DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH

OVERVIEW

HIGH ENERGY PHYSICS

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

Since the program supports basic research into the nature of matter and energy at the most fundamental level, it is directly relevant in the long term to the national goal of energy security and high energy physics is a major contributor to the National Energy Strategy (NES) goal "Fortifying our Foundations". Research in high energy physics is a stated part of the DOE mission and the DOE serves as the Executive Agent for the U.S. program in high energy physics. High energy physics has proven to be an extremely challenging and appealing intellectual activity. It attracts some of the best minds in the nation, and provides substantial input to the intellectual ferment which fuels the nation's science and engineering enterprise. High energy physics is an excellent discipline for the training of physicists, and many high energy physics Ph.D. recipients go on to highly productive careers in other scientific disciplines.

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

The Fermi National Accelerator Laboratory (Fermilab) is one of the outstanding scientific institutions in the world and the accelerator under construction at the Superconducting Super Collider Laboratory (SSCL) will have unparalleled capabilities. Thus, high energy physics research activities contribute in a major way to the world preeminence of the nation's scientific and technical enterprise both now and in the future.

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

There are three DOE supported high energy physics accelerator centers: Fermilab, the Stanford Linear Accelerator Center (SLAC), and the Alternating Gradient Synchrotron (AGS) complex at Brookhaven National Laboratory (BNL). Each of these centers provides unique research capabilities and is operated as a national facility which is made available to qualified experimenters on the basis of the scientific merit of their research proposals. To these is being added the Superconducting Super Collider Laboratory. Funding for construction of the Superconducting Super Collider (SSC) is presented in a separate FY 1993 budget request.

Experiments by U.S. scientists are also carried out at the Cornell Electron Storage Ring (CESR) facility which is largely supported by the National Science Foundation. U.S. experimenters also carry out research at foreign accelerators which have unique capabilities not available in the U.S. Finally, some important experiments do not require accelerators, but instead take advantage of processes that occur in the natural environment, sometimes deep underground, deep underwater, or on mountaintops. The experimental research, as well as theoretical research, is carried out largely by university-based scientists.

The ability to carry out forefront exploratory research on the physics frontier is critically dependent on the experimental capabilities of the accelerator, colliding beam, and detector facilities, the effective utilization of those facilities, and the provision of upgraded and new facilities on a timely basis. This dependence of the program on facilities strongly influences program planning and strategy.

Two recently completed major upgrades of U.S. high energy physics facilities, the Stanford Linear Collider (SLC) and the Fermilab Tevatron Collider, are now in operation for research. The Tevatron is the world's highest energy particle accelerator, and the only one in operation which uses superconducting magnets. It will keep the U.S. program highly competitive and at the cutting edge for the next several years. The SLC should approach the level of 100,000 polarized Z's per year during 1992 and will provide unique opportunities. Strong and effective utilization of these facilities in the next few years is critical to the U.S. program.

More than 75 percent of the physics research done at U.S. high energy physics accelerator facilities is carried out by university-based scientists, and their participation is critical to the strength and vitality of the U.S. program. It is essential that the capability of university scientists to participate effectively in world forefront experiments be maintained. With the planned utilization of the existing facilities, particularly the Tevatron and the SLC, strong continuing support for university-based scientists will be needed to allow effective participation by these scientists and to maintain the technical capabilities of the major university laboratories. Support for scientists participating in planning and in R&D activities related to the use of the SSC is an increasing component of the high energy physics research activity.

The Superconducting Super Collider (SSC) is being constructed to provide a new, more powerful particle accelerator capable of exploring the TeV mass region. The SSC is essential to advance our understanding of the fundamental nature of matter and energy and to enable the U.S. High Energy Physics program to remain at the research frontier beyond the 1990's. The SSC will be a proton-proton collider having an energy of 20 TeV per beam. It will permit exploration of this new domain of physics research which cannot be reached by any existing facility. Construction of the SSC and of its initial complement of detectors is presented in a separate SSC budget submission. The SSC is an integral part of the national High Energy Physics program; therefore, the basic research support for the physicists planning and preparing experiments to be conducted at the SSC will continue to be an integral part of the High Energy Physics program presented in this budget submission.

The strategy for the overall High Energy Physics program for FY 1993 revolves around the following key factors:

o Careful planning to optimize the physics output of the program. It is anticipated that the assistance of a HEPAP Subpanel will be available to provide advice on the structure and objectives of the program in the near and mid term.

o Operations of the forefront research capabilities of the SLC collider and of the Tevatron accelerator/collider will be conducted at the maximum reasonable level. The Tevatron collider operations in FY 1993 will allow research utilization both of the mature Collider Detector at Fermilab (CDF) and of the complementary new D-Zero detector facility. The SLC at SLAC will be operated for physics research with its new polarized electron beam capability and the SLC Large Detector (SLD). The SLAC linac will be operated for fixed target experiments in End Station A. With its new booster becoming operational, BNL's Alternating Gradient Synchrotron (AGS) will provide progress toward improved direct tests of the Standard Model via detailed study of rare decay modes of kaons.

o Construction of the Main Injector at Fermilab will be continued. This project will greatly enhance the physics capabilities of the existing Tevatron accelerator and its detector facilities during the last half of the decade. It will provide early experience with collider detectors at luminosities approaching that of the SSC, and could yield new physics results which would significantly influence the SSC physics goals and detector designs. It will also make calibration and test beams for SSC detector subsystems continuously available for use without interference with the Tevatron research programs.

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

o Pursuit of long range accelerator and detector R&D studies to develop new and advanced concepts and technologies is critical to the long range viability and continued advancement of the program. Innovative new technologies are essential to the continued enhancement and extension of accelerator and detector capabilities of high energy physics research. Priority will be given to continuing the most promising concepts.

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OFFICE OF ENERGY RESEARCH
(dollars in thousands)

LEAD TABLE

High Energy Physics

Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Base	FY 1993 Request	Program Change Request vs Base: Dollar	Program Change Request vs Base: Percent
Operating Expenses						
Physics Research	$135,107	$145,370	$145,370	$145,900	$530	0%
Facility Operations	258,417	270,690	270,690	281,909	11,219	4%
High Energy Technology	67,387	73,830	73,830	69,425	(4,405)	-6%
SSC Lab Research	0	0	0	2,500	2,500	--
Capital Equipment	82,989	87,740	87,740	73,220	(14,520)	-17%
Construction	38,851	50,369	50,369	57,930	7,561	15%
TOTAL	$582,751	$627,999	$627,999	$630,884	$2,885	0%
Summary						
Operating Expenses	($460,911) a/	($489,890)	($489,890)	($499,734)	$9,844	2%
Capital Equipment	(82,989)	(87,740)	(87,740)	(73,220)	(14,520)	-17%
Construction	(38,851)	(50,369)	(50,369)	(57,930)	7,561	15%
Total Program	($582,751) b/c/	($627,999)	($627,999)	($630,884)	$2,885	0%
Staffing (FTEs)	(Reference General Science Program Direction)					

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

a/ Total has been reduced by $5,828,000 ($1,911,000 Physics Research, $1,950,000 Facility Operations, $1,967,000 High Energy Technology) reprogrammed to Energy Supply for SBIR.
b/ Total has been reduced by sequester of $7,652 in accordance with Senate Report 101-378.
c/ Total has been reduced by $32,600,000 for General Reduction.

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SUMMARY OF CHANGES

High Energy Physics

FY 1992 Enacted Appropriation..	$ 627,999
Adjustments - Increased personnel costs..	0
FY 1993 Base..	627,999
- Funding required to maintain a constant overall level of program activity............	+ 22,862
<u>Physics Research</u>	
- Reduction in funding for physics research requiring significant reductions in the level of activity at the laboratories and universities.........................	- 4,849
<u>Facility Operations</u>	
- Increases in funding for facility operations allowing slight increases in facility operations..	+ 1,203
<u>HEP Technology</u>	
- Reduction in funding for HEP technology requiring substantial reductions in HEP technology activities in the universities and laboratories and especially at SLAC and BNL...	- 7,137
<u>Capital Equipment</u>	
- Reduction in funding for Capital Equipment requiring reductions in the planned level of activity for fabrication of experimental apparatus..........................	- 18,266
<u>SSC Laboratory</u>	
- Initiation of separate subprogram for SSC laboratory based HEP research efforts.......	+ 3,000

Construction

- Continuation of Fermilab Main Injector construction project...........................	+ 15,000
- Reduction in level of effort for AIP and GPP provided to support the accelerator facilities and laboratories...	- 2,762
- Reduction for completion of Fermilab Linac Upgrade project...........................	- 6,166
FY 1993 Congressional Budget Request..	$ 630,884

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KEY ACTIVITY SUMMARY

HIGH ENERGY PHYSICS

I. Preface: Physics Research

This activity provides support for university and laboratory based research groups conducting experimental and theoretical research in high energy physics. This research probes the nature of matter and energy at the most fundamental level, and the characteristics of the basic forces in nature. Experimental research activities include: planning, design, fabrication and installation of experiments; conduct of experiments; analysis and interpretation of data; and dissemination of results. Theoretical physics research provides the framework for interpreting and understanding observed phenomena and, through predictions and extrapolations based on existing theories, identifies key questions for future experimental explorations. This subprogram supports research groups at more than 100 universities as well as at the 11 DOE laboratories which participate in high energy physics research.

Experiments in high energy physics require the use of large particle accelerators, together with complex detection apparatus, to study the results of the collisions of particles at high energies. The DOE-supported operating high energy physics accelerators are located at three existing central laboratories, Fermilab, SLAC, and BNL. These three, together with the SSC which is under construction at the SSC Laboratory, are made available to qualified scientists on the basis of the scientific merit and promise of their research proposals. Detectors and experimental facilities are located at the DOE accelerator laboratories, at other accelerators around the world, and at a number of sites not associated with accelerators. More than 75 percent of the research done with these facilities is performed by university-based physicists. The balance of the research is done by scientists at the accelerator laboratories and certain other DOE laboratories. Because of the size and complexity of a typical high energy physics experiment, users from a number of institutions frequently collaborate on a given experiment. These research teams typically include a mix of physicists, engineers, technicians, and graduate students. After a research proposal to the laboratory is approved, the research teams participate in the design and fabrication of the experimental apparatus and provide manpower for the experiment during the data-taking phase at the laboratory. There is significant interaction and participation from laboratory staff and use of laboratory support facilities for each experiment. The entire process, from conception of the experiment to publication of results, typically takes up to five years if no major new detector is involved; if major detector design and fabrication is involved, the total duration can be several years longer. U.S. user groups also participate in experiments which take advantage of unique accelerator capabilities and opportunities at other laboratories; for example, the Cornell Electron Storage Ring (CESR), supported by the U.S. National Science Foundation, and at foreign laboratories such as DESY (Germany), CERN (Western Europe), KEK (Japan), and SERPUKHOV (Russia). There is also a program of experiments not requiring beams from accelerators, of which experiments to search for proton decay and magnetic monopoles are presently the major component.

FY 1993 will be a year of strong research output as the data collected in FY 1992 and previous years is analyzed from the forefront SLC collider at SLAC with the recently installed SLD detector and from the world unique Tevatron collider at Fermilab with its CDF and D-Zero collider detector facilities. Experimental groups will be supported at a reduced level. Priority will be given to analysis of existing data and data collection at the operating facilities. Restoration of the technical capabilities of the major university laboratories will continue, but at a constrained rate. In addition, FY 1993 will include effort on planning for experiments for the SSC.

II. A. Summary Table: Physics Research

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Fermilab	$ 9,994	$ 10,048	$ 10,443	+ 4
SLAC	12,168	12,580	12,580	0
BNL	7,975	8,555	7,895	- 8
ANL	5,650	5,870	5,400	- 8
LBL	11,176	11,290	10,390	- 8
Universities and Other Labs	88,144	97,027	99,192	+ 2
Total, Physics Research	$ 135,107	$ 145,370	$ 145,900	0

II. B. Major Laboratory and Facility Funding

Argonne National Laboratory (East)	$ 5,650	$ 5,870	$ 5,400	- 8
Brookhaven National Laboratory	$ 7,975	$ 8,555	$ 7,895	- 8
Fermi National Accelerator Laboratory	$ 9,994	$ 10,048	$ 10,443	+ 4
Lawrence Berkeley National Laboratory	$ 11,176	$ 11,290	$ 10,390	- 8
Stanford Linear Accelerator Laboratory	$ 12,168	$ 12,580	$ 12,580	0

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

Program Activity	FY 1991	FY 1992	FY 1993
Physics Research			
Fermilab	The Fermilab research groups continued the physics analysis and data taking in the fixed target part of their programs, and made final preparations in the colliding beam research programs for a long operating period starting in FY 1992. Following extended data processing activities and preliminary physics interpretation during the first half of this year, the fixed target detector facility groups entered into intense around-the-clock operations for more data collection late in the year. The groups involved in research using the CDF and D-Zero collider detector facilities completed their apparatus and computer programs in preparation for a long data run scheduled to extend over the next two years. Many of the Fermilab research physicists devoted part of their time working on the Solenoidal Detector Collaboration (SDC) detector to be used at the SSC Laboratory. The theoretical physics group and the particle astrophysics group continued their roles of providing interpretations and insights as new experimental results emerge.	The fixed target research groups will finish their data taking and achieve completion of almost all of the approved experiments. They will turn their efforts to the processing and analysis of the data collected. They will also work on the design of modifications and reconfigurations of their detector facilities for future use. The colliding beam research groups will enter into an intense period of commissioning of their detector facilities again with beam, and then a long physics run during the last half of the year. Theoretical physics, particle astrophysics and SDC design work will all continue.	After several months interruption for installation and commissioning of the Linac Upgrade project, the Tevatron collider run begun last year will resume and continue through most of the rest of FY 1993. The collider research groups will continue data collection, while the fixed target research groups will continue their physics analysis activities of last year, and preparations for a future data collection period. The SDC participants expect to begin fabrication work on components and subsystems of that future SSC detector facility, and preparations for putting them into test beams. Particle astrophysics and theoretical physics will continue.
	$ 9,994	$ 10,048	$ 10,443

III. Physics Research (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
SLAC	Research in High Energy Physics at SLAC involves experiments carried out with all of SLAC's high energy physics accelerator facilities: (1) the SLAC Linear Collider (SLC), (2) the PEP storage ring, and (3) the SLAC 2-mile Linac. The linac serves a unique fixed target facility at End Station A and also is the injector for SLC and PEP. A new detector (SLD), designed to optimize results with SLC, was installed in 1991. The laboratory's highest priority was to continue increasing SLC luminosity, complete the commissioning of the SLD, and to install and commission equipment to provide a polarized SLC electron beam by the beginning of FY 1992. Analysis of data from earlier runs of the Mark II detector at SLC and of the TPC detector at PEP were completed in FY 1991. A fixed-target experiment with polarized He3 was carried out in End Station A. Analysis of these first runs has been completed. No running of PEP for high energy physics was planned for FY 1991. The theoretical physics group will continue its role of providing interpretation and insights on new experimental results.	SLAC's highest priority will go to running the SLD at the SLC at the highest achievable luminosity and polarization. It is expected that by the end of FY 1992 a rate of more than 50 polarized Z's/hour will have been achieved. This will correspond to an accumulation of good measurements on 10,000 to 20,000 polarized Z's. Effort will be concentrated on promptly completing the analysis of these events. Data taking and analysis of fixed target experiments in End Station A using the 2-mile Linac polarized electron beam are expected to increase. Some SLAC high energy physicists will be pursuing detailed studies of charm and tau physics using data provided by the Institute of High Energy Physics in Beijing, China using its BES detector at the Beijing Electron Positron Collider (BEPC). Theoretical physics efforts will continue.	The level of effort for this activity is reduced about 5% from the FY 1992 level. SLAC's highest priority will go to running the SLD at the SLC at the highest achievable luminosity and polarization. Effort will be concentrated on maximizing the number of good events and analyzing the complete run. Data taking and analysis of fixed target experiments in End Station A using the 2-mile Linac polarized electron beam will continue. Detailed study of charm and tau physics in collaboration with the Institute of High Energy Physics in Beijing, China will continue. Theoretical physics efforts will continue.
	$ 12,168	$ 12,580	$ 12,580

III. Physics Research (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
BNL	Data accumulation involving a kaon-decay experiment began, which may challenge the prediction of the Standard Model for the rate of certain rare decays. Beam tests of a new high-rate target for another of the kaon-decay experiments were conducted. Two of the four large superconducting coils were fabricated for the g-2 experiment. The BNL D-Zero group completed the D-Zero detector and prepared for its first operation at the Tevatron at Fermilab.	One of the rare kaon-decay experiments will commission its new radiation-hardened beamline and upgraded high-rate detector. Operational beam time will be used largely for engineering shakedown runs of the beamlines and detectors. Fabrication of the g-2 experiment will continue. The BNL D-Zero group is expected to run most of FY 1992 with the Tevatron collider at Fermilab. Analysis of the D-Zero data is expected to provide important new physics results.	The level of effort for this activity is reduced by about 13% from FY 1992. The radiation-hardened high intensity kaon beamline and the upgraded high rate kaon-decay experiment should accumulate data challenging specific Standard Model predictions for the rates of certain rare kaon decays. The g-2 experiment will be ready for engineering shakedown running. Analysis of data from the D-Zero experiment may be showing exciting new physics at high particle masses.
	$ 7,975	$ 8,555	$ 7,895
ANL	ANL leadership of the U.S. participation in the ZEUS electron-proton experiment at HERA/DESY continued as construction was completed and commissioning began. ANL also provides a major role in instrumentation and analysis for the CDF detector and continued leadership of both the polarized scattering program at Fermilab and the SOUDAN-2 proton decay experiment. ANL work on the Solenoidal Detector Collaboration (SDC) for the SSC continues to move toward a complete technical proposal.	The ANL program will include the ZEUS electron-proton detector at DESY in Hamburg and the CDF at Fermilab. The SOUDAN-2 detector, with leadership from ANL, will be in its final year of construction. A large fraction of the effort given to detector development will be focussed on the barrel calorimeter for SDC which has been selected to be one of the first experiments at the SSC lab. This work builds smoothly on the successful ZEUS calorimetry work. ANL has a strong theory group with an outstanding phenomenology component. Much of the research will be focused on the physics of CDF and SDC.	The level of effort for this activity is reduced by about 13% from FY 1992. The lab will have to defer completion of some tasks and/or decrease the scope of others. Some staff reductions will be required. Experimental groups will continue to concentrate on taking data from detectors at colliding beam facilities with beams of energies and intensities previously unattainable. The ANL program will include the ZEUS electron-proton detector at DESY in Hamburg and CDF at Fermilab. The SOUDAN-2 detector, with leadership from ANL, will be completed and ready to take data. An increasing fraction of the effort will be given to detector development focussed on the large SDC which has been selected to be one of the two first experiments at the SSC lab.
	$ 5,650	$ 5,870	$ 5,400

Program Activity	FY 1991	FY 1992	FY 1993
LBL	LBL continued its strong participation in both the D-Zero and CDF detectors at Fermilab and will continue to have a major role in analysis of Mark II and TPC data. Work on the Solenoidal Detector Collaboration (SDC) for the SSC continued to move toward a complete technical proposal. LBL also continues strong programs in astrophysics and theory. The Particle Data Group, which serves as the archivist of particle data properties, is part of the LBL program.	Experimental groups at LBL will concentrate on taking data from CDF and DO detectors at Fermilab. A large fraction of the effort at LBL will be given to detector development focussed on the SDC detector which has been selected to be one of the first of two large detectors at the SSC lab. Strong theory and astrophysics programs exist at LBL. The Particle Data Group which serves as the archivist of particle data properties is part of the LBL program.	The level of effort for this activity is reduced about 13% from FY 1992. The lab will have to defer completion of some tasks and decrease the scope of their planned activities. Staff reductions will be required. Experimental groups will continue to concentrate on taking data from the CDF and D-Zero detectors at Fermilab. A large fraction of the effort will be given to detector development focussed on the large SDC detector which has been selected to be one of the first experiments at the SSC lab. Strong theory and astrophysics programs exist at LBL. The Particle Data Group which serves as the archivist of particle data properties is resident at LBL.
	$ 11,176	$ 11,290	$ 10,390
Universities and Other Labs	Groups at universities and other DOE laboratories (including scientists at SSC lab) participated in major experiments at U.S. and foreign laboratories and scientists engaged in planning and R&D activities in preparation for experiments at the SSC. Important new experiments include the SLD experiment at the SLC (SLAC) for precision studies of electron-positron beam collisions producing Z particles; the D-Zero experiment at the Tevatron (Fermilab) to study proton-antiproton beam collisions, complementing the CDF experiment; and, the ZEUS experiment at HERA (DESY) to study electron-proton beam collisions at high energies. The manpower, technical, and computational capabilities of leading universities increased somewhat to better analyze the voluminous data produced by cutting edge experiments. Includes computer lease at MIT.	Groups at universities and other DOE laboratories (including scientists at SSC lab) will participate in major experiments at U.S. and foreign laboratories. Also, many of the groups will engage in planning and R&D activities in preparation for experiments at the SSC. Important new experiments will have initial running, including: the SLD experiment at the SLC (SLAC); the D-Zero experiment at the Tevatron (Fermilab); and, the ZEUS experiment at HERA (DESY). Also, the precision measurement of the muon's anomalous magnetic moment will be in final stages of preparation at BNL, as will the MACRO experiment (Italy), the SOUDAN II experiment (Minnesota), and the DUMAND experiment (Hawaii). The manpower, technical, and computational capabilities of leading universities will be increased somewhat to better analyze the voluminous data produced by cutting edge experiments. Includes	The level of effort for this activity is reduced about 3% from FY 1992. Groups at universities and other DOE laboratories will participate in major experiments at U.S. and foreign laboratories. Also, many of the groups will engage in planning and R&D activities in preparation for experiments at the SSC. Important new experiments will continue initial running, including: the SLD experiment at the SLC (SLAC); the D-Zero experiment at the Tevatron (Fermilab); the ZEUS experiment at HERA (DESY); and the MACRO Experiment (Italy). Also, the precision measurement of the muon's anomalous magnetic moment will be in preparation at BNL, as will some upgraded experiments at BNL for rare K-decays, and preparations for fixed target experiments at Fermilab, the SOUDAN II experiment (Minnesota), and the DUMAND experiment (Hawaii). To minimize the reduction in support for

III. Physics Research (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Universities and Other Labs (Cont'd)		computer lease at MIT.	the highest priority activities, about 5 university groups will be dropped or substantially reduced. Only the most scientifically compelling new non-accelerator and foreign accelerator experiments will be undertaken. Includes computer lease at MIT and funding for the SBIR assessment. Funding for SSCL staff to conduct research in high energy physics, not specifically related to the construction of the SSC, is requested in the SSC Laboratory Research subprogram.
	No activity.	No activity.	In an effort to manage administrative costs more closely, the PSO/Office Directors' share of FTE-dependent costs for space, supplies, and telecommunications are included in this budget and will be transferred during the execution year.
	$ 88,144	$ 97,027	$ 99,192
Physics Research	$ 135,107	$ 145,370	$ 145,900

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(dollars in thousands)

KEY ACTIVITY SUMMARY

HIGH ENERGY PHYSICS

I. Preface: Facility Operations

This activity includes funding for the operation and maintenance of the national laboratory research facilities including accelerators, colliders, secondary beam lines, detectors for experiments, experimental areas, computing and computer networking facilities. It includes the costs of manpower, electric power, expendable supplies, replacement parts and subsystems, and inventories. The major DOE supported facilities to be operated in FY 1993 are the Fermilab Tevatron (800 GeV proton fixed target and 900 GeV antiproton-proton colliding beams); SLAC (50 GeV linear accelerator) and the SLC (50 GeV on 50 GeV electron-positron collider); and the BNL AGS (25 GeV proton fixed target program) with the recently commissioned AGS booster. The SLAC SLC, and the Fermilab Tevatron will be operated for physics for the most of FY 1993. The BNL AGS accelerators will be operated for only a limited portion of FY 1993.

II. A. Summary Table: Facility Operations

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Fermilab Operations	$ 130,345	$ 136,430	$ 142,735	+ 5
SLAC Operations	85,682	89,500	91,502	+ 2
BNL-AGS Operations	39,180	42,590	44,962	+ 6
Other Operations	3,210	2,170	2,710	+ 25
Total, Facility Operations	$ 258,417	$ 270,690	$ 281,909	+ 4

II. B. Major Laboratory and Facility Funding

Brookhaven National Laboratory	$ 39,180	$ 42,590	$ 44,962	+ 6
Fermi National Accelerator Laboratory	$ 130,345	$ 136,430	$ 142,735	+ 5
Stanford Linear Accelerator Laboratory	$ 85,682	$ 89,500	$ 91,502	+ 2

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

Program Activity	FY 1991	FY 1992	FY 1993
Facility Operations			
Fermilab Operations	The Tevatron was in operation for physics research in FY 1991 for 11 weeks. This was a continuation of the fixed target research program and the test beam activities begun in 1990. All but four of the sixteen approved fixed target experiments at Fermilab will fully complete their data-taking early next year, and those four will accumulate significant quantities of new research data. Major efforts were undertaken in preparation for operation of the antiproton-proton colliding beam research program for FY 1992.	The Tevatron is scheduled to be in operation for research for 39 weeks in FY 1992. The first 14 weeks of the fiscal year will conclude the fixed target research programs begun last year, including the full completion of twelve major experimental efforts. This will be followed by a 3 month shutdown required in order to change the Tevatron accelerator complex over to the colliding beam mode of operations, and in order to move into place the two massive collider detector facilities. These are the upgraded CDF detector facility, and the newly completed, complementary, D-Zero detector facility. There will then follow a 25 week period of operations and data collection with these two facilities.	It is planned to operate the Tevatron for physics research for as many as 30 weeks in FY 1993. The Tevatron will be operating in the collider mode at the beginning of the fiscal year. Completion of the Linac Upgrade construction project and installation of upgrades of the Tevatron refrigeration system will be accomplished during a several month shutdown in mid-FY 1993. Maintenance on the accelerator facilities, as well as the installation of upgraded CDF and D-Zero detector components, will be done while the Tevatron is off. After a brief Tevatron and Linac commissioning period, the D-Zero and CDF detectors will resume data taking with the significantly higher Tevatron luminosity which the upgraded Linac capabilities will make available.
	$ 130,345	$ 136,430	$ 142,735
SLAC Operations	SLAC scheduled about 17 weeks of SLC operation divided between continued accelerator and beam studies (at 10 and 60 pps) to achieve higher luminosity and physics running (at 120 pps) for physics research. Although the Mark II detector continued during the first month, most of the physics running occured with the superior SLD detector. Polarized beam in SLC is not expected to be regularly available until early FY 1992. The linac ran at 120 pps for two experiments in End Station A for about 8 weeks. Continuation of computer leases is included.	SLAC is expected to operate SLC and SLD for about 30 weeks at 120 pps for checkout of the polarized beam and physics research. Polarized beam in SLC is expected to be regularly available during most of the 1992 running. With significantly improved luminosity, polarized beam in the SLD should yield important new physics results. About 2 weeks of linac running at 120 pps will be dedicated to experiments in End Station A near the end of FY 1992. Includes continuation of computer leases.	The level of effort for this activity is reduced about 3% from FY 1992. SLAC is expected to operate SLC and SLD for about 26 weeks with polarized beam. With significantly improved luminosity, and the polarized beam of very small size, the modern SLD detector is expected to provide important new physics results. The first two months of FY 1993 will be dedicated to running 6-sectors of the linac at 120 pps for experiments in End Station A. Includes continuation of computer leases.
	$ 85,682	$ 89,500	$ 91,502

III. Facility Operations (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
BNL-AGS Operations	The AGS operated for about 14 weeks for high energy physics. Rare kaon decay experiments were continued. Other experiments during this time included two searches for six-quark states and there were tests of calorimeter modules for SSC detectors. About 10 weeks of heavy ion physics funded by Nuclear Physics was also planned. Total AGS operation in FY 1991 was about 24 weeks.	Commissioning of the new Booster will require a series of short runs spread out over the year. The beam injection link from the Booster to the AGS will also be commissioned. Tests of the upgrades necessary for the AGS to handle safely the new high intensities will also require sporadic running time. The AGS is expected to operate for about 8 weeks of high energy physics data-taking and also about 8 weeks of nuclear physics. One of the kaon-decay experiments will have a shakedown run with its new radiation-hardened beamline and upgraded high-rate detector. The system for extraction of beam from the AGS to the g-2 experiment will be ready for testing.	The AGS is expected to operate for about 12 weeks of slow extracted beam for high energy physics, and for up to 10 additional weeks for nuclear physics. The AGS vacuum system, transverse damping system, and gamma transition jump system will be refurbished and upgraded during FY 1993, which will result in significantly reduced beam loses during acceleration. The AGS experimental program, including beamlines and detectors for four high energy experiments on the AGS floor, will be readied for high intensity data taking in FY 1994.
	$ 39,180	$ 42,590	$ 44,962
Other Operations	Includes program specific computer networking activities. Funding for the SBIR assessment on the HEP program has been removed.	Continuation of FY 1991 program at about the same level of effort. Includes program specific computer networking activities and funding for the SBIR assessment on the HEP program.	Continuation of FY 1991 program at about the same level of effort. Includes program specific computer networking activities and funding for the SBIR assessment on the HEP program.
	Upgrades of ESNET to conform to the National Research and Education Network Standards continued to be implemented; funding was shared among ER programs that benefit from ESNET. This subprogram's share is $1,085.	ESNET will be fully supported in the Applied Mathematical Sciences subprogram of the Basic Energy Sciences Program.	ESNET will be fully supported in the Applied Mathematical Sciences subprogram of the Basic Energy Sciences Program.
	No activity.	No activity.	In an effort to manage administrative costs more closely, the PSO/Office Directors' share of FTE-dependent costs for space, supplies, and telecommunications are included in this budget and will be transferred during the execution year.

III. Facility Operations (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Other Operations (Cont'd)	$ 3,210	$ 2,170	$ 2,710
Facility Operations	$ 258,417	$ 270,690	$ 281,909

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

KEY ACTIVITY SUMMARY

HIGH ENERGY PHYSICS

I. Preface: High Energy Technology

This activity provides funding for the technological base for maintaining and improving the scientific effectiveness, reliability, and efficiency of existing facilities and for extending the capabilities of accelerators, colliders, and detectors by developing and proving new concepts and technologies. Includes R&D with a near term focus in support of current, ongoing construction projects, fabrication of major detectors, and improving existing research capabilities. There is also a strong longer term focus on development of advanced concepts leading to greater performance capability and more cost effective operation of accelerator and detector facilities. Includes theoretical studies of accelerator physics; exploration of new concepts for particle acceleration, storage, and transport; and fabrication and testing of apparatus based on these studies. Also includes studies of new types of detectors and improved detector performance, for example: improved particle identification, improved precision in delineating tracks and locating vertices, decrease in susceptibility to degradation of performance caused by nuclear radiation, etc. The High Energy Physics Technology program is carried out primarily in the DOE laboratories, but with a significant program of advanced concept development in universities and industry. Since the limits of present accelerator technology are being reached by present generations of existing and planned machines (SSC, LEP at CERN), a strong effort has focused on a search for new accelerator technologies applicable to the long term needs (beyond the year 2000) for physics research. The FY 1993 funding requested represents a reduction in level of effort of about 15% (including the impact of inflation). This will lead to some loss of personnel and infrastructure essential to the longterm viability of the U.S. high energy physics research program. The reduction of skilled staff is estimated at about 60 in accelerator physics and technology throughout the U.S. high energy physics program.

II. A. Summary Table: High Energy Technology

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Fermilab..	$ 16,870	$ 17,140	$ 18,805	+ 10
SLAC...	15,846	16,110	16,700	+ 4
BNL..	12,370	9,660	4,830	- 50
LBL..	8,553	8,850	8,150	- 8
Universities, Other Laboratories, and Other Contractors.................................	13,748	22,070	20,940	- 5
Total, High Energy Technology	$ 67,387	$ 73,830	$ 69,425	- 6

II. B. Major Laboratory and Facility Funding

Brookhaven National Laboratory	$ 12,370	$ 9,660	$ 4,830	- 50
Fermi National Accelerator Laboratory	$ 16,870	$ 17,140	$ 18,805	+ 10
Lawrence Berkeley National Laboratory	$ 8,553	$ 8,850	$ 8,150	- 8
Stanford Linear Accelerator Laboratory	$ 15,846	$ 16,110	$ 16,700	+ 4

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

Program Activity	FY 1991	FY 1992	FY 1993
High Energy Technology			
Fermilab	R&D was directed at improving the energy, intensity and luminosity of the Tevatron. This included work on the linac low energy injection system and on Booster accelerator instrumentation, radio frequency systems, beam damper systems, and beam dynamics studies. An enhanced program of reducing beam losses in the Booster, Main Ring and Tevatron accelerators began, as did an R&D program to improve performance of the antiproton source. The antiproton production rates were raised by developing improved beam cooling equipment, raising production target performance by sweeping the proton beam, increasing target beamline acceptance, and improving control systems. There continued to be a strong R&D effort in support of the Linac Upgrade construction project. The special R&D efforts begun in FY 1990 on luminosity improvements, much of which involve studies for the new Main Injector, continued. The generic detector R&D program, which deals with experimental area beams and detection devices, colliding beam experimental facilities (CDF and D-Zero), charged particle detector R&D, developing improved data handling methods, and advanced computing methods R&D, also continued.	The R&D programs to improve the performance of the accelerator and storage ring subsystems will be continued. There will be a major R&D effort related to the new Main Injector construction project including an increased effort on the design and fabrication of the full scale prototype and pre-production dipole magnets. Design and fabrication of prototype power supplies, rf power amplifiers, and instrumentation and controls systems will be undertaken in FY 1992. R&D work will continue for the Tevatron on low-beta insertions and the system that will allow operation with more than six bunches in the Tevatron, as well as work on the antiproton source cooling systems, controls and diagnostics. The last year of R&D associated with the Linac Upgrade will continue with a view to completing the project and beginning commissioning. R&D is also included on improvements to beam transport, targeting systems designs, and new particle detection techniques. Studies for future improvements to the Collider Detector at Fermilab (CDF) and to the D-Zero detector, in support of the expected increased Tevatron luminosity will also continue.	Priority will continue to be given to support of the Main Injector construction project. R&D will continue to be directed toward further refinement of the accelerator design. R&D efforts directed at dipole magnets will be completed while the design and prototyping work on power supplies, rf amplifiers and instrumentation and controls systems will be continued. Priority will also be given to support of collider operations and continuing luminosity upgrades. R&D directed at increasing the beam intensity for the fixed target and a proton beam sweeping magnet for the antiproton production system will be undertaken. Development of transverse dampers needed at injection into the Main Ring and the Tevatron to restrict emittance growth, will continue. Studies for improvements to the CDF and D-Zero detectors will also continue.
	$ 16,870	$ 17,140	$ 18,805

III. High Energy Technology (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
SLAC	Successful operation of the SLC has revealed new R&D information on the performance and operation of linear colliders. Studies based on these results began for the dual purpose of improving operating performance and efficiency of the SLC, particularly with polarized electrons, and of guiding and aiding studies of linear colliders in the TeV range. R&D leading to improvements in luminosity and reduction of background was focused on enhancing the performance of the SLD during its first physics run. Advanced accelerator R&D in support of the technology for TeV linear colliders, endorsed by a 1990 HEPAP study, continued the development of several high-power microwave sources operating at frequencies of 11 GHz or higher and power levels of 100 MW or higher, with a specific goal of addressing technical suitability and cost-effectiveness. As part of this activity, R&D continued to study radically new, high-gradient accelerating structures. Work continued on a Final Focus Test Beam facility to study electron and positron beams of nanometer radii needed in TeV linear colliders. The conceptual design for an ultra-high-luminosity B-factory, also endorsed by the 1990 HEPAP study, was completed in FY 1991.	The strong R&D program to support improved operation of the SLC for physics research using polarized electrons will continue. Consistent with HEPAP recommendations, R&D on advanced accelerator concepts needed for development of linear colliders in the TeV range will build on machine studies carried out with SLC, advanced theoretical studies, and work on development of more cost-effective, high-power microwave sources with a view to developing integrated systems. R&D will continue on high-power, highly efficient microwave sources operating at or above 11 GHz and on new, high-gradient accelerating structures. Studies on very high current beam effects and collective phenomena will continue. Generic R&D to develop detector technology needed to do physics research in a very high-luminosity, high-radiation environment will continue.	The level of effort for this activity is being reduced slightly from the FY 1992 level. Priority will be given to support for the operation of the SLC for physics research with particular emphasis on improved performance with polarized electrons. Long range R&D in support of TeV linear colliders will continue. The design of a prototype 1-GeV accelerator module planned to study new linear collider accelerator structures and radiofrequency power sources will continue. R&D to develop the detector technology required to do physics at high luminosity electron-positron colliders will continue at a reduced level.
	$ 15,846	$ 16,110	$ 16,700

Program Activity	FY 1991	FY 1992	FY 1993
BNL	Program included continued R&D support for improved AGS intensity, duty cycle, flexibility of operation and reliability, and for reduced beam loss and maintenance, with special emphasis on AGS vacuum systems, AGS beam orbit correction systems, and AGS radio frequency R&D for powering high beam intensities. Special effort was directed at commissioning, and early high intensity operation of, the newly completed Booster accelerator and at integrating it into the physics program. The experimental facility R&D needed for improvement of particle detectors, beam lines and targets for AGS experiments including preparation for measurement of the muon g-2 value continued. An extra effort began to complete the test setup for advanced accelerator experiments so that researchers nationwide can begin to test new acceleration concepts and high brightness radiation sources as part of the national very long range accelerator R&D program.	Continue R&D programs to improve flexibility, reliability and economy of AGS operation and to reduce radiation levels and maintenance requirements; R&D on simplified polarized proton acceleration, particularly with Siberian Snakes; improvement of particle detectors, beam lines and targets for AGS experiments. With completion of the AGS Booster, R&D shifts to the injection of full intensity Booster beams into the AGS and the acceleration of these higher beam intensities in the AGS. An expanded program of experiments on new acceleration concepts and on ultra bright radiation sources is planned, including initial studies on switched power technology for improved high brightness electron injectors and very high gradient acceleration. The reduction of funding reflects, in part, the completion of the AGS Booster project and a shift in emphasis in the generic accelerator R&D program away from HEP to the nuclear physics program in support of RHIC. R&D on detectors will include an increased effort related to BNL participation in the GEM collaboration for designing one of the new experiments for the SSC.	The overall level of effort for this activity is being reduced by about 55% from the FY 1992 level. A major portion of the reduction is related to an accelerated phase out of support for superconducting magnet R&D activities at BNL. Additional reductions reflect the completion of Booster commissioning activities during FY 1992. The level of effort for the continuing program is being reduced by about 19%. Priority will be given to R&D in support of improving reliability and economy of AGS operation and reducing radiation levels and maintenance requirements. Improvement of particle detectors, beam lines and targets for AGS experiments will continue at a reduced level, preserving work on important new experiments and in particular on a new fast extraction system for use with the muon g-2 experiment. Support will continue for R&D in novel accelerator concepts and high brightness particle sources at a reduced but viable level. Support will also continue for R&D related to the planned GEM detector at the SSC lab.
	$ 12,370	$ 9,660	$ 4,830

Program Activity	FY 1991	FY 1992	FY 1993
LBL	R&D focused on superconducting magnet technology; beam instrumentation and cooling; advanced research into the generation of very high energy particle beams; studies of the physics and technology central to achieving very high luminosities in colliding beam machines; and general studies of the physics and theoretical techniques for understanding the principles underlying the operation of accelerators, colliding beam devices, and charged particle transport systems. Special emphasis was given to the conceptual development of state-of-the-art B-factory colliding beam storage rings that could be placed in the PEP tunnel at SLAC, to development of the two beam accelerator concept, and to demonstrations of very high field (>10 T) accelerator dipole magnets. Advanced technology R&D was also carried out on new particle detectors, the supporting technologies, and on advanced data handling and processing. A special initiative has begun on the SDC for the SSC physics program.	R&D continues at nearly a constant level of effort on high-field superconducting magnet technology; beam instrumentation and cooling; advanced accelerator theory and experiment; advanced high power microwave sources and the two-beam acceleration concept; physics of very high luminosity colliders; and R&D on advanced detector systems. R&D on high current effects in accelerator systems will focus on beam loading, active dampers, beam-beam interaction effects, and improved magnetic optical design. R&D on new particle detectors continues with some reordering of resources to bring greater effort to bear on design and development of the SDC for physics research at the SSC.	The level of effort for this activity is being reduced about 13% relative to FY 1992. Priority will be given to activities in support of very advanced superconducting magnet technology needed for the future national program. Activities in very advanced, exploratory accelerator and detector R&D will be curtailed, including R&D in support of the SSC related SDC. Advanced accelerator R&D work will focus on rf power systems, the vacuum system, beam dynamics, magnet design, and new concepts.
	$ 8,553	$ 8,850	$ 8,150
Universities, Other Laboratories, and Other Contractors	This subprogram supported a broad range of topics in very advanced accelerator and detector technologies needed to ensure a strong future experimental research capability in high energy physics. Research carried out in universities, industry, research institutes, and other government research centers (e.g. NIST, NRL, etc.) addresses topics ranging from development of improved superconductors through new and advanced accelerator concepts, such as the use of lasers and collective effect phenomenon to accelerate charged particles, and new	FY 1992 will see full effort on significant program activities started in FY 1991. The ANL wakefield accelerator experiments, high power microwave power source test facility at LLNL, the accelerator test bed and laser accelerator experiments at BNL, and the high brightness electron source at UCLA should all be in final development or first operation. These and other R&D activities in U.S. universities, industry, research institutes, and other government resource centers will continue to search for new concepts and	The overall level of effort for this activity is being reduced about 11% relative to FY 1992. The reduction in funding will be distributed in such a way as to preserve the highest priority elements of the program. Generally new initiatives for university research will be denied in the interest of preserving and completing existing projects and in particular the timely completion of graduate student research theses. This reduced program will continue the focus on utilization of the special resources of universities, industry, not for profit research

III. High Energy Technology (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Universities, Other Laboratories, and Other Contractors (Cont'd)	theoretical concepts in non-linear charged particle beam dynamics. The focus of this work is on technologies applicable beyond the year 2000. Some exploratory work on the development and potential application of very high critical field superconducting magnets was begun. A concerted effort was made to search for promising new charged particle beam acceleration concepts. First major tests of advanced accelerator concepts identified as feasible in prior year R&D were under taken at the advanced accelerator test bed established as a user center at BNL. R&D on advanced, generic technology essential for large detectors operating at high event rates was expanded to its planned level. It should be noted that the principal funding for graduate student training in accelerator physics is in this subprogram. Funding for the SBIR assessment has been removed.	technologies on which high energy physics research in the 21st century will depend. In addition, important work will continue on superconducting materials for very high field superconducting magnets and on new and innovative approaches to designing and building such magnets. R&D will also focus heavily on the generic technology essential for future detectors with a particular focus on the needs for high luminosity proton-proton and electron-positron colliders. Also includes funding for the SBIR assessment.	institutes, and government laboratories to address a broad spectrum of technology development important to the very long term future productivity of the physics research. Major tests of new charged particle acceleration schemes will be in progress at the advanced test bed established at BNL and on a new wakefield test set-up at ANL. Work on very high field superconducting magnets will be in progress. R&D will continue on advanced, generic technology essential for future detectors. Also includes funding for the SBIR assessment.
	No activity.	No activity.	In an effort to manage administrative costs more closely, the PSO/Office Directors' share of FTE-dependent costs for space, supplies, and telecommunications are included in this budget and will be transferred during the execution year.
	$ 13,748	$ 22,070	$ 20,940
High Energy Technology	$ 67,387	$ 73,830	$ 69,425

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

KEY ACTIVITY SUMMARY

HIGH ENERGY PHYSICS

I. Preface: Superconducting Super Collider Laboratory Research

This activity provides funding for support for a physics research program based at the SSC Laboratory and utilizing, in the near term, other HEP accelerator facilities. Funding was provided in FY 1991 and FY 1992 under the Physics Research suprogram.

II. A. Summary Table: Superconducting Super Collider Laboratory Research

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
SSC Laboratory Research.........................	$ 0	$ 0	$ 2,500	>999
Total, Superconducting Super Collider Laboratory Research	$ 0	$ 0	$ 2,500	>999

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

Program Activity	FY 1991	FY 1992	FY 1993
Superconducting Super Collider Laboratory Research			
SSC Laboratory Research	Funding for SSCL staff to conduct research in high energy physics, not specifically related to the construction of the SSC, was contained in the HEP Physics Research subprogram in FY 1991.	Funding for SSCL staff to conduct research in high energy physics, not specifically related to the construction of the SSC, was contained in the HEP Physics Research subprogram request for FY 1992.	Physicists on the staff of the SSC Laboratory will conduct research in high energy physics not specifically related to the construction of the SSC. The research will consist of preparation of and participation in collaborative experiments using the CDF detector facility at Fermilab. There will be, in addition, a small theory effort focussed on physics questions related to the planned SSC program. SSCL researchers will also participate in planning and developing the experiments which will be conducted at the SSC. Capital equipment funding in the amount of $500,000 is also requested for this activity in a separate portion of this budget submission.
	$ 0	$ 0	$ 2,500
Superconducting Super Collider Laboratory Research	$ 0	$ 0	$ 2,500

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

KEY ACTIVITY SUMMARY

HIGH ENERGY PHYSICS

I. Preface: Capital Equipment

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

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

II. A. Summary Table: Capital Equipment

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Fermilab..	$ 29,699	$ 30,485	$ 30,945	+ 2
SLAC..	19,781	18,809	14,809	- 21
BNL...	8,354	8,810	6,630	- 25
SSC Laboratory..................................	0	0	500	>999
Universities and Other Laboratories.............	20,905	25,146	16,206	- 36
BNL- General Purpose Equipment..................	4,250	4,490	4,130	- 8
Total, Capital Equipment	$ 82,989	$ 87,740	$ 73,220	- 17

II. B. Major Laboratory and Facility Funding

Brookhaven National Laboratory	$ 8,354	$ 8,810	$ 6,630	- 25
Fermi National Accelerator Laboratory	$ 29,699	$ 30,485	$ 30,945	+ 2
Stanford Linear Accelerator Laboratory	$ 19,781	$ 18,809	$ 14,809	- 21
Superconducting Super Collider Laboratory	$ 0	$ 0	$ 500	>999

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

Program Activity	FY 1991	FY 1992	FY 1993
Capital Equipment			
Fermilab	The D-Zero detector facility was completed during FY 1991 with the purchase and installation of the final electronics components ($4,100). Upgrades to accommodate the increased Tevatron collider luminosity, expected in the near future, were also made ($2,700); significant upgrades to the CDF calorimetry and electronics, and an extension to larger acceptance of the massive muon detection systems, were carried out ($7,100); modifications, improvements and new detector and secondary beam components in support of the fixed target research programs ($6,900); a significant addition to the Fermilab general computing capabilities and facilities in order to handle the huge amounts of raw data generated by both the collider and the fixed target research programs ($4,950); equipment needed for accelerator R&D, in support of the entire accelerator complex, including systems instrumentation needs, controls, local computing and cryogenic components, and for general site needs. ($3,949).	In preparation for the significantly increased luminosity to be provided in the 1993 Tevatron collider run due to completion of the Linac Upgrade project, both of the collider detector facilities require upgrades of their particle tracking systems and data acquisition electronics. In addition, the CDF detector facility will need to upgrade and improve its plug calorimeters and forward muon detection systems ($9,200 total); and the D-Zero detector facility will need more extended scintillator veto arrays and a new silicon-based vertex detector system ($7,590 total). The fixed target experimental program and test beams will require beam line and detector modification ($4,300); equipment additions will continue for the Fermilab computing systems both in the experimental areas and in the central computing facility ($5,215); equipment for the support of the entire accelerator complex, for R&D efforts, for the extended cryogenic and controls systems, and for general site-related needs ($4,180).	Design and fabrication of new electronics and other subsystems are needed in order to accommodate the greatly increased proton and anti-proton bunch frequency planned to be instituted during FY 1994. Both facilities will require faster triggering capabilities as well as increased on-line computing and data collection electronics capacities. CDF needs a much improved Silicon vertex detector system as well, and D-Zero will have to replace its central tracking and electron identification systems. The equipment funding allocated for these major Fermilab collider detector facilities in FY 1993 will total $7,400 for D-Zero and $8,600 for CDF. During the Tevatron shutdown planned for the installation of the final Linac Upgrade Project components in mid-FY 1993, new and upgraded components for both the CDF and the D-Zero detector facilities will be installed. The fixed target research program and the test beams will require modifications to beam lines and detectors in preparation for the next fixed target run in FY 1994-95 ($5,800). Continuing extensions to the computing facilities in order to be able to match the steadily increasing data collection rates of the major experimental facilities will be made ($4,950); equipment will be provided for the sequence of accelerators and their control systems, instrumentation, and general site-related equipment ($4,195).
	$ 29,699	$ 30,485	$ 30,945

III. Capital Equipment (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
SLAC	Major emphasis has been on commissioning the SLD detector ($1,736), providing needed support for SLC ($780), providing needed support for the polarized beam ($1,516), support for Advanced Accelerator R&D ($5,850), support of physics research activities including computing hardware ($1,050), and general laboratory equipment including housekeeping, new machine tools, CAD CAM, and HVAC upgrades ($2,349). Includes the planned acquisition of major portions of a new mainframe central computer ($6,500).	Major emphasis on equipment needs in commissioning the high luminosity polarized beam capability and the SLD detector for full physics operations ($5,059); second polarized source ($1,350); support for advanced accelerator R&D ($7,300); new experiments ($1,000); other computing hardware ($1,845); and general laboratory equipment including new machine tools and upgrade of HVAC distribution system ($2,255).	The level of effort in this activity is reduced by about 26% from FY 1992. Funds will be provided for support of the high priority research with the SLD ($1,500) and the SLC ($1,550) and its polarized beam ($2,000). Funds will be provided in support of physics research including computer equipment ($1,000) and to meet needs in advanced accelerator R&D including the Final Focus Test Beam ($2,420). Funding will also be provided for a new central computer ($3,500). Support will also be provided for general laboratory equipment including new machine tools, CAD CAM, and HVAC upgrades ($2,839). The reduced funding will impact all parts of the program but primarily the fabrication of large scale test setups in the linear collider R&D effort.
	$ 19,781	$ 18,809	$ 14,809
BNL	Significant funding for muon anomalous magnetic moment (g-2) experiment ($2,169); support for rare kaon decay experiments ($1,910); support for other experiments ($1,250); beam line components ($1,150); accelerator R&D ($730); and general AGS support ($1,145).	Continuation of muon anomalous magnetic moment (g-2) experiment ($2,420); support for rare kaon decay and other experiments ($2,900); beam line components ($1,800); accelerator R&D ($730); and general AGS support ($960).	The level of effort for this activity is reduced about 30% from FY 1992. Continued fabrication of the muon anomalous magnetic moment (g-2) experiment ($1,920); support for upgrades to the experiments to handle the new higher Booster intensities ($2,500); beamline components, including radiation-hardened magnets and new shielding ($1,430); accelerator R&D ($620); general AGS support ($160). The reduced funding will impact all points of the program, but primarily the upgrades of existing experiments and the preparation of new experiments.
	$ 8,354	$ 8,810	$ 6,630

III. Capital Equipment (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
SSC Laboratory	Funding for SSCL capital equipment to conduct research in high energy physics, not specifically related to the construction of the SSC, was contained in the University and Other Laboratories activity in FY 1991.	Funding for SSCL capital equipment to conduct research in high energy physics, not specifically related to the construction of the SSC, was contained in the University and Other Laboratories activity in FY 1992.	Funding is requested for capital equipment to conduct research in high energy physics, not specifically related to the construction of the SSC. The funds requested will provide for general purpose lab equipment, computer work stations, and electronics and other hardware directly related to the CDF program. This program is more fully described in the Superconducting Super Collider subprogram portion of this budget submission.
	$ 0	$ 0	$ 500
Universities and Other Laboratories	The U.S. ZEUS Collaboration is well along toward completion of the central calorimeter of the ZEUS detector, thus permiting initiation of a full program of electron-proton collider research at the new HERA accelerator in Hamburg, W. Germany. The DUMAND detector (Hawaii) was begun and MACRO (Italy) and SUDAN (Minnesota) are well into fabrication. New computer systems for L3 and ALEPH at LEP received initial complements of support. Funding was provided to meet, in part, ongoing need for upgrade of computer and other data analysis equipment, as well as infrastructure equipment for design and fabrication of experimental equipment, in order that university-based physicists fully and actively contribute to high energy physics research on campus. Capital equipment funds were needed at LBL for equipment to support ongoing experiments at Fermilab and SLAC, equipment for advanced detector prototypes, for equipment in support of the superconducting R&D magnet work, advanced accelerator research and development studies and related test and support equipment. Capital equipment funds were needed at LBL for	The ZEUS detector at the new HERA accelerator in Hamburg, Germany will be completed and begin full data taking. The MACRO detector (Italy) and the Soudan detector (Minnesota) will be completed. The DUMAND detector (Hawaii) will be partially complete. It is anticipated that the L3/ALEPH computer upgrades at LEP (CERN) will receive additional funding and that there will be new experiments in preparation such as new fixed target experiments at the Tevatron and AGS. Funding will be provided to meet, in part, ongoing need for upgrade of computer and other data analysis equipment, as well as advanced equipment for design and fabrication of experimental equipment, in order that university-based physicists fully and actively contribute to high energy physics research on campus. Hardware for advanced accelerator concept experiments at BNL's accelerator test bed and ANL's wakefield test set-up is included. Capital equipment funds are needed at LBL for equipment to support ongoing experiments at Fermilab and SLAC, equipment for advanced detector prototypes, for equipment in support of	The level of effort in this activity is reduced about 41% from FY 1992. The U.S. ZEUS Collaboration will continue its initial program of research at HERA (Hamburg), as will other U.S. groups at MACRO (Italy) and Soudan (Minnesota). DUMAND (Hawaii) will be operational. It is anticipated that there will be few new experiments. Some funding will be provided to meet, in part, ongoing needs for upgrade of computer and other data analysis equipment, as well as advanced equipment for design and fabrication of experimental equipment, in order that university-based physicists can fully and actively contribute to high energy physics research on campus. Hardware for advanced accelerator concept experiments at the BNL-ATF and the ANL wakefield test facility is included. Includes funding for the MIT-LEPICS computer upgrade. Preparations for data taking in FY 1994 of some upgraded rare K-decay experiments at BNL and fixed target experiments at Fermilab will be in progress. Capital equipment funds are needed at LBL for equipment to support ongoing experiments at Fermilab and SLAC, equipment for

III. Capital Equipment (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Universities and Other Laboratories (Cont'd)	equipment to support ongoing experiments at Fermilab and SLAC, equipment for advanced detector prototypes, for equipment in support of the superconducting R&D magnet work, advanced accelerator research and development studies and related test and support equipment.	the superconducting R&D magnet work, advanced accelerator research and development studies and related test and support equipment. Includes funding for the MIT-LEPICS computer upgrade.	advanced detector prototypes, for equipment in support of the superconducting R&D magnet work, advanced accelerator research and development studies and related test and support equipment. New non-accelerator experiments and upgrades to experiment at foreign accelerators will be undertaken only in cases with exceptional importance. The funding reductions will impact proposed new experiments and significant enhancements of existing detectors.
	$ 20,905	$ 25,146	$ 16,206
BNL- General Purpose Equipment	Provides general purpose equipment for the entire laboratory.	Provides general purpose equipment for the entire laboratory.	The level of effort for this activity is reduced about 13% from FY 1992. Provides general purpose equipment for the entire laboratory. With reduced funding, many of these needs will have to be deferred. Includes mainframe computer upgrade (TEC $8,500).
	$ 4,250	$ 4,490	$ 4,130
Capital Equipment	$ 82,989	$ 87,740	$ 73,220

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

KEY ACTIVITY SUMMARY

HIGH ENERGY PHYSICS

I. Preface: Construction

II. A. Summary Table: Construction

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Accelerator Improvements and Modifications......	$ 14,534	$ 15,805	$ 15,095	- 4
Fermilab Linac Upgrade..........................	12,000	6,166	0	-100
General Plant Projects..........................	12,317	13,398	12,835	- 4
Fermilab Main Injector..........................	0	15,000	30,000	+100
Total, Construction	$ 38,851	$ 50,369	$ 57,930	+ 15

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

Program Activity	FY 1991	FY 1992	FY 1993
Construction			
Accelerator Improvements and Modifications	Constant level of effort compared to FY 1990. Funding used for modifications to maintain and improve the technical capability and operational efficiency of the accelerator complexes.	Increased funding in response to the continuing large need for modifications to maintain and improve the technical capability and operational efficiency of the accelerator complexes.	Level of effort reduced about 9% relative to FY 1992 reflecting overall funding constraints.
	$ 14,534	$ 15,805	$ 15,095
Fermilab Linac Upgrade	Production of the copper accelerating cavities begun in FY 1990 continued through FY 1991 and several modules of them will be moved into the Linac gallery preparatory to the final installation work in FY 1992. Most of the klystron power sources were delivered, installed, and tested. The building and utility additions to the Linac gallery were largely completed by the end of the fiscal year.	All of the klystron power sources will be installed and prepared for use. The final sets of copper accelerating cavities will be completed and moved into the Linac gallery. All of the civil construction and technical component fabrication will be completed by the end of FY 1992. Only the final installation and backup of assembled components in the linac gallery will remain to be completed.	Project funding will be completed in FY 1992. The new components will be installed, connected, aligned and brought into operation in the linac gallery. Full operational status and project completion will be accomplished by mid-FY 1993.
	$ 12,000	$ 6,166	$ 0
General Plant Projects	Constant level of effort compared to FY 1990. Funding used for small general purpose construction projects, e.g. roads, utilities, and environmental, safety and health needs.	Increased funding in response to accumulated operational, environmental, and safety needs.	Level of effort reduced about 9% relative to FY 1992 reflecting overall funding constraints.
	$ 12,317	$ 13,398	$ 12,835
Fermilab Main Injector	No Construction activity.	Extensive preliminary and engineering design work will start on both civil construction packages and technical components. Emphasis in civil construction will first be on site preparation work, environmental mitigation efforts and an assembly building to house technical component assembly work, followed by the ring enclosure and its service buildings and utilities. Major physical construction will be under contract and beginning to make progress by the summer of 1992.	The site preparation construction work, the assembly building, and about one quarter of the ring tunnel enclosure will be completed during FY 1993. Engineering design will be underway on the beamline enclosures and their service buildings. The 20 foot long dipole magnets and the 9000 Ampere power supplies will be engineered and under fabrication contract by late FY 1993. Design work on the rest of the technical components will be in an advanced stage by then.

III. Construction (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Fermilab Main Injector (Cont'd)		Engineering design on the beamline enclosures will also be initiated.	
	$ 0	$ 15,000	$ 30,000
Construction	$ 38,851	$ 50,369	$ 57,930

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
OFFICE OF ENERGY RESEARCH
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

KEY ACTIVITY SUMMARY

CONSTRUCTION PROJECTS

High Energy Physics

IV. A. Construction Project Summary

Project No.	Project Title	Total Prior Year Obligations	FY 1992 Appropriated	FY 1993 Request	Unappropriated Balance	TEC
GPE-103	General Plant Projects	$ ---	$ ---	$ 12,835	$ 0	$ 12,835
93-G-301	Accelerator Improvements and Modifications	---	---	15,095	0	15,095
92-G-302	Fermilab Main Injector	---	15,000	30,000	140,000	185,000
90-R-104	Fermilab Linac Upgrade	16,634	6,166	0	0	22,800
Total, High Energy Physics Construction		$ 16,634	$ 21,166	$ 57,930	$140,000	$235,730

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
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GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

High Energy Physics

IV. B. Plant Funded Construction Project

1. Project title and location: GPE-103 General Plant Projects
Various locations

Project TEC: $12,835
Start Date: 3rd Qtr. FY 1993
Completion Date: 2nd Qtr. FY 1995

2. Financial Schedule:

Fiscal Year	Appropriated	Obligations	Costs
1993	$12,835	$12,835	$4,100
1994	---	---	6,200
1995	---	---	2,535

3. Narrative:

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

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

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

Brookhaven National Laboratory	$ 5,695
Fermi National Accelerator Laboratory	4,350
Stanford Linear Accelerator Center	2,790
Total Estimated Cost...............	$12,835

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
OFFICE OF ENERGY RESEARCH
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

High Energy Physics

IV. B. Plant Funded Construction Project

1. Project title and location: 93-G-301 Accelerator Improvements and Modifications
Various Locations

Project TEC: $15,095
Start Date: 2nd Qtr. FY 1993
Completion Date: 2nd Qtr. FY 1995

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1993	$ 15,095	$ 15,095	$3,600
1994	---	---	5,700
1995	---	---	5,795

3. Narrative:

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

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

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

Brookhaven National Laboratory	$ 2,850
Fermi National Accelerator Laboratory	7,605
Stanford Linear Accelerator Center	4,640
Total Estimated Cost...............	$15,095

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
OFFICE OF ENERGY RESEARCH
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

High Energy Physics

IV. B. Plant Funded Construction Project

1. Project title and location: 92-G-302 Fermilab Main Injector
Batavia, Illinois

Project TEC: $185,000
Start Date: 3rd Qtr. FY 1992
Completion Date: 4th Qtr. FY 1997

2. Financial schedule:

Fiscal Year	Appropriations	Obligations	Costs
1992	$ 15,000	$ 15,000	$ 11,000
1993	30,000	30,000	23,000
1994*	44,000	44,000	36,000
1995*	44,000	44,000	42,000
1996*	44,000	44,000	45,000
1997	8,000	8,000	28,000

3. Narrative:

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

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

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

4. Total Project Funding (BA):

	Prior Years	FY 1992	FY 1993 Request	To Complete
Construction........................	$ 0	$15,000	$30,000	$140,000
Capital Equipment...................	200	400	300	200
Operating Expenses..................	300	4,500	6,900	17,400

* Outyear amounts reflect funding levels higher than amounts contained in the OMB passback. The funding of these outyear requirements will be addressed in the next budget cycle.

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
PROJECT DATA SHEETS
GENERAL SCIENCE AND RESEARCH - PLANT AND CAPITAL EQUIPMENT
HIGH ENERGY PHYSICS

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

1. Title and location of project: General plant projects, various locations

2. Project No.: GPE-103

3a. Date A-E work initiated: 2nd Qtr. FY 1993

3b. A-E work duration: various

4a. Date physical construction starts: 3rd Qtr. FY 1993

4. Date construction ends: 2nd Qtr. FY 1995

5. Previous cost estimate: None
Total Project Cost: None

6. Current cost estimate: $12,835
TECC: $12,835
TPC: $12,835

7. Financial Schedule:

Fiscal Year	Appropriations	Obligations	Costs
1993	$ 12,835	$ 12,835	$ 4,100
1994	0	0	6,200
1995	0	0	2,535

8. Brief Physical Description of Project

These projects provide for the many miscellaneous alterations, additions, modifications, replacements, and non-major construction required at the Brookhaven National Laboratory, Fermi National Accelerator Laboratory and the Stanford Linear Accelerator Center facilities. GPP projects focus on the conventional laboratory facilities whereas AIP projects focus on the technical facilities.

PROJECT DATA SHEETS

1. Title and location of project: General plant projects, various locations 2. Project No.: GPE-103

8. Brief Physical Description of Project (continued)

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

Brookhaven National Laboratory		$5,695
Sanitary System Upgrading - Accelerator Development Department	$ 900	
Liquid Helium Storage - Accelerator Development Department	300	
Power Supply Buildings - Accelerator Development Department	1,200	
Beam Tunnel Improvements - Alternating Gradient Synchrotron Department	600	
Additional Fire Detection - Alternating Gradient Synchrotron Department	300	
Electrical Power Extension - Alternating Gradient Synchrotron Department	400	
Cooling Water Wells Upgrade - Alternating Gradient Synchrotron Department	300	
Cooling Water Addition - Alternating Gradient Synchrotron Department	300	
Fencing - alternating Gradient Synchrotron Department	400	
Building Renovation - Department of Applied Science	300	
Mezzanine Extension - Department of Applied Science	400	
Computer Network Expansion - Computing and Communications Division	200	
Steam Service Extension	95	
Fermi National Accelerator Laboratory		$4,350
DO Office Addition	$ 1,200	
Facilities Management Building - West Addition	1,200	
Fire Department/Security Office Building	300	
Magnet Storage Building Addition	370	
Industrial Building #1 Addition	1,050	
Low-level Counting Laboratory Replacement	230	

PROJECT DATA SHEETS

1. Title and location of project: General plant projects, various locations

2. Project No.: GPE-103

8. Brief Physical Description of Project (continued)

Stanford Linear Accelerator Center.. $2,790*

HVAC Replacement - Light Fabrication (Bldg #25) and Central Lab Two-Story..	$	370
Paving Research Yard, SLC Adit, and Visitor Parking Lot (Main Gate).............		225
Roofing - Central Lab Two-Story....................................		286
Users' Office Space - Warehouse Upgrade....................................		260
Underground Valve Survey and Upgrade - Linac and Campus.........................		232
Replace Research Area Substation Personnel Protection System and Emergency Trip Circuits..		146
PEP Variable Voltage Transformer Shelters....................................		201
Safety Switches for Linac Motors, Sectors 16-30 and Cooling Tower LCW Systems....		322
Upgrade the Linac K-Sub Panels and Motor Controls...............................		748

*These projects will be constructed at the Stanford Linear Accelerator Center on non-Government owned property.

9. Purpose, Justification of Need and Scope of Project

General plant projects are required for the general maintenance, modification and improvement of the overall laboratory plant and include minor new construction, capital alterations and additions, and improvements to buildings and utility systems. These are short-term projects whose timely accomplishment is essential for maintaining the productivity, increasing the operational cost effectiveness, and ensuring that necessary support services are available to the research program at the DOE-owned facilities. Since it is difficult to detail the most urgently needed items in advance, a continuing evaluation of requirements and priorities may result in additions, deletions, and changes to the currently planned subprojects. No significant R&D program is anticipated as a prerequisite for design and construction of the subprojects under consideration.

PROJECT DATA SHEETS

1. Title and location of project: General plant projects, various locations	2. Project No.: GPE-103

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

The funds requested for FY 1991 are estimated as follows:

Brookhaven National Laboratory	$ 5,695
Fermi National Accelerator Laboratory.................................	4,350
Stanford Linear Accelerator Center....................................	2,790
Total Estimated Cost	$12,835

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

10. Details of Cost Estimate

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

11. Method of Performance

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

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
PROJECT DATA SHEETS
GENERAL SCIENCE AND RESEARCH - PLANT AND CAPITAL EQUIPMENT
HIGH ENERGY PHYSICS

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

1. Title and location of project: Accelerator improvements and modifications, various locations

2. Project No.: 93-G-301

3a. Date A-E work initiated: 2nd Qtr. FY 1993

3b. A-E work duration: various

4a. Date physical construction starts: 3rd Qtr. FY 1993

4b. Date construction ends: 2nd Qtr. FY 1995

5. Previous cost estimate: None
Total Project Cost: None

6. Current cost estimate: $15,095
TECC: $15,095
TPC: $15,095

7. Financial Schedule:

Fiscal year	Appropriations	Obligations	Costs
1993	$15,095	$15,095	$ 3,600
1994	0	0	5,700
1995	0	0	5,795

8. Brief Physical Description of Project

This project provides for a variety of minor modifications, improvements and additions to the major high energy particle accelerators, colliding beam devices and experimental facilities. Funds of this type are necessary on an annual basis to maintain and improve the effectiveness of these facilities. In addition to the replacement of components for improved reliability and cost effectiveness of operation, it is often necessary to modify the facility to accommodate changes required by the research program. The funds requested, which represent less than 1 percent of the present value of the government's investment in these facilities, produce a large return in terms of more cost effective operation and greater research productivity.

1. Title and location of project: Accelerator improvements and modifications, various locations

2. Project No.: 93-G-301

8. Brief Physical Description of Project (continued)

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

Brookhaven National Laboratory... $2,850

Funds are requested for modifications, improvements, and additions to the Alternating Gradient Synchrotron (AGS) and its related experimental facilities. Items planned include: upgrade to Linac instrumentation, AGS RF system, switchyard (Phase II) and FEB Extraction system; radiation hardening of extraction coils; and power supplies for polarized proton tune quadruples.

Fermi National Accelerator Laboratory.................................. $7,605

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

Modifications to the accelerator facilities are expected to include: antiproton sweeping system improvements; antiproton stack-tail bandwidth upgrades; switchyard modifications for 900 GeV operations; and cryogenic controls modernization.

Modifications to the experimental facilities are expected to include: 150 GeV experimental area modifications; and high intensity neutral kaon beam improvements.

Stanford Linear Accelerator Center (SLAC)............................... $4,640

Funds are requested for modifications, improvements and additions to the SLAC linear accelerator, the SLC colliding beam facilities, and to the associated experimental facilities. Items now planned for FY 1993 include: Linac improvements; modulator and power supply upgrades; modifications to the linac control room instrumentation; machine protection and personnel protection systems; girder alignment controllers; polarization project upgrades, and A-line upgrade.

PROJECT DATA SHEETS

1. Title and location of project: Accelerator improvements and modifications, various locations

2. Project No.: 93-G-301

9. Purpose, Justification of Need and Scope of Project

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

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

10. Details of Cost Estimate

a. Engineering, design and inspection and component assembly and installation............	$15,095
Total estimated cost..	$15,095

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

11. Method of Performance

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

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
PROJECT DATA SHEETS
GENERAL SCIENCE AND RESEARCH - PLANT AND CAPITAL EQUIPMENT
HIGH ENERGY PHYSICS
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: Fermilab Main Injector
Fermi National Accelerator Laboratory
Batavia, Illinois

2. Project No.: 92-G-302

3a. Date A-E work initiated: 3rd Qtr. FY 1992
3b. A-E work (Title I & Title II) duration: 18 months

4a. Date physical construction starts: 3rd Qtr. FY 1992

4b. Date construction ends: 4th Qtr. FY 1997

5. Previous construction cost estimate: $177,800
Total Estimated Cost: 177,800
Total Project Cost: 197,000

6. Current construction cost estimate: $185,000
TECC: 185,000
TPC: 215,200

7. Financial Schedule

Fiscal Year	Appropriations	Obligations	Costs
1992	$ 15,000	$ 15,000	$ 11,000
1993	30,000	30,000	23,000
1994*	44,000	44,000	36,000
1995*	44,000	44,000	42,000
1996*	44,000	44,000	45,000
1997	8,000	8,000	28,000

* Outyear amounts reflect funding levels higher than amounts contained in the OMB passback. The funding of these outyear requirements will be addressed in the next budget cycle.

1. Title and location of project:	Fermilab Main Injector Fermi National Accelerator Laboratory Batavia, Illinois	2. Project No.:	92-G-302

8. Brief Physical Description of Project (Continued)

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

Many technical components will be recycled from the existing Main Ring, including quadrupole magnets, some power supplies and correction magnets, radio frequency 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 at the F-zero straight section.

Specifically provided for in the scope of the project are:

a. Construction of a 3.3 km ring enclosure with 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 required to implement the 8 GeV Booster-to-Main Injector beamline, the 150 GeV proton and antiproton Main Injector-to-Tevatron transfer lines, and the 120 GeV Main Injector-to-Antiproton Production Target beamline.

c. Construction of technical components required to implement the delivery of 120 GeV beam from the Main Injector to the existing external experimental areas; construction of an assembly building to house the assembly and testing of Main Injector components; construction of a new sub-station and 345KV power lines for distribution of electrical power to the Main Injector location.

d. Modifications to the Tevatron ring tunnel 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 recycled from the old Main Ring.

PROJECT DATA SHEETS

1. Title and location of project: Fermilab Main Injector
Fermi National Accelerator Laboratory
Batavia, Illinois

2. Project No.: 92-G-302

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

The primary purpose of this project is to greatly increase the Tevatron collider luminosity which can be delivered to the two existing collider detector facilities at Fermilab. Fermilab is the only operational high energy physics facility in the world with sufficiently high energy to produce the top quark, which is the last unobserved fundamental particle building block according to our current understanding of the basic structure of all matter. Increasing the luminosity of the Fermilab proton-antiproton collider to as much as $50x10^{30}cm^{-2}sec^{-1}$ will almost guarantee first observation of the top quark at Fermilab, if its mass lies within the range indicated by all present data. The project will also greatly increase the number of protons which can be delivered to the Tevatron for acceleration and delivery to the existing fixed target experimental areas. Other important purposes are to provide an expanded capability for 120 GeV beams for fixed target physics research, and to provide year-round beams for the testing and calibration of SSC detector components and subsystems simultaneously with Tevatron collider operations for physics research.

Increasing the collider luminosity requires increasing the number of protons and antiprotons injected into the Tevatron. The substantial improvement in injection intensities results from the large effective aperture of the Main Injector ring, and from its fast repetition rate capability. These are achieved through tight beam focussing, high magnetic field quality, and elimination of the overpasses which had to be installed in the Main Ring in order to accommodate the collider detector facilities. The Main Injector will be capable of accelerating protons to 120 GeV every 1.5 seconds for antiproton production, as compared to a 2.6 second cycle for the present Main Ring. The beam intensity injected into the Tevatron by the Main Injector will approach 6×10^{13} protons per 60 second cycle, which is about three times greater than could be achieved with the Main Ring. The Tevatron proton-antiproton colliding beam luminosity will be increased to about 50×10^{30} $cm^{-2}sec^{-1}$, which is five times greater than could be achieved using the Main Ring. These performance goals are expected to be reached after some months of operational experience with the upgraded facilities.

PROJECT DATA SHEETS

1. Title and location of project: Fermilab Main Injector
Fermi National Accelerator Laboratory
Batavia, Illinois

2. Project No.: 92-G-302

10. Details of Cost Estimate*

	Item Cost	Total Cost
a. EDI&A at 18% of construction costs		$ 22,600
b. Main Injector construction costs		125,400
1. Conventional construction	$ 45,700	
2. Special facilities	79,700	
c. Contingency at 25% of above costs		37,000
Total estimated cost		$185,000

* The annual escalation rates assumed for FY 1993 through FY 1997 are 3.9, 4.7, 4.8, 4.9, and 4.9 percent respectively.

11. Method of Performance

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

12. Funding Schedule of Project Funding and Other Related Funding Requirements

a. Total project costs	FY 1991	FY 1992	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	Total
1. Total facility costs								
(a) Construction line item	$ 0	$11,000	$23,000	$36,000	$42,000	$45,000	$28,000	$185,000
	$ 0	$11,000	$23,000	$36,000	$42,000	$45,000	$28,000	$185,000
2. Other project costs								
(a) R&D costs necessary to complete construction	$ 300	$ 4,500	$ 6,500	$ 2,200	$ 900	$ 400	$ 0	$ 14,800
(b) Pre-operating costs	0	0	0	0	0	1,450	3,350	4,800
(c) Inventories and spares	0	0	400	1,400	3,500	3,500	700	9,500
(d) Capital equipment	200	400	300	100	100	0	0	1,100
Total other project costs	500	4,900	7,200	3,700	4,500	5,350	4,050	30,200
Total project costs	$ 500	$15,900	$30,200	$39,700	$46,500	$50,350	$32,050	$215,200

1. Title and location of project: Fermilab Main Injector
Fermi National Accelerator Laboratory
Batavia, Illinois

2. Project No.: 92-G-302

12. Funding Schedule of Project Funding and Other Related Funding Requirements (Continued)

b. Total related incremental annual funding requirements (estimated life of project: 20 years)

1. Power costs for Main Injector test beam operations	$5,150
2. Experimental areas operating costs for test beams	1,450
Total incremental annual funding (in FY 1997 dollars)	$6,600

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

a. Total project costs
   1. Total facility cost
      (a) Construction 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, will be concentrated in the first two years. Specifically included are the development of the high current dipole magnets and associated power supplies. A small number of Main Injector dipole magnets and power supplies will be fabricated and tested using R&D operating funds.
      (b) Pre-operating costs - Includes personnel and power costs for a several-month commissioning period.
      (c) Inventories and spares - Provides for special process spares for the major technical components, primarily magnets and power supplies, and for an increase in common use inventories for Main Injector related items.
      (d) Capital equipment - Includes test instruments, electronics, and other general equipment to support 12.a.1 and 12.a.2.a.

b. Total incremental funding requirements - We assume that the Fermilab Tevatron complex will continue both its fixed target and its colliding beam research programs, with each running about 40% of the time on the average. The Main Injector replaces the present Main Ring in all of its functional roles, and it is designed to require about the same amount of power to operate for those purposes. The new Main Injector capability for test beam operations simultaneously with Tevatron operations for physics research will require an average increase in power plus other operating costs by about $6.6M annually. The operating costs in 12.b reflect the incremental demands of delivering 120 GeV protons to the test beam areas during Tevatron colliding beam and fixed target operating periods for physics research.