tevatron. The D-Zero upgrade to silicon tracking is completed.
- o Develop the capability to test, at BNL, superconducting cable in superfluid helium.
- o Funding in the amount of $4,800,000 is being used for planning and design activities in the U.S. in preparation for the proposed U.S. involvement in the LHC project at CERN.
- o Continued R&D at BNL on RF guns and laser acceleration in the range of 40 to 100 MeV.
- o Complete studies designed to upgrade the SLC to a performance level of 250,000 Z°s per year with greater than 80% polarization of the electron beam.
- o Continue R&D at SLAC on the feasibility of a high energy linear collider including high gradient structures, RF System and beam optics.
- o Complete and bring into initial operation the Next Linear Collider Test Facility (NLCTF) at SLAC.
- o Funding in the amount of $4,932,000 and $715,000 has been budgeted for the SBIR and STTR programs, respectively.

III. Performance Summary: HIGH ENERGY TECHNOLOGY (Cont'd)

FY 1997 Planned Accomplishments:

- Perform the first ever experiments studying wakefield acceleration in dielectric loaded waveguide.
- Apply new LBNL superconducting cables to specific high energy physics magnet upgrades, and fabricate a new higher-field magnet specifically based on improved high-field cable.
- Perform laser acceleration tests on the LBNL Advanced Light Source test beam line; begin tests on relativistic klystron two-beam accelerating hardware.
- Continue collaborative studies at LBNL and SLAC on B-Factory and large linear collider.
- Completion and testing of a new tracking subsystem for the CDF at Fermilab with improved radiation resistance.
- Production testing of LHC superconducting cable at BNL under the US/CERN program for participation in the new collider.
- Funding in the amount of $12,000,000 is requested for U.S. based efforts on the LHC project in accord with the U.S.-CERN agreement on participation in the LHC which is expected to be concluded in 1996.
- Complete and bring into operation a new barrier cavity for use in the AGS at BNL during beam injection and stacking. This will allow new record proton beam intensities, making new generation high precision experiments possible.
- Bring into operation a laser grating accelerator at the ATF at BNL.
- Continue upgrades to the Tevatron Collider accelerator at Fermilab and to the CDF and D-Zero detector facilities in preparation for operation with the higher beam intensities available from the new Fermilab Main Injector beginning in FY 1999.
- Completion of initial feasibility studies for a large linear collider.
- Commissioning of the NLCTF and initial tests on high gradient accelerating structure performance and RF power systems.
- Funding in the amount of $4,231,000 has been budgeted for the SBIR program.

III. Performance Summary: HIGH ENERGY TECHNOLOGY (Cont'd)

Explanation of funding changes FY 1996 to FY 1997:

The decrease of $270,000 at Fermilab results from the programmatic shifts to provide funding for the involvement in the LHC and for the three major detector fabrication programs.

The decrease of $310,000 at SLAC results from the programmatic shifts to provide funding for the involvement in the LHC and for the three major detector fabrication programs.

The decrease of $130,000 at BNL results from the programmatic shifts to provide funding for the involvement in the LHC and for the three major detector fabrication programs.

The decrease of $180,000 at LBNL results from the programmatic shifts to provide funding for the involvement in the LHC and for the three major detector fabrication programs.

The net increase of $6,847,000 in the University and Other Laboratory activity is the result of a $7,200,000 increase in funding for R&D related to the LHC project together with a $348,000 increase in other program activities and a $701,000 decrease in the allocation for the SBIR programs.

HIGH ENERGY PHYSICS

RELATED CAPITAL FUNDING
(Tabular dollars in thousands, Narrative in whole dollars)

I. Mission Supporting Goals and Objectives:

This activity provides for improvements and modifications to existing accelerator and detector facilities that are necessary to explore the fundamental nature of matter. Major accelerator and detector construction projects are included in the construction section. The subprogram includes Accelerator Improvement Projects, which are small projects designed to improve existing accelerator and detector facilities; and Capital Equipment, which provides for new equipment and facilities or the enhancement or extension of existing facilities when Plant changes are not required. In addition, the subprogram includes General Plant Projects and General Purpose Equipment which provide for general purpose facilities not directly a part of the scientific program of a laboratory but essential for maintaining the infrastructure of a site and for addressing ES&H needs.

II. Funding Schedule:

Program Activity	FY 1995	FY 1996	FY 1997	$ Change	% Change
Capital Equipment	$57,700	$65,120	$70,780	$+5,660	+8.7%
General Plant Projects	12,146	12,275	12,025	- 250	-2.0%
Accelerator Improvement Projects	10,590	9,110	8,940	- 170	-1.9%
Total, Related Capital Funding	$80,436	$86,505	$91,745	$+5,240	+6.1%

III. Performance Summary:

FY 1995 Accomplishments:

- Established formal collaboration among the parties who will build BaBar, the B-factory detector. This collaboration involves SLAC and a number of other US and foreign universities and laboratories. Initiated detailed engineering design of the detector. The B-factory detector at SLAC has been identified as a Major Item of Equipment, and was funded at $7,500,000, with a Total Estimated Cost of $67,000,000.

III. Performance Summary: RELATED CAPITAL FUNDING

- The Super-Kamiokande experiment in Japan has been identified as a Major Item of Equipment, and was funded at $880,000, with a Total Estimated Cost of $3,584,000.

- The g-2 experiment at BNL has been identified as a Major Item of Equipment, and was funded at $2,923,000, with a Total Estimated Cost of $16,893,000.

- Rare K decay experiment at BNL has been identified as a Major Item of Equipment, and was funded at $400,000, with a Total Estimated Cost of $9,864,000.

- The D-Zero Upgrade at Fermilab has been identified as a Major Item of Equipment, and was funded at $4,447,000, with a Total Estimated Cost of $55,270,000.

- The CDF Upgrade at Fermilab has been identified as a Major Item of Equipment, and was funded at $4,447,000, with a Total Estimated Cost of $57,940,000.

- KTeV at Fermilab has been identified as a Major Item of Equipment, and was funded at $3,461,000, with a Total Estimated Cost of $18,125,000.

- The Next Linear Collider Test Facility at SLAC has been identified as a Major Item of Equipment, and was funded at $1,700,000, with a Total Estimated Cost of $13,100,000.

- GPP funding was provided for minor new construction, other capital alterations and addition, and for buildings and utility systems. Funding of this type is essential for maintaining the productivity and usefulness of Department-owned facilities and in meeting its requirement for safe and reliable facilities operation. Since it is difficult to detail this type of project in advance, a continuing evaluation of requirements and priorities may result in additions, deletions, and changes in the currently planned projects. The total estimated cost of each project did not exceed $2,000,000.

- AIP funding supported additions and modifications to accelerator facilities which are supported by the HEP research program.

III.Performance Summary: RELATED CAPITAL FUNDING (Cont'd)

FY 1996 Accomplishments (to date and planned):

- Acquisition and fabrication of equipment in support of the R&D program related to the proposed U.S. involvement in the LHC project at CERN. The fund being provided is $1,200,000.

- Procurement of major components of the BaBar detector for the B-factory at SLAC. The B-factory detector at SLAC has been identified as a Major Item of Equipment, and was funded at $14,000,000, with a Total Estimated Cost of $67,000,000.

- The Antimatter Spectrometer in Space experiment has been identified as a Major Item of Equipment, and will be funded at $2,125,000, with a Total Estimated Cost of $2,625,000.

- The Super-Kamiokande experiment in Japan has been identified as a Major Item of Equipment, and will be funded at $1,080,000, with a Total Estimated Cost of $3,584,000.

- The g-2 experiment at BNL has been identified as a Major Item of Equipment, and will be funded at $2,500,000, with a Total Estimated Cost of $16,893,000.

- Rare K decay experiment at BNL has been identified as a Major Item of Equipment, and will be funded at $1,000,000, with a Total Estimated Cost of $9,864,000.

- The D-Zero Upgrade at Fermilab has been identified as a Major Item of Equipment, and will be funded at $7,625,000, with a Total Estimated Cost of $55,270,000.

- The CDF Upgrade at Fermilab has been identified as a Major Item of Equipment, and will be funded at $7,625,000, with a Total Estimated Cost of $57,940,000.

- KTeV at Fermilab has been identified as a Major Item of Equipment, and will be funded at $1,525,000, with a Total Estimated Cost of $18,125,000.

- The Next Linear Collider Test Facility at SLAC has been identified as a Major Item of Equipment, and will be funded at $1,700,000, with a Total Estimated Cost of $13,100,000.

III.Performance Summary: RELATED CAPITAL FUNDING (Cont'd)

- o GPP funding will be provided for minor new construction, other capital alterations and addition, and for buildings and utility systems. Funding of this type is essential for maintaining the productivity and usefulness of Department-owned facilities and in meeting its requirement for safe and reliable facilities operation. Since it is difficult to detail this type of project in advance, a continuing evaluation of requirements and priorities may result in additions, deletions, and changes in the currently planned projects. The total estimated cost of each project will not exceed $2,000,000.

- o AIP funding supported additions and modifications to accelerator facilities which are supported by the HEP research program. The total estimated cost of each project will not exceed $2,000,000.

FY 1997 Planned Accomplishments:

- o Funding in the amount of $3,000,000 is being requested for acquisition and fabrication of equipment in support of the R&D program related to the U.S. involvement in the LHC project at CERN in accord with the U.S.-CERN agreement on participation in LHC which is expected to be concluded in 1996.

- o Completion of the subsystems of the BaBar detector and initiation of assembly in the detector hall in anticipation of first research with the B-factory in FY 1999. The B-factory detector at SLAC has been identified as a Major Item of Equipment, and will be funded at $20,500,000, with a Total Estimated Cost of $67,000,000.

- o Delivery and testing of the large solenoidal magnet for the D-Zero detector facility upgrade at Fermilab.

- o The Antimatter Spectrometer in Space experiment has been identified as a Major Item of Equipment, and will be funded at $500,000, with a Total Estimated Cost of $2,625,000.

- o The Super-Kamiokande experiment in Japan has been identified as a Major Item of Equipment, and will be funded at $593,000, with a Total Estimated Cost of $3,584,000.

- o Rare K decay experiment at BNL has been identified as a Major Item of Equipment, and will be funded at $1,000,000, with a Total Estimated Cost of $9,864,000.

III. Performance Summary: RELATED CAPITAL FUNDING (Cont'd)

- The D-Zero Upgrade at Fermilab has been identified as a Major Item of Equipment, and will be funded at $10,000,000, with a Total Estimated Cost of $55,270,000.

- The CDF Upgrade at Fermilab has been identified as a Major Item of Equipment, and will be funded at $10,000,000, with a Total Estimated Cost of $57,940,000.

- GPP funding will be provided for minor new construction, other capital alterations and addition, and for buildings and utility systems. Funding of this type is essential for maintaining the productivity and usefulness of Department-owned facilities and in meeting its requirement for safe and reliable facilities operation. Since it is difficult to detail this type of project in advance, a continuing evaluation of requirements and priorities may result in additions, deletions, and changes in the currently planned projects. The total estimated cost of each project will not exceed $2,000,000.

- AIP funding supported additions and modifications to accelerator facilities which are supported by the HEP research program. The total estimated cost of each project will not exceed $2,000,000.

Explanation of funding changes FY 1996 to FY 1997:

- The decrease of $250,000 in GPP results from the programmatic shifts to provide funding for the involvement in the LHC and for the three major detector fabrication programs.

- The decrease of $170,000 in AIP results from the programmatic shifts to provide funding for the involvement in the LHC and for the three major detector fabrication programs.

- The funding for Other Capital Equipment at BNL is unchanged.

- The increase of $5,660,000 in programmatic Capital Equipment reflects an increase of $1,800,000 for R&D efforts related to the proposed U.S. involvement in the LHC project, an increase of $4,170,000 in the funding for SLAC with strong emphasis on the B-factory detector, an increase of $4,500,000 in the funding for Fermilab with strong emphasis on the CDF and D-Zero upgrade projects at Fermilab offset by a decrease of $4,810,000 in other program activities.

HIGH ENERGY PHYSICS

CONSTRUCTION
(Tabular dollars in thousands, Narrative in whole dollars)

I. Mission Supporting Goals and Objectives:

II. Funding Schedule:

Program Activity	FY 1995	FY 1996	FY 1997	$ Change	% Change
Construction	$87,000	$104,000	$100,000	$-4,000	-3.9%
Total, Construction	$87,000	$104,000	$100,000	$-4,000	-3.9%

III. Performance Summary:

FERMILAB MAIN INJECTOR

FY 1995 Accomplishments:

- Completion of construction of 3/4 of ring tunnel and fabrication and testing 1/4 of the main dipole magnets for the Fermilab Main Injector Project.
- At the end of FY 1995, the Fermilab Main Injector Project was 36% complete.

FY 1996 Accomplishments (to date and planned):

- Completion of construction of all of the ring tunnel and service buildings, and fabrication and testing of 70% of the main dipole magnets for the Fermilab Main Injector Project.
- At the end of FY 1996, the Fermilab Main Injector Project will be 62% complete.

III. Performance Summary: CONSTRUCTION (Cont'd)

FY 1997 Planned Accomplishments:

- Completion of 95% of the main dipole magnets, all of the magnet power supplies, and the local electric power substation for the Fermilab Main Injector Project.

- At the end of FY 1997, the Fermilab Main Injector Project will be 80% complete.

SLAC B-FACTORY

FY 1995 Accomplishments:

- Completion of tunnel clearing; initiation of refurbishment of magnets for the high energy ring; and initiation of fabrication of magnets for the low energy ring; for the B-factory Project at SLAC.

- At the end of FY 1995, the SLAC B-factory Project was 36% complete.

FY 1996 Accomplishments (to date and planned):

- Completion of fabrication and installation of all of the magnets and vacuum chambers for the high energy ring; successful testing of the electron transfer lines; completion and initial testing of the control system; and completion of the positron extraction system for the B-factory Project at SLAC.

- At the end of FY 1996, the SLAC B-factory Project will be 70% complete.

III. Performance Summary: CONSTRUCTION (Cont'd)

FY 1997 Planned Accomplishments:

- Completion of the technical components of the B-factory and initiation of testing with beam in anticipation of project completion in FY 1998.
- At the end of FY 1997, the SLAC B-factory Project will be 90% complete.

SLAC MASTER SUBSTATION UPGRADE

FY 1995 Accomplishments:

- N/A (project begins in FY 1997)

FY 1996 Accomplishments (to date and planned):

- N/A (project begins in FY 1997)

FY 1997 Planned Accomplishments:

- Initiation of an infrastructure improvement project at SLAC to upgrade and reconfigure the master substation which supplies power to the entire SLAC site. This will replace obsolete and hard to maintain switchgear; improve worker safety; and extend the useful life of the two primary transformers.
- At the end of FY 1997, the SLAC Master Substation Upgrade Project will be 25% complete.

III. Performance Summary: CONSTRUCTION (Cont'd)

Explanation of funding changes FY 1996 to FY 1997:

Level funding for the Fermilab Main Injector maintains the project on the approved funding profile.

The decrease of $7,000,000 in the SLAC B-factory maintains the project on the approved funding profile.

Funding of $3,000,000 is included for initiation of the SLAC Master Substation Upgrade.

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

	FY 1995	FY 1996	FY 1997	$ Change	% Change
Capital Operating Expenses					
General Plant Projects (total)	$12,146	$12,275	$12,025	$-250	-2.0%
Capital Equipment (total)	57,700	65,120	70,780	+5,660	+8.7%
Accelerator Improvement Projects (total)	10,590	9,110	8,940	-170	-1.9%

Construction Project Summary (both Operating and Construction Funded)

Project Number	Project Title	TEC	Previous Approp.	FY 1995 Approp.	FY 1996 Approp.	FY 1997 Request	Unapprop. Balance
92-G-302	Fermilab Main Injector	$229,600	$51,650	$43,000	$52,000	$52,000	$30,950
94-G-304	B-Factory	177,000	36,000	44,000	52,000	45,000	0
97-G-303	SLAC Master Substation Upgrade	12,400	--	--	--	3,000	9,400
	Total High Energy Physics	--	$87,650	$87,000	$104,000	$100,000	$40,350

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

	TEC	Previous Approp.	FY 1995 Approp.	FY 1996 Approp.	FY 1997 Request	Acceptance Date
1. g-2 Experiment	$ 16,893	$ 11,470	$ 2,923	$ 2,500	$ 0	FY 1996
2. Rare k-decay Experiment	9,864	7,464	400	1,000	1,000	FY 1997
3. KTeV Experiment	18,125	13,139	3,461	1,525	0	FY 1996
4. D-Zero Upgrade	55,270	8,490	4,447	7,625	10,000	FY 1999
5. CDF Upgrade	57,940	9,960	4,447	7,625	10,000	FY 1999
6. B-factory detector (BaBar)*	67,000	1,000	7,500	14,000	20,500	FY 1998
7. Next Linear Collider Test Facility	13,100	9,700	1,700	1,700	0	FY 1996
8. AntiMatter in Space	2,625	0	0	2,125	500	FY 1997
9. Super-Kamiokande	3,584	500	880	1,080	593	FY 1998

* 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.

DEPARTMENT OF ENERGY

FY 1997 CONGRESSIONAL BUDGET REQUEST

GENERAL SCIENCE AND RESEARCH

PROJECT DATA SHEETS

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High Energy Physics

DEPARTMENT OF ENERGY
FY 1997 CONGRESSIONAL BUDGET REQUEST

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

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 14% 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.

DEPARTMENT OF ENERGY
FY 1997 CONGRESSIONAL BUDGET REQUEST
(Changes from FY 1996 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: B-Factory
Stanford Linear Accelertor 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 (Title I & Title 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 (Federal Funds):

Fiscal Year	Appropriations	Obligations	Costs
1994	$ 36,000	$36,000	$13,385
1995	44,000	44,000	39,470
1996	52,000	52,000	60,000
1997	45,000	45,000	47,430
1998	0	0	16,715

8. Project Description, Justification and Scope

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 in the PEP tunnel. The two rings will intersect in one of the existing PEP interaction

8. Project Description, Justification and Scope (Continued)

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.

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 broad program of experimental studies of bottom quark, charm quark, tau lepton, and two-photon physics with large numbers of events and thus high

8. Project Description, Justification and Scope (Continued)

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 $b\bar{b}$ (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.

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.

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

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

9. 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: There is significant foreign involvement in the detector (see Section 12a).

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

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

10. 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.

11. 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	$ 39,470	$ 60,000	$ 47,430	$ 16,715	$177,000
2. Other project costs							
(a) R&D	19,700	5,200	4,400	4,300	1,300	0	34,900
(b) Pre-operations	0	0	0	0	1,300	11,200	12,500
(c) Capital Equip. for R&D	100	300	500	0	0	0	900
(d) Detector (Capital Equip.)	0	100	3,500	10,400	30,000	23,000	67,000
(e) Spares	0	0	0	0	0	900	900
Total other project. costs	19,800	5,600	8,400	14,700	32,600	35,100	116,200
Total project cost	19,800	18,985	47,870	74,700	80,030	51,815	293,200
(f) Non-Federal contribution	0	0	0	0	0	0	0
(g) Net Federal total project cost	$ 19,800	$ 18,985	$ 47,870	$ 74,700	$ 80,030	$ 51,815	$293,200

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

1. Power costs for B-Factory	$ 9,100
2. Other operating costs for B-Factory	19,100
Total annual funding (in FY 1999 dollars)	$ 28,200

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

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

12. 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. There is significant foreign involvement in the detector (see (f) below).
      (e) Spares: Provides for spares of critical technical components with significant delivery times.
      (f) Non-Federal contribution: The total detector costs in 2(d) reflects cost savings of about $20,000,000 resulting primarily from the contribution of detector components and subsystems by non-U.S. collaborating institutions.

b. Related annual costs

   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 1997 CONGRESSIONAL BUDGET REQUEST
(Changes from FY 1996 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: 30 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	36,517
1996	52,000		52,000	48,400
1997	52,000		52,000	52,000
1998	30,950		30,950	38,583
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. 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. 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 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 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. Project Description, Justification and Scope (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.

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 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 has recently been 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. 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 luminosity will be increased to at least 5×10^{31} $cm^{-2}sec^{-1}$. These performance goals are expected to be achieved after months of operational experience with the new accelerator.

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

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

9. Details of Cost Estimate*

		Item Cost	Total Cost
a.	Engineering Design Inspection and assembly at 17 percent of construction costs		$28,400
b.	Main Injector construction costs		167,900
	1. Conventional construction	$75,500	
	2. Special facilities	92,400	
c.	Contingencies at 17 percent of above costs		33,300
	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.

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	200	100	100	350
(d) Inventories and Spares	0	0	0	0	0
Total other project costs	5,400	4,500	6,100	1,800	1,350
Total project costs	$ 5,400	$ 5,490	$ 16,037	$ 29,118	$ 37,867

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	$ 38,583	$ 15,855	$229,600
	$ 48,400	$ 52,000	$ 38,583	$ 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	1,000	1,000	2,000
(c) Capital equipment	100	150	0	0	1,000
(d) Inventories and Spares	1,000	3,500	3,800	0	8,300
Total other project costs	1,100	3,650	4,800	1,000	29,700
Total project costs	$ 49,500	$ 55,650	$ 43,383	$ 16,855	$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.