

# A Bridge Too Far

The Demise of the Superconducting Super Collider

Michael Riordan

*UC Santa Cruz, Emeritus*

CERN Colloquium

27 October 2016

# Large Projects in High-Energy Physics

## Stanford Linear Accelerator Center

- construction 1961 to 1966
- \$114 million (~ 550 million 1990\$)
- **Wolfgang Panofsky**, SLAC Director

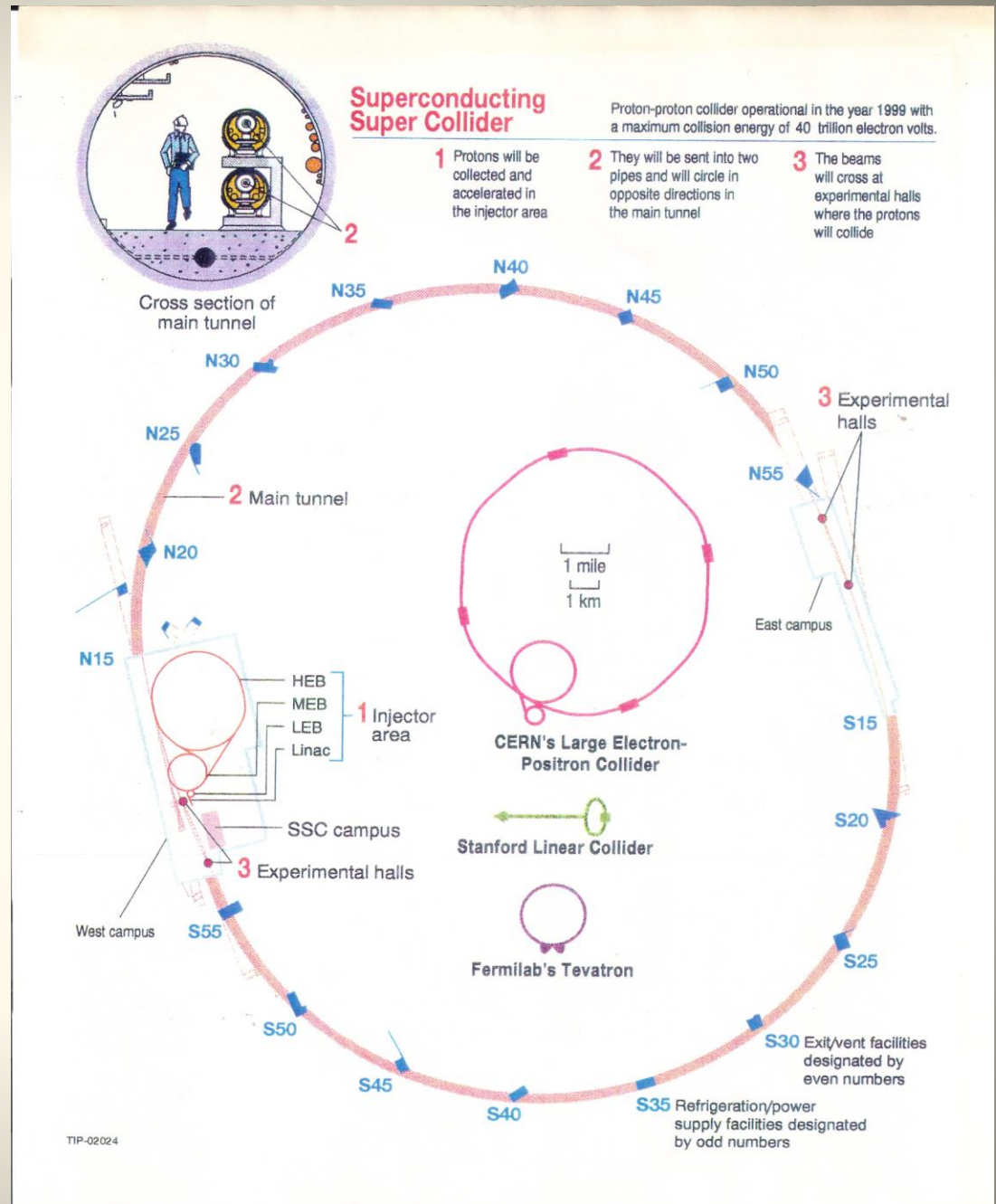
## Fermi National Accelerator Laboratory

- construction 1968 to 1972
- \$243 million (~ 750 million 1990\$)
- **Robert Wilson**, Fermilab Director

## CERN Large Electron Positron Collider

- construction 1983 to 1989
- 910 million Swiss francs\* (budgeted)
- about \$550 million at 1.65 CHF/\$
- **Herwig Schopper**, CERN Director General
- Emilio Picasso, LEP Project Manager

\*external costs of equipment only, as projected, in 1983 Swiss francs. They eventually exceeded 1 billion CHF.



“In all failures, the beginning is  
certainly half the whole.”

— George Eliot, *Middlemarch*



George A. Keyworth, “Science in a New Era of Competition”

*Science*, Vol. 217, No. 4560 (August 13, 1982), pp. 606-609.

“Today they [Brookhaven, Fermilab and SLAC] are starved into a state of near intellectual malnutrition.”

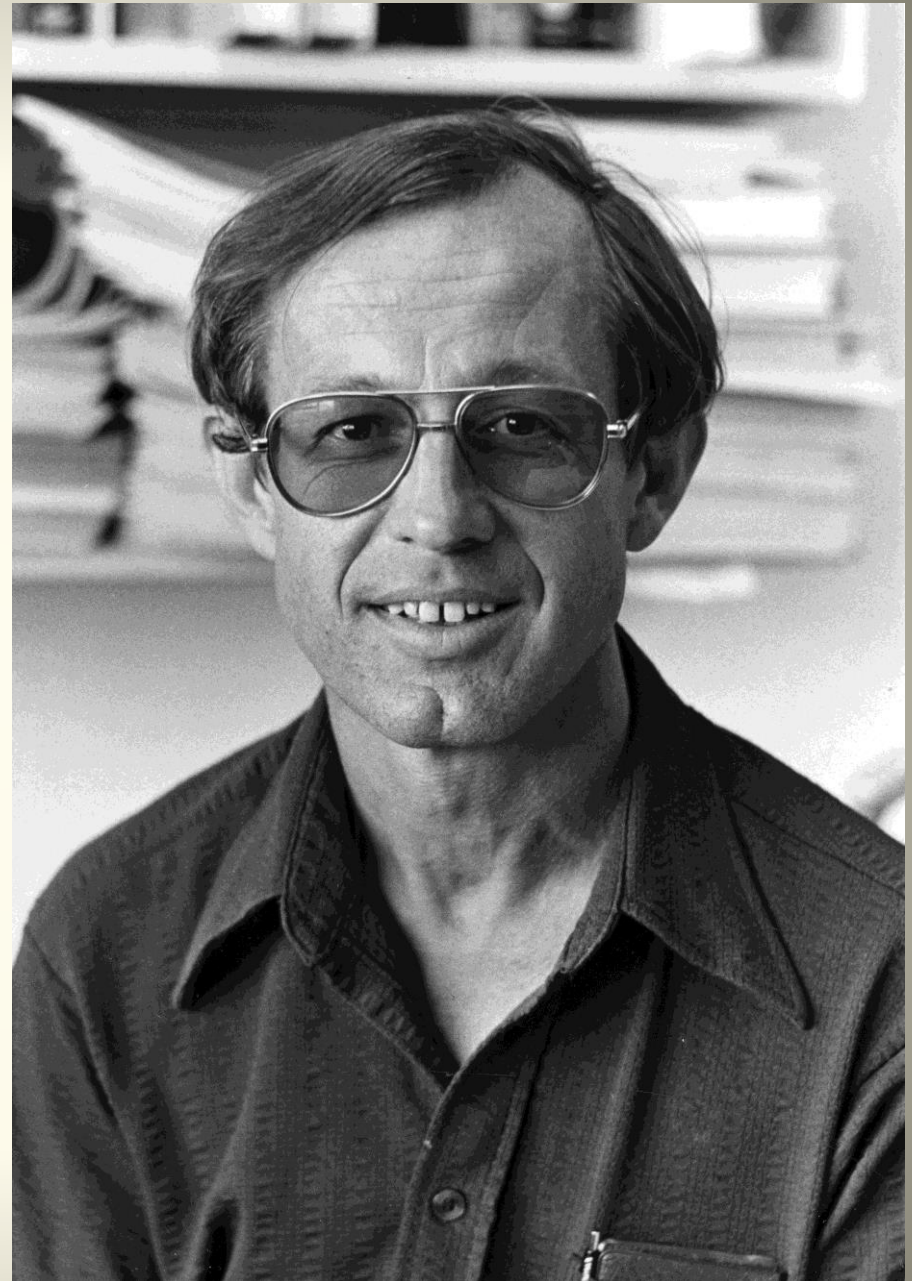


# Wojcicki Subpanel Recommendations

July 1983

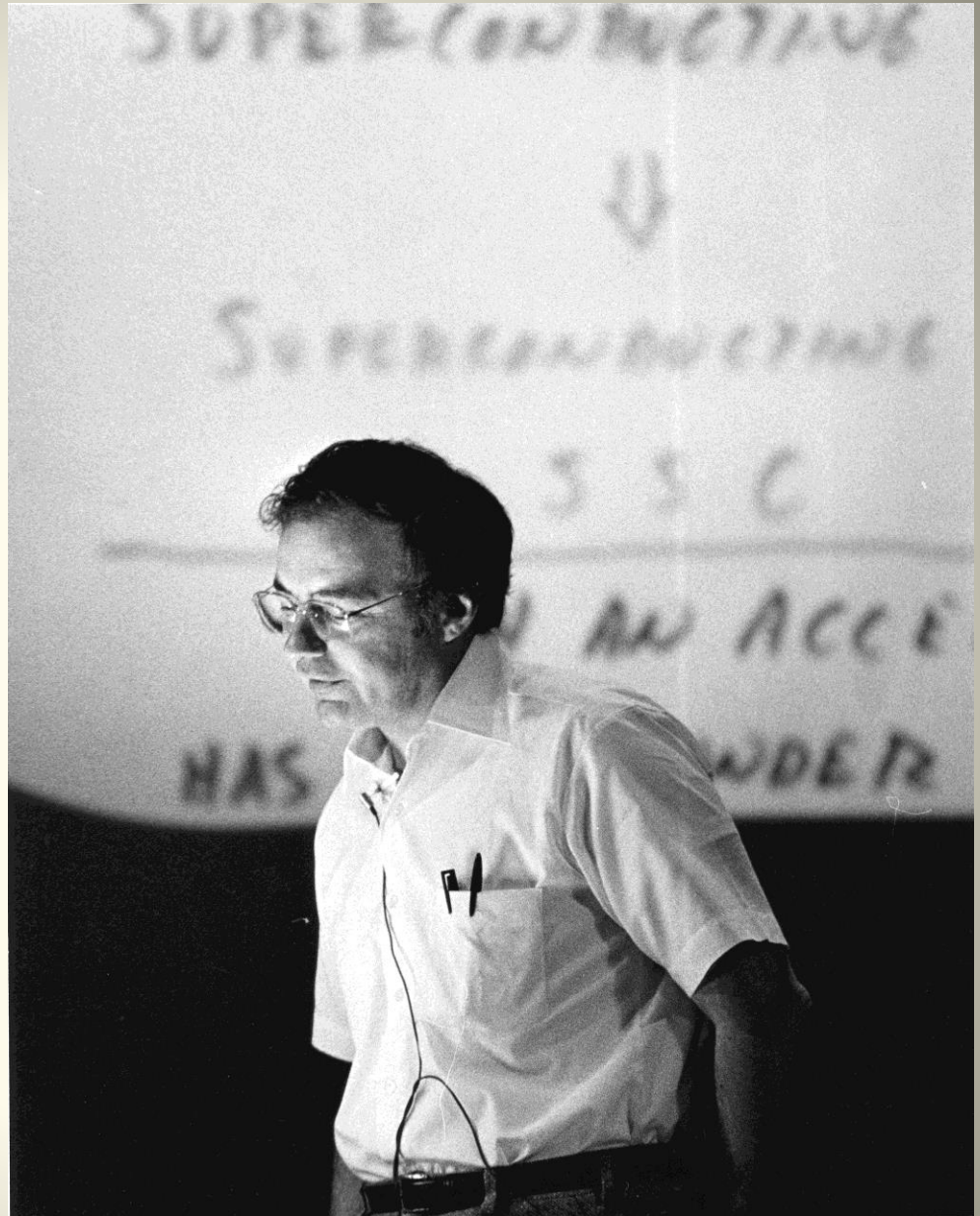
- Build a new accelerator called the “Superconducting Super Collider” at a US site, roughly 30 km in diameter, with proton beam energies of 10-20 TeV and luminosity up to  $10^{33} \text{ cm}^{-2}\text{s}^{-1}$  at a cost estimated at  $\sim \$2$  billion.
- Complete both the Tevatron at Fermilab and SLC at SLAC; upgrade the Cornell Electron Storage Ring.
- Support accelerator technology research and development.
- Terminate the CBA/Isabelle project at Brookhaven.\*

\* not unanimously, but by 10-7 vote



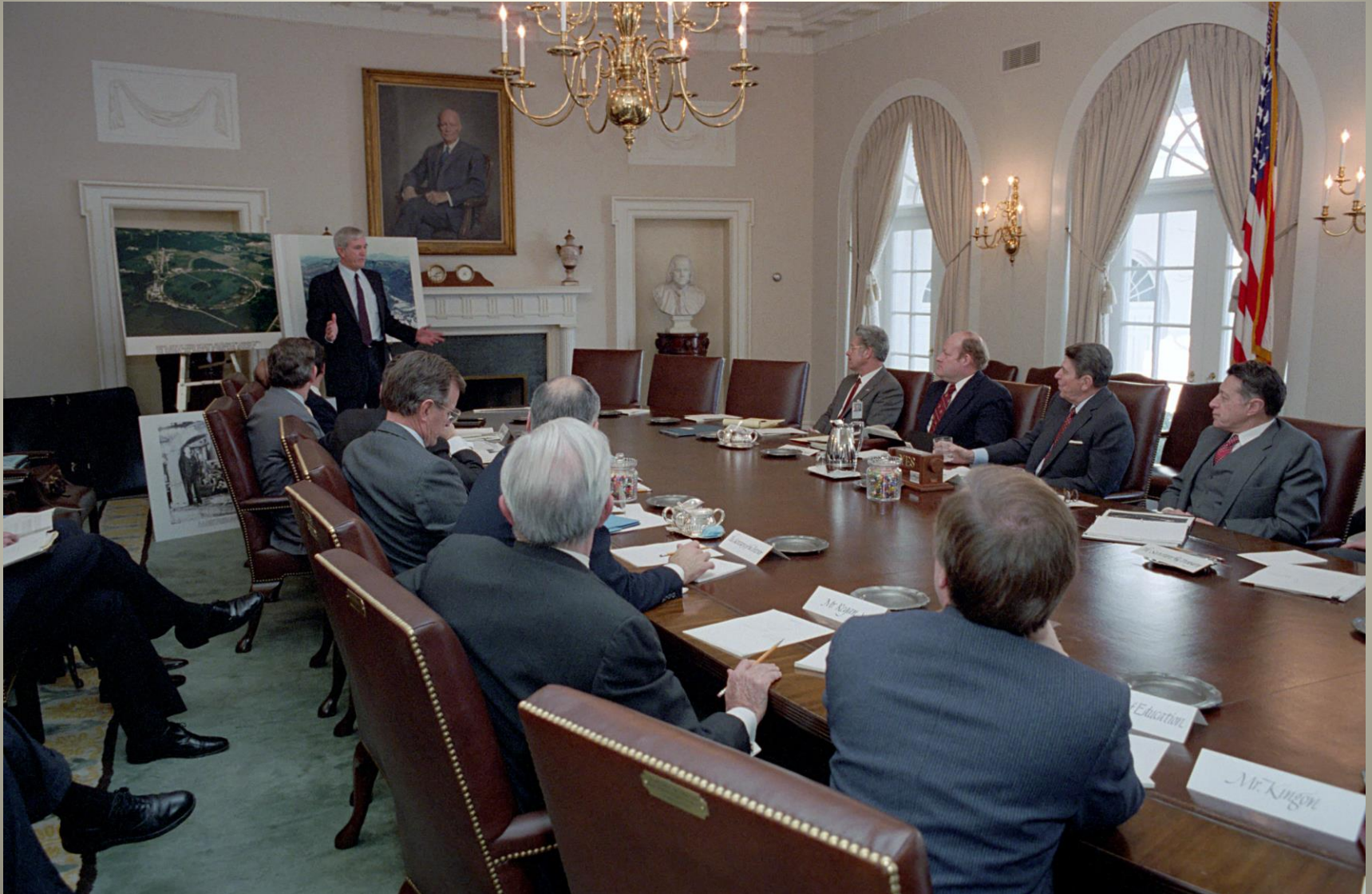
# Superconducting Super Collider Conceptual Design

- Developed 1984-1986 by the SSC Central Design Group led by [Maury Tigner](#)
- 40 TeV proton collider with luminosity  $10^{33}\text{cm}^{-2}\text{s}^{-1}$
- Report delivered to the DOE on April 1, 1986
- \* Total estimated cost was \$3.01 billion (1986 dollars), excluding R&D, detectors, computers, commissioning
- Estimate based on 8600 superconducting dipoles, 52 mile circumference, and a 1 TeV proton injector
- **Magnet apertures 4 cm**





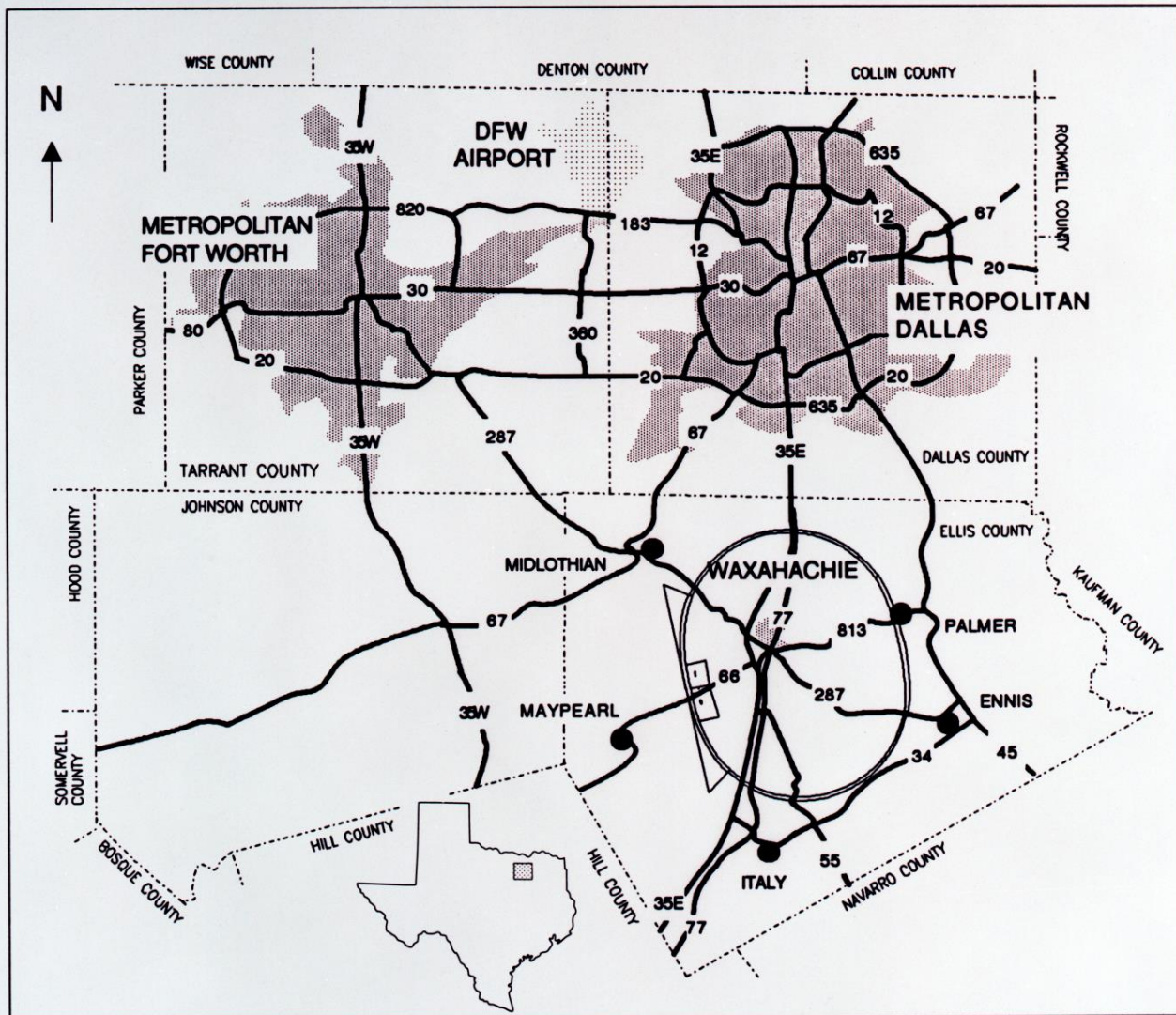
# Domestic Policy Council meeting, January 29, 1987



“The United States has a long history of collaborative research efforts with other friendly nations. But this is an American Project, American leadership. We are going forward with it.”

— Energy Secretary John Herrington  
January 30, 1987





XBL 891-256

## The Winning SSC Site: Waxahachie, Texas

- Judged “excellent” or “good” on all six DOE site criteria
- Illinois/Fermilab received a “poor” rating on Setting

## The Proposed URA Team\*

### Universities Research Association, Inc.

- non-profit corp. of ~ 80 universities
- corporate offices in Washington, DC
- had managed Fermilab since 1968

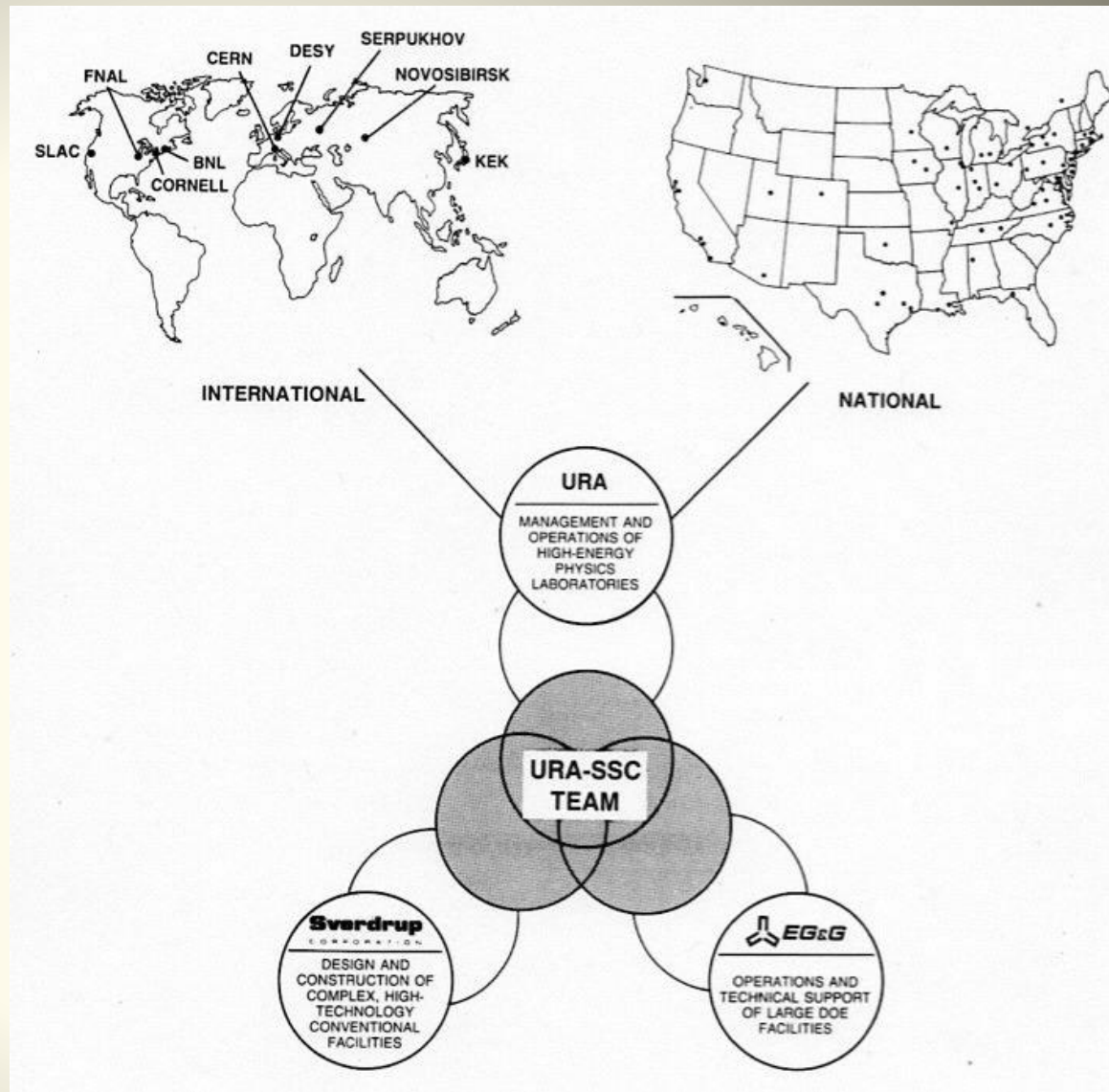
### Sverdrup Corporation, St. Louis

- construction management firm
- Trident Submarine Base, Georgia
- Baltimore Harbor Tunnel

### EG&G, Inc., Boston

- operations management firm
- Idaho Engineering Laboratory
- Nevada Test Facility

\* from URA SSC Management and Operations Proposal, November 1988



# Proposed SSC Leadership, November 1988

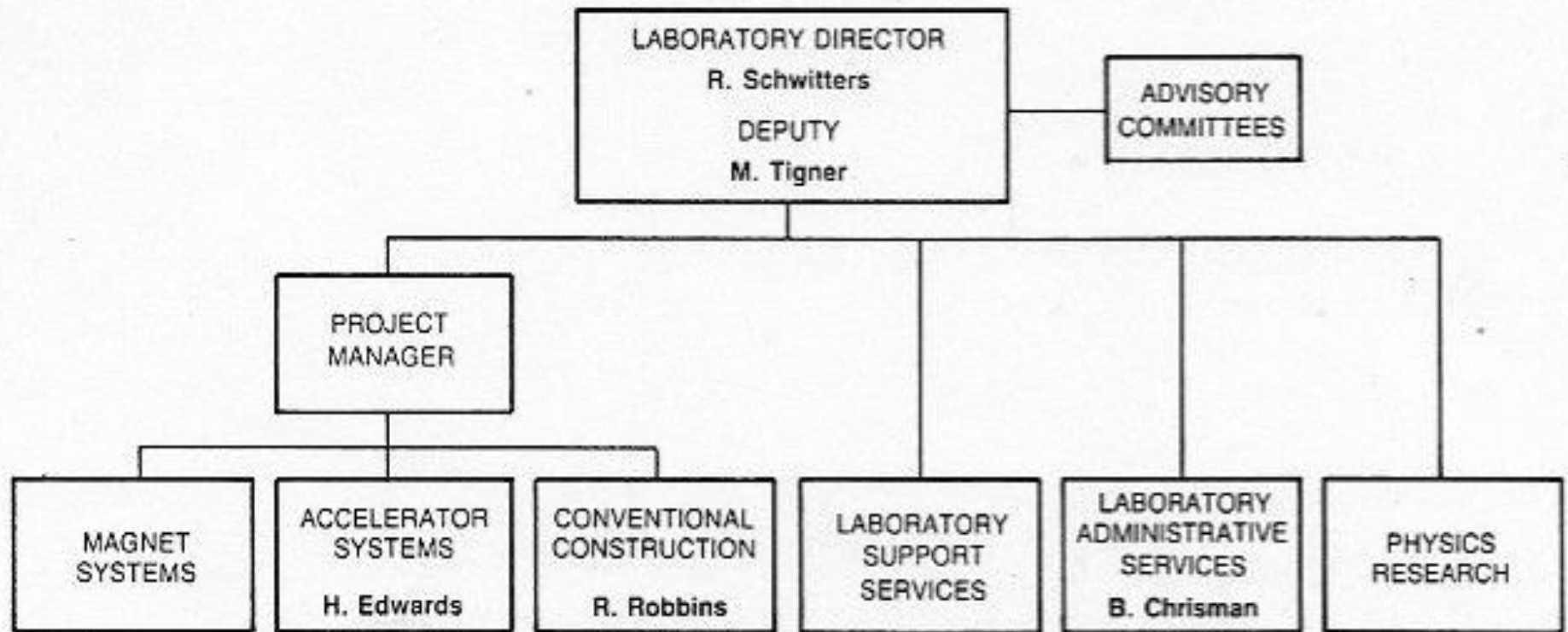
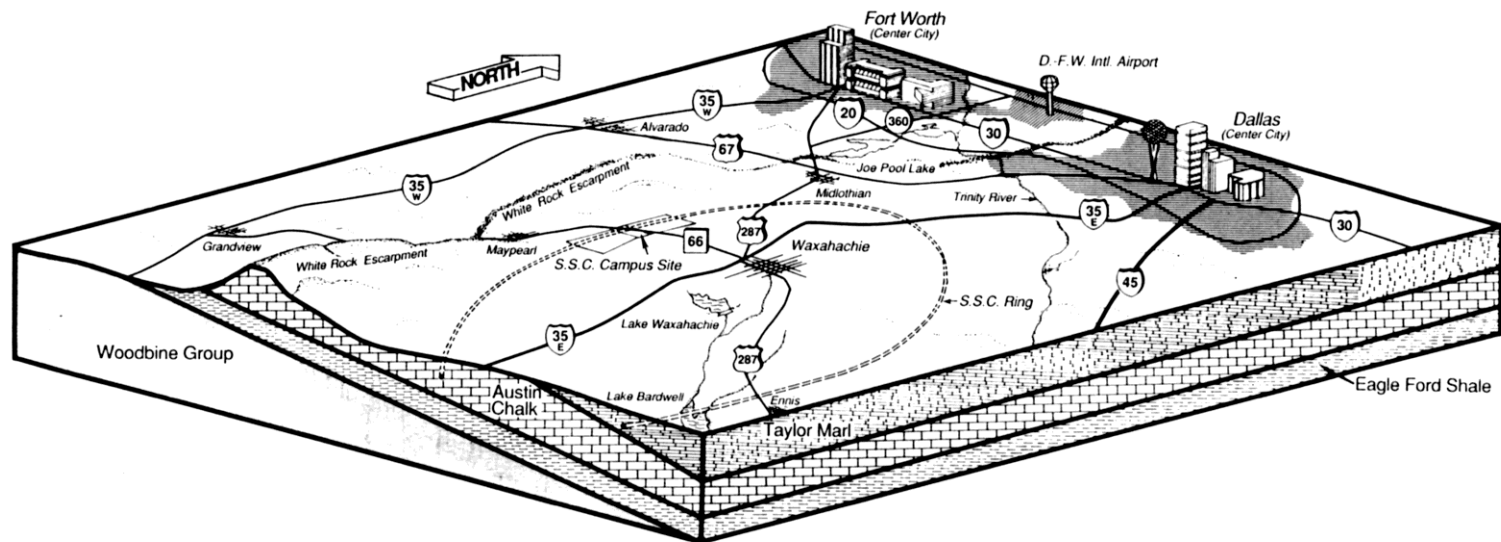
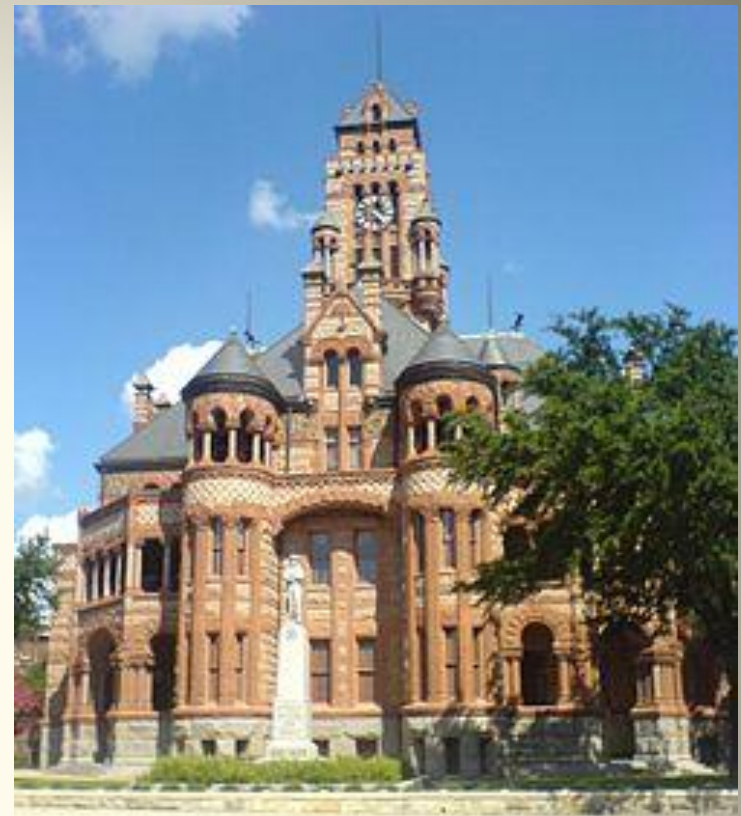


Figure 3.5-1. URA-SSC Laboratory organization.



# Roy Schwitters at Waxahachie Site



# Site-Specific Design Changes

- Site-specific design team led by [Helen Edwards](#)
- Dipole magnet aperture increased from 4 cm to 5 cm\*
- High Energy Booster energy increased from 1 TeV to 2 TeV
- Dipole magnet length to be reduced from 17.4 m to 15.8 m
- Number of dipole magnets increased from 8600 to 8800
- Main ring circumference increased from 52 to 54 miles
- Estimated cost increase: \$1-2 billion, including other items

\* but quadrupole magnet aperture curiously remained at 4 cm???



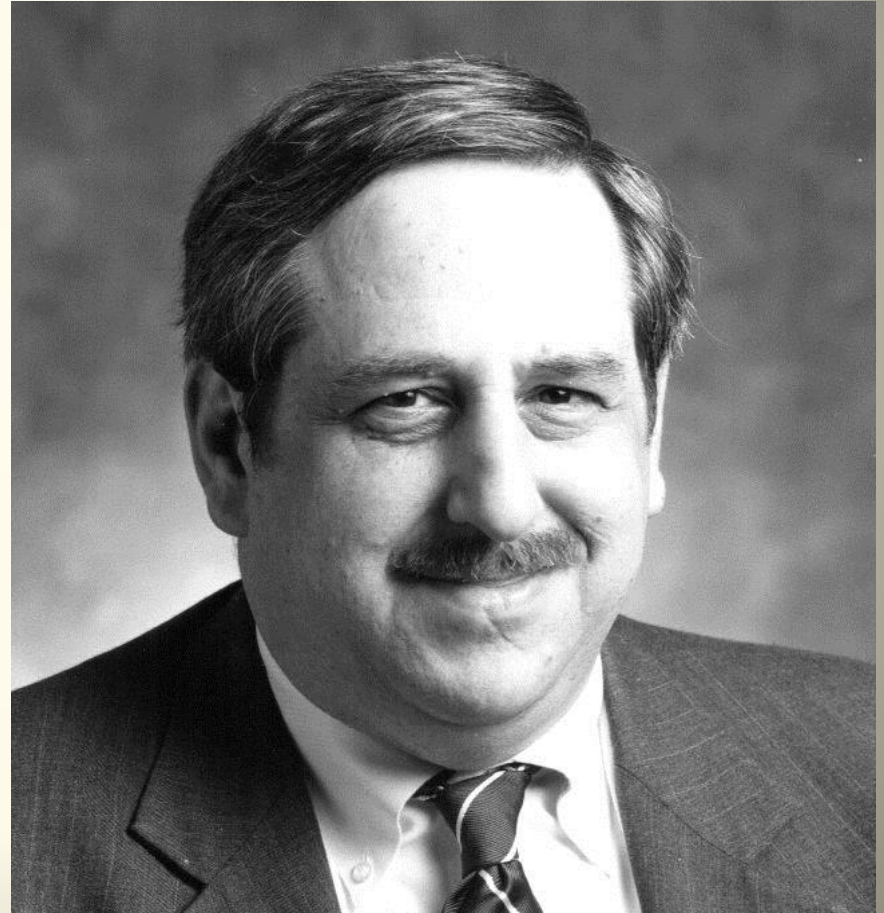


# A Little Help from the Nuclear Navy

Admiral James A. Watkins



Edward J. Siskin, P.E.





# Edward J. Siskin, SSC General Manager

- B.S. degree, Electrical Engineering, Univ. Pennsylvania, 1963
- Naval Reactors Division, Atomic Energy Commission, 1970-84
  - reported to Admiral Hyman G. Rickover
  - knew Admiral Watkins from this experience
- Executive Vice President, Stone & Webster Corp.\*, 1984-89
  - responsible for S&W operations in southeastern United States
  - included all S&W nuclear work and chemical plant safety work
- Registered Professional Engineer in Electrical, Mechanical, Chemical, Civil and Nuclear Engineering

\* Stone & Webster served as Oak Ridge construction manager during WWII.

# Memorandum to the Secretary of Energy

— September 14, 1990

"The URA position at the meeting was that it was unacceptable to them to have the AE/CM contract broken out and that while they admitted there were problems, they saw no advantage to changing their current management structure. They were very firm in their position that all aspects of the Lab had to report to the Laboratory Director or the scientific community would feel they were cut out of the process."

— Joseph Cipriano,  
Director, DOE Site Office



Department of Energy  
SSC Project Office  
2550 Beckleymeade, Mail Stop 1020  
Dallas, Texas 75237-3946

September 14, 1990

## MEMORANDUM FOR THE SECRETARY OF ENERGY

The following is my independent assessment of significant SSC events during the past two weeks:

a. MDL is still on track for ground breaking on 3 October and beneficial occupancy by 1 April 1991. We are identifying a large number of shortfalls in planning and process as we proceed but have enough brute force applied to get it done. I am trying to get the Lab to focus on the process and planning problems so we can get them fixed in time to support FY 91 construction. The

since a

This is taking up a lot of my time and yet I cannot report great progress.

b. Mort Meyerson called a meeting between me, Johnny Toll, Roy, the URA Board of Overseers, and some TNRLC members. Mort agrees with our assessment that the Project Manager needs to be elevated in status at the Lab and we have to do something to get our arms around the conventional construction problem quickly. He feels so strongly about this that he said he had told the Governor of Texas that he believed the project would fail if it were not fixed and announced that Texas would not pay more than a pro rata share of project costs until it was resolved. Since we are counting on Texas for significant up front funding, this is an issue that must be resolved. The URA position at the meeting was that it was unacceptable to them to have the AE/CM contract broken out and that while they admitted there were problems, they saw no advantage to changing their current management structure. They were very firm in their position that all aspects of the Lab had to report to the Laboratory Director or the science community would feel they were cut out of the process. Mort and I both felt there was little successful communication at the meeting that lasted four hours.

c. In my opinion, the current Lab structure would work in either . Thus a change in is indicated before we get to much further. who has



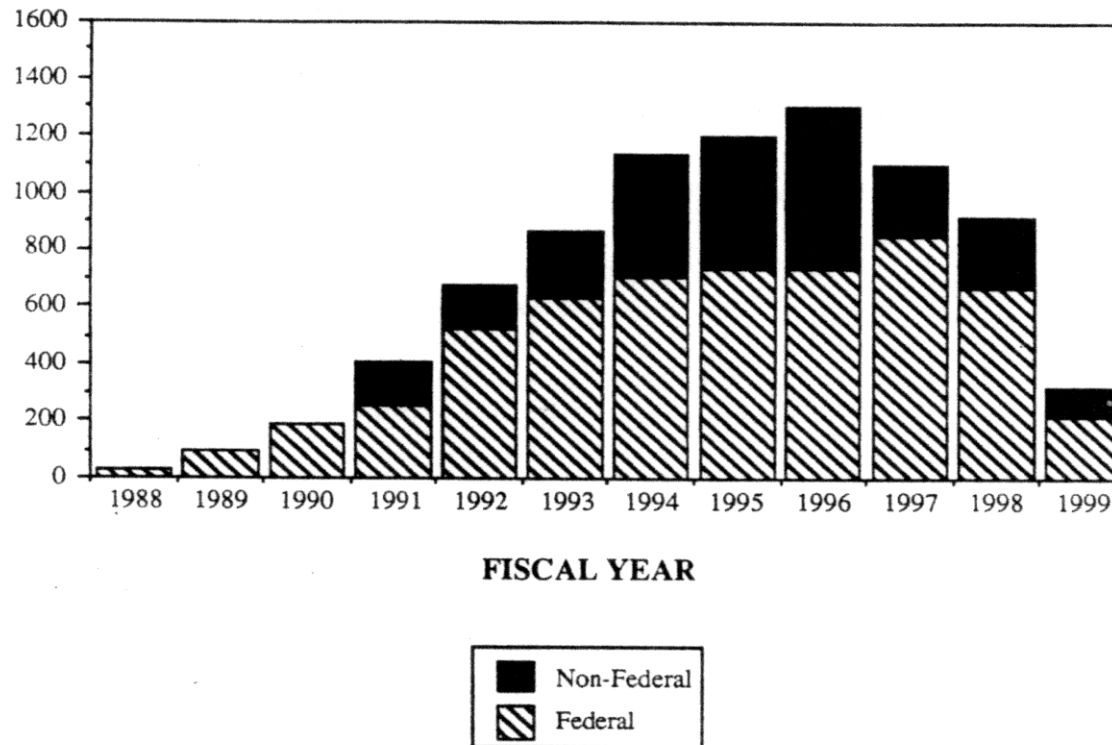
2 9/19 Henon-

NUTS

NO

1 Agree

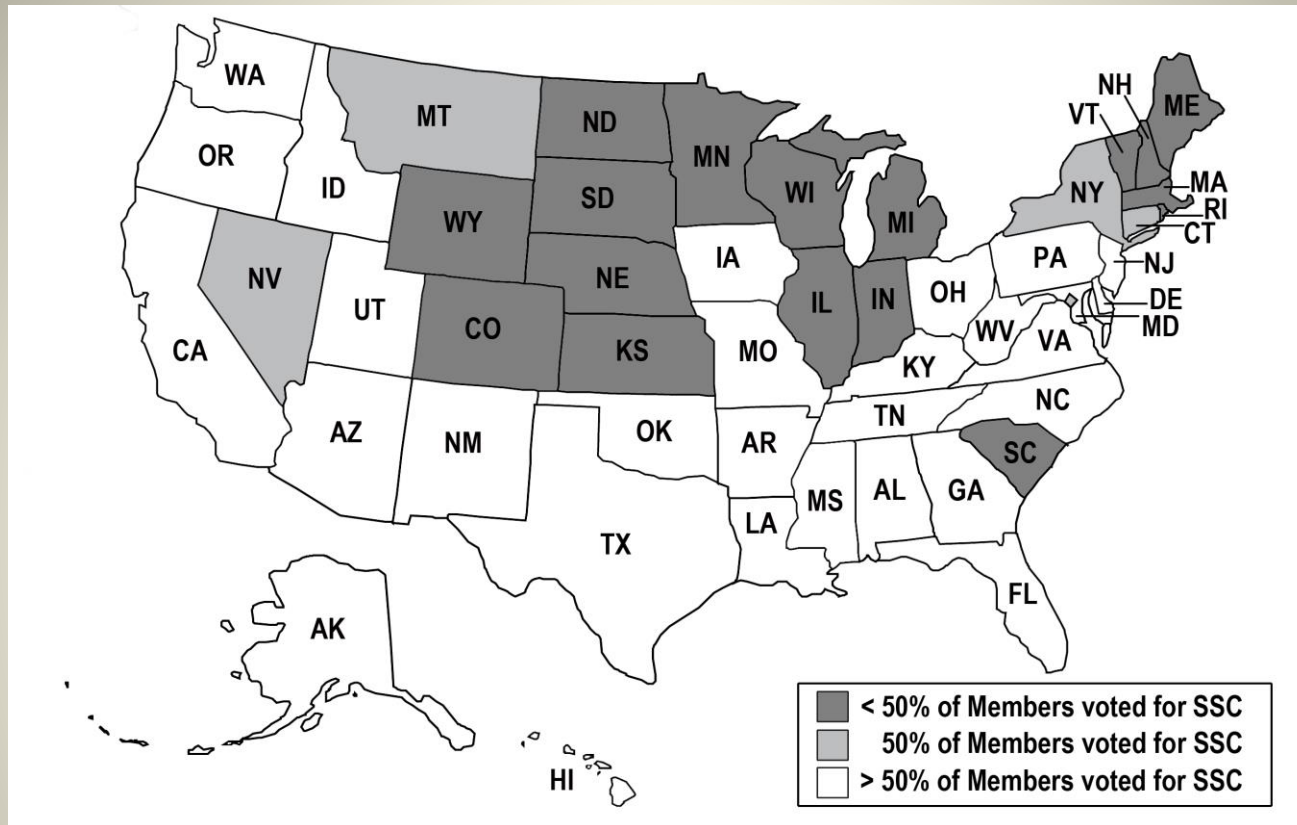
## SSC Baseline Funding Profile (Millions of As-Spent Dollars)



**Total Estimated Cost of the SSC, 1991: \$8.25 billion**

- based on 40 TeV Main Ring with 5 cm dipole apertures and 2 TeV injector
- includes lab infrastructure, detectors, computers, contingency and inflation





## May 1991 House Vote: A seemingly comfortable victory margin

Slattery Amendment to kill the SSC defeated by 251 by 165.

But note rough North vs. South, Rust Belt vs. Sun Belt voting pattern.

# The SSC Project Manager Parade:

- N. Douglas Pewitt (acting), March to October 1989  
— former high government official in OMB, DOE and OSTP
- Richard J. Briggs, October 1989 to March 1990  
— project manager on LLNL induction accelerator (~ \$100 M project)
- N. Douglas Pewitt (acting), March to May 1990
- Theodore Kozman (acting), May to September 1990  
— LLNL/LBL mechanical engineer, headed SSC Accelerator Systems Div.
- Paul Reardon, September 1990 to December 1991  
— former Fermilab Business Manager, BNL Associate Director (RHIC)
- John Rees, January 1992 to October 1993  
— project manager on SLAC PEP and SLC colliders (~ \$100 M projects)

“Congressional support for the Super Collider is a mile wide and an inch deep.”

— NY Congressman Sherwood L. Boehlert



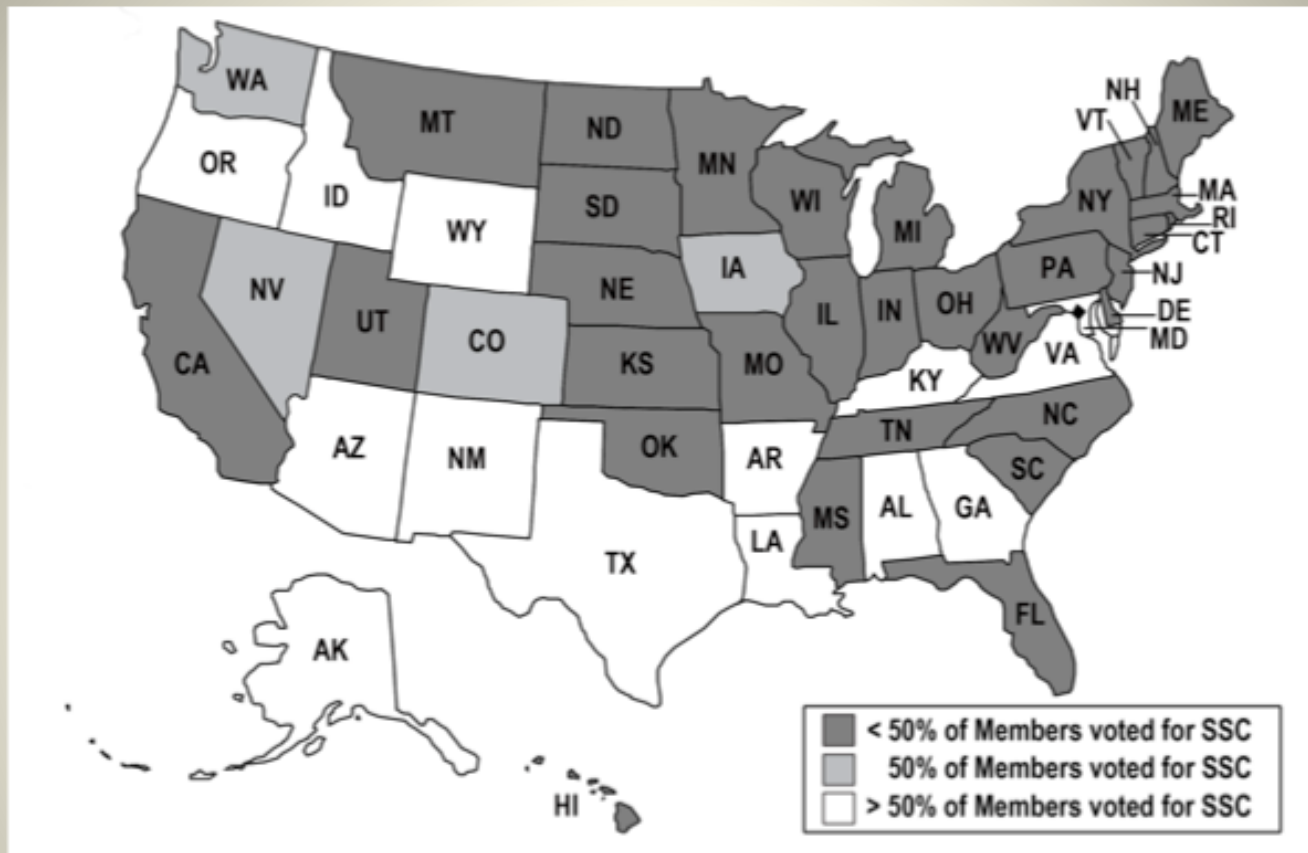
# House Leaders of the SSC Opposition

Sherry Boehlert, R-NY



Jim Slattery, D-KS



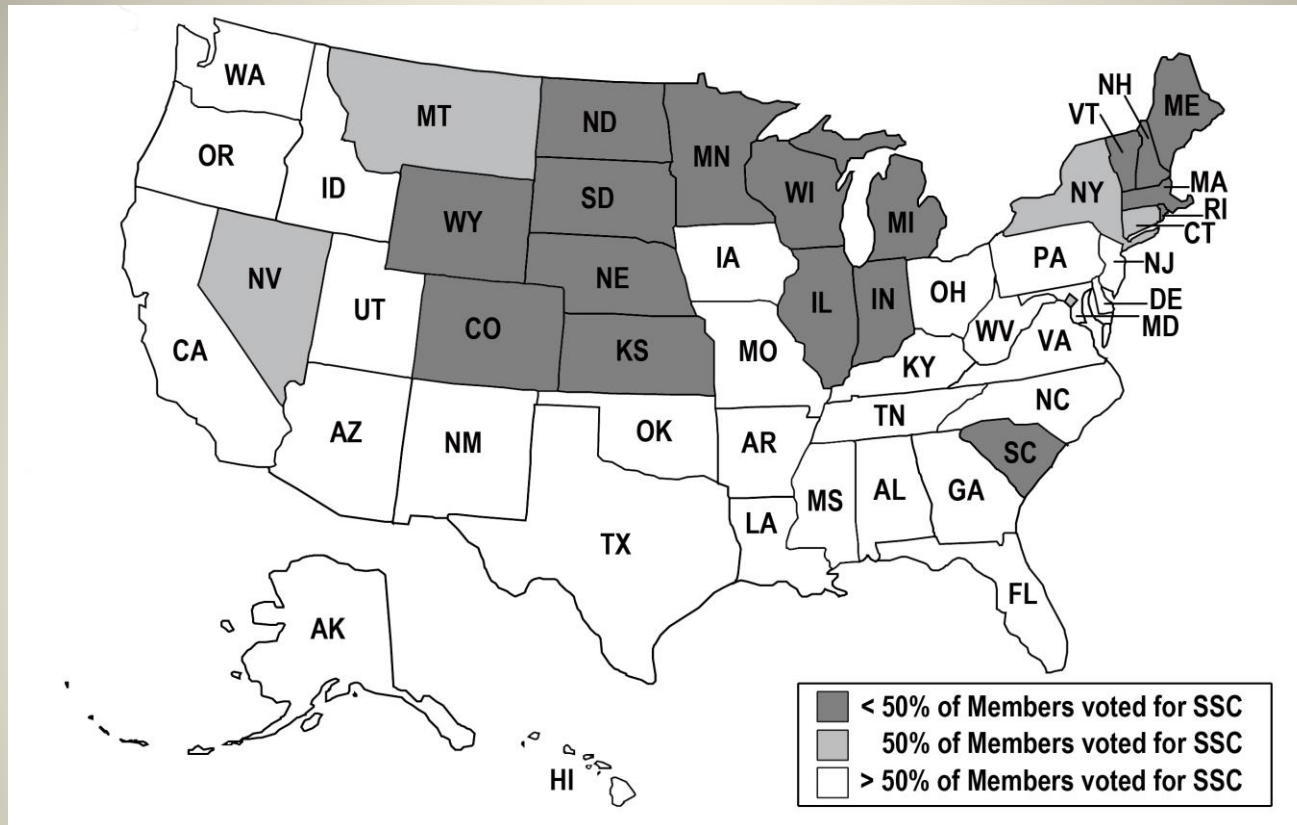


## June 1992 House Vote: Lightning Strikes the SSC

Vote Margin Was 232 to kill the SSC versus 181 to continue funding it.

Compare that with the 251 to 165 margin in favor of the project in 1991.

And this was essentially the same House members voting both times.

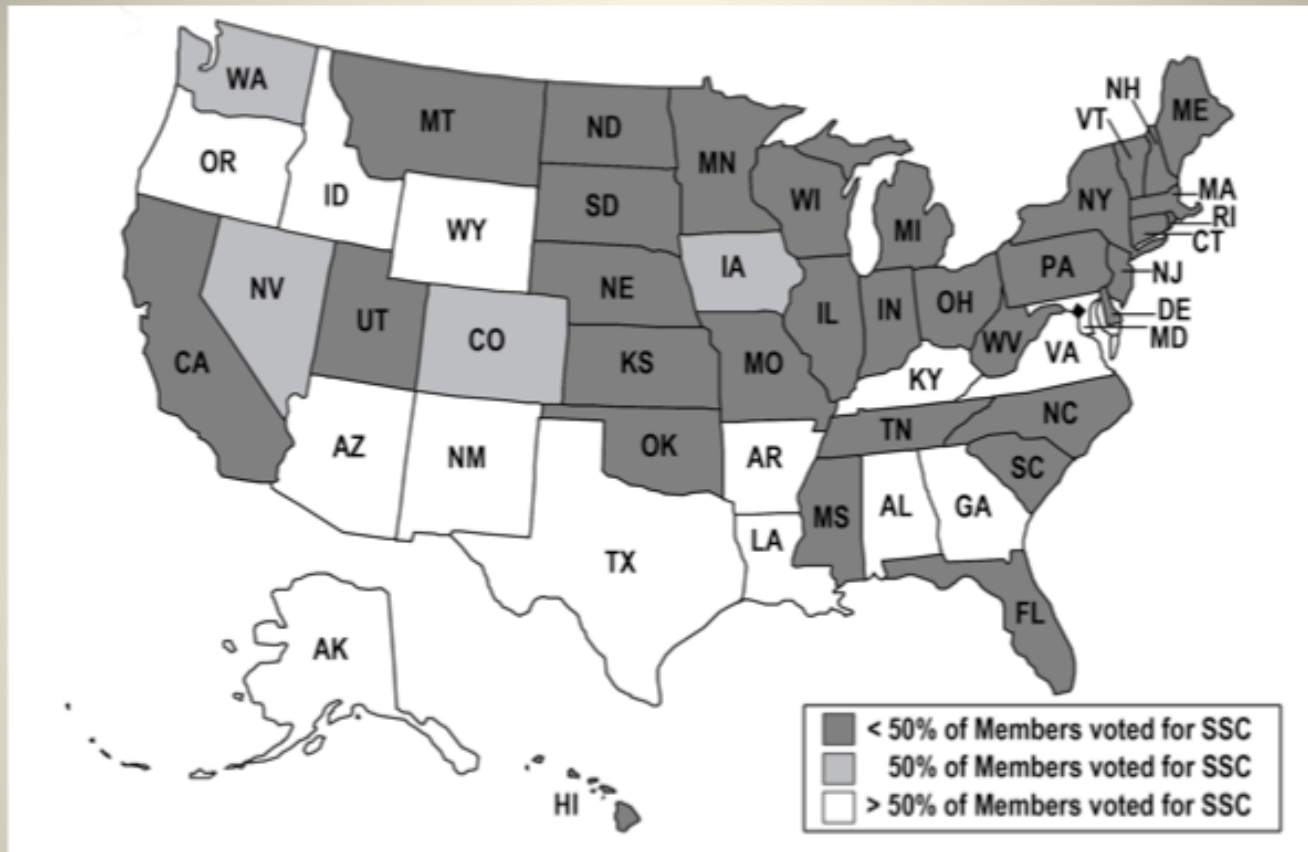


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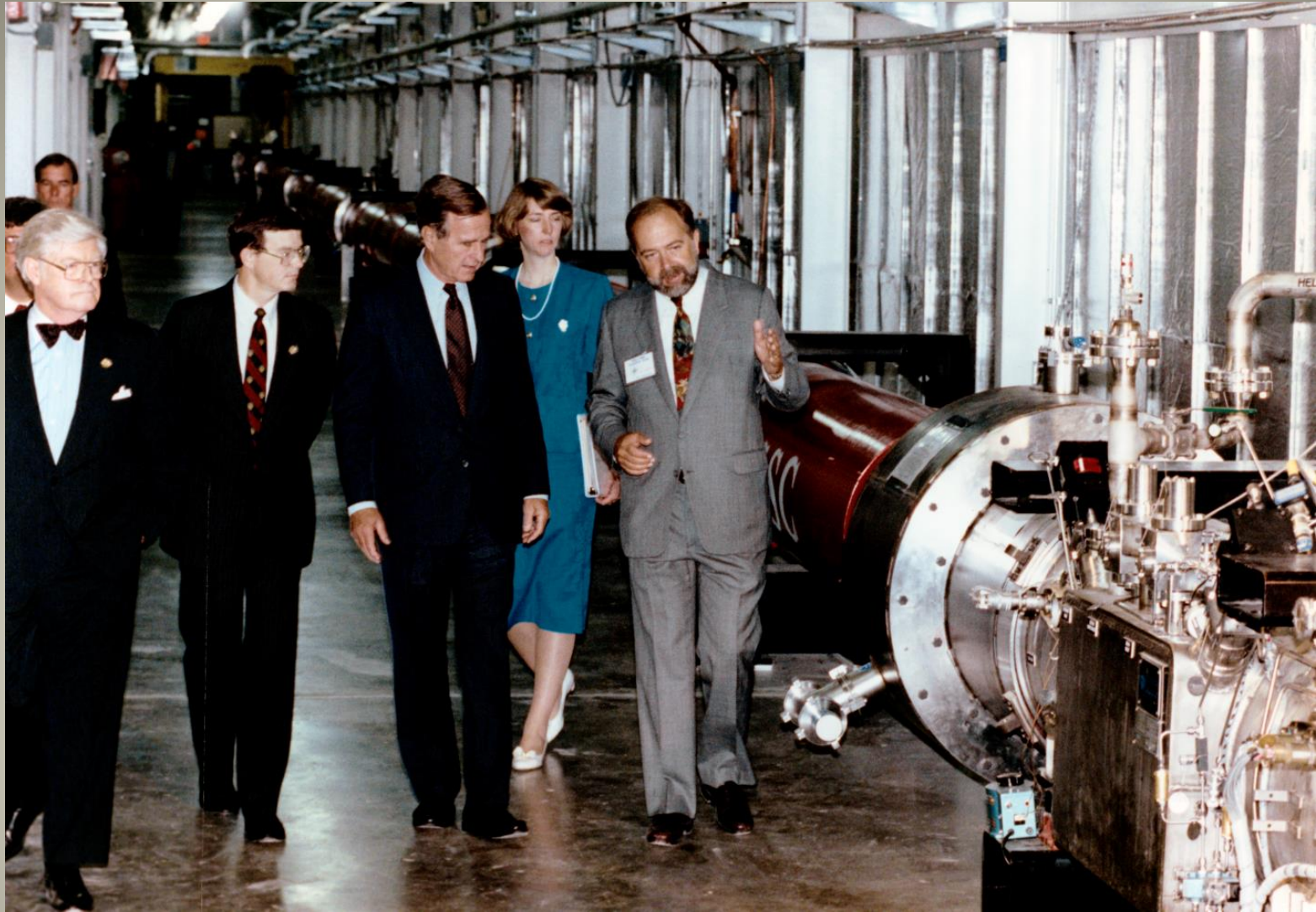
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“The SSC had become the poster child for Congressional pork”

— CA Congressman Leon E. Panetta



## President Bush Visits the SSC Lab, July 30, 1992

To Bush's right are Presidential Science Advisor Allan Bromley and Congressman Joe Barton (R-TX) of the Ennis district ; to his left are Deputy Undersecretary of Energy Linda Stuntz and Roy Schwitters.



## Senator J. Bennett Johnston at SLAC in 1992





# SSC North Campus and Tunnel, Early 1993





# Clinton-Miyazawa Press Conference, April 16, 1993





# Todd Stern/John Podesta Memo for Mack McLarty\*

March 18, 1993

“NSC raised objections to sending a letter the first time DOE proposed it, a couple of weeks ago. NSC agrees that we should convey to the Japanese our firm backing for the SSC, but still objects strongly to sending a letter to Miyazawa. Such a letter would be seen as suggesting that we attach greater importance to Japanese participation in the SSC than we do to Japanese efforts on other fronts, *such as aid to Russia.*” [italics added]

NSC = National Security Council

\* Clinton's First Chief of Staff

March 18, 1993

## MEMORANDUM FOR MACK MCLARTY

FROM: TODD STERN  
JOHN PODESTA

SUBJECT: Hazel O'Leary/Superconducting Supercollider

This is an update on Hazel O'Leary's note to you and memo recommending that a letter be sent to Prime Minister Miyazawa of Japan seeking Japanese support for the Superconducting Super Collider (SSC). The memo argues that the SSC will die on the Hill unless Members are convinced of Japanese support; and that the Japanese won't commit until they are assured of solid Administration backing for the project.

NSC raised objections to sending a letter the first time DoE proposed it, a couple weeks ago. NSC agrees that we should convey to the Japanese our firm backing for the SSC, but still objects strongly to sending a letter to Miyazawa. Such a letter could be seen as suggesting that we attach greater importance to Japanese participation in the SSC than we do to Japanese efforts on other fronts, such as aid to Russia. In addition, Ambassador Armacost believes that a letter at this time would not be a productive way to proceed with the Japanese. NSC believes that we can send the Japanese clear, effective signals of our support for the SSC in other ways.

Legislative Affairs agrees with O'Leary that getting the Japanese on board is important for the SSC's viability on the Hill, but agrees with the NSC that a presidential letter is not necessary.

NSC is now talking with DoE to work out an agreed approach.

Our recommendation would be to let the process go forward in this manner rather than forwarding Secretary O'Leary's memo to you up to the President at this time, but if you have a different view on this, please let us know.

## SSC Cost Growth, 1982-93

Snowmass meeting, 7/82: \$1–3 billion

Wojcicki panel, 6/83: \$1.4–2.2 billion

Conceptual design, 4/86: \$3.01 billion\*

Reagan endorsement, 1/87: \$4.5 billion

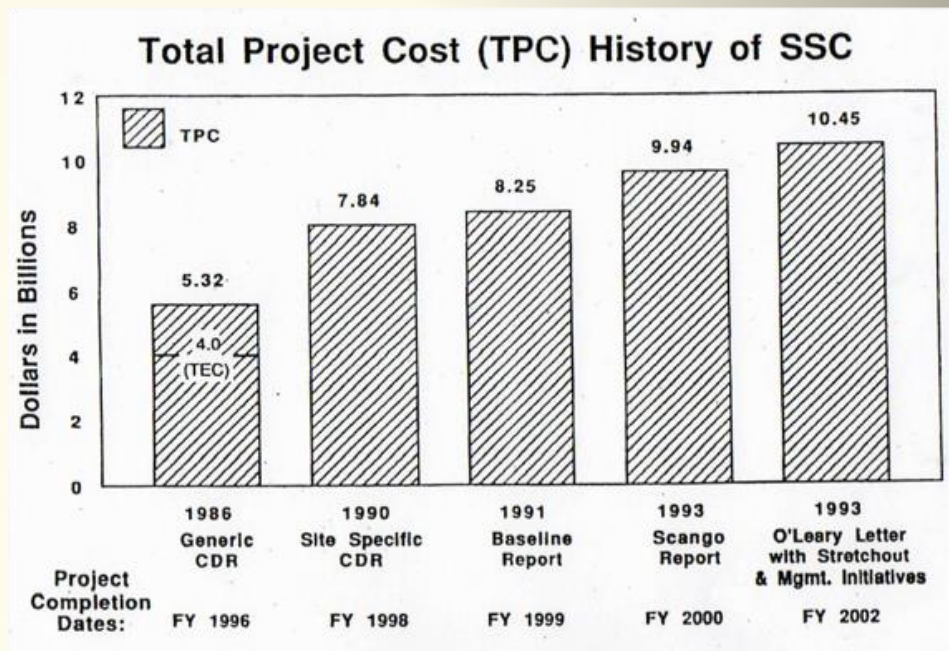
Congress approval, 9/89: \$5.9 billion

SSC “Green Book,” 2/91: \$8.25 billion

Scango report, 8/93: \$9.94 billion\*\*

\* collider cost only, in 1986 dollars.

\*\* not including “Clinton stretch-out,”  
which would add over \$1 billion.









# Two Daunting Tasks for the SSC Leadership:

- Building the physical SSC infrastructure
- Establishing the human lab infrastructure

# The SSC: A Bridge Too Far

- The cost of the SSC project was grossly underestimated.
  - US physicists grabbed at Reagan's "Throw deep!" (or "Think big!")
  - but multibillion-dollar US projects require political compromises
  - didn't have "political capital" to sustain project for over a decade
- US turned its back on cooperative World Accelerator idea.
  - and there was a **fundamental flaw** in the SSC's founding rhetoric
  - by the 1980s, aligned nations had to be treated as *equal partners*
- The Cold War was ending and a new era about to begin.
  - US "civil security" (Kriger) no longer an important national priority
  - basic research funding in physical sciences leveling off or declining

**James W. Cronin\***  
**Dear Colleague Letter**

22 August 1988

“If the SSC is placed at a site other than Fermilab, we will be starting a fifth high energy laboratory. I believe it is a mistake to spread even more thinly the human resources and scarce operating funds that will be available to high energy physics. It is crucial for the future health of particle physics in the United States that the SSC be built at Fermilab.”

\* Nobel Laureate, physics

THE UNIVERSITY OF CHICAGO  
CHICAGO • ILLINOIS 60637  
THE ENRICO FERMI INSTITUTE  
5640 ELLIS AVENUE

312-702-7102

22 August 1988

Dear Colleague:

We all agree that if further progress is to be made in particle physics we must have a collider which can reach several TeV in the collisions of elementary constituents. Thus, for the future of particle physics in the United States, the proposed SSC is a scientific imperative. It would seem, however, that none of us should be overly concerned where the SSC will be located.

Until recently I also subscribed to this latter view, but now I feel strongly that the machine should be sited at Fermilab. For the past three years I have served on the Scientific Policy Committee of CERN. Being there I have come to realize that the Europeans have an enormous advantage in having only two high energy laboratories. Their concentration of facilities has produced impressive economies and a diversity of physics opportunities.

If the SSC is placed at a site other than Fermilab we will be starting a fifth high energy laboratory. I believe it is a mistake to spread even more thinly the human resources and scarce operating funds that will be available to high energy physics. It is crucial for the future health of particle physics in the United States that the SSC be built at Fermilab.

The construction schedule of the SSC will inevitably be lengthy. For the builders of the SSC it will be valuable to have the collider at a location where there is an existing laboratory with an active physics program. Fermilab is the natural place to make the next step in energy. There is enormous expertise and an existing infrastructure to get a start on the SSC without delay. During the SSC construction Fermilab will naturally remain a strong lab which is essential because of the necessity of TeV test beams for the SSC detectors.

If you agree with me on the importance of locating the SSC at Fermilab, please express this in a letter to Dr. Wilmot Hess, SSC Site Task Force, GTN, Office of Energy Research, US Department of Energy, Washington, DC 20545. Please do this promptly as the decision on the site is drawing near. I would also appreciate copies of any correspondence to the Department of Energy stimulated by this letter.

Sincerely yours,

*James W. Cronin*

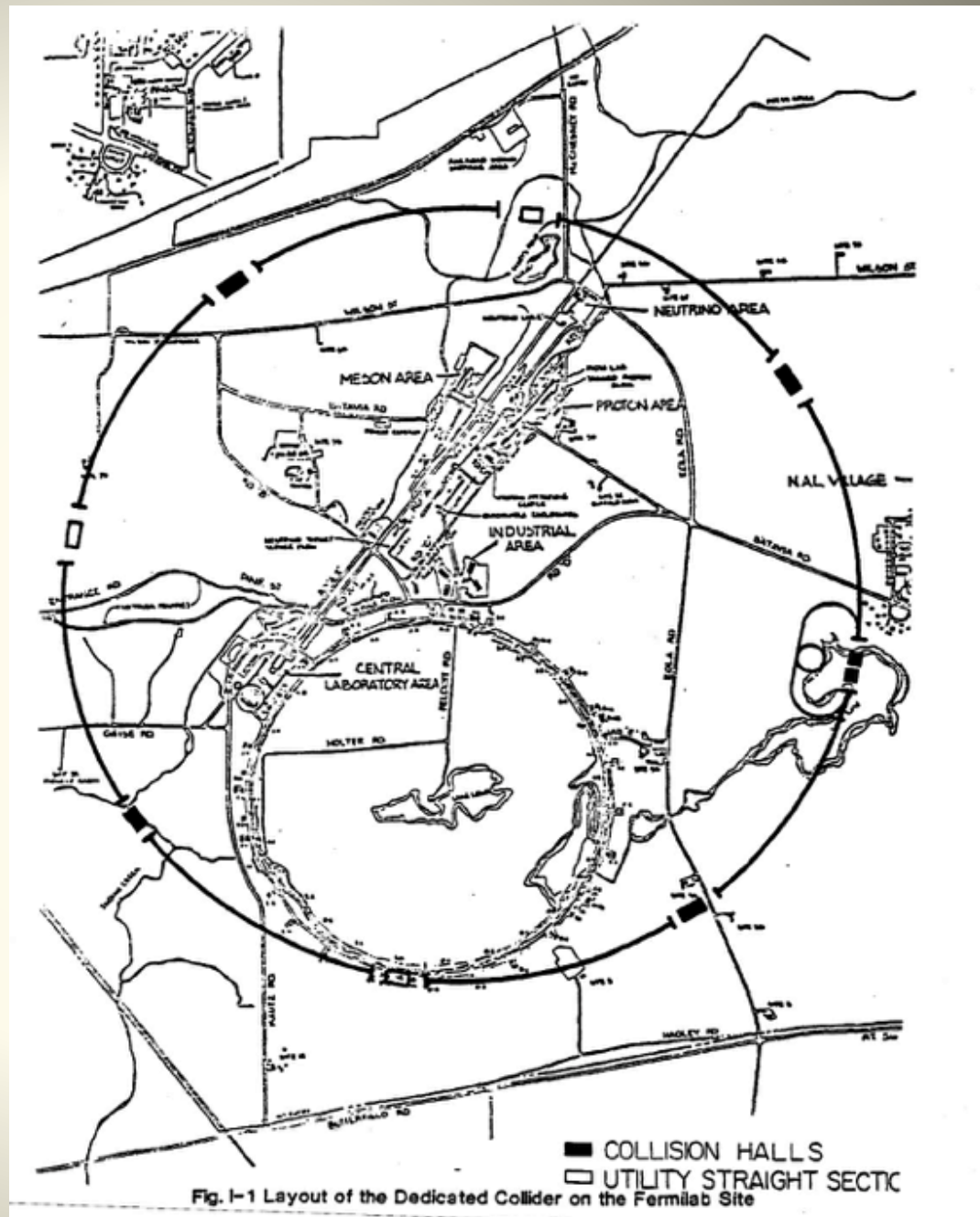
James W. Cronin  
Professor of Physics



# The Road Not Taken: Dedicated Collider at Fermilab

Proposal dated May 1983  
(to Wojcicki subpanel)

- 2 TeV on 2 TeV p-pbar collider
- luminosity over  $10^{31} \text{ cm}^{-2}\text{s}^{-1}$   
(without any Main Injector added)
- could be built *completely within* the existing Fermilab site boundary, thus avoiding local opposition.
- to use recently successful Tevatron superconducting magnet technology
- total project cost less than \$1 billion
- but Wojcicki subpanel deemed this collider insufficient to study the TeV energy scale (for proton constituents)

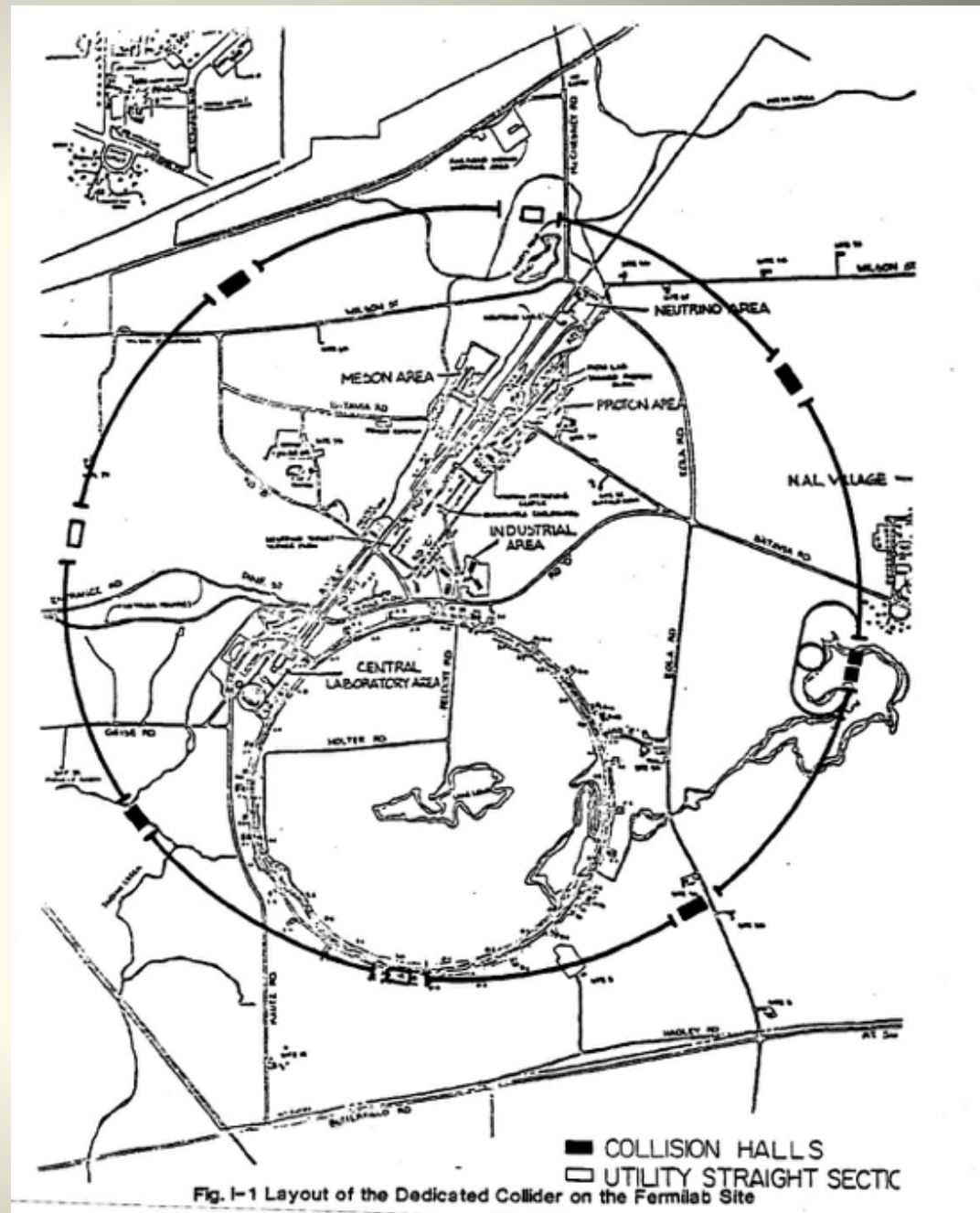


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- total project cost less than \$1 billion
- but this machine upgradable to a 6 TeV proton-proton collider with a luminosity of  $10^{33} \text{ cm}^{-2}\text{s}^{-1}$  using SSC superconducting magnets (Lee Teng, March 1988)

Could such a Dedicated Collider have discovered the 125 GeV Higgs boson?



“There comes a point when the magnitude of the project is so large that the chance of success on a strictly national basis is less than on a genuinely collaborative basis despite the difficulties and compromises the latter implies.”

— John M. Deutch, May 1984  
Memo to SSC Board of Overseers



# Tunnel Visions

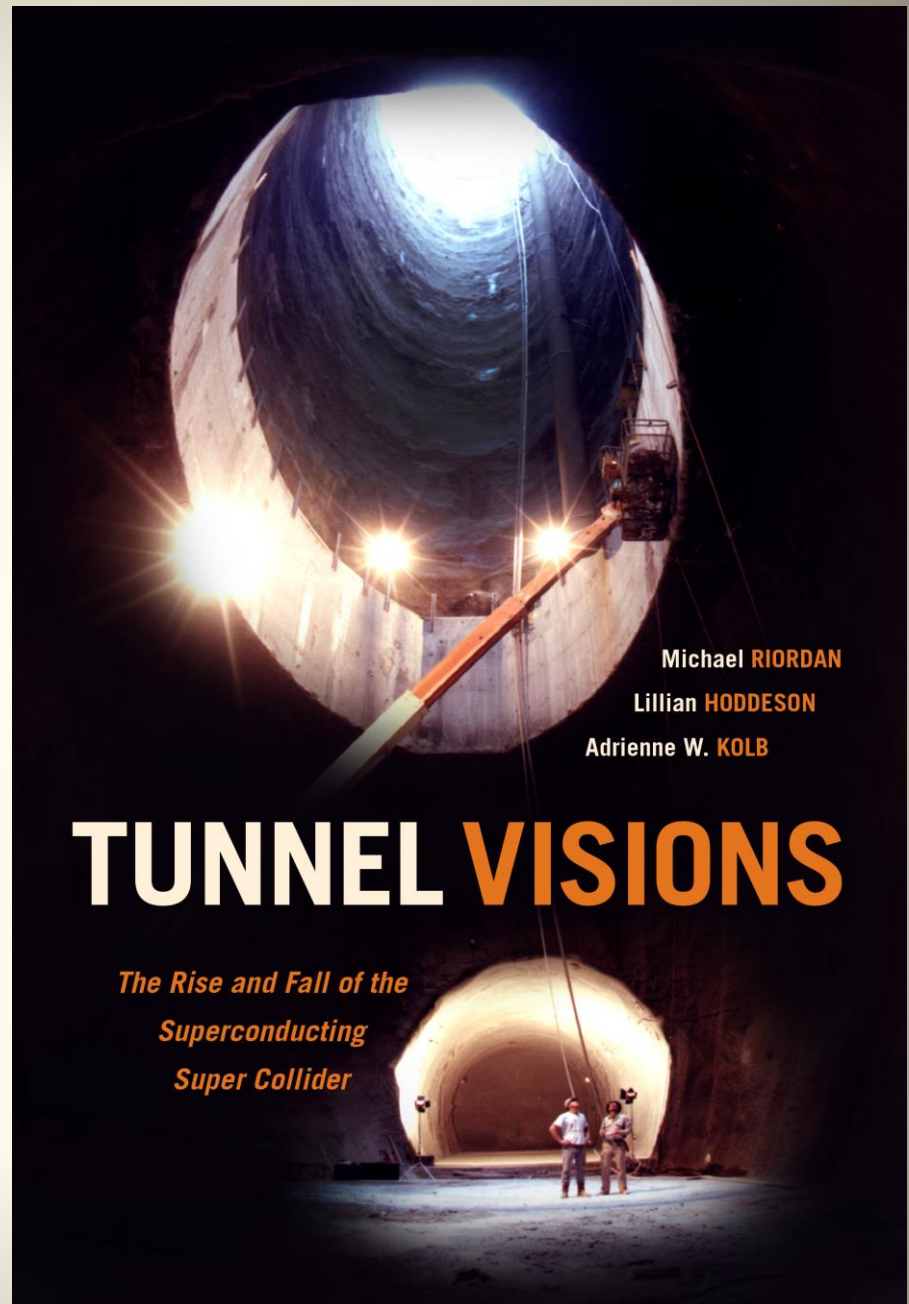
The Rise and Fall  
of the

Superconducting  
Super Collider

by Michael Riordan,  
Lillian Hoddeson and  
Adrienne W. Kolb

Published November 2015 by  
University of Chicago Press

And be sure to read the notes!

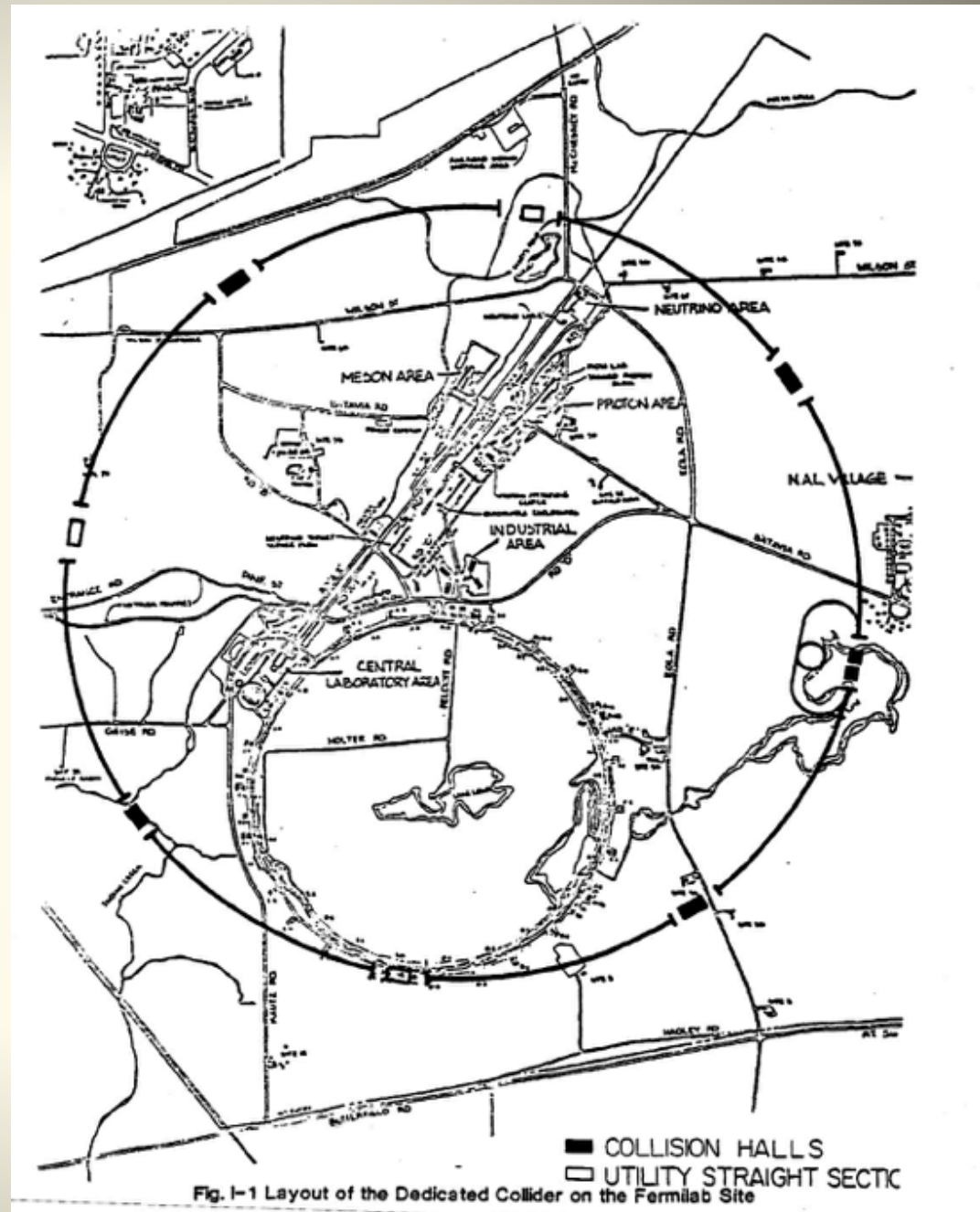


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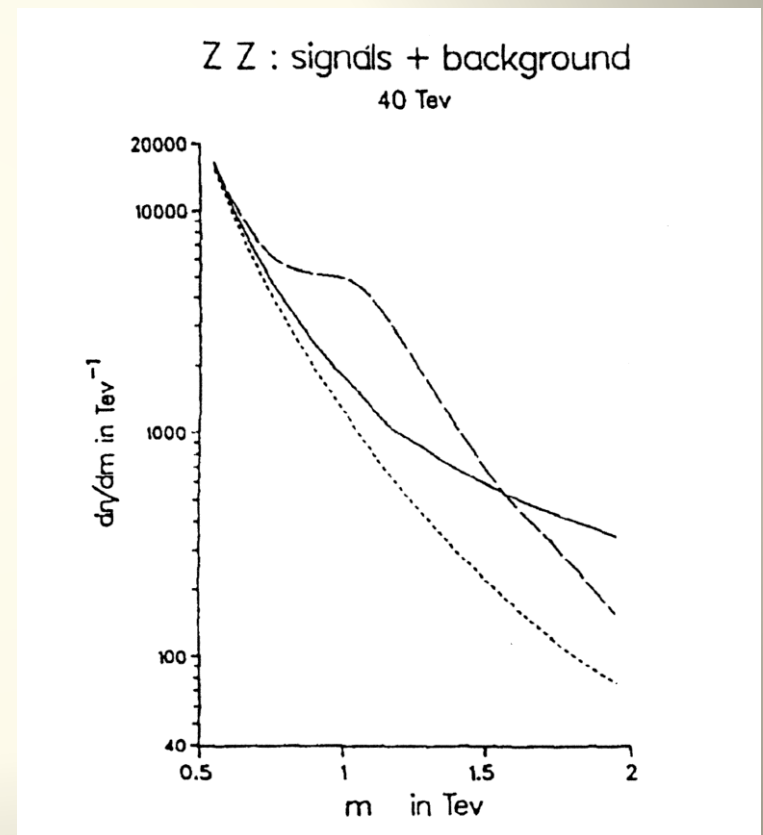
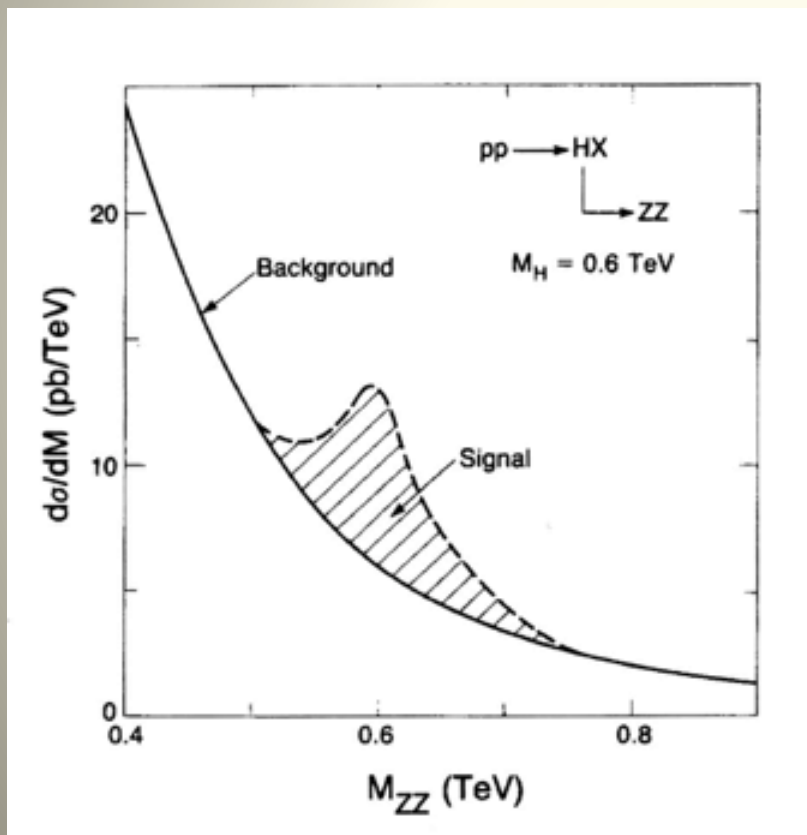
Could such a Dedicated Collider have discovered the 125 GeV Higgs boson?



# The Higgs Boson in the late 1980s

SSC Conceptual Design Report, 1986

M. Chanowitz, ARNS, 1988





# 2012 Higgs Boson Discovery at the LHC

(at  $E_{\text{cm}} = 7 - 8 \text{ TeV}$  and  $L \sim 10^{33}$ )

