

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 pres-

sure 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

mesons and pi mesons) were of such high energy that when struck against a copper target they produced some of the newly discovered psi particles. From the results it appears that antiprotons, K mesons and pi mesons are six times as useful as protons in producing psi particles. One interpretation is that these particles contain antiquarks—protons, according to theory, do not—and the collision of an antiquark in the incoming particle with a quark in the target is an efficient way to make psi particles.

The second experiment also deals with

a trendy topic—interactions of neutrinos at high energy. Four months of data taking have yielded 53,000 neutrino interactions and 15,000 antineutrino interactions. Of these, 300 belong to the rare and fascinating category that includes a pair of muons in the final products of the interaction. Such “dimuon” events are thought to be related to the production of theoretically predicted, but heretofore unseen, species of particle. The claim is made that the accuracy of the CERN dimuon data is far greater than that of the dimuon events so far recorded in the United States. □

Bloodless surgery saves heart victim

In what is believed to be the first operation of its kind in the United States, a Washington, D.C., area man was drained of his blood supply for 37 minutes while doctors repaired a tear in the arterial wall of his heart. In addition, the body temperature of 43-year-old Eugene Tison was lowered to 60°F for the operation, in which the damaged portion of the aorta was replaced with a Dacron tube.

Tison, an employee of Voice of America, suffered a dissecting aneurysm while bowling June 1. The dissection, or splitting, of a portion of the aorta forced blood to flow in two channels, instead of one, between the aorta's inner and outer layers. The heart is hard pressed to continue pumping under such an abnormally heavy work load, and Tison's life was threatened by massive internal bleeding.

Washington Hospital Center surgeons Luis Mispireta and Jorge Garcia sewed the tear, but blood continued to seep through another section of the aortic wall. The walls had been so weakened by Tison's struggle over the previous 18 hours, the doctors reported last week, that the surgical clamp had torn a fresh hole in the wall. It was apparent that another portion of Tison's sopping, flimsy aortic wall needed to be repaired and that the rest of the artery could probably not again stand up to the clamping involved in conventional, open-heart procedure. Mispireta and Garcia quickly decided to attempt the radical, blood-draining procedure.

Tison's body was cooled to about 60 degrees, effectively stopping all body functions and temporarily postponing its need for blood. The surgeons drained the body's full supply of blood for 37 minutes while they replaced the damaged aortic section with a four-inch Dacron tube. The brain was sustained during that period by the oxygen contained in residual pools of blood attached to the surface tissue. However, there was no blood pressure and no moving blood supply during the 37 minutes. Blood was then pumped back into Tison, and in the 50 minutes it took to get his body temperature back to normal, the surgeons finished suturing the synthetic tube to the remaining healthy sections of aorta.

Dopamine hydrochloride was injected into the bloodstream to stimulate heart beat, and Tison was given sodium nitroprusside to keep his blood pressure down and maintain minimal stress on the aorta. Tison was discharged from the hospital

last week.

The doctors concede that the surgery—a combination of “profound hypothermia” and “total systematic arrest”—runs the risk of brain damage, or possibly death, but they said there was little alternative in Tison's condition. The body can tolerate such cold temperatures for about one hour, they added.

Similar body-temperature-lowering procedures have been performed in the past in certain types of spinal cord and brain tumor surgery—some for longer periods than in the Tison case. But Washington Hospital Center officials say they believe this may be the first instance anywhere, and almost certainly in the United States, where the cooling and blood-draining technique has been used in open-heart surgery.

Doctors believe that dissected aneurysms may be hereditary. Tison's father died 43 years ago of what his mother was told was a ruptured blood vessel. □

Olfactory synchrony of menstrual cycles

Six years ago, a young Harvard psychologist made a startling discovery: Martha K. McClintock, studying a group of coeds in a suburban Boston college dormitory, found that roommates and close friends experience menstrual synchrony to a significant degree. Suddenly, it became clear that social interaction could affect women's menstrual cycles, just as it influences them in mice, monkeys and other creatures.

While this may have reduced “the noblest animal” a notch in some minds, it ignited countless curiosities. McClintock proved that the effect could not be due to food, common stress periods, awareness of menstrual timing or to the cycles of the moon and that the only significant factor seemed to be time spent in each other's company. But what transpired during that time together to cause the menstrual synchrony?

That question may have been answered this year by another young researcher, Michael J. Russell, of the Brain Behavior Research Institute at Sonoma State Hospital in Eldridge, Calif. Russell's major research interest is human olfactory communication, and he wondered whether the synchrony could be related to olfactory cues in women just as it's been shown to be in mice. His latest experiment, presented to the recent Pacific Division meeting of the American Association for the Advancement of Science in San Francisco, provides strong evidence that the McClintock effect is indeed related to the sense of smell.

Russell conducted his study at San Francisco State University where he is a guest lecturer in the psychology department. He chose 15 volunteers, ages 19 to 39, for his experimental and control group, and 1 “sensory donor,” a woman

named Genevieve Switz. She had a history of “driving” a friend's menstrual cycle—that is, the friend's became synchronous with hers when they roomed together in the summer and disynchronous when they moved apart in the fall. During the experiments, Switz wore small cotton pads under her arms for 24-hour periods and donated the accumulated perspiration to Russell. He, in turn, mixed it with a few drops of ethanol and applied it to the upper lip of the experimental subjects three times a week over a period of four months. Control subjects received applications of ethanol alone.

In January, the experimental subjects' menstrual periods started an average of 9.3 days away from the donor's starting day. By May, that “starting distance” had been reduced to 3.4 days. The control group, on the other hand, started an average of 8.0 days away from the donor in January, and by May, started 9.2 days from her—no significant change.

It might seem odd that Russell chose to use human perspiration rather than some other body secretion to supply the olfactory stimulus. Others such as saliva, vaginal secretions or even foot odor might have worked as well, he explains, and he would like to test each of them some day. But in a typical modern setting, perspiration odor seemed the likeliest medium of transfer for the chemical signal—if indeed a chemical signal existed at all—and thus he chose to test it.

What then is in the donor's and presumably other women's body secretions, that can influence menstrual cycles? “I don't know,” says Russell, “but that certainly is a prime subject for investigation.” In the meantime, though, he says his findings are a demonstration that odors can change the menstrual cycle. □