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MONTHLY PROGRESS REPORT NO. 125
August 15, 1953 to September 15, 1953
October 5, 1953

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UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

August 15, 1953 to September 15, 1953

MONTHLY PROGRESS REPORT NO. 125*

October 5, 1953

1. EXPERIMENTAL PHYSICS
(A. E. C. Program No. 5211)UNCLASSIFIEDProduction of H^3 and He^3 in Deuteron-Deuteron Collisions

A run was conducted on the 184-inch cyclotron to compare the yield of H^3 and He^3 from deuteron-deuteron collisions. The new liquid deuterium target was used. The three parameters of H^3 , dE/dx and E were used to separate and identify the particles. The He^3 's were readily identified and counted. The H^3 's, however, were not separable from a heavy background of target created deuterons of widely varying energies. These deuterons could not have come down the magnetic channel except by some secondary process such as scattering off the channel walls. They may have come around the outside of the channel by virtue of the fringing field. The next run will concentrate on eliminating them by better collimation and better shielding. A comparison of the He^3 yield with previous H^3 measurements allows one to say that, within a factor of two, the He^3 yield and H^3 yield are equal.

The Photoproduction of Negative Pions from Deuterium

The identification of the process $\gamma + d \rightarrow \pi^- + p + p$ has been described previously. [See R. Madey, Ph.D. Thesis (Unpublished - UCRL-1634). Also see R. Madey, K. C. Bandtel and W. J. Frank, Phys. Rev. 85, 771A (1952), "The Photoproduction of Negative Mesons from Deuterium".] These data were taken when the synchrotron beam was about 200 times lower than it now is. A synchrotron run has been completed recently during which the identification has been done again with better statistics. The identification consists of angular correlations, coplanarity and range tests, and time of flight correlation. The possibility of attempting to fit the data to theoretically predicted curves is being investigated.

* Previous report UCRL-2332 (No. 124).

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Range - Energy Program

Work on the new range-energy tables has been completed and the results are in process for publication under the number UCRL-2301. The data will be printed up in five sections, one for each of the following particles: π^+ mesons, protons, deuterons, tritons, and He^3 . In each will be tables of range and stopping power versus kinetic energy, plots of range versus kinetic energy, and plots of stopping power versus kinetic energy for the given particle in the following list of substances: Be, C, Al, Cu, Pb, Air, H_2 , D_2 , H_2O , D_2O , CH_2 , CD_2 , Stilbene, Phenyl-Cyclo-Hexane, and $\text{C}_5\text{H}_8\text{O}_2$ (plexiglass).

Also included will be a table of total energy, momentum, β , $1/\beta C$, and γ versus kinetic energy for the given particle. The energy range covered by the various graphs and tables will be from about 1 to 10^4 Mev.

Gamma Ray Pair Spectrometer

Calculations made from the last run bring out the following results. The experimental bremsstrahlung spectrum from 140 Mev protons on beryllium at 90° is in very good agreement with a $d\nu/\nu$ type of spectrum corrected for nuclear momentum distribution. Also, the thermocouple technique of monitoring internal beam current appears to be a valid one. At the present time, an artificial calibration is being made to refine these thermocouple results.

A Comparison Study of $p + d \begin{cases} \rightarrow \text{H}^3 + \pi^+ \\ \rightarrow \text{He}^3 + \pi^0 \end{cases}$ as a Test of Charge Independence

The study of the angular distribution and yield of the first process ($p + d \rightarrow \text{H}^3 + \pi^+$) has been completed and reported in UCRL-2292. A similar study of the second process ($p + d \rightarrow \text{He}^3 + \pi^0$) involving a coincidence between the two particles would be rather difficult because of problems connected with the detection of the π^0 . For this reason, it was decided to compare only the heavy particles at a given angle by measuring both range and the specific ionization. The counter arrangement has been built and is presently being calibrated with the He^3 and H^2 beams of the cyclotron. The deuterons are used at energies corresponding to the dE/dx and E triton losses in the proper counters.

Cerenkov Radiation Counters

Work is continuing on a Cerenkov counter. Dumont 6292 phototubes have been tested at various temperatures down to 65°C . Two coincidence circuits have been built which have resolution times of the order of 5×10^{-9} seconds, for 0.2 volt pulses, and ratios of 25:1 for 0.4 volt pulses. Testing of magnetic toroids as coincidence and memory storage units has been instigated.

Nuclear Internal Momentum Distributions

A cyclotron run was made observing one proton from each collision only. The gates are formed by a double coincidence in two stilbene "slit" crystals. This gives a high counting rate, and allows one to check the uniformity of the 35 spectrometer channels. The electronic tubes in the 35 channel amplifiers were re-arranged to make the response more uniform. The shielded cable leads from the 35 phototubes have been shortened and made the same.

The width of the defining slit was cut to one-eighth inch, and the target sizes were cut in half, in order to sharpen up the energy resolution of the spectrometer. The hydrogen peak now falls in about two of the 35 channels. With this method CH_2 , CD_2 , lithium, beryllium, carbon, and aluminum were observed. The beryllium and carbon spectra are very similar, but are somewhat wider than the lithium spectrum. Better statistics are needed.

Nuclear Scattering of 2.8 Mev Gamma Rays

Attempts to measure the elastic scattering of 2.8 Mev gamma rays from hydrogen have been frustrated by having too weak a source of Na^{24} gamma rays to detect a difference between CH_2 and C. As a consequence a styrafoam liquid hydrogen target of 120 liters capacity is being built to give a higher ratio of hydrogen scattering to background scattering.

Liquid Hydrogen Bubble Chamber

A liquid hydrogen bubble chamber similar to the one built by R. Hildebrand at Chicago is under construction.

Resonance Excitation of Delayed Heavy Particle Emitters

Another bombardment was made to study the characteristics of the Na^{20} integrating counter. Using a filling of 0.8 cm neon and 2 atm. of helium, it was possible by fine adjustment of both the linear amplifier gain and the scaler discriminator to make the integrating counter agree within ± 3 percent with integration from the Faraday cup up to average currents of 4×10^{-8} amperes. At higher currents, a saturation effect appeared which might be ascribed to a lowering of voltage on the counter by the huge ionization resulting from the beam passing through the counter. Below this level, the difficulty encountered in the above adjustments arises from the following:

- (1) In addition to the inherent alpha energy distribution from the $\text{Ne}^{20*} \rightarrow \alpha + \text{O}^{16}$ reaction, the range of the alphas is greater than the diameter of the counter. Consequently the minimum alpha pulse height is only a few volts above the maximum β pulse height.

- (2) As the current through the counter is raised, each pulse height decreases in relative proportion.
- (3) Since the branching ratio of the Na^{20} positron activity to Ne^{20*} is small, the beta pulses begin to pile up on each other.

The effect of (2) and (3) at high current is to decrease the region between the minimum alpha pulse height and the pile up beta pulse heights to a volt or less. This effect can be lessened by reducing the amount of neon present, but only at the expense of sacrificing the number of counts per microcoulomb of beam.

Neutrino Experiment

The apparatus has been modified for use outside the bombardment area of the linear accelerator. The target is placed in the accelerator beam just after it enters the bombardment area. A vacuum pipeline carries the Ne^{19} back out of the bombardment area to the apparatus proper which is thus protected from the high neutron flux in the bombardment area. Preliminary indications are that this location has eliminated a troublesome source of background in the recoil counter. The dynode structure of a Dumont 6292 photomultiplier tube is now being used for the recoil counter, as the first dynode has a larger area than the RCA tube used until now.

Film Program

The Scattering of Electrons by Atomic Nuclei. The scattering of electrons and positrons at both large and small angles has been studied by observing their tracks as they penetrate nuclear emulsions. The large angle scattering ($> 4.0^\circ$) of ~ 40 Mev electrons and positrons has been compared with the Rutherford scattering law. Within the statistics available, fair agreement was found with the relativistic Rutherford formula.

A scheme of analysis for γ -ray spectra based upon multiple scattering measurements of the pair production electrons has been developed. It is applied to the determination of the energy spectrum of γ -rays emitted by a beryllium target under bombardment by 330 Mev protons.

The Range-Momentum Separation of Spallation Products. A technique, involving a range-momentum separation of particles, for studying the high-momentum range of the spallation products has been developed and applied to 380 Mev alphas on carbon and silver. The scanning for the spectra of He^3 , H^3 , d and p is under progress. The carbon and silver data, characteristic of the light and heavy elements found in photographic emulsion, will

be compared with the star production in G5 emulsion by 380 Mev α -particles. The prong number distribution of the first 116 stars observed in this latter study is:

number of prongs	1	2	3	4	5	6	7
number of stars	18	37	18	19	12	6	6
percentage	15.5	31.9	15.5	16.4	10.3	5.2	5.2

The π^+ and π^- Production Cross Sections. The study of π^+ and π^- production cross sections as a function of atomic number, Z, and neutron number, N, by protons is being continued.

Spiral Orbit Spectrometer. The spiral orbit spectrometer has been used successfully at the synchrotron and the scanning of the plates to measure the π^+ production cross section by $\gamma + p$ is now being carried on.

Meson Beam Tests. A test run for the meson beam geometry on the 22-inch meson magnet was made. Information was obtained about the energy spread of the π^+ peak produced by $p + p$ (340 Mev) when absorbed by 1/4 in. to 1/2 in. Cu absorber. The data showed the possibility of using the π^+ peak for the purpose of scattering experiments.

Other Research. Other research programs under progress are: (a) γ -ray spectrum from Pb under bombardment by the 320 Mev bremsstrahlung beam; (b) high energy β -ray spectra; and (c) momentum and angular distributions of spallation products from various targets under proton, deuteron, and alpha bombardment.

Cloud Chamber Studies

Pion Production in Deuterium by 300 Mev Neutrons. The control console of the 10 atmosphere cloud chamber has been redesigned and rebuilt to make control easier and more precise. A new manifold for the nitrogen supply has been built and a bottle holder designed that will fasten to the magnet frame. The new manifold will permit the changing of nitrogen bottles without interrupting the cloud chamber's operation. This will result in saving considerable cyclotron time.

Interactions of 32 Mev Protons in He³. The analysis of the elastic scattering has been completed, giving a center of mass angular distribution of elastically scattered protons from 25° to 165°. The distribution is highly peaked in the forward direction, falls to a minimum, and rises in the backward direction - an effect probably due to exchange type interactions. The analysis of the inelastic events is now in progress.

Interaction of 32 Mev Protons in Oxygen and Nitrogen. A run which resulted in about 400 pictures was made. No analysis has been started since this is insufficient data for any reliable statistics. Another run is being planned.

Interaction of 32 Mev Protons in Methane. A run was made and some data was acquired, however another run is being scheduled.

Thirty-five Atmosphere Diffusion Chamber. This chamber was operated in the neutron beam on Sept. 19 and 20th. The first day the chamber was filled with hydrogen and the second day helium was used. No analysis has been made, however some mesons were observed in helium.

It was noted that the sensitive region was only 0.7 inches deep in both gases at a pressure of 500 P.S.I. An expansion unit is being designed and built to make the chamber a semi-expansion type. Theoretically this will make the sensitive region much deeper.

Low temperature "O" rings made of Teflon and Kel-F. have been ordered and will be tried along with the expansion unit.

The Largest Diffusion Type Chamber. An extensive report of all work done on the 8 ft. long by 4 ft. wide and 4 in. deep diffusion type cloud chamber is in process. It states the problems of the experiment, the results and the analysis of the data.

Synchrotron Studies

A number of long runs filled up the month's activity on the synchrotron. In addition some work on calibration was performed. This work has resulted in fair agreement between the Cornell ionization chamber, the Illinois ionization chamber and the Blocker-Kenney methods. In connection with the photofission measurements mentioned below, calibrations at energies down to 150 Mev were made, and the agreement was also fairly good. The three methods seem to agree to about 10 percent at present. In this connection, it is important to know the maximum energy of the bremsstrahlung. Measurements with the pair spectrometer have given about 335 Mev instead of the commonly 322 Mev.

A short run was made to test out the equipment for the measurement of the yield of π^+ photomesons from H at larger angles. A run for collecting data is scheduled for next month.

The runs have been completed on the Compton effect at high energies. The data came in somewhat slower than had been expected so that the angular distribution data is accurate to about 10 percent. The angles measured were 4° , 8° , 16° , 20° , and 30° . The results are being computed and will be reported.

The photofission cross section of U and B is being investigated by varying the upper energy of the synchrotron beam. The upper energy was measured on the pair spectrometer and the calibration of quanta was measured as mentioned above. Results will be reported.

2. THEORETICAL PHYSICS
(A. E. C. Program No. 5211)

UNCLASSIFIED

A program of calculation aimed at generalizing Fermi's treatment of extremely high energy nuclear collisions is under way. It is hoped that the results will be useful in estimating orders of magnitude of possible processes occurring in the bevatron beam.

An impulse-approximation calculation of the reaction $n + d \rightarrow \pi^- + p + d$ has been carried out under the assumption that meson production results from $n - n$ collisions only. The experimental $p - p\pi^+$ excitation function and angular dependence are taken to apply to the $n - n\pi^-$ process by assuming charge symmetry. The large number of variables required to specify a final state allows a variety of choices as to the proper variables to be compared with the existing cloud chamber data. The meson angular distribution appears to be consistent with presently available data, although the calculated results are not sensitive to the assumed angular dependence of the $n - n\pi^-$ process. It is expected that the meson energy distribution will be more sensitive. The large observed probability for a high energy final state proton shows a need for correction to the impulse approximation. Additional calculations are in progress.

A search is being made for a new way of circumventing infinities in field theory by generalizing the classical methods applied by Hadamard to spurious singularities in hydrodynamic problems.

A thesis has been written on the nucleon compton effect and on high energy deuteron photodisintegration.

The application of Monte Carlo methods is being planned for a problem in neutron reflection by slabs, considering energy degradation and variation of scattering cross section with energy.

The meson-nucleon scattering calculations for intermediate coupling constants, reported previously, are continuing. The results of numerical work will soon be available in sufficient quantity to allow an assessment of the implications of the new method being used. A paper is being prepared for submission to the Physical Review.

The phenomenological study of meson production in proton bombardment of nuclei has been completed. A very good fit of the data for π^+ and π^- production at 13 and 27 Mev from various nuclei from aluminum to lead has been obtained by taking into account proton energy degeneration and meson reabsorption in the nucleus.

The Bethe-Salpeter equation for a deuteron has been considered in the adiabatic limit, with rigorous inclusion of the negative energy components. An estimate indicates that neglect of these components by other workers may have been unjustified. The second and fourth order adiabatic potentials are being calculated.

The first order corrections to the impulse approximation are being studied, in order to assess its applicability to the scattering of π mesons by bound systems. The corrections include multiple scattering effects and those arising from the binding potential.

3. MTA TARGET PHYSICS PROGRAM
(A. E. C. Program No. 4900)

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During this period, most of the activity of the target group was concentrated on fundamental calculations of attenuation cross sections of various target materials for different bombarding particles, and attempts to construct nuclear models to explain these cross sections. One further attenuation run was made using He^3 ions, and the results of this run are being compared with previous attenuation data obtained with protons and deuterons. A complete report of this work is being written and will be published within the next month.

Work on the proton-recoil telescope is continuing, and the rapid absorber-changer has been completed.

The profile studies of the 320 Mev deuteron orbits inside the cyclotron were completed, using the two shielded ion chambers on the proton probe. The analysis of these results is still incomplete, although preliminary indications are that the beryllium stripping target is about at the optimum position. This would tend to indicate that any increase in external deuteron beam must be effected by an increase in the circulating beam and not by increasing the fraction of the beam brought out of the cyclotron.

4. ACCELERATOR CONSTRUCTION AND OPERATION UNCLASSIFIED

Bevatron Construction. (Program No. 9001)

Magnet. During the period all the top pole bases have been installed and preparations made for putting the top yoke slabs in place. Some of the parts which have been stored outdoors since the last magnet operation last fall are being cleaned. Design work on the shrouding for the magnet air cooling system which has to surround the entire magnet is almost complete. The present schedule calls for completion of assembly of the magnet by September 25th and first operation at low power during the week of the 28th. By October 5th we expect to have equipment ready for the start of magnet testing which is scheduled to go on for five weeks.

Vacuum System. On August 27th, installation of the last curve tank was completed and the complete vacuum tank was pumped down. Since that time, it has been under vacuum a total of about two weeks. At the end of the period the pressure had been down to 2×10^{-5} mm without liquid nitrogen, to 1×10^{-5} mm with liquid nitrogen traps in the tangent tanks and to 5×10^{-7} mm with liquid nitrogen traps on the ion gage. Half a dozen leaks were found which were repaired without difficulty. As the untrapped pressure is still falling steadily, we hope that an untrapped pressure of 10^{-5} mm will be obtained by the time operation starts. A pressure of 10^{-5} mm is expected to be entirely adequate for operation.

Injector. The linear accelerator is operating steadily on proton-proton scattering. The inflector parts are in the machine shop and proceeding on schedule. It was decided to reduce the deflection angle from 40 to 35 degrees in order to increase the energy acceptance of the inflector. This is rather a minor change in parts now being made.

Accelerator. During the period the saturable reactors were installed to tune the drift tube accelerating electrode, and the oil cooling system for the reactors has been placed in operation. Some trouble occurred from high voltages due to static charges built up in the flowing oil. Enough current flowed to start to puncture one of the lucite reactor cases. We believe this problem has been solved by modification of the oil filters. The plate power supply for the final power amplifier tube has been installed and tested.

184-inch Cyclotron Operation. (Program No. 5741)

The cyclotron was used for research experiments approximately 83.5 percent of the 531 hours that the crew was on duty.

An appreciable fraction of the time was used this month on tests of an enclosed ion source. The ion source was expected to do two things: (1) increase the beam current, (2) decrease the radial oscillations. Actually the beam current was approximately one-half of that normally obtained with the standard open ion source. However, it was found upon removal of the ion source that one of the cold cathodes was completely gone and the other one showed very little erosion, and thus there is the question that the arc may not have been properly distributed along the tube.

Preliminary analysis of the data showed that the radial oscillations were reduced and thus the ion source acted as was expected in this respect.

The time distribution was as follows:

Operations for customers	443.25 hours	83.5 percent
Maintenance	7.75	1.5
Pump down (cold cathode ion source tests)	17.00	3.2
Installation of new equipment (cold cathode ion source)	57.75	10.8
Miscellaneous	<u>5.25</u>	<u>1.0</u>
Totals	531.00 hours	100.0 percent

184-inch Cyclotron Modification. (Program No. 4900.02)

Magnet. Repair of the weld cracks on one of the auxiliary coil tanks has been completed and this tank is undergoing final vacuum testing. The second coil tank is expected to follow in approximately two weeks.

The first shipment of the auxiliary coil conductor insulating tape has been received and some difficulty in the adhesive sticking to the wrong surface in unrolling the tape has been encountered. Negotiations with the supplier of this tape is underway to improve the situation on the balance of the order.

The pole disc blank order from Lukens Steel has been completed and bids are in on the machining contract. The order will be placed with the low bidder immediately.

Radio Frequency Design. Detailed design is in progress on the dee and the movable panels, as well as continued studies using the one-half scale model to determine the best method of coupling the oscillators into the resonance cavity. The capacitor vacuum tank is complete and bids have been received on fabricating this item.

Vibrating Condenser. Orders have been placed for the forgings from which the vibrating blades will be machined. A machining contract is now under negotiation with a San Francisco shop. Some difficulty has been encountered with the copper plating peeling away from the nitrided surface on one of the test blades. A program of study of plating techniques is being considered to ensure that this will not happen on the production parts.

Deflector. Orbit plots are continuing. In order that the deflector design may be optimized, it is planned to build a model of the proposed pulsed magnetic deflector in which the magnetic field produced can be measured as a function of position and time.

General. Considerable design effort is being devoted to fixtures and special devices to facilitate the installation of the various parts during the shutdown. Detailed planning is continuing in order that the down time may be minimized.

60-Inch Cyclotron Operation. (Operated by the University of California)

The 60-inch cyclotron was run for 147 hours during the past month, out of an available 340 hours. This lack of operation was due to a decrease in request for bombardment time rather than in the inability of the machine to perform.

The remaining time was spent in pursuing heavy ion acceleration problems and in testing various source ideas.

Synchrotron Operation. (Program No. 5731)

The synchrotron performance was satisfactory during this report period with the exception of vacuum difficulties for a few days. These difficulties were caused by a crack in a rubber segment joining gasket. Various attempts at patching failed when the leak would open up after a few hours running. Finally a successful technique was devised and the patching has not failed during the past three weeks running.

Bombardments are continuing to be made for various groups with the electron linear accelerator.

The group's major effort continues on the development of the Livermore electron linear accelerator.

Operating statistics are as follows:

Operation for customers	302.0 hours	75.4 percent
Maintenance	<u>98.5</u>	<u>24.6</u>
Totals	400.5 hours	100.0 percent

Linear Accelerator and Van de Graaff Operation. (Program No. 5751)

During the period of August 15 to September 1, there were no linear accelerator bombardments for research purposes. This period was spent in "shake down" operation on the rebuilt Van de Graaff generator, and some research bombardments were made at 4 Mev. Also during this period, the linear accelerator was opened and some minor repairs made. On September 2, the machine was returned to routine operation and has so continued. The machine performance has been excellent. The new control system has markedly improved Van de Graaff operation. The high voltage stability of the machine has also proven much better. Currents up to 0.3 μ a of 32 Mev protons can now be produced at will.

While the linear accelerator was open, provision for later installation of a test variable oscillator coupling loop was made. Progress is being made on a new pre-exciter design which will replace the old radar oscillators now used.

Following are the operating statistics:

Running time (research)	176 hours	53 percent
Repairs and maintenance	160	47
Totals	<u>336</u> hours	<u>100</u> percent

5. CHEMISTRY
(A. E. C. Program No. 5311)

UNCLASSIFIED

Intracyclotron Alpha Ray Spectrometer

An alpha ray spectrometer has been constructed for use in the magnetic field of the cyclotron to observe the alpha particles emitted from a target immediately after the beam of the cyclotron is turned off. It utilizes 180° focussing. Observations are made in nuclear emulsions. Energies are estimated both by length of track and by position on the plate.

Gadac

A simple analog computer has been constructed which plots the growth and decay of members of a radioactive disintegration chain. Simple condenser resistor combinations represent the decay constants and are set to any desired values. The computer is also being used to solve problems of the cross sections involved in multiple neutron capture processes.

Gamma Spectrum of AcK

The gamma spectrum of AcK has been studied with a scintillation spectrometer. Radiation of 80-83 kev energy, which may be K x-rays, was observed to be rather abundant, although it was not reported in previous work on this radioactivity.

Gold Produced from Tantalum

Irradiation of tantalum with carbon ions in the 60-inch cyclotron has produced two new isotopes of gold with half-lives of 42 ± 5 minutes and 9 ± 2 minutes. This result is not expected to affect the gold market appreciably.

Isotopes of Iridium, Platinum, Gold, and Mercury

A number of neutron deficient isotopes of iridium, platinum, gold, and mercury are being studied. They are produced at various energies in the 184-inch cyclotron. Some assignments have been made on the basis of genetic relations, but not all of the results are consistent with previous reports. Work is continuing to try to resolve the discrepancies.

Crystal Structure of AuCl₃

Gold chloride, AuCl₃, has been prepared by combination of the elements at about 200°. The gold chloride collects in cooler portions of the tube as nice single crystals.

X-ray diffraction data (Weissenberg method) correspond to space group P2₁ C with lattice constants

$$\begin{aligned} a &= 6.57 \text{ \AA} \\ b &= 11.00 \text{ \AA} \\ c &= 6.44 \text{ \AA} \\ \beta &= 113.3^\circ \\ Z &= 4 \end{aligned}$$

The atomic positions are not yet known.

Metals and High Temperature Thermodynamics

Work is in progress on the following problems: the heats of formation and absolute absorption coefficients of high temperature molecules, reflection coefficients of molecular beams, magnesium oxide gas, refractory silicides, sodium carbonate vapor, and high temperature halide molecules.

Basic Chemistry, Including Metal Chelates

The following problems are under investigation: the complexing of scandium by fluoride ion, and the thermodynamics of thiosulfate.

Process Chemistry

Work is in progress on the following problems: the preparation of titanium metal, film boiling from subcooled liquids, the thermal conductivity of gases at high temperatures, the agitation of liquid-liquid systems, solubility studies, thermal diffusion in liquids, the capacity of perforated plate liquid-vapor contacting columns, gas-phase mass transfer studies, and vacuum flow through annular sections.

Health Chemistry

The Equipment Development Group and the Airborne Activities Control Group are spending essentially full time on preparation of equipment and testing operation of same for a highly active irradiation to be received from the MTR at Idaho Falls early in October; the processing of this material will take place at Livermore.

6. BIOLOGY AND MEDICINE UNCLASSIFIED (A. E. C. Program No. 6300-6500)

Biological Studies with the 184-inch Cyclotron

An exploration of the biological effects due to local irradiation of various regions of the head was conducted in a series of experiments irradiating the posterior pituitary and the pituitary stalk in rats. The effect of this treatment on the water balance of the animals is being studied.

Activation Analysis

A number of pilot experiments were performed applying the particle beam of the 60-inch cyclotron for activation analysis on short-lived components of animal tissue. Deuteron activation results chiefly in Na²⁴ and P³² activities. Proton and alpha activation, however, results in quite low sodium and phosphorus activity and more radioactivity in metal constituents of tissue. The work is being continued.

Instrumentation - Distribution of Gamma Ray Emitting Isotopes in Animals and Human Beings.

A new gamma ray pinhole camera is being built and tested which has, besides the lead pinhole, an image amplifier tube permitting direct viewing of relatively small samples of radioactive substances which have gamma ray activity. This development seems encouraging and has great advantages concerned with scanning methods which previously were used for visualization of distribution of gamma ray emitting substances.

Physical Chemistry of Lipoproteins

Work on the development of an integrated system for the analysis of chemical subfractions of the various lipoproteins continued during the past month. Of especial interest are some developments by Lindgren of the use of Abbé refractometry as an adjunct to the chromatographic separation of lipid subfractions of the lipoproteins. Refractometric measurement of isolated eluate fractions, it appears, may provide a more sensitive, precise approach to quantitative analysis of subfractions than the infra-red approach, especially for phospholipids.

The chromatographic separation of lipids on columns, already established within the laboratory as an effective procedure, has been studied this month with respect to the factors involved in column filler variability. Studies of the activation procedure for the filler may lead to more reproducible behavior of the columns in lipid fractionation.

The Mechanism of Lipoprotein Transformation

Kinetic studies of the crucial glyceryl ester hydrolyzing system (activated by heparin injection) have continued. It had previously been found in the work of the group that the reaction slows significantly as appreciable quantities of glyceryl ester is hydrolyzed. This led to the suspicion that perhaps one of the products of the reaction, such as fatty acid itself, might be inhibitory to further hydrolysis. Direct studies this past month indicate that sodium oleate (which is one of the reaction products) is definitely inhibitory to further progress of the hydrolysis.

Studies are also in progress to determine the nature of the "decay" which occurs in heparin active factor preparations. Undoubtedly, the hydrolytic system loses strength upon standing. Current work is being directed toward establishment of the rates of this activity loss and factors which may be involved in it.

Biologic Effects of Irradiation Upon Lipoproteins

In the studies of x-ray irradiation upon rabbits, mice and dogs, it is definitely established now that lipoprotein changes occur in all species. One major change in lipoproteins, in addition to the appearance of new high Sf classes of lipoproteins, is the transformation of the major naturally occurring lipoprotein (approximately Sf 8) to a more rapidly floating lipoprotein species of approximately Sf 11. The chemical basis for this particular lipoprotein transformation is being investigated, since not only should this provide evidence on the factors determining lipoprotein stability and structure, but perhaps of more immediate importance, a concept of the chemical basis of the irradiation effect.

Tracer Studies

A recheck on long and short term thullium, thorium, cerium, radium and iron tracer studies have been started.

The LD₅₀ for astatine in rats is being investigated and its use being included in the experiments on the relative biological effects of alpha and beta emitters.

The deposition of aerosols in the lungs of primates on a long term basis is being continued.

Radiation Chemistry

Radiation chemistry of aqueous solutions of organic acid is continuing. Considerable effort has been expended in the development of adequate analytical procedures for determination of glycolic and glyoxalic acids together with aldehydes and ketones which are anticipated products on irradiation of aqueous glycine and acetic acid.

Radioautography

Histological interpretation of the At²¹¹ rat tissues mentioned in the last monthly report is proceeding, as are further studies on similar tissues. Tissue sections on the normal monkey (Mischief) have been completed, as have the radioautographs of this animal's thyroid.

Organic Chemistry

Research efforts in organic chemistry have been devoted to the following projects:

1. A synthesis of bis- β -mercapto-isobutyric is being carried out. This compound is a thioctic acid analog and will be used for model experiments.
2. Routes for the syntheses of the labeled peptides alanyl-2-C¹⁴-leucine and leucyl-3-C¹⁴ alanine are being investigated.
3. Methods to improve the synthesis of thioctic acid-7, 8-C¹⁴ are being tested.
4. Studies are continuing on the effects of high energy radiation on such organic compounds as choline, acetyl choline, glycine, methanol, ethylene glycol, and polystyrene.

Animal Biochemistry

The research work being carried on in this field includes the following subjects:

1. Studies are in progress on the effects of X-irradiation on:
 - a. The concentration of various coenzymes in the livers of mice.
 - b. The rate of incorporation of adenine into nucleotides and nucleic acid.

2. The metabolism of fatty acids by pantothenic acid-deficient rats.
3. The relationship of Δ^7 -cholestenol to atherosclerosis and the evidence that this compound is a precursor of cholesterol.
4. Studies on adenine metabolism.

Plant Biochemistry

The nature of the process of photosynthesis continues as the principal interest in this field. The following research is being conducted:

1. The mechanism of the conversion of electromagnetic radiation (light) into chemical bond energy.
2. Mechanism of energy conversion in plants utilizing bacteriochlorophyll.
3. Search for compounds required in the carbon dioxide reduction cycle.
4. Short-term photosynthesis experiments.
5. Comparative biochemistry of carbon dioxide fixation by plants and microorganisms.
6. Mechanism of aromatic biosynthesis in plants.

7. PLANT AND EQUIPMENT REPORT UNCLASSIFIED

Bevatron. (Account No. 5-271-9001)

The entire vacuum tank system is presently being tested for vacuum leaks. The complete erection of the magnet was started approximately two weeks ago with the placement of top pole pieces and the top yoke slab. The accelerator electrode is being tested and certain components will have to be slightly modified. The injector is approximately 96 percent complete.

Chemical Laboratory Building 70. (Account No. 5-271-1002)

Under the general contract to Swinerton and Walberg footings and foundation walls are being poured and forms are continually being erected. The plumbing contractor, C. F. Braun, has almost completed the placing of sewer and drain lines. The electrical contractor, T. L. Rosenberg, has been placing electrical conduits at the foundation level. The entire project is approximately 17 percent complete.

Electronics Research Building 80. (Account No. 5-271-2002)

The preliminary proposal for the design and construction of the Electronics Research Building has been approved by the A. E. C. and an architect will be chosen in the immediate future.

Miscellaneous Construction. (Account No. 5-271-2001)

The Gamma House Building 66 has been approved by the Regents and plans and specifications will be out for bid in the very near future. A contractor will be signed in the immediate future to build and install the destructor. Alterations to the Director's Office in Building 50 are approximately 94 percent complete. The parking lot south of Building 15 is 100 percent complete and paving around Building 68 is 100 percent complete.

MAN-MONTHS EFFORT REPORT
SCIENTIFIC PERSONNEL

Program No.	Subdivision	Man Months Effort	Vac. and Sick Leave
<u>Operations</u>			
3000	Weapon's Research	General	260.18 13.28
4000	Reactor Development - MTA	Design and Development	18.90 1.67
5000	Physical Research		
5200	Basic Physics Research	General Physics Research	76.56 15.51
		Theoretical Studies	12.86 3.28
		Film Detection	14.78 5.53
		Cloud Chamber	14.27 1.39
		Magnetic Measurements	3.38 2.49
		Sub-Total	121.85 28.20
5311	Basic Chemistry Research	Chemistry of Heavy Elements	8.82)
		Nuclear Properties of Heavy Element Isotopes	16.86)
		Transmutations with 184 in. and 60 in. Cyclotrons	9.64)
		Analytical and Services	12.37)
		Mass Spectroscopy, Beta Ray Spectroscopy	1.68) -- 7.39
		Instrument Development and Services	4.55)
		X-Ray Crystallographic Measurements	1.74)
		Radiation Chemistry	1.97)
		Office and Travel	7.04)
		High Temperature and Special Chemistry	16.25 0.75
		Health Chemistry Research	7.87 3.41
		Sub-Total	88.79 11.55
5361	Applied Chemistry Research	Process Chemistry	12.65
5731	Electron Synchrotron	Operations	7.11
5741	Synchro Cyclotron (184 in.)	Operations	9.44
5751	Linear Accelerator	Operations	11.39
5761	Proton Synchrotron-Bevatron	Operations	9.73 0.94
TOTAL PHYSICAL RESEARCH			260.96 40.69

MAN-MONTHS EFFORT REPORT
SCIENTIFIC PERSONNEL

<u>Program No.</u>	<u>Subdivision</u>	<u>Man Months Effort</u>	<u>Vac. & Sick Leave</u>	<u>Com- ments</u>	<u>Vac. & Sick Leave</u>
6000	Biology and Medicine Research				
6300	Medical Research				
	Health Medicine	1.22			
	Internal Irradiation	6.31		2.22	Consultant
	Sub-Total	<u>7.53</u>			Man Months
6400	Biological Research				
	Miscellaneous	3.30)		1.91)	
	Instrumentation	1.63)		-)	
	C ₁₄ Metabolism	3.43)		0.50)	
	Use of Radioactive Material in Human Physiology	13.19)		4.33)	
	Trace Elements	3.29)		0.97)	
	Physical Biochemistry	13.67) --	8.08	2.63) --	1.65
	Biochemical Response to Radiation	5.26)		1.00)	
	Metabolism of Lipoproteins	5.36)		8.69)	
	Iron Metabolism Hematopoiesis	4.31)		-)	
	Biological Effects of Cosmic Radiation	2.05)		0.25)	
	Radiation and Mutation Rate	1.45)		0.35)	
	Bio-organic Chemistry	28.32	2.87	-	
	Metabolism of Fission Products	18.18	2.07		
	Animal Colony	1.56	0.44	3.36	
	Sub-Total	<u>105.00</u>	<u>13.46</u>	<u>23.99</u>	<u>1.65</u>
6500	Biophysics Research				
	Health Physics	4.79		-	
	Irradiation Studies	5.50		1.01	
	Sub-Total	<u>10.29</u>		<u>1.01</u>	
TOTAL BIOLOGY AND MEDICINE RESEARCH		<u>122.82</u>	<u>13.46</u>	<u>27.22</u>	<u>1.65</u>
GRAND TOTAL - OPERATIONS		<u>662.86</u>	<u>69.10</u>	<u>27.22</u>	<u>1.65</u>

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