DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
GENERAL SCIENCE AND 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 in which major breakthroughs in understanding are anticipated and which cannot be reached by any other facility either in existence or planned. 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 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. The SSC holds the potential for new breakthroughs in science, technology, and education that could profoundly touch every American. The design of the SSC is based firmly on principles and engineering concepts used in previous accelerators. It is backed by an R&D program specifically related to the SSC which has been in progress since 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. A preliminary design and cost estimate developed in the 1986 Conceptual Design Report and supporting documentation have served as a baseline for the project. 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 has been prepared to reflect the characteristics of the Texas site and R&D achievements since 1986. This forms the basis for the technical, cost and schedule baseline for the SSC published by the Department in January 1991. The baseline Total Project Cost (TPC) is $8.249 billion (as-spent), with completion projected by the end of FY 1999.

There has been substantial progress on the Superconducting Super Collider (SSC) in 1990 and 1991. Main accomplishments include: (1) award of the contract for SSC architect engineer/construction management services to the team of Parsons-Brinckerhoff/Morrison Knudsen, which will perform the design and construction of all on-site conventional facilities such as tunnels, surface buildings, utilities, and roads; (2) completion of the Supplemental Environmental Impact Statement and Record of Decision for construction and operation of the SSC; (3) completion of a Memorandum of Understanding with the State of Texas that outlines the principles that will govern the interaction between the Department and the State of Texas regarding its participation in, and $1 billion contribution to, the SSC; (4) transfer of initial land parcels to the Federal Government by the State of Texas as part of the land acquisition program by the State which is running well ahead of schedule; (5) initiation of construction of the Magnet Development Laboratory which will be completed and in operation in the Fall of 1991; (6) award of contracts to General Dynamics and Westinghouse, respectively, as leader-follower contractors for the engineering development, prototype production, and production of a limited number of the collider dipole magnets; (7) award of a contract to Babcock & Wilcox as the contractor for the engineering development, prototype production and production of a limited number of collider quadrupole magnets; (8) in the detector area, the large general purpose detector proposed by the Solenoidal Detector Collaboration, which includes major foreign participation, was approved for further design and proposal

development, and a letter of intent has been received for a new international collaboration for a second large detector (GEM) for the initial SSC physics program; (9) establishment of a strong laboratory presence in the Waxahachie area in the SSC Central Facility recently acquired for project use by the State of Texas; and (10) successful testing of eight models of the new 50-millimeter design magnets; these short models (1 - 1.8 meters) consistently demonstrated performance significantly above the required operating currents and, thus, were highly successful; the first two full length, 15-meter dipole magnets of the 50 millimeter design were successfully tested in November 1991; and, (11) a string of five of the full length 40 mm magnets was tested at Fermilab late in FY 1991.

One of the most important accomplishments of the past year is the Department's "Report on the Superconducting Super Collider Cost and Schedule Baseline," which was published in January 1991. This report represents the culmination of an extensive effort by the SSC Laboratory to develop a site-specific conceptual design, along with cost and schedule estimates for the SSC, and the efforts of the Department to thoroughly review the Laboratory's work, to reconcile differences noted by three independent review committees, and to develop a credible cost and schedule baseline for the SSC. The Department's baseline for the SSC identifies a total project cost of $8,249 million (as-spent), with project completion by the end of FY 1999. The detailed features of the baseline are documented in the Department's baseline report. The baseline incorporates changes to the base-cost estimate made by the SSC Laboratory for some elements of the construction project, a schedule extension of one year, along with a less aggressive funding profile, and a contingency allowance of $843 million.

The baseline is technically feasible. It will provide a high energy physics laboratory capability that meets the scientific objectives of the SSC and that results in a facility that can be commissioned readily, and operated with high reliability. It establishes a credible total project cost estimate and an aggressive but cost-effective schedule. The Department's baseline provides a cost-effective basis for planning and executing the SSC in a manner that will ensure that the scientific objectives of the SSC will be achieved and that it will be completed on schedule and within cost. The Department and the SSC Laboratory management are fully committed to meeting these goals. Strong management teams are now in place at the Department and at the SSC Laboratory. Strict, formal change control procedures are in place and the Department is retaining full control of the expenditure of contingency funds.

The cost and schedule estimates presented in the Department's baseline are intimately linked with the funding profile indicated. Any change in funding profile will have an impact on schedule and total project cost. Receipt of funding as indicated in the baseline funding profile will enable the Department to execute the project as estimated, with confidence that the project can be completed on schedule and within the baseline Total Project Cost.

The request for Federal funds in FY 1993 includes $116,828,000 in operating funds for continued R&D on superconducting magnets, R&D on other accelerator technical systems, R&D on detector subsystems, general laboratory operating costs, and DOE program direction costs; $63,000,000 in capital equipment funds for detector subsystems, accelerator component and system prototypes, apparatus in support of on-site accelerator system and magnet tests, laboratory computing equipment, and a variety of general laboratory equipment and instrumentation essential to establishing a new research laboratory; and, $470,172,000 in Federal construction funds for detailed design of technical systems and conventional facilities, the magnet industrialization program, fabrication of injector and collider technical systems and components, on-site construction of conventional facilities and project management and administration. In addition to the Federally-funded activities described above, construction of on-site facilities and work on technical systems is expected with funds contributed by non-Federal sources. The contribution of Texas funds will be in accordance with the Memorandum of Understanding between the Department and the State of Texas which outlines principles of agreements for contributions to the SSC and support of the project. Exact funding contributions for each fiscal year will be agreed upon annually. Discussions are underway with potential foreign partners to develop specific proposals for participation and to begin negotiating agreements on the magnitude and type of contributions. International contributions to accelerator construction are expected in FY 1993 in the form of technical subsystems and components. Delegations led by the Deputy Secretary and advance teams led by other Department officials have visited Japan, Korea, Western Europe, Canada, and the Commonwealth of Independent States. A commitment has been received from India for a $50 million contribution; joint working groups have been established with the Union of Sovereign States and South Korea to determine the scope of their participation in the SSC. Discussions are also on-going with several other countries.

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LEAD TABLE

Superconducting Super Collider (SSC)

Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Base	FY 1993 Request	Program Change Request vs Base Dollar	Program Change Request vs Base Percent
Operating Expenses	$114,637	$103,593	$104,493	$116,828	$12,335	+ 12%
Capital Equipment	33,000	56,340	56,340	63,000	6,660	+ 12%
Construction	93,865	323,767	323,767	470,172	146,405	+ 45%
TOTAL	$241,502	$483,700	$484,600	$650,000	$165,400	+ 34%
Summary						
Operating Expenses	$114,637 a/	$103,593	$104,493	$116,828	$12,335	+ 12%
Capital Equipment	33,000	56,340	56,340	63,000	6,660	+ 12%
Construction	93,865	323,767	323,767	470,172	146,405	+ 45%
Total Program	$241,502 b/c/d/	$483,700 b/	$484,600 b/	$650,000 b/	$165,400 b/	+ 34%
Staffing (FTEs)	53	96 e/	96	96		

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

a/ Total has been reduced by $1,361,000 reprogrammed to Energy Supply for SBIR.
b/ 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 partners are completed.
c/ Total has been reduced by sequester of $3,157 in accordance with Senate Report 101-378,
d/ Total reduced by $75,000,000 Conference Action reduction.
e/ Revised request.

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SUMMARY OF CHANGES

Superconducting Super Collider (SSC)

FY 1992 Appropriation	$ 483,700
Adjustments - Increased personnel costs	+ 900
FY 1993 Base	$ 484,600
SSC R&D and Operations	
- R&D to concentrate on design of superconducting magnets and development of designs for the injectors, other collider technical systems and detectors	+ 12,335
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	+ 6,660
Construction	
- Increased level of SSC construction for major efforts on both technical components and conventional facilities to meet baseline cost and schedules	+146,405
FY 1993 Congressional Budget Request	$ 650,000

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KEY ACTIVITY SUMMARY

SUPERCONDUCTING SUPER COLLIDER (SSC)

I. Preface: SSC Research, Development and Operations

The SSC R&D program provides support for the studies that develop the conceptual design and technological foundation for the SSC and its technical systems. The program currently has a strong focus on superconducting magnet development but also includes R&D on detectors and other accelerator systems which are also critical elements of the SSC.

This subprogram also provides the Federal staffing resources and associated funding required to oversee and administer a highly complex program to plan, design, construct, and operate the multibillion dollar SSC. The magnitude and complexity of the project resulted in formation of the Office of Superconducting Super Collider (OSSC) which reports directly to the Director of Energy Research. Under a recent reorganization, responsibility for SSC project management and oversight of scientific and technical activities was transferred to Texas. The new OSSC structure provides for an SSC Project Office and an Administration Office in Texas and an SSC Support Office at DOE Headquarters.

II. A. Summary Table: SSC Research, Development and Operations

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
SSC R&D	$ 107,537	$ 92,593	$ 104,928	+ 13
SSC Program Direction	7,100	11,000	11,900	+ 8
Total, SSC Research, Development and Operations	$ 114,637	$ 103,593	$ 116,828	+ 13

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

Program Activity	FY 1991	FY 1992	FY 1993
SSC Research, Development and Operations			
SSC R&D	In FY 1991 the superconducting magnet R&D program included activities to fabricate and test 40mm magnets, further refine and develop the design of the 50mm magnets and test that design with short model magnets, fabricate and prepare for testing the first full-length 50mm magnets, continue R&D on superconductor, work with the industrial vendors to prepare for producing the first industrially assembled test magnets, and begin preparations for the magnet string test scheduled for late in FY 1992. A significant portion of the work is conducted at other laboratories. Accelerator R&D included refinement of the design and establishment of technical specifications for the injector accelerators & collider technical systems, the fabrication and testing of prototypes of components, and preparation of the accelerator systems required for the magnet string tests. The detector R&D focused on an enhanced program of detector subsystem R&D and the development of detailed proposals for selected detectors.	A major feature of the FY 1992 R&D program will be final preparation for and implementation of the magnet string test to take place late in the fiscal year. Superconducting magnet R&D will continue to further refine the superconducting dipole design and to pursue development of the superconducting quadrupole and high energy booster superconducting dipole magnets. Accelerator R&D will focus on testing and evaluation of prototypes of components and systems, refinements of the design of the injectors and collider, and the development of final specifications for procurement of these systems. Detector subsystem R&D will continue at a reduced level and the emphasis will progressively shift toward engineering design of specific approved detectors. The remainder of the request is needed for general laboratory operations such as laboratory management and administration, and the laboratory's, technical and experimental support groups.	The FY 1993 R&D program will include the continuation of superconducting magnet R&D, accelerator R&D and detector R&D. The program will include R&D to further refine the design of the superconducting magnets for the collider and high energy booster ($27,600); accelerator R&D to complete design of various accelerator systems and components and to fabricate and test prototypes of components ($26,000); detector and experimental systems R&D and operation of computing capability ($21,200); general laboratory operations such as laboratory management and administration and the laboratory's technical and experimental support groups ($30,128).
	$ 107,537	$ 92,593	$ 104,928

III. SSC Research, Development and Operations (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
SSC Program Direction	Provided funds for salaries, benefits, and travel for 53 full-time equivalents (FTEs) in the Office Of Superconducting Super Collider (OSSC). ($5,910)	Provide funds for salaries, benefits, and travel for 83 FTEs included in the FY 1992 budget for the Office of SSC and 6 FTEs for Energy Research support personnel. A revised request for seven additional FTEs is discussed below. ($8,875)	Provide funds for salaries, benefits, and travel for 90 FTEs for the Office of SSC and 6 FTEs for Energy Research support personnel. Provide for 7 additional FTEs over the FY 1992 budget level, as discussed in FY 1992. Provide for normal increased personnel costs resulting, for example, from a general pay raise and within-grade and merit increases. ($9,795)
	Prior to the reorganization, the OSSC-HQ provided program direction and management oversight of the SSC program with a total FY 1991 budget of $392 million which includes non-Federal contributions. Expended significant staff time on negotiation and implementation of cost-sharing arrangements with foreign partners. Continued to manage the expanded scientific R&D program and provide guidance and oversight from HQ on detailed design and civil construction activities. Managed the project baseline at the HQ level and met the heavy demand for project reviews, briefings and information requests from the Congress, public and media. Provided ES&H support to ensure safe and efficient project implementation, including completion of the Supplemental Environmental Impact Statement and the associated Record of Decision.	Provide 16 FTEs to staff the SSC Support Office to manage HQ activities related to the DOE SSC program and additional non-Federal contributions. Continue to oversee negotiation and implementation of detailed cost-sharing arrangements with foreign countries. Continue to participate in oversight of accelerator and detector R&D programs. Develop policy for and coordinate SSC program activities with the high energy physics program. Integrate SSC program planning with Departmental strategic planning activities. Continue to provide support for project control and civil construction at the HQ level and meet demands for project reviews, briefings, information requests, and other program support requirements of the SSC project.	Continue to provide 16 FTEs to staff the SSC Support Office to manage HQ activities related to the DOE SSC program and additional non-Federal contributions. Continue to oversee negotiation and implementation of detailed cost-sharing arrangements with foreign countries. Continue to participate in oversight of accelerator and detector R&D programs. Develop policy for and coordinate SSC program activities with the high energy physics program. Integrate SSC program planning with Departmental strategic planning activities. Continue to provide support for project control and civil construction at the HQ level and meet demands for project reviews, briefings, information requests, and other program support requirements of the SSC project.

III. SSC Research, Development and Operations (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
SSC Program Direction (Cont'd)	Continued to build up the staff of the SSC Project Office (SSCPO) to ensure that the appropriate oversight and management were available at the on-site office to ensure that cost and schedule baselines are met and to implement recent delegations of personnel and procurement authority. Provided project oversight and guidance and managed on-site systems engineering and civil construction activities including site preparation, campus buildings, and injector facilities. Continued to oversee development of technical systems such as the collider dipole magnets. Interacted daily with M&O contractor staff and State of Texas representatives. Assisted OSSC-HQ as required.	Provide 7 additional FTEs to staff the Texas offices to a level of 74 to provide policy and program direction and effective day-to-day DOE oversight and management of this large, complex project, which is one of the Department's and Administration's major science initiatives. Provide independent assessments of progress, issues and recommendations to the Secretary of Energy. Continue to provide project oversight and management of construction activities at the site, oversee the many design and development efforts for technical systems, oversee the laboratory's procurement and business activities, administer the M&O contract, and provide administrative support at the site. Implement an ES&H program that ensures compliance with all regulations and directives. Serve as focal point for daily interactions with M&O contractor staff, State of Texas representatives, SSC Support Office at HQ, and others as required.	Provide 74 FTEs, including the increase of 7 requested over the FY 1992 budget, to staff the SSC Texas offices to continue to provide effective policy and program direction and day-to-day DOE oversight and management of this large, complex project. Continue to provide program management and project oversight of construction activities at the site, oversight of the many design and development efforts for technical systems, oversee the laboratory's procurement and business activities, administer the M&O contract, ensure compliance with ES&H regulations and directives, and provide administrative support at the site. Continue to serve as focal point for daily interactions with M&O contractor staff, State of Texas representatives, SSC Support Office, and others as required.
	No activity.	Provide six FTEs for ER HQ program and management support to the SSC in the areas of budget and finance, personnel administration, acquisition and assistance, policy review and coordination, and construction management support.	Continue to provide for ER HQ program and management support to the SSC at the level included in the FY 1992 budget.
	Provided a variety of program support to the OSSC-HQ and SSCPO such as printing and binding and contractual support such as relocation services.	Continue a variety of program support as in FY 1991. Increased funding will provide support for additional staff, primarily at the site. ($2,125)	Continue a variety of program support as in FY 1991 and FY 1992. ($2,105)
	$ 7,100	$ 11,000	$ 11,900

III. SSC Research, Development and Operations (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
SSC Research, Development and Operations	$ 114,637	$ 103,593	$ 116,828

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KEY ACTIVITY SUMMARY

SUPERCONDUCTING SUPER COLLIDER (SSC)

I. Preface: SSC Capital Equipment

The SSC has significant capital equipment requirements for procurements in support of R&D efforts on the many accelerator technical system and components and for engineering design and 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 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
SSC Capital Equipment.....	$ 33,000	$ 56,340	$ 63,000	+ 12
Total, SSC Capital Equipment	$ 33,000	$ 56,340	$ 63,000	+ 12

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

Program Activity	FY 1991	FY 1992	FY 1993
SSC Capital Equipment	In FY 1991 there was an enhancement in the level of fabrication of prototype detector subsystems and components, an increase in accelerator component and systems fabrication and an enhanced level of equipment required to establish a new laboratory.	Provides for fabrication of detector subsystems and components; equipment in support of the accelerator R&D effort and equipment for on-site testing; equipment in support of the magnet R&D effort, a variety of items of general laboratory technical support equipment that are essential when establishing a new research laboratory.	Provides a major increase for the design and fabrication of SSC detector systems following selection of the two large general purpose detectors ($44,000). Also provides continued support for fabrication of accelerator systems and components prototypes ($5,000); components for prototype superconducting magnets and for magnet laboratory equipment ($5,000); general laboratory equipment ($4,000); computing equipment ($5,000 total), including the Physics Detector Simulation Facility ($3,000).
	$ 33,000	$ 56,340	$ 63,000
SSC Capital Equipment	$ 33,000	$ 56,340	$ 63,000

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KEY ACTIVITY SUMMARY

SUPERCONDUCTING SUPER COLLIDER (SSC)

I. Preface: Construction

II. A. Summary Table: Construction

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Construction	$ 93,865	$ 323,767	$ 470,172	+ 45
Total, Construction	$ 93,865	$ 323,767	$ 470,172	+ 45

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

Program Activity	FY 1991	FY 1992	FY 1993
Construction	Provided for detailed design of technical systems and conventional facilities, including the AE/CM contractor. Technical systems construction included procurement of linac components (RFQ and klystrons), cryogenics and control systems. The magnet program includes the dipole industrial contract, initiation of the quadrupole contract and procurement of components for the magnet development and test laboratories. Conventional construction included construction of the Magnet Development Laboratory. Also included were the award of the Accelerator System String Test (ASST), the Magnet Test Lab, and support facilities in the E-1 area, and some utilities and infrastructure.	Provides $129,900 for the magnet program, including the Collider Dipole Magnet Industrialization Program which includes the development and acquisition of tooling, and the procurement of materials and components for the 70 preproduction magnets to be manufactured in FY 1993. The remainder of the magnet program includes the collider quadrupole contracts, the high energy booster dipole and quadrupole contract, procurement of equipment and tooling for the on-site magnet facilities, and advance procurement of superconducting wire and cable. Also provides $36,100 for design of conventional facilities (collider tunnel, injector enclosures, experimental areas, campus buildings, and other surface facilities); $43,300 for collider system technical components other than the superconducting magnets; and $45,000 for injector technical systems for the linac, Low Energy Booster (LEB) and Medium Energy Booster (MEB); Conventional facilities construction includes; completion of the ASST facility, the award of the first shafts and first collider tunnel sector contracts, commencement of Linac, LEB and MEB construction, and initiation of underground tunnel construction in the fourth quarter of FY 1992 ($70,200); onsite utilities and roads for the west campuses, and the administration building at the west interaction region ($51,900). Also provides $39,942 for project management and administration and $39,300 for contingency.	Required for the project to proceed in accordance with Department's cost and schedule baseline. Provides $206,600 for the superconducting magnet program, including $187,900 for the collider dipole and quadrupole contracts with industry and $18,700 for the high energy booster magnet contracts. The FY 1993 dipole program will include fabrication of the 70 preproduction magnets and acquisition of materials and components for the 500 low-rate production magnets to be fabricated in FY 1994. Also provides: $68,000 for fabrication of elements of the linac, low energy booster, medium energy booster, and high energy booster; $135,900 for fabrication of other collider technical systems; $14,700 for design of conventional facilities by the AE/CM; $143,600 for enclosure construction for the low energy booster, medium energy booster, high energy booster and collider, including tunnels and surface structures; $61,000 for other conventional construction including initiation of one experimental hall, test beams, campus buildings, utilities and infrastructure; $39,145 for project management and administration; and $34,227 for contingency.

III. Construction (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Construction (Cont'd)		Of the total construction requirement of $455,642 described above it is expected that approximately $131,875 will be met with anticipated non-Federal contributions, primarily from the State of Texas. The Federal construction funding requirement is therefore estimated to be $323,767.	Of the total construction requirement of $703,172 described above it is expected that $233,000 will be met with anticipated non-Federal contributions, with $133,000 coming from the State of Texas and $100,000 from foreign sources. The Federal construction funding requirement is therefore estimated to be $470,172.
	$ 93,865	$ 323,767	$ 470,172
Construction	$ 93,865	$ 323,767	$ 470,172

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KEY ACTIVITY SUMMARY

CONSTRUCTION PROJECTS

Superconducting Super Collider

IV. A. Construction Project Summary

Project No.	Project Title	Total Prior Year Obligations	FY 1992 Request	FY 1993 Request	Unappropriated Balance	TEC
90-R-106	Superconducting Super Collider	$ 345,086	$ 455,642	$ 703,172	$4,842,902	$6,346,802
	Less Estimated Non-Federal Contributions	(124,629)	(131,875)	(233,000)	(2,068,000)	(2,557,504)*
Total, Federal Superconducting Super Collider Construction		$ 220,457	$ 323,767	$ 470,172	$2,774,902	$3,789,298

* Estimate based on DOE goal for non-Federal participation in SSC. Firm agreements are yet to be negotiated.

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KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Superconducting Super Collider (SSC)

IV. B. Plant Funded Construction Project

1. Project title and location: 90-R-106
Superconducting Super Collider (SSC)
Ellis County, Texas

Project TEC: $6,346,802a/
Start Date: 1st Qtr. FY 1990
Completion
Date: 4th Qtr. FY 1999

2. Financial schedule:

Fiscal Year	Appropriated a/	Obligations	Costs
1990	126,592	102,704	84,995
1991	218,494	242,382	191,189
1992	455,642	455,642	364,274
1993	703,172	703,172	653,966
1994	978,897	978,897	942,518
1995	1,061,050	1,061,050	1,045,861
1996	1,094,449	1,094,449	1,126,909
1997	883,176	883,176	956,938
1998	696,202	696,202	734,330
1999	129,128	129,128	245,822

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 54 miles in circumference. Up to four 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.

a/ Total construction project funding indicated. Funding required through appropriation process will be less as a result of anticipated non-federal contributions. The Department is seeking non-Federal participation in the SSC to share the benefit and the responsibility of the construction and operational phases of the SSC program. The data presented are estimates based on obtaining one-third of the Total Project Cost from non-Federal contributions. Identification of the details of the non-Federal contributions will depend upon completion of negotiation of agreements with foreign partners and on cost-sharing agreements with Texas. Outyear amounts reflect funding levels higher than amounts contained in the OMB passback. The funding of these outyear requirements will be addressed in the next budget cycle.

- 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 at a significantly enhanced pace in FY 1993. The request for appropriated funds includes: $15 million for conventional facilities design, $204 million for conventional facility construction, $68 million for injector technical systems fabrication, $207 million for superconducting magnet program, $136 million for collider technical system fabrication (other than the superconducting magnets); and $39 million for project management, and administration; and $34 million for contingency. Of the $703 million requirement for construction, it is estimated that $233 million will be provided from non-Federal funds, resulting in a requirement for $470 million of Federal funds.

- Total BA funding for the project including construction, detectors and R&D and preoperational 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	FY1999	Total
Total Project Funding	$ 33.0	$ 97.6	$ 214.5	$ 383.4	$ 622.7	$871.1	$1,137.6	$1,244.1	$1,302.7	$1,101.7	$915.9	$324.8	$8,249.1
Estimated Non-Federal Contributions	0	0	0	149.0	150.0	233.0	427.0	466.0	570.0	250.0	250.0	105.0	2,600.0
Federal Share[c/]	$ 33.0	$ 97.6	$ 214.5	$ 234.4	$ 472.7	$638.1	$ 710.6	$ 778.1	$ 732.7	$ 851.7	$665.9	$219.8	$5,649.1

c/ Excludes direct Federal management and on-site administrative costs shown below. (BA in Thousands)

	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997
Program Direction.....	$ 2,400	$ 7,100	$11,000	$11,900	$12,400	$13,000	$13,700	$14,500
FTE's.....	15	58	96	96	96	96	96	96

4. Total Project Funding (BA in Thousands): (Federal Share - excludes Program Direction)

	Prior Years	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997
Construction.....	$ 0	$126,592	$ 93,865	$323,767	$470,172	$551,897	$595,050	$524,449	$633,176
Operating Expenses & Capital Equipment.....	130,585	87,893	140,537	148,933	$167,928	$158,703	$183,050	$208,251	$218,481

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
PROJECT DATA SHEETS
GENERAL SCIENCE AND RESEARCH - 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

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

3b. A-E work duration: 66 months

4a. Date physical construction starts: 1st Qtr, FY 1990

4b. Date construction ends: 4th Qtr. FY 1999

5. Previous Const. cost estimate: $6,351,203
Total Project Cost: $8,249,062

6. Current cost estimate:
TECC: $6,346,802
TPC: $8,249,062

7. Financial Schedule:

Fiscal Year	Appropriations*	Obligations*	Costs
1990	$ 126,592	$ 102,704	$ 84,995
1991	218,494**	242,382	191,189
1992	455,642***	455,642	364,274
1993	703,172****	703,172	653,966
1994	978,897	978,897	942,518
1995	1,061,050	1,061,050	1,045,861
1996	1,094,449	1,094,449	1,126,909
1997	883,176	883,176	956,938
1998	696,202	696,202	734,330
1999	129,128	129,128	245,822

* Total project construction funding indicated. Funding required through appropriation process will be less as a result of anticipated non-Federal contributions. The Department is seeking non-Federal participation in the SSC to share the benefit and responsibility of the construction and operational phases of the SSC program. The data presented are estimates based on obtaining non-federal contributions at a level of one-third of the TPC. The exact timing and magnitude of the non-Federal contributions will depend upon completion of agreements with non-Federal partners that specify which SSC systems are to be 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 foreign partners. Outyear amounts reflect funding levels higher than amounts contained in the OMB passback. The funding of these outyear requirements will be addressed in the next budget cycle.

** Includes $93,865,000 of Federal Funds and $124,629,000 of the Texas contribution in FY 1991.

*** Includes $323,767,000 of Federal funds and $131,875,000 in non-Federal contributions.

**** Includes $470,172,000 of Federal funds and an estimated $233,000,000 in non-Federal contributions.

PROJECT DATA SHEETS

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 beams of protons traveling in opposite directions in two rings of superconducting magnets 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 4 potential)

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 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 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 in the base project. The design can accommodate future upgrades such as beam bypass tunnels where an additional four interaction regions could be added for future expansion of experimental capabilities.

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

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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 87 km (54 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 seventy 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 twenty five minutes when the beams reach their collision energy of up to 20 TeV, about ten times the injection energy. Then 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 $^{-2}s^{-1}$.

The injector system consists of a source and a linear accelerator (which accelerates the protons to 600MeV), a Low Energy Booster (LEB) (11GeV), a Medium Energy Booster (MEB) (200GeV) and a High Energy Booster (HEB) (2TeV). The MEB also provides test beams for use in testing detector components and systems.

By far the largest and most costly of the SSC technical systems are the main ring magnets -- some 8500 dipoles and nearly 2000 quadrupoles. An extensive cryogenic system is required to maintain the magnets at the operating temperature.

The SSC conventional facilities structures can be classified into four major categories -- the Collider Tunnel, the Collision Halls, the Campus-Injector Complex, and Cryogenic and Surface Support Facilities. The underground Collider Tunnel is approximately 54 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 extraction facilities) and the collision halls containing the detectors. Four collision halls are to be constructed. For future flexibility, space has been left for four more collision halls.

The Campus-Injector Complex has a very different character. In this location, and to a lesser extent at the East 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. There is also the Central Facility located approximately in the center of the main ring, which houses a significant portion of the laboratory staff and facilities. The utilities and services for the entire SSC, as well as all of the operating staff, largely are concentrated in these areas. The campus complex will consist of buildings arranged in four major groups -- laboratory, industrial, warehouses, and support buildings.

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8. Brief Physical Description of Project (continued)

At the surface and distributed at a number of points around the ring are service areas which house refrigerator facilities with large helium compressors, power supplies and other support functions for the collider tunnel. These areas also have vertical shafts which provide tunnel access and egress for personnel and equipment. 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 domestic water supply averaging 234,000 gallons per day.

The laboratory staff during regular operation will consist of about 2700 people, of whom 2200 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.

Construction activities will proceed at a significantly enhanced pace in FY 1993. The request for appropriated funds includes: $15 million for conventional facilities design; $204 million for conventional facility construction, $68 million for injector technical systems fabrication, $207 million for superconducting magnet program, $136 million for collider technical system fabrication (other than the superconducting magnets); and $39 million for project management and administration; and $34 million for contingency. Of the $703 million requirement for construction, it is estimated that $233 million will be provided from non-federal funds, resulting in a request for $470 million of federal construction funds.

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.

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

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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, which has been in operation for a number of years with 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 likely most interesting phenomena. The very high energy of the SSC will take it to a completely unexplored domain, providing answers to some of the most fundamental questions concerning the nature of matter and the forces acting on it, as well as 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 basic forces between these particles have been identified. The present understanding of matter and forces is extensive and extraordinarily 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.

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

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 about 20 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.

1. Title and location of project: Superconducting Super Collider (SSC)
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10. Details of Cost Estimate

		Item Cost	Total Cost
a.	Engineering, Design, Inspection, and Administration @ approximately 16% of item b		$ 750,370
b.	Construction Costs		4,747,816
	1. Conventional Systems	$1,087,685	
	(a) Improvements to Land (site preparations, utilities, roads, fencing and landscaping) $ 127,595		
	(b) Campus Buildings 83,195		
	(c) Accelerator Facilities (structures & underground enclosures) 706,909		
	(d) Experimental Facilities (structures & underground enclosures) 169,986		
	2. Technical Systems	3,660,131	
	(a) Injector Systems 604,036		
	(b) Collider Systems		
	(1) Superconducting Magnets 2,220,945		
	(2) Other Systems 835,150		
c.	Contingency @ 19% of above costs (exclusive of a reduction for estimated contingency on the production of expected foreign in-kind contributions)		848,616
	Total Estimated Cost		$6,346,802

11. Method of Performance

Design, construction, and inspection of the facility is the responsibility of the Management and Operating Contractor. The design and construction of the conventional facilities have been 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 is being utilized to the maximum extent possible while meeting the SSC requirements in a cost effective manner. The SSC will involve the participation of the State of Texas and expected international partners.

PROJECT DATA SHEETS

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

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

	Prior[a/] Years	FY 90	FY 91	FY 92	FY 93	FY 94	FY 95	FY 96	FY 97	FY 98	FY 99	Total
a. Total project cost												
1. Total facility cost												
(a) Construction line item.....	$ 0	$ 85.0	$191.2	$364.3	$654.0	$942.5	$1045.9	$1126.9	$956.9	$734.3	$245.8	$6346.8[b/]
2. Other project costs												
(a) R&D and Laboratory Support.....	123.1	47.4	119.4	120.8	94.1	71.7	49.5	48.2	54.8	50.4	45.9	825.3
(b) Pre-operations..	0	0	0	0	0	7.4	16.2	26.7	32.0	39.8	42.9	165.0
(c) Initial Complement of Detectors and Computers.....	7.5	29.5	40.0	34.2	72.6	92.2	118.6	134.6	138.1	133.7	111.0	912.0[c/]
Total other project costs.....	130.6	76.9	159.4	155.0	166.7	171.3	184.3	209.5	224.9	223.9	199.8	1902.3
Total project cost.....	$130.6	$161.9	$350.6	$519.3	$820.7	$1113.8	$1230.2	$1336.4	$1181.8	$958.2	$445.6	$8249.1[d/]
Estimated Non-Federal Contribution.....	$ 0	$ 0	$107.2	$157.8	$248.6	$ 392.5	$ 453.2	$ 575.5	$ 304.4	$ 256.3	$105.0	$2600.0
Estimated Federal Costs.	130.6	161.9	243.4	361.5	572.1	721.3	770.0	760.9	877.4	701.9	340.6	$5649.1

a/ FY 1988 and FY 1989.
b/ Assumes site provided at no cost to DOE. Total construction cost including anticipated international, state, and other non-Federal contributions.
c/ Includes detector fabrication, as well as detector R&D and computers.
d/ Total project cost including a preliminary estimate of non-Federal contributions to the SSC. The exact magnitude 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. The Department's goal is to achieve non-Federal participation of one-third of the TPC.

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

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

b. Annual Funding Requirements After Completion* (FY 1992 dollars)

1. Annual facility operating costs	$ 224.0
2. Capital equipment	66.0
3. General Plant Projects (GPP)	35.0
4. Accelerator Improvement Projects (AIP)	55.0
Total other related annual funding requirements	$ 380.0**

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

**To be updated when SSC Laboratory completes analysis of annual funding requirements.

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 and Laboratory Support

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. Also includes costs of laboratory technical support, administrator services and management costs.

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

2. Other Project Costs (continued)

(b) Pre-Operation Costs

Pre-Operations costs are projected for the operations of each injector accelerator system and collider sector until commissioning of that element is completed. The successive completion of the Linac, LEB, MEB, and HEB injectors is forecast beginning in FY 1994. The costs for pre-operations include manpower, materials, power, and utilities associated with the commissioning of each accelerator system. Operating costs of technical systems beyond the completion of commissioning are to be covered outside of the TPC, as are general laboratory operating costs not directly related to the construction project.

(c) Initial Complement of Detectors

The baseline provides an allowance of $910 million of US funds for the initial complement of detector systems for the SSC, for detector R&D and for computing requirements. Anticipated foreign participation will enhance the capability of the initial detectors.

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.