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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 1989

U.S. Department of Energy
Assistant Secretary,
Management and Administration
Office of the Controller

February 1988

DEPARTMENT OF ENERGY

FISCAL YEAR 1989 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 1989 CONGRESSIONAL BUDGET REQUEST

SUMMARY OF ESTIMATES BY APPROPRIATIONS

BUDGET AUTHORITY IN THOUSANDS OF DOLLARS

	FY 1987 ACTUAL	FY 1988 ESTIMATE	FY 1989 REQUEST
APPROPRIATIONS BEFORE THE ENERGY AND WATER DEVELOPMENT SUBCOMMITTEES:			
ENERGY SUPPLY RESEARCH AND DEVELOPMENT..	$1,258,137	$1,860,087	$1,969,760
URANIUM ENRICHMENT.....	1,209,494	950,000	1,184,000
GENERAL SCIENCE AND RESEARCH.....	326,596	355,108	364,986
ISOTOPE PRODUCTION AND DISTRIBUTION FUND	509	89	16,243
BASIC RESEARCH USER FACILITIES.....	473,206	574,945	972,613
ATOMIC ENERGY DEENSE ACTIVITIES.....	7,481,852	7,749,364	8,100,000
DEPARTMENTAL ADMINISTRATION.....	226,874	164,243	177,814
ALASKA POWER ADMINISTRATION.....	2,881	3,026	3,159
BONNEVILLE POWER ADMINISTRATION.....	432,259	165,000	136,000
SOUTHEASTERN POWER ADMINISTRATION.....	19,647	27,400	36,267
SOUTHEASTERN - CONTINUING FUND.....	3,772	---	---
SOUTHWESTERN POWER ADMINISTRATION.....	25,337	16,648	15,389
WESTERN AREA POWER ADMINISTRATION.....	238,008	249,515	298,413
WESTERN AREA POWER EMERGENCY FUND.....	225	24	---
FEDERAL ENERGY REGULATORY COMMISSION....	99,079	100,000	106,760
NUCLEAR WASTE FUND.....	499,000	360,000	448,832
GEOTHERMAL RESOURCES DEVELOPMENT FUND...	72	72	75
SUBTOTAL, APPROPRIATIONS BEFORE THE ENERGY AND WATER DEVELOPMENT SUBCOMMITTEES.....	12,296,948	12,575,521	13,830,311

DEPARTMENT OF ENERGY

FISCAL YEAR 1989 CONGRESSIONAL BUDGET REQUEST

SUMMARY OF ESTIMATES BY APPROPRIATIONS

BUDGET AUTHORITY IN THOUSANDS OF DOLLARS

	FY 1987 ACTUAL	FY 1988 ESTIMATE	FY 1989 REQUEST
APPROPRIATIONS BEFORE THE INTERIOR AND RELATED AGENCIES SUBCOMMITTEES:			
ALTERNATIVE FUELS PRODUCTION.....	437	---	---
CLEAN COAL TECHNOLOGY.....	---	50,000	525,000
FOSSIL ENERGY RESEARCH AND DEVELOPMENT..	293,171	326,975	166,992
NAVAL PETROLEUM AND OIL SHALE RESERVES..	122,177	159,663	185,071
ENERGY CONSERVATION.....	232,362	309,517	89,359
ENERGY REGULATION.....	23,400	21,565	20,772
EMERGENCY PREPAREDNESS.....	6,044	6,172	6,154
STRATEGIC PETROLEUM RESERVE.....	147,433	164,162	173,421
STRATEGIC PETROLEUM ACCOUNT.....	---	438,744	1,017,907
ENERGY INFORMATION ACTIVITIES.....	60,301	61,398	62,856
SUBTOTAL, INTERIOR AND RELATED AGENCIES SUBCOMMITTEES.....	885,325	1,538,196	2,247,532
SUBTOTAL, ENERGY AND WATER DEVELOPMENT SUBCOMMITTEES.....	12,296,948	12,575,521	13,830,311
SUBTOTAL, DEPARTMENT OF ENERGY.....	13,182,273	14,113,717	16,077,843
PERMANENT - INDEFINITE APPROPRIATIONS:			
PAYMENTS TO STATES.....	912	1,839	1,909
TOTAL, DEPARTMENT OF ENERGY.....	$13,183,185	$14,115,556	$16,079,752

DEPARTMENT OF ENERGY
FY 1989 CONGRESSIONAL STAFFING REQUEST
TOTAL WORK FORCE

	FY1987 FTE USAGE	FY1988 -FY87	FY1988 CONGR REQ	FY1989 -FY88	FY1989 CONGR REQ
ENERGY & WATER SUBCOMMITTEE					
HEADQUARTERS	4,697	264	4,961	73	5,034
FIELD	9,356	58	9,414	-75	9,339
SUBCOMMITTEE TOTAL	14,053	322	14,375	-2	14,373
INTERIOR SUBCOMMITTEE					
HEADQUARTERS	1,181	66	1,247	-111	1,136
FIELD	882	25	907	-140	767
SUBCOMMITTEE TOTAL	2,063	91	2,154	-251	1,903
GRAND TOTAL	16,116	413	16,529	-253	16,276
ADJUSTMENT		-263	-263	-209	-472
ADJUSTED TOTAL	16,116	150	16,266	-462	15,804

DEPARTMENT OF ENERGY
FY 1989 CONGRESSIONAL STAFFING REQUEST
TOTAL WORK FORCE

	FY1987 FTE USAGE	FY1988 -FY87	FY1988 CONGR REQ	FY1989 -FY88	FY1989 CONGR REQ
10:ENERGY SUPPLY RESEARCH AND DEV	922	14	936	10	946
HEADQUARTERS	644	7	651	10	661
FIELD	278	7	285	0	285
15:URANIUM ENRICHMENT	59	8	67	0	67
HEADQUARTERS	48	8	56	0	56
FIELD	11	0	11	0	11
20:GENERAL SCIENCE AND RESEARCH	42	-3	39	7	46
HEADQUARTERS	42	-3	39	7	46
25:ATOMIC ENERGY DEFENSE ACTIVITI	2,782	88	2,870	40	2,910
HEADQUARTERS	492	62	554	21	575
FIELD	2,290	26	2,316	19	2,335
30:DEPARTMENTAL ADMINISTRATION	3,333	133	3,466	6	3,472
HEADQUARTERS	1,756	79	1,835	6	1,841
FIELD	1,577	54	1,631	0	1,631
34:ALASKA POWER ADMINISTRATION	36	-1	35	0	35
FIELD	36	-1	35	0	35
36:BONNEVILLE POWER ADMIN	3,398	-18	3,380	-50	3,330
FIELD	3,398	-18	3,380	-50	3,330
38:SOUTHEASTERN POWER ADMIN	38	2	40	0	40
FIELD	38	2	40	0	40
42:SOUTHWESTERN POWER ADMIN	192	-6	186	0	186
FIELD	192	-6	186	0	186
46:WAPA - POWER MARKETING	1,160	-21	1,139	0	1,139
FIELD	1,160	-21	1,139	0	1,139
50:WAPA - COLORADO RIVER BASIN	219	21	240	0	240
FIELD	219	21	240	0	240
52:FEDERAL ENERGY REGULATORY COMM	1,562	97	1,659	0	1,659
HEADQUARTERS	1,562	97	1,659	0	1,659
54:NUCLEAR WASTE FUND	307	8	315	-15	300
HEADQUARTERS	152	14	166	29	195
FIELD	155	-6	149	-44	105
56:GEOTHERMAL RESOURCES DEV FUND	1	0	1	0	1
HEADQUARTERS	1	0	1	0	1
65:CLEAN COAL TECHNOLOGY	0	45	45	13	58
HEADQUARTERS	0	21	21	5	26
FIELD	0	24	24	8	32
65:FOSSIL ENERGY RESEARCH AND DEV	709	-6	703	-133	570
HEADQUARTERS	141	-3	138	-10	128
FIELD	568	-3	565	-123	442
70:NAVAL PETROL & OIL SHALE RES	89	6	95	0	95
HEADQUARTERS	17	5	22	0	22
FIELD	72	1	73	0	73
75:ENERGY CONSERVATION	320	32	352	-109	243
HEADQUARTERS	197	30	227	-84	143
FIELD	123	2	125	-25	100
80:EMERGENCY PREPAREDNESS	64	7	71	0	71
HEADQUARTERS	64	7	71	0	71
81:ECONOMIC REGULATION	288	-13	275	-22	253
HEADQUARTERS	288	-13	275	-22	253
85:STRATEGIC PETROLEUM RESERVE	147	0	147	0	147
HEADQUARTERS	28	-1	27	0	27
FIELD	119	1	120	0	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	16,116	413	16,529	-253	16,276
ADJUSTMENT		-263	-263	-209	-472
ADJUSTED TOTAL	16,116	150	16,266	-462	15,804

VOLUME III

HIGH ENERGY PHYSICS

DEPARTMENT OF ENERGY

FISCAL YEAR 1989 CONGRESSIONAL BUDGET REQUEST

GENERAL SCIENCE AND RESEARCH

HIGH ENERGY PHYSICS

VOLUME 3

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DEPARTMENT OF ENERGY
FY 1989 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
OFFICE OF ENERGY 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. Experiments are carried out at U.S. accelerator centers and also 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. 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. Funding for operation and maintenance of these major "user facilities" is included in the Basic Research User Facilities (BRUF) appropriation which is discussed in the narrative supporting the BRUF request. As a complement to these three existing centers. The Administration proposes to initiate construction of the Superconducting Super Collider in the FY 1989 budget under the Basic Research User Facilities appropriation.

The participation of university based scientists is critical to the research effort of the U.S. program. It is essential to maintain the capability of university scientists to participate effectively in world forefront experiments. The ability of the scientists 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, effective utilization of existing facilities and the provision of upgraded and new facilities on a timely basis. The dependence of the program on such facilities strongly influences program planning and strategy. While the funding for facility operations is included in the new BRUF appropriation, funding for physics research conducted in these facilities continues to be supported in the General Science and Research appropriation.

Two major upgrades of U.S. high energy physics facilities, the Stanford Linear Collider (SLC) and the Fermilab Tevatron Collider, will be available full-time for research operation in FY 1989. These facilities will keep the U.S. program highly competitive and at the cutting edge for the next several years. The SSC is required to advance the research frontier and provide the essential capability for the U.S. to maintain a competitive world-forefront High Energy Physics program in the mid 1990's and beyond.

The FY 1989 request contains, in the Basic Research User Facilities appropriation, major funding for construction in the U.S. of the Superconducting Super Collider (SSC). The SSC is a science initiative of great importance to the nation. This proton-proton collider facility is essential for the U.S. to maintain a world-forefront High Energy Physics program in the late 1990's and beyond. With a total energy of 40 TeV, twenty times the highest energy presently available in the world, this facility will significantly extend the frontier of investigation and is expected to yield fundamental discoveries of the nature of matter and energy and the basic forces which govern their transformations. The SSC will also contribute significantly to the economic and technological competitiveness of the Nation. The design of the SSC is based firmly on principles and engineering concepts used previously and is backed by an extensive R&D effort including a thorough conceptual design report and cost estimate which have been carefully reviewed by the Department.

As stated earlier, the funding for High Energy Physics Research is contained in the General Science and Research appropriation; and the funding for the operation, maintenance, and improvement of existing facilities, as well as funds required for construction of new facilities is included in the new BRUF appropriation. While the importance of maintaining a proper balance between the high energy physics research and the operation of the user facilities is recognized, the separation of these activities serves to clearly delineate the resources needed to effectively carry out the research and to operate the facilities.

The strategy for the High Energy Physics Program in FY 1989 revolves around the following key factors:

- Highest priority is given to conducting research with the new world forefront research capabilities of the SLC electron-positron collider, and the Tevatron proton-antiproton collider. High priority is also given to operating the Tevatron fixed target program at a high level. Research 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 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 for 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 early in FY 1990 and the detectors can be completed by the end of 1990.

- 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 1989 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
OFFICE OF ENERGY RESEARCH
(dollars in thousands)

LEAD TABLE

High Energy Physics

Activity	FY 1987 Actual	FY 1988 Approp.	FY 1989 Base	FY 1989 Request	Program Change Request vs Base	
					Dollar	Percent
Operating Expenses						
Physics Research	$109,021	$116,698	$116,698	$123,806	$+ 7,108	+6%
High Energy Technology	21,376	20,300	20,300	21,100	+ 800	+4%
Subtotal Operating Expenses	$130,397	$136,998	$136,998	$144,906	$+ 7,908	+6%
Capital Equipment	58,957	63,800	63,800	66,100	+ 2,300	+4%
Construction	12,500	16,600	16,600	9,382	- 7,218	-43%
Total	$201,854 b/	$217,398 b/	$217,398 b/	$220,388 b/	$+ 2,990	+1%
Operating Expenses	(130,397)a/	(136,998)	(136,998)	(144,906)	+ 7,908	+6%
Capital Equipment	(58,957)	(63,800)	(63,800)	(66,100)	+ 2,300	+4%
Construction	(12,500)	(16,600)	(16,600)	(9,382)	- 7,218	-43%
Staffing (FTEs)	(Reference General Science Program Direction)					

Authorization: Section 209, P.L. 95-91.

a/ Total has been reduced by $379,000 (Physics Research) reprogrammed to Energy Supply for SBIR.
b/ $293,146,000 in FY 1987, $339,200,000 in FY 1988, and $709,418,000 in FY 1989 has been transferred to the Basic Research User Facilities appropriation.

DEPARTMENT OF ENERGY
FY 1989 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

SUMMARY OF CHANGES

High Energy Physics

FY 1988 Appropriation	$ 217,398
- Funding required to maintain a constant overall level of program activity	+ 8,696
Physics Research	
- Physics research at a level consistent with the operating level of facilities	+ 2,440
High Energy Technology	
- Advanced detector R&D at about same level of effort as FY 1988	- 12
Capital Equipment	
- Overall level of effort the same as FY 1988. Special emphasis on SLD detector at SLC and D-Zero detector at Tevatron collider, maintaining schedule to permit first physics with these detectors early in FY 1990 and completion by the end of 1990	- 250
Construction	
- BNL GPP and completion of Fermilab Computing Upgrade	- 7,884
FY 1989 Congressional Budget Request	$ 220,388

DEPARTMENT OF ENERGY
FY 1989 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, fabrication and installation 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 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, and are made available to qualified scientists on the basis of the scientific merit and promise of their research proposals. More than 80 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 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 duration can be several years longer. U.S. user groups also participate in experiments which take advantage of unique accelerator capabilities and opportunities at foreign laboratories such as DESY (West Germany), CERN (Western Europe), and KEK (Japan). 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 1988 will be a year of strong research output from the new world forefront Tevatron and SLC colliders and new Tevatron fixed target capabilities. A highly productive level of research activity is planned for FY 1989 as the data collected in FY 1988 is analyzed and these new facilities operate in an intensive data taking mode. Experimental groups are supported at a level consistent with the operating level of these facilities.

II. A. Summary Table

Program Activity	FY 1987	FY 1988	FY 1989	% Change
Physics Research.....	$109,021	$116,698	$123,806	+ 6
Total, Physics Research.....	$109,021	$116,698	$123,806	+ 6

II. B. Major Laboratory and Facility Funding

Fermi National Accelerator Laboratory.....	$ 10,205	$ 8,000	$ 8,400	+ 5
Stanford Linear Accelerator Center.....	10,948	11,000	11,500	+ 5
Brookhaven National Laboratory.	7,092	7,200	7,600	+ 5
Argonne National Laboratory....	4,900	5,100	5,300	+ 4
Lawrence Berkeley Laboratory...	8,643	9,200	9,600	+ 4
Other Laboratories.....	2,048	1,790	1,860	+ 4
Universities and Other.....	65,185	74,408	79,546	+ 7
Total Physics Research.....	$109,021	$116,698	$123,806	+ 6

III. Activity Descriptions

Program Activity	FY 1987	FY 1988	FY 1989
PHYSICS RESEARCH			
Fermilab	Fermilab staff participate in the preparation, conduct and analysis of data from experiments using the Fermilab facilities, while also providing a crucial support and liaison function for the many university users involved in experimental programs at Fermilab. This is the first year of research	Analysis of the data collected in the FY 1987 collider and fixed target runs will require a major effort, as will preparation of the publications and theoretical interpretations of this new information. Researchers will also participate in extensive data taking, in both the fixed target and collider programs. ($8,000)	The Fermilab research groups will continue at about a constant level of effort as in FY 1988, and will be analyzing data from the earlier runs, as well as collecting data in collider and fixed target experiments. ($8,400)

Program Activity	FY 1987	FY 1988	FY 1989
.Fermilab (Cont'd)	use of the Tevatron's new collider capabilities, and of the full set of upgraded fixed target facilities. Data taking is scheduled for much of the year. There is also a theoretical research activity underway as well as a small program of high energy astrophysics research. ($10,205)		
SLAC	The SLAC research groups focus their efforts on collaborative experiments with university groups using the SLC, PEP and SPEAR facilities. In FY 1987 as SLC prepares to come into operation, emphasis will shift toward preparation for the first experiment with the Mark II detector at SLC. There will be extensive preparations for the resumption of PEP & SPEAR operations for HEP in FY 1988. There is also a strong theoretical research activity. ($10,948)	Major activities will be related to 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 for HEP following the FY 1987 shutdown. The SLAC research groups will be heavily involved in conducting experiments and data taking. ($11,000)	It is expected that SLC will achieve enhanced luminosity. The groups will concentrate efforts on study of Z particles produced in the MARK II detector and tests of the new SLD detector. Data taking with the MARK III detector at SPEAR and the TPC at PEP will continue. ($11,500)
BNL	The BNL research groups focus on experiments at the AGS, but also participate in experiments at Fermilab and CERN. The AGS program includes a wide variety of fixed target experiments, with particular emphasis on the new generation of rare decay experiments. ($7,092)	The program will continue FY 1987 activities with significant emphasis on operation of the new generation of rare kaon decay experiments at the AGS and on participation in preparation for the D-Zero experiment at Fermilab. ($7,200)	The program will continue at about the same level of effort. A major FY 1989 activity will be the data-taking on the rare kaon decay experiments at the AGS and the D-Zero experiment at Fermilab. ($7,600)

III. PHYSICS RESEARCH (Cont'd)

Program Activity	FY 1987	FY 1988	FY 1989
Other Labs	These groups concentrate their efforts as users at the U.S. accelerator centers and at foreign facilities with unique capabilities. The LBL program includes participation in preparation for the Mark II experiment at SLC as well as a large theoretical effort and the Particle Data Center. ($15,591)	These programs will remain at about the FY 1987 level of activity. The emphasis will reflect the full operational status of the new Fermilab and SLAC facilities. ($16,090)	These programs will remain at about a constant level of activity with emphasis on data taking schedules at the new Fermilab and SLAC facilities and analysis of data for physics results. ($16,760)
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 foreign accelerator facilities with unique capabilities, as well as in non-accelerator experiments and theoretical research. The level of effort is appropriately scoped relative to the level of facility operation. ($65,185)	These programs will be maintained near the FY 1987 level of activity, with priority given to experiments with the new Fermilab and SLAC facilities. Initiate Class IV computer upgrade at MIT/Laboratory for Nuclear Science, and Class V mainframe acquisition at MIT for L3 experiment. Includes funding for the SBIR assessment. ($74,408)	The level of effort for research will be slightly increased in FY 1988 to enable university groups to participate more effectively in the data taking in FY 1989 and analysis of the data acquired in FY 1988. Continue Class IV computer upgrade and Class V mainframe acquisition at MIT. Includes funding for the SBIR assessment. ($79,546)
Total	$109,021	$116,698	$123,806

I. Preface: HIGH ENERGY TECHNOLOGY

Provides the technological base for maintaining and improving the scientific effectiveness, reliability, and efficiency of existing detector facilities and for extending the capabilities of detectors and data analysis capabilities by developing and proving new concepts and technologies. Includes R&D with a near term focus in support of ongoing major detectors (D-Zero and SLD), and improving existing detector facilities. There is also a strong longer term focus on development of advanced generic concepts to provide the technological base for future detectors of greater performance capability and more cost effective operation. This program is carried out primarily in the DOE laboratories, but with a significant program of advanced concept development in universities.

II. A. Summary Table

Program Activity	FY 1987	FY 1988	FY 1989	% Change
High Energy Technology.....	$ 21,376	$ 20,300	$ 21,100	+ 4
Total, High Energy Technology	$ 21,376	$ 20,300	$ 21,100	+ 4

II. B. Major Laboratory and Facility Funding

Fermi National Accelerator Laboratory.....	$ 7,500	$ 7,500	$ 7,800	+ 4
Stanford Linear Accelerator Center.....	8,760	7,600	7,900	+ 4
Brookhaven National Laboratory.	1,840	1,300	1,400	+ 8
Lawrence Berkeley Laboratory...	1,940	1,900	2,000	+ 5
Universities and Other.....	1,336	2,000	2,000	0
Total, High Energy Technology.	$ 21,376	$ 20,300	$ 21,100	+ 4

III. Activity Descriptions

Program Activity	FY 1987	FY 1988	FY 1989
HIGH ENERGY TECHNOLOGY (Cont'd)			
Fermilab	A major effort is R&D in support of the D-Zero detector. Also includes work related to CDF upgrades and upgrades of fixed target detectors as well as work on advanced data analysis tools and generic long range detector R&D. ($7,500)	R&D continues general support activities for the fixed target and colliding beam detector technology. A high emphasis is placed on support of D-Zero detector and of advanced data analysis tools. ($7,500)	R&D will focus on the need to make the D-Zero detector operational. Other programs will continue at about the same level as in FY 1988. ($7,800)
SLAC	R&D for SLD will be a major focus of the detector R&D program. Studies of advanced detector concepts will also continue. ($8,760)	Program will continue as in FY 1987 with focus on R&D in support of the SLD detector. ($7,600)	R&D will focus on need to make the SLD detector operational. Work in support of future upgrades and generic advanced detector R&D will also be pursued. ($7,900)
BNL	R&D focuses on studies in support of detectors for new experiments at the AGS. ($1,840)	Program continues as in FY 1987 with some new emphasis on advanced generic detector R&D. ($1,300)	Program continues at about the same level as FY 1988 with emphasis shifting more strongly to advanced detector R&D. ($1,400)
LBL	Significant effort in advanced detector development including work on detectors for experiments in which LBL is participating in advanced generic detector R&D. ($1,940)	Program continues as in FY 1987. ($1,900)	Continuation of the FY 1988 programs at roughly the same level of effort Generic detector R&D will focus on large-area, radiation-hard, pixel arrays for operation in high background rate environments. ($2,000)
Universities and Other Contractors	This includes a program of advanced technology studies by universities and other contractors. The program includes R&D in support of on-going	Program continues with emphasis on generic studies of advanced concepts and technology development for large collider detectors. ($2,000)	A continuation of the basic program at about the FY 1988 level of effort with particular emphasis on R&D on advanced generic technology for

III. HIGH ENERGY TECHNOLOGY (Cont'd)

Program Activity	FY 1987	FY 1988	FY 1989
Universities and Other Contractors (Cont'd)	detectors and on studies of advanced concepts and technologies for detectors with the goal of providing the technological basis for future detectors with greater capabilities at an affordable cost. ($1,336)		detectors and on upgrades of the 0-Zero and SLD detectors as they come into operation. ($2,000)
Total	$ 21,376	$ 20,300	$21,100

I. Preface: CAPITAL EQUIPMENT

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

Timely introduction of new 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: 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: large analysis magnets for detector systems; precision regulated power supplies; 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. Priority is given in FY 1989 to keeping the major new collider detectors for SLC and Tevatron on schedule for completion by the end of 1990 and to sustaining the base program efforts of the laboratories and universities at about the FY 1988 level of effort.

II. A. Summary Table

Program Activity	FY 1987	FY 1988	FY 1989	% Change
Capital Equipment.....	$ 58,957	$ 63,800	$ 66,100	+ 4
Total, Capital Equipment.....	$ 58,957	$ 63,800	$ 66,100	+ 4

II. B. Major Laboratory and Facility Funding

Fermi National Accelerator Laboratory.....	$ 21,400	$ 24,800	$ 25,800	+ 4
Stanford Linear Accelerator Center.....	14,482	15,900	16,500	+ 4
Brookhaven National Laboratory.	3,087	2,900	3,000	+ 3
Universities and Other Laboratories.....	16,288	16,300	16,750	+ 3
Brookhaven National Laboratory-Other Capital Equipment.....	3,700	3,900	4,050	+ 4
Total, Capital Equipment.....	$ 58,957	$ 63,800	$ 66,100	+ 4

Major Detectors (Funding Included Above)

SLD.....	$ 12,700	$ 13,800	$ 14,000
D-Zero.....	10,500	13,500	14,000
L3.....	5,350	5,500	4,300

Program Activity	FY 1987	FY 1988	FY 1989
CAPITAL EQUIPMENT			
Fermilab	Primary emphasis on keeping the D-Zero detector facility on schedule for completion late in 1990 and initial physics capability in 1989 ($10,500); completion of technical components for new fixed target detectors ($6,300); full complement of electronics for the CDF detector ($3,200); computing equipment for use in experimental areas and central facility ($1,400). ($21,400)	Major progress towards completing the D-Zero detector late in 1990, with initial physics capability in 1989 ($13,500); upgrades and improvements to fixed target detectors ($6,000); upgrades to the capabilities of the CDF detector ($2,800); site-wide additions to computing and networking capabilities ($1,500); general experimental support equipment ($1,000). ($24,800)	D-Zero detector to reach limited physics capability near the end of this year, with completion expected late in 1990 ($14,000); major improvements to the CDF detector including extension of muon detection systems to full solid angle coverage ($3,500); new and upgraded detectors for the fixed target research program ($5,400); computing equipment for the central facility and experimental areas ($2,000); general experimental support equipment ($900). ($25,800)
SLAC	Major emphasis on proceeding with SLD detector on a schedule to permit completion by the end of 1990, with limited first physics late in 1989 ($12,700); Mark II, Mark III, and TPC improvements ($1,100); general computing equipment ($682). ($14,482)	Major emphasis on proceeding with SLD detector on a schedule for completion in 1990 with limited first physics late in 1989 ($13,800); completion in 1990; Mark II and Mark III improvements ($500); general equipment experimental support ($1,600). ($15,900)	Major progress on SLD detector, on schedule for completion late in 1990 and first limited physics late in 1989 ($14,000); general experimental support equipment ($1,000); general computer equipment ($1,500). ($16,500)
BNL	Major emphasis on completion of new generation rare kaon decay detectors ($1,500); support for other experiments ($1,000); general experimental support equipment ($587). ($3,087)	Major emphasis on new experimental initiatives ($1,600); support for other experiments ($800); general experimental support equipment ($500). ($2,900)	Continued emphasis on new experimental initiatives ($1,800); support for ongoing experiments ($700); general experimental support equipment ($500). ($3,000)

III. CAPITAL EQUIPMENT (Cont'd)

Program Activity	FY 1987	FY 1988	FY 1989
Universities and Other Laboratories	This supports the major capital equipment needs of the experimental research groups at the universities ($13,688) and at the non-accelerator laboratories (LBL, ANL, Ames) ($2,600). Within the university funding, support of U.S. participants in experiments at foreign facilities is included, with the major effort being the substantial participation in the LEP-L3 detector which is under MIT leadership. Another major effort includes U.S. participation in the ZEUS detector at HERA. ($16,288)	Includes $2,700 for equipment needs of groups at the non-accelerator laboratories and $13,600 for needs of university groups. Major equipment needs continue for the L3 detector and the ZEUS experiment at HERA. Additional needs are expected as users prepare for Tevatron fixed target experiments, AGS rare kaon experiments, and non-accelerator experiments. ($16,300)	Includes $2,800 for equipment needs of groups at non-accelerator laboratories and $13,950 for university groups. Equipment needs will continue for U.S. groups participating in LEP and HERA experiments. Additional needs are expected for preparation of Tevatron fixed target experiments and non-accelerator experiments. ($16,750)
BNL - General Purpose Equipment	Provide general purpose equipment at the Brookhaven National Laboratory, for which the High Energy Physics program has landlord responsibility. Includes equipment used in administrative functions, vehicles and general purpose equipment for other programmatic activities. ($3,700)	Provide general purpose equipment at the Brookhaven National Laboratory, for which the High Energy Physics program has landlord responsibility. Includes equipment used in administrative functions, vehicles and general purpose equipment for other programmatic activities. ($3,900)	Provide general purpose equipment at the Brookhaven National Laboratory, for which the High Energy Physics program has landlord responsibility. Includes equipment used in administrative functions, including acquisition of additional memory, storage and channels for existing IBM 3090/180 computer, and vehicles and general purpose equipment for other programmatic activities. ($4,050)
Total	$ 58,957	$ 63,800	$ 66,100

DEPARTMENT OF ENERGY
FY 1989 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 1988 Appropriated	FY 1989 Request	Remaining Balance	TEC
86-R-104	Central Computing Upgrade	9,968	11,000	3,632	---	24,600
GP-E-103	General Plant Projects - BNL	---	---	5,750	---	5,750
GP-E-103	General Plant Projects - BNL	---	5,600	---	---	5,600
Total, High Energy Physics Construction		$ 9,968	$ 16,600	$ 9,382	$ ---	$ XXX

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FY 1989 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: $24,600
Start Date: 3rd Qtr. FY 1986
Completion Date: 4th Qtr. FY 1989

2. Financial schedule:

Fiscal Year	Appropriations	Obligations	Costs
1986	$ 2,968	$ 2,968	$ 1,513
1987	7,000	7,000	5,430
1988	11,000	11,000	9,900
1989	3,632	3,632	7,757

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 projected growth in need for computing power at Fermilab is due primarily to the large additional data analysis requirements of the new Tevatron collider experiments and the continued expansion 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 1989 funding will provide for the final procurements and installation of hardware.

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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: GP-E-103 General Plant Projects
Brookhaven National Laboratory

Project TEC: $ 5,750
Start Date: 3rd Qtr. FY 1989
Completion
Date: 2nd Qtr. FY 1991

2. Financial Schedule:

Fiscal Year	Appropriated	Obligations	Costs
1989	$ 5,750	$ 5,750	$ 2,100
1990	---	---	3,000
1991	---	---	650

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. High Energy Physics has the responsibility to provide funding for all GPP needs at BNL.

(b) These projects are required for the general maintenance, modifications 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 major items of work to be performed is contained in the Construction Project Data Sheet. Some of these may be located on non-government owned property.

DEPARTMENT OF ENERGY
FY 1989 CONGRESSIONAL BUDGET REQUEST
BASIC RESEARCH USER FACILITIES
OFFICE OF ENERGY RESEARCH

OVERVIEW

Basic Research User Facilities - High Energy Physics (BRUF-HEP)

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 major 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. As a complement to these three existing centers, construction of the Superconducting Super Collider (SSC) will be initiated in the FY 1989 budget. 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, effective utilization of existing facilities and the provision of upgraded and new facilities on a timely basis. The dependence of the program on such facilities strongly influences program planning and strategy. While the funding for operation of these facilities is included in the new BRUF appropriation, funding for physics research conducted in these facilities continues to be supported in the General Science and Research appropriation.

Two major upgrades of U.S. high energy physics facilities, the Stanford Linear Collider (SLC) and the Fermilab Tevatron Collider, will be available full-time for research operation in FY 1989. These facilities will keep the U.S. program highly competitive and at the cutting edge for the next several years. The SSC is required to advance the research frontier and provide the essential capability for the U.S. to maintain a competitive world-forefront High Energy Physics program in the mid 1990's and beyond.

The FY 1989 request contains, in the SSC portion of the BRUF appropriation, major funding for construction in the U.S. of the Superconducting Super Collider (SSC). The SSC is a science initiative of great importance to the nation. This proton-proton collider facility is essential for the U.S. to maintain a world-forefront High Energy Physics program in the late 1990's and beyond. With a total energy of 40 TeV, twenty times the highest energy presently available in the world, this facility will significantly extend the frontier of investigation and is expected to yield fundamental discoveries of the nature of matter and energy and the basic forces which govern their transformations. The SSC will also contribute significantly to the economic and technological competitiveness of the Nation. The design of the SSC is based firmly on principles and engineering concepts used previously and is backed by an extensive R&D effort including a thorough conceptual design report and cost estimate which have been carefully reviewed by the Department.

As stated earlier, the funding for High Energy Physics Research is contained in the General Science and Research appropriation; and the funding for the operation, maintenance, and improvement of existing facilities, as well as funds required for construction of new facilities is now supported through the new BRUF appropriation. While the importance of maintaining a proper balance between the high energy physics research and the operation of the user facilities is recognized, the separation of these activities serves to clearly delineate the resources needed to carry out effectively the research and to operate the facilities.

The strategy for FY 1989 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 the Tevatron proton-antiproton collider. High priority is also given to operating the Tevatron fixed target program at a high level. Operations 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.

- SSC construction will be initiated in FY 1989. With funding as planned, the project can be completed in 1996. R&D on SSC technical systems will proceed at a substantially enhanced level in FY 1989.

- Provision and upgrade of major detector capabilities (funded in the General Science and Research appropriation), on a timely basis is crucial for effective utilization of the accelerator and collider facilities.

- 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.

Construction and operation of these large, complex and expensive facilities requires sustained, central federal support since they are far too large and costly to expect any single non-federal research institution to provide such facilities for the benefit of a multitude of users.

The FY 1989 plan provides for an effective level of facility operations. Fermilab will operate 10 months for physics and SLAC will operate SLC for 32 weeks at 120 pulses per second. The plan also includes operation of the Brookhaven National Laboratory AGS for high energy physics for about 16 weeks, and operation of PEP and SPEAR for high energy physics.

DEPARTMENT OF ENERGY
FY 1989 CONGRESSIONAL BUDGET REQUEST
BASIC RESEARCH USER FACILITIES
OFFICE OF ENERGY RESEARCH
(dollars in thousands)

LEAD TABLE

Basic Research User Facilities - High Energy Physics (BRUF-HEP)

Activity	FY 1987 Actual	FY 1988 Approp.	FY 1989 Base	FY 1989 Request	Program Change Request vs Base	
					Dollar	Percent
Facility Operations	$204,300	$233,300	$233,300	$256,600	$+ 23,300	+ 10%
High Energy Technology	39,124	43,400	43,400	45,100	+ 1,700	+ 4%
Capital Equipment	11,100	12,900	12,900	13,700	+ 800	+ 6%
Construction	18,843	24,600	24,600	31,018	+ 6,418	+ 26%
Total	273,367	314,200	314,200	346,418	+ 32,218	+ 10%
Operating Expenses	(243,424)a/	(276,700)	(276,700)	(301,700)	+ 25,000	+ 9%
Capital Equipment	(11,100)	(12,900)	(12,900)	(13,700)	+ 800	+ 6%
Construction	(18,843)	(24,600)	(24,600)	(31,018)	+ 6,418	+ 26%
Total Program	($273,367)	($314,200)	($314,200)	($346,418)	$+ 32,218	+ 10%
Staffing (FTEs)	(Reference General Science Program Direction)					

Authorization: Section 209, P.L. 95-91.

a/ Total has been reduced by $4,300,000 (Facility Operations) reprogrammed to Energy Supply for SBIR.

DEPARTMENT OF ENERGY
FY 1989 CONGRESSIONAL BUDGET REQUEST
BASIC RESEARCH USER FACILTIES
(dollars in thousands)

SUMMARY OF CHANGES

Basic Research User Facilities - High Energy Physics (BRUF-HEP)

FY 1988 Appropriation	$ 314,200
- Funding required to maintain a constant overall level of program activity	+ 12,813
Facility Operations	
- Strong operation for research of the new world leading collider facilities at Fermilab and SLAC	+ 13,970
Construction	
- Continuation of AGS Accumulator/Booster as planned, and AIP and GPP near constant level of effort	+ 5,435
FY 1989 Congressional Budget Request	$ 346,418

DEPARTMENT OF ENERGY
FY 1989 CONGRESSIONAL BUDGET REQUEST
BASIC RESEARCH USER FACILITIES
(dollars in thousands)

KEY ACTIVITY SUMMARY
BASIC RESEARCH USER FACILITIES - HIGH ENERGY PHYSICS (BRUF-HEP)

I. Preface: BRUF - HIGH ENERGY PHYSICS - FACILITY OPERATIONS

Provides funding for the operation of accelerators, colliders, secondary beam lines, detectors for experiments, experimental areas, and computing facilities. Includes the costs of manpower, electric power, expendable supplies, and inventories. Major DOE supported facilities to be operated in FY 1989 include: Fermilab Tevatron (800 GeV proton fixed target and 900 GeV on 900 GeV antiproton-proton colliding beams); 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). The world forefront SLAC SLC and Fermilab Tevatron accelerators will both be available full-time for physics operation in FY 1989, as well as the AGS, PEP and SPEAR. Incremental funds will be required in FY 1989 at SLAC and Fermilab to provide for an improved level of operation for physics experiments, including the significantly increased electric power costs associated with the new capabilities. The FY 1989 request gives highest priority to operation of the world leading SLC and Tevatron colliders for physics research at an effective level.

II. A. Summary Table

Program Activity	FY 1987	FY 1988	FY 1989	% Change
BRUF-HEP Facility Operations...	$204,300	$233,300	$256,600	+ 10
Total, BRUF-HEP Facility Operations.....	$204,300	$233,300	$256,600	+ 10

II. B. Major Laboratory and Facility Funding

Fermi National Accelerator Laboratory.....	$103,979	$115,500	$125,700	+ 9
Stanford Linear Accelerator Center.....	63,900	74,200	85,700	+ 15
Brookhaven National Laboratory.	35,500	39,300	40,600	+ 3
Other Operations.....	921	4,300	4,600	+ 7
Total BRUF-HEP Facility Operations.....	$204,300	$233,300	$256,600	+ 10

III. Activity Descriptions

Program Activity	FY 1987	FY 1988	FY 1989
BRUF-HEP			
Fermilab Operations	Following an accelerator startup period, Fermilab operated about 4 months in the collider mode and 4 months in fixed target mode during FY 1987. This was the first physics run for the CDF and three smaller collider experiments, and the technical goals for this first run of the antiproton source and Tevatron collider operations were met. The last four months of the fiscal year are scheduled for an extended fixed target run and will include the commissioning of one new secondary beam line and the first physics utilization of two others. A total of 15 major fixed target experiments are projected to be taking data simultaneously. ($103,979)	The Tevatron is scheduled to be operated 10 months for physics. The collider program is projected to run for 6 months and the fixed target program for 4 months. All of the upgraded and new fixed target secondary beam lines should be fully operational. ($115,500)	Fermilab is scheduled to operate the Tevatron collider and fixed target programs for a total of about 10 months for physics, to be shared about equally among colliding beam experiments and fixed target experiments. The new D-Zero collider detector is projected to be in operation for the first time with limited physics capabilities near the end of the year. ($125,700)
SLAC Operations	SLAC operated for SLC tests in the latter half of the year. Because of funding limitations SPEAR and PEP were not operated for high energy physics in FY 1987. (Note that in FY 1987 there was dedicated operation of SPEAR only for synchrotron radiation research, supported by Basic Energy Sciences). ($63,900)	SLAC is scheduled for about 22 weeks of operation for physics with SLC, mostly at reduced pulse rate. Operation of PEP and operation of SPEAR for high energy physics will take place for two months at the end of the year. ($74,200)	SLAC is scheduled for about 32 weeks of operation at 120 pulses per second for physics with SLC. Operation of PEP and SPEAR for high energy physics will also take place for about two months early in the year. ($85,700)

III. BRUF-HEP (Cont'd)

Program Activity	FY 1987	FY 1988	FY 1989
BNL-AGS Operations	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 6 weeks for heavy ion physics funded by Nuclear Physics. Therefore, total AGS operation in FY 1987 will be about 20 weeks. ($35,500)	AGS will operate for about 15 weeks for high energy physics to include 12 weeks for slow beam operation and 3 weeks for polarized protons. Additional operation of about 8 weeks is planned for heavy ion physics funded by Nuclear Physics. Therefore, total AGS operation in FY 1988 will be about 22 weeks. ($39,300)	AGS will operate for about 16 weeks for High Energy Physics to be split among the various operating modes. Emphasis would be on rare kaon experiments and neutrino experiments. Additional operation of 8 weeks is planned for heavy ion physics funded by Nuclear Physics. Total AGS operation in FY 1989 would be about 24 weeks. ($40,600)
Other Operations	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 1987 has already been transferred to the SBIR program). ($921)	Continuation of the FY 1987 program, with a slight increase for spares and inventories for the new facilities at Fermilab and SLAC. Also includes funding for the SBIR assessment on the High Energy Physics program. ($4,300)	Continuation of FY 1988 programs at about same level of effort. Also includes funding for the SBIR assessment on the High Energy Physics program. ($4,600)
Total	$204,300	$233,300	$256,600

I. Preface: BRUF-HEP HIGH ENERGY TECHNOLOGY

Provides the technological base for maintaining and improving the scientific effectiveness, reliability, and efficiency of existing facilities and for extending the capabilities of accelerators and colliders by developing and proving new concepts and technologies. Includes R&D with a near term focus in support of ongoing accelerator and collider operations, and improving existing facilities. There is also a longer term focus on development of advanced concepts leading to future accelerators and colliders 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 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 1987	FY 1988	FY 1989	% Change
BRUF-HEP High Energy Technology	$ 39,124	$ 43,400	$ 45,100	+ 4
Total, BRUF-HEP High Energy Technology.....	$ 39,124	$ 43,400	$ 45,100	+ 4

II. B. Major Laboratory and Facility Funding

Fermi National Accelerator Laboratory.....	$ 9,535	$ 7,800	$ 8,500	+ 9
Stanford Linear Accelerator Center.....	4,500	4,900	5,100	+ 4
Brookhaven National Laboratory.	11,231	13,500	13,500	--
Lawrence Berkeley Laboratory...	5,339	5,700	5,900	+ 4
Universities and Other.....	8,519	11,500	12,100	+ 5
Total, BRUF-HEP High Energy Technology.....	$ 39,124	$ 43,400	$ 45,100	+ 4

III. Activity Descriptions

Program Activity	FY 1987	FY 1988	FY 1989
BRUF-HEP HIGH ENERGY TECHNOLOGY			
Fermilab	With the successful commissioning and operation of the Tevatron proton-antiproton collider, the focus of accelerator R&D shifts toward improving operational reliability and enhancing the luminosity of the Tevatron. Accelerator R&D is addressing methods to minimize beam emittance increases throughout the facility, to reduce undesirable background in the collider detector, to achieve lower temperature operation of the Tevatron's superconducting magnets, and to further improve the antiproton source accumulation rate. ($9,535)	Work will continue at constant level to increase Tevatron luminosity by reducing emittance, increasing beam intensity and reducing interaction point beam spotsizes. Tests of reduced operating temperature of the Tevatron superconducting magnets will be carried out. Tests of a new accelerator structure and development of higher power klystrons for the Linac will begin. Studies of the antiproton source will be carried out to improve the yield, cooling rate, and emittance of the antiproton beam. ($7,800)	R&D in support of improving Tevatron operation with 1 TeV beam energies will be carried out. Studies will continue on injector upgrades, focusing on raising the the Linac energy and on improving beam currents through use of RFQ's with H ions. R&D will be carried out to improve stochastic cooling of anti-protons and collider luminosity, and, therefore, research productivity. ($8,500)
SLAC	As SLC prepares to come into operation, the focus of R&D studies shifts from construction related R&D toward support of commissioning of the SLC. Experiments on SLC will explore strengths and limits of linear collider technology with particular emphasis on high luminosity and polarized electron-positron operation. ($4,500)	As SLC technology becomes understood, and operation for physics research starts in the second quarter of the fiscal year, R&D will be carried out 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 also be pursued. ($4,900)	R&D will continue to increase luminosity and performance of the collider. The studies of advanced concepts for colliders will become a major focus with possible prototype component fabrication. Studies of high efficiency radiofrequency sources, high gradient acceleration schemes, and advanced final focusing techniques will be pursued. ($5,100)

III. BRUF-HEP HIGH ENERGY
TECNOLOGY (cont'd)

Program Activity	FY 1987	FY 1988	FY 1989
BNL	Major focus on studies to maintain the operating effectiveness and flexibility of the AGS, in support of upgrade of AGS intensity and in support of the AGS booster construction project. Also includes substantial program of R&D on advanced accelerator concepts with a heavy focus on superconducting magnets for advanced accelerators. ($11,231)	Program includes continued R&D support for improved polarized proton operation of the AGS, a continuation of the superconducting magnet R&D program, continued R&D in support of the booster and studies of advanced accelerator concepts, including an advanced test facility for laser accelerator studies. ($13,500)	Program will include R&D to improve the performance and reliability of the AGS to continue R&D in support of the booster project, R&D to prepare the AGS for the higher energy injection and higher intensities resulting from the booster and to pursue advanced accelerator concepts including initial experiments with the advanced test facility for laser accelerator studies. ($13,500)
LBL	Major focus on studies of superconducting magnets for advanced accelerators. Also includes work on antiproton cooling in support of the Tevatron collider, accelerator theory and development of the two-beam accelerator concept. ($5,339)	Program continues at nearly a constant level of effort including continued studies on superconducting magnets and beam cooling. Preparations for a two beam accelerator test using the ATA at LLNL will continue. ($5,700)	Continuation of the FY 1988 programs at roughly the same level of effort with the same general scope. ($5,900)
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 with the goal of providing the technological basis for	Program continues with emphasis focused on studies of advanced accelerator concepts which require experimental verification. ($11,500)	A continuation of the basic program at about the FY 1988 level of effort with particular emphasis on those advanced accelerator concepts in the experimental verification phase stage. ($12,100)

III. BRUF-HEP HIGH ENERGY TECHNOLOGY (cont'd)

Program Activity	FY 1987	FY 1988	FY 1989
Universities and Other Contractors (Cont'd)	future facilities with greater capabilities at an affordable cost. Included are theoretical studies of beam dynamics, collective methods of particle acceleration, high power RF sources, superconducting materials improvement, and high field superconducting magnets. ($8,519)		
Total	$ 39,124	$ 43,400	$45,100

I. Preface: BRUF-HEP CAPITAL EQUIPMENT

Capital Equipment funding is required to maintain and enhance the scientific capability of the accelerators and colliders and to provide the secondary beam line components and portable shielding needed to do high quality, forefront high energy physics experiments. It is also required for replacement of accelerator components that have worn out or become obsolete. Such equipment is essential for effective utilization of the high energy accelerator and collider facilities.

Timely introduction of new beam capabilities, and the regular upgrading and modification of existing capabilities, is essential. Examples of specific items of equipment needed include: beam transport magnets; precision regulated power supplies; particle beam diagnostic and control systems; special cryogenic components for liquid hydrogen targets and superconducting devices; and a host of specialized electronics and other items of laboratory support equipment. Funding in FY 1989 will provide for support of planned beam line and accelerator upgrading and modifications.

II. A. Summary Table

Program Activity	FY 1987	FY 1988	FY 1989	% Change
BRUF-HEP Capital Equipment.....	$ 11,100	$ 12,900	$ 13,700	+ 6
Total, BRUF-HEP Capital Equipment.....	$ 11,100	$ 12,900	$ 13,700	+ 6

II. B. Major Laboratory and Facility Funding

Fermi National Accelerator Laboratory.....	$ 6,100	$ 4,700	$ 5,000	+ 6
Stanford Linear Accelerator Center.....	2,700	5,800	6,200	+ 7
Brookhaven National Laboratory.	2,300	2,400	2,500	+ 4
Total, BRUF-HEP Capital Equipment.....	$ 11,100	$ 12,900	$ 13,700	+ 6

III. Activity Descriptions

Program Activity	FY 1987	FY 1988	FY 1989
BRUF-HEP CAPITAL EQUIPMENT			
Fermilab	Primary emphasis on two secondary beams ($1,600); purchase installation of replacement central site transformer ($1,100); general purpose laboratory site equipment ($3,400). ($6,100)	Primary emphasis on upgrades and improvements to fixed target secondary beam lines ($2,100); and general site equipment ($2,600). ($4,700)	Primary emphasis on new and upgraded secondary beams for the fixed target research program ($2,500); equipment for accelerator R&D ($500); general site equipment ($2,000). ($5,000)
SLAC	General laboratory support equipment ($1,650); equipment in support of SLC ($950); and advanced accelerator R&D support. ($100); ($2,700)	Major emphasis on polarization of SLC beams ($1,100); superconducting final focus of SLC beams ($1,750); general laboratory support equipment ($2,950). ($5,800)	Major emphasis on completion of polarization of SLC beams and superconducting quadrupoles for SLC luminosity upgrades ($2,500); equipment for accelerator R&D ($1,000); general laboratory support equipment ($2,700). ($6,200)

III. BRUF-HEP CAPITAL EQUIPMENT (Cont'd)

Program Activity	FY 1987	FY 1988	FY 1989
BNL	Major emphasis on beam line components ($900); support for experiments ($400); general AGS support equipment ($1,000). ($2,300)	Major emphasis on beam line components ($1,000); support for experiments ($400); general AGS support equipment ($1,000). ($2,400)	Continued emphasis on beam line components ($1,000); support for experiments ($450); accelerator R&D equipment ($300); and general AGS support equipment ($750). ($2,500)
Total	$ 11,100	$ 12,900	$ 13,700

DEPARTMENT OF ENERGY
FY 1989 CONGRESSIONAL BUDGET REQUEST
BASIC RESEARCH USER FACILITIES
OFFICE OF ENERGY RESEARCH
(dollars in thousands)

KEY ACTIVITY SUMMARY

CONSTRUCTION PROJECTS

Basic Research User Facilities - High Energy Physics (BRUF-HEP)

IV. A. Construction Project Summary

Project No.	Project Title	Total Prior Year Obligations	FY 1988 Appropriated	FY 1989 Request	Remaining Balance	TEC
89-R-301	Accelerator Improvements and Modifications	---	---	11,700	---	11,700
88-R-101	Accelerator Improvements and Modifications	---	11,200	---	---	11,200
GP-E-302	General Plant Projects	---	---	5,318	---	5,318
GP-E-103	General Plant Projects	---	5,100	---	---	5,100
86-R-105	AGS Accumulator/Booster	4,415	8,300	14,000	4,985	31,700
Total, BRUF-HEP Construction		$ 4,415	$24,600	$ 31,018	$ 4,985	XXX

DEPARTMENT OF ENERGY
FY 1989 CONGRESSIONAL BUDGET REQUEST
BASIC RESEARCH USER FACILITIES
OFFICE OF ENERGY RESEARCH
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY
Basic Research User Facilities - High Energy Physcis (BRUF-HEP)

IV. B. Plant Funded Construction Project

1. Project title and location: 89-R-301 Accelerator improvements and modifications
Various locations

Project TEC: $11,700
Start Date: 3rd Qtr. FY 1989
Completion
Date: 2nd Qtr. FY 1991

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1989	$ 11,700	$ 11,700	$ 5,300
1990	---	---	5,800
1991	---	---	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 nonvgovernment owned property. Following is a listing of the funding proposed for the various locations:

Brookhaven National Laboratory	$ 2,300
Fermi National Accelerator Laboratory	6,050
Stanford Linear Accelerator Center	3,350
Total Estimated Cost.....	$11,700

DEPARTMENT OF ENERGY
FY 1989 CONGRESSIONAL BUDGET REQUEST
BASIC RESEARCH USER FACILITIES
OFFICE OF ENERGY RESEARCH
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Basic Research User Facilities - High Energy Physics (BRUF-HEP)

IV. B. Plant Funded Construction Project

1. Project title and location: GP-E-302 General Plant Projects
Various locations

Project TEC: $ 5,318
Start Date: 3rd Qtr. FY 1989
Completion
Date: 2nd Qtr. FY 1991

2. Financial Schedule:

Fiscal Year	Appropriated	Obligations	Costs
1989	$ 5,318	$ 5,318	$ 1,900
1990	---	---	3,000
1991	---	---	418

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 Fermi National Accelerator Laboratory and the Stanford Linear Accelerator Center facilities. Basic Research User Facilities has the responsibility to provide funding for all GPP needs at Fermilab and SLAC.

(b) These projects are required for the general maintenance, modifications 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 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:

Fermi National Accelerator Laboratory	$ 3,418
Stanford Linear Accelerator Center	1,900

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BASIC RESEARCH USER FACILITIES
OFFICE OF ENERGY RESEARCH
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Basic Research User Facilities - High Energy Physics (BRUF-HEP)

IV. B. Plant Funded Construction Project

1. Project title and location: 86-R-105 AGS Accumulator/Rooster
Brookhaven National Laboratory
Upton, New York

Project TEC: $31,700
Start Date: 3rd Qtr. FY 1986
Completion
Date: 2nd Qtr. FY 1991

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1986	$ 1,915	$ 1,915	$ 1,207
1987	2,500	2,500	1,939
1988	8,300	8,300	5,200
1989	14,000	14,000	13,200
1990	4,985	4,985	8,000
1991	---	---	2,154

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 1989 funding will continue construction of AGS Accumulator/Booster and will permit completion of conventional construction, initiation of the RF system, assembly of ring magnet half cell units, procurement of instrumentation controls and power supplies, and progress on the vacuum and beam injection and ejection systems.