Stanford Fails to Score in "Gluon Race"

Work on a huge new particle accelerator pushes ahead, though some physicists are bitter about defeat to West Germany

Stanford. In the foothills of California's Santa Cruz Mountains, on the grounds of the 2-mile-long Stanford Linear Accelerator Center (SLAC), physicists are working at a feverish pace to complete the construction of a $78 million particle accelerator that many scientists think should have been the first to provide evidence of the gluon.

The machine was proposed in April 1974, a full 6 months before a similar proposal was launched in West Germany. By July 1978, however, the Americans had already lost the construction race when the scientists at the Deutsches Elektronen-Synchrotron (DESY) laboratory switched on their accelerator (*Science*, 10 Nov. 1978).

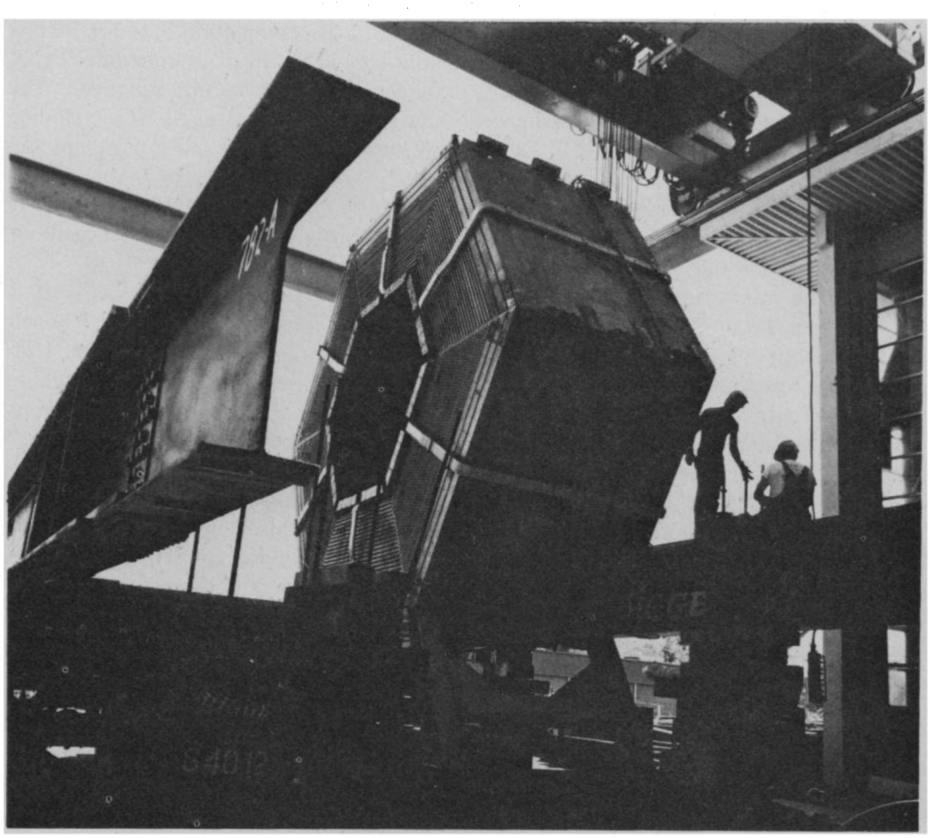
Recent developments have made that loss seem more humiliating. The first significant results after more than a year of research by the West Germans have been announced. Some say evidence for the existence of the gluon will mark a major step forward in comprehending what matter is made of and how it holds together. The discovery was announced recently at a meeting at the Fermi National Accelerator Laboratory outside Chicago. And not everyone is pleased. "We could have been number one," says Sidney Drell, a physicist at Stanford and chairman of the High Energy Physics Advisory Panel of the U.S. Department of Energy. "We obviously would have been much happier to get there before the Germans."

The reaction of other physicists at SLAC has been varied. Some are bitter. They say their machine could have been completed up to 2 years earlier had it not been for needless bureaucratic delay. They note, moreover, that their machine will have higher rates of collision among the speeding particles than the German accelerator, and may therefore be better able to make significant discoveries. Others belittle the German discovery, saying it is controversial or suggesting that it is a minor achievement. One reason that the Germans made the most of the gluon work, according to these SLAC scientists, is because they are intending to propose the construction of a huge new accelerator and that a well-received success would certainly not hurt the chances for funding that project. A few at Stanford claim, moreover, that U.S. scientists exaggerated the significance of the gluon work. They say that the extensive coverage of the discovery given by the U.S. press (such as articles in *Time* and *Newsweek*) was part of a well-planned effort by certain U.S. physicists to spotlight the increasing gap between the funding of high energy physics here and in Western Europe.

Even if the physicists are making the most out of the Germans winning the so-called gluon race, the problems are nevertheless real. Total support of the high energy physics programs in Western Europe is now estimated to be about twice as large as that of the United States. The rise of the competition during the past decade marks a historic change in this field of science that was dominated by Americans for 40 years. And during that change there have been some concrete firsts. It was the Western Europeans, for example, who in 1972 discovered that weak nuclear interactions can occur not only through a change in electric charge but also through the exchange of so-called neutral currents. The recent "gluon discovery" has added to their track record. "We're going to have to be satisfied to compete in this field, rather than dominate it," says Drell. "We are learning to live with others, especially the Europeans, as vigorous partners."

At Stanford, the evidence that the United States is falling behind is clear. The backbone of the new accelerator site is a concrete tunnel some 2.2 kilometers in circumference, buried deep underground. By December, according to officials at SLAC, it will house a finished colliding beam accelerator known as PEP, for the positron-electron project, that will be fed particles from the linear accelerator. PEP will accelerate electrons to energies of 18 billion electron volts (GeV) and send them crashing head on into their antimatter opposites, particles called positrons, coming at high speed from the opposite direction. For now, however, the only collisions at the site are among some 70 tool-carrying physicists, electricians, and machinists, all wearing hard hats.

Signs of their work abound. Blueprints are taped to concrete walls, and cranes and hoists for moving large magnets are



A particle detector being moved into place in August. [Source: Joe Faust, SLAC]

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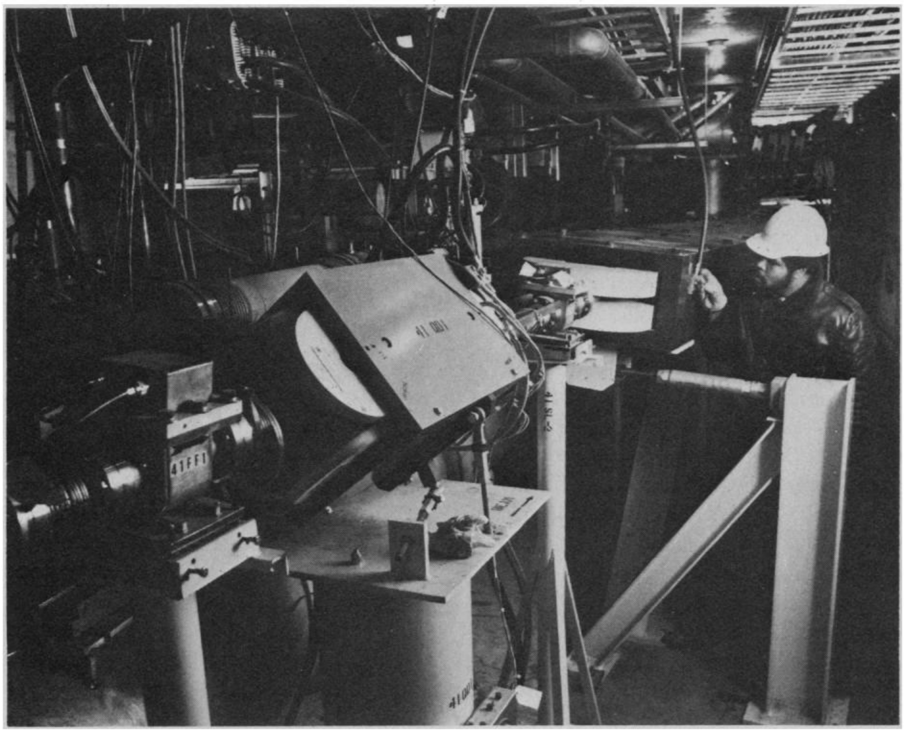

A technician adjusts bending magnet that surrounds the beam line. [Source: Joe Faust, SLAC]

scattered around the grounds. Already in place are a large part of the circular vacuum rings and more than 70 percent of the 630 bending and focusing magnets, each weighing up to 10 tons. The site is not all bustle and activity, however. A house-sized cavern sits some 60 feet below the surface with water dripping down its walls. It will eventually hold an experiment. As of now, however, there are no wires, no magnets, no vacuum rings, and no detectors. The only sound is the whine of a sump pump.

All the delay does not go down well with John Rees, director of PEP. During an interview in his office, Rees waved a graph contrasting year-by-year progress on the German accelerator (PETRA) with work on the American one. "It makes me want to cry," he said.

The gap, according to Rees, is in large part attributable to the differing philosophies that prevailed on how to deal with the economic recession of 1974. To stimulate a sagging economy, the Germans decided to pump $5.8 billion into their economy. When the science ministry got its share of this windfall, it gave a large chunk of it for the construction of PETRA. The director of DESY thus found himself in the happy position of receiving construction money even before the PETRA project had been approved.

In the United States, on the other hand, the administration was retrenching. The Office of Management and Budget found that PEP was a "high priority item, but one which should be deferred in a time of recession." The upshot was that full authorization of the project was delayed until late 1976. The gap was further widened, says Rees, because of a long process of contract bidding and selection that is required by bureaucratic regulation in Washington. Once funds became available, work on PEP began at a furious pace. Rees noted that although heavy rains at one point put a contractor's earth-moving machines out of commission, the completion date for PEP is still 4 months ahead of schedule. Problems can still crop up, however. The union of technicians at SLAC, including welders, machinists, and electricians, recently voted to strike for higher wages and more benefits. For the moment, they are still at work as contract negotiations continue.

Some physicists at SLAC, as well as those not connected with the PEP accelerator, such as David Cline at the University of Wisconsin, say that the gluon discovery is not that significant. "Gluons have been talked about for a long time," Cline says. "It's not like the J/psi particle, for instance, where nobody really talked about this thing before it was discovered. The gluon concept, in a way, is not better understood now than before. The things that the Germans saw only confirm certain prejudices. It doesn't mean that you couldn't explain the evidence in some other way." The Germans may have been under political pressure to play up the discovery, Cline suggests, not only because of a new 70 to 100 GeV positron-electron accelerator that they have proposed but because of the dearth of other significant results during the past year of operation.

The DESY scientists, for instance, have not yet found evidence for a sixth or "top" quark. No one was certain that evidence of it would be found in the energy range opened up by the PETRA accelerator, but many hoped that it might be, and the negative result has been a disappointment to physicists. "If one accepts the fact that the sixth quark has a charge of two-thirds," says Wolfgang K. H. Panofsky, director of SLAC, "then it looks like there is room in the energy region covered by PETRA for the sixth quark. On the other hand, that doesn't mean that there are any structures or surprises in that energy region at all. But there is a spectre that people are worried about—that any one energy region that a new machine gets into is just going to be dull."

The few discoveries made thus far have turned the gluon work into something of a media event. Contributing to this push, according to physicists at SLAC, is the behind-the-scenes work of Leon Lederman, director of the Fermilab, who hosted the conference where the gluon disovery was announced and who has a reputation as a skillful advocate of big physics projects. "Physicists are ecstatic," he is quoted as saying in a 10 September *Newsweek* article. "Now we are beginning to understand how it is all put together."

Making an effort to point out the lead of the Germans to the reading public is not an altogether irrational impulse. Between the construction of Fermilab and the construction of PEP, there was a 9-year hiatus in which the U.S. high energy physics community saw no new construction starts. Since then, however, things have brightened up a bit. The Administration currently has set a *floor* of about $300 million per year for high energy physics. Most of that money is going into the construction of proton-proton accelerators such as ISABELLE at the Brookhaven National Laboratory on Long Island, rather than going toward the next generation of electron-positron accelerators. This is something of a gamble. During recent years, it has been electron-positron machines, such as PETRA, that have made many of the major discoveries. And some physicists are worried by this change in emphasis. "If the predominant results continue to be produced in electron-positron storage rings," says Panofsky, "then there will be a strong shift of activity away from the United States. In my view, this would be difficult to accept."

—WILLIAM J. BROAD