Fusions By Electron Beam Produced at Sandia

The program for obtaining controlled thermonuclear fusion by a kind of mini-H-bomb process, compressing a pellet of fuel by zapping it with energy from all sides until the temperature and density reach fusion conditions, began with the idea that laser light would deliver the energy to the pellet. It was not long before suggestions arose that beams of electrons or even of light ions could do the job, too, and perhaps in less touchy ways than laser light. Now Sandia Laboratories of Albuquerque announces the first nuclear fusions produced in the United States by electron-beam implosion of fuel pellets.

The evidence that fusions have in fact taken place is neutrons with an energy of 2.45 million electron-volts. These are a characteristic product of the fusion of two deuterium nuclei. In the Sandia experiments about a million such neutrons were produced per pulse of the electron-generating equipment. The experiments are done by Sandia's Fusion Research Department, directed by Gerold Yonas. James S. Chang, A. V. Farnsworth, M. M. Widner and R. J. Leeper played important roles in these particular experiments.

Although the notion of imploding fusion fuel pellets with electron beams is said to have been first proposed on the industrial flats east of San Francisco Bay—at Physics International in San Leandro to be precise—the Soviet Union has mounted a large program and is somewhat ahead at the moment. The first evidence for electron-imploded fusion in the world came from the Kurchatov Institute in Moscow early in 1976. The Soviet ability to produce electron beams for this and other purposes has been the subject of much speculation recently (SN: 5/21/77, p. 329).

Proponents of electron (and ion) beams for implosion fusion have argued that the use of particle beams rather than light beams to deliver energy to the fuel pellets means that the technology of pellet manufacture is not so important to success. The energy is more easily delivered by particle beams. The pellets can be larger, and their exact shape is not as critical. In fact the pellets used in the Sandia experiments were as large as BB shot. Those used in laser experiments are customarily micropellets much smaller than the head of a pin.

On the other hand, the technology for producing high-power electron beams and transporting them to the target is not as well understood as laser technology. Sandia's research for the last five years has concentrated heavily on this aspect of the work. The electrons are produced in what is essentially a supersophisticated version of the old-fashioned vacuum tube. The electron accelerator used in the Sandia experiments (called REHYD) maintains a potential difference of about a million volts between the anode and cathode of its vacuum diode. Electrons are pulled from the cathode and accelerated toward the anode, where the fuel pellet is located. In the experiment, the beam current, about 250,000 amperes, generated strong magnetic fields that focused the beam down to the diameter of the target (about a tenth of an inch or between 2 and 3 millimeters). The pellet absorbed about 40 billion watts of power. Ablation of its outer layer generated an imploding pressure of about 5 million atmospheres, which crushed the pellet about a thousandfold, raising its temperature to something between 5 million and 10 million degrees K. The length of the pulse was approximately a tenth of a microsecond.

Experiments are continuing with the aim of reaching higher power and shorter pulses. An accelerator now under test is able to produce 8 trillion watts in pulses 24 nanoseconds long. A 40-trillion-watt accelerator is scheduled to be completed late in 1979. According to theoretical figures a fusion power plant using electron-beam methods would require 100 trillion watts in 10-nanosecond pulses. □

Oldest dates for Mayan origins

A second year of excavations at Mayan ruins at Cuello, Belize (formerly British Honduras), has confirmed earlier estimates of an established settlement at the site by 2500 B.C. (SN: 4/24/76, p. 261) and suggests that the original occupation may have occurred before 4000 B.C. The results are reported by a six-member group led by Norman Hammond in the June 16 NATURE.

Radiocarbon dating of specimens of partially burned wood from various strata at the excavation has produced a consistent chronology of occupation at the site from the earliest known times in the formative periods of the civilization. According to this new chronology, these early periods should now be redated by as much as a thousand years, compared to previously accepted theories:

- Early Formative Period: 2500-1300 B.C., which coincides with the limits proposed by others for early ceramic making in Mesoamerica.
- Middle Formative Period: 1300-450 B.C., marked by extensive slash-and-burn agriculture on the surrounding ridges.
- Late Formative Period: 450 B.C.-A.D. 250, ending with the first appearance of inscribed stone monuments that marked the beginning of the so-called Classic Period of Mayan Civilization.

Three specimens of charred wood, however, did not fit into the otherwise consistent chronology. All three were found in strata of the Early Formative period, but in each case they apparently predated the immediately surrounding material by more than 1,500 years. Two of the samples appear to date from about 4000 B.C.

The authors conclude that these samples probably represent material that was reused and redeposited at the site by people who lived more than a millenium after the wood was originally charred (only charred wood could have escaped decay in the tropical environment for that long). The great question, then, becomes: Was the fire that burned the wood natural or manmade?

Although they admit that the data are still "sparse and questionable," the researchers offer three pieces of evidence that tend to support the idea that habitation at the site might go back to 4000 B.C.: First, the pottery found for the earliest firmly established date at the site was already highly developed. Second, human interference with vegetation at a nearby site appears to antedate the established chronology. And third, there does not seem to be a credible alternative ancestry elsewhere in the Americas for the site's later inhabitants. □

First 400-GeV results from Europe

The Super Proton Synchrotron at the CERN laboratory in Geneva, which is Western Europe's counterpart to the accelerator at the Fermi National Accelerator Laboratory in Batavia, Ill., went into operation for experiments on Jan. 7. Of 39 experiments set up at the accelerator, 25 are now taking data, and three have finished. Results of two of these, the first experimental results of the SPS, were reported to the June meeting of the CERN council by Leon Van Hove.

The first experiment physicists usually do with a new accelerator is a so-called beam dump. This is basically a test that everything functions well and that the accelerated protons can produce the secondary particles they are supposed to produce. In this case the primary proton beam and the secondaries (antiprotons, K