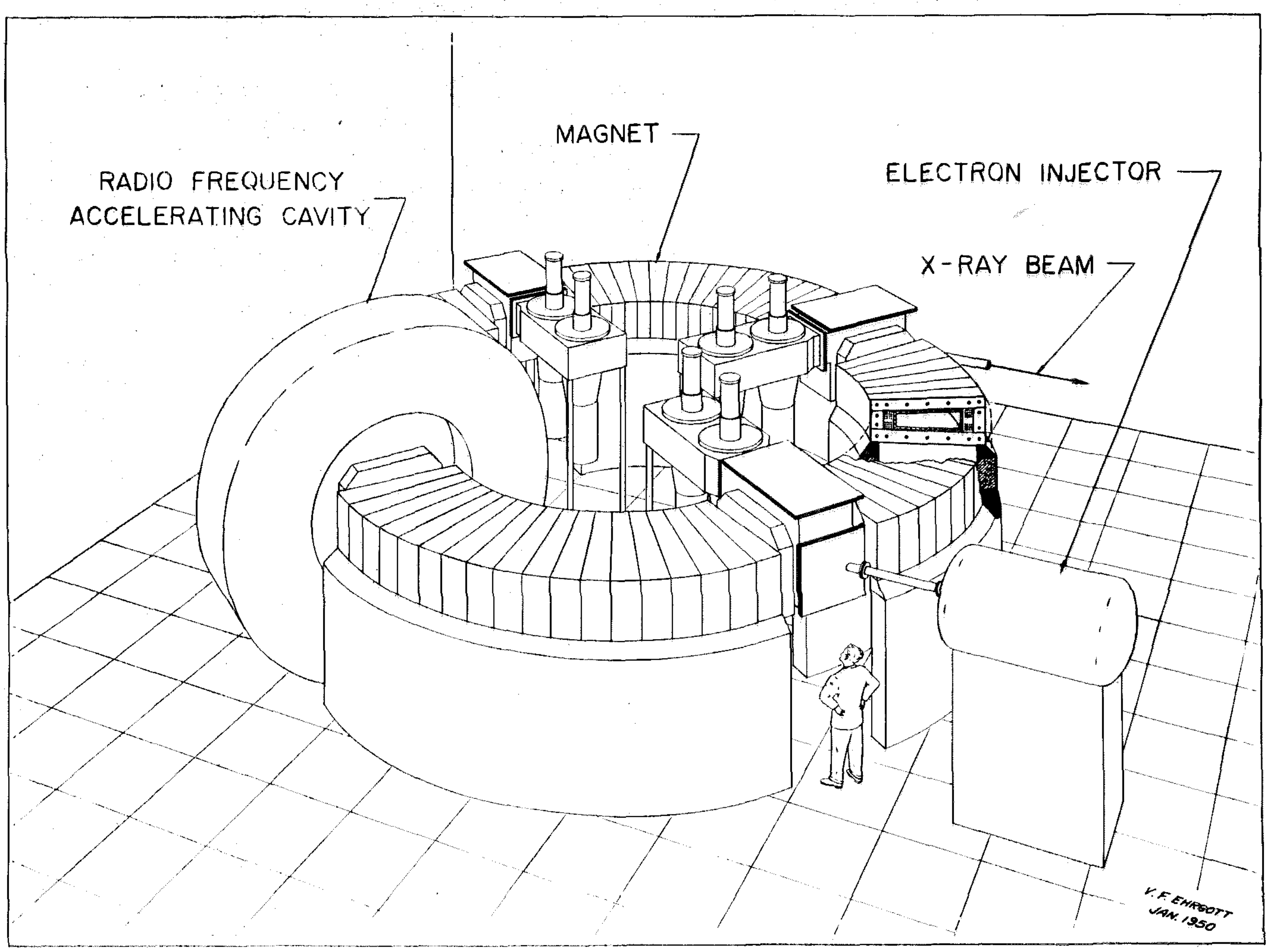


The Billion-Volt Synchrotron

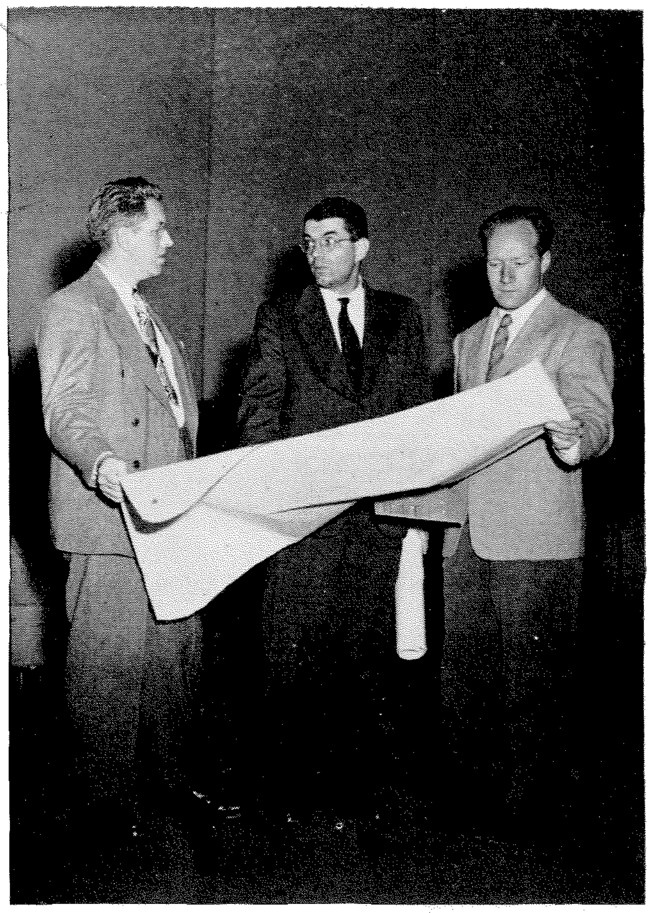
Caltech's new electron accelerator will be the most powerful machine of its type ever built

The Institute has announced plans for a new high energy physics laboratory in which it will build a one-billion-volt electron acclerator, or "atom smasher" (E & S, July '49). The acclerator, an electron synchrotron, will be the most powerful machine of this type ever built. The electron synchrotron principle was first developed by Edwin M. McMillan (who graduated from Caltech in 1928, received his M.S. here in 1929, and his Ph.D. in 1932) of the University of California at Berkeley. A 300,000,000-volt unit is now in operation on the Berkeley campus, and there are similar units at Cornell University, and the Massachusetts Institute of Technology.

Final plans and designs for the Caltech synchrotron were developed during a year-long survey jointly financed by the Office of Naval Research and the Atomic Energy Commission. The conclusion of the survey—that research with electrons of a billion-volt energy was a highly important unexplored field—resulted in an Atomic Energy Commission contract to assist the Institute in building such a machine.

The synchrotron will be built in two stages. First, a magnet (to be obtained from the University of California, where it was used for a pilot model of the six-billion-volt proton acclerator now under construction there) will be used, with minor modifications, to speed up electrons until they have energies of 500,000,000 electron volts. After some experience has been obtained at this energy, the additional modifications will be made to bring the synchrotron to the billion-volt level. The first stage should be completed in about a year; the second in an additional year and a half.

The synchrotron will be housed in the present Optical Shop, where the 200-inch mirror for the Palomar tele-



The men in charge of getting the billion-volt electron accelerator built and in operation—Bruce Rule, Robert V. Langmuir, and Robert L. Walker

scope was ground and polished. Estimated cost of the completed installation, not including the building already available, is something over a million dollars. Annual operating costs of the experimental program to be undertaken after the billion-volt phase has been completed will be about $300,000 a year.

Three man team

Three men will be in charge of getting the accelerator built and in operation—Dr. Robert V. Langmuir, Senior Research Fellow in Physics; Bruce Rule, Director of Central Shop Facilities and Project Engineer in Astrophysics; and Dr. Robert L. Walker, Assistant Professor of Physics.

Dr. Langmuir, who received his Ph.D. from Caltech in 1943, was brought back to the Institute in 1948 from the General Electric Research Laboratories, where he worked on construction of the 70,000,000-volt GE synchrotron. Bruce Rule, who was project engineer for the Palomar Observatory, will handle the applied engineering in construction of the synchrotron. Dr. Walker, who came to Caltech last year from the Laboratory of Nuclear Studies at Cornell University, was connected with the Manhattan Project during the war, and worked at the Metallurgical Laboratory of the University of Chicago and at the Los Alamos laboratory where the atomic bomb was built. He is mainly responsible for the design of experimental equipment to be used in connection with synchrotron research projects.

While the fundamental principles in electron synchrotrons were first proposed simultaneously by E. M. McMillan of the University of California and Dr. V. Veksler of Russia, the actual design of the instrument to be built at Caltech is to be a modified version of a type first suggested by Dr. H. R. Crane, Professor of Physics at the University of Michigan. Dr. Crane, who received his B.S. from Caltech in 1930, and his Ph.D. in 1934, is now back here for a few months as visiting professor.

A race-track accelerator

The machine will be of the so-called "race track" type, in which the magnet is split into four quadrants with straight sections in between. As the electrons circulate around the race track at speeds very close to the velocity of light, a radio frequency oscillator will provide properly timed accelerations during each turn while the electrons are traversing one segment of the straight track. The outside diameter of the race track will be about 36 feet and the electrons will travel around it for a total distance of some 90,000 miles before reaching the maximum energy of a billion electron volts. Electrons will be fed into the machine at an initial energy of about 1,500,000 electron volts by the use of a pulse transformer. As each burst of electrons is introduced into the machine the magnetic field automatically rises steadily to keep the electrons in a proper orbit, while at the same time radio frequency acceleration goes into operation.

When they reach their full energy, the electrons may be used directly for the bombardment of atomic nuclei, or more frequently they will be used to produce billion-volt X-rays by impingement on a suitable target. At these energies the effects of electrons and of X-rays are expected to be more or less indistinguishable.

It has already been found that in cosmic-ray phenomena, as well as in the high-energy experiments at Berkeley, at the University of Rochester and other places, that the bombardment of nuclei with energies above 200,000,000 electron volts results in the copious production of mesons. These are the mysterious short-lived particles first predicted by the Japanese theoretical physicists Yukawa, and first discovered experimentally by Dr. Carl Anderson in the Caltech laboratories. This particle, intermediate in mass between the light electron and the heavier proton, seems to be important in nuclear binding forces, serving as a sort of glue to hold nuclei together.

Increasing our knowledge of nuclear forces

"The purpose of this new accelerator," says Dr. R. F. Bacher, Chairman of the Division of Physics, "will be to seek additional knowledge about the nature of the forces that hold atomic nuclei together. Our knowledge of nuclear forces and their relation to the fundamental particles of nature is very incomplete. To obtain a better understanding of these forces is one of the most important goals of present-day physics. At the Berkeley Radiation Laboratory and at the Brookhaven National Laboratory, this problem will be studied with the accelerated protons (hydrogen nuclei) which they will obtain from the great machines now under construction. We shall attack the problem using the X-rays and electrons from the billion-volt electron synchrotron. We expect this work to yield additional important information."

"As in all basic research problems," President DuBridge points out, "the results obtained cannot be predicted. Much less can one predict what practical application, if any, will turn up. We do know, however, that nuclear energy is the main source of energy of the universe, and it is clearly important for us to understand more about the nature of this energy."