Illinois and Virginia Scrap Over Accelerator

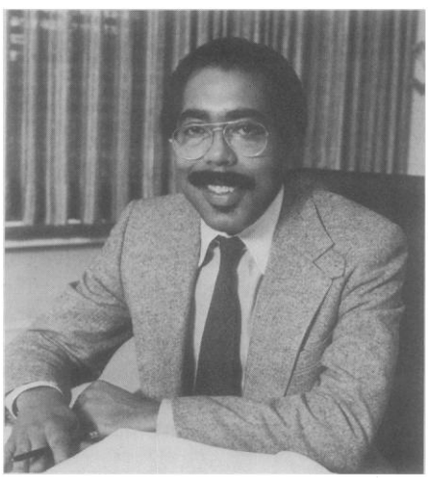
A proposal to build a $150-million electron accelerator in Virginia has touched off a political fight and split DOE's advisory groups

Last January, five contenders began to vie to be named the builder of a new government-financed accelerator, the most powerful tool ever designed for nuclear physics. Thus began what has become a pork barrel scrap, involving two Republican senators, a national laboratory, 23 universities, several government agencies, and the White House.

The five original candidates for the project were told to compete vigorously and then abide by the decision of a group of experts. Three low-energy designs were knocked out early in March when the judging committee decided to favor the two high-cost, high-performance proposals, priced at about $150 million each. Then on 22 April, the final decision was announced: the best proposal had been submitted by a total neophyte in this business, a consortium of 23 southern universities based in Virginia. The runner-up, the Argonne National Laboratory, was astounded. After reading the experts' report, Argonne's leaders decided to ignore decorum and fight for a reversal. This campaign has just begun, and it is causing a good deal of angst in the physics community.

At issue is a proposed 4-billion-electron-volt (GeV) continuous-beam electron accelerator that would allow nuclear physicists to see deeper into the structure of the nucleus than before. It would bring them into the small-scale universe of particle physicists. Some describe the new machine as a light that could illuminate an unexplored area between traditional nuclear physics and the near edge (as opposed to the far frontier) of particle physics. It may serve as a bridge between the two specialties. This is why nuclear physicists are excited about it. But at the moment their machine is caught in an old fashioned political fight, one which has engaged some of the nation's top research directors and elected officials. The loss of this project would be a major setback for Argonne and signal a weakening of Illinois' clout in such struggles. For these reasons, Argonne will not leave the field quietly.

There are some big players on Argonne's side. First is Argonne itself, a neighbor of Chicago with 27 years of experience in nuclear science, an annual budget of $210 million, and a staff of 4500. Then there are some noteworthy individuals: a popular Republican senator, Charles Percy, who heads an active Illinois delegation; a contingent of Illinois university presidents and midwestern executives; an influential Department of Energy (DOE) advisory committee which for budgetary reasons strongly opposed building new projects like this outside the existing national labs; and a member of that DOE committee and executive officer of the American Association for the Advancement of Science, William Carey. Percy has already called the White House and arranged for DOE secretary Donald Hodel to meet a large delegation from Chicago in a quasi-public complaint session on 25 May in the Senate Foreign Relations Committee room.



Walter Massey

Director of Argonne laboratory

Those who want to uphold the 22 April recommendation are no lightweights, either. The group includes the 23 southern universities whose proposal beat Argonne's idea; the governor and legislature of Virginia, which have already committed funds for physics professorships; another strong Republican senator, John Warner (Virginia), who chairs the subcommittee that reviews DOE's budget; an influential scientific body—the Nuclear Science Advisory Committee (NSAC)—which recommended to DOE and the National Science Foundation that this accelerator be built; and finally, the head of that committee and board chairman of the American Association for the Advancement of Science, D. Allan Bromley.

The contest threatens to become one of those pork barrel brawls that White House science adviser George Keyworth has complained about in the past. Indeed, Keyworth has already been visited by agents from four of the five competitors, including SURA, as arranged on 9 February by Senator Warner. Although Keyworth has not been officially involved, he has become familiar with the case. He could hardly avoid it, as this will be the decade's most important equipment contribution to the discipline in which he was trained. Then, too, Keyworth took undergraduate physics from Bromley, chairman of the committee that chose the accelerator design.

The stew began to boil in late April just as the NSAC committee prepared to release its decision. Argonne suspected that the unbelievable was about to happen—the award was about to go to an unknown group called the Southeastern Universities Research Associates (SURA). In the phrase of a critic, this "paper consortium" came into existence only in 1980 and then only for the purpose of bidding on the accelerator. SURA still lacks a headquarters and a staff, and has not made a final decision on where it would build the new laboratory. Argonne's director, Walter Massey, hearing rumors of trouble, went before NSAC to make a personal appeal. He pledged to come up with faculty positions for U.S. physicists, for this seemed to be an important point in favor of SURA. But the last-minute pitch was of no avail. SURA won.

Massey says, "If somebody had come to me and said, 'Look, Walter, your proposal is just not as good. I'm sorry, we don't believe you could build this,' that would be fine. But that's not what happened." According to Massey, the NSAC committee said that "either place can build a first-rate facility, and then they went to the other proposal and made all kinds of changes and contingent provisions. They made no allowances for us in terms of contingencies or changes." He says that if DOE decides to build a new lab in Virginia, it will be flouting the explicit recommendation of another group—the Energy Research

Advisory Board—which wrote in a September 1982 report that no new DOE laboratories should be built, and that existing labs should be given "those new tasks for which new laboratories might otherwise be established." If the accelerator experts say that Argonne can build a first-rate machine, then "How can DOE go out and build a new lab?" Massey asks. "As a taxpayer, I would want somebody to explain that to me."

Bromley's explanation is that his group was asked to look at technical considerations only. The controversy over new versus old labs was "completely outside the purview of my panel" and something "on which I will not comment." While it is true that either design could have been "the basis for a first-class facility," both have problems. The primary reason for choosing SURA, Bromley says, is that the technical problems SURA may encounter "at worst could cause a small loss in time but would not in any way affect the experimental program," while the ones that might occur at Argonne might have "a significant impact on the experimental program."

There were two other reasons for choosing SURA. The university consortium pledged 35 professorships for physicists, including an early funding commitment for five "Commonwealth" chairs for the director of the project and the chief machine designers, paid for by the state of Virginia. It is an offer to increase the visibility, the prestige, and the number of new practitioners of nuclear physics. According to Senator Warner's office, it could increase the number of U.S. physicists by 10 percent. Bromley describes it as "a very strong indication that they're going to get some very good machine designers," because there are few senior positions for such people at U.S. universities. Bromley adds that it is "essential" that some of the accelerator specialists who helped SURA prepare its submission become part of the final project.

Finally, the Bromley panel chose the SURA design because it seemed more flexible. With the addition of another ring (costing around $10 million) it should be possible to increase the maximum electron energy level from 4 to 6 GeV. The Argonne design cannot be increased above 4 GeV.

Massey believes that the panel acted on "spurious criteria" in rejecting Argonne. "What is there in this report or this whole process that said the number of faculty positions was going to be the first criteria?" he asks. There was no indication, either, that the potential for expanding the energy level would be important. As Massey points out, the big issue when the panel began deliberating was whether or not 2 GeV would be adequate. He argues that if the panel had made it clear that these two points were important, Argonne could have satisfied them.

Bromley responds by saying there were no specifications to meet; his panel simply evaluated the proposals as received and chose the best. Hans von

James McCarthy

Conceiver of the SURA design

Baeyer, a physicist on the staff of the College of William and Mary and SURA's chief political organizer, says, "There comes a time when you have cut off the revisions and say, 'This is the proposal.' " All the candidates had a chance to grill their competitors and defend their own ideas in an unusual round-

Bromley responds by saying there robin session of the NSAC panel in February.

Inevitably, the physics itself is crucial. The key factor is the level of energy produced, and SURA's scientific spokesman, nuclear theorist Franz Gross, was instrumental in persuading NSAC of the need for a high-energy machine.

Bromley recalls that when the panel began, he held the traditional view that an energy output of around 2 GeV would be adequate. A tool this powerful would take the field one step beyond the familiar area of nuclear research into a zone where the structure of the nucleus appears to "melt" and exhibit new patterns of behavior. As Bromley describes it, there are three energy ranges of interest: less than 1 GeV, 1 to 2 GeV, and 2 GeV on up. In the first energy range, the nucleons (neutrons and protons) appear in the form traditionally modeled by nuclear physicists. In the second, the one Bromley was first interested in, the structure and distortions of the nucleons become apparent. Above 2 GeV, the nucleons "effectively begin to melt" and behave as "a sort of quark-gluon plasma," and above 4 GeV, one begins to see particle physics.

In the middle of NSAC's deliberations, Bromley was won over to a more adventurous—and also more costly—approach which saw the opportunity to leap two steps at once by going to 4 GeV and linking nuclear and particle physics. This decision was made formally on 7 March, eliminating low-energy designs submitted by MIT, the National Bureau of Standards, and the University of Illinois. The new goal, as Bromley sees it, will be to borrow the theory of quark behavior (quantum chromodynamics) developed by particle physicists and use it to interpret the behavior of the nucleus under various levels of stress. "We want to probe how the quarks within the nucleus behave as we go through these three phases," he says. "If you stop much below 4 GeV, you really haven't gotten into the phase where the quarks are the dominant players." Reaching experimental levels of 4 GeV and above will "solidly anchor" this new venture in the evidence on particle behavior. If the new accelerator is not so powerful, nuclear physicists will not be able to poach on the turf of particle physicists, nor will they have as much confidence in their analysis of the "melting nucleus."

The virtue of SURA's design is that it would reach these high-energy levels by conventional means—by linking the well known technology of a pulsed linear accelerator with a new "stretcher ring" that would stretch the pulse into a nearly constant beam. The stretching technology has already been shown to work on a smaller scale, in Japan. The major technical uncertainty has to do with the tubes that generate the power, the Klystrons. They would have to be made three times more powerful than the most powerful used today. The NSAC panel assumed for the sake of caution that this improvement would not be possible in the short construction period allowed (4.5 years), and so downrated SURA's current to half the proposed level. Critics at Argonne view this as a serious fault, but NSAC members say that if this failure actually occurs, it will only slow the rate of experiments, not change the kind that can be undertaken.

The obstacles Argonne faces are formidable. According to accelerator experts on the NSAC panel and others on the outside, Argonne's design suffers from two inherent problems which might be hard to overcome. Because it would recirculate a single beam 37 times through a microtron ring, it would require the development of precise new

control magnets. Furthermore, six of these 600-ton devices would have to be aligned to within 0.1 millimeter and kept in alignment for months at a time. Because such high standards have never been met, NSAC's subgroup of technical experts worried that even if the magnets were built correctly, they might not remain stable and might require high-cost maintenance.

Second, the experts worried that fluctuations in the synchrotron radiation of the beam might increase the diameter to a size that would not fit within the given aperture. This could lead to a power loss and might even damage the accelerator. The synchrotron radiation problem becomes pronounced over 3.5 GeV. Thus, the experts feared that the machine might never be useful at higher energy levels, or not without some expensive new beam confinement systems.

As one NSAC member says, "These involve state-of-the-art advances. On one hand, they might be a great thing to do, but on the other, nuclear physics badly needs a few successes." The problems of the Isabelle accelerator on Long Island clearly weighed on NSAC's thinking. In off-the-record discussions, panel members made distinctions between Argonne's potential "hard failures" and SURA's "soft failures."

Argonne's backers make the most of the latter. These include all the uncertainties that go with inexperience and a lack of infrastructure. Massey says, "There is no way on earth anybody will convince me that building a new laboratory from nothing is going to cost the same" as giving the task to an old hand like Argonne. On matters of pricing, NSAC did a curious thing. It threw out the estimates that were submitted and worked directly with the proposers to come up with numbers it could trust. In the end, the top contenders came out costing about the same, $150 to $160 million for construction and $275 million for operation over 15 years. But NSAC found one major flaw in SURA's proposed location, Newport News, Virginia. Some panel members argued vehemently that the lab should be near a major airport or university. Argonne has both of these, of course. NSAC's final report urges SURA to consider relocating in order to "provide improved access" to major universities and airports, provided it can be done "without significant increase" in the total cost.

SURA will not move from Virginia, that much is clear. There are several reasons. This is where SURA was born (physicist James McCarthy of the University of Virginia at Charlottesville conceived it); this is its political base; and the state has already promised funds for five professorships. Virginia's Senator Warner and other state politicians backed the proposal from the outset, not only because of the construction jobs it would bring, but also because they saw it as a way of establishing a local colony of high-technology enterprise, the kind that has been so important for the economies of California and Massachusetts.

The Newport News site was chosen

CERN Physicists Have Evidence of Z^0

While the American physics community continues to agonize over the design and location of future accelerators, the Europeans may have scored another experimental coup. Researchers at the European Laboratory for Particle Physics (CERN) near Geneva may have found the second of three particles needed to verify the unified theory of weak (nuclear decay) and electromagnetic forces. The particle is called the Z^0.

The physicists, headed by Carlo Rubbia of CERN and Harvard University, are making no firm claims for the moment because they have only one event. But the signature of the Z^0 is so clean and unobscured by background that there is hardly any other explanation for the observation.

Elementary particle physicists are in the midst of a quest to unify all the forces of nature in one mathematical formalism. Yet, despite all the speculation about Grand Unified Theories, supersymmetry, and other theories, physicists still do not know for sure if even the first step in the unification program—the marriage of the weak and electromagnetic forces—is correct. There are basically two questions: are the forces unified at all and, if so, are they tied together in the way physicists think they are. Experimentalists must find three particles (the W, the Z^0, and the Higgs) and measure their properties in detail to verify the so-called Standard Model that most theorists accept.

Rubbia's group has already found the W, which comes in positive and negative electrically charged versions (*Science*, 4 February, p. 480). The Z^0 is electrically neutral. All three particles are created when protons and antiprotons collide head on in CERN's SPS accelerator, which for the moment is the only machine in the world capable of this kind of experiment.

In talks at Princeton University and Brookhaven National Laboratory, Rubbia emphasized that the single event can only be "a candidate for the Z^0" but nevertheless expressed confidence that it was real. The event does satisfy the criteria for being a Z^0 in three ways. First, there is an electron-positron pair, each particle of which zips away in a direction opposite that of the other. Second, the energy of each particle is about 50 GeV. This is a bit high, but there should be a statistical distribution of energies, so one event is not definitive. Third, the single Z^0 candidate was found in a data sample that also contained 12 W's. According to theory, Z^0's should be produced about one-tenth as frequently as W's.

There is one problem with the Z^0 event, which Rubbia discussed at Brookhaven. The CERN particle detector consists of an inner "tracking chamber" that electronically records the trajectories of electrically charged particles that pass through. Outside the tracking chamber is a layer of "electromagnetic calorimeters" that measure the energy of photons and light particles such as electrons. Pending recalibration of the detector, there is an inconsistency between the trajectory recorded for one of the particles in the electron-positron pair and its energy. The trajectory is that of a much lower energy particle.

Explanations for this finding exist but must be verified. The best cure is to find more Z^0 candidates. The current experimental run is scheduled to end on 4 July. At the rate data are being collected, the physicists expect three or four more events of this type.

For now, the best counsel is patience. A skeptic pointed out to *Science* that the first W "candidates" at CERN turned out not to be W's. The particle was, however, detected in subsequent events.—**ARTHUR L. ROBINSON**

simply because the state controls two large empty buildings there worth over $10 million. These could be incorporated cheaply into the project, saving some construction costs. The larger one, a concrete-lined hall that used to house NASA's Space Radiation Effects Laboratory, is still faintly radioactive. Thus, von Baeyer says, "They couldn't sell it to the Boy Scouts." The other is an office building nearby that houses state educational programs, including von Baeyer's satellite branch of William and Mary. Because of NSAC's charge to do so, SURA is now reconsidering where it might build the accelerator. Among the alternate sites are Charlottesville and Blacksburg, neither of them comparable to Chicago.

An aide to Senator Percy mutters, "If they build another federal facility in Newport News, it'll slide into the river." It already has a major naval base. He suspects that the federal bureaucracy favors SURA over Argonne in part because of its convenience to Washington, its relatively pleasant weather, and its backing by Senator Warner. von Baeyer, for one, is not shy about SURA's political record, or its regional appeal. "How do you get a state legislature to commit funds to a project like this without being politically active?" he asks. Warner has been a lobbyist for the project since 1980, but von Baeyer defies anyone to find anything improper in this.

Percy's staff claims that the senator refrained from becoming involved earlier because Argonne's scientists believed that the taint of politics would hurt them in the technical review. Percy's staff now sees that restraint as mistaken, and the senator is making up for lost time. He lobbied hard to stave off a rumored phasedown of Argonne activity in 1981; now he is belatedly trying to help it compete for basic physics assignments. On 20 April Percy telephoned presidential aide James Baker and arranged for DOE secretary Hodel to appear at the meeting to be held in late May. On 23 April, a Saturday, Percy called Hodel at home and elicited a promise that no decision would be made until after Chicago had made its case. Argonne, meanwhile, is sharpening its cost calculations for a frontal attack on SURA.

How will DOE sort out these appeals? It is far from clear at this point, for NSAC's technical recommendation was only that, and this case involves some volatile political interests.

—ELIOT MARSHALL

Caltech Torn by Dispute Over Software

A young physicist resigned from Caltech after 2 years of bitter arguments whose resolution satisfied no one

For the past 2 years, a bitter argument has been raging at the California Institute of Technology over who owns a potentially valuable computer program and what constitutes a conflict of interest. The argument has involved persons at every level of the Caltech administration as well as members of its physics department. And the lasting effects of this dispute have left everyone unhappy. A brilliant young physicist has resigned from Caltech, the computer program's development has been abandoned, and rifts have grown between administrators and faculty.

At the heart of the dispute are new questions about the ownership of intellectual property that universities are only beginning to face: Should computer programs, which can be copyrighted but not patented, be treated like patentable inventions with royalties accruing to the developers? Should a university invest in a company in which a faculty member has significant financial interest? To what extent may faculty members get involved in business dealings?

Different institutions are answering these questions in different ways. But the problems at Caltech seem to stem from the fact that it is a "true community of scholars," according to its provost and its president, where issues tend to be resolved without reference to formal rules and regulations. Thus when physicist Stephen Wolfram challenged what outdated written regulations there were, he felt deeply wronged that the Caltech administration said he was not acting according to the Caltech spirit.

The story begins about 3 years ago when Wolfram, who had just joined the physics department, decided that he needed to spend some time writing a computer program. Wolfram is considered a wunderkind who was eagerly sought by Caltech. He wrote his first paper in theoretical physics at age 15 while a student at Eton, went to Oxford 2 years ahead of schedule at age 17, entered graduate school at Caltech at age 18—by which time he had already published ten papers—and got his Ph.D. in 1980 at age 20. At age 21 he received a MacArthur award—the youngest person ever to receive one.

> Vogt says, "Just as monks give up certain privileges, our faculty give up the privilege to be involved in full-time commercial ventures."

Wolfram recalls that he was motivated to write the computer program by some problems that had arisen during the course of his physics research. "I was interested in calculating Feynman diagrams in quantum field theory," he says. "Those calculations involved some very complicated algebra. One can't realistically do such calculations by hand."

There were some computer programs available that could do symbolic manipulations of the sort Wolfram required, but Wolfram found them inadequate. "The programs ran slowly but the most devastating thing was that the calculations I wanted to do overflowed the memory of the program."

So he organized and headed a group consisting of graduate students and Geoffrey Fox, a Caltech faculty member, to write a new computer program that could efficiently handle complex algebraic expressions. "I decided to make the program as general as possible," Wolfram recalls. "It was clear that there were a lot of people who could potentially use such a thing."

Wolfram and his group began writing the program in June 1980 and had a working version of a large portion of it in October of that year. It was mostly finished by June 1981. During this time, Wolfram points out, he continued to do research in theoretical physics. Writing