

the magnet

Season's Greetings

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HEAVY ELEMENTS FORMED IN NUCLEAR TEST

The successful production of synthetic ultra-heavy elements in an underground nuclear detonation has been demonstrated and reported by LRL scientists.

Announcement of this important advance in technology was reported by Livermore director John Foster late last

month. Foster was reporting on the analysis of materials obtained after a completely contained underground nuclear explosion in Nevada on October 9. The

results of the experiment, he said, demonstrate the practicability of using the method to produce significant quantities of isotopes of ultra-heavy synthetic elements.

The measurements show that in a very short time—about one hundred millionth of a second—the explosion pumped up to 17 consecutive neutrons into atoms of natural uranium. Following capture of the neutrons, the uranium isotopes underwent beta decay to form heavier elements in the periodic table, including californium-254 and fermium-255.

The experiment (code-named PAR) was the latest in a series started in 1962, and is part of the AEC's Plowshare program to apply nuclear explosives to peaceful purposes.

In PAR, a specially designed nuclear explosive system containing a uranium-238 target was detonated at a depth of 1330 feet in the alluvium of the Nevada Test Site. The explosion had a yield of about 30 kilotons. The explosive was designed to enable the U-238 nuclei present in the target to absorb the maximum number of neutrons.

The formation of heavy elements through neutron capture and subsequent beta decay was first observed in the

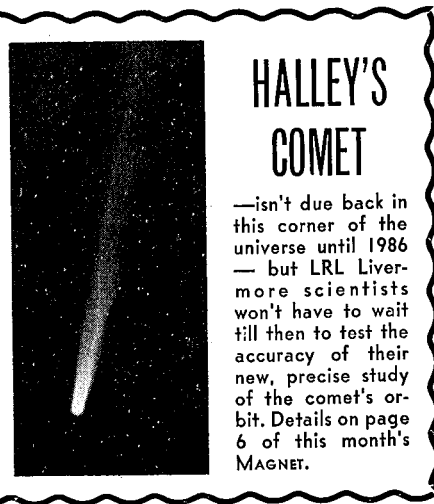
initial hydrogen bomb test (MIKE) in the Pacific in 1952. In the debris of MIKE, scientists discovered element 99, einsteinium, and 100, fermium, which had been created by multiple neutron capture in the uranium present. Partly as a result of MIKE, cosmologists now believe that this process occurs in the stars and plays an important role in the synthesis of elements in nature.

Analysis of small samples of fused glass, obtained by drilling to the region involved in the PAR detonation, shows that the explosion yielded a neutron flux approximately three times greater than that of the 1952 MIKE test. The PAR flux was twice as great as had been achieved in previous Plowshare underground experiments.

A major indication of success was the concentration—a thousand times greater than previously achieved—of californium-254 in the PAR samples. Observations on the yields of californium-254 and other heavy species are in general agreement in the four laboratories studying PAR samples—LRL Livermore and Berkeley, Los Alamos, and Argonne.

So far, scientists have observed elements as heavy as fermium-255, which requires successive captures of 17 neu-

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HALLEY'S COMET

—isn't due back in this corner of the universe until 1986 — but LRL Livermore scientists won't have to wait till then to test the accuracy of their new, precise study of the comet's orbit. Details on page 6 of this month's **MAGNET**.

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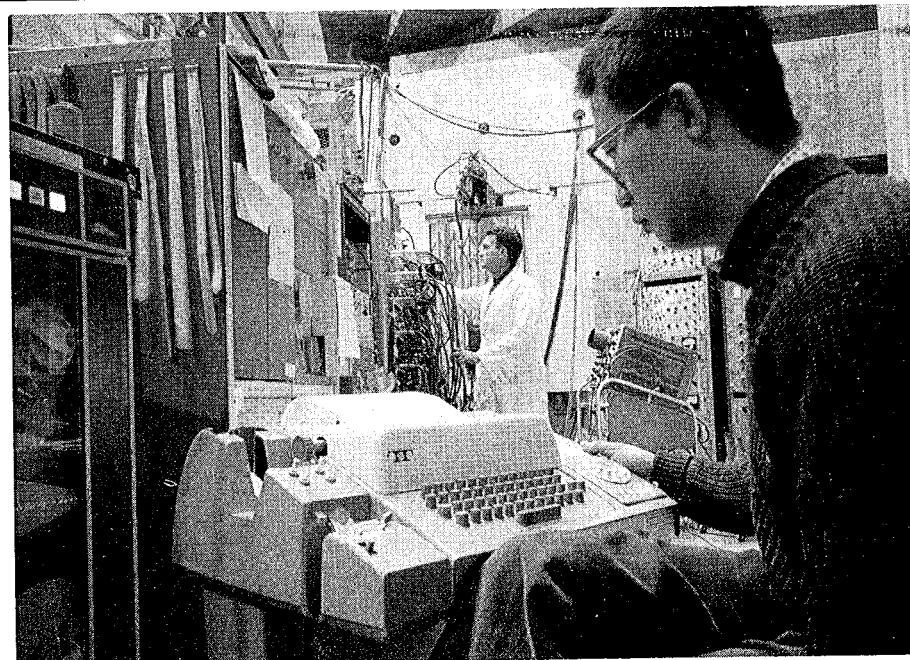
Computer-Centered Counting System Gives Fast Results

A pint-sized but precocious computer no larger than an office desk is revolutionizing the way nuclear physics experiments are performed at LRL Berkeley accelerators.

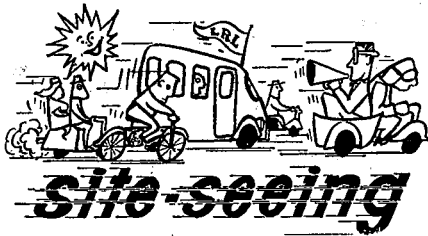
The computer, the compact Programmed Data Processor (PDP) 5, is the core of a new system of data collection and preliminary analysis devised within the past year by Electronic Engineering's Nuclear Instrumentation Systems Group, under Fred Kirsten. The system is adaptable for use with electronic counters, spark chambers, wire chambers—virtually all the commonly-used particle detection devices with the exception of bubble chambers.

By substituting a computer for conventional electronic gadgetry like pulse height analyzers and data combiners, the new system permits instantaneous feed-

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A NEW RELATIONSHIP between computer and experimenter is foreshadowed in this PDP-centered counting system at the 184-inch cyclotron. Computer is the upright unit, second from left. Physicists David Cheng (foreground) and Burns MacDonald, of the Moyer-Helmholz group, use an on-line typewriter (foreground) to ask questions of the computer, get their answers right back on the same sheet of paper. Experiment, which ran in early December, was a study of proton-neutron polarization from 300 to 700 MeV.



IT WAS a little over ten years ago that a group of Berkeley employees got together to form the Laboratory's first recreational and social association—and decided to name it after the cyclotron which for so long symbolized this Laboratory's work and achievements. Recently, "in recognition of the assistance they gave to the club in its formative years," the directors of the 184 Club presented honorary Charter Memberships to seven veterans of that first group, all still members in good standing, now members for life. Those honored were—Jean Baxter (Business Office), Verdery Chester (Stores), Ernie Coleman (Business Office), Margaret Ezra (Electronics Engineering), John Freshwater (Plant Engineering), John Nelson (Plant Engineering), and Grimes Westford (Machine Shop).

* * * *

FILMS FEATURING LRL people and programs are included in the extensive film library on atomic-energy subjects offered by the AEC to the public for educational, nonprofit, and non-commercial group screenings.

The films, produced by AEC-affiliated laboratories across the country, range from technical to non-technical and deal with specific scientific, technological, and engineering aspects of the atomic-energy program. Some LRL titles available on loan from the AEC Motion Picture Libraries include *Project Sedan* (1962), *Project Gnome* (1963), *Industrial Applications of Nuclear Explosives* (1958), *Analysis of Neutron-Nucleon Scattering Experiments* (1961), *Cyclotron Irradiation of the Pituitary* (1958), *Project Gnome Technical Report* (1963), and *Living With a Gloved Box* (1963).

Other subjects covered by the AEC-produced films include uranium prospecting, mining and production; nuclear reactors; nuclear propulsion; nuclear research; beneficial radiations—in industry, biology, agriculture, and medicine; radiation hazards, safety, and waste disposal; atoms for peace; nuclear weapons and testing.

As a part of its information and education program, the AEC maintains ten motion-picture libraries from which qualified borrowers throughout the U.S. and Canada may obtain prints free of charge. The AEC Motion Picture Library in this area is located at the San Francisco Operations Office, 2111 Bancroft Way, in Berkeley.

PDP-5 System for Data Analysis...

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back of information to the experimenter. It also allows quick and easy modification of the whole detection system: a PDP-5-centered system can be altered simply by changing the computer's program, instead of tinkering with wires and circuits.

Continuous Display

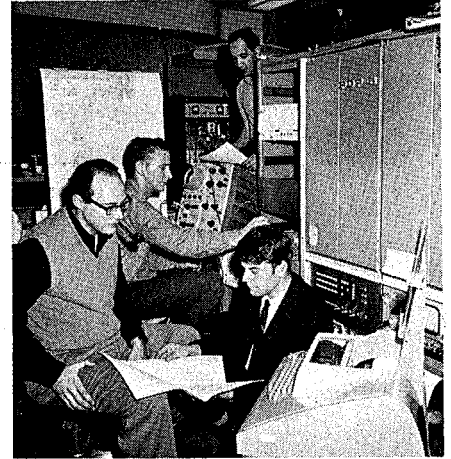
Under the new system, an on-line PDP-5 computer receives all data as it is recorded by scintillation counters, spark chambers, or other detection devices. The computer makes a quick analysis of the data (i.e., types of events recorded, energy range, etc.) and presents it in the form of a histogram or continuous graph display on the face of a cathode ray tube. Detailed analysis of data is not attempted. This is done later, by feeding the data, in the form of magnetic tape, into an off-line high power computer like the IBM 7094.

The system requires a standard PDP-5 as part of the apparatus for each experiment. Fortunately, the PDP-5 is extremely inexpensive as computers go (a fully-equipped unit sells for about \$27,000.) LRL Berkeley currently has five of them. Two are permanently assigned to the physics program, a third, leased on a temporary basis, is also assigned to physics, a fourth is assigned to chemistry and is located at the 88-inch cyclotron, and a fifth belongs to the UCLA User's Group.

The PDP-5's are so portable that they are easily shuttled around the Hill. Between experiments, they are moved back to the Nuclear Instrumentation Group's electronics shop, or to another of the Hill's instrumentation shops, to be linked together with other electronic devices to form a system for the next job.

Future Goals

The use of a computer "on-line" in physics experiments is new at the Berkeley Lab, and represents an important step towards the eventual goal of direct, instantaneous communication between experimenters and high-speed computers. Systems currently under development, in Berkeley and in Livermore, may someday



BETWEEN JOBS a PDP-5 computer returns to Nuclear Instrumentation's shop in Building 50-A, where it is prepared for its next assignment. Shown above, checking out program for a forthcoming Bevatron run, are programmer Tony Schaeffer (pipe, L.), and Nuclear Instrumentation Group members Mike Wolverton, Stan Klezmer (rear) and Sypko Andreae.

make it possible for each experiment to have a powerful computer like the 7094 "on-line." In the meantime, physicists who have used the new PDP-centered system declare themselves well satisfied with the advances in speed and efficiency over older methods. Formerly, an experimenter had to wait until his data were processed from tape on the 7094 (a delay sometimes amounting to hours or days) before he knew if he were getting the results he wanted from his experimental setup.

Development of the PDP-5 system was part of the Electronic Engineering Department's continuing program to explore new hardware and techniques in the field of data acquisition and analysis. The 12-man Nuclear Instrumentation Group is a part of E.E.'s Physics Instrumentation Division, headed by Dick Mack. Work on the PDP-5 system and associated projects for physics is supervised and coordinated by Sypko Andreae. Much of the "software," or programming, has been done by a Math & Comp group under Don Zurlinden.

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