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Secret Advance in Nuclear Fusion Spurs a Dispute Among Scientists

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In top-secret experiments, Federal researchers have achieved one of the nation's most costly and elusive scientific goals: to ignite a nuclear fusion reaction in tiny pellets of hydrogen, producing powerful bursts of energy.

The success was achieved in unorthodox experiments some two years ago at the Government's underground nuclear test site in the Nevada desert, according to Federal scientists and officials, who spoke on the condition of anonymity. The results have triggered a bitter dispute over how the field of small-scale fusion should progress.

For decades, hundreds of American scientists have sought to tame nuclear fusion, at a cost of more than $2 billion. Advocates say the technique, if perfected, could be used by the 1990's to study nuclear physics, to develop antimissile weapons and, perhaps in the next century, to generate cheap, almost limitless electrical power. Advance Viewed as Crucial

Although the secret ignition was achieved with a method that has no practical use, it is viewed as a crucial advance that will help determine the feasibility of harnessing small-scale fusion.

The secret ignition was attained in a departure from the nation's main strategy, which has attempted, without success, to use beams of concentrated light from giant laboratory lasers to ignite the reaction. Instead, fusion in tiny fuel pellets was triggered by a blast of radiation from an exploding nuclear weapon. Such secret experiments, which are believed to have never before been publicly disclosed, were conceived more than a decade ago as a way to assess the feasibility of the field, which is known as microfusion.

Some prototype fuel pellets, glass capsules filled with hydrogen isotopes, are so small that a dozen can easily fit on the head of a pin. Their power output could be equivalent to up to hundreds of pounds of high explosive. Practicality Is Questioned

In the fusion reaction, atoms are joined to release the kind of energy that powers the stars and hydrogen bombs. In nuclear fission, by contrast, heavy atoms such as uranium are split to power atom bombs and nuclear reactors. The key question in microfusion is its practicality.

To the surprise of experts, the secret achievement in the Nevada desert required more energy than expected, triggering a clash among Federal scientists and Government officials over how to advance the $160 million-a-year field. Disclosure of the result is also likely to encourage critics outside the Government who charge that microfusion is too formidable to ever be practical.

In the dispute, some scientists now assert that the nation's laser-based microfusion program needs a radical change of course in order to insure success. Other scientists vigorously disagree, saying the nuclear test was an unconventional but vital milestone that has demonstrated microfusion's feasibility and generated valuable data that will help make it practical. 'Historical Turning Point'

Despite the discord, the secret success has generally elated fusion scientists who know of it.
In a tantalizing, little-noticed statement last September, Sheldon Kahalas, director of the nation's

microfusion effort, run by the Federal Department of Energy, told a Princeton University conference that **a top-secret effort code-named Centurion-Halite had achieved results that marked a "historical turning point"** for the fusion program. In response to questions, he refused to elaborate and he did not mention the role of underground nuclear tests.

However, he and other scientists at the Princeton conference said the nation was ready to start planning a full-scale laboratory microfusion facility, which they estimated would cost between $500 million and $1 billion.

"There's a new sense of excitement," William J. Hogan, a microfusion official at the Lawrence Livermore National Laboratory in California, said in an interview. "In the last two years, we've gotten almost all the data we wanted. That's remarkable. We kind of startled ourselves." Scientists and officials quoted by name in this article spoke freely about the dispute and some of the implications of the secret tests, but they declined to discuss how the classified experiments were done. In general, information concerning nuclear weapons and their design is classified secret because the Government wants such information, which can have military uses, kept out of foreign hands.

A Long Quest to Create Tiny Man-Made Suns
For decades, one of the fondest hopes of science has been constructive control of the energy of nuclear fusion, to create tiny, man-made suns. These miniature fireballs could be anywhere from hundreds of thousands to millions of times smaller than hydrogen bombs, making them tame enough for use in laboratories and reactors.

From modest beginnings in the early 1960's, the microfusion idea has grown into a sizable Federal program centered at the Government's main laboratories for the design of nuclear weapons: the Livermore laboratory in California and the Los Alamos National Laboratory in New Mexico. Both belong to the Energy Department.
The main approach to microfusion has been to try to ignite fuel pellets with powerful lasers, although generations of lasers have come and gone with no consensus developing on what is the best kind. To reach ignition, a tiny glass sphere filled with deuterium and tritium, isotopes of hydrogen, must be compressed to very high densities and heated to almost 100 million degrees Celsius, several times the temperature at the center of the sun. So stressed, it would undergo rapid thermonuclear reactions, fusing hydrogen into helium and giving off bursts of energy.

To lessen the difficulty of focusing multiple laser beams on a minuscule target, weapons scientists surround the fuel pellet with a metal case that converts coherent laser light into X-rays, which compress the target with great uniformity.

Despite considerable effort, no ignition has been achieved with these methods. The main problem has been lack of sufficient laser energy.

Today the nation's most energetic microfusion laser is Livermore's Nova, a $200 million device bigger than a football field whose 10 beams can bombard a fuel pellet with some 100,000 joules of energy. A joule is roughly the energy of a flashlight switched on for one second.
In March 1986, an expert panel of the National Academy of Sciences said the energy needed for pellet ignition might prove to be as high as 10 million joules. It said an additional uncertainty was the minimum mass of fuel needed to achieve ignition.

In concert with such publicly known efforts and estimates, a top-secret Federal program, conducted jointly by Livermore and Los Alamos, has been under way for at least a decade to achieve microfusion ignition by harnessing the output of nuclear weapons, which can produce radiation more powerful than any laser's. The main output of nuclear weapons are X-rays, which are directed at the tiny fuel pellets. Scientists Race to Design Full-Scale Laser Facility
After years of failures, the program achieved its initial success at ignition some two years ago, Federal scientists and officials said. **What surprised some of them was how much energy it took, and how relatively large the tiny fuel pellets had to be in order to achieve ignition.**

The exact numbers of both the amount of energy required and the size of the pellets are secret.

But the energy needed for a laboratory laser to mimic the classified achievement would be in the range of 100 million joules, or 10 times what the National Academy of Sciences said might be necessary, experts familiar with the experiments said.

Moreover, subsequent nuclear tests at lower energy levels failed, although some Federal scientists are confident these will eventually succeed.

The data sent scientists racing to design a full-scale laser facility. So too, the Energy Department last year began to plan what it calls a **Laboratory Microfusion Facility.**

But the nuclear success has triggered a bitter clash over how to achieve microfusion. At issue is whether to press ahead with lasers and targets in the range of 5 to 10 million joules, or to shift to include lasers big enough to mimic the conditions of the underground achievement. Experts agree that the current generation of microfusion lasers are unsuited for producing such high energies, the cost being prohibitive.

At Los Alamos, secluded high in the mountains of New Mexico, two physicists have championed the high-energy approach and won favorable review from eight colleagues appointed to evaluate its merits. But the laboratory's senior management, saying budgets are too tight to pursue the novel and unproven scheme, has ordered work on it to cease and has laid off one of the two scientists.

The aim of the disputed idea is to build a giant laser running on hydrogen and fluorine gas. These chemicals combine explosively, much like rocket fuel, producing heat and light that can be converted into laser beams. Indeed, hydrogen-fluoride lasers are common. The novel twist, which has undergone some testing, is to extract the chemical energy very rapidly, in billionths of a second, by triggering its combustion with intense beams of electrons. In theory, such a laser, if large enough, **could deposit 100 million joules of energy on a target**.

The scientists behind the idea, P. **Leonardo Mascheroni** and Claude R. Phipps, said it deserved serious study and suggested that resistance to it stems from an over zealous commitment to the status quo. "It's a cultural thing," said Dr. Mascheroni, a native of Argentina who was recently laid off after nine years at Los Alamos. "They don't want to admit something different."

Los Alamos officials said budget cuts have forced many layoffs, and that Dr. Mascheroni's ideas have been found wanting. "There was nothing so compelling that we thought we should drop the approach we're taking now," said John E. Browne, head of defense programs at Los Alamos.

Despite official resistance, the hydrogen-fluoride proposal was favorably reviewed by an eight-person Los Alamos panel chaired by Gregory H. Canavan, a respected senior scientist who formerly headed the Energy Department's microfusion effort. After deliberating two months, the Canavan panel in February 1987 recommended that four to six scientists work on the idea for a year. The fundamental attraction, the panel said, was that the giant laser, if found feasible, would be 10 to 20 times cheaper to build than conventional rivals pushed to the 100-million-joule range. The success of the venture, it concluded, "could bring the energies that may be required for fusion experiments." Current Effort Defended Despite the ProblemsToday, Los Alamos says the idea's merits are not great enough to divert scarce funds from the laboratory's current microfusion effort, which centers on a $60 million krypton-fluoride laser that to date has generated only 25 joules. Although the laboratory admits the laser has problems, it says the device will eventually produce 10,000 joules.

Moreover, Federal scientists in charge of microfusion said ignition would be achieved at energy levels far below 100 million joules, based on calculations derived from secret tests.

"We view that classified data as saying you don't have to have as much of a driver as people thought," said Dr. Hogan of the Livermore laboratory, adding that the data "pretty well confirms

our opinion" that 5 to 10 million joules are sufficient to achieve ignition.

At Energy Department headquarters, Dr. Kahalas, director of the national program, defended the laser efforts at Los Alamos as "reasonable" and at Livermore as "excellent." He added that if higher-energy drivers were ever deemed necessary, other candidates would probably be considered in addition to hydrogen-fluoride lasers.

Weapons scientists agree that microfusion could be used to study the physics and effects of nuclear weapons, to perfect nuclear-powered antimissile arms such as the X-ray laser, and to power futuristic reactors to generate electricity.

Dr. Mascheroni, the former Los Alamos physicist, argued that the field was so important that the nation needed an insurance policy in case the conventional wisdom was wrong. He said he hoped the dispute would trigger a new National Academy of Sciences review of microfusion, and a Congressional inquiry into the field's management.

But an Energy Department official insisted that the program was healthy and showing considerable promise (…)

"It has had what I would call an enormous success," said Dr. Kahalas, director of the national effort. "There's no way I can tell you about a classified program. But we think we're very close to showing this thing is feasible." A STEP TOWARD HARNESSING FUSION ENERGY In a successful secret experiment, deuterium and tritium isotopes of hydrogen in a tiny pellet were bombarded with X-rays from an underground nuclear bomb test, heating and compressing them to great density. The isotopes fused, producing helium and a burst of nuclear energy, identical to reactions in the sun and hydrogen bombs. The method has no practical use, but might help determine how fusion energy can be harnessed. Source: Department of Energy