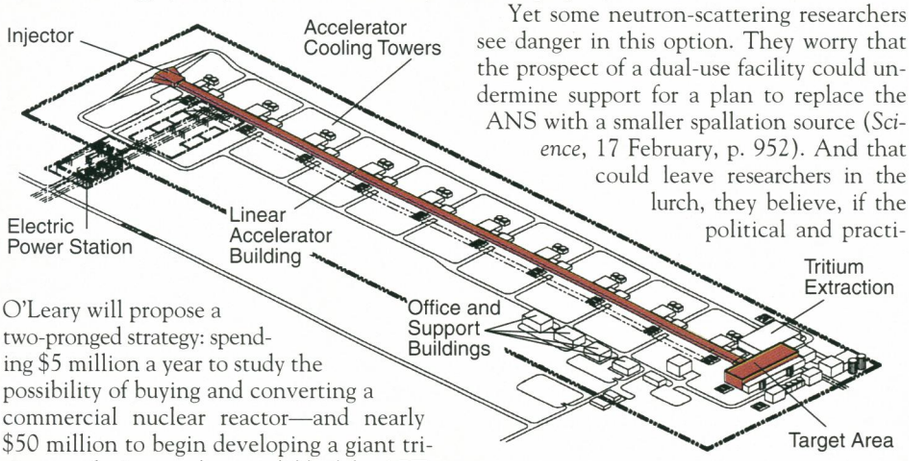
DEPARTMENT OF ENERGY

Could Defense Accelerator Be A Windfall for Science?

Some time in the next few weeks, Energy Secretary Hazel O'Leary is expected to make an announcement that could delight officials at the Los Alamos National Laboratory while sending ripples of anticipation and anxiety through the neutron-scattering community. The focus of these mixed feelings is a plan for making tritium, the hydrogen isotope that is a vital ingredient for thermonuclear warheads. Sources in the Department of Energy (DOE) and the Senate say O'Leary will propose a two-pronged strategy: spending $5 million a year to study the possibility of buying and converting a commercial nuclear reactor—and nearly $50 million to begin developing a giant tritium-producing accelerator, dubbed the APT, for Accelerator Production of Tritium.



SOURCE: LANL

Tritium factory. Proposed accelerator would slam protons against lithium to make tritium—and perhaps also provide neutrons for research.

The strategy is intended to fill a gap that has preoccupied the Department of Defense since 1989, when the Bush Administration shut down the nation's last remaining tritium source, an aging reactor at Savannah River, South Carolina. O'Leary's decision will provide years of APT development work for Los Alamos, but it will disappoint backers of a huge special-purpose reactor, to be built in South Carolina, that has been proposed as an alternative tritium source. And the possibility of a giant new accelerator could also offer some dangerous consolation for researchers still bemoaning the loss of the Advanced Neutron Source (ANS), a $2.8 billion research reactor that was canceled last February by the Clinton Administration.

Consolation, because some engineers and physicists say that the APT itself could do double duty as a source of neutrons for studies of materials and biomolecules, generating them by "spallation"—dislodging the neutrons from atoms in a target. "With small modification to the APT, the U.S. can have both the world's premier neutron source and a secure tritium supply," wrote Burton Richter, director of the Stanford Linear Accelerator Center (SLAC), in a letter last January to Vic Reis and Martha Krebs, the DOE assistant secretaries responsible for nuclear weapons and energy research, respectively. Krebs, in a response to Richter's suggestion last April, dismissed such dual use as impractical. But Michael Kreisler, leader of the nuclear, particle, and atomic physics division of the Lawrence Livermore National Laboratory (LLNL), who led an independent evaluation of the project, believes that "APT could do it."

Yet some neutron-scattering researchers see danger in this option. They worry that the prospect of a dual-use facility could undermine support for a plan to replace the ANS with a smaller spallation source (*Science*, 17 February, p. 952). And that could leave researchers in the lurch, they believe, if the political and practical problems of pairing up military work and civilian research at the same facility do prove intractable. "It's a real question: Could you use [the accelerator] for things other than production of tritium?" asks Frank Dietrich, a staff physicist at LLNL who helped review the project for the DOE.

White House officials who support civilian science say that if the neutron-scattering community wants a facility, it had better get on board the APT project. Given the budget squeeze, they warn scientists to abandon hopes that a new and purely civilian spallation source will be built anytime soon. "The only people with a sizable amount of money are the defense folks," one White House source says. "It's half a loaf or none," warns another.

A new tritium source, on the other hand, seems a sure thing: Pentagon demands and a conservative Congress have pushed O'Leary into promising a decision on a new source by November. And although the technology of converting lithium or helium into tritium with a powerful proton beam is untried, a series of outside panels has concluded the APT is feasible.

DOE sources say O'Leary will recommend funding the APT through the design and technology-demonstration phase. About $300 million over the next 4 years would go to Los Alamos to build the "front end": the ion source and proton injectors. The full-sized accelerator, 1 to 1.5 kilometers long and costing more than $2 billion, would be completed elsewhere, either at Savannah River or the Nevada Test Site, sometime between 2005 and 2010. Right now, Savannah River has the upper hand. "She is under a lot of pressure to choose South Carolina," a DOE official says.

APT advocates say that the accelerator would be free of the political liabilities of a giant new reactor. They also argue that it would be far more flexible than a reactor—a big plus, given the high uncertainty of tritium demand, which will depend on future arms control accords and international stability. "If the demand is much less, an accelerator can be turned off," explains Wolfgang Panofsky, director emeritus of SLAC, "while a reactor, once activated, has to be baby-sat forever."

Supporters add that if tritium demand is low, the accelerator could be put to work as a neutron source for basic research. Paul Lisowski, director of the APT project at Los Alamos, says there would be power to spare in the 100-megawatt beam needed to produce tritium. Just 5 megawatts could generate a neutron flux comparable to the one expected from the ANS, which would have produced 10 times the neutron flux of the world's best existing source. Says Lisowski, "One could imagine making tritium for part of the year and making neutrons for science for another part of the year. Or you could split the beam." Adds Dietrich, "You can't do exactly the same kind of physics [as the ANS]," because the neutrons would be faster moving. "But you could still make a hell of a lot of neutrons."

In his letter to Krebs and Reis, Richter proposed a national workshop to examine the possibility, along with a serious cost study. And last month at a DOE workshop at Oak Ridge National Laboratory, the defense and neutron communities agreed to work together on the necessary technology. But such talk alarms some materials scientists, who prefer a dedicated neutron source. These skeptics argue that retrofitting the APT as a neutron source would mean "a whole lot of headaches," as Bill Appleton of Oak Ridge puts it. It could also give Oak Ridge a headache: The lab is the leading candidate to house the smaller spallation source that could be threatened by the APT.

Appleton, Oak Ridge's associate director for advanced materials, physical, and neutron sciences, points out that while a continuous, diffuse beam would work best for tritium production, spallation requires a sharply focused beam that is pulsed on

and off. For spallation, moreover, negative ions—hydrogen atoms with an extra electron—generally make the best projectiles, while tritium production requires protons. That means, according to Appleton, that retrofitting the APT for spallation would mean adding another ion source and a second storage ring for the negative hydrogen ions. By Appleton's calculations, the retrofitting could tack $520 million to $780 million onto the APT's cost, making it only slightly cheaper than building two separate machines. Richter, in his letter, gave a more sanguine cost estimate: "a few hundred million dollars."

Even if Richter's estimate is nearer the mark, however, many scientists think combined military and civilian use of the tritium accelerator is inherently impractical. "When you try to do dual use in any facility, it simply doesn't work," says Appleton. Walter Kohn, a physicist at the University of California, Santa Barbara, who chaired the committee that endorsed the ANS in January 1993, agrees. The Los Alamos Neutron Scattering Center (LANSCE), which combines basic research with nuclear weapons work, offers a good example, he says. "LANSCE had ... many serious problems, design conflicts, scheduling conflicts," says Kohn. "Its performance had fallen short of the original specifications, in good part because of this multiple use."

Dual-use advocates counter that the Department of Defense has built huge margins of error into its tritium-need projections, in case arms control accords go awry or a new arms race begins. Chances are good, they say, that the accelerator will sit idle for long stretches of time, and the conflicts that worry Kohn wouldn't come up. Says Richter, "I see no reason why [APT] could not operate at almost any duty cycle one wants, from 6 hours a day for physics and 18 hours a day for [tritium] production, to the other extreme of one quarter of the year for physics and three quarters of the year for production."

The debate over dual use will be moot, of course, if two powerful backers of the South Carolina reactor have their way in Congress: Senator Strom Thurmond (R–SC), chair of the Senate Armed Services Committee, and Representative Floyd Spence (R–SC), chair of the House National Security Committee. Also posing a threat to the accelerator is the possibility of making tritium in a commercial reactor, which O'Leary will recommend exploring. That strategy would cost less than half as much as building either an accelerator or a new reactor, according to an unpublished analysis by the Washington consulting firm Putnam, Hayes and Bartlett.

But a knowledgeable Senate staff member, speaking on condition of anonymity, said the DOE's two-pronged strategy could work in favor of Los Alamos and the neutron-scattering community. Given DOE's severe budget constraints, he thinks the department will ultimately go ahead with the cheapest option—purchasing or leasing an existing reactor. The full-scale accelerator would fall to the budget knife. But by then, enough of a prototype accelerator would have been completed at Los Alamos for it to be converted into a new neutron source. "Then we would have a world-class spallation source at Los Alamos," concludes the staffer. Oak Ridge officials would be miffed, but physicists, at least, would have fewer mixed feelings.

–Jonathan Weisman

Jonathan Weisman is a science and defense writer at The Oakland Tribune.

SPACE PHYSICS

Shuttle Mission to Seek Antimatter

A Chinese-built magnet may fly aboard the space shuttle in 1998 in an attempt to give scientists an unobstructed view of antimatter and other exotic particles winging their way through the cosmos. But the project—the brainchild of Nobel laureate Samuel Ting—is a bit of a political hot potato, coming during a period of growing tension between the United States and China.

Ting described the experiment last week to a standing-room-only crowd of physicists at an international meeting in Shantou, China (see box on p. 916). The Massachusetts Institute of Technology physicist said that if the 6-ton Alpha Magnetic Spectrometer (AMS) performs successfully on the shuttle, it could be placed aboard the space station in 2001. Under a plan Ting has been pushing in Washington for the past 18 months, the National Aeronautics and Space Administration (NASA) would provide a ride into space, while the Department of Energy (DOE) would finance the $3 million instrument.

The idea has won enthusiastic support within both agencies. DOE officials say they want to provide an exciting new program for high-energy physicists in a time of tight money. And NASA Administrator Daniel Goldin is eager to prove that world-class science can be conducted on the shuttle and on the space station, according to agency managers. "There's no question Goldin wants to do this," says one. "Having an experiment by a Nobel laureate on the shuttle and station gives us prestige."

The project's Chinese connection has made some NASA managers nervous, however. Although Chinese officials have indicated their interest in participating in the space station, the White House last year warned the agency to steer clear of initiating joint projects with China given the political animosity between the two countries. As a result, NASA is quick to point out that Ting's experiment should not be seen as a joint effort between the two countries. "This is not a NASA project," says one NASA official. "And we've made it clear to DOE that we don't want any Chinese present at the [shuttle] launch." Adds another NASA official: "We're just the truck drivers."

Although Ting says that NASA signed off on the project in April, spokespeople for both agencies insist that a final decision has not been made. According to other sources, NASA and DOE expect to complete work this fall on a memorandum of understanding.

If the project is approved, the spectrometer would allow scientists to search for additional proof of the existence of antimatter, says Luciano Maiani, president of Rome's National Institute of Nuclear Physics, who is familiar with the project. By orbiting the instrument 300 kilometers above Earth, Ting said, the shuttle would take AMS beyond the planet's magnetic field; that would allow researchers to spot particles like antiprotons much more readily than from the ground or atmosphere. Experiments with balloons, at heights of up to 40 kilometers, have recorded about 10 antiproton events, but Ting says he expects to observe 200 such events on the 10-day space shuttle mission.

CERN

Attractive idea. MIT's Samuel Ting hopes the space shuttle will carry his Chinese-built magnet for the detection of antimatter.

At the heart of the spectrometer would be a magnet shaped like a 1-meter-square