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MONTHLY PROGRESS REPORT
No. 102

September 15, 1951 to October 15, 1951

October 31, 1951

DECLASSIFIED

Classification changed to
by authority of D. J. Flaum, E. J. Thyrum, LRL
on April 1961, B. Fobell
Date Person making change

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UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

September 15, to October 15, 1951

MONTHLY PROGRESS REPORT No. 102

October 31, 1951

1. Bevatron

UNCLASSIFIED

(AEC Program No. 1500)

The magnet winding crew has completed 480 of the 704 turns. The cracks in clamp bars appear to be limited to one order of bars which are used in the end windings. All bars installed have been inspected and a few have been removed because of cracks. All bars to be installed in the future will be proof tested.

The magnet generator bearing has been repaired and an all day run is to be made next week.

2. 184-inch Cyclotron Operation

UNCLASSIFIED

(AEC Program No. 5741)

The cyclotron was used for research experiments approximately 96 percent of the 495-1/2 hours that the crew was on duty. The time distribution was as follows:

Operation for customers	477.75 hours	96.4%
Electrical troubles	13.75 hours	2.8%
Mechanical troubles	4.00 hours	0.8%
Total	495.50 hours	100.0%

3. 60-inch Cyclotron Operation

UNCLASSIFIED

(AEC Program No. 903)

This month record alpha carbon beams were established. With alpha particles, 50 microamperes of external beam was recorded; with carbon, 30 millimicroamperes was recorded. Beam performance was up to the usual efficiency of approximately 80 percent.

4. Synchrotron Operation

UNCLASSIFIED

(AEC Program No. 5731)

The synchrotron was disassembled early in September in order to replace a cracked quartz vacuum chamber segment. Reassembly was completed at the end of the first week in September. The beam was found with difficulty and could not be adjusted properly before it would fade away. A coincidence between finding the beam and recently having the vacuum chamber at atmospheric pressure was noted. Raising the pressure in the vacuum chamber by throttling the pumps did not allow the beam to return.

The inside of the vacuum chamber was then sprayed with conducting paint in order to electrically pick up any isolated patches in the conducting coating. The pressure remained high for a number of weeks due to the gassing of the paint and the phenomenon of the beam fading away has not as yet been observed. The beam intensity has been lower than normal and efforts have continued to improve it.

The synchrotron beam was used for physics research projects during the latter part of this report period.

5. Linear Accelerator and Van de Graaff Operation

UNCLASSIFIED

(AEC Program No. 5731)

As the numbers below indicate, the operating efficiency of the linear accelerator during this past month was quite high. A minor repair, the replacement of a broken belt in the Van de Graaff, constituted the only delay in the entire period.

Running time	312.25 hours	93%
Maintenance	13.50 hours	4%
Repair	10.25 hours	3%

The machine now runs steadily at an average proton current of 0.2 μ amp.

6. Experimental Physics

UNCLASSIFIED

(AEC Program No. 5211)

Film Program. Diffraction Scattering of Protons. In an effort to observe the diffraction scattering and interference between diffraction scattering and Coulomb scattering of high energy protons, a collimating system has been designed for the deflected beam of the 184-inch cyclotron. Using nuclear emulsion detectors and foils of heavy elements as scatterers, it is expected that the scattering in the interval 0-15° can be observed with an angular

resolution of 0.2°. A trial run has been made with the present geometry. From a preliminary examination of the plates, it appears that useful information may be obtained from them. Further experiments are planned with a scattering system which is evacuated.

Cloud Chamber. The diffusion cloud chamber designed and built for study of Compton scattering by protons has been assembled and is being tested. Control circuits and equipment for this chamber have been built. The 10 atmosphere cloud chamber, designed and built for study of n-p scattering at high energies, is now operating and preliminary test pictures have been taken. The ion chamber for photo-disintegration of He^3 is out of the shop, and is being assembled. It has been pressure-tested with satisfactory results. A new improved cloud chamber camera has been designed; detail drawings are being made. New equipment for reprojecting film is being designed, and some of the pieces are in the shop. Pictures have been taken using the synchrotron beam during another experiment. These preliminary experiments have been used to check control circuits for the cloud chamber and the coincidence circuits, and most difficulties have been eliminated. The circulating water for the heat exchanger for the magnet has dropped to such low values, because of additional drains for other purposes at the laboratory, that it has been necessary to add a booster pump, which has been installed temporarily with rubber hoses. A flow of 6 gallons per minute, which is barely adequate, is obtained.

Proton-Deuteron Scattering Using 345 Mev Protons. The first run with the revised equipment showed the usefulness of a delayed coincidence channel to give the accidental coincidence counting rate. However, the equipment did not perform as well at high counting rates as was expected and some further revisions are in progress.

Products of 90 Mev Neutrons on Carbon. Two collimators have been prepared in order to define a two-inch diameter beam at the neutron port; a seven foot long, 1-1/4" collimator to go in the igloo, and a six foot long, 2" collimator to go in the exterior neutron port. Calculation of results of the first run of the spinning disc method showed a critical dependence of the results on the exact irradiated area; hence the emphasis on collimation. Also, collimation and shortened probe-disc distance may be expected to lower the rather high backgrounds encountered. Mechanical realignment of the counters facing the spinning disc seems to have eliminated one source of disc vibration that arose at certain counter orientations. It is of interest to note that as long as the counter area is reasonably small, results are independent of the counter area, although not independent of counter efficiency. Preparations are being completed for a second run in the near future.

Nuclear Internal Momentum Distributions from the Quasi-elastic Scattering of 340 Mev Protons from Nucleons in Light Nuclei. The energy spectra of 340 Mev protons scattered by C, D, and H at an angle of 30° have been reported in the previous monthly report. Since then data have been taken at 40°. The internal momentum distributions which were used to fit the data at 30° also fit the data well at 40°. It will be recalled that the theoretical momentum distribution of the deuteron is used to describe the spectra of the protons scattered by deuterium. A gaussian momentum distribution of width corresponding

to an energy of 16 Mev is used to obtain the theorectical spectra of protons scattered from carbon. The Chew-Goldberger momentum distribution does not fit the data well at energies quite far removed from the free p-p collision energy. It over-emphasizes the high momentum components. The peaks of the spectra at 30° and at 40° of protons scattered from deuterons lie at the free p-p collision energy to within the energy resolution of the equipment. The peak of the spectrum of protons from carbon lies about 10 Mev below the free p-p collision energy at 30° and about 30 Mev below this energy at 40°.

Development of Cerenkov Radiation Gamma Detector. A Cerenkov radiation gamma detector has been used to detect the decays of π^0 mesons produced both by the deflected proton beam in the cave and by the circulating beam on an internal target. At 90° to the direction of the proton beam and with the detector 10 cm from the target the 100% effective area of the counter was found to be 0.03 cm^2. The end of the lucite rod facing the target has an area of 0.5 cm^2.

300 Mev Neutron Elastic and Inelastic Scattering Cross Section Determination. Construction work on the apparatus is nearing completion, and preparations are being made for calibrating the efficiency of the counter telescope. The large, 5-inch diameter stilbene crystal disc has been grown, polished, and mounted in its telescope fixture. Tungsten absorbers have been prepared for energy definition of the recoil protons.

The Photoproduction of Negative Mesons from Deuterium. Another run has been made at the synchrotron in an effort to obtain the angular distribution of negative pions from deuterium. Pion-proton coincidences were looked for at pion laboratory angles of 90° and 120°. The angle of the proton telescope was varied seven degrees each side of the associated correlation angles; these correlation angles are predicted from the conservation laws for the photoproduction of negative pions from a free neutron at rest. The difference in the counting rates between heavy water and ordinary water show a well-defined peak at the predicted proton angles of 31.5° and 20°. The low counting rates do not permit any firm conclusions to be drawn about the relative yields at these two points.

The instrumentation was changed from the previous run in an effort to improve the statistical accuracy. A third scintillation counter was added to each telescope in order to take advantage of the energy correlation of the production process from a very loosely bound neutron in deuterium. The production of negative pions and protons from the tightly bound neutrons. in oxygen is less likely to show both the proper angular and energy correlations simultaneously than the production from a nearly free neutron. Hence, the third counter was used as an anti-coincidence counter to discriminate against particles which have energies greater than that expected for the production of pions and protons from a nearly free neutron. Absorbers were adjusted to limit the photon production energy to 300 Mev for processes surviving anti-coincidence. A comparison of the heavy water vs. ordinary water difference counting rate produced from photons greater than 260 Mev with that from photons in the energy interval from 260 Mev to 300 Mev showed a noticeable improvement

in statistical accuracy. Absorption of protons in the target is the chief factor which prevents looking for processes from photon energies lower than 260 Mev in the bremsstrahlung spectrum.

Development of Crystal Counters. Development of crystals, crystal-holders, and circuits for detection of heavy particles is being carried out. The phase getting most attention is the response of a crystal to particles passing through various portions of the counting area.

Cross-Section for π^+ Meson Production by Protons on Protons. The reaction $p + p \longrightarrow d + \pi$ has been investigated at 10° in the center of mass using a magnetic field to separate the mesons from the proton beam. A value of the cross-section at this angle is forthcoming, pending measurement of the fringe field of the magnet.

π^- Meson Capture in Hydrogen and Deuterium. Construction of an improved pair spectrometer involving better resolution and angular focussing, measurements of the magnetic field, and computation of pair trajectories were continued.

Photo Cross-Sections in Beryllium. The pair spectrometer at the synchrotron has been instrumented for a determination of the total cross section for absorption and scattering of high energy photons by various elements. The non-pair contribution to the total cross section is appreciable in very light elements, and preliminary results for beryllium at 300 Mev indicate this non-pair part to be a few percent greater than the theoretical Compton cross section. Statistics are being improved in order to evaluate this small residual cross section.

Experimental Check for 100 Mev γ-Rays of the Klein-Nishina Formula. The equipment for the experiment has been essentially completed and bench-tested. Preliminary runs at the synchrotron are now needed for final checks and adjustments of the equipment before starting the accumulation of data.

Linear Accelerator Studies. The major uses of the Linear Accelerator in this period were in 1) the study of inelastic scattering of protons, 2) the activation of radioactive isotopes for chemists, and 3) the study of short lived radioactivities in light elements. As the experiments concerned with the above are completed, detailed reports will be made.

Synchrotron Studies. During the last week of this period, the synchrotron beam was sufficient to start experimental work again. The operation is still far from ideal, but the beam is usable. Several short runs were made during the process of tuning up the machine. These were runs using the pair spectrometer, and a run exposing photographic emulsions to high energy positrons and electrons. The electrons are produced in a target placed in the pair spectrometer, and the plates are placed to receive different energy electrons and positrons. The purpose is to study positron-electron and electron-electron scattering in the emulsion. To make this study it is necessary to "eradicate" and develop the films carefully. Several runs are necessary to get good plates at all the energies desired. The results of electron-electron scattering have been reported.

During the week of operation a long run on the reaction $D + \gamma \longrightarrow p + \pi^- + p$ was made. The technique used in detecting the particles has been discussed, and the results of the measurements should soon be available.

Because of the long period with little beam, the synchrotron has a long list of experiments waiting to be done. These include the photo-disintegration of the deuteron with counters and with a cloud chamber, measurements on neutral π mesons, the rate of π^+ mesons to π^- mesons, on the energy distribution of photo-neutrons.

7. Theoretical Physics

UNCLASSIFIED

(AEC Program No. 5211)

Work is continuing on an analysis of nuclear cross sections for high energy neutrons and protons, and on a study of the interference effects in high energy n-d and p-d cross sections.

An attempt is under way to apply to nuclei a technique similar to that of the Fermi-Thomas statistical model of the atom, in order to compare the results with those of the shell model.

Experimental data on high energy photodissociation of nuclei is being examined; the angular distribution of the observed proton stars suggests the presence of a large free meson effect.

Tensor forces in the proton-proton interaction are being studied.

Qualitative agreement has been obtained between theory and experiment on some photonuclear effects, although both are only approximate as yet.

The study of the scattering of protons from carbon is continuing.

A calculation of charge exchange scattering in deuterium has been completed.

Work on photoproduction of neutral mesons in deuterium is under way.

Work on the extension of the Tomonaga approximation to field problems involving intermediate coupling is continuing.

Calculations have begun on the influence of tensor forces on the reaction $p + p \longrightarrow d + \pi^+$.

8. M.T.A. Program

SECRET

(AEC Program No. 1500)

Mark I Accelerator. On the Mark I accelerator the shot peening process has been completed but not the clean up. The number one power supply is in the stage of being tested. The earliest completion date for Mark I turn-up is

late February or mid-March, depending on whether it is possible to simultaneously perform head welding and the installation of liner panels. If it is not possible to do these jobs simultaneously there will be an additional delay of three weeks in construction. Every effort will be made to do the work concurrently. It is possible that most of the fumes from the welding can be removed from the tank by means of temporary ventilation. It is decided that the tank will not be washed; washing on test panels produced no improvement in the x-ray level.

Negotations have been concluded with the Distillation Products Industries to convert the Mark I diffusion pumps from oil to mercury operation. The amount of experience with large mercury pumps is not great. DPI would only guarantee a pumping speed of 6,000 liters per second with the mercury pumps using the present cooling water supply. If the cooling water circuits are altered to produce water at approximately 40° F a pumping speed of 12,000 liters per second would be guaranteed. Present plans have proceeded without additional refrigeration of the cooling water. Thus, the 48 diffussion pumps will be equivalent to only one-forth as many oil diffusion pumps. However, by putting in the dust curtains the pumping speed in the liner area has been increased by a factor of three so that the overall effect of the two changes acting in different directions is not large. Twenty-four of the converted diffusion pumps have been shipped and the remaining twenty-four will be shipped when it has been decided when it will be necessary to pump down again before completion of the liner installation. It is thought that all of the converted diffusion pumps will be back from DPI in November.

Ion Pump Experiments. Experimental work is being done on the construction and operation of the ion pump. These experiments so far have been successful in that ionization has been achieved at useful pressures. In general the results are encouraging and seem to be indicative. If such a pump could be operated satisfactorily a great saving on the cost of the A-12 accelerator might be possible.

Drift Tube Surface Cleaning. The results of recent experiments on cleaning the surfaces of drift tubes to reduce x-ray production has shown that it is possible to eliminate the x-rays almost completely by the use of proper cleaning methods. The cleaning method that has produced the most satisfactory results to date has been that of electro-plating with the use of ortho-phosphoric acid. It seems to be possible to increase the smoothness of the copper surface as well as to clean the surface by the use of electro-polishing methods. Electro-polishing differs from ordinary deplating with the use of acid and current in that the current is lower. This prevents agitation of the thin film of ortho-phosphoric acid caused by oxygen produced at the surface. Thus the film of this solution is thinner above the ridges than above the valleys and the ridges tend to deplate at a higher rate. There is still time to experiment further before deciding how best to clean the surfaces of the Mark I drift tubes.

A-12 Design. General engineering studies for A-12 are about complete and the detailed engineering can be started. The problem is the freezing of a few fundamental parameters of A-12, such as length and diameter of the vessel, so that the detailed studies may proceed. There are objections to the design freeze at the present time. By allowing the engineers to go ahead now on the detailed engineering drawings of a design based on a few frozen parameters, it would tend to build up a large amount of engineering inertia precluding the possibility of major changes in tank dimensions, even though advantageous. Such changes are entirely possible and can be more firmly stated after completion of tests in the near future using the B-1 cavity. These tests are being made to determine in large cavities at high voltage gradients whether x-ray production and excessive sparking can be controlled by pretreating cavity surfaces. Similar tests on small cavities have been successful. If the B-1 tests confirm previous results a decision may be made to use long thin drift tubes for A-12 and/or shorten the tank. The B-1 cavity tests are a turning point concerning the tank dimensions.

Drift tubes of a "stove pipe" design are now being considered for A-12. These drift tubes might consist of a long pipe or tube with approximately 36 inches bore diameter with a wall thickness of only 9 inches. Midway between the ends would be a bulge to contain the focussing magnet. By thus increasing the shunt impedance a considerable saving in power would result. This work is very encouraging and further experimental investigation is planned in the immediate future. Although the A-12 accelerator designs are now proceeding on the basis of fat drift tubes, these could later be redesigned to thin drift tubes using the same vessel contour but spacing the gaps differently.

Investigations into the use of a cellular design for the high energy end of A-12 is being made. Although the design does not increase the energy level it doubles the number of times that a particle accelerates in reaching this level. A small power saving results but at the expense of complexity in the structure. However if the energy levels in the A-12 accelerator is raised above 350 Mev to approximately 600 Mev, the cellular structure would be extremely important.

A-12 Target Studies. It has been possible to measure the neutron-deuteron ratio and neutron distribution with angle for several combinations of primary and secondary targets in the 230 Mev, 10^{-13} ampere scattered beam of the University of Chicago cyclotron. It has been found that the slope of the extrapolation curve previously adopted was essentially correct and that the secondary target for higher energies need not be thicker than that for the lower energies. Furthermore, it was discovered that the distribution dn/Ω was relatively independent of energy. The energy of the beam was determined from range measurements using two ionization chambers with an intermediate dural absorber of varying thickness. It was also measured by determining the absorption in a wedge using nuclear emulsions. The value of n/d gives an extrapolated magnitude of 6.8 at 250 Mev and 12 at 350 Mev. Various primary-secondary target arrangements were studied using both the water tank and long

boron-trifluoride counter methods for counting the neutron production. Generally the boron-trifluoride counter was found to give values about 15 percent lower than the water tank. The distribution $dn/d\Omega$ was found to be essentially the same as that reported for 190 Mev neutrons. An investigation is now being made of the possibility of stripping He^3 from enriched helium in the 184-inch cyclotron to obtain deuterons at approximately 340 Mev.

Preliminary calculations are under way for the number of neutrons caught in the target and a study of how this number is effected by the size of the target, energy of the beam, etc. Preliminary computations are being made using the three group diffusion method. The first group contains neutrons with energies up to the U^{238} fission threshold; the second group contains those neutrons with energy higher than the U^{238} fission threshold but lower than 10 Mev; and the third group contains the remaining neutrons with energy less than 50 Mev. The production of neutrons in the first two groups can be guessed at fairly accurately, while the third may be estimated by a comparison of the water tank and boron-trifluoride counter results. It is hoped that the target thickness may be specified by the consideration of the results of these studies.

Calculations are being made of the loading of the water lattice for the production of tritium. Various alloys have been considered. For example, 7 weight percent lithium plus aluminum; 1.58 weight percent lithium plus lead; 1.1 weight percent lithium plus magnesium; 30 weight percent lithium plus magnesium. The losses considered are the direct solid angle losses of neutrons reflected out of the target opening, losses through the target, losses through the lattice and losses to the coolant, etc. It has been found, for example, that with the 7 percent lithium plus aluminum, using 3/4 inch diameter rods in a triangular array, that the total losses amount to 21.3 percent with a net efficiency of 78.7 percent. It has been found with still more recent designs that these losses may be cut in half. The general result is that by proper choice of parameters 80 to 85 percent efficiency is quite feasible. Using a volume ratio of alloy to water of 0.343 one can obtain thermal-utilization factors of 0.97 for 30 weight percent lithium and in magnesium compared to 0.93 for 7 weight percent lithium in aluminum.

A-12 Target Hazards. An analysis of the hazards attendant upon the operation of the A-12 target and lattice has been made. The major hazards that are likely to occur center around possible coolant failures, since for the A-12 lattice design under consideration there is no criticality hazard. The effect of coolant loss in the lattice and in the primary beam have been considered. In the case of coolant loss in the lattice accompanied by beam shut down, the temperature rise in the hottest slug in the lattice will be slow enough so that melting will not occur for about 24 hours. In the thorium primary target the complete loss of cooling would result in the melting of the thorium within three hours. A uranium primary target would melt in about 1-1/4 hours. In the secondary target the uranium would melt within seven hours after complete loss of coolant. The probable effect of total coolant loss would be the release of about 65 megacuries inside the lattice and lattice cavity. This would be containable within a properly designed target housing.

Loss of coolant sufficiently severe to result in melting the fuel elements would also cause hazard from leakage of the cooling media. If the distilled water used for cooling the secondary target and lattice should reach the Missouri River at the rate of 1500 cubic feet per minute it would result in about one-half the tolerance for large population centers. This assumes that the cooling water would mix with about one fourth the volume of the river. About 50 tons of NaK would be required to cool the primary target. A leak in the NaK line would not result in a hazard except in the case of a major catastrophe, since inert gas blanketing will be used and provision will be made to retain any NaK leakage from spreading. In an extreme case 8 megacuries of activity could be released to the atmosphere if the NaK caught fire or came in contact with water. A figure of 30,000 curies is most reasonable.

9. Chemistry

SECRET

Part A
(AEC Program No. 5311)

Decay of Am^{241}. The bent-crystal x-ray spectrograph has been used to measure the neptunium L x-rays which follow internal conversion of gamma rays in the alpha decay of Am^{241}. Eight lines were observed with energies in good agreement with those predicted by extrapolation of the data for lower elements. In the same experiments, eight gamma rays of energies ranging from 14 to 60 kev were observed. Six alpha groups from this decay have been observed (two of them incompletely resolved) with the magnetic alpha spectrograph.

Alpha Decay of Bi^{203}. A mixture of bismuth radioactivities was isolated from a lead target which had been bombarded with 60 Mev protons. At times when Bi^{203} and Bi^{204} were the principal activities, several samples were placed in nuclear emulsions sensitive to alpha particle tracks. Alpha tracks corresponding to 4.8 ± 0.1 Mev were found, and the number found in several plates at different times corresponded well to the 12 hour half-life of Bi^{203} and Bi^{204}. By the systematics observed in other alpha emitters, Bi^{203} is expected to have a shorter half-life for alpha decay than Bi^{204}, so the observed particles probably came from Bi^{203}. The ratio α/K, based on 18 tracks found in one set of experiments, is estimated to be 10^{-7}.

Carbon Ion Bombardments. Cm^{242} and Cm^{240} have been prepared from thorium by bombardment with carbon ions, by $(C^{12},2n)$ and $(C^{12},4n)$ reactions, respectively. The yields found are 5 to 10 times as large as for corresponding reactions on U^{238}. If this difference is accurate, it reflects the increased competition of fission with increasing Z, and indicates even poorer yields of (C^{12},xn) reactions on higher elements.

Ion Exchange Separations. The separation of the lanthanide and actinide ions by elution of ion exchange columns with citric acid solutions has been reported. Recent experiments show similar separations when tartaric acid is used. An interesting observation is that racemic tartaric acid, and meso tartaric acid behave somewhat differently. Further experiments are in progress.

Preparation of TbF_4. TbF_4 was prepared by heating TbF_3 in fluorine at 540°C. The new compound was identified by its x-ray diffraction pattern, which corresponded to the ZrF_4 structure. The monoclinic unit cell has the dimension

a = 12.1 A
b = 10.3 A
c = 7.9 A
β = 126°

TbF_4 is the only compound known of tetravalent tervium other than the dioxide. The same apparatus has been used to prepare UF_4, ThF_4, and CeF_4 from either oxides or trifluorides. These compounds were already known to have the same monoclinic structure. Magnetic susceptibility measurements are being made of the cerium and terbium compounds as a check on the average oxidation number.

Chemistry UNCLASSIFIED

Part B

(AEC Program No. 5311)

Metals and High Temperature Thermodynamics. Work is in progress on the following problems:

1. Gaseous oxides.
2. Gaseous hydroxides.
3. Refractories.
4. Oxide phase diagrams.
5. Thermal condictivity of gases at high temperatures.

Basic Chemistry. The following problems are under investigation:

1. Thermodynamics of rhenium.
2. The hydrolytic polymerization of zirconium.
3. Germanium chemistry.
4. Electron exchange rate between Fe^{2+} and Fe^{3+}.
5. Thermodynamics of indium.
6. Thermodynamics of thiosulfate.
7. Solubility of the rare earth fluorides.

Chemistry UNCLASSIFIED

Part C

(AEC Program No. 6400)

Synthetic and Experimental Chemistry. Synthesis of the following labeled compounds has been studied or carried out: leucine-3-C^{14}, norleucine-3-C^{14}, cholesterol-23-C^{14}, cholesterol-T, steric acid-T ethyl-1 or -2-C^{14} iodide, n-butyl-1-C^{14} bromide, isobutly-1-C^{14} bromide or iodide, glycine-2-C^{14}, valine-4,

4^1-C_2^{14}, and hippuric-C^{14} acid (benzoylglycine-2-C^{14}).

The preparation of a number of alpha labeled amino acids via the azlactone condensation has been carried out using such compounds as benzaldehyde, anisaldehyde, 3,4-dimethoyxbenzaldehyde, and o-ethoxybenzaldehyde. The purification of amino acids by fractional elution from Dowex-2 resin with ammonia has been studied also.

Other problems being investigated include: (1) Irradiation of glycine-1-C^{14}, adanine-4,6-C^{14}, and guanine-4-C^{14} by cobalt-60 γ rays. (2) Improvement and expansion of low-level C^{14} assay equipment. (3) Irradiation synthesis studies on mixtures of simple organic and inorganic molecules.

Biological Chemistry. During the past month the following projects in the biochemistry field have been active: (1) Metabolism rates of normal and hypophysectomized rats using methyl labeled acetate and the effects of ACTH on these rates. (2) Studies on cholesterol metabolism in rats when administered with inositol. (3) Degradation of products from eggs of chickens fed sodium acetate-1-C^{14}. (4) Exploratory studies on the paper chromatography of nucleic acids derived from Scenedesemus to determine how much and possibly what nucleic acids are present in this plant. (5) Metabolism of glycine-2-C^{14} in man, and (6) The paper chromatography of steroids.

Photosynthesis Chemistry. The study of the sequence of intermediates in the plant synthesis of organic compounds from carbon dioxide continues. Better methods of degrading ribulose and sedoheptulose are being sought. Preparation and oxidation of the osazones of these sugars is being investigated.

The analysis of phosphorylated compounds by ion exchange is continuing and is being extended to phospho-nucleotides.

The feeding experiments with malic and aspartic acids showed that of the malic acid which entered or attached to the cells, about 5 percent was converted to aspartic acid during 20 minutes of photosynthesis while aspartic acid gave 4 percent malic acid and 1 percent glutamic acid in 10 minutes of photosynthesis. Other products were negligible in each case.

The study of $C^{14}O_2$ fixation by barley roots was completed. Principal products were malic, citric, aspartic and glutamic acids, and serine, asparagine and glutamine.

An attempt is being made to refine kinetic studies of the $C^{14}O_2$ fixation by photosynthesizing plants. Improvements in aliquoting techniques and insurance of steady-state conditions are being sought.

Degradation of glucose from glucose phosphate formed by Euglena during 40 minutes dark fixation of $C^{14}O_2$ showed no C^{14} in carbon no. 6.

Studies of the pigment system of a blue-green alga have shown that after the cells are broken by grinding with alumina, ultrasonic vibration, or treatment with nitrous oxide, ultracentrifugation gives a separation of the pigments. A sediment is obtained containing only chlorophyll and carotenoids and a supernatant containing only phycocyanin.

10. Medical Physics

Part A

(AEC Program No. 6000)

Tracer Studies. Tracer studies investigating the metabolic properties of gold, scandium, tungsten and plutonium in rats are in progress.

Radioautography. Radioautographic work has continued in an attempt to adapt osmic acid fixation and carbo-wax techniques to radioautography. This is being carried on in collaboration with the Photosynthesis Laboratory using algae and C^{14}.

Radiochemistry. Microcurie amounts of carrier-free Mn^{54} have been separated from a vanadium target using a previously reported procedure. The phosphorous activity produced by the Si(α,pn) reaction has been isolated to determine the P^{33} yield.

The ion-pair yield values for the radiation induced oxidation of ferrous ion in dilute aqueous solution has been found to be reproducible to ± 2 percent using the centrifugal pump target assembly previously reported. Techniques are bing developed for the separation of reaction products from the radiation induced oxidation and reduction of organic compounds.

Medical Physics

UNCLASSIFIED

Part B

(AEC Program No. 6000)

Biological Effects of Radiation with the 184-inch Cyclotron. In collaboration with Professor Curt Stern and his group an experiment is being carried out on the effect of dose rate of deuterons on Drosophila Melanogaster. Among the effects studied are dominant and sex linked lethal mutations.

A study of selective irradiation of the rat pituitary gland is being continued.

Activation Analysis. Elution data for gallium, rhenium, ruthenium, and arsenic on Dowex 50 have been determined.

Biological Effects of Radiation on Yeast Cells. Haploid yeast cells have been grown and irradiated with x-rays under strictly anaerobic conditions and the results compared with data obtained with cells grown and irradiated in air. It was found that the survival curve was not affected by a change in the atmosphere in which the cells were grown before or after irradiation, but that the atmosphere in which the cells were kept during the irradiation period was important.

The yeast cells were less sensitive to x-rays when they were irradiated in an atmosphere free from oxygen. However, the shape of the survival curve remained exponential, and the results can be explained on the basis of our previous model. This is in contrast with the results found on E. coli by the group at Oak Ridge National Laboratory.

Instrumentation. Work has been continued on the project proposed by Alvarez for improved x-ray localization of gall stones in an iodized gall bladder. Promising results are now being obtained by using denser barium and iodine filters (600 mg cm^2). Good cancellation of bone and bubbles in a phantom model are obtained. Gass stones still do not show up well in the gall bladder but this is believed due to fogging of the film by scattered x-radiation. The use of a Bucky filter should correct this.

An automatic counting rate recorder using a Leeds and Northrup recorder has been added to our automatic sample changer. The counting rate of each sample is plotted as a point on a chart. This instrument will be used to plot elution curves from the samples obtained from ion exchange columns.

Studies with C^{14} Labeled Stilbamidine. A third patient with multiple myeloma has recently been given a tracer dose of labeled stilbamidine. It is too early to know whether the distribution and excretion of radioactivity will be similar to the results found in the two proviously studied patients.

Studies in Lipoprotein Metabolism. A summary of the studies in lipoprotein metabolism has been completed. This report indicates the response sensitivity of fat metabolism to irradiation. Some observation on disturbances of heparin availability in the irradiated animal and the influence of heparin deficiencies on fat metabolism are also described. This resume will appear in the next Quarterly Report (January, 1952).

11. Health Chemistry

UNCLASSIFIED

(AEC Program No. 5311)

Equipment Development Group. Work in progress is listed below:

1. The equipment for unsoldering hard solder which attaches the target foil to the target backing plate in some 60-inch cyclotron bombardments was completed.

2. The equipment for processing Hanford-pile-bombarded animal ash was completed.

3. The equipment for use in loading and unloading samples for the beta-ray spectrometer was completed.

4. The equipment for use in some special bombardments at the 60-inch cyclotron where fast handling is mandatory was completed.

5. Final design for an internal foil target probe for use in the 60-inch cyclotron was made and the drawings are completed.

6. In the Berkeley Box group regular maintenance and modifications on the boxes and centrifuges continued, and four major-job boxes were completed.

7. Studies on special processes for solidification and purification of liquid waste are continuing.

8. 160 drums of active waste in cement, as well as several large packages, were dumped at sea during this period; this waste included that from Hunter's Point, Tracer Lab. and CR and D.

12. Plant and Equipment

RESTRICTED

Bevatron Instrument. (Program No. 1500.5-424-9001) Magnet winding is 69 percent complete. Enough copper is on hand to finish Quadrant III and commence winding Quadrant IV.

M.T.A. - Mark I. (Program No. 1500. 5-424-9004) Development and design continuing.

M.T.A. - Mark II. (Program No. 1500. 5-424-1004) Development and design continuing.

Miscellaneous Construction. (Program No. 1500. 5-424-1001)

North Gate House. Foundation is being poured, floor joists are in place and work is progressing on the erection of the walls. Rough plumbing and earthwork is 13.9% complete.

Slope Stabilization. The subcontract for earthwork and concrete is complete. Native trees, shrubs and grass seed are being procured and a crew will commence planting operations in the next 10 days. Planting will be undertaken with two objectives, to prevent erosion in the slopes, and to restore the natural appearance to the hills.

Paving for 184-inch Cyclotron Site. All rough grading is complete except for the area to the west of the cyclotron building. Approximately 55 percent of the drainage system is complete. About 60 percent of the concrete forming and pouring has been done. The total job is 65 percent complete.

Animal House. (Program No. 1600. 6-424-9007) The general construction contract on the Animal House was completed and the building accepted on October 1. The work being done on purchase order for built-in laboratory furniture may be considered roughly 50 percent complete. Work on the construction of animal runs, run fencing and interior resilient floor covering may be considered 60 percent complete. It is hoped that the building can be occupied for use by November 15.

Radiological Laboratory at the U.C. Medical School. (Program No. 1600. 6-424-9008) Notice of completion of the building was filed on September 18, 1951. Installation of the synchrotron and its appurtenances is approximately 90 percent complete. No difficulties have been encountered to date. In about a week it should be time to start checking circuits and painting some of the apparatus. An engineer from General Electric is expected about October 28 to direct starting up the synchrotron for the first time.

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MAN-MONTHS EFFORT REPORT

Scientific Personnel

PROGRAM	SUBDIVISION	MAN-MONTHS EFFORTS	COMMENTS
9200 M.T.A. - Mark I	Design and Development	4.90	
9200 M.T.A. - Mark II	Design and Development	54.00	
9500 Bevatron	Miscellaneous	.20	
Operations			
3000 Weapons Research	General	1.46	
5211 Physics Research			
Experimental Physics	Cloud Chamber	13.98	
	General Physics Research	58.52	
	Instrument for General Use	2.37	
	Special Development	10.70	
	Magnetic Measuring Equipment	3.00	
	Charge-Exchange Accelerator	.50	
Theoretical Physics	General	11.38	
Photographic Film Detectors	General	18.37	
Isotope Separation	General	-	
Radioactivity Physics	General	4.25	
5261 Applied Physics Research			
Thomas Cyclotron	Electron and X-C Models	24.54	

PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
Operations (Continued)			
Chemistry Research			
5311 Basic Chemistry Research, Part A	Chemistry of Heavy Elements	3.355	
	Nuclear Properties of Heavy Element Isotopes	9.875	
	Transmutations with 184-inch and 60-inch cyclotrons	8.24	
	Analytical and Services	16.375	
	Special Chemistry Development	1.00	
	Mass Spectroscopy, Beta Ray Spectroscopy	-	
	Instrument Development and Services	4.25	
	X-Ray Crystallographic Measurements	2.10	
	Health Chemistry Research	8.81	
Basic Chemistry Research, Part B	Metals and High Temperature Thermodynamics	3.0	
	Basic Chemistry, including Metal Chelates	4.0	
5361 Applied Chemistry Research	Process Chemistry	10.56	
Reactor and Accelerator Operation			
5731 Synchrotron	Operation	10.81	
5741 184-inch Cyclotron	Operation	12.31	
5751 Linear Accelerator and Van de Graaff Generator	Operation	13.45	

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PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
6000 Biology and Medicine Part A	Metabolic Properties of Various Materials	10.0	
	Radiochemistry	5.0	
	Radioautography	2.0	
6000 Biology and Medicine Part B	Instrumentation for Quantitative Measurement of Radiation	1.58	1.60 Consultant
	C^{14} Metabolism	2.32	.25 Man-Months
	Use of Radioactive Materials in Human Physiology and Experimental Medicine	8.09	6.04
	Trace Elements and Irradiation Studies	3.74	2.37
	Radiation and Mutation Rate	1.55	.25
	Physical Biochemistry	14.18	3.48
	Biochemical Response to Irradiation	3.35	.50
	Miscellaneous	1.00	-
	Donner Animal Colony Expense	1.92	2.75
	Metabolism of Lipo Protein and Lipids	5.58	9.41
	Iron Metabolism Hematopoiesis	3.37	.50
	Internal Irradiation and Hematological Response	2.03	.13
	Biological Effects of Cosmic Radiation	1.98	.38
	Health Medicine	4.07	-
6400 Biological Research	Synthetic and Experimental Organic Chemistry	4.65	
	Biological Chemistry	6.65	
	Photosynthesis Chemistry	5.0	
	Metabolism of Fission Products	11.42	
6500 Biophysics Research	General	2.09	

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