Laser Fusion: Breakeven Within 3 Years?

Edward Teller was the first to say it publicly at last week's Conference on Laser Engineering and Applications, in Washington, but before long others were voicing agreement: The long-awaited achievement of "scientific breakeven" in laser fusion is probably less than three years away and may be as close as one year. But the often controversial Teller also made two other statements which sparked more dissension—that the Soviet Union is probably a year ahead of the United States in the race toward laser fusion and that engineering problems will prevent large-scale energy production from the new power source in this century.

Scientific, or theoretical, breakeven means getting as much thermonuclear energy out of a fusion experiment as one puts in through laser light, compressing a tiny pellet of hydrogen isotopes (SN: 8/17/74, p. 107). Large energy losses in the lasers themselves stand between this achievement and the practical breakeven point of getting back as much energy as one puts into the whole experimental apparatus. Teller doubts that an adequately efficient apparatus can be produced in time to allow building a laser fusion reactor in this century. Indeed, he says, there is a danger of getting too excited over scientific breakeven and wasting a lot of money in trying to accelerate the rest of the program too rapidly. This problem is further complicated by security restrictions that Teller says have prevented an open exchange of views and data: "Secrecy must not be allowed to amplify the effects of stupidity."

When he made these remarks, Teller knew something that was not publicly announced until the next day—that other scientists at Lawrence Livermore Laboratory (LLL) had just succeeded in making the best demonstration yet of laser-produced fusion in the core of a fuel pellet. Just over a year ago similar claims were made by KMS Fusion of Ann Arbor, Mich. But many experts in the field then doubted both the KMS data and the significance attached to them (SN: 5/25/74, p. 333), although later data allayed some of the skepticism (SN: 2/15/75, p. 99). Specifically, they speculated that KMS had succeeded only in heating a pellet through internal currents rather than compression—an approach they said would lead nowhere because the pellet would disperse before large-scale fusion could take place inside. The proper approach, most believed, was to compress the pellet as much as possible first and then let the temperature rise during ignition in the core.

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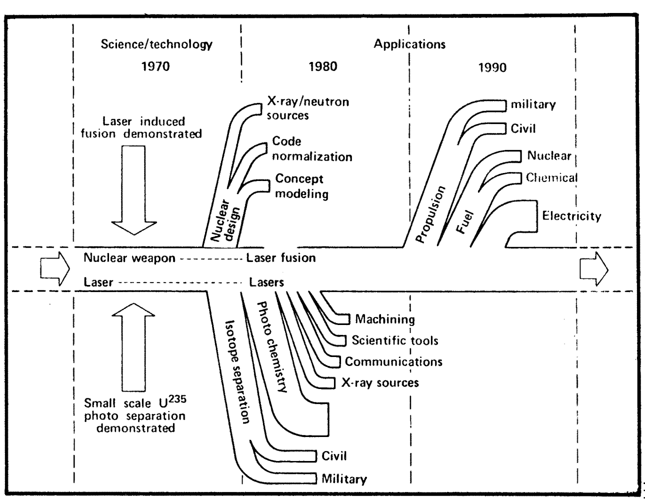
Teller: Russians may be a year ahead.

Unfortunately, the pellets in question are about the size of a large grain of dust, and only indirect evidence exists to indicate what exactly goes on inside the tiny pellet during its few exciting billionths of a second. In a fusion reaction two hydrogen isotopes, deuterium and tritium, join to form helium, giving off a neutron in the process. Counting neutrons has so far been the favorite, though difficult, way of estimating how many fusions took place. The results are open to differing interpretations.

Livermore scientists took a different tack, counting the helium nuclei (alpha particles) as they spewed forth. By applying two laser beams with a total power of 500 billion watts (almost equal to the entire electrical generating power of the United States) for less than a billionth of a second, the scientists were able to count some eight million alpha particles, indicating that at least this many fusion reactions had taken place. An analysis of the energy distribution of the alphas further indicated that computer simulation of the expected compression process had been essentially correct. William F. Krupke, deputy leader of LLL's laser project, told SCIENCE NEWS that the experiment had proven "highly supportive of our experimental approach and rationale."

The success of this experiment, involving two laser beams, bodes well for LLL's projected 20-beam experiment, called SHIVA, designed to demonstrate scientific breakeven, and scheduled for completion in 1977. But if Teller is right about the Russians' being ahead in the laser fusion race, then breakeven might come first at the MISCHEN project of Moscow's Kurchatov Institute, described for the conference by N.G. Kovalsky. The MISCHEN III apparatus, scheduled for completion in either 1976 or 1977, consists of 16 groups of laser beams (with four component beams per group), and is designed to produce a total energy of nearly 40 kilojoules (thousands of watt-seconds) in a burst lasting about one nanosecond (one billionth of a second). Though SHIVA will produce only about 10 kilojoules energy, Krupke still thinks his laboratory has a chance to beat the Russians to breakeven because of the greater care taken in controlling internal energy losses.

Once scientific breakeven is achieved, a major shift of emphasis can be expected in the laser fusion program, as the solid state neodymium-glass lasers being used in all the experiments so far simply cannot be scaled up to the size necessary for practical fusion reactors. More powerful gas dynamic lasers are good candidates, but the most efficient of these—the CO_2 laser—emits light in the infrared and what is required is light with shorter wavelengths, in the visible or ultraviolet portions of the spectrum. Once achievement of breakeven shows unequivocably that a new source of energy is possible, then the search for the best laser to bring it about is expected to intensify. □



LLL

Optimistic timetable for introduction of laser fusion and other laser technologies including isotope separation, weaponry and industrial processes.