The Supercollider That Never Was

The Texas-based high-energy accelerator would have easily found the Higgs and been capable of searching for still more evidence of new physics

Oct 15, 2013 | By David Appell

If all had gone according to plan, the gargantuan U.S. high-energy physics project would have already found the Higgs particle, having solidly won the competition with its European competitor. Peter Higgs, in fact, might have collected his physics Nobel a few years earlier.

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The Superconducting Super Collider (SSC) that would have graced the rolling prairies of Texas would have boasted energy 20 times larger than any accelerator ever constructed and might have been revealing whatever surprises that lay beyond the Higgs, allowing the U.S. to retain dominance in high-energy physics. Except the story didn't play out according to script. Twenty years ago, on October 21, 1993, Congress officially killed the project, leaving behind more than vacant tunnel in the Texas earth.

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Since then, the glory of particle physics has moved to Europe. Last year the Large Hadron Collider (LHC) at the CERN laboratory in Geneva, Switzerland, discovered the Higgs, the biggest event in physics in a generation, and, adding insult to injury, announced it on a U.S. national holiday: the Fourth of July.

What went wrong with the SSC, in a nation then usually admired for its can-do attitude? What lessons were learned to apply to future efforts? And what has been the impact on U.S. physics since the spotlight moved to Europe?

What happened?

Although no one reason explains the cancellation, a few key aspects of the project stand out. The inability to secure any foreign sources of funding was pivotal, especially

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as the project's cost increased by a factor of three from initial estimates amid a national recession and political insistence on controlling government spending. The project's scale was 20 times bigger than anything physicists had ever managed before, and cultural differences between the scientific side of the accelerator's management and the military-industrial culture imposed by the U.S. Department of Energy (DoE) led to conflicts, seemingly endless audits and an overall lack of trust.

An accelerator that would collide high-energy protons, the SSC's ring was to be 87.1 kilometers in circumference, circling the small town of Waxahachie, Tex., 48 kilometers south of Dallas. At 20 tera-electron volts (TeV, or trillion electron volts) per proton—close to the regime of ultrahigh-energy cosmic rays—it was to have 20 times the collision energy of any existing or planned machine; it would have had five times the energy of even today's LHC collisions. That design had only one tenth the beam luminosity of the LHC, but because of its higher energy, it would have produced about half the Higgs events seen at CERN, says John Gunion of the University of California, Davis, enough to have found the Higgs and with the higher energy necessary to detect what, if anything, lies past the Higgs energy, such as supersymmetric or dark matter constituents.

When canceled, about 20 percent of the SSC was complete—specifically, two dozen kilometers of tunnel had been drilled with 17 access shafts, and 18,600 square meters of buildings erected. Over $2 billion had already been spent, mostly by the DoE, but also $400 million by the state of Texas.

At its end the project was already employing 2,000 people at the site or in Dallas, about 200 of whom were scientists, plus a contingent of Russian physicists employed after the end of the Cold War. Another 13,000 jobs linked to the project never materialized. About half the SSC scientists left the field of physics, according to a 1994 survey by *Science* magazine, some to become analysts in the financial industry. Many took a loss on homes sold in a sudden buyer's market.

Overbudget, the SSC had been on shaky ground for at least a year before the plug was pulled. Design began in 1983, and then Pres. Ronald Reagan's science advisor told the design committee to be "bold and greedy." Reagan approved the project in 1987, encouraging physicists to "throw deep." (Early names for the collider included the "Ronald Reagan Accelerator," the "Desertron" (because it was so large it could only be built in the U.S. Southwest), and even the "Gippertron.")

Originally estimated to cost $4.4 billion, the U.S. House of Representatives voted to kill the project in the summer of 1992, when costs had risen to $8.25 billion, but it was saved by the Senate, although a $100-million cut below requested funds put the project further behind schedule, increasing its costs even more. By the fall of 1993 the estimated cost had risen to a minimum of $11 billion (equivalent to $18 billion today), in part because administrative overhead proved larger than anticipated, and refined calculations of expected beam losses lead to a magnet redesign. (There were to be about 10,000 of them in the ring.) The latter's increased cost, about $2 billion, could have been avoided by accepting a smaller ring and its resulting lower energy, but that idea was rejected by upper scientific and academic management.

But not all of the project's costs were included in the initial estimates, according to a DoE report completed four years after the ax came down. About $500 million for detectors, $400 million for operations needed before the lab was finished, $60 million for land purchases and $118 million for DoE project management were excluded from cost estimates. Crucial to projects of such a size, a project cost and scheduling system was never fully implemented, concealing substantial cost overruns, according to the

report.

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"The Department of Energy was looking for a new level of project management when they embarked on supercollider," says Michael Riordan, a science historian who is a lead author of the forthcoming *Tunnel Visions: The Rise and Fall of the Superconducting Super Collider*. "They did not trust they could get that from the high-energy physics community, and I think they were partially correct in that."

Foreign funds that never came

It was always expected that $2.6 billion in funds from foreign governments and from the accelerator's home state would supplement DoE dollars. Although Texas did promise $900 million, and deliver $400 million before the project's cancellation, none of the seven countries that DoE officials looked to for the rest came up with money, except for a $50 million pledge from India.

From the beginning officials seemed conflicted about the project's goals. Riordan wrote that at a 1987 press conference, the day after Reagan's go-ahead, "Secretary of Energy John Herrington told reporters that the SSC would be 'an American project [with] American leadership,' but at the same time the DoE also intended 'to seek maximum cost-sharing funding from other countries.'" Such nationalistic rhetoric tamped enthusiasm from Canada, Europe, and Japan when DoE went looking for financial pledges.

In Europe maintaining success at the CERN laboratory was the priority, after its 1983 discoveries of the W and Z bosons responsible for weak interactions, and it would have made little sense to collaborate on a machine larger than the Large Hadron Collider they were then considering. Despite the Soviet Union's dissolution in 1991 Russia's focus and funds went elsewhere; the end of the Cold War also repurposed attitudes in the U.S., reducing emphasis on big, technological science projects that displayed national might. The SSC also competed for funding with the development of the International Space Station, including the Johnson Space Center and other NASA operations in Texas.

That left Japan as a major target for foreign funding. Delegations began visiting Japan as early as 1984, but tensions over Tokyo's inroads into the U.S. automobile market often got in the way, as did U.S. requests that Japan establish quotas for importation of U.S. auto parts. By 1991 Pres. George H. W. Bush's popularity was falling, and the Japanese were not convinced of U.S. commitment to the SSC. The accelerator was to feature prominently in Japan–U.S. observances of the 50th anniversary of the December 1941 attack on Pearl Harbor, but Bush's trip to Japan was delayed as trade tensions mounted. With the tenor of the relationship in flux, high-level talks on the SSC came to nothing, and Bush's visit to Japan in early 1992, where the Japanese expected the U.S. president to directly ask Prime Minister Kiichi Miyazawa for SSC funding, ended with Bush's unfortunate and embarrassing regurgitation on Miyazawa. Noting that Bush's reelection looked increasingly unlikely, Japan postponed a decision on the SSC. And despite expressing support for it as a presidential candidate, Bill Clinton and his administration never gave much support to the project.

What should the U.S. have done differently? Burton Richter, the Nobel laureate who was then director of the Stanford Linear Accelerator Center (now known as the SLAC National Accelerator Laboratory) in California, says "it was a very bad mistake to seek funding only after the design parameters of the project were determined."

There was also infighting among subfields of U.S. physics, as condensed matter physicists were especially concerned that the SSC would drain funding from other

specialties. Many physicists spent at least a year grieving and venting their disappointment and anger in public, especially in *Physics Today*, the U.S. magazine devoted to covering the field. When the SSC was finally canceled, the late Rustum Roy, professor of materials sciences at The Pennsylvania State University, expressed his joy to the *New York Times*. “This comeuppance for high-energy physics was long overdue.” Roy said. “There is an acute oversupply of scientists in the United States,” which he and others said was the educational system’s responsibility to fix.

Richter, now director emeritus at SLAC, thinks the bitterness between subfields of physics has faded, and that scientists learned a valuable lesson: “Once a project is approved, shut up.”

A lack of will

It was not just physics that lost out when the SSC was canceled. There had been tremendous support from the state of Texas and from the local community, and their enthusiasm came to naught. Some lost land rights that went to construction of the tunnel, and dozens of homes were moved for building construction, but there was little of the bitterness that might be expected today. “There was a great feeling of support from the local people,” says Roy Schwitters, professor of physics at The University of Texas at Austin who was the SSC’s director for its last five (and most significant) years, “even from those who lost their homes. They liked the idea that the country did super, far-out things,” he added. Local schools welcomed the collider, and lab scientists set up cosmic-ray monitors in classrooms to teach the basics of particle science (with plans to later demonstrate that no harmful radiation was coming from the accelerator). “I think it was a tragedy for the country, and certainly for high-energy physics,” Schwitters says. “It’s almost removed the possibility—the vision—that you can build really new major projects when the scientific community gets behind and supports them.”

Some see an even larger picture in the SSC’s demise. “You can blame lots of people,” says Nicholas Samios, former director of the Brookhaven National Laboratory, “but it was clearly a lack of will. We always got things done. It turned a getting-things-done society into a conservative, play-it-safe, no-risk society,” Samios laments. “We’re not made of the right stuff anymore.”

Today the SSC buildings are occupied by Waxahachie chemical manufacturer Magnablend. Access shafts have been filled in, and what tunnel remains collects rainwater. Amidst endless budget problems, Congress flits with large science projects like the James Webb Space Telescope, canceling and then reversing as costs and completion dates lengthen—scenarios eerily familiar to the SSC’s tragic path. The European-based CERN was the major focus of the 2013 physics Nobel to Peter Higgs and François Englert, and it is Japan, not the U.S., talking of hosting an International Linear Collider.

Despite fears at the time, the SSC did not herald the end of U.S. particle physics, by any means. (In 1993 the Division of Physics of Beams made up 3.4 percent of the American Physical Society’s membership; this year it is 2.3 percent, a decline of 361 members.) Physics faces a host of new questions, such as the nature of dark energy, the identity of dark matter and the subtle properties of neutrinos, not all of which can be answered by ever more powerful accelerators. But others can, such as the exact properties of the Higgs boson and the ever-tantalizing possibility of supersymmetry. The current design of the LHC places a hard energy limit of 16 TeV (8 TeV in each beam), and no physics above that threshold can appear, no matter how high its beam intensities. The SSC would have punched at a higher weight.

Yet Riordan believes the U.S. made a mistake by reaching for such a high energy at the SSC, when a lower energy might have discovered the Higgs particle, as recent experience has confirmed. “The high-energy physics community insisted on the largest possible machine, so large it didn’t have the skills to manage it,” he says. “American physicists wanted to leapfrog the Europeans and reestablish their leadership in high-energy physics—which was a political reason, not a physics reason.”

Many believe accelerator physics still has an important role to play, such as with a linear collider that will by necessity be a worldwide effort. “I do not believe that we can make significant progress without also pushing back the frontier of high energy,” Nobel laureate Steven Weinberg wrote in an essay titled “The Crisis of Big Science” in *The New York Review of Books* last year. “So in the next decade we may see the search for the laws of nature slow to a halt, not to be resumed again in our lifetimes.”

The SSC was an epic project that ended in failure. The U.S. has yet to stride again its own once prominent footsteps; but perhaps worse, it no longer dares to dream in color. Whatever the future for high-energy physics the U.S. and the world, the hulking beast that would have been the Superconducting Super Collider will not soon be forgotten.

ABOUT THE AUTHOR(S)

David Appell is a science writer living in Salem, OR.

Comments

lamorpa October 15, 2013, 8:17 AM

But instead we got to temporarily take over Iran and Afghanistan. Think of the possibilities! ...

dbtinc October 15, 2013, 8:36 AM

We should all be ashamed of ourselves for letting the pols take our tax dollars and dispense trillions in these places that will never be better than they were the day we stepped foot on their territory. We've dumbed ourselves down to where the pursuit of science moves off shore and we don't seem to care. Does Gibbons "The Decline and Fall of the Roman Empire" seem all to familiar in these modern times?

Gregory CH October 15, 2013, 9:27 AM

What happened? The failure of the project had its roots in a "too big to fail" attitude of its management that led to ill advised technical and political decisions. This gave opponents all the ammunition they needed to kill the project.

The death of the SSC marked the beginning of our decline in science and engineering leadership because we view the value of science through the prism of politics.

willfree October 15, 2013, 10:55 AM

"Waxahachie, Tex., 48 kilometers south of Dallas"

Kilometers? No wonder we killed that project, crawling as it was with invasive foreign units.

"20 tera-electron volts (TeV, or trillion electron volts) "

You are talking to Americans here. What is that in calories?

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jafrates ➚ **lamorpa** October 15, 2013, 1:02 PM

The project was killed long before the fall of Afghanistan and Iraq (which you seemed to be in too much of a hurry to spell right).

At the time, Congress was deciding which of the two big science projects to defund, and all the complex matters behind it came down to whether to cancel the SSC or the ISS. The space station was given funding and the collider canceled. As the article mentions, there were a lot of issues with the project and lessons learned. I still hope that one day, the US will be able to complete a new collider, but I don't expect it in the next 30 years.

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elautin October 15, 2013, 3:09 PM

I was disappointed when the SSC project was cancelled. But, I am a science and technology enthusiast.

Billions and billions of dollars of taxpayer money being spent, but spent wisely? The rewards would be: the advancement of physics, the enlightenment of humanity, the maintenance of prestige of the USA as the pinnacle of science achievements. The money would not disappear, but result in employment of thousands in Texas and thousand more in American industries that supplied materials for the SSC. And of course there would be considerable spinoffs in technology—just as from the Apollo project.

But does it make financial sense? Were there “better” uses for these billions of dollars? What was lost by letting the prestige and thousands of American physics move to CERN? The work was still done. The Higgs was created. Was preventing this loss worth the billions of saved dollars?

Why are these mammoth projects cancelled after billions of dollars are already spent? Why was the Shoreham nuclear power plant cancelled after five billion dollars were invested? Too big to fail—failed with Shoreham and failed with the SSC. The foresight was not there in the planning stages. Gamesmanship and power politics resulted in a large power plant on Long Island that was never used and a large underground water storage tunnel in Texas—now that is stupid!

I was disappointed when the SSC project was cancelled. Should I have been?

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james rebel October 15, 2013, 3:18 PM

Another depressant that provides ammunition for delaying or stopping future research, by reference, is the National Ignition Facility at the National Laboratory in Livermore, CA. Built in the late 1990s-early 2000s, at an advertised cost of 12 billion, it has not, to recent date, managed to achieve a fusion ignition. The negative criticisms are "ramping up" and the budget hawks are lurking.

james rebel

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james rebel October 15, 2013, 3:25 PM

I responded to the first article of interest in today's Scientific America news letter. Please read "Can Fusion Energy Achieve a Breakthrough?" for details about the National Ignition Facility situation.

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ErnestPayne October 15, 2013, 3:40 PM

The defense department budget is $600,000,000,000.00. Toss in the trillions wasted in Afghanistan and Iraq and this project is "small potatoes". Given the latest idiocy in Washington it is the tip of the iceberg of scientific departure from america.

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geojellyroll October 15, 2013, 6:52 PM

The USA keeps sweeping up Nobel Prizes. Science is more than mega white elephant projects.

The Shuttle, the Supercollider, Constellation, the ISS, the JW Telescope. All testaments to siphoning off research dollars. Worthwhile..yes. Worthwhile for 'x' billions...no.

The cookie jar is stuffed with IOUs. Why it is stuffed is irrelevent....the money is owing. The insane over spending on the above projects has destroyed the credibility of future mega projects. This includes any 'practical' missions to the Moon or Mars which will require tens of billions in funding.

Regardless of one's politics, priorities, dreams, etc....there is no money. All governmnet agencies are going to have annual cutbacks. a 17 trillion dollar debt is still growing...55,000 per capita.

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