still more palatable, DOE seems to be on the verge of declassifying the Livermore program—a move Koonin's review committee urged 3 years ago. Now, says John Lindl, deputy program leader for the Livermore project, the National Security Council, the State Department, DOE, and the Defense Department have agreed to the recommendation; all that's lacking is approval by Energy Secretary Hazel O'Leary. "We're expecting she'll sign off on it," says Lindl, "but we don't have it yet." Besides widening the scientific constituency for the program, declassification should open the way to collaborations with, for instance, the Japanese, French, and Germans, all of whom have ongoing laser fusion programs.

Only a test

Still, physicists familiar with the program caution that it should not be oversold. For one thing, if and when NIF gets built—which could happen by 2001—laser fusion will still have a long way to go to become a practical energy source. The best NIF can offer, says Marshall Rosenbluth, a University of California, San Diego, physicist and a member of the ICFAC panel, is "a proof of principle test of inertial fusion either for defense applications, or in the longer run for energy applications."

That's because NIF, like Nova, would be what the physicists call a one-shot target experiment. "The laser could fire perhaps once an hour," says Lindl, because "a lot of waste heat comes off, and you have to allow the optics to cool." A fusion power plant would have to achieve the same implosion feats as NIF—but at the rate of at least five to ten times a second. The best bet for drivers that could achieve such repetition rates are heavy ion accelerators, says Campbell, and Livermore is working in collaboration with the Lawrence Berkeley Laboratory to develop them. Like lasers, the ion beams would bombard a hohlraum, which would emit x-rays and compress the pellet. But because they focus their beams using magnetic fields, accelerators are more resistant to neutrons and heat, and they're also far more efficient than glass lasers.

Such devices are at least a few decades in the future, however. For now, says Lindl, lasers are the best tool for studying ICF: "A lot of what we learn about hohlraums and pellets [at laser facilities] carries over to ion beams." And, for now, lasers also provide the best shot for achieving ignition. "When laser fusion started up," says Massachusetts Institute of Technology physicist Arthur Kerman, an ICFAC panelist, the technology "was eight orders of magnitude, 100 million times away, from a sensible version of what was needed. They have come a very long way in 30 years. They may have come far enough."

–**Gary Taubes**

SUPERCONDUCTING SUPER COLLIDER

Fight Heats Up Over SSC's Remains

Ever since Congress killed the Superconducting Super Collider (SSC) in October, physicists and Texas state officials have been hoping to salvage something from the $2 billion already spent on what was to be an $11 billion project. Like transplant surgeons examining a cadaver, they have identified several vital organs that could give new life to other projects. These include a central laboratory building, a $27 million liquid helium cryogenics facility considered among the best in the world, a magnet development and test facility, and a partially completed linear accelerator (linac) that would cost $60 million to finish. It's unclear, however, just who will get these former SSC body parts, and who will pay to operate them once the SSC lab is closed.

JOHN BIRD, SSC LABORATORY

Lining up. The partially completed linac building, top, was to be joined by low-energy and medium-energy boosters.

Part of the uncertainty comes from the ambiguous language in the legislation that brought the 7-year project to a halt. Department of Energy (DOE) Secretary Hazel O'Leary was told to carry out an "orderly termination" of the project, reflecting the desire of opponents to have the project done away with quickly and efficiently. But she was also told to submit a plan by July 1994 that would "maximize the value of the investment" and "minimize the loss to the United States and involved states and persons"—a process that could take a very long time. "On the one hand," says Fred Gilman, associate director of the SSC lab, "people point to the word 'termination' and think of leaving nothing behind. But other words talk about the possible use of assets, which would point the other way."

First in line for those assets appears to be the state of Texas. A memorandum of understanding between the DOE and Texas—which former SSC director Roy Schwitters calls "this famous agreement"—states that in the event of termination of the project, Texas has a legal claim to any facilities to which it contributed greater than half the value. Texas has already spent more than $400 million and, according to a DOE spokesman, its money has indeed paid for more than half of all the major scientific facilities built to date as well as the central laboratory building and computing resources.

Texas has already identified several possible uses for these facilities. In a recent meeting in Washington with O'Leary, Texas Governor Ann Richards proposed that the SSC lab become home to one or more of four possible projects: a national test beam facility, a cold magnet research and development facility, a central laboratory to facilitate future international physics collaborations, and a cancer treatment laboratory. Texas researchers have a fifth suggestion—convert the lab into a consortium for research on large superconducting devices. "The general impression was that it would be an embarrassment or a waste or sinful to say that, after $2 billion, you get nothing, zip, zero for it," says Vigdor Teplitz, head of the physics department at Southern Methodist University in Dallas, who organized a meeting last month of representatives from 10 research universities in the state.

But Texas is not the only relative with an interest in the deceased. The U.S. high-energy physics community as a whole is worried that money may be diverted from DOE's already tight high-energy physics budget into projects outside the field, or into operating a physics laboratory not on the frontiers of science. "The high-energy physics base program has been slowly eroded to help SSC," says Nick Samios, director of Brookhaven National Laboratory in New York. "We did that knowingly. Now we need restoration of the base program. If you have another mouth to feed, it will make it very difficult."

O'Leary has asked the department's High Energy Physics Advisory Panel (HEPAP) to form a subpanel to discuss how termination of the SSC can contribute to the long-term vitality of high-energy physics, and physicists across the country have already begun floating ideas to use SSC facilities to boost the base program. Robert Adair, a Yale physicist and HEPAP member, calls the proposals that have come up so far the equivalent of "corridor talk." The cryogenics facility, for instance, would be a useful addition to any laboratory that has a superconducting accelerator, which includes Fermilab, Brookhaven, and the soon-to-be-completed CEBAF outside Norfolk, Virginia. SSC scientists say the cryogenic facilities could probably be dismantled and moved for just a few million dollars.

The linac is another bone of contention. Instead of making it the centerpiece of a medical facility for cancer therapy and other biomedical purposes, as Richards envisions, Brookhaven scientists are thinking about its value as an upgrade of Brookhaven's 33-year-old Alternating Gradient Synchrotron (AGS), converting it into a machine that could generate intense beams of particles known as kaons.

Of all the ideas floating around, the most intriguing to physicists is to use the facilities as a base for U.S. participation at CERN, the European physics laboratory. Advances in the SSC's detector technology complement what's being planned for CERN's proposed Large Hadron Collider (LHC) project, say SSC scientists, and the magnet test and development laboratory could build and test magnets for the LHC as well. "The Europeans do not have magnets yet for the LHC," says Burton Richter, director of the Stanford Linear Accelerator Center and president of the American Physical Society. "It would make sense to use a cut-down SSC laboratory to do the industrial construction and testing of those magnets."

Both ideas fall into the realm of wild speculation, however, because U.S. participation at CERN is still in an inchoate state, and the LHC itself has yet to be formally approved. Lorenzo Foa, who will become the next research director of CERN and is the lab's representative to HEPAP, told a meeting of the HEPAP panel last month that CERN is considering delaying for 6 months any further decisions on the LHC to provide time to evaluate possible U.S. participation.

While discussions about assets continue, lab officials are more worried about carrying out the "orderly termination" Congress has demanded. On 12 November, John Peoples, the director of Fermilab, became the SSC director after Schwitters resigned. Peoples says his first task is to implement DOE's forthcoming orders to reduce the laboratory staff, including 150 physicists, as well as deciding the fate of some 3000 outstanding contracts. After that, he says, he will work on the thorny issue of maximizing assets. "When the contractors come back with their possibilities," he says, "and the physicists think of what's possible, and the SSC staff thinks of what's possible, and the state of Texas thinks about what's possible, then something sensible and very defensible will come out. And that's what we'll bring back to Congress."

–Gary Taubes

PEST CONTROL

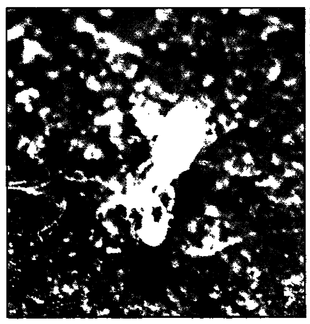
Debating the Use of Transgenic Predators

Marjorie Hoy wants to do the right thing. The University of Florida biological control specialist hopes to use genetic engineering to produce mites and insects that are highly effective enemies of crop pests. Her work is in its early stages—neither she nor other researchers are poised to field test genetically engineered arthropods—but she wants to know that, when she does release such an arthropod, it won't do more harm than good. The problem she faces, however, is that the rules for determining safety haven't yet been determined themselves.

So, with the help of the U.S. Department of Agriculture's (USDA) National Biological Control Institute, Hoy organized a small workshop on the topic in Gainesville, Florida: "Risks of releasing transgenic arthropod biological control agents." From 13 to 16 November, some 30 ecologists, entomologists, and molecular biologists gathered to outline scientific guidelines that researchers can use to help them plan experimental releases of transgenic arthropods.

The potential such creatures have for controlling crop pests is many and varied. Hoy, for instance, is working to develop a transgenic version of a mite, *Metaseiulus occidentalis*, that helps control pest spider mites in California almond orchards. Hoy has inserted a marker gene into the mite that could be used to track how far transgenic mites disperse when they are released. The next step is to make a predatory mite with a gene for insecticide resistance; conventional spraying for other almond pests currently kills off the predatory mite, leading to a spider mite population boom. More desirable traits in a predator—such as altering its host specificity or improving its ability to diapause over winter—are more complex genetically and will take longer to develop.

Scientists have been field testing transgenic crops in this country for years, so why are they worried about arthropods? For one thing, arthropods move. The same problem faces researchers working with transgenic fish, such as salmon that grow faster than wild salmon. Unlike transgenic plants, which typically can survive only in managed agricultural systems, fisheries geneticist Anne Kapuscinski of the University of Minnesota says, "many transgenic fish and insects can escape and do well. It makes the questions you must ask more complex and important because there is a greater chance of environmental risk." (Kapuscinski organized a similar workshop back in August at the University of Minnesota on environmental safety standards for releases of genetically modified fish and shellfish.)


M. HOY

Future pest control. This predatory mite could be genetically modified to improve its ability to feed on spider mites (smaller animal with dark spots).

Concerns about transgenic arthropods aren't limited to their mobility, but extend to shifts in their appetites and even in their genes. University of Minnesota entomologist David Andow, who attended the conference, says that a biological control agent might develop a taste for a nontarget herbivore, for example, which could release a weed previously controlled by the herbivore.

Workshop participants also discussed the possibility of transfer of the foreign gene from the genetically engineered organism to other arthropod species. Insects sport a wide variety of transposable elements, so-called jumping genes, that are likely vectors for incorporating foreign genes into arthropods. But these genes may facilitate their own cross-species transfer, and if the transposable element contained a gene that conferred resistance to an insecticide, for example, such a transfer to a pest would be a calamity.

Many scientists at the workshop felt this fear was somewhat exaggerated. Hugh Robertson, a molecular biologist at the University of Illinois, says this type of transfer may occur "more often than we thought" on an evolutionary time scale, "but on a human time scale it is a rare event." But Jane Rissler, a senior staff scientist at the Union of Concerned Scientists, doesn't think this is reassuring enough. "How can you know so little [about transposable elements] and predict that nothing else will happen?" she asks. "It doesn't appear to be a big risk but is something to keep in mind when you don't know the genome very well."

That's the type of concern workshop participants hope to address in their draft guidelines, now being drawn up. These guidelines are intended to stimulate scientific discussion about the risks and benefits of this type of pest control, and eventually to play a role in formulating government policy.

–Billy Goodman

Billy Goodman is a science writer in Montclair, New Jersey.