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UNIVERSITY OF CALIFORNIA

Radiation Laboratory

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MONTHLY PROGRESS REPORT
No. 97

April 15 to May 15, 1951

May 31, 1951

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Berkeley, California

UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

April 15 to May 15, 1951

MONTHLY PROGRESS REPORT No. 97

May 31, 1951

1. Bevatron (AEC Program No.1500) — UNCLASSIFIED

Magnet. Winding of the first quadrant of the magnet was completed May 17 and installation of the coil covers is proceeding. If the rate of progress attained on the first quadrant is maintained the winding will be completed in January 1952.

Both motor generators have been run with field excitation but without load. No important defects have appeared.

Vacuum Tank. The outgassing rate of the sample tank section has been measured and the calculated pressure difference between the center and end of a quadrant due to this cause is not excessive.

2. 184-inch Cyclotron Operation (AEC Program No.5741) — UNCLASSIFIED

The cyclotron was used for research experiments approximately 94 percent of the 486 hours that the crew was on duty.

The time distribution was as follows:

Operating for customers	457.00 hours	93.8%
Filament change	3.00 hours	0.6%
Mechanical trouble (rotary condenser maintenance)	20.25 hours	4.2%
Electrical trouble	6.00 hours	1.3%
Visitors	.50 hours	0.1%
	486.75 hours	100.0%

3. 60-inch Cyclotron Operation (AEC Program No.903) — UNCLASSIFIED

Operation was somewhat curtailed during the month due to a radiation spill. This necessitated a 3-day shutdown for decontamination and painting of the entire floor area. A bombardment efficiency of about 80 percent of the remaining available time was recorded.

4. Synchrotron Operation (AEC Program No.5731) UNCLASSIFIED

The shut-down for work on the rotating mechanism for the pair spectrometer was followed by a complete breakdown occasioned by sparking across the rf gap. Upon removal of the donut from the magnet and disassembly, there was found to be a good deal of copper sputtered presumably from the resonator surface onto the gap. At the last shutdown, Scotch electrical tape was wound around the boots, to prevent ozone attack. The boots looked fine, but vacuum grease had been forced into the system, presumably by the tight winding on the boots, so it is possible that this grease abetted the trouble. The plating on the inside of the donut was also in very poor shape. Particularly the connections between inside surface and outside grounding strap had been worn off at the the end surfaces of the quartz. Attempts to plate some silver on this section to make a permanent coating are being tried. Since the beam has slowly decreased for several months, it is hoped that considerable improvement can be made. The main runs were in the nature of instrumentation runs.

The time distribution for the period April 1 to May 1 was as follows:

Operations for customers	270.75 hours	72.01%
Maintenance	9.25 hours	2.46%
Installation	96.00 hours	25.53%
	376.00	100.00%

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

During this month a new booster pump was installed in the Calgon cooling system. One-half of the repair time was spent detecting vacuum leaks in the high pressure system in the Van de Graaff. A small fraction of the time was was also spent in machine research in an attempt to improve the operating efficiency.

The time distribution was as follows:

Running	63%
Bake-in	4.5%
Repair	22%
Installation	9%
Machine research	1.7%

6. Experimental Physics (AEC Program No.5211) UNCLASSIFIED

Film Program. Meson Decay Energetics. The result to date on the momentum of the μ^+ meson from the decay of a π^+ meson at rest is 29.86 ± 0.06 Mev/c. The π^+/μ^+ mass ratio at present stands at 1.317 ± 0.004. If it is assumed that a neutrino is the other particle resulting from the decay, the difference, $\pi^+ - \mu^+$,

implied by these results is 66.46 ± 0.16 electron masses. Knowing the mass difference and mass ratio of the π^+ and μ^+, their individual values are found to be 276.1 ± 2.3 and 209.6 ± 2.4 electron masses. These results come from a new experiment in which contamination mesons coming from points other than the target have been largely eliminated. The straggling of apparent masses is about that anticipated from the range straggling.

Meson Scattering. Progress has been made on the measurement of large angle meson scattering by the "internal albedo" method. In the experiment carried out so far, π^- mesons of 50-70 Mev enter an aluminum absorber perpendicular to the surface. The meson population is sampled by stripped emulsion embedded in in the aluminum. All the mesons stopping in the emulsion are recorded and analyzed. Considerable numbers of stopped mesons are found in emulsion at depths less than the normal depth of penetration and going in the opposite direction to the primary beam. A preliminary result based on 33 back-scattered mesons gives a total nuclear scattering cross-section of 300 millibarns for mesons of energy 35-55 Mev. Further work to define more precisely the momentum interval of the primary meson beam will be necessary for a better measurement. The method can be extended to distinguish between elastic and inelastic scattering.

Cloud Chamber. The 22-inch cloud chamber in a magnetic field of 8200 gauss was placed in the π^+ meson beam. The mesons first traversed the half-inch lucite wall of the chamber. Then they passed through a half-inch of copper and then on through 4 carbon plates 3/16 inch thick each. Two out of three pictures on the average showed a μ decay positron coming from a meson stopping in the carbon. The positron spectrum of 100 decays looks just like that obtained by Anderson for positive and negative μ decays. Over 600 μ decays were counted and their energy is being measured.

While this experiment was being done nuclear plates were exposed to the meson beam so as to determine the ratio of π and μ mesons entering the chamber 12 feet from the production point.

A portable diffusion chamber 6 inches in diameter was completed and used to examine visually the radiation coming through and around the shielding at the 184-inch cyclotron while using the meson beam. Also a weak neutron beam was run through the chamber. It was easy to observe stars in the gas visually.

A diffusion chamber filled with hydrogen gas and helium gas has been operated upside down, that is with the cold surface above. This works well initally and then unfavorable turbulent convection currents appear. The behavior of this chamber is being studied further.

The full beam from the synchrotron collimated down to an area one inch by three inches has been run through the rectangular chamber at the synchrotron containing helium gas. The tracks are clear and distinct.

D-p Scattering Using 190 Mev Deuterons. The study of inelastic scattering continues with most of the effort devoted to observing the p-p scattering processes in which one proton emerges at 30° from the beam, laboratory coordinate system. The total d-p cross section is also being studied using the following method: Since in all cases two charged particles emerge from the scattering

process, it is possible to obtain information on the total cross section by simply using a single counter at various angles. Integration of the single counting rate over the whole solid angle gives the rate at which charged particles are emerging from the sample, which is just twice the rate at which d-p collisions are occurring. The total cross section can be calculated directly from the rate of collisions. The method is limited by the necessity of using a polyethylene target which involves a subtraction of the effects from carbon in the target. At small angles the carbon subtraction becomes very difficult and it is not yet known whether or not much of the total cross section will appear in inaccessible angles near the beam. It is clear however, that the method will be useful at larger angles.

Precision Analysis of Gamma-Rays Resulting from Proton Bombardment of Carbon and Wolfram Targets. The experiments quoted in the last report have been continued by extending the angles of observation to include 0°, 180°, 135° and 45°. The resultant gamma-ray spectra showed a monotonic dependent on angles. It is therefore possible to obtain a gamma-ray spectrum which represents the mean gamma-ray spectrum averaged over a sphere. It can be shown that if the spectrum observed is a peak π^0 spectrum, that such a mean distribution would have to be symmetrical with respect to 1/2 the π^0 mass as produced on a logarithmic scale. The observed mean spectrum fails to show such symmetry; the peak appears to be shifted towards high energies. If one postulates that an admixture of 5 percent or more higher energy gamma-rays are present in the spectrum, then the remainder of the spectrum can be reconciled with being radiation from π^0 disintegration. It is possible, but certainly not proved here, that this 5 percent admixture corresponds to internal radiative capture of mesons made within the same nucleus.

High Energy Nucleon-Nucleon Collisions. The 35 channel magnetic particle spectrometer that is used to obtain energy spectra in this experiment is still undergoing modification for better energy resolution. The particle trajectories have been found using the "wire" method. These measurements show that the deflections of the particles in the magnet are about 7 percent greater than those calculated using a constant field over the physical dimensions of the magnet. An analysis of the magnetic field plot taken in a plane between the pole pieces shows that the additional bending of the particles is well accounted for by the fringing field.

Cerenkov Radiation. The polarization of Cerenkov radiation was checked by using strips of polaroid across the film in the camera. The light was plane polarized in the direction predicted by the theory. The ratio of exposure behind the polaroid oriented at 90° to that behind the polaroid at 0° was less than 0.005 indicating completely plane polarized light.

Neutral Meson Program. The yields of neutral mesons from proton bombardment of various nuclei from hydrogen to lead have been investigated. Plans are being made to measure the yields from a more complete set of nuclei and to measure the excitation function of protons on deuterium.

Scattering of π^+ Mesons by Carbon. Using a cleaner geometry, the 90° scattering experiment was repeated. The value obtained for the differential cross section for scattering of 47 Mev mesons from carbon at 90° is $(17\pm5)10^{-27}$ cm^2/ster. This is in good agreement with the previously determined value.

Isolaric State of Proton. Attempts are being made to find evidence for the excited state of the proton by looking at the reaction $p + p \rightarrow \pi^+ + n + p$ at that meson energy for which the meson and neutron have the same velocity. It is expected that if an attractive interaction exists between neutron and meson, there will be an increase in the meson production cross section analogous to the increase at high meson energy due to the proton-neutron interaction.

7. Theoretical Physics (AEC Program No.5211) SECRET

MTA. A design for the front end of Mark II with an initial radius of 0.34 feet, an injection energy of 0.094 Mev, and a maximum gap voltage of 1.088 mv/foot was made. The radius increased quite slowly to permit a slow increase in efficiency--which was quite low at the start. At the end of eleven drift tubes the energy was 2.04 Mev, a radius of 0.77 feet, and a length of 21 feet. It seems possible with such a design to have a phase acceptance angle of about 200°. Work is continuing to find what magnetic fields will be required.

Other Studies. The studies of π-meson production in complex nuclei and the investigation of meson absorption and scattering in nuclear matter are being continued. A method of analyzing π^0-meson production in deuterium is being studied.

8. MTA Program (AEC Program No.1500) SECRET

Mark I Vacuum Studies. Further detailed study is being given to the liquid nitrogen trapping system for the Mark I machine and to ways by which the capacity of the trap might be increased. It would be possible to double the number of cooling tubes and to supply each tube with two, one-quarter inch thick, eight inch long fins and thus increase the trapping area from 181 square feet to 1412 square feet. Some tests to study trapping are being planned for the 200 megacycle electron model. It has been suggested also that tests be made on the B1 cavity to determine the effectiveness of carbon dioxide cooled baffles for holding back pump oil.

Ion Injector Development. Additional work has been done on the ratio of atomic ions to molecular ions in the injector beam. The molecular ion content of the beam is a sensitive function of arc current and gas pressure. Beams with 90 percent atomic ions have been obtained and with additional work it is reasonable to expect beams of 80 percent atomic ions from an injector operating with usable pressures. The main objection to the presence of the molecular ions is the secondary electrons and consequently the x-rays produced when the electrons strike metal surfaces within the tank.

Oscillator Development. Separate pre-excitors are to be used for the Mark I accelerator. These will feed power to the cavity to give initial build-up through large loops which will be rotated out of the coupling position after the sub-excitor on the main oscillators has operated to hold the tank voltage. It is considered possible to design equipment for use in conjunction with the main oscillators of Mark II which will allow build up without using separate pre-excitors. The equipment to be used in conjunction with the main oscillator includes an amplifier and possibly an impedence transforming device to place an effective changing capacity at the coupling loops. The amplifier is used only at the start up and is switched out of the circuit before full voltage is applied to the oscillators.

It has been found from experience with the 40 foot linear accelerator now in operation that the multipactoring effect is dependent upon the location of the pre-excitor loop. If the loop is placed at the high energy end, no biasing is required and the multipactoring effect is reduced at the low energy end; whereas placing the pre-excitor at the middle of the tank makes biasing necessary. No restrictions exist as to the placement of the main oscillators if they are distinct from the pre-excitor.

Work is progressing on the oscillator tube development program of the RCA company. They are chiefly concerned with the modifcation of the 5831 tube to a new style called A2332. This tube should be capable of producing an output of 1 megawatt pulsed or 500 kilowatts for cw operation. The total filament emission current will be 125 amperes with the plate voltage having a maximum of 20,000 volts and a minimum of 1,500 volts. The tube operates with 80 percent efficiency at 500 kilowatt output and 70 percent efficiency for an output of 700 kilowatt. The estimated life of the thoriated wolfram filament are 10,000 hours. Some experimental tubes with filament length increased by 20 percent were being tested. Representatives of RCA are being given information on the design of cluster oscillators and it is expected that they will submit a proposal for the construction of the cluster oscillators.

Mark II Magnet Calculations. Magnet calculations for Mark II are now in preliminary form and will remain so until the injector end of the machine is designed and more complete data is available on the tailoring of the beam to fit the behavior of the accelerated particles at the high energy end. The focusing forces are so designed that they are always greater by a fixed amount than the defocusing forces. The preliminary calculations allow a 25 percent difference between focusing and defocusing forces for Mark II at the point corresponding to the output energy of Mark I. Focusing forces for Mark I are designed to be 18 percent greater than the defocusing forces. Tailoring of the beam is such as to allow an expansion to a diameter of 36 inches in the first approximately 150 feet and then a gradual decrease in diameter to 28 inches through the remaining length of the machine.

Shielding Studies. Further calculations have been made on the shielding requirements for the Mark II machine on the basis of different assumptions as to the distribution of the lost beam along the length of the accelerator. The choice of shielding thickness required for the roof has been made imperically on the basis of experience with the shielding of the 184-inch cyclotron. The machine is being designed so that the rejected portion of the beam will be lost within the first 50 or 60 feet with essentially no beam lost beyond that point. On this assumption, the maximum shielding thickness will be about 10.6 feet. However, it would seem safer to plan the installation of foundations heavy enough to support a shielding 15 feet thick, which might be required under very unfavorable assumption as to the distribution of the lost beam. It is possible that the shielding cost could be reduced by making the shielding thinner in the area where there will not be need of operating personnel. For the first 1000 feet a 6 foot shielding wall is planned with provision for increasing this thickness to as much as 15 feet over the last 500 feet of the accelerator.

Mark II Planning. The present three year Mark II schedule envisions operation starting in April 1954 with production beginning six months later. The design of the Mark II tank will need to be available in August, however, to carry out

this schedule. The location of the supporting ribs for the first 100 feet cannot be determined until the drift tube positions are known, because of the close spacing of the drift tubes near the injection end. It is not necessary to know the exact location of the other drift tubes in order to design the tank.

The matter of the necessity for a 1500 foot tank and the decision to operate at 12 megacycles are both being reconsidered. Because of the greater than one quarter of a Mev per foot of electric field gradient that can be held in large evacuated tanks, and also because the injection of ion currents of 500 milliamperes in a four inch diameter beam are possible it would seem that the design involving a 750 foot tank operated at 20 megacycles should be reconsidered. This would cut the capital costs by a large amount. At present both the choice of length and diameter is defined by the maximum permissible gradient.

It is also felt that it might be desirable to investigate the operation at other energies in view of the better information now available. It might be that 250 Mev would be better in the light of economic consideration. The changes in the energy of the accelerator would not affect the design of the power equipment now out for bids but would modify the number of units that would be required to obtain the energy.

Mark II Target Program. The experimental physics program for the target has as its purpose the gathering of information that will allow the maximum production of neutrons in the target and consequently the maximum production in the lattice. Since 350 Mev deuterons are not available, it will be necessary to extrapolate from results with 190 Mev deuterons, and in order that confidence may be placed in this extrapolation the target process must be studied in detail. Previous yield studies have established the fact that thorium and uranium are the best target materials. A target will be made consisting of a thorium primary and a uranium secondary, together with jacketing and cooling material to determine the neutron yield from various targets and geometric arrangements. Experiments in radio-chemistry are being designed to find the mechanism by which neutrons are produced in the target. Measurements are being made of the ratio of the number of fissions to the number of captures. This can be done by measuring the amount of Ba^{139} produced in fission and the amount of Np^{239} produced by capture. The number of neutrons per fission when known will allow the target thickness to be calculated, from which the maximum number of neutrons captured can be computed.

Lattice experiments are being conducted to determine the various fluxes in a graphite lattice and also to measure the total yield of neutrons. The lattice is a five foot graphite cube with a hole to admit the charged particle beam and split to allow target materials to be inserted. Copper tubes containing carbon tetrachloride run through the cube except in the outer one foot. Chlorine 38 activity can be used to measure neutron capture. Experiments will be done to determine the energies and angular distribution of neutrons at various depths in the target. This information is needed to determine shielding requirements and also to obtain maximum yields. Preliminary measurements of energies and angular distributions will be made by using threshold detectors. To study whether inelastically scattered neutrons actually accompany a fission, a target foil will be placed in a fission chamber and a second fission chamber in coincidence with the first will be used to detect the inelastically scattered particles.

Beam Precession Studies. The problem of beam power dissipation in the primary target involves distribution of the beam intensity over the entire target surface. The method that has been studied to distribute the beam power over the largest surface is rotation of the beam in either a circular or Lissajous figure. The studies of the beam profile show that the intensity of beam is highest at the center and drops off roughly as the inverse of the radius. The maximum beam intensity in the circular sweep case is found along the path followed by the center of the beam on the target. The average intensity along the path of the beam center will be of the order of the average beam intensity when the peak-to-average intensity in the beam is about 30. The ratio of beam radius to precession radius was varied to find the resulting ratio of peak-to-average intensity on the target. It was found that the smallest target size is obtained for a given maximum intensity on the target when the beam radius equals the target radius.

Sweeping the beam in Lissajous patterns of various ratios has been considered as an alternative method for reducing the peak-to-average intensity on the target. It was found that by using a ratio of about six to five and a square target with sides four times the beam radius that the ratio of peak intensity on the target to average beam intensity could be reduced to about 0.75. Triangular beam sweeping has been considered because of the advantage of constant velocity and uniformity of spacing. It was found however that the maximum intensity point shifted to the center and was even greater for frequencies of less than 7 to 6. For an approximated triangular wave formed by using harmonics imposed on the fundamental an intensity ratio better than the true triangular wave could be obtained. The best ratio obtained using an optimum fraction of the third harmonic, was found to be about 20 percent better than the simple Lissajous figure and 35 percent better than the circular precession.

An electrical arrangement has been devised that will allow the beam to scan the target in the 6 to 5 ratio Lissajous pattern. The power needed for sweeping will be in the order of 20,000 KVA.

9. Chemistry SECRET

Part A
(AEC Program No.5311)

Properties of Berkelium Isotopes. The first berkelium radioactivity to be observed was a 4.6 hour activity which is assigned to Bk^{243}. Recent experiments on the alpha spectra of curium resulting from decay of berkelium samples indicate that Cm^{244} is probably present with Cm^{243}. The alpha spectra of these two long-lived curium isotopes have been determined with material separated with the mass spectrograph. The conditions of the experiments were such that, if Cm^{244} is actually present, Bk^{244} must have very nearly the same half-life as Cm^{243}.

Spallation of Nickel. The yields of 20 nuclides from Cu^{64} to Na^{24} produced by 340 Mev protons on nickel have been measured as part of the program of study of the distribution of spallation yields.

Alpha Branching of Fr^{222}. The alpha branching of Fr^{222}, which decays mainly by beta emission with 14 minute half-life, has been observed to be between 0.1 and 0.01 percent by milking of Bi^{214} by recoils and by chemical separations. The intermediate At^{218} has not been observed in this work.

Properties of Em^{209}. The half-life of Em^{209} has been shown to be 30 to 40 minutes by isolation of emanation produced by the decay of Ra^{213}. Ra^{213} has a half-life of about two minutes. Em^{209} decays mainly by electron capture to At^{209}.

Beta Spectrum of Ac^{228}. The double-focusing magnetic beta spectrograph has been used to study the continuous beta spectrum and the conversion electrons of Ac^{228}. The beta spectrum has been resolved, by Fermi plots, into three components of 1.10, 1.74, and 2.03 Mev. The correlation of the many conversion lines with gamma-ray energies has not been completed, but at least six gamma-rays are present. The new beta energies require serious revision of decay schemes based on some of the gamma-ray energies by previous workers. The 2.03 Mev beta is probably a transition to the ground state of Th^{228}.

Magnetic Alpha Spectrograph. The new magnetic spectrograph for alpha particles has been used to study Pu^{239} and Pu^{240}, whose alpha energies are nearly the same. Several groups very close together have been resolved. The main group of Pu^{240} is about 10 Kev higher than the main group of Pu^{239}.

Chemistry SECRET

Part B
(AEC Program No.5311)

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

1. Oxide phase diagrams.
2. Gaseous hydroxides of Mo and W.
3. High temperature x-ray studies.
4. Liquid metal systems.
5. Heat transfer in forced convection film boiling.

Basic Chemistry, including Metal Chelates. The following problems are under investigation:

1. Germanium chemistry.
2. Thermodynamics of rhenium.
3. Electron exchange rate between Fe^{2+} and Fe^{3+}.
4. The polymerization of aqueous zirconium.

Chemistry UNCLASSIFIED

Part C
(AEC Program No.6400)

Synthetic and Experimental Chemistry. High specific activity runs of the following C^{14}-labeled compounds have been either begun or completed: 60 mc of norvaline-3-C^{14} hydrochloride; 160 mc of potassium formate-C^{14} which was then converted to labeled methanol and methyl iodide; 50 mc of aspartic-β-C^{14} acid. Other compounds whose preparations are being studied include: hippuric acid (benzoylglycine-2-C^{14}), leucine-3-C^{14}, norleucine-3-C^{14}, valine-4,4'-C_2^{14}, isoamyl-1-C^{14} bromide, cholesterol-23-C^{14}, stearic acid-T, cholesterol-T, and vinyl acetic-1-C^{14} acid.

A study has been initiated of the azlactone synthesis of the amino acids. It is hoped that the intermediate for this condensation, hippuric acid, can be prepared and that by condensation with a series of aliphatic and aromatic aldehydes that a number of α-labeled amino acids can be easily prepared. Diglycine, glycyltyrosine and glycylleucine have been irradiated. Analytical methods have been devised for assay of the amino nitrogen in these peptide mixtures to determine if there is a total loss from the solution by the material. Preparation of glycylphenylalanine labeled with C^{14} is being investigated. Other projects currently being studied include: (1) Rate studies on isotope effects of C^{14} in oxalic acid and substituted malonic acids; (2) improved ionization chamber equipment for low level C^{14} measurements; (3) special equipment (Berkeley box) for high level C^{14} synthetic work; and (4) separation of mixtures of amino acids on Dowex 50 ion exchange resin columns.

Biological Chemistry. Cholesterol (separated from chicken eggs) has been fed to two rats and the distribution of radioactivity measured. Some $C^{14}O_2$ was excreted and some radioactivity was found in the urine and other body fractions. Work is in progress to separate more fully some of these components. For biological studies in double labeling of molecules experiments have been conducted to determine the concentration of tritium and carbon simultaneously in the same sample. A procedure for burning has been developed which works well. Both water and carbon dioxide are collected, and to date a standard deviation of 4 percent on both isotopes in analytical work has been obtained.

The detailed study of stilbamidine metabolism has continued. A large portion of the stilbamidine absorbed in the liver is found in the mitochondria and this heavy fraction has been broken up by sonic disintegration and by sudden release of gas pressure. Both methods cause a "solution" of total nitrogen of the mitochondria, but most of the radioactivity is still found in a fraction that can be centrifuged. A correlation between the amount of radioactivity absorbed in the liver and the weight of the tumor has also been found. Attempts are being made to measure stilbamidine uptake by the fecal and excretion curves of mice.

Major excretion products after the injection of the two purines, 8-azaguanine and 8-azaadenine, have been identified as 5,7-dihydroxy-1-v-triazolo (d)-pyrimidine (8- azaxanthine) and 5-hydroxy-7-amino-1-v- triazolo(d)-pyrimidine (8-azaisoguanine). A number of products have been degraded from the

in vitro incubation of liver slices with sodium propionate-3-C^{14}.

Photosynthesis Chemistry. Sedoheptulose monophosphate and ribulose-1,5-diphosphate have been identified as early intermediates in the photosynthetic reactions leading to sucrose. Sedoheptulose and fructose monophosphates are synthesized concurrently and both precede glucose phosphates in steady-state photosynthesis. Kinetic experiments intended to determine the relative sequence of ribulose mono- and diphosphates are in progress. Periodate degradation of sedoheptulose and ribulose from non-uniformly labeled preparations is in progress. The synthetic sequence of these sugars and their role as C_2 donors in the synthesis of phosphoglycerate will be investigated from these new data. Identification of the intermediates of sedoheptulose synthesis is in progress. Sucrose-C^{14} metabolism of Chlorella is being studied. Photosynthesis and dark fixation of $C^{14}O_2$ by Euglena and a blue green algae S.Cedorum, is being studied.

10. Medical Physics
Part A
(AEC Program No.6000)

UNCLASSIFIED

Tracer Studies. Tracer studies are being continued on radioactive radioisotopes of rhenium, iridium, plutonium, lead and chromium. The effect of "Versene" and other chelating agents upon the removal of plutonium from rats is also being continued.

Astatine. Two monkeys were injected with At^{211} and carrier-free radioiodine simultaneously. The purpose was for a direct comparison of the accumulation of these two elements in the thyroid gland, and to prepare radioautographs.

Radiochemistry. Carrier-free procedures have been developed for the preparation and isolation of Hg^{197} from deuteron bombarded gold and Fe^{59} from deuteron bombarded cobalt. Previously reported procedures were used to prepare carrier-free $Pt^{191,192}$, $Rh^{101,102}$, A^{37}, At^{211}, and $I^{124,125,126}$.

Construction of target cell and other apparatus for radiation chemistry is in progress.

Medical Physics
Part B
(AEC Program No.6000)

UNCLASSIFIED

Biological Effects of Radiation. Bacteria: The preparation of desiccated bacteria is being continued, and the growth dynamics of these samples is being studied. Dried samples of strains B and B/r of E.coli grown aerobically and anaerobically are being made. By using suitable quantities for innocula, populations in various stages in the growth curve are readily obtained for irradiation experiments. Such irradiation studies are under way.

Double Nucleated Lymphocytes. A comparison has been made of cell distribution, by means of differential counts, in direct smears of venous blood and in smears of buffy coat preparations. Excellent agreement is obtained both in dogs and

human subjects. It is of interest that no double nucleated lymphocytes were seen during the process of making these 1,000 cell differential counts in six persons and 2,000 cell differential counts in two dogs, with the exception of one individual in whose smears two such cells were seen. There is no indication that he has had more radiation exposure than the others. Evaluation of this awaits the examination of larger numbers of lymphocytes in each individual. In all of the preirradiation control counts which have now been completed on the dogs, not a single double nucleated lymphocyte has been found.

Studies with C^{14} Labeled Stilbamidine. Sufficient studies have now been made in animals injected with C^{14} labeled stilbamidine to show that there is a definite correlation between the liver concentration of activity and the weight of tumors lying remotely from the liver--an indirect effect of tumor on host.

Iron Turnover Studies. Iron turnover studies were done in normal and hypophysectomized rats and normal and hypophysectomized rats treated with ACTH using Fe^{59}. Both of the groups of ACTH injected animals when compared to their respective controls showed an increase in red cell iron turnover. This indicates that the increase in red cell volume previously reported upon in these same animals was due to an increase in red cell production. At the time of sacrifice P^{32} tagged blood was injected and by counting samples of tissue the amount of blood present in the tissue was determined. Total iron determinations were done on liver, spleen, muscle, duodenum, bone marrow and blood. Knowing the amount of blood present in a sample of tissue and the total iron in that blood it was possible to determine the blood-free iron value for this given tissue, thus avoiding the inherent errors in the perfusion technique. The values for tissue iron were consistent; however, there was no significant difference in the groups of animals studied in this experiment. Further study of these lipoprotein molecules associated with atherosclerosis as well as several other lipoprotein species has revealed that essentially all of the blood lipids (including fat, cholesterol, cholesterol esters, and phospholipids) exist in the blood only in the form of structural entities within several of these lipoprotein molecular classes. Current work is directed toward an understanding of the factors involved in the defect which results in the abnormal elevation of such molecules as the Sf 10-20 lipoproteins in certain individuals. Several errors in lipid metabolism have now been classified by the ultracentrifugal analysis of serum lipoproteins. Such are manifest in (a) atherosclerotic state (b) nephrosis (c) xanthoma tuberosum (d) biliary obstruction (e) acute hepatitis (f) certain cases of diabetes (g) hypothyroidism (h) hypercholesterolemia (i) xanthelasma. In addition, there are certain bizarre, but characteristic ultracentrifugal lipoprotein patterns which are seen in presumably normal individuals, but are as yet unclassified.

As an extension of studies of the factors involved in the maintenance of the levels of the various serum lipoproteins, it has now been found that heparin can produce a profound alteration in the lipoprotein pattern in a manner which may prove of value in the further understanding of atherosclerosis. Heparin, of course, has long been used clinically in the therapy of thromboembolic disease, but not for any possible influence it might have upon metabolic factors leading to atherosclerosis. It has been found that heparin administered

to rabbits and human beings causes profound reorientation in the distribution of low-density lipoproteins, characterized by a shift of lipoproteins of high S_f rates to those of successively lower S_f rates. Heparin administered to cholesterol-fed rabbits prevents the development of high levels of S_f 10-50 lipoproteins and retards the development of atherosclerosis in such animals. Following heparin administration the plasma contains an "active principle" associated with the ultracentrifugal globulins, which produces similar reorientation of the lipoprotein spectrum in vitro. Heparin added directly to serum is ineffective in vitro. Intermittent heparin administration to patients with severe angina pectoris results in relief from symptom for periods of several days beyond a single injection. Experimental methods and a discussion of results will be given in detail in a forthcoming Quarterly report.

Biological Effects of Radiations on Animals (184-in. Cyclotron). The radiation of the pituitary glands of young male rats was continued. The inhibition effect on growth occurs with a considerable time delay, which extends even after large doses of deuterons, to approximately 12 days. During the first few days there appears to be a slight stimulating effect on the gonads and testicles, their weight is larger than normal on comparable days and in some instances viable sperms were observed earlier in the irradiation than in the normal rats. Larger series of animals are being irradiated to obtain greater statistical significance.

Activation Analysis. Elution characteristics for iridium, zirconium, and palladium from Dowex-50 ion exchange column have been determined. Gamma-gamma and beta-gamma coincidence counting has been applied as an additional criterion in the identification of unknown elements in the activated samples.

Acceleration of Multiply Charged Ions. A preliminary report has been completed on the new method of injection proposed for producing high energy beams of multiply charged nuclei in particle accelerators. Briefly the method is as follows: (a) In a low voltage ion source ions are made with low multiplicity of charge. For example, in the acceleration of neon singly or doubly charged neon ions might be used. In a linear accelerator these ions are accelerated to travel at velocities somewhat higher than the velocity of the K electrons of the nucleus. It is essential that during this preacceleration there should be no exchange of electrons. From the preaccelerator the particles are injected in a cyclotron. When the particles reach the dee they are passed through a thin metal foil which strips them of all their electrons. Their radius in the magnetic field then becomes small, and if in the proper phase, they will be accelerated in the cyclotron until they reach the full radius. In this manner 10 times charged neon ions of approximately 1800 Mev could be generated. The preaccelerator could also be used in connection with another linear accelerator or with the bevatron, and the advantage of the method proposed here is chiefly to provide an intense source of multiply-charged ions travelling at high enough velocity so that they will not capture electrons.

Since the preaccelerator is designed for a given charge to mass ratio, the same preaccelerator could be used for several different nuclei. For example C^{+}, Mg^{++} and A^{+++} would all be accelerated with the same preaccelerator. The length of the linear accelerator needed to achieve proper preacceleration is of the order of 100 feet. Further theoretical work has been initiated.

Instrumentation. A Faraday cage has been designed for irradiating micro-organisms with the intense proton beam of the linear accelerator. This instrument will allow integration of the total particle flux received by the micro-organisms. It will be put to use chiefly for studying the biological effect as a function of specific ionization and of beam intensity.

Equipment for monitoring the 110 Mev carbon beam for the purpose of biological experiments has been completed and it is being further improved. The experiments are done on the reflected carbon beam and through a slit system. Two ionization chambers and one particle counter is combined with a set of absorbers. The micro-organisms are mounted on the top of agar blocks spread in such a manner that there is a single layer of cells.

Counting equipment for in vivo measurements of gamma rays in human subjects will have four crystal counters combined with recording counting rate meters and is in the last stages of mechanical assembly. This device should be completed within six weeks.

11. Health Chemistry (AEC Program No.5311) — CONFIDENTIAL

Research and Development Group Activities. Work in progress is listed below:

1. A preliminary run was made with equipment for processing radioactive iron from bombarded cobalt. Improvements are in progress.

2. Holders for quartz windows in the arc stand spectrometer equipment were completed. These are of value for protective purposes as well as for collimating the beam.

3. Equipment for processing Hanford pile-bombarded americium was readied, the sample received and the chemistry finished.

4. Equipment for handling thorium-uranium bombardments was finished.

5. Hanford pile-irradiated animal ash samples were received and processed; the problem of handling these items is under study and improvements are being developed.

6. A setup for decontaminating objects used in connection with C^{14} has been studied and recommendations are now in the hands of the architectural group.

7. Work is in progress on three special boxes for handling thorium-uranium bombardments.

8. A disposable gloved box, made of cardboard, for use in the very simplest of chemical processes, was made and used successfully; this type of box is being further investigated.

9. An improved yttrium box has been completed and is ready for installation and testing.

10. A teflon spigot for use in chemical experiments where corrosion-resistant equipment is mandatory was built.

11. Improvements have been made on the chain drive manipulator (used in two-inch lead boxes) and on the rotating reagent rack.

12. A catalog of Health Chemistry equipment is being made and a drawings file of the material revised.

13. A holder for 3.75 curies of Co^{60} has been built. This source of cobalt is being built up in such a manner that a dose of one million roentgens may be given in about four days.

12. Plant and Equipment

OFFICIAL USE ONLY

Measurements Project. (Program No. 1300. 3-424-1720) Tests completed.

Bevatron Building and Instrument. (Program No. 1500. 5-424-9001) Installation of coil winding on the first quadrant is 90 percent complete. Bids have been received and order is to be let for installation of air filter in the magnet cooling system.

MTA - Mark I. (Program 1500. 5-424-9004) Development and design continuing.

MTA - Mark II. (Program 1500. 5-424-1004) Development and design continuing.

Accelerator Design Building. (Program 1500. 5-424-1004) The inside partitions are in place. Painting is about 10 percent complete. Transite siding is on. Plastering and stucco work in the laboratory area and entry respectively are 50 percent complete. Heating and ventilating system is being installed. The total job is on schedule and 55 percent complete.

Sheetmetal and Insulator Shop. (Program 1500. 5-424-1001) This building is complete and has been accepted.

Miscellaneous Construction. (Program 1500. 5-424-1001)

Hydrogenation Shelter. The hydrogenation shelter near Donner Laboratory was completed April 20, 1951.

Pipe Welders' Shack. This work was completed May 11, 1951.

Counting Equipment Room. This work was completed on May 7, 1951.

Decontamination Yard Extension. This work was started on March 28, 1951 and is 90 percent complete.

Corp. Yard Development. This was started on March 26, 1951 and is 80 percent complete.

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Miscellaneous Construction (Continued)

Waste Oil Tank. This work was started on May 2, 1951 and is 20 percent complete.

Building 29 and 30 Sprinkler System. This work was started on May 1, 1951 and the Sprinkler System in Building 30 is 40 percent complete.

North Gate House. - Building 65. Preliminary plans have been approved and bids are to be taken May 29, 1951.

Slope Stabilization - Bevatron Site Area. Bids were opened April 16, 1951.

Animal House. (Program 1600. 6-424-9007) Outside foundation and walls have been stripped and backfilling under the slab is proceeding.

Radiological Laboratory at the University of California Medical School. (Program 1600. 6-424-9008) Plasterer has a large crew and is still installing the final coat on the first floor. Ventilation ducts are being installed on the upper floor. Although the work is proceeding at a good pace now, it will not be possible for this subcontractor to finish the construction less than six weeks late.

LMM/6-4-51
Information Division

MAN-MONTHS EFFORT REPORT
Scientific Personnel

Program No.		Subdivision	Man Months Effort	Comments
Plant and Equipment				
1300	Weapons	General	1.9	
1500	Bevatron	Miscellaneous	.2	
	MTA-Mark I	Design and Development	25.8	
	MTA-Mark II	Design and Development	33.9	
Operations				
Physics Research				
3000	Weapons	General	16.8	
5211	Thomas Cyclotron	Electron and X-C Models	13.1	
	Experimental Physics	Cloud Chamber	8.6	
		General Physics Research	35.4	
		Instrument for General Use	5.3	
		Special Development	6.2	
		Magnetic Measuring Equipment	2.3	
	Theoretical Physics	General	9.5	
	Photographic Film Detectors	General	11.4	
	Isotope Separation	General	.5	
	Radioactivity Physics	General	1.0	

Program No.		Subdivision	Man-Months Effort	Comments
Operations (Continued)				
Chemistry Research				
5311	Basic Chemistry Research, Part A	Chemistry of Heavy Elements	5.2	
		Nuclear Properties of Heavy Element Isotopes	8.3	
		Transmutations with the 184" and 60" cyclotrons	9.2	
		Analytical and Services	11.4	
		Special Chemistry Development	2.2	
		Mass Spectroscopy, Beta Ray Spectroscopy	2.0	
		Instrument Development and Services	3.4	
		X-Ray Crystallographic Measurements	2.1	
	Basic Chemistry Research, Part B	Metals and High Temperature Thermodynamics	3.0	
		Basic Chemistry, including Metal Chelates	2.0	
5361	Applied Chemistry Research	Process Chemistry	10.8	
Reactor and Accelerator Operation				
5731	Synchrotron	Operation	5.9	
5741	184-inch Cyclotron	Operation	10.1	
5751	Linear Accelerator and Van de Graaff Generator	Operation	11.7	

Program No.		Subdivision	Man-Months Effort	Comments
6000	Biology and Medicine Part A	Metabolic Properties of various Materials	11	
		Radiochemistry	4	
		Radioautography	2	
6000	Biology and Medicine Part B	Instrumentation for Quantitative Measurements of Radiation	1.5	.6 Consultant
		C^{14} Metabolism	2.7	.6 Man-Months
		Use of Radioactive Materials in Human Physiology and Experimental Medicine	7.5	7.0
		Trace Elements and Irradiation Studies	4.9	1.0
		Radiation and Mutation Rate	1.6	.3
		Physical Biochemistry	10.5	2.3
		Biochemical Response to Irradiation	2.3	1.0
		Miscellaneous	1.0	-
		Donner Animal Colony Expense	1.5	1.7
		Metabolism of Lipo Protein and Lipids	4.1	8.7
		Iron Metabolism Hematopoiesis	3.3	.5
		Internal Irradiation and Hematological Response	2.0	-
6400	Biological Research	Synthetic and Experimental Organic Chemistry	6.0	
		Biological Chemistry	7.9	
		Photosynthesis Chemistry	3.9	
		Metabolism of Fission Products	14.3	
6500	Biophysics Research	General	2.2	