DEPARTMENT OF ENERGY
FY 1991 CONGRESSIONAL BUDGET REQUEST
OFFICE OF ENERGY RESEARCH

OVERVIEW

SUPERCONDUCTING SUPER COLLIDER (SSC)

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. Experimental research in high energy physics most often requires the use of large particle accelerators, colliding beam devices, and large particle detectors. 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. The Stanford Linear Collider (SLC) and the Fermilab Tevatron, together with the other high energy physics facilities, will keep the U.S. program highly competitive and at the cutting edge for the next several years.

Although the present model for understanding the subnuclear world has been very successful, we know that it is not complete and cannot provide answers to a number of very fundamental questions. After extensive studies and careful review it has been determined that exploration of the Tev mass region is essential to advance understanding of the fundamental nature of matter and energy and to enable the U.S. High Energy Physics program to remain at the research frontier in the late 1990's and beyond. To explore this region a new, more powerful particle accelerator is required. The SSC is a proton-proton collider having an energy of up to 20 Tev per beam that will permit exploration of this new domain of physics research which cannot be reached by any facility either in existence or planned. The SSC holds the potential for new breakthroughs in science, technology and education. While the primary purpose of the SSC is to provide new fundamental knowledge and insights, history has clearly demonstrated that major advances in fundamental understanding lead subsequently to developments in technology and practical products which profoundly affect the quality of life for all Americans and enhance the economic competitiveness of our nation.

The design of the SSC is based firmly on principles and engineering concepts used in previous accelerators. It is backed by a thorough conceptual design report and cost estimate which have been carefully reviewed by the Department and by outside experts, by an R&D program specifically related to the SSC which began in FY 1984, by prior efforts in the High Energy Physics program to develop accelerator quality superconducting magnets and by the experience gained in the successful operation of the Tevatron. In January 1989, the Department selected the site for the SSC and awarded a contract to Universities Research Association, Inc., to serve as the Management and Operating

Contractor for the SSC. A revised conceptual design is being prepared to reflect the characteristics of the Texas site and R&D achievements since 1986. This will form the basis for establishing technical, cost and schedule baselines for the SSC. These baselines will be validated by DOE early in 1990 and form the basis for revised project estimates.

The SSC is a critical part of the Administration's initiative to strengthen the position of the nation as a world leader in science and technology. It will be both a symbol of the nation's commitment to scientific leadership in this century and the next, and an instrument by which U.S. leadership can be maintained. It will produce discoveries, innovations and spin-offs that could profoundly touch every American.

Significant funding for R&D ($89,578,000) and initial Federal construction funding for the SSC ($128,992,000) was appropriated in FY 1990. Major R&D achievements are expected in FY 1990, including further progress on refining and optimizing the design of the superconducting magnets, major effort on Phase II of the magnet industrialization program and design of the injectors and other SSC technical systems. The initial construction funding in FY 1990 will permit establishment of an effective SSC laboratory team, detailed design work on technical systems and conventional facilities, site preparation, long lead technical component procurements and construction of initial on-site support structures. The State of Texas has indicated that it would contribute about $80,000,000 in FY 1990. A detailed agreement on the Texas contribution has not been reached.

The request for FY 1991 includes $116,000,000 in operating funds for continued R&D on accelerator systems and detectors; $33,000,000 in capital equipment for laboratory computing equipment, scientific instrumentation, laboratory support equipment which are essential ingredients for establishing a new research laboratory and for detector prototype fabrication; and $168,866,000 for construction to support continued detailed design, the magnet industrialization program, procurement of technical systems components, on-site construction, and project management activities. In addition, significant construction of on-site facilities and other SSC systems is expected with funds contributed by the State of Texas.

The Department and the SSC Laboratory are in the process of developing a revised project conceptual design along with cost estimate and schedule. This is a rapidly evolving situation and appropriate revisions will be incorporated into the budget request and outyear plans after the new technical, cost and schedule baselines have been validated.

DEPARTMENT OF ENERGY
FY 1991 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
OFFICE OF ENERGY RESEARCH
(dollars in thousands)
LEAD TABLE
Superconducting Super Collider (SSC)

Activity	FY 1989 Actual	FY 1990 Estimate	FY 1991 Base	FY 1991 Request	Program Change Request vs Base	
					Dollar	Percent
Operating Expenses.....	$82,107	$68,872	$73,740	$116,000	$+ 42,260	+ 57%
Capital Equipment.....	16,000	20,706	20,706	33,000	+ 12,294	+ 59%
Construction.....	0	128,992	128,992	168,866	+ 39,874	+ 31%
Total.....	$98,107	$218,570	$223,438	$317,866	+ 94,428	+ 42%
Operating Expenses.....	(82,107)a/	(68,872)a/	(73,740)	(116,000)	$+ 42,260	+ 57%
Capital Equipment.....	(16,000)	(20,706)	(20,706)	(33,000)	+ 12,294	+ 59%
Construction.....	0	(128,992)	(128,992)	(168,866)	+ 39,874	+ 31%
Total Program.....	($98,107)b/	($218,570)c/d/e/f/	($223,438)	($317,866)c/	+ 94,428	+ 42%
Staffing (FTEs).....	10	40 g/	40	52		

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

a/ Includes $522,000 in FY 1989; and $838,000 in FY 1990 General Science Program Direction support.
b/ Excludes $1,387,000 which represents applicable portion of $12,000,000 General Reduction contained in FY 1989 appropriation.
c/ Includes funding provided through appropriation process only. Non-federal contributions will permit additional activities. The size and scope of these contributions will be known after firm agreements with the State of Texas and foreign contributors are completed.
d/ Does not reflect proposed reprogramming of $3,755,000 to General Science Program Direction for revised request for an additional 30 FTE's.
e/ Excludes $4,176,000 which represents applicable portion of $21,000,000 General Reduction contained in FY 1990 Appropriation.
f/ FY 1990 reflects final Gramm-Rudman-Hollings sequester adjustments.
g/ Revised Request.

DEPARTMENT OF ENERGY
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GENERAL SCIENCE AND RESEARCH
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SUMMARY OF CHANGES

Superconducting Super Colllider (SSC)

FY 1990 Appropriation	$ 218,570
Adjustments - Increased personnel costs	+ 4,868
FY 1991 Base	$ 223,438
SSC R&D	
- Enhanced level of R&D to complete design of superconducting magnets and to develop designs for other technical systems	+ 42,260
Capital Equipment	
- Equipment in support of SSC accelerator and detector R&D programs and for general purpose equipment essential to set up a new laboratory	+ 12,294
Construction	
- Enhanced level of SSC construction	+ 39,874
FY 1991 Congressional Budget Request	$ 317,866

DEPARTMENT OF ENERGY
FY 1991 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

KEY ACTIVITY SUMMARY

SUPERCONDUCTING SUPER COLLIDER (SSC)

I. Preface: SSC R&D

In FY 1989 and prior years the SSC R&D program focused heavily on superconducting magnets which are a large and critical element of the SSC. In FY 1990 substantial magnet R&D will continue and a significant level of activity related to other technical systems will be initiated. In FY 1991 a continued significant level in SSC R&D is required to optimize the design of the superconducting dipole magnets, to continue R&D aspects of the program of industrialization for magnet fabrication, to advance the conceptual design of the injector, quadrupole and correction magnets, and other technical systems (such as refrigeration, vacuum and controls), to provide technical input for refining the design of conventional facilities, and to proceed with detector R&D for specific SSC detectors.

II. A. Summary Table: SSC R&D

Program Activity	FY 1989 Actual	FY 1990 Estimate	FY 1991 Request	% Change
SSC R&D	$ 81,585	$ 68,034	$ 110,300	+ 62
Total, SSC R&D	$ 81,585	$ 68,034	$ 110,300	+ 62

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

Program Activity	FY 1989	FY 1990	FY 1991
SSC R&D	The goal of the SSC R&D program is to insure that designs of technical systems and components meet the necessary quality and reliability standards and to demonstrate this by fabrication of prototypes and testing of components. The R&D program in FY 1989 will provide critical technical input into establishing the collider footprint on the site and establishing the technical, cost and schedule baselines for the SSC. The new SSC laboratory team is conducting a thorough reevaluation of all technical systems with particular attention to magnet design and injector system parameters. The superconducting magnet R&D program includes: further fabrication and testing of full-scale dipoles of advanced design; completion of Phase I of the magnet industrialization program; preparation for Phase II of the magnet industrialization program; and prototyping and testing of quadrupoles. Also underway are accelerator physics studies, preparation of the supplemental EIS and the SSC detector development program.	The FY 1990 program will continue to have a strong focus on the long superconducting dipole magnets, with the fabrication and testing of about a dozen long magnets built in the HEP laboratories to optimize the design and initiation of Phase II of the magnet industrialization program ($45,000); design, prototyping and testing on other collider technical systems, including the focusing and correction magnets, RF, vacuum, etc. ($9,500); designs for the four injector accelerators ($3,500); technical input for conventional system development ($1,000); and, a significant program of detector R&D as this program moves from generic R&D to a program which includes both generic R&D and R&D on specific SSC detectors ($8,541). Implementation plans for the Energy Sciences Network project, identified in the Applied Mathematical Sciences subprogram of the Basic Energy Sciences program, will proceed. The SSC program's share for the implementation of ESNET is $493.	The FY 1991 program will continue: to have a strong focus on dipole magnet R&D to finalize dipole design for the pre-production magnets and to support the transition to industrial fabrication of pre-production magnets in FY 1992 ($32,000); to finalize designs of the injectors and other collider technical systems ($16,000); to support a major enhancement in detector R&D as specific detector designs evolve ($32,000); to support general laboratory operations ($15,300); and to provide physics program support ($15,000). Upgrades of ESNET to conform to the National Research and Education standards will continue to be pursued and will be shared among ER programs that benefit from ESNET.
	$ 81,585	$ 68,034	$ 110,300
SSC R&D	$ 81,585	$ 68,034	$ 110,300

DEPARTMENT OF ENERGY
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KEY ACTIVITY SUMMARY

SUPERCONDUCTING SUPER COLLIDER (SSC)

I. Preface: Program Direction

This subprogram provides the Federal staffing resources and associated funding required to plan, direct, and administer a highly complex program to plan, design, construct, and operate the multibillion dollar SSC. The initial stages of the creation of the SSC have required substantial and extraordinary staff effort in areas such as: technical and management direction of the R&D program; establishment of research policies and formulation of long-range plans and budgets; conduct of site selection activities; development of environmental impact statements; responding to public inquiries; and planning for creation of a new laboratory. Other activities with rapidly increasing needs for staff include the securing and management of agreements with the State of Texas and foreign contributors. The magnitude and complexity of the project resulted in elevation of management direction from a Division level in the Office of High Energy and Nuclear Physics to the recently formed Office of Superconducting Super Collider (OSSC) which reports directly to the Director of Energy Research. An SSC Project Office (SSCPO) at the SSC site in Texas is also being established. Implementation of the SSC Management Plan will result in substantial additional staffing requirements to manage effectively all aspects of the SSC project.

II. A. Summary Table: Program Direction

Program Activity	FY 1989 Actual	FY 1990 Estimate	FY 1991 Request	% Change
Program Direction	$ 522	$ 838	$ 5,700	+580
Total, Program Direction	$ 522	$ 838	$ 5,700	+580

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

Program Activity	FY 1989	FY 1990	FY 1991
Program Direction	Provided funds for salaries, benefits, and travel for ten full-time equivalents (FTE's) in the Office of Superconducting Super Collider (OSSC). ($509)	Provide funds for salaries, benefits, and travel for ten FTE's for OSSC included in the FY 1990 budget, including normal increased personnel costs. A revised request for an additional 30 FTE's required to implement the SSC Management Plan is discussed below. ($788)	Provide funds for salaries, benefits, and travel for 52 FTE's required in the OSSC to implement the SSC Management Plan. Provide for an additional 42 FTE's over the FY 1990 budget and 12 over the revised FY 1990 level of effort. Provide for normal increased personnel costs resulting, for example, from within-grade and merit increases and the impact of the FY 1990 general and executive pay raises. ($4,760)
	The OSSC-HQ managed the many technical, project management, and administrative tasks and extensive Congressional, state and local, and public interface activities associated with the SSC. Analyzed technical designs and cost estimates resulting from the advanced technology R&D effort and sought to increase international collaboration and non-Federal cost-sharing in this new accelerator facility. Provided oversight of an extensive industrialization program for magnet R&D and technology transfer. Prepared extensive program documentation, prepared briefings and budget justifications, and conducted reviews. Provided technical support to the SSC Site Task Force (STF) and handled residual site selection issues.	Provide 25 FTE's for the OSSC-HQ, an additional 15 FTE's over the FY 1990 budget. This staff provides program direction and management oversight of the DOE SSC program totaling $219 million as well as the non-Federal funding contributions. R&D will focus on magnet industrialization, detectors, engineering and fabrication of injectors, accelerator R&D, physics, and theoretical analyses. External relations will increase, particularly with Texas regarding land acquisition and funding contributions. State and international agreements for cost-sharing arrangements will be negotiated. Site specific activities will increase, and construction activities will begin. Workload related to project management plans, briefings, reviews, and documentation will continue to be heavy. OSSC-HQ staff has primary responsibility for project control activities as well as policy and technical direction to the SSCPO.	Provide 28 FTE's for staffing the OSSC-HQ to manage a $318 million DOE SSC program and additional non-Federal contributions. Additional funding will support an additional 18 FTE's over the FY 1990 budget, including 15 which are also required in FY 1990. Significant staff time will be expended on negotiation and implementation of cost-sharing arrangements with Texas and foreign countries. Continue to manage the expanded scientific R&D program and provide guidance and oversight from HQ on detailed design and civil construction activities. Manage project control at the HQ level and meet the heavy demand for project reviews, briefings and information requests from the Congress, public and media. Provide ES&H, legal, and administrative support to ensure safe and efficient project management.

III. Program Direction (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Program Direction (Cont'd)	Provided initial support at the site through temporary employee details.	Provide 15 FTE's for staffing the SSCPO. Provide technical guidance and support activities at the site, with the State of Texas, and with the M&O contractor. Provide guidance and direction on the scientific program and monitor technical progress, provide engineering and construction support, maintain project control at the field level, and ensure ES&H and quality assurance control and compliance. Provide OSSC-HQ assistance as required.	Provide 24 FTE's to staff the SSCPO. Provide project direction and guidance and oversee civil construction activities including site preparation, campus buildings, and injector facilities. Oversee development of technical systems such as the collider dipole magnets. Interact daily with M&O contractor staff and State of Texas representatives. Assist OSSC-HQ as required.
	Provided a variety of program support such as printing and binding, supplies and materials, and contractual services. ($13)	Provide a variety of program support similar to FY 1989. Also provide for support costs of Automated Office Support System workstations at HQ. ($50)	Provide for a variety of program support as in FY 1989 and FY 1990 at an increased level to support the additional staff. Also provide for rents at the site, employee relocations, and other services at the SSCPO. ($940)
	$ 522	$ 838	$ 5,700
Program Direction	$ 522	$ 838	$ 5,700

DEPARTMENT OF ENERGY
FY 1991 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

KEY ACTIVITY SUMMARY

SUPERCONDUCTING SUPER COLLIDER (SSC)

I. Preface: SSC Capital Equipment

In FY 1991, the SSC will have significant capital equipment requirements for procurements in support of R&D efforts and for initial procurement of detector components and systems. Also included are the equipment needs for establishing a major new research laboratory, including in-house computing capability, acquisition of general purpose scientific instrumentation and general laboratory support equipment.

II. A. Summary Table: SSC Capital Equipment

Program Activity	FY 1989 Actual	FY 1990 Estimate	FY 1991 Request	% Change
SSC Capital Equipment.....	$ 16,000	$ 20,706	$ 33,000	+ 59
Total, SSC Capital Equipment	$ 16,000	$ 20,706	$ 33,000	+ 59

II. B. Major Laboratory and Facility Funding

Superconducting Super Collider Laboratory	$ 16,000	$ 20,706	$ 33,000	+ 59

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

Program Activity	FY 1989	FY 1990	FY 1991
SSC Capital Equipment	Equipment in support of R&D programs such as tooling; general laboratory equipment such as power supply systems, test, control and measurement equipment; and components for detector development and prototyping.	Provides capital equipment in support of the SSC R&D program, including prototyping the many technical systems and components of the collider and its four injector accelerators; power supplies, test and control instrumentation; computing equipment, and components for the magnet test facility near the site. Also provides for extensive prototypes of detector components.	Provides capital equipment for detector systems and component prototypes ($15,000); for the magnet R&D program including the on-site magnet development facility ($8,000); and for the accelerator R&D efforts on other technical systems ($3,000). Also provides equipment that is crucial for establishing a major new research laboratory. Funds will provide for establishing in-house computing capability ($5,000); general laboratory equipment such as standardized electronics, vacuum pumps, instrumentation, and power supplies, shop tools, vehicles and office machines ($2,000).
	$ 16,000	$ 20,706	$ 33,000
SSC Capital Equipment	$ 16,000	$ 20,706	$ 33,000

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FY 1991 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND RESEARCH
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KEY ACTIVITY SUMMARY

SUPERCONDUCTING SUPER COLLIDER (SSC)

I. Preface: Construction

II. A. Summary Table: Construction

Program Activity	FY 1989 Actual	FY 1990 Estimate	FY 1991 Request	% Change
Construction	$ 0	$ 128,992	$ 168,866	+ 31
Total, Construction	$ 0	$ 128,992	$ 168,866	+ 31

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

Program Activity	FY 1989	FY 1990	FY 1991
Construction	No activity.	Provides initial construction funding for the SSC. Permits significant progress in detailed design of technical components and conventional facilities, selected long lead procurements for the injectors and for collider magnets, site preparation and the contracts for the first on-site buildings. TEC - $4,300,000. ($128,992)	Provides for detailed design of technical systems ($33,000); detailed design of conventional facilities ($18,000); injector system fabrication ($20,000); collider system fabrication, including support of the magnet industrialization program ($48,000); project management and support ($35,000); and site preparation, utilities and on-site structures ($14,866). The amounts indicated are the current estimates in a rapidly evolving situation. Appropriate revisions to the FY 1991 request and overall project plan will be made after the new technical, cost and schedule baselines are validated.

III. Construction (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Construction (Cont'd)		In addition to the construction activities to be conducted with Federal funds, it is anticipated that there will be contributions from the State of Texas to finance construction activities including campus buildings, on-site support buildings, experimental halls, other SSC systems and R&D programs. The State of Texas has indicated that it would contribute 40 percent of the amount of Federal funds appropriated in FY 1990. On this basis, a substantial Texas contribution of about $120,000,000 is also expected in FY 1991. Initial contributions from foreign participants may become available in FY 1991. This is subject to completion of negotiations with the State of Texas and foreign contributors.	In addition to the construction activities to be conducted with Federal funds, it is anticipated that there will be contributions from the State of Texas to finance construction activities including campus buildings, on-site support buildings, experimental halls, other SSC systems and R&D programs. The State of Texas has indicated that it would contribute 40 percent of the amount of Federal funds appropriated in FY 1990. On this basis, a substantial Texas contribution of about $120,000,000 is also expected in FY 1991. Initial contributions from foreign participants may become available in FY 1991. This is subject to completion of negotiations with the State of Texas and foreign contributors.
	$ 0	$ 128,992	$ 168,866
Construction	$ 0	$ 128,992	$ 168,866

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OFFICE OF ENERGY RESEARCH
GENERAL SCIENCE AND RESEARCH
(dollars in thousands)

KEY ACTIVITY SUMMARY

CONSTRUCTION PROJECTS

Superconducting Super Collider

IV. A. Construction Project Summary

Project No.	Project Title	Total Prior Year Obligations	FY 1990 Request	FY 1991 Request	Unappropriated Balance	TEC
90-R-106	Superconducting Super Collider	$ 0	$ 208,992	$ 368,866	$ 3,722,142	$4,300,000
	Less Non-Federal Contributions	0	(80,000)	(200,000)	(1,520,000)	XXX
Total, Superconducting Super Collider Construction		$ 0	$ 128,992	$ 168,866	$ 2,202,142	XXX

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FY 1991 CONGRESSIONAL BUDGET REQUEST
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GENERAL SCIENCE AND RESEARCH
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KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Superconducting Super Collider (SSC)

IV. B. Plant Funded Construction Project — Project TEC: $ 4,300,000[a/]

1. Project title and location: 90-R-106 — Start Date: 1st Qtr. FY 1990
Superconducting Super Collider (SSC) — Completion Date: 2nd Qtr. FY 1998
Ellis County, Texas

2. Financial schedule:

Fiscal Year	Appropriated[b/]	Obligations	Costs
1990	208,992	208,992	125,000
1991	368,866	368,866	300,000
1992	625,000	625,000	600,000
1993	673,000	673,000	650,000
1994	669,000	669,000	650,000
1995	641,000	641,000	640,000
1996	641,000	641,000	640,000
1997	473,142	473,142	490,000
1998	0	0	205,000

3. Narrative:

- The Superconducting Super Collider is a high luminosity proton-proton collider with beam energy of up to 20 trillion electron volts (TeV). The collider itself consists of two rings of superconducting magnets and associated systems in a common tunnel, about 53 miles in circumference. Up to six interaction regions will be outfitted with collision halls and support areas for experiments. The project includes a series of injector accelerators which provide the input beam for acceleration and circulation in the collider rings. The associated office and laboratory facilities (buildings, structures, and utilities) required to support the technical systems are also included. The TEC is the full construction cost and does not take into account any anticipated international or state contributions and assumes that the site will be provided at no cost to DOE. This estimate was verified by independent experts. The new technical, cost and schedule baselines may lead to revisions in the cost estimate.

- The SSC will ensure forefront experimental capability for continued progress in advancing the frontier of knowledge of matter and energy at its most fundamental level, with resulting impacts on the Nation's science and technology base. The collider will cause oppositely directed bunches of protons to collide, basically head-on, making available a total of up to 40 TeV of energy within an extremely small volume. These energies are expected to produce new types of matter and new forms of energy. Internal structure, and even more basic building blocks of matter, may be revealed. Large detectors will be used in the interaction regions to detect and record interactions of interest. The SSC, through its investigation of fundamental physical processes, will provide new insights into questions of great significance to other sciences as well as high energy physics, and to our knowledge and understanding of the world in which we live. It will be a powerful and unique tool for extending those investigations of matter and energy that have led us to an understanding of the atom, the nucleus, and on to their smallest components.

- Construction activities will proceed on a broad front in FY 1991. The request for appropriated funds includes $33 million for detailed design of technical systems, $18 million for conventional facilities design, $15 million for site preparation, utilities and on-site structures, $20 million for injector system fabrication, $48 million for collider system fabrication (largely in support of the magnet industrialization program and magnet material procurements), and $35 million for project management, support equipment, and rental space. No tunneling construction is expected to occur until a decision has been made to go to commercial production of the superconducting magnets.

- The outyear BA projections for the project including construction, detectors, R&D, and preoperations costs, in escalated dollars are:

(Dollars in Millions)

	FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	Total
Total Project Funding	$ 33.0	$ 97.6	$297.7	$512.2	$759.0	$803.0	$788.0	$837.0	$897.8	$748.3	$120.0	$5,893.6 a/b/c/
Estimated Non-Federal Contributions	0	0	80.0	200.0	200.0	300.0	300.0	300.0	300.0	120.0	0	1,800.0
Federal Share	$ 33.0	$ 97.6	$217.7	$312.2	$559.0	$503.0	$488.0	$537.0	$597.8	$628.3	$120.0	$4,093.6

a/ The technical basis of the cost estimate is the 1986 Conceptual Design Report. The Department and the SSC Laboratory are in the process of developing a revised conceptual design along with cost estimate and schedule. This is a rapidly evolving situation and appropriate revisions will be incorporated into the budget request and outyear plans after the new technical, cost and schedule baselines have been validated.

b/ Total project funding indicated. Funding required through appropriation process will be less as a result of anticipated non-federal contributions presently estimated to total $1.8 billion. The projection of a total non-federal contribution to the SSC of $1.8 billion and the year-by-year spread of the estimated contributions are preliminary estimates. The exact funding type and timing of the non-Federal contributions will depend on which SSC systems are provided by others and how these systems fit into the project schedule. Improved firm estimates will be available after completion of definitive cost-sharing agreements with the State of Texas and foreign contributors.

c/ Excludes direct federal management and on-site administrative costs shown below:

	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1995
Program Direction.....	$ 522	$ 838	$ 5,700	$11,300	$12,600	$12,800	$13,100
FTE's.....	12	40	52	106	124	124	124

4. Total Project Funding (BA):

	Prior Years	FY 1989	FY 1990	FY 1991 Request	To Complete
Construction.....	$ 0	$ 0	$128,992	$168,866	$2,202,142
Operating Expenses & Capital Equipment.....	33,000	97,585	88,740	143,300	1,230,960

DEPARTMENT OF ENERGY
FY 1991 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
PLANT AND CAPITAL EQUIPMENT
SUPERCONDUCTING SUPER COLLIDER (SSC)

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

1. Title and location of project: Superconducting Super Collider (SSC) Ellis County, Texas

2. Project No.: 90-R-106

3. Date A-E work initiated: 3rd Qtr. FY 1989

3.a Data physical construction starts: 1st Qtr. FY 1990

4. Date construction ends: 2nd Qtr. FY 1998

5. Previous cost estimate: $4,300,000
Less amount for PE&D: 0
Net cost estimate: $4,300,000
Date: December 1988

6. Current cost estimate: $4,300,000
Less amount for PE&D: 0
Net cost estimate: $4,300,000*
Date: December 1989

7. Financial Schedule:

Fiscal Year	Authorization**	Appropriations**	Obligations**	Costs
1990	$ 208,992***	$ 208,992***	$ 208,992***	$ 125,000
1991	368,866****	368,866****	368,866****	300,000
1992	625,000	625,000	625,000	600,000
1993	673,000	673,000	673,000	650,000
1994	669,000	669,000	669,000	650,000
1995	641,000	641,000	641,000	640,000
1996	641,000	641,000	641,000	640,000
1997	473,142	473,142	473,142	490,000
1998	0	0	0	205,000

* The technical basis of the cost estimate is the 1986 Conceptual Design Report. The Department and the SSC Laboratory are in the process of developing a revised project conceptual design along with cost estimate and schedule. This is a rapidly evolving situation and appropriate revisions will be incorporated into the budget request and outyear plans after the new technical, cost and schedule baselines are validated.

** Total project construction funding indicated. Funding required through appropriation process will be less as a result of anticipated non-Federal contributions. The present projection of a total non-Federal contribution to the SSC of $1.8 billion and the year-by-year spread of the estimated contributions are preliminary estimates. The exact timing and funding type of the non-Federal contributions will depend on which SSC systems are provided by others and how these systems fit into the project schedule. Improved firm estimates will be available after completion of definitive cost-sharing agreements with the State of Texas and foreign contributors.

*** Includes $128,992,000 of Federal funds and an estimated Texas contribution of about $80,000,000. No agreement has yet been reached with the Texas National Research Laboratory Commission.

****Includes $168,866,000 of Federal funds and an estimated $200,000,000 of non-Federal funds. We estimate that Texas would contribute about $120,000,000 and that the remainder would have to come from foreign sources. No agreements for the non-Federal funds exist at this time.

1. Title and location of project: Superconducting Super Collider (SSC) Ellis County, Texas

2. Project No.: 90-R-106

8. Brief Physical Description of Project

The Superconducting Super Collider (SSC) consists of a superconducting storage ring system in which counter-rotating beams of protons are made to collide at certain interaction points, producing ultra-high energy reactions for physics studies. The project includes a series of injector accelerators which provide the input beam for acceleration and circulation in the collider rings. The associated laboratory facilities (buildings, structures, and utilities) required to support the technical systems are included.

Proposed SSC Design Objectives

Proton beam energy up to 20 TeV

Luminosity $10^{33} cm^{-2} s^{-1}$
Number of interaction regions 4 (plus 2 potential)

The injector systems consist of a source and linear accelerator, followed by three booster synchrotrons in cascade. In addition to providing protons for injection into the two main rings, the final booster synchrotron alternately produces external beams for testing the response of detector components before their use in the interaction regions.

In the collider, oppositely directed bunches of protons, each with an energy of up to 20 TeV (20 trillion electron volts), are caused to collide with each other, almost head-on, making available a total of up to 40 TeV of energy in each proton-proton collision. Since the probability of interaction per proton is comparatively low, the beams can be recirculated to collide repetitively for many hours without significant attenuation. Thus the SSC is constructed as a pair of storage rings capable of holding tightly confined, counter-rotating proton beams. The rings are made to cross at up to six locations where the collision reactions take place and where detectors that observe and measure the reaction products for physics study can be located. Four interaction regions are to be provided as experimental areas outfitted with collision halls and detectors in the base project. An additional two are available for possible future expansion of experimental capabilities.

1. Title and location of project: Superconducting Super Collider (SSC) Ellis County, Texas

2. Project No.: 90-R-106

8. Brief Physical Description of Project (continued)

The two collider rings confining the proton beams are housed one above the other in a common underground tunnel. The beams are guided around the desired path through an evacuated tube by a system of superconducting electromagnets. This magnetic confinement system consists of a periodic array of bending and focusing magnets. The circumference of the rings is approximately 85 km (53 miles), a size governed by the maximum magnetic field and the maximum energy. The operating cycle of the SSC begins with the collider magnets maintained at low field for about forty minutes while the proton beams are loaded into both collider rings. With injection complete, the acceleration system is activated. The increase in the beam energy is accompanied by a corresponding increase in the confining magnet strength thus keeping fixed the position of the beam orbit. This synchronous acceleration is complete in about fifteen minutes when the beams reach their collision energy of up to 20 TeV, about twenty times the injection energy. Then the accelerating system is turned down and the beams are steered into collision at the interaction points. The resulting reactions can take place for about a day before the beams are depleted sufficiently so that the refill and acceleration cycle must be repeated. The design luminosity, a measure of the effectiveness of a collider in producing useful collisions, is 10^{33} cm $^{-2}$s^{-1}.

By far the largest and most costly of the SSC technical systems are the main ring magnets -- some 8000 dipoles and nearly 1800 quadrupoles. An extensive cryogenic system is required to maintain the magnets at the operating temperature.

The SSC conventional facilities structures can be classified into two major categories -- the Collider Tunnel and the Campus-Injector Complex. The underground Collider Tunnel is approximately 53 miles in circumference. The tunnel is composed of arc sections of uniform periodicity, interrupted by two special sections called clusters. Within these clustered areas are the utility sections needed for specialized accelerator functions (such as injection, radio frequency acceleration, and the beam abort/dump facilities) and the collision halls containing the detectors. Four collision halls are to be constructed. For future flexibility, space has been left for two more collision halls.

The Campus-Injector Complex has a very different character. In this location, and to a lesser extent at the Interaction Hall Cluster on the other side of the ring, there are groups of laboratory, shop and office buildings with associated grounds, roads, parking lots, utilities yards, etc. The utilities and services for the entire SSC, as well as all of the operating staff, largely are concentrated in these two laboratory areas. The campus complex will consist of buildings arranged in four major groups -- laboratory, industrial, warehouses, and support buildings.

1. Title and location of project: Superconducting Super Collider (SSC) Ellis County, Texas 2. Project No.: 90-R-106

8. Brief Physical Description of Project (continued)

Connecting to the below-ground systems are a large array of electrical cables and mechanical pipes. At the surface and distributed at a number of points around the ring are refrigerator facilities with large helium compressors. At two or more locations around the large ring are located major electrical sub-stations connecting the accelerator complex to the power grid. The entire facility requires a reliable and stable source of electric power with peak demands up to about 200 MW and a water supply of up to 2700 gallons per minute.

The laboratory staff during regular operation will consist of about 3000 people, of whom 2500 are resident staff and workers and 500 are visiting scientists on short-term stays of days to months. During construction, the population will fluctuate. In addition to the basic buildings, roads and parking areas, appropriate environmental and support systems are needed for this population, including items such as heating and ventilation of buildings and work areas, provision for sewage and solid waste disposal, provision of police and fire protection, emergency medical aid and other standard considerations.

Initial construction activities will proceed on a broad front in FY 1991. The request for appropriated funds includes $33 million for detailed design of technical systems, $18 million for conventional facilities design, $15 million for site preparation and utilities, $20 million for injector system fabrication, $48 million for collider system fabrication (largely in support of the magnet industrialization program), and $35 million for project management, support equipment, and rental space. No tunneling construction is expected to occur until a decision has been made to go to commercial production of the superconducting magnets.

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

The purpose of the SSC is to ensure forefront experimental capability for continued progress in advancing the frontier of knowledge of matter and energy at the most fundamental level, with resulting impacts on the Nation's science and technology base. The scientific work of the laboratory will be focused on the study of reactions among the elementary constituents of matter at the highest energies.

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

The SSC will build on the experience of earlier hadron-hadron colliders, especially the Fermilab Tevatron Collider, just now coming into operation with its high energy and its superconducting magnets. The SSC represents an enormous step in both energy and luminosity over existing machines. In the energy regime of interest only a proton-proton machine is today capable of the high luminosity necessary to gather information on the rarest and possibly most interesting phenomena. The very high energy of the SSC will take it to a completely unexplored domain, providing answers to some of the fundamental questions posed above and undoubtedly uncovering new, unanticipated phenomena.

The recent progress of particle physics has brought astounding results. A distinct level of matter below the proton has been identified. Three generations of that matter have been found, and the basic forces between these particles have been identified. The present understanding of matter and forces is extensive and extra ordinarily successful, but is not complete. Many crucial questions need to be answered. Are there more quarks and leptons? Are there additional levels of matter beneath the quarks and leptons? What is the origin of mass? Are there new, undiscovered forces in nature? New energy sources? These are some of the challenges in particle physics for which the SSC will play a major role.

Facilities in operation, or soon to be, will explore the near frontier but will be unable to extend the energy frontier to the extent necessary to address many important questions. The only currently feasible way to reach the energies of interest is by a high-luminosity, multi-TeV proton collider. The SSC will have impressive potential for discovery in the following areas:

New quarks and leptons

The SSC will search for new quarks and leptons up to masses of a few TeV, a factor of 40 beyond the present limit.

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

New force particles

The SSC will search for new force particles, like the W and Z of the weak force, up to masses of 7 TeV, a factor of 20 beyond the present 0.3 TeV.

New hypothetical particles

The SSC will search for hypothetical new "supersymmetric" particles up to masses of 1.5 TeV, a factor of 30 beyond today's limit.

Mass generation

The SSC will explore the mass-generating phenomenon at energies more than an order of magnitude beyond today's limits.

Internal structure

The SSC will search for internal structure (even more basic building blocks) in quarks and leptons to distances 40 times smaller than the present limits.

These examples serve only to illustrate the power of the SSC relative to other high energy facilities. Nature is usually more subtle and intricate than the projection of the human mind. Surprises will surely occur and a rich and diverse research and discovery program will develop, including in directions not now even contemplated. The basic strength of the SSC is its long reach up in energy and its high luminosity.

The SSC, through its investigation of fundamental physical processes, will provide new insights into questions of great significance to other sciences as well as particle physics, and to our general knowledge and understanding of the world in which we live. It will be a powerful tool for extending those investigations of matter and energy that have led us to an understanding of the atom, the nucleus, and on to their smallest components.

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Superconducting Super Collider (SSC) Ellis County, Texas

2. Project No.: 90-R-106

10. Details of Cost Estimate*

		Item Cost	Total Cost
a.	Engineering, Design, Inspection, and Administration @ approximately 23% of item b		$ 664,000
b.	Construction Costs		2,857,000
	1. Conventional Systems	$ 823,000	
	(a) Improvements to Land (site preparations, roads, fencing, and landscaping)	$ 32,000	
	(b) General Utilities (electrical, water, communications & waste systems)	90,000	
	(c) Campus Buildings	61,000	
	(d) Injector Facilities (Structures & underground enclosures)	57,000	
	(e) Collider Facilities	496,000	
	(f) Experimental facilities (Structures & underground enclosures)	87,000	
	2. Technical Systems	2,034,000	
	(a) Injector Systems	270,000	
	(b) Collider Ring Systems		
	(1) Magnets	1,431,000	
	(2) Cryogenics	172,000	
	(3) Other systems	161,000	
c.	Standard Equipment (vehicles and office equipment)		22,000
d.	Contingency @ 21% of above costs		757,000
	Total Estimated Cost		$4,300,000

*Based on March 1986, Conceptual Design Report.

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Superconducting Super Collider (SSC) Ellis County, Texas — 2. Project No.: 90-R-106

11. Method of Performance

Design, construction, and inspection of the facility will be the responsibility of the Operating Contractor. The design and construction of the conventional facilities will be subcontracted to architectural/engineering and construction/management firms. It is anticipated that the vast majority of the hardware and technical components will be procured from industry using fixed-price contracts awarded on the basis of competitive bidding. The private sector will be utilized to the maximum extent possible while meeting the SSC requirements in a cost effective manner.

12. Funding Schedule of Project Funding and Other Related Funding Requirements (dollars in millions)

	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94	FY 95	FY 96	FY 97	FY 98[b]	Total
a. Total project cost												
1. Total facility cost[a]												
(a) Construction line item.....	$ 0	$ 0	$125.0	$300.0	$600.0	$650.0	$650.0	$640.0	$640.0	$490.0	$205.0	$4,300.0[c]
2. Other project costs[d]												
(a) R&D necessary to complete construction....	33.0	56.6	59.0	71.3	39.0	23.0	15.0	12.0	3.0	1.7	0	313.6
(b) General Laboratory Equipment.....	0	13.0	12.0	23.0	5.0	2.0	1.0	1.0	1.0	0	0	58.0
(c) Pre-operations	0	0	0	0	0	5.0	15.0	40.0	70.0	110.0	120.0	360.0[e]

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Superconducting Super Collider (SSC) Ellis County, Texas — 2. Project No.: 90-R-106

12. Funding Schedule of Project Funding and Other Related Funding Requirements (dollars in millions) (continued)

	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94	FY 95	FY 96	FY 97	FY 98	Total
(d) Initial Complement of Detectors and Computers.....	0	8.0	17.7	49.0	90.0	100.0	88.0	143.0	182.8	163.5	0.0	842.0 f/
(e) Preliminary Design Technical Systems Development	0	20.0	0	0	0	0	0	0	0	0	0.0	20.0
Total other project costs.....	33.0	97.6	88.7	143.3	134.0	130.0	119.0	196.0	256.8	275.2	120.0	1,593.6
Total project cost.....	$33.0	$97.6	$213.7	$443.3	$734.0	$780.0	$769.0	$836.0	$896.8	$765.2	$325.0	$5,893.6
Estimated non-Federal Contributions g/	0	0	80.0	200.0	200.0	300.0	300.0	300.0	300.0	120.0	0	1,800.0
Federal Share	$33.0	$97.6	$133.7	$243.3	$534.0	$480.0	$469.0	$536.0	$596.8	$645.2	$325.0	$4,093.6

a/ Based on March 1986, Conceptual Design Report. The Department and the SSC Laboratory are in the process of developing a revised project conceptual design along with cost estimate and schedule. This is a rapidly evolving situation and appropriate revisions will be incorporated into the budget request and outyear plans after the new technical, cost and schedule baselines are validated.

b/ Construction completion 2nd quarter FY 1998.

c/ Assumes site provided at no cost to DOE. Total construction cost including anticipated international, state, local and industrial contributions.

d/ Inflation indices used to convert Other Project Costs to then year dollars: FY 1989, 3.1%; FY 1990, 2.6%; FY 1991, 2.2%; FY 1992 and all outyears, 2.15%.

e/ Pre-operations shown only through construction project completion.

f/ Full cost of initial complement of detectors (including R&D) and central computer.

g/ The projection of a total non-federal contribution to the SSC of $1.8 billion and the year-by-year spread of the estimated contributions are preliminary estimates. The exact funding type and timing of the non-Federal contributions will depend on which SSC systems are provided by others and how these systems fit into the project schedule. Improved firm estimates will be available after completion of definitive agreements with the State of Texas and foreign contributors.

1. Title and location of project: Superconducting Super Collider (SSC) Ellis County, Texas — 2. Project No.: 90-R-106

12. Funding Schedule of Project Funding and Other Related Funding Requirements (dollars in millions) (continued)

b. Annual Funding Requirements After Completion*(FY 1991 dollars)

1. Annual facility operating costs	$ 220.5
2. Capital equipment	71.4
3. General Plant Projects (GPP)	8.6
4. Accelerator Improvement Projects (AIP)	12.8
Total other related annual funding requirements	$ 313.3

*Cost levels estimated for normal operation in the first full year of operation after completion of construction.

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

a. Total project cost

1. Total facility cost

Explained in items 8, 9, and 10

2. Other project costs

(a) R&D necessary to complete construction

This will provide further design and cost optimization of components. In addition to the Technical Accelerator systems, this program will also address the issues of Safety, Quality Assurance, Operations, Reliability, and Maintainability. Optimization of the facility for experimental High Energy Physics research potential will also be made.

1. Title and location of project: Superconducting Super Collider (SSC) Ellis County, Texas 2. Project No.: 90-R-106

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

2. Other Project Costs (continued)

(b) Accelerator Equipment

Accelerator equipment is required in support of the Research and Development program. This category does not include the equipment associated with detector systems, required for the SSC experimental program.

(c) Pre-Operation Costs

Pre-Operations costs are projected for the operations of each major accelerator system after construction activities and acceptance tests are complete. The successive completion of the Linac, LEB, MEB, and HEB accelerator systems is forecast beginning in FY 1993. The costs for pre-operations include manpower, materials, power, and utilities associated with the operations of each accelerator system.

(d) Initial Complement of Detectors

From preliminary studies, it is projected that the costs for the initial complement of detector systems for the four experimental areas, including the computing center, will be approximately $842M.

b. Other Related Funding Requirements

Total costs are estimated for the operation of the SSC laboratory facility in the first full year of operation after construction completion. The projected costs for laboratory operations, capital equipment, GPP, and accelerator improvements are included.