Either AIDS exists in that part of Japan but has not been diagnosed, which seems unlikely especially in view of the publicity AIDS has received during the past year, or the Japanese may respond differently to the infection. Another possibility, Gallo points out, is that a change occurred in the HTLV family in Africa or Haiti that conferred a new capability for immune suppression on the virus. Comparison of the nucleotide sequences of the DNA of viral isolates from the various sources may help to clarify this issue.

Why some people might develop AIDS as a consequence of HTLV infection while others get leukemia is unclear. It might be an as yet undetermined difference in the infecting HTLV or in the host response to the infection. It might depend on the site at which the viral DNA integrates in the genome of infected cells.

In any event, there are now a number of approaches that may be taken to clarify the relation between HTLV and AIDS. A prospective study of high-risk individuals to see whether HTLV infection precedes or follows development of AIDS is a possibility. Another is to look at people who have other types of immune suppression, children with congenital immunodeficiency diseases or kidney transplant patients, for example, to see if they too have an increased number of HTLV infections.

If HTLV does eventually prove to be the cause of AIDS, then a specific test for the early diagnosis of the condition may be feasible. Especially desirable is an assay for the AIDS agent in blood. The possibility that the condition may be transmitted in blood products has naturally generated a great deal of concern. Ultimately a vaccine may be developed to protect high-risk individuals. But that all awaits firm proof of the cause of AIDS.—Jean L. Marx

High Energy Physics Looks to the Future

Physicists meet this June in Woods Hole to ponder new accelerators; most contentious is the fate of the CBA, née Isabelle

Every 2 years or so, the Department of Energy (DOE) asks its High Energy Physics Advisory Panel (HEPAP) to convene a subpanel on long-range planning for new accelerator facilities. There is always a certain drama to these exercises—after all, the recommendations involve the futures of whole national laboratories and hundreds of millions of dollars, not to mention the course of particle physics—but this year there seems to be a special sense of urgency:

- The recent discovery of the W boson at CERN, the European Laboratory for Particle Physics in Geneva, underscores an American sense of having fallen behind in high energy physics, of missing out on the truly exciting discoveries.
- At the same time (and partly as a result), the Reagan Administration has already begun to boost its funding for high energy physics; moreover, accelerator technology has now evolved to the point where the HEPAP subpanel can begin to make serious recommendations on an Ultra High Energy Accelerator, a 20-trillion-electron-volt-(TeV) device that would represent an order-of-magnitude advance in energy over current machines, and which could once again put the United States solidly in the forefront.
- Most importantly, however, the subpanel must once and for all decide the fate of Brookhaven National Laboratory's proposed Colliding Beam Accelerator (CBA), the reincarnation of troubled, controversial Isabelle (*Science*, 13 November 1981, p. 769).

"The committee's got a tough job," says William A. Wallenmeyer, director of DOE's high energy physics program. "Usually with these things I have a pretty clear idea beforehand what the obvious decision is. Not on this one."

Under chairman Stanley G. Wojcicki, the HEPAP subpanel holds its final meeting at Woods Hole, Massachusetts, during the week of 5 June, which is about the last date its recommendations can affect the fiscal year 1985 budget. The European challenge will be very much on people's minds.

It is only a slight oversimplification to say that high energy physics today is a worldwide effort to test the so-called standard model of particle interactions, in which the Weinberg-Salam theory describes the unified electromagnetic and weak interactions, and quantum chromodynamics (QCD) describes the strong, or nuclear, force. Every new accelerator is planned with this goal in mind. In recent years, however, the standard model has sometimes seemed to be a special province of Europe.

"They have had two major successes," recalls Wojcicki. First, the electron-positron colliding beam machine PETRA came on line at West Germany's DESY laboratory in 1978, about a year before the equivalent American machine, PEP, started operation at the Stanford Linear Accelerator Center. "They were able to skim the cream," he says. A prime example was the first empirical evidence for gluons, the quanta that are thought to hold the quarks together in the proton and neutron and that are an essential feature of QCD.

Second, of course, was the recent discovery of the W boson at CERN's new proton-antiproton collider, the SPS. The W is a central prediction of the Weinberg-Salam model; another, the Z boson, should appear at the SPS soon. Meanwhile, the accelerator has also produced hints of the long-sought top quark. "Once again, they are walking off with the most exciting physics," says Wojcicki.

Europe is also building up considerable momentum for the future. CERN has gotten the go-ahead for its enormous LEP, a billion-dollar, 9-kilometer-wide electron-positron ring that will operate at 50 billion electron volts (GeV) per beam, with the possibility of 100 GeV later. [Electron-positron annihilation at these energies is a particularly clean way to produce and study the W's, Z's, and new quarks (*Science*, 31 July 1981, p. 528)]. And it now appears that DESY will get its high energy electron-proton collider.

In the United States, by contrast, the high energy program has suffered through the budgetary uncertainties of the first two Reagan years—to save money the big American accelerators are currently being operated only part time—and the fiasco of Isabelle. The latter was to have been the major new facility for the late 1980's. Instead it was thrown into limbo as project scientists struggled to master their recalcitrant new superconducting magnets. The result has

Brookhaven National Laboratory

Brookhaven's Isabelle site

The tunnel is finished. Will it ever be filled?

been a crisis of American confidence, with many physicists warning that the program faces a future of progressive mediocrity and the not-so-gradual loss of its best people to Europe.

However, this gloomy prospect was considerably relieved last January when the Reagan Administration gave its go-ahead for the Stanford Linear Collider project, an add-on to the venerable Stanford Linear Accelerator that would provide 100-GeV electron-positron collisions by 1986—2 years before LEP. Indeed, in retrospect the gloom seems premature. Quite aside from the new Stanford initiative, Fermilab has almost finished its 1-TeV Tevatron II, which will be the highest energy fixed-target facility in the world. Moreover, by 1985 this device will be upgraded into a proton-antiproton collider known as the Tevatron I, which will operate at nearly four times the energy of CERN's SPS (1 TeV per beam versus 270 GeV), and at more than ten times the luminosity. It will also be the first collider to use superconducting magnets.

"I feel that we will see a growing amount of momentum in the United States in the next few years," says Fermilab theorist James D. Bjorken. "Our present program [including the Stanford Linear Collider] is lean, but healthy up until the late 1980's. But if there is nothing beyond that, *then* we're in trouble."

It is this future that the Woods Hole subpanel will have to address. A year ago their task might have been simpler, their debate little more than a referendum on Brookhaven's Colliding Beam Accelerator. Now, however, the real possibility of a 20-TeV Ultra High Energy Accelerator is likely to color everything else they discuss.

"That energy range [20 TeV] allows us to cross a new frontier," says Maury Tigner of Cornell University. The standard model may make successful predictions at current energies, he says. But it is somewhat ad hoc, with arbitrary elements such as the so-called Higgs particles, and with no indication of how the QCD and Weinberg-Salam sectors relate to one another. The hope is that the Ultra High Energy Accelerator will provide hints for a better theory—or at least eliminate some of the numerous candidate theories. "Everyone is hot to see the Higgs, or the particles associated with ideas like supersymmetry and technicolor," says Tigner. "The revelation of some substructure to the quarks would be a very important guide." Even ostensibly boring results would be informative. The most popular extensions of the standard model, the grand unified theories, predict that there is nothing of interest between the mass range of the W's and Z's and the realm of new, superheavy particles at 10^{16} GeV.

The idea of a 20-TeV collider has been around for many years. But the current widespread enthusiasm only dates from a conference last summer at Snowmass, Colorado,* when people first began to realize that such a machine might lie within the reach of current technology. The concept was explored further at a conference this spring at Cornell. "There's been a tremendous improvement in superconducting magnet technology," says Tigner, "and we've mastered colliding beams. Add to that the advances in electronics, which is absolutely the key, and it becomes natural for people to think about taking this step."

The Ultra High Energy Accelerator would be huge, with a main ring more than 30 kilometers across (compared with 2 kilometers for Fermilab). Land costs alone might easily drive it into the desert, which explains the occasional reference to the "Desertron." Its cost would be in excess of $1 billion. On the other hand, Tigner argues, given inflation this is not a great deal more than the cost of Fermilab in 1970. "The fact is that after more than 25 years of development, proton-synchrotrons are very cost-effective," he says. "A 20-TeV machine having 100 times the original energy of Fermilab could be built with today's technology at only twice the real cost of Fermilab."

Not surprisingly, then, Wojcicki puts the Ultra High Energy Accelerator at the top of his list for Woods Hole. How soon do we need it? he asks. What kind of machine should it be: electron-positron, electron-proton, proton-antiproton, or proton-proton? Each has its advantages. What are the time scales and costs? And most especially, how should it be managed? Should it be a new entity or associated with one of the three existing accelerator centers? What about an international effort? Could it be done without adding years of politics and haggling over the site?

Even with an aggressive push for the new machine, however, it is unlikely that the device would be operational until well into the 1990's—which leads to a far more contentious question: should the United States build an intermediate accelerator to fill the gap after the Tevatron I and the Stanford Linear Collider in the mid-1980's? More to the point, should the DOE proceed with the Colliding Beam Accelerator?

"It's already very late for CBA," says Wojcicki. It is a waste—and grossly unfair—to keep the Brookhaven staff hanging in limbo. "To delay it another year is tantamount to killing it," he says.

The project does have a lot of support in the community. By all accounts, the Brookhaven scientists have solved the magnet problems that nearly scuttled the project and are ready to go as soon as Washington gives the word. Some $130 million has already been spent on the Colliding Beam Accelerator, with some $400 required for completion. It will be a 400-GeV proton-proton collider featuring a very high luminosity, or beam intensity. This should translate into a very high collision rate and the opportunity to search for very rare (and therefore very interesting) reaction products.

*Elementary Particle Physics and Future Facilities Conference, 28 June to 16 July 1982, organized by the Division of Particles and Fields of the American Physical Society.

But the issue is complicated by the fact that the Colliding Beam Accelerator now has rivals for the intermediate machine slot, the most serious being the "Dedicated Collider" proposed to the Woods Hole group by Fermilab.

The dedicated collider idea has been around for some time as a possible next step after the Tevatron, although the approach of the Woods Hole meeting has certainly given it impetus. Its ring would nearly fill the existing Fermilab site outside of Chicago, and would bring protons and antiprotons together head on at 2 TeV per beam. (In another version it would be an electron-proton machine.) This is five times the energy of the Colliding Beam Accelerator. On the other hand, the collider's luminosity would be lower by a factor of 100. In any case, the Fermilab device would use the same magnet design already proved in the Tevatron, allowing the whole system to be built for a relatively modest $370 million.

Thus, as Wojcicki's committee heads toward Woods Hole, the fate of the Colliding Beam Accelerator is far from clear. The members are not in a mood to rubber-stamp anything, and, says Wojcicki, they may well want to question whether *any* intermediate machine should be built. Might the effort to fill this supposed "gap" in the late 1980's actually drain the ongoing programs and delay the 20-TeV machine?

This is more than a question of hardware, he points out. "One of the things the Woods Hole panel will be addressing is the vitality of high energy physics," he says. When young students make career decisions, a major factor is the opportunity and excitement that they see in a given field. "It is important to have vigorous new facilities to attract and retain these people," he says.

Wojcicki concedes that such statements can seem utterly self-serving—and sometimes are. (In a recent speech to the American Physical Society, for example, presidential science adviser George A. Keyworth felt compelled to make scathing reference to high energy physicists' "pet projects" and "pork-barrel squabbles," and to call for a show of statesmanship.) But the issue is real.

"I think it would be a mistake to build accelerators or detectors just to give people something to do," says Wojcicki. In fact, if the country built the wrong machine (that is, an unexciting machine) it would sap the vitality of the field. The question on the Colliding Beam Accelerator or any other accelerator is simply this: is it a machine that will do worthwhile physics?—**M. MITCHELL WALDROP**

Invasion by Alien Genes

Two species of mice that live commensally with humans are found in Europe. To the west is *Mus domesticus* while to the east is *Mus musculus*, closely related species that nonetheless can readily be distinguished by certain anatomical features and a small but distinct difference (about 5 percent) in their nuclear genes. What a surprise, then, to discover that the commensal mouse in northern Denmark and further up into Scandinavia is clearly *Mus musculus* as defined by its anatomy and nuclear DNA but is *Mus domesticus* in the composition of the DNA of its mitochondria.

This discovery, recently reported in the *Proceedings of the National Academy of Sciences* by Stephen Ferris and his colleagues at the University of California, Berkeley, and the University of Aarhus, Denmark (*1*), bears on the traditional definition of a biological species. According to the traditional view a species is "a group of individuals whose common gene pool is protected against the inflow of alien genes." The Scandinavian *Mus musculus* has clearly suffered an inflow of alien genes, to the point where its mitochondrial genome is indistinguishable from that of another species.

A second case of two closely related but distinct species sharing a common mitochondrial genome, also recently published in the *Proceedings*, indicates that the phenomenon might be quite common (*2*). Jeffrey Powell of Yale University reports nuclear and mitochondrial DNA data on two species of fruit fly from California, *Drosophila pseudoobscura* and *Drosophila persimilis*, that reveal a pattern similar, although somewhat less clear-cut, to that from the European mice. Powell says that these data should not be taken to question the validity of the species concept but biologists should be aware that "the evolutionary biology of nuclear and cytoplasmic genomes may be different."

Mitochondrial DNA differs from that in the nuclear genome in a number of ways, in addition to being outside the nucleus: it exists in thousands of copies per cell; it evolves five to ten times faster; and it is maternally inherited (when a sperm and an ovum fuse, each contributes half the nuclear genes but only the egg cell contains significant numbers of mitochondria). This last difference, plus some putative selective advantage of one species' mitochondrial DNA over that of another, has apparently allowed the flow of mitochondrial genes between species while the flux of nuclear genes has remained more restricted.

Along the boundary known as the hybrid zone, where *Mus domesticus* and *Mus musculus* populations are contiguous or overlap, occasional breeding across species occurs, giving rise typically to subfertile offspring. From a comparison of patterns of DNA framents obtained by cutting mitochondrial genomes with restriction enzymes, Ferris and his colleagues have concluded that the *Mus musculus* population seen today in northern Denmark was established by a colonization event within the last 100,000 years, perhaps involving a single *Mus domesticus* female as the source of the alien mitochondria.

A hybrid produced through mating between a male *Mus musculus* and a female *Mus domesticus* would have a mixed nuclear genome, but its mitochondrial genome would be entirely that of *Mus domesticus*. Repeated crossing of these descendants with *Mus musculus* would quite rapidly dilute out the *Mus domesticus* component of the nuclear genome but the mitochondrial genome would remain that of *Mus domesticus* (through the female line at least). Ferris and his colleagues speculate that the spread of the *Mus domesticus* mitochondrial genome throughout the *Mus musculus* population in northern Scandinavia might be a consequence of an adaptive or replicative advantage possessed by the *Mus domesticus* mitochondrial DNA.

Like Powell, Ferris and his colleagues see no need to abandon the biological species concept as currently understood, but they do "forsee the possible need for defining species in terms of their nuclear genes."

—**ROGER LEWIN**

References

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2. J. Powell, *ibid.*, p. 492.