DOE/MA-0274
Volume 3 of 4

Congressional Budget Request

General Science and Research
Uranium Enrichment
Geothermal Resources Development Fund
Power Marketing Administrations
Departmental Administration

Volume 3

FY 1988

U.S. Department of Energy
Assistant Secretary,
Management and Administration
Office of the Controller
Washington, D.C. 20585

January 1987

FPARTMENT OF ENERGY

FISCAL YEAR 1988 CONGRESSIONAL BUDGET REQUEST

GENERAL SCIENCE AND RESEARCH

URANIUM ENRICHMENT

GEOTHERMAL RESOURCES DEVELOPMENT FUND

POWER MARKETING ADMINISTRATIONS

DEPARTMENTAL ADMINISTRATION

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DEPARTMENT OF ENERGY

FISCAL YEAR 1988 CONGRESSIONAL BUDGET REQUEST

SUMMARY OF ESTIMATES BY APPROPRIATIONS

BUDGET AUTHORITY IN THOUSANDS OF DOLLARS

	FY 1986 Actual BA	FY 1987 Estimate BA	FY 1988 Request BA
Appropriations Before The Energy and Water Development Subcommittees:			
Energy Supply Research and Development	$ 1,701,351	$ 1,254,131	$ 1,914,710
Uranium Enrichment	1,549,015	1,210,400	1,070,000
General Science and Research	659,059	719,517	814,498
Atomic Energy Defense Activities	7,292,405	7,481,852	8,050,000
Departmental Administration	235,676	139,509	166,133
Alaska Power Administration	3,245	2,881	3,026
Bonneville Power Administration	404,329	327,659	205,800
Southeastern Power Administration	---	19,647	27,400
Southeastern - Continuing Fund	4,028	---	---
Southwestern Power Administration	29,180	25,337	16,648
Western Area Power Administration	195,842	240,309	295,515
Western Area Power Emergency Fund	147	225	---
Federal Energy Regulatory Commission	45,107	-3,465	-900
Nuclear Waste Fund	499,037	499,000	500,000
Geothermal Resources Development Fund	69	72	72
Subtotal, Appropriations Before the Energy and Water Development Subcommittees	$12,618,490	$11,917,074	$13,062,902

DEPARTMENT OF ENERGY

FISCAL YEAR 1988 CONGRESSIONAL BUDGET REQUEST

SUMMARY OF ESTIMATES BY APPROPRIATIONS

BUDGET AUTHORITY IN THOUSANDS OF DOLLAR

	FY 1986 Actual BA	FY 1987 Estimate BA	FY 1988 Request BA
Appropriations Before Interior and Related Agencies Subcommittees:			
Alternative Fuels Production	$ 2,775	$ ---	$ ---
Clean Coal Technology	---	---	50,000
Fossil Energy Research and Development	309,389	251,402	168,900
Naval Petroleum and Oil Shale Reserves	13,002	122,177	159,700
Energy Conservation	426,187	149,679	86,090
Energy Regulation	23,423	23,400	21,680
Emergency Preparedness	5,750	6,044	6,206
Strategic Petroleum Reserve	107,533	147,433	270,181
Energy Information Activities	57,724	60,301	61,599
Subtotal, Interior and Related Agencies Subcommittees	945,783	760,436	824,356
Subtotal, Energy and Water Development Subcommittees	12,618,490	11,917,074	13,062,902
Subtotal, Department of Energy	13,564,273	12,677,510	13,887,258
Permanent - Indefinite Appropriations:			
Payments to States	629	705	727
Total, Department of Energy	$13,564,902	$12,678,215	$13,887,985

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL STAFFING REQUEST
TOTAL WORK FORCE

	FY1986 FTE USAGE	FY1987 -FY86	FY1987 CONGR REQ	FY1988 -FY87	FY1988 CONGR REQ
ENERGY & WATER SUBCOMMITTEE					
HEADQUARTERS	4,663	170	4,833	47	4,880
FIELD	9,393	62	9,455	-4	9,451
SUBCOMMITTEE TOTAL	14,056	232	14,288	43	14,331
INTERIOR SUBCOMMITTEE					
HEADQUARTERS	1,254	-13	1,241	-104	1,137
FIELD	883	5	888	-143	745
SUBCOMMITTEE TOTAL	2,137	-8	2,129	-247	1,882
GRAND TOTAL	16,193	224	16,417	-204	16,213
ADJUSTMENT		-317	-317	54	-263
ADJUSTED TOTAL	16,193	-93	16,100	-150	15,950

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL STAFFING REQUEST
TOTAL WORK FORCE

	FY1986 FTE USAGE	FY1987 -FY86	FY1987 CONGR REQ	FY1988 -FY87	FY1988 CONGR REQ
10:ENERGY SUPPLY RESEARCH AND DEV	918	8	926	0	926
HEADQUARTERS	639	4	639	0	639
FIELD	283	4	287	0	287
15:URANIUM ENRICHMENT	65	2	67	0	67
HEADQUARTERS	54	2	56	0	56
FIELD	11	0	11	0	11
20:GENERAL SCIENCE AND RESEARCH	38	1	39	0	39
HEADQUARTERS	38	1	39	0	39
25:ATOMIC ENERGY DEFENSE ACTIVITI	2,710	142	2,860	30	2,890
HEADQUARTERS	491	52	543	19	562
FIELD	2,227	90	2,317	11	2,328
30:DEPARTMENTAL ADMINISTRATION	3,273	77	3,350	20	3,370
HEADQUARTERS	1,693	46	1,739	5	1,744
FIELD	1,580	31	1,611	15	1,626
34:ALASKA POWER ADMINISTRATION	36	2	38	-3	35
FIELD	36	2	38	-3	35
36:BONNEVILLE POWER ADMIN	3,491	-61	3,430	-50	3,380
FIELD	3,491	-61	3,430	-50	3,380
38:SOUTHEASTERN POWER ADMIN	38	2	40	0	40
FIELD	38	2	40	0	40
42:SOUTHWESTERN POWER ADMIN	193	-7	186	0	186
FIELD	193	-7	186	0	186
46:WAPA - POWER MARKETING	1,176	-16	1,160	0	1,160
FIELD	1,176	-16	1,160	0	1,160
50:WAPA - COLORADO RIVER BASIN	219	0	219	0	219
FIELD	219	0	219	0	219
52:FEDERAL ENERGY REGULATORY COMM	1,597	62	1,659	0	1,659
HEADQUARTERS	1,597	62	1,659	0	1,659
54:NUCLEAR WASTE FUND	291	20	311	46	357
HEADQUARTERS	154	3	157	23	180
FIELD	137	17	154	23	177
56:GEOTHERMAL RESOURCES DEV FUND	1	0	1	0	1
HEADQUARTERS	1	0	1	0	1
65:FOSSIL ENERGY RESEARCH AND DEV	706	-3	703	-113	590
HEADQUARTERS	141	-3	138	0	138
FIELD	565	0	565	-113	452
70:NAVAL PETROL & OIL SHALE RES	99	-4	95	0	95
HEADQUARTERS	20	2	22	0	22
FIELD	79	-6	73	0	73
75:ENERGY CONSERVATION	322	30	352	-109	243
HEADQUARTERS	201	26	227	-84	143
FIELD	121	4	125	-25	100
80:EMERGENCY PREPAREDNESS	64	7	71	0	71
HEADQUARTERS	64	7	71	0	71
81:ECONOMIC REGULATION	348	-53	295	-20	275
HEADQUARTERS	348	-53	295	-20	275
85:STRATEGIC PETROLEUM RESERVE	152	-5	147	-5	142
HEADQUARTERS	34	-12	22	0	22
FIELD	118	7	125	-5	120
90:ENERGY INFORMATION ACTIVITIES	446	20	466	0	466
HEADQUARTERS	446	20	466	0	466
94:ADVANCES FOR CO-OP WORK	2	0	2	0	2
FIELD	2	0	2	0	2
GRAND TOTAL	16,193	224	16,417	-204	16,213
ADJUSTMENT		-317	-317	54	-263
ADJUSTED TOTAL	16,193	-93	16,100	-150	15,950

DEPARTMENT OF ENERGY

FISCAL YEAR 1988 CONGRESSIONAL BUDGET REQUEST

GENERAL SCIENCE AND RESEARCH

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GENERAL SCIENCE AND RESEARCH ACTIVITIES

For expenses of the Department of Energy, activities including the purchase, construction and acquisition of plant and capital equipment and other expenses incidental thereto necessary for general science and research activities in carrying out the purposes of the Department of Energy Organization Act (Public Law 95-91), including the acquisition or condemnation of any real property or facility or for plant or facilities acquisition, construction, or expansion; purchase of passenger motor vehicles (not to exceed [12] 22, of which 18 are for replacement only); [$708,400,000] $814,498,000 to remain available until expended. (Energy and Water Development Appropriations Act, 1987, as included in Public Laws 99-500 and 99-591, section 101(e).)

DEPARTMENT OF ENERGY

FISCAL YEAR 1988 CONGRESSIONAL BUDGET REQUEST

SUMMARY OF ESTIMATES BY APPROPRIATION BY MAJOR ACTIVITY

GENERAL SCIENCE AND RESEARCH

BUDGET AUTHORITY IN THOUSANDS OF DOLLARS

	FY 1986 Actual	FY 1987 Estimate	FY 1988 Request
High Energy Physics	$490,440	$499,679	$566,598
Nuclear Physics	172,527	217,043	245,100
High Energy and Nuclear Physics Program Direction	2,092	2,453	2,800
Subtotal, General Sciences	665,059	719,175	814,498
Less Use of Prior Year Balances and Other Adjustments	-6,000	342	---
Total, General Science and Research.	$659,059	$719,517	$814,498

DEPARTMENT OF ENERGY

FISCAL YEAR 1988 CONGRESSIONAL BUDGET REQUEST

GENERAL SCIENCE AND RESEARCH

HIGH ENERGY PHYSICS

VOLUME 3

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DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH

OVERVIEW

High Energy Physics

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

Experimental research in high energy physics most often requires the use of large particle accelerators, colliding beam devices, and large particle detectors. There are three DOE supported accelerator centers (Fermilab, Brookhaven National Laboratory (BNL), and Stanford Linear Accelerator Center (SLAC)), each of which provides world unique capabilities and is operated as a national facility available to qualified experimenters on the basis of the scientific merit of their proposals. Experiments are also carried out at foreign accelerators with unique capabilities not available in the U.S. Some important experiments do not require beams from accelerators but use detectors elsewhere, often in deep underground laboratories. 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 accelerators, colliding beam and detector facilities, and the provision of upgraded and new facilities on a timely basis as well as the effective utilization of existing facilities. The dependence of the program on such facilities strongly influences program planning and strategy.

Two major upgrades of U.S. high energy physics facilities, the Stanford Linear Collider (SLC) and the Fermilab Tevatron Collider, will begin operation in FY 1987 and will be in full operation in FY 1988. These facilities will keep the U.S. program highly competitive and at the cutting edge for the next several years. By the mid 1990's, a major new facility will be required to advance the energy frontier and such a facility will be essential for the U.S. to maintain a competitive world-forefront High Energy Physics program in the mid 1990's and beyond. To this end, the Department has since FY 1984 supported an R&D program aimed at the development and design, including the modeling of components, for a proton-proton collider facility with a total energy of 40 trillion electron volts called the Superconducting Super Collider.

The strategy for FY 1988 revolves around the following key factors:

- Highest priority is given to operating the new world forefront research capabilities of the SLC electron-positron collider and Tevatron proton-antiproton collider at a high level. High priority is also given to the Tevatron fixed target program which recently has come into operation. In FY 1988 a full set of Tevatron fixed target experiments will be operational for physics research. Operation at SLAC of the upgraded Positron Electron Project (PEP) electron-positron collider with the improved Time Projection Chamber (TPC) detector and operation at BNL of the Alternating Gradient Synchrotron (AGS) program focusing on rare kaon decay and neutrino experiments are also important.

- Continued effective participation of university scientists in the program is important. University scientists directly carry out over three-fourths of the experimental and theoretical research in the field. Universities have a leading role in providing intellectual leadership for the field of High Energy Physics and in training of highly skilled scientists and engineers. It is recognized and considered an asset that many of these experts are eagerly sought and migrate to other disciplines and industry after being trained in high energy physics.

- Provision and upgrade of major detector capabilities on a timely basis is crucial to effective utilization of the accelerator and collider facilities. Particular priority is given in this fiscal year to continue progress on the fabrication of the SLAC Large Detector (SLD) for the Stanford Linear Collider and the D-Zero detector for the Tevatron collider so that first physics with these detectors can begin in FY 1989.

- Pursuit of long range accelerator and detector R&D studies to develop new and advanced concepts and technologies for accelerator improvements and for future accelerators with greater research capability in an economically feasible manner is critical to the long range viability and continued advancement of the program.

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

LEAD TABLE

High Energy Physics

	FY 1986 Actual	FY 1987 Appropriation	FY 1988 Base	FY 1988 Request	% Change from FY 1987 Approp.
Physics Research.....	$105,768	$109,400	$109,400	$119,698	+ 9
Facility Operations.....	172,977	208,379	208,379	240,300	+15
High Energy Technology.....	86,662	80,500	80,500	77,200	- 4
Capital Equipment.....	69,984	70,057	70,057	80,200	+14
Construction.....	55,049	31,343	31,343	49,200	+57
Total.....	490,440	499,679	499,679	566,598	+13
Operating Expenses.....	(365,407)a/	(398,279)	(398,279)	(437,198)	+10
Capital Equipment.....	(69,984)	(70,057)	(70,057)	(80,200)	+14
Construction.....	(55,049)	(31,343)	(31,343)	(49,200)	+57
Total Program.....	($490,440)a/b/c/	($499,679)	($499,679)	($566,598)	+13
Staffing (FTEs).....	(Reference General Science Program Direction)				

Authorization: Section 209, Public Law 95-91.

a/ Total has been reduced by $4,618,000 for SBIR.
b/ Includes $6,000,000 transfer of appropriation.
c/ Total reduced by $22,042,000 in accordance with P.L. 99-177, the Balanced Budget and Emergency Deficit Control Act of 1985 (Gramm/Rudman/Hollings).

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

SUMMARY OF CHANGES

High Energy Physics

FY 1987 Appropriation enacted	$499,679
- Funding required to maintain a constant overall level of program activity	+18,700
Physics Research	
- Physics research at a level consistent with the operating level of facilities	+6,300
Facility Operations	
- First full year of operation for research with the new world leading collider facilities at Fermilab and SLAC	+24,000
High Energy Technology	
- Advanced accelerator and detector R&D including studies of advanced accelerator concepts which have reached the stage requiring experimental verification	-6,300
Capital Equipment	
- Special emphasis on SLD detector at SLC and D-Zero detector at Tevatron collider, maintaining schedule to permit first physics with these detectors in FY 1989	+7,600
Construction	
- Continuation of Fermilab Computing Upgrade and AGS Accumulator/Booster, AIP and GPP near constant level of effort	+16,619
FY 1988 Congressional Budget Request	$566,598

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

KEY ACTIVITY SUMMARY

HIGH ENERGY PHYSICS

I. Preface: Physics Research

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, and set up of experiments; conduct of experiments; analysis and interpretation of data; and dissemination of results. Theoretical physics research provides the framework for understanding observed phenomena and, through predictions and extrapolations based on existing theories, suggests key questions for future experimental explorations. This subprogram supports research groups at about 100 universities as well as at Fermilab, SLAC, BNL, LBL, ANL, LANL, Ames, ORNL, and PNL.

Experiments in high energy physics generally require the use of large particle accelerators, together with complex detection apparatus, to study the results of the collisions of high energy particles. The DOE-supported accelerators and experimental facilities are located at three central laboratories, where they are made available to qualified scientists on the basis of the scientific merit and promise of their research proposals. More than 75 percent of the research done with these central facilities is performed by university-based physicists. 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 accepted, the research teams participate in the design and fabrication of the experimental setup and provide manpower for the experiment during the data-taking phase at the laboratory. There is usually 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 duration can be several years longer. U.S. user group participation in experiments using unique accelerator capabilities and opportunities at foreign laboratories such as DESY (West Germany), CERN (Western Europe), and KEK (Japan) is also supported. There is also a program of experiments not requiring beams from accelerators, of which experiments to search for proton decay are presently the major component.

In FY 1986 there was a strong focus on analyzing data from earlier experiments and on preparation of experiments for the new world forefront facilities about to come into operation at SLAC and Fermilab. Groups did participate in data taking at the AGS and during limited operation at SLAC. The new world forefront Tevatron and SLC colliders will begin operation for the first time for physics during FY 1987. Experimental groups require increased support for effective participation in experiments with these facilities in FY 1988 as they come into full operation. There will be continuation of theoretical programs and other experimental programs underway. A high level of research activity is planned for in FY 1988 as these new facilities move out of their shakedown period into a year of stable operation for research.

II. A. Summary Table

Program Activity	FY 1986	FY 1987	FY 1988	% CHANGE
Physics Research.....	$105,768	$109,400	$119,698	+ 9

II. B. Major Laboratory and Facility Funding

	FY 1986	FY 1987	FY 1988	% CHANGE
Fermi National Accelerator Laboratory	$ 9,396	$ 9,400	$ 9,900	+ 5
Stanford Linear Accelerator Center	10,818	10,800	11,500	+ 6
Brookhaven National Laboratory	7,029	7,000	7,400	+ 6
Argonne National Laboratory	4,801	4,900	5,200	+ 6
Lawrence Berkeley Laboratory	8,463	8,600	9,100	+ 6
Other Laboratories	1,758	1,665	1,900	+14
Universities and Other	63,503	67,035	74,698	+11
Total Physics Research	$105,768	$109,400	$119,698	+ 9

III. Activity Descriptions

Program Activity	FY 1986	FY 1987	FY 1988
Fermilab	Fermilab staff participate in the preparation, conduct and analysis of data from experiments using the Fermilab facilities, while providing a crucial support and liaison function for the many university users involved in experimental programs at Fermilab. Most of the FY 1986 activity was analysis of data from the 1985 fixed target run and preparation for new experiments coming into operation in FY 1987 with completion of the Collider, and final elements of the fixed target upgrade. There is also a theoretical research activity underway as well as a small program of high energy astrophysics research. ($9,396)	As the Tevatron Collider and fixed target programs come into operation for physics, the research groups will concentrate on collaborating with university groups conducting experiments with these facilities. The completion of physics analyses of the data collected in the 1985 fixed target run, and preparation of the publications, will require a major effort, as will theoretical interpretations of this new information. ($9,400)	This will be the first full year of operation of the Fermilab Tevatron facilities for research, and it should be a very productive research year. The Fermilab research groups will continue at about constant level of effort as in FY 1987, and will be analyzing data from the FY 1987 runs, and collecting data in collider and fixed target experiments. ($9,900)
SLAC	The SLAC research groups focus their efforts on collaborative experiments with university groups using PEP and SPEAR facilities. In FY 1986 these groups were involved in data taking at these colliders and in preparation for SLC experiments which begin in FY 1987. There is also a theoretical research activity. ($10,818)	As SLC comes into operation, emphasis will shift toward conduct of the first experiment with the Mark II detector at SLC. PEP and SPEAR will not operate for high energy physics research this year. ($10,800)	Major activities will be the first full year of SLC operation with data-taking on the Mark II detector, and the first operation for research of the upgraded PEP facility with the upgraded TPC detector. In addition, there will be the first operation of SPEAR following the 1987 shutdown and the initial test operation of the SLD detector. ($11,500)
BNL	The BNL research groups focus on experiments at the AGS, but also participate to some degree in experiments	The program will contine FY 1986 activities with significant emphasis on participation in preparation for the DO	The program will continue at about the same level of effort. A major FY 1988 activity will be the initial major

III. Physics Research (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1988
BNL (Cont'd)	at Fermilab and CERN. The AGS program includes a wide variety of fixed target experiments, with particular emphasis on preparation for new generation of rare decay experiments. ($7,029)	experiment at Fermilab and on initial operation of the new generation of rare kaon decay experiments at the AGS. ($7,000)	data-taking on the rare kaon decay experiment at the AGS. ($7,400)
Other Labs	These groups concentrate their efforts as users at the DOE accelerator centers and at foreign facilities with unique capabilities. The LBL program includes participation in the Mark II experiments as well as a large theoretical effort and the Particle Data Center. ($15,022)	These programs are similar but reduced from the FY 1986 level of effort. ($15,165)	These programs will be restored to about the FY 1986 level of activity. The emphasis will reflect the full operational status of the new Fermilab and SLAC facilities. ($16,200)
University Program	This program supports experimental and theoretical research groups at about a hundred universities throughout the nation. The university groups participate in experiments at the major U.S. accelerator facilities and at unique foreign accelerator facilities, as well as in non-accelerator experiments and theoretical research. The level of effort is appropriately scoped to match the level of facility operation. ($63,503)	Programs will continue at approximately a constant level of effort with emphasis shifting toward experiments at Tevatron and SLC as the new facilities come into operation. ($67,035)	These programs will be increased somewhat above the FY 1987 level of activity, consistent with the operational status of the new Fermilab and SLAC facilities. ($74,698)
Total	$105,768	$109,400	$119,698

I. Preface: Facility Operations

Provides funding for the operation of accelerators, colliders, secondary beam lines, detectors for experiments, experimental areas, and computing facilities. Includes the associated costs of manpower, electric power, expendable supplies, and inventories. Major DOE supported facilities to be operated in FY 1988 include: Fermilab (800 GeV proton fixed target and 900 GeV on 900 GeV antiproton-proton colliding beam Tevatron; SLAC (50 GeV linear accelerator serving as injector for the SPEAR 4 GeV on 4 GeV electron-positron collider, the PEP 15 GeV on 15 GeV electron-positron collider, and the SLC 50 GeV on 50 GeV electron positron collider); and, BNL AGS (30 GeV proton and polarized proton fixed target program). In FY 1987, the world forefront SLC and Tevatron colliders will both be brought into operation for physics. Incremental funds will be required in FY 1988 at SLAC and Fermilab to provide for the higher level of operation for physics experiments, including the significantly increased electric power usage. At SLAC the funding need is particularly large because of the rapidly rising WAPA power rates and the need to purchase much of the additional power from PG&E at more than twice the WAPA rate. The FY 1988 request gives priority to operation of SLAC and Fermilab for physics research at high levels and the incremental funding is for these two programs.

II. A. Summary Table

Program Activity	FY 1986	FY 1987	FY 1988	% CHANGE
Facility Operations	$172,977	$208,379	$240,300	+15

II. B. Major Laboratory and Facility Funding

Fermi National Accelerator Laboratory	$ 86,259	$102,000	$115,100	+13
Stanford Linear Accelerator Center	50,090	63,900	80,800	+26
Brookhaven National Laboratory	35,710	36,500	38,800	+ 6
Total Facility Operations	$172,059	$202,400	$234,700	+16

III. Activity Descriptions

Program Activity	FY 1986	FY 1987	FY 1988
Fermilab Operations	Fermilab operated two weeks for proton-antiproton collider tests at the beginning of the fiscal year but did not operate for physics during the rest of FY 1986 due to a 9 month construction related shutdown and to the GRH funding reductions. There was extensive activity related to testing the new Tevatron systems and to upgrading and rebuilding many of the older accelerator systems. ($86,259)	Fermilab is scheduled to operate for about 3 months for Tevatron tuneup, 3 months for colliding beam experiments and 4 to 5 months for fixed target experiments. ($102,000)	Fermilab is scheduled to operate the Tevatron collider and fixed target programs for a total of about 10 months to accomplish a full program of physics. The time will be shared about equally among four colliding beam experiments and twelve fixed target program experiments. ($115,100)
SLAC Operations	SLAC operated 20 weeks for PEP experiments, and concurrently achieved 14 weeks of high energy experiments at SPEAR. The last half of the year was devoted to SLC system tests. (Note that half of the total SPEAR operation is devoted to dedicated operation for synchrotron radiation research supported by Basic Energy Sciences). ($50,090)	SLAC is scheduled to operate for SLC tests for about 17 weeks, followed by 13 weeks of operation for physics with SLC at reduced pulse rate. SPEAR and PEP will not operate for high energy physics during FY 1987 due to funding limitations. ($63,900)	SLAC is scheduled for about 26 weeks of operation for physics with SLC and PEP, during which time there will concurrently be 17 weeks of SPEAR operation for HEP experiments. ($80,800)
BNL-AGS Operations	AGS operated for 27 weeks, including 15 weeks for the neutrino program, 5 weeks for slow external beam with multiple experiments and 7 weeks for polarized protons. ($35,710)	AGS is scheduled to operate for about 14 weeks for high energy physics research for the slow external beam program with multiple experiments. There will be an additional operation of about 7 weeks for	AGS will operate for about 15 weeks for high energy physics to be split among the various modes. Additional operation of about 8 weeks is planned for heavy ion physics funded by Nuclear Physics.

III. Facility Operations (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1988
BNL-AGS Operations (Cont'd)		heavy ion physics funded by Nuclear Physics. Therefore, total AGS operation in FY 1987 will be about 21 weeks. ($36,500)	Therefore, total AGS operation in FY 1988 will be about 23 weeks. ($38,800)
Other	This provides funding to LBL for its participation in the operation, maintenance, and upgrading of the Time Projection Chamber (TPC) detector at PEP. It also provides for special process spares, common use stores, and other specialized activities to meet requirements for effective operation of the accelerator laboratories (SBIR funding in FY 1986 has already been transferred to the SBIR program). ($918)	Continuation of the FY 1986 program, with a slight increase for spares and inventories as major new facilities come into operation at Fermilab and SLAC. Also includes funding for the SBIR assessment on the High Energy Physics program. ($5,979)	Continuation of FY 1987 programs at reduced level of effort. ($5,600)
Total	$172,977	$208,379	$240,300

I. Preface: High Energy Technology

Provides the technological base for maintaining and improving the scientific effectiveness, reliability and efficiency of existing facilities and for extending the capability of accelerators, colliders, and detectors by developing and proving new concepts and technologies. Includes R&D with a near term focus in support of ongoing construction (particularly Tevatron and SLC) and ongoing major detectors (CDF, DO, SLD, and L3) and improving existing facilities and with a longer term focus on development of advanced concepts leading to future accelerators, colliders, and detectors of greater performance capability and more cost effective operation. Includes theoretical studies of accelerator physics, exploration of new concepts for particle acceleration, storage and transport, fabrication and testing of apparatus based on these studies, and input for design of actual devices. The program also includes advanced accelerator R&D studies with a particular emphasis on higher energy accelerators employing superconducting magnets. In FY 1986 and FY 1987 this work was directed toward a 20 Tev on 20 Tev proton-proton collider called the Superconducting Super Collider (SSC). The FY 1988 status of the SSC is presently under consideration. The High Energy Technology program is carried out primarily in the DOE laboratories, but with a significant program of advanced concept development in universities and industry.

II. A. Summary Table

Program Activity	FY 1986	FY 1987	FY 1988	% CHANGE
High Energy Technology.....	$86,662	$80,500	$77,200	- 4

II. B. Major Laboratory and Facility Funding

	FY 1986	FY 1987	FY 1988	% CHANGE
Fermi National Accelerator Laboratory.....	$23,378	$19,100	$21,900	+13
Stanford Linear Accelerator Center.....	16,000	13,300	15,000	+13
Brookhaven National Laboratory.....	19,453	17,100	16,900	- 1
Lawrence Berkeley Laboratory.....	8,510	8,800	7,900	-10
Universities and Other.....	19,321	22,200	15,500	-30
Total High Energy Technology.....	$86,662	$80,500	$77,200	- 4

III. Activity Descriptions

Program Activity	FY 1986	FY 1987	FY 1988
Fermilab	Activities focused largely on R&D in support of the Tevatron construction efforts, with particular emphasis on studies to optimize the performance of the Tevatron as a collider. Advanced accelerator R&D studies are also pursued, with particular emphasis on superconducting magnets for advanced accelerators. A significant program of detector R&D was pursued, with emphasis on Tevatron detectors. ($23,378)	As the Tevatron Collider and fixed target facilities come into operation, the focus of studies will shift from construction related R&D toward optimization of performance of these facilities. Advanced accelerator and detector R&D studies will continue. ($19,100)	As operation of the Tevatron for physics research stabilizes, R&D to more fully understand the new accelerator systems and to enhance the reliability and efficiency of their operation will become increasingly important. A substantial R&D effort will be devoted to the goal of achieving a major increase in luminosity beyond the present design goal and on the detector technology needed to utilize this increase. There will also be an expansion of advanced accelerator and advanced detector R&D. ($21,900)
SLAC	Activities focused largely on R&D in support of the SLC project which poses many difficult technological challenges. R&D also directed toward improved performance and reliability of the SPEAR and PEP colliders. Also includes studies of advanced accelerator concepts with a focus on developing new techniques for future extensions of the capability of electron positron colliders. Detector R&D program with strong focus on the SLD detector for SLC. ($16,000)	As SLC comes into operation, the focus of R&D studies shifts from construction related R&D toward support of commissioning of the SLC, carrying out accelerator R&D experiments on SLC to explore strengths and limits of linear collider technology and studying the improvement and optimization of SLC performance with particular emphasis on high luminosity and polarized electron-positron operation. Studies of advanced accelerator and detection concepts will continue. ($13,300)	As SLC technology becomes understood, and operation for physics research stabilizes, R&D will be expanded to improve luminosity and performance, and to make further progress on linear collider technology. Studies of advanced concepts, particularly new, high power, high efficiency radiofrequency sources will increase somewhat. ($15,000)
BNL	Major focus on studies to maintain the operating effectiveness and flexibility of the AGS and in support of upgrade of AGS intensity by the Accumulator/Booster project. Also includes substantial program of R&D on advanced accelerator	Program continues at a substantially reduced overall level of effort, with focus on studies in support of the AGS Accumulator/Booster project, on advanced detectur R&D and on superconducting magnet R&D. ($17,100)	Program will include R&D in support of the AGS Accumulator/Booster project, and improved polarized proton operation of the AGS, on a continuation of the superconducting magnet R&D program, and on advanced accelerator concepts,

III. High Energy Technology (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1988
BNL (Cont'd)	concepts with a heavy focus on superconducting magnets for advanced accelerators. ($19,453)		including an advanced test facility for laser accelerator studies. ($16,900)
LBL	Major focus on studies of superconducting magnets for advanced accelerators. Also includes work on antiproton cooling in support of the Tevatron collider and accelerator theory. Significant effort in advanced detector equipment. ($8,510)	Program continues at about constant level of effort, with focus on studies of antiproton cooling and superconducting magnet R&D, and development of the two-beam accelerator concept. ($8,800)	Continuation of the FY 1987 program at reduced overall level of effort. ($7,900)
Universities and Other Contractors	This includes a program of advanced technology studies by universities and industrial contractors. The program focuses on studies of advanced concepts and technologies for accelerators and detectors with the goal of providing the technological basis for future facilities with greater capabilities at an affordable cost. Included are theoretical studies of beam dynamics, collective methods of particle accelerators, laser acceleration of particles, high power RF sources and high field superconducting magnets. ($19,321)	Program continues with emphasis focused on studies of advanced accelerator concepts which require experimental verification, and on advanced concepts and technology development for large collider detectors. ($22,200)	A continuation of program at reduced level of effort with particular emphasis on advanced accelerator concept programs in the experimental verification phase and also for R&D on advanced concepts for collider detectors. ($15,500)
Total	$86,662	$80,500	$77,200

I. Preface: Capital Equipment

Capital Equipment funding is required to provide the secondary beam line components, particle detection apparatus, 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 major 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 or more 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 analysis 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

Program Activity	FY 1986	FY 1987	FY 1988	% CHANGE
Capital Equipment	$69,984	$70,057	$80,200	+15

II. B. Major Laboratory and Facility Funding

Fermi National Accelerator Laboratory	$31,277	$27,900	$31,200	+12
Stanford Linear Accelerator Center	13,602	18,100	23,400	+29
Brookhaven National Laboratory	5,218	5,000	5,300	+ 6
Universities and Other Laboratories	16,153	15,357	16,300	+ 6
Brookhaven National Laboratory - Other Capital Equipment	3,734	3,700	4,000	+15
Total Capital Equipment	$69,984	$70,057	$80,200	+14

II. C. Major Detectors (Funding Included Above)

Mark II	$ 2,600	$ 1,100	$ --	
Mark II - Upgrade	--	--	800	
SLD	5,900	13,000	17,300	
CDF	9,000	3,000	--	
CDF - Upgrade	--	--	2,800	
D-Zero	7,000	10,500	15,800	
L-L3	7,700	5,350	4,000	
Fermilab Fixed Target Program	10,200	8,400	7,500	
ZEUS	--	1,000	2,500	

III. Activity Descriptions

Program Activity	FY 1986	FY 1987	FY 1988
Fermilab	Major emphasis on having the CDF detector ready to take data when the Tevatron collider comes into operation early in FY 1987 ($9,000); significant effort to complete Tevatron fixed target beams and detectors ($10,200); progress on the D-Zero detector ($7,000); general purpose computing ($1,300); general laboratory support equipment for the electronics	Emphasis on keeping the D-Zero detector on schedule for initial physics capability in 1989 ($10,500); completion of technical components of two new fixed target beams and detectors ($8,400); completion of CDF detector electronics ($3,000); purchase and installation of replacement central site transformer ($1,100); computing equipment for use in	Major progress towards completing the D-Zero detector in 1990 with some physics capability in 1989 ($15,800); new and upgraded fixed target beam lines and detector apparatus ($7,500); significant upgrade to the capabilities of the CDF detector ($2,800); general purpose computing equipment ($1,700); general purpose laboratory site equipment, and

III. Capital Equipment (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1988
Fermilab (Cont'd)	equipment pool, accelerator related equipment and equipment in support of the R&D programs. ($3,727)	the experimental areas and elsewhere ($1,500); general purpose laboratory and site equipment, and accelerator and R&D program support equipment ($3,400).	accelerator and R&D program support equipment ($3,400).
SLAC	Major emphasis on completing Mark II detector in time for SLC turn on in FY 1987 ($2,600); significant progress on the SLD detector ($5,900); support for PEP luminosity upgrade and TPC detector upgrade ($1,200); support of SLC R&D program ($800); computer related equipment ($500); general laboratory support equipment ($2,602).	Major emphasis on proceeding with SLD detector on a schedule to permit first physics in FY 1989 ($13,000); completion in FY 1990; TPC, Mark II and Mark III detector improvements ($1,900); general computing equipment ($1,200); general laboratory support equipment ($2,000).	Major progress on SLD detector ($17,300); superconducting quadrupoles for SLC luminosity upgrade ($2,000); general laboratory support equipment ($2,300); Mark II upgrade ($800); and general purpose computing ($1,000).
BNL	Major emphasis on detectors for rare kaon decay experiments ($1,500); beam line components ($1,100); equipment for other experiments ($1,000); support for accelerator R&D programs ($600); general AGS support equipment, including instrumentation pool ($1,018).	Major decay emphasis on completion of new generation rare kaon detectors ($1,800); beam line components ($1,000); support for other experiments ($800); support for accelerator R&D ($500); general AGS support equipment ($1,000).	Major emphasis on new experimental initiatives ($2,000); beam line components ($1,000); support for other experiments ($800); support for accelerator R&D ($500); general AGS support equipment ($100).
Universities and Other Laboratories	This supports the major capital equipment needs of the experimental research groups at the universities and at the non-accelerator laboratories (LBL, ANL, Ames). The request includes funds for groups at non-accelerator laboratories ($3,382) and universities ($12,834). Within the university funding, support of U.S. participants in experiments at foreign accelerators is included, with the major effort being the substantial participation in the LEP-L3 detector which is under MIT leadership.	Includes $2,600 for equipment needs of groups at the non-accelerator laboratories and $12,757 for needs of university groups. Major equipment needs for the L3 detector continue and funding for U.S. participation in ZEUS experiment at HERA is initiated.	Includes $3,000 for equipment needs of groups at non-accelerator laboratories and $13,300 for university groups. Equipment needs will continue for U.S. groups participating in LEP and HERA experiments. Increased needs are expected as users prepare for second generation Tevatron fixed target experiments and AGS rare kaon experiments.
Total	$69,984	$70,057	$80,200

DEPARTMENT OF ENERGY
FY 1988 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 1987 Appropriated	FY 1988 Request	Remaining Balance	TEC
88-R-101	Accelerator Improvements and Modifications	---	---	11,600	---	11,600
GP-E-103	General Plant Projects	---	---	11,300	---	11,300
86-R-104	Central Computing Upgrade	$ 2,968	$ 7,000	$ 13,500	$ 1,032	$ 24,500
86-R-105	AGS Accumulator/Booster	1,915	2,500	12,800	12,585	29,800
Total, High Energy Physics Construction		$ 4,883	$ 9,500	$ 49,200	$ 13,617	$ 77,200

DEPARTMENT OF ENERGY
FY 1988 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: 88-R-101 Accelerator improvements and modifications
Various locations

Project TEC: $11,600
Start Date: 3rd Qtr. FY 1988
Completion
Date: 2nd Qtr. FY 1990

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1988	$ 11,600	$ 11,600	$ 5,100
1989	---	---	5,900
1990	---	---	600

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 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	$ 2,300
Fermi National Accelerator Laboratory	6,000
Stanford Linear Accelerator Center	3,300
Total Estimated Cost.....	$11,600

DEPARTMENT OF ENERGY
FY 1988 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: GP-E-103 General Plant Projects
Various locations

Project TEC: $11,300
Start Date: 2nd Qtr. FY 1988
Completion
Date: 2nd Qtr. FY 1990

2. Financial Schedule:

Fiscal Year	Appropriated	Obligations	Costs
1988	$ 11,300	$ 11,300	$ 3,300
1989	---	---	6,100
1990	---	---	1,900

3. Narrative:

(a) General Plant Projects provide for the many miscellaneous alterations, additions, modifications, replacements, and non-major construction required for general purpose, non-technical 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, 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.

(c) A description and listing of the 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	$ 5,800
Fermi National Accelerator Laboratory	3,500
Stanford Linear Accelerator Center	2,000
Total Estimated Cost.....	$11,300

DEPARTMENT OF ENERGY
FY 1988 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: 86-R-104 Central Computing Upgrade
Fermi National Acclerator Laboratory
Batavia, Illinois

Project TEC: $24,500
Start Date: 3rd Qtr. FY 1986
Completion Date: 3rd Qtr. FY 1989

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1986	$ 2,968	$ 2,968	$ 1,513
1987	7,000	7,000	5,300
1988	13,500	13,500	9,900
1989	1,032	1,032	7,787

3. Narrative:

(a) This project is comprised of two parts: a) The acquisition of a major computing capacity and capability upgrade, including a new large processor, a set of user friendly interface mainframes, replacement and expansion of the disc and tape storage systems, and additional interfaces to support both online user terminals and to provide access to special purpose data processors; and b) a building to house the upgraded central computing system.

(b) Fermilab's central computing facility serves a wide variety of needs, the major ones being the analysis of data from experiments, theoretical physics calculations, accelerator design calculations, and stress analysis and magnetic field calculations used in the design of magnets and other equipment. A large central computing facility has proven to be the most cost effective solution to these computing needs in terms of hardware and software support, utilization of peripherals, and flexibility of computer configurations. The present and project growth in need for computing power at Fermilab is due primarily to the large additional data analysis requirements of the Tevatron collider experiments and the growing sophistication of the fixed target experimental program. Effective utilization of the new research capabilities provided by the Tevatron program requires significantly improved computing capability at Fermilab.

(c) The FY 1988 funding will provide for completion of mainframe procurements and installation of hardware.

DEPARTMENT OF ENERGY
FY 1988 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: 86-R-105 AGS Accumulator/Booster
Brookhaven National Laboratory
Upton, New York

Project TEC: $29,800
Start Date: 3rd Qtr. FY 1986
Completion
Date: 3rd Qtr. FY 1990

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1986	$ 1,915	$ 1,915	$ 1,207
1987	2,500	2,500	2,000
1988	12,800	12,800	11,300
1989	12,585	12,585	9,900
1990	---	---	5,393

3. Narrative:

(a) The Accumulator/Booster (A/B ring) is a rapid cycling synchrotron that serves as an intermediate stage between the present linac injector or tandem Van de Graaff and the Alternating Gradient Synchrotron (AGS) for protons, polarized protons, and heavy ions.

(b) The Accumulator/Booster will improve the performance and capabilities of the AGS for (1) normal proton operation, (2) operation with polarized protons and (3) operation with heavy ions. For normal proton operation, beam intensity will be raised by a factor of 4; for polarized proton operation, beam intensity will be raised by a factor of more than 20; and, for heavy ion operation, ion mass capability will be extended from mass 32 to about mass 200. In each of these three modes of operation, the increased capability will have direct and immediate benefits by making accessible areas of science not previously accessible or by significantly increasing the data collection rate for the experimental program already planned and underway at the AGS.

(c) The FY 1988 funding will continue construction of AGS Accumulator/Booster and will permit initiation of conventional construction and fabrication of magnets and other accelerator systems.

DOE/MA-0274

Congressional Budget Request

Construction Project Data Sheets:
Energy Supply Research and Development
General Science
Uranium Enrichment
Naval Petroleum & Oil Shale Reserves

FY 1988

U.S. Department of Energy
Assistant Secretary,
Management and Administration
Office of the Controller
Washington, D.C. 20585

January 1987

DEPARTMENT OF ENERGY
1988 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
GENERAL SCIENCE AND RESEARCH
GENERAL SCIENCE AND RESEARCH - PLANT AND CAPITAL EQUIPMENT
GENERAL SCIENCE AND RESEARCH
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.: 88-R-101

3. Date A-E work initiated: 1st Qtr. FY 1988

3a. Date physical construction starts: 3rd Qtr. FY 1988

4. Date construction ends: 2nd Qtr. FY 1990

5. Previous cost estimate: None
Less amount for PE&D: None
Net cost estimate: None
Date: None

6. Current cost estimate: $11,600
Less amount for PE&D: 0
Net cost estimate: $11,600
Date: Dec. 1986

7. Financial Schedule:

Fiscal year	Authorization	Appropriations	Obligations	Costs
1988	$11,600	$11,600	$11,600	$ 5,100
1989	0	0	0	5,900
1990	0	0	0	600

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.: 88-R-101

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

Brookhaven National Laboratory..... $2,300,000

Funds are requested for modifications, improvements and additions to the Alternating Gradient Synchrotron (AGS) and its related experimental facilities. Items planned include: Upgraded vacuum pumps, rf power amplifiers, computer control upgrade, Siemens upgrade, low and high intensity ring instrumentation, transverse and longitudinal damping system, external beam dump, general access control system upgrade and AGS radiation survey robot.

Fermi National Accelerator Laboratory..... $6,000,000

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

Modifications to the accelerator facilities are expected to include: Accelerator Diagnostic and control components to improve beam stability, intensity and manipulation; power supply and quench protection improvements; improve cryogenic systems and expand helium liquefaction and refrigeration capacity for operational stability; provide for beam transport improvements to minimize loss of beam in the accelerator; low beta magnet and power supply improvements to optimize luminosity at collision areas in the ring during colliding beam operations; and provide for switchyard upgrade to improve beam intensity at experimental areas.

Modifications to the experimental facilities are expected to include: Detector upgrade to improve resolution and data collection; Beam transport magnet and power supply improvements to reduce power consumption and increase beam line performance; Upgrade branch computer to match requirements of higher resolution detectors; Expansion of experimental hall to accommodate larger and more complex detector systems; Replacement of Neutrino target tube enclosure; and provide for a proton beam transport system and enclosure to accommodate a neutrino beam enriched in tau neutrinos.

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

2. Project No.: 88-R-101

8. Brief Physical Description of Project (continued)

Stanford Linear Accelerator Center (SLAC)..... $3,300,000

Funds are requested for modifications, improvements and additions to the SLAC linear accelerator and PEP colliding beam facilities, the SPEAR ring, and the SLC and to the associated experimental facilities. Items now planned for FY 1988 include: Expansion of the wide-band cable system around the SLAC site; Conversion of beam switchyard from a PDP-11 computer system to a VAX control system; Upgrade of beam containment and system monitors to meet current beam configurations and provide radiation control in occupied areas; Implement a fault tree analysis system to provide rapid identification of problems in the various SLAC systems, thus increasing the efficiency of the accelerator; Replacement of modulator PCB capacitors in the AC filter circuits; A high quality precision energy spectrometer for the SLC.

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

Accelerator improvements 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. 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.

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

2. Project No.: 88-R-101

10. Details of Cost Estimate

a. Engineering, design and inspection and component assembly and installation.....	$11,600
Total estimated cost.....	$11,600

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
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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.: GP-E-103

3. Date A-E work initiated: 1st Qtr. FY 1988

3a. Date physical construction starts: 2nd Qtr. FY 1988

4. Date construction ends: 2nd Qtr. FY 1990

5. Previous cost estimate: None
Less amount for PE&D: None
Net cost estimate: None
Date: None

6. Current cost estimate: $11,300
Less amount for PE&D: 0
Net cost estimate: $11,300
Date: Dec. 1986

7. Financial Schedule:

Fiscal Year	Authorization	Appropriations	Obligations	Costs
1988	11,300	11,300	11,300	3,300
1989	0	0	0	6,100
1990	0	0	0	1,900

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 general laboratory facilities whereas AIP projects focus on the technical facilities.

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

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

8. Brief Physical Description of Project (continued)

Brookhaven National Laboratory		**$5,800**
Installation of alarm system console for the Secondary Alarm Station located in Police Headquarters	$810	
Installation of communication services and communication interfaces for the Control Alarm Station and the Secondary Alarm Station	500	
Enlargement of AGS Ring Service Buildings	300	
Expansion of main substation for AGS	500	
Building expansion for National Synchrotron Light Source	750	
Steam main extension	700	
Domestic Water main replacement	700	
Construction of heavy equipment storage building	300	
Improvement of air distribution system in chemistry building	340	
Sanitary System Extension	900	
Fermi National Accelerator Laboratory		**$3,500**
General Utility Improvements	500	
Service Building Improvements - Accelerator Complex	500	
Main Ring Power Factor Upgrade	900	
Tunnel Lighting Improvements	200	
Replacement Sheds at RF Area	250	
Remote Handling Facility Upgrade	450	
Service Building Improvements - Experimental Areas	300	
Facilities Operations and Engineering Building - Phase II	400	

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

2. Project No.: GP-E-103

8. Brief Physical Description of Project (continued)

Stanford Linear Accelerator Center..... $2,000*

Replace heating, ventilating and air conditioning.....	400
Pave Klystron Gallery Road, North.....	350
Remodel existing Plant Maintenance and Utilities Building.....	330
Replace twenty year old roofing on five buildings.....	320
Installation of energy management control system.....	200
Upgrade Plating Shop treatment system.....	400

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

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

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

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

2. Project No.: GP-E-103

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

The funds requested for FY 1988 are estimated as follows:

Brookhaven National Laboratory	$ 5,800
Fermi National Accelerator Laboratory	3,500
Stanford Linear Accelerator Center	2,000
Total Estimated Cost	$11,300

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.

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

1. Title and location of project: Central Computing Upgrade
Fermi National Accelerator Laboratory
Batavia, Illinois

2. Project No.: 86-R-104

3. Date A-E work initiated: 1st Qtr. FY 1986

3a. Date physical construction starts: 3nd Qtr. FY 1986

4. Date construction ends: 3rd Qtr. FY 1989

5. Previous cost estimate: $24,100
Less amount for PE&D: 0
Net cost estimate: $24,100
Date: August 1986

6. Current cost estimate: $24,500
Less amount for PE&D: 0
Net cost estimate: $24,500
Date: December 1986

7. Financial Schedule:

Fiscal Year	Authorization	Approriations	Obligations	Costs
1986	$ 2,968	$ 2,968	$ 2,968	$ 1,513
1987	7,000	7,000	7,000	5,300
1988	13,500	13,500	13,500	9,900
1989	1,032	1,032	1,032	7,787
Total	$ 24,500	$ 24,500	$ 24,500	$ 24,500

8. Brief Physical Description of Project

The proposed project is comprised of two parts:

a) The acquisition of a major computing capacity and capability upgrade, including a new large central processor, replacement and expansion disc and tape storage systems, and additional interfaces to support both online user terminals and access to special purpose data processors.

b) A building to house the upgraded central computing system and support personnel.

1. Title and location of project: Central Computing Upgrade
Fermi National Accelerator Laboratory
Batavia, Illinois

2. Project No.: 86-R-104

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

a. Central Computing System Upgrade

Fermilab's central computing facility serves a wide variety of needs, the major ones being the analysis of data from experiments, theoretical physics calculations, accelerator design calculations, and stress analysis and magnetic field calculations used in the design of magnets and other equipment. A large central computing facility has proven to be the most cost effective solution to these computing needs in terms of hardware and software support, utilization of peripherals, and flexibility of computer configurations. The Fermilab central computing facility represents a major computing resource which is accessible to the U.S. university participants in Fermilab experiments for the analysis of their data. At present the Fermilab central computing facility consists of the equivalent of seven Cyber 175 computers. An evaluation of the projected computing load indicates that an increase in the computing capacity of at least a factor of five will be needed by 1988. This projected increase in load is primarily due to the large additional data analysis requirements of the new colliding beam detectors for Tevatron I. The computer system being acquired will meet these new needs, and will provide the basis for growth into the early 1990's as the accelerator intensity improves and the experiments are refined.

b. Building to House Upgraded Central Computing System

Since 1973 Fermilab's central computing system, tape storage, and on-line computer maintenance have been housed in Wilson Hall. Growth in subsequent years has now led to a degree of congestion which is severely affecting the efficiency and reliability of these operations. Since additional space in Wilson Hall to house additional computing hardware is unavailable, it is planned to move these activities to a separate building specifically designed for this usage, where it will also be much easier to provide proper security for the very high value equipment which is involved.

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Central Computing Upgrade
Fermi National Accelerator Laboratory
Batavia, Illinois

2. Project No.: 86-R-104

10. Details of Cost Estimate

	Part A Computer Upgrade Total Cost	Part B Building Item Cost	Part B Building Total Cost
a. Engineering, design and inspection at 2.3% of Procurement and Installation (Part A) and 10.6% of construction costs (Part B)..	$ 300		$ 700
b. Construction costs			6,800
1. Improvements to land including road, parking & landscaping...		$ 300	
2. Building		6,400	
a. Basic Structure $3,800			
b. Mechanical 1,600			
c. Electrical 900			
d. Conveying System (Elevator) 100			
3. Utilities		100	
4. Procurement	13,800		
5. Installation	200		
Subtotal	$14,300		7,500
c. Contingency at approximately 11% of the above cost for Part A and 15% for Part B	1,600		1,100
Total Estimated Cost by Part	$15,900		$ 8,600
Total Estimated Cost			$24,500

I. Title and location of project: Central Computing Upgrade
Fermi National Accelerator Laboratory
Batavia, Illinois

2. Project No.: 86-R-104

II. Method of Performance

Design of conventional and special facilities will be by the operating contractor. To the extent feasible, construction, procurement, and installation will be accomplished by fixed-price subcontracts awarded on the basis of competitive bidding.

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

	FY 1986	FY 1987	FY 1988	FY 1989	Total
a. Total project costs					
1. Total facility costs					
a. Construction line item.....	$ 1,513	$ 5,300	$ 9,900	$ 7,787	$24,500
2. Other project costs					
a. Existing equipment relocation....	0	0	50	50	100
Total project costs.....	$ 1,513	$ 5,300	$ 9,950	$ 7,837	$24,600

b. Other related annual funding requirements (FY 1988 dollars - estimated life of project: 25 years)

1. Building maintenance and operating cost (including power).....	$ 600
2. Programmatic operating expenses directly related to the computing facility.....	12,000
3. Capital equipment not related to construction but related to the programmatic effort in the computing facility.....	1,500
4. GPP or other construction related to programmatic effort in the facility.....	0
Total related annual funding requirements.....	$14,100
Less: Costs associated with the operation of the existing computing facility in its present location.....	- 9,900
Net incremental annual costs resulting from the construction of the new building and the operation of the upgraded computing facility.	$ 4,200

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Central Computing Upgrade
Fermi National Accelerator Laboratory
Batavia, Illinois

2. Project No.: 86-R-104

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

a. Total project costs:

1. Construction Line Item (No Narrative Required)

2. Other project costs
   a. Existing equipment relocation - the existing computing equipment presently located in Wilson Hall will be relocated to the new building as construction is completed, at an estimated cost of $100,000.

b. Total related annual funding requirements. It is estimated that the building will be used 25 years for its programmatic purpose.

1. Facility operating costs. The major elements comprising the annual operating costs are electricity for lighting and air conditioning, natural gas for heating and labor for custodial and maintenance.

2. Programmatic operating expenses directly related to the facility. The estimate given here is based on the cost of the programmatic effort presently being provided for the existing facility.

3. Capital equipment not related to construction but related to the programmatic effort in the facility. This represents an appropriate funding level for central computer system enhancements.

4. GPP - No narrative required.

5. General - The net incremental costs to operate the upgraded facility are shown in item 12 at $4,200,000. The present Fermilab central computing facility is currently operational in its Wilson Hall location and will incur an annual expense of about $9,900,000 in FY 1987. These costs would continue if the upgrade were not undertaken. The incremental costs cover items such as additional personnel, hardware and software maintenance charges, custodial, maintenance, and repair needs for the building, as well as utility costs. It has been assumed that the electrical power cost at the new facility will be partially offset by savings at Wilson Hall.

DEPARTMENT OF ENERGY
1988 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
GENERAL SCIENCE AND RESEARCH
HIGH ENERGY PHYSICS
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: AGS Accumulator/Booster
Brookhaven National Laboratory
Upton, NY

2. Project No.: 86-R-105

3. Date A-E work initiated: 1st Qtr. FY 1986

3a. Date physical construction starts: 3rd Qtr. FY 1986

4. Date construction ends: 3rd Qtr. FY 1990

5. Previous cost estimate: $28,200
Less amount for PE&D: 0
Net cost estimate: $28,200
Date: July 1986

6. Current cost estimate: $29,800
Less amount for PE&D: 0
Net cost estimate: $29,800
Date: Dec. 1986

7. Financial Schedule

Fiscal Year	Authorization	Appropriations	Obligations	Costs
1986	$ 1,915	$ 1,915	$ 1,915	$ 1,207
1987	2,500	2,500	2,500	2,000
1988	12,800	12,800	12,800	11,300
1989	12,585	12,585	12,585	9,900
1990	0	0	0	5,393

8. Brief Physical Description of Project

The Accumulator/Booster (A/B ring) is a rapid cycling synchrotron that acts as a booster injector to the Alternating Gradient Synchrotron (AGS) for both protons and heavy ions and as an accumulator and injector for polarized protons. Protons and polarized protons will be injected into the A/B ring at 200 MeV from the existing linac and accelerated to 1.5 GeV for injection into the AGS. Heavy ions will be injected into the A/B ring and accelerated to a maximum energy which depends on the particular heavy ion, then stripped and injected into the AGS. The transfer line to carry the heavy ions from the Tandem Van de Graaff to the AGS was finished during FY 1986.

1. Title and location of project: AGS Accumulator/Booster
Brookhaven National Laboratory
Upton, NY

2. Project No.: 86-R-105

8. Brief Physical Description of Project

The Accumulator/Booster will have a circumference of 202 meters which is equal to 1/4 that of the AGS. This will allow efficient, synchronous bucket-to-bucket transfer of beam from the A/B ring to the AGS. The balance of the machine is designed with the objective of making it simple, relatively inexpensive, capable of accelerating protons to about 1.5 GeV, capable of accumulating polarized protons, and capable of accelerating heavy ions.

The lattice chosen is an arrangement with bending magnets missing from every other cell. The Accumulator/Booster will utilize separated function magnets. This will minimize end effects in a lattice which has such a small packing factor. Magnetic field cycling requirements are up to 5.5 kG at 7.5 Hz rate for 1.5 GeV protons and 13 kG at 1 Hz rate for heavy ions. The heavy ion acceleration aspect is the determining constraint on the magnet specifications. The power supply requirements for both cases are almost identical. The tune and aperture of the ring are chosen to avoid depolarizing resonances, to match to the admittance of the AGS, and to be flexible enough to accommodate research and development of devices and techniques for the acceleration and storage of polarized protons. To cover the ion velocities of approximately 0.04 to 0.875 of the speed of light, the rf system consists of four cavities, two for protons and two for heavy ions, each covering a different frequence range.

The A/B ring will be housed in a ring building located in the vee formed by the junction of the 200 MeV linac building and the old 50 MeV linac building. This is very close to the AGS injection system and near the end of the transfer line from the Tandem. The existing 50 MeV linac building will serve as part of the A/B ring enclosure as well as house all power supplies necessary for this project. It will also serve as an assembly and staging area for ring elements prior to installation in the tunnel. Most of the ring will be located in a tunnel to be constructed north of the 50 MeV linac building, and two penetrations will enable the remaining 75-feet to be in the linac building itself. For most of the ring, the structural concrete and fifteen feet of earth fill will provide the necessary radiation shielding.

1. Title and location of project: AGS Accumulator/Booster
Brookhaven National Laboratory
Upton, NY

2. Project No.: 86-R-105

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

The Accumulator/Booster will improve the performance and capabilities of the AGS for (1) normal proton operation, (2) operation with polarized protons and (3) operation with heavy ions. In each of these three modes of operation, the increased capability will have direct and immediate benefits by making accessible areas of science not previously accessible or by significantly increasing the data collection rate for the experimental program already planned and underway at the AGS.

(1) Normal Proton Research

When operating for normal proton research, the Accumulator/Booster will be used to accelerate protons to 1.5 GeV for injection into the AGS. At present injection is at 200 MeV. Injection at the higher energy will increase the space charge limit for the circulating beam and result in an increase of the extracted proton beam intensity by a factor of four to about 5×10^{13} protons per pulse.

For over two decades the Alternating Gradient Synchrotron has produced a steady flow of important physics, including major discoveries such as CP violation, the muon neutrino, the omega minus, the J/Psi, and the first charmed baryon. Today this machine is still the center of a vigorous research program, with experiments studying quantum chromodynamics via the search for glueballs and hard scattering exclusive reactions, searching for neutrino oscillations, and pushing the limits of the most complete theory, quantum electrodynamics, by measuring the vacuum polarization. In preparation are studies of extremely rare K decays via flavor changing neutral currents, which probe beyond the standard model to test very high energy theories like supersymmetry and technicolor. The increased beam intensity provided by the Accumulator/Booster will enhance this entire program but is of special importance to the rare K decay experiments.

1. Title and location of project: AGS Accumulator/Booster
Brookhaven National Laboratory
Upton, NY

2. Project No.: 86-R-105

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

(2) Polarized Proton Research

When operating for polarized proton research, the Accumulator/Booster will be used to accumulate 20-30 linac pulses for subsequent injection into the AGS. This will increase the extracted polarized proton beam intensity by the same factor of 20-30. The polarized proton beam intensity which is available initially at the AGS will be adequate for the initial round of experiments, but the follow-on experiments will be limited by the available beam intensity. Much higher intensities are required to fully explore the physics of spin-dependent phenomena at AGS energies. The Accumulator/Booster, with the present polarized proton source, will result in a beam intensity of about 2×10^{11} protons per pulse.

The AGS has been modified to allow the acceleration of polarized protons. Initial research operation at low energy occurred late in FY 1984. The polarized proton beam intensity which is available at the AGS will be adequate for the initial round of experiments, but the follow-on experiments will be limited by the available beam intensity. The projected factor of 20 improvement will substantially improve the quality and cost effectiveness of the presently planned experimental program and allow consideration of new experiments where the increased beam intensity would be essential.

(3) Heavy Ion Research

When operating for heavy ion research, the Accumulator/Booster will accelerate partially stripped heavy ions from the existing Tandem Van de Graaff. The ions emerging from the Accumulator/Booster will have sufficient energy to allow them to be fully stripped with high efficiency before injection into the AGS. Because of the vacuum system considerations the AGS can only accelerate fully stripped heavy ions; the maximum energy available from the Tandem itself is such that only light ions (sulfur and below) can be fully stripped. The transfer line project which is presently underway will make available at the AGS beams of fully stripped high energy heavy ions up to sulfur. The Accumulator/Booster coupled with the Tandem will extend the heavy ion capability of the AGS to include heavy ions up to gold. The accelerated beam intensity of 2×10^{9}/pulse for Au, as an example, is a factor of 10^{3} greater than presently available at any other machine at energies greater than 1 GeV/amu. For the particular example of Au, the accelerated beam intensity is at the calculated space charge limit of the A/B ring.

1. Title and location of project: AGS Accumulator/Booster
Brookhaven National Laboratory
Upton, NY

2. Project No.: 86-R-105

10. Details of Cost Estimate*

	Item Cost	Total Cost
a. Engineering, design and inspection at 33% of construction cost (17% of conventional construction and 35% of special facilities)	$	$ 6,200
b. Construction Cost		18,700
1. Conventional Construction	2,100	
Tunnel and utilities	$ 2,100	
2. Special Facilities and Accelerator Systems	16,600	
Magnets	6,200	
Magnet power supplies	3,000	
Other Systems	7,400	
c. Contingency at approximately 20% of above cost		4,900
Total estimated costs		$29,800

*Based on Completed Conceptual Design.

11. Method of Performance

Building design will be on the basis of a negotiated AE contract and its construction will be a competitively obtained lump sum contract. Design, assembly, and testing of the special facilities and accelerator system will be done by the staff of the Brookhaven National Laboratory. Component parts, wherever possible, will be fabricated by industry under fixed-priced competitively-obtained procurement actions.

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: AGS Accumulator/Booster
Brookhaven National Laboratory
Upton, NY

2. Project No.: 86-R-105

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

a. Total project costs	FY 1986	FY 1987	FY 1988	FY 1989	FY 1990	Total
1. Total facility costs						
(a) Construction line item.....	$ 1,207	$ 2,000	$11,300	$ 9,900	$ 5,393	$29,800
Total facility costs.....	$ 1,207	$ 2,000	$11,300	$ 9,900	$ 5,393	$29,800
2. Other project costs						
(a) R&D necessary to complete construction.....	200	200	100	100	0	600
Total other project costs.....	200	200	100	100	0	600
Total project costs (Item 1 & 2).....	$ 1,407	$ 2,200	$11,400	$10,000	$ 5,393	$30,400

b. Other related annual funding requirements (in FY 1988 dollars)

1. Facility operating costs.....	$ 1,200
2. Capital equipment not related to construction.....	200
Total related annual funding requirements.....	$ 1,400

1. Title and location of project: AGS Accumulator/Booster
Brookhaven National Laboratory
Upton, NY

2. Project No.: 86-R-105

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

a. Total Project Funding

1. Total facility costs

(a) Construction line item - explained in Items 8, 9 and 10.

2. Other project costs

(a) R&D necessary to complete construction - includes development of beam instrumentation, controls concepts and computer software at a cost of $600,000.

b. Total related annual funding requirements

1. Operating costs - There will be an annual requirement for additional FTE's with additional materials, supplies and support services associated with the physics program.

2. Capital equipment not related to construction but related to the programmatic effort in the facility. These equipment funds will provide growth in the scientific capability of the facility through the acquisition of: new detectors monitoring equipment, and controls improvement, and general purchase capital items for the operating program.