UNIVERSITY OF CALIFORNIA — BERKELEY

RADIATION LABORATORY

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UNIVERSITY OF CALIFORNIA

Radiation Laboratory

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MONTHLY PROGRESS REPORT

No. 91

October 15 to November 15, 1950

November 30, 1950

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Berkeley, California

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1. Bevatron

UNCLASSIFIED

Magnet. The bottom yoke slabs and about half the leg slabs for the first (southeast) quadrant have been erected. Deliveries on coil parts have progressed to the point that the date of December 18 has been tentatively set for the start of coil winding.

Magnet Power Supply. Erection of one motor-generator set is practically complete and erection of the other is proceeding rapidly. Vacuum pumps of the five rectifier sets so far received are in operation. Wiring and bus work are being installed.

Other Work. The vacuum pumping system for the test tank section is down to a good vacuum but the sample tank sections has not yet been assembled. Minor jobs such as covering trenches and installing vanes in the air ducts are in progress.

2. 184-inch Cyclotron Operation

UNCLASSIFIED

The cyclotron was used for research experiments approximately 86 percent of the 500 hours that the crew was on duty.

The time distribution was as follows:

	Hours	Percent
Operation for customers	427.75	85.5
Filament change	1.25	0.3
Electrical trouble (oscillator)	9.00	1.8
Mechanical trouble	6.50	1.3
Miscellaneous	3.50	0.7
New equipment installation (concrete shielding)	52.00	10.4
	500.00	100.0

Installation of the additional concrete shielding was continued this month.

3. 60-inch Cyclotron Operation

UNCLASSIFIED

Recurrence of deflector insulator fracturing lead to the complete realignment of all components and a redesign of the internal stress cone to equalize electrical and mechanical forces. Since installation of the assembly, no further

heating of the insulator or excessive electric drains have been encountered.

Despite the outage accumulated with the deflector repairs, operating efficiency of about 80 percent was maintained.

4. Synchrotron Operation UNCLASSIFIED

The synchrotron beam has been maintained at high intensity during this period. An intensity better than 1000 R/min was recorded for several days. This intensity was measured on a Victoreen thimble surrounded by 1/8 inch of lead at a distance of 1 meter from the target. The synchrotron was operated at reduced intensity for most of the experimenters. This was done in order to reduce the random coincidence background in coincidence counting experiments.

Following are operating statistics for the period:

	Hours	Percent
Research operating time	301.45	75.1
Tests with synchrotron	42.15	10.5
Maintenance and installation	57.90	14.4
	401.50	100.0

5. Linear Accelerator and Van de Graaff Operation UNCLASSIFIED

All oscillators have been tested at 400 kw output. Transmission lines have been installed in the tank and the tank has been evacuated. The new Van de Graaff foundations have been excavated and forms have been installed. The Van de Graaff "mobilization" is now 75 percent complete. It is expected that the linear accelerator as a whole will be operative by Christmas.

6. Experimental Physics UNCLASSIFIED

Film Program. About 65 cm of 200 Mev electron and positron track in nuclear emulsion was scanned in a study of high energy electron processes. Electron-electron scattering is frequent, but large energy transfers infrequent; indeed the number appears to be significantly less than the theoretical prediction. A number of events interpreted as pair formation by the primary particle have been recorded. There is some danger of confusion in this type of event, but if real, the number is far in excess of the number anticipated.

Long range programs on meson masses, the kinetic energy of the μ meson, the branching ratio of π^+ mesons, and grain density studies have continued active during the month.

Attempts, which have not yet proved successful, were made to determine the spectrum of decay electrons from μ^+ mesons using the spirorbit spectrometer, to find the deuterons presumed to be formed in the process $p(p,\pi^+)D$, and to

obtain a sample of μ^- mesons known to be free of π^- meson contamination.

Cloud Chamber. The rectangular chamber for the photodisintegration of the deuteron was operated and a study made of the effect of using a hole plate and of leaving out the hole plate. The conclusion was that no change in the operation of the chamber could be traced to the presence or absence of the hole plate.

The pantagraph chamber in the large magnet was placed in a beam of positive mesons coming out of the cave. These mesons were made by 350 Mev protons striking a polyethylene target in a magnetic field which turned the mesons through 90° through a hole in the wall of the cave. 105 π-μ decays in flight in the chamber were observed and 7 μ mesons stopped in the gas of the chamber showing the decay positrons. Over a thousand pictures were taken in a field of 8270 gauss with the magnet running steadily.

A polyethylene plate was placed vertically in a continuous cloud chamber filled with air and tracks were seen to within 3/4 in. of the plate.

A preliminary report on the neutron-deuteron scattering experiment was completed.

300 Mev Pair Spectrometer for Use at the Synchrotron. Instrumentation has been completed for measuring pair production cross sections, total attenuation cross sections and similar numbers for the 320 Mev x-ray beam of the synchrotron. A primary run has indicated satisfactory conditions with background and counting rate.

Attempts to Detect Coincidence Between Postive Mesons and Deuterons Corresponding to the Process $p+p \rightarrow \pi^+ + d$. A coincidence arrangement has been designed using liquid scintillators to detect the deuterons in the above process. The existence of the deuterons in p-p collisions has been strongly inferred from other experiments but it appears to be a matter of importance to establish their existence directly. The experiment is not an easy one, owing to the fact that the deuteron is emitted nearly in the forward direction and is thus difficult to separate from the primary beam. Results to date have been inconclusive.

Delayed Neutron Emission. Sufficient data has been secured from two cyclotron runs to indicate that the half-life of the neutron activity under observation is 0.165 sec. $\pm$ 0.015 sec. The activity has been observed using Be_3N_2 and boron targets in the deuteron beam.

Neutral Meson Program on the 184-inch Cyclotron. The past month has seen nearly complete success in the development of good electronic methods for counting the two coincident photons resulting from decay of the neutral meson. Some work remains to be done in decreasing the dead time of the counting system, but the resolution time with which the coincidences are determined is approximately 10^{-8} seconds and the discrimination ratio between triple and quadruple coincidences are a factor of at least thirty.

Worthwhile experiments on the angular distribution of neutral mesons created by high energy proton bombardment seem now to be possible.

Proton and Neutron Elastic Scattering. The 90 Mev results of Bratenahl et al were further verified, using our triple coincidence scintillation counter telescope, with absorber and converter between target and telescope. Moderate success was met in an attempt to detect 270 Mev neutrons by the same method. The scattered flux of neutrons and the detection efficiency of the telescope for neutrons of this energy are very low. For this reason, more exploratory runs must be made before the feasibility of this 270 Mev neutron experiment can be determined.

Electronic Meson Counting Method. Preliminary measurements have been made on π^+ production by protons as a function of Z. Measurements were made at 53 Mev meson energy in the forward direction using magnetic separation of mesons from the primary proton beam. The elements studied were C, Al, Cu, Fe, Ag, and Pb. Cross section divided by Z decreases slowly with increasing Z.

P-p Scattering at 340 Mev. The results based on the coincidence counting method are very nearly in final form and the results should be complete within a few weeks. Further work will be done shortly on scattering at very small angles to the beam. This will require the use of a liquid hydrogen target.

D-p Scattering Using 180 Mev Deuterons. A preliminary run has been made on inelastic scattering. The results of the first run indicate that good measurements are feasible. This experiment is continuing.

Meson Studies. Scintillation counters using π-μ decay have been used successfully at the synchro-cyclotron for the measurement of production cross sections of π^+ mesons. By using magnetic separation of mesons from the 340 Mev proton beam cross sections have been measured for production at 0° of 50 Mev mesons for targets of various Z. These preliminary measurements show that the cross section vs Z curve has the same form as that obtained at Rochester for 20 Mev mesons produced at 150° by 240 Mev protons.

Further attempts to measure the scattering of mesons using the meson beam and the π-μ detection apparatus indicate that the problem is an order of magnitude more difficult than anticipated because of a high neutron background produced by the proton beam in the production target of the meson beam. The experiment measuring the cross sections for production of mesons at 0° by protons on protons has been nearly completed. By using the Cerenkov radiation produced by the proton beam, the beam energy has been determined before and after the experiment, and this datum, with the meson spectrum, indicates a deuteron is produced in the π^+ production.

Production of mesons at lower proton beam energy and at other angles is being measured at present.

A method for counting particles in flight and identifying them by pulse height is being developed. This should be a powerful tool for detecting negative as well as positive mesons.

Synchrotron Studies. This month saw the beginning of some new experiments on the synchrotron, the continuation of the previous experiments, and some work on the machine itself.

Work on the scattering of γ-rays has been started using scintillation counters. To discriminate against charged particles a counter in anti-coincidence is first in the line from the target irradiated with synchrotron γ-rays. Then the γ-ray produces a pair and one or both of the pairs is counted in further crystals. Absorbers tell the energy of the electrons and consequently of the γ-rays. Cu radioactivity detectors are being used to attempt to find γ-rays scattered by nuclei. Progress has been made in getting the component parts of the pair spectrometer operating, the counting system is, of course, requiring the most development work. Work on cloud chamber experiments is also again under way. The experiments on the yield of neutrons from substances irradiated with γ-rays, the angular distribution of shower γ-rays, and the yields of Li^8 are all proceeding and nearing completion. A run on the yield of photo-mesons from deuterium has also been made and an experiment to try to detect μ pairs is getting under way.

7. Theoretical Physics SECRET

MTA. The conditions to be met for minimizing the power losses in the long MTA were studied under various assumptions as to how the accelerating voltage would vary along the machine. It appeared that the precise method in which the applied voltage varied was not too important. The conclusion was that other criteria-- not power loss-- should determine what type of variation would be most desirable.

The problem of injection at higher energy than 80 Kev and with larger initial aperture than used heretofore was considered. It appeared that the matter could be satisfactorily studied only if orbits for the coupled logitudinal and radial motion were calculated. The possibility of using high speed calculating machines to solve the equations for the coupled motions is being investigated.

Other Studies. Calculations are being extended on the lateral spread and angular distribution of cosmic ray showers. Range-energy calculations are in progress. A study of recent experimental results on photo-nuclear reactions as a function of atomic weight is being conducted.

The proposal of a short-range singularity in nuclear forces is being applied to an analysis of experiments done at this laboratory of the transmission of fast neutrons through nuclei. An attempt is being made to relate the γ-ray spectrum arising from the absorption of π^- mesons in deuterium to the singlet-s phase shift for slow neutron-neutron scattering.

Calculations are being made of the low energy stripping of deuterons and of the angular distribution as a function of the mass number of the target nuclei and of the energy of the incident deuteron.

8. M.T.A. Program SECRET

L-1 Test Cavity. Some of the design parameters of the L-1 test cavity have been fixed. The diameter is to be 25 ft. and the length 40 ft. Power for the drift tube magnet in the single long drift tube will be approximately 300 kw,

while that required for the magnet in the half drift tube will be about 150 kw. The estimated power to excite the cavity is in the vicinity of 7 megawatts but to allow for uncertainties and miscellaneous losses, somewhere between 8 and 10 megawatts will be allowed for cavity excitation.

Calculations have been made regarding the possible x-ray levels resulting from the operation of the L-1 cavity. Under high level loading x-ray intensities of 25 R/sec may be produced at the outside of the tank. This represents a lethal dose with a single pulse of the beam. To reduce the intensity to tolerance will require 12 ft. of ordinary concrete. Great care will be required in the design of openings in the shielding for periscope and transmission lines.

Recent tests have indicated a threshold of 21.5 Mev for the γ,n reaction on copper. The design of the L-1 test cavity provides a voltage radient across the full gap of 21.5 Mev and consequently some activity can be expected to be produced when operating at maximum voltage. To eliminate this problem an alternative design of the L-1 cavity has been suggested in which only one full length drift tube would be included. The cavity is now being designed for either geometry and a choice between the two will be made at a later date.

Ion Source Development. Test cathodes for the ion injector have continued with experiments on the cathodes employing lanthanum borides fused on graphite. It does not appear that this type of cathode will prove satisfactory unless the lanthanum boride can be incorporated within a tough base material rather than used as a surface layer. Tests of the Phillips type cathode have been quite satisfactory. Some have been destroyed by overheating but none of them by exhaustion although runs have extended to as long as 60 hours.

It has been discovered that ion beams can be obtained from the injector when the first two accelerating electrodes are grounded. Total ion currents of 2 amperes have been obtained with this method.

Measurements of the focus of the beam using vanes on the shielded cup have shown that under normal operation where three electrodes are used in a acceleration-deceleration system 90 percent of the ions passed through a hole 3 inches in diameter while with the first two electrodes grounded, above 90 percent passed through a hole 3-1/2 inches in diameter.

Oscillator Development. The one megawatt oscillator is operating satisfactorily and yields an output of 1 megawatt at a plate voltage of 17.5 kv, and with an efficiency of 78 percent. The resonance load B-1 is now being pumped down to vacuum. X-ray production experiments have continued. The voltage on the electrodes under CW operation has reached 1.05 megavolts and produces an x-ray intensity of 90 R as measured through a 1 inch lucite window at the top of the tank. The preliminary design of the pre-exciter housing has been made and engineering drawings are now being prepared. It is thought that the use of low level excitation is still advisable. In the event that the ion locking problem proves serious, however, it will be necessary to augment this with high level pulse pre-excitation.

Electronics. The electronic crow bar has been perfected so as to operate satisfactorily in a vacuum. It appears to be very reliable. While no exact measurements

have been made it appears from tests on the XC equipment that only a few r.f. cycles are required to short the load.

Some concern has been expressed over the design of the r.f. joints in the supporting stems for the drift tubes and for the tank door and fastening of the movable end walls cylindrical surface of the cavity. There is now under design a coaxial line with a power requirement of about 50 kw to produce current densities of about 100 amperes per inch to be used in the testing of various types of r.f. joints. This equipment should be completed in about one month.

Mark I Shielding. Estimates of the amount of shielding required about the Mark I accelerator have been re-examined in light of the upward revision in the amount of energy that is expected to go into the form of x-rays. On the basis of the expected average neutron flux it was recommended that a shielding wall of approximately 7 ft. thick surround the accelerator with shielding of 10 ft. thick around the target. It has been found that the 7 ft. of concrete required for neutron shielding is still adequate to absorb the x-rays as well.

It has been estimated that with the current measuring target the equilibrium activity would, if unshielded, give a tolerance dose in 20 minutes at a distance of 600 ft. It has been calculated that 4 inches of lead will be required for shielding the target. A design is being studied in which the current measuring target could be lifted into a shielded coffin supported on the top of the tank and the coffin and target transported to a working location.

Mark I Electron Model. On the electron model of Mark I the ratio between input and output electron currents was found to be about 3 to 1 which is an approximate confirmation of the estimated phase acceptance angle of 150°. A higher power oscillator is being installed in order to overcome the gas loading problems peculiar to this model.

Mark I Construction. The winding operation on the drift tube magnets at the Oscar Krenz Company is proceeding. The shell for the No. 4 drift tube is being fabricated and is nearly completed. It is being fabricated from a full sized sheet of 1/4 in. copper which is pounded into shape with wooden mallets. The first four tubes for the large size magnets have been received and the steel for the end plates of the magnet covers are expected to be delivered in about two weeks. The drift tube stems are now out for bid and the copper tubing and calrod heaters for all the drift tubes are now on order.

At Livermore, the 10th reinforcing ring has just been erected and the steel erection for the vacuum vessel is now about 25 percent completed. The east west tunnel on the south side of the building has been started. The Contra Costa Electric Company has installed the foundation for the 40,000 kva transformer and have about 60 percent of the excavation done for the underground conduit and the Pacific Gas and Electric Company has erected all of its poles and is in the process of putting up insulators. Thomas and Rosenfeld are fabricating the vacuum manifolds and are reconditioning the Kinney pumps. Bids on the power supply building are being analyzed. Two companies are working on bids for the liner but satisfactory bids have not yet been received from either of them. All the copper sheet for fabrication of the liner is now in

storage at Livermore.

Mark II Radioactive Hazards. The radioactive hazards of the Mark II target have been studied. For the specific example calculated in which the operating fission power level was taken as 10 megawatts, the fission product activity would be 1.5 megawatts at 0.1 second after shutdown and would decrease rapidly thereafter with time. This corresponds to about 250 megacuries at 0.1 sec. If the cooling were abruptly removed the uranium would melt in about 2.5 seconds if the operation of the accelerator were continued. In the event of pump failure it is estimated that about 6 seconds would be required to heat the one ton of water within the target to the boiling point, provided the thermal load continued uninterrupted. Even if these accidents were to occur it would not result in serious hazards to the community in view of the enclosure of the accelerator and target in such a heavy reinforced concrete shield. Consideration is being given to a system which would flood the target in the event of an emergency.

Mark II Neutron Economy. Calculations have been made on neutron economy in the target, and estimates derived on the loss of neutrons by resonant capture in the primary target. A model graphite lattice is being built in order to test the basic soundness of the calculations. This model will have a diameter of about 5 ft. and will be 5 ft. long. It will have provision for the use of a primary target of either thorium or uranium, as well as for the insertion of appropriate blanket material. The graphite bed will be provided with aluminum tubes through which will flow carbon tetrachloride. The carbon tetrachloride has about the same capture cross section per unit volume as does a 5 percent lithium aluminum alloy or uranium. The total neutron absorption by the carbon tetrachloride will be determined by the measurement of the Cl^{36} activity produced and will therefore duplicate the diffusion properties of these target materials. Provision will be made for holes through the graphite lattice so that flux distribution of neutrons of various energies can be determined by the insertion of foil aluminum metals which have resonance capture in the desired regions. Resonance and thermal capture in uranium will be measured by the use of cadmium covered and bare uranium foils respectively, in which neptunium activity will be determined. This graphite lattice will be made from C-18 graphite, of which there is an ample supply in store at the Laboratory.

Electron Model of High Current Cyclotron. Experimental work on the electron accelerating model cyclotron is continuing. It accelerates the electron to about 70 Kev and models the relativistic behavior of deuterons up to an energy of 250 Mev. To get the electrons out to a 13 inch radius requires a voltage of about 500 volts. This figure is probably not the minimum obtainable since great care has not been taken in shaping the magnetic field and since the contour of the pole face was based upon rather crude calculations. Studies of the effect of modifying the field shape with circular wires placed on the upper and lower pole faces at 2 inch radial intervals have been made. By careful adjustment of the currents in these windings the minimum dee voltage required was reduced somewhat less than 200 volts. To get deuterons up to 250 Mev using a full-sized cyclotron would require that these voltages be multiplied by 2000. Thus a two dee machine would require voltages of between one half and one million volts to produce 1/4 gram of neutrons per day, and would require a magnet weighing

approximately 10,000 tons. Such a magnet excited to 10,000 gauss maximum would require approximately one megawatt. With 250 Mev deuterons 60 to 65 milliamperes average beam would be required to produce 1/4 gram neutrons per day. In order to continue the study of this type of machine, it is planned to convert the XC magnet into a proton cyclotron of Thomas design to produce protons of 20 to 25 Mev. The operation will be pulsed in order to minimize power requirement, radiation and induced radioactivity. Such a model will allow a determination of the beam current to be expected from a full sized machine and will allow for a convenient study of the beam orbits in the central region which cannot be done on the electron model.

9. Chemistry SECRET

Part A

Carbon Ion Transmutations. The experiments with C^{+6} ions accelerated in the 60-inch cyclotron have led to substantial increases in intensity, using an internal probe target. Evidence has been found for the transmutation of copper into bromine isotopes (including an isotope not previously reported), as well as the gold into astatine and uranium into californium reactions found some time ago. Use of enriched carbon-13 has also been successful, and has led to even better yields of radioactivity than with carbon-12.

Po^{200} and Po^{201}. An alpha activity (5.84 Mev) of 11-minute half-life, known for some time, has been definitely assigned to Po^{200} by relating it to its electron capture descendent Tl^{200}. An alpha activity (5.70 Mev) of 18-minute half-life was assigned to Po^{201} by relating it in the same way to Tl^{201}.

Crystal Structure of Thorium Nitrate Hexahydrate. X-ray diffraction patterns of single crystals of the common hydrate of thorium nitrate (believed to be approximately the hexahydrate) have shown the unit cell to have the symmetry and dimensions:

Space group Fdd Z = 8
a = 11.2 A
b = 22.8
c = 10.6

The thorium atoms are located in the special positions

8 (a) (00Z; 1/4 1/4 1/4 + Z) + F. C.

in which Z can be taken as zero without loss of generality. The positions of the light atoms have not been determined.

Alpha Decay of Cm^{241}. An alpha group of 5.90 Mev has been assigned to 35-day Cm^{241}, for which no radiations were previously well established. The energy of these alpha particles is such that they are not believed to correspond to the ground state transition.

Plutonium in Nature. Pu^{239} has been detected in a number of uranium ores in the following concentrations:

Ore	Ratio Pu^{239}/Ore	Ratio Pu^{239}/U
Pitchblendes:		
Canadian (13.5%U)	9.1×10^{-13}	7.1×10^{-12}
Belgian Congo (38%U)	48×10^{-13}	12×10^{-12}
Colorado (50%U)	38×10^{-13}	7.7×10^{-12}
Monazites		
Brazilian (0.24%U)	0.21×10^{-13}	8.3×10^{-12}
N. Carolina (1.64%U)	0.59×10^{-13}	3.6×10^{-12}
Fergusonite		
Colorado (0.25%U)	$<0.1 \times 10^{-13}$	$<4 \times 10^{-12}$
Carnotite (10%U)	$\leq 0.4 \times 10^{-13}$	$\leq 0.4 \times 10^{-12}$

The amounts are explained by the capture of neutrons by U^{238}, the neutrons coming from spontaneous fission of U^{238} and from α,n reactions on light elements in the ores. The variations depend on the relative amounts of uranium, thorium, light elements, and neutron absorbing elements. Cosmic-ray neutrons are unimportant.

Spallation of Protons Only. A number of reactions of the types (α,xp) and (p,xp) are being studied with medium element targets. In general the yields are very small, but measurable.

Specific Activity of U^{235}. Our previous measurements of the specific activity of U^{235} depend on an uncertain estimate of the degree of backscattering in a 2π counter geometry. A new set of experiments is underway, using a medium geometry (approximately 0.04π) counter, which is calibrated relative to a low-geometry counter using U^{234} samples of the same mass thickness as our U^{235} samples.

Chemistry

UNCLASSIFIED

Part B

Synthetic and Experimental Chemistry. During the past month the following high specific activity C^{14}-labeled compounds have either been prepared or their preparation begun: Sodium-n-valerate-1-C^{14} (10 mc.); amyl-1-C^{14} bromide (10 mc.); sodium n-caproate-2-C^{14} (30 mc.); sodium propionate-1-C^{14} (47 mc.); propyl-1-C^{14} iodide (47 mc.); and norvaline -3-C^{14} (47 mc.).

In addition, the preparation of the following compounds is being studied: butyl-1-C^{14} iodide, norleucine-3-C^{14}, isopropyl-methyl-C_2^{14} iodide (2-iodopropane-1,3-C_2^{14}), octanoic-1-C^{14} acid, valine-methyl-C_2^{14}, leucine-3-C^{14}, vinyl acetic-1-C^{14} acid, glucose-1-C^{14}, mannose-1-C^{14}, D-glucose-6-C^{14} and naphthyl-acetic-α-C^{14} acid.

Several antispasmodic (antihistaminic) drugs have been synthesized for studies of mechanisms of physiological action and fate of these compounds in the organism.

Work on the determination of low activity C^{14} samples has continued. Proportional counting chambers for a variable discrimination counting apparatus have been constructed and three 500 cm^3 ionization chambers have been built and are shortly to be calibrated. For their use a special vacuum line has been assembled, which will permit 5-10 minute breath samples from humans to be treated to remove CO_2 and to dry and purify this CO_2 and to fill the ionization chamber to a specified pressure. It is hoped that a sensitivity of 0.005 dis./min./mg. of $BaC^{14}O_3$ may be achieved.

Biological Chemistry. Nucleic Acids and Purines. An attempt has been made to determine what effect, if any, 8-azaaguanine may have on the metabolism of guanine-4-C^{14} in C57 mice when the two compounds are injected intraperitoneally in a gum arabic suspension. As yet it has not been possible to demonstrate any large difference in the amount of radioactivity in several organs or the carcass of mice either two or six hours after injection. Additional experiments are in progress in normal mice and similar experiments are planned with tumorous mice.

Stilbamidine Metabolism. A repeat fractionation of the livers of "A" strain mice with sarcomas after injection of radioactive stilbamidine has been made, showing major fraction of the activity is present in the "mitochondria" fraction. Since succinic oxidase activity is associated solely with the mitochondria, the determination of this enzyme activity in the various fractions obtained by the fractionation procedure will evaluate the efficacy of the procedure and also determine whether a correlation exists between enzyme activity (therefore mitochondria) and radioactivity. We are determining this enzyme activity and plan to determine enzyme as well as radioactivity in the next fractionation of livers from mice after injection of stilbamidine.

Organic Compounds in in vitro Liver Slices. Products from these incubation experiments have been degraded using chromic acid and periodic acid. The products from the degradations are being separated using chromatographic columns.

A number of biological problems are being worked on jointly with other organizations within the University.

Photosynthesis Chemistry. The identification of the intermediates of carbon dioxide reduction in photosynthesis is being continued.

Enzymatic hydrolysis of the phosphorylated intermediates has resulted in the isolation of the known hydrolysis products and of several unknown ones. Chemical identification of these is in progress.

C^{14} photosynthesis experiments with algae equilibrated with radiophosphate have demonstrated that the intermediates of sucrose synthesis are phosphorylated. Phosphorus-carbon ratios in unknown phosphates have been measured. New experiments of similar type have been performed in which the phosphate esters are more completely separated.

Periodate degradation of fructose in sub-micro amounts obtained from fructose phosphates in 60 second photosynthesis by soy bean leaves resulted in the following distribution: C_3C_4 - 45 percent; C_2,C_5 - 31 percent; C_1,C_6 - 23 percent. This technique was designed for the degradation of compounds in tracer amounts, particularly uniformly labeled unknown compounds for the purpose of their identification. A series of experiments for the accumulation of such uniformly labeled compounds has been performed. The use of $C^{14}O_2$ instead of $HC^{14}O_3^-$ as a photosynthesis substrate has been tested.

A new series of iodoacetamide inhibition experiments with Chlorella has been performed. Determination of the radioactive amino acid components of the protein synthesized is in progress.

Chemistry SECRET

Part C

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

1. Vapor pressure determinations.
2. Gaseous hydroxide species of Mo and W.
3. Liquid metal systems.
4. Heat transfer in forced convection film boiling.

Basic Chemistry. Solvent Extraction. The following problems are under investigation:

1. Electron exchange rate between Fe^{3+} and Fe^{2+}.
2. Thermodynamics of germanium.
3. Thermodynamics of rhenium.
4. Zirconium chemistry.

10. Medical Physics UNCLASSIFIED

Part A

Tracer Studies. Work has been initiated and/or continued with radioactive chromium, bismuth, thulium and potassium.

Radioautographic Studies. Progress continues on preparing photographs, sections and radioautographs of the thyroid gland of rats which had been first treated with varying dosage levels of At^{211} and after the destruction of the gland had progressed, a subsequent tracer dose of iodine was given for radioautographic determination of remaining functional tissue.

Radiochemistry. A carrier-free procedure has been developed for the isolation of Pd^{103} from deuteron bombarded rhodium. The Pd^{103} is separated from rhodium and other concurrently produced activities by co-precipitation with selenium metal from 6N hydrochloric acid. Selenium is then separated by distillation.

Previously developed procedures were used in the isolation of : (1) 250 μc of $Bi^{204,206}$ from deuteron bombarded lead, (2) 10 mc of $K^{42,43}$ from alpha bombarded argon.

Microcurie amounts of $Mo^{93,99}$ have been isolated from alpha bombarded zirconium using a carrier-free procedure.

Medical Physics

UNCLASSIFIED

Part B

Induced Activity Trace Analysis. Data are being accumulated on human blood plasma, red cells, and white cells by this technique. The determination of cobalt in red cells yielded an approximate figure of 4×10^{-9} g Co per g of wet cells.

Mechanism of Radiation Effects on Uni-Cellular Organisms. Theoretical and experimental distribution of the number of genic defects in preradiated diploid and haploid yeast cells are being compared. Techniques are being developed for study of the metabolism of normal and preradiated yeast cells on liquid media.

Radiation Effects on Mammals (184-inch Cyclotron). A study demonstrating the fine control of the 184-inch beam and its great depth dose effect has been completed. It comprised radiation hypophysectomy of white rats using 190 Mev deuterons. Selective irradiation of the rat pituitary can be accomplished by this method, and production of growth hormones can be partially or completely interrupted without irradiation damage to any other tissues. (In cooperation with Dr. Donald Van Dyke, Institute of Experimental Biology.)

Use of 120 Mev $C_6(6+)$ Particles for Biological Investigation. Instrumentation is being completed for initial biological use of high energy carbon particles from the 60-inch cyclotron. The rate of energy loss of these particles is between that of low energy alpha rays and fission products, and their utilization may yield important clues to the mechanism of radiation effects.

Instrumentation. Two progress reports were submitted during the month on progress in instrumentation; the first (UCRL-886) concerned routine use of fluorescent counters for counting of gamma active samples in glass vials. For Fe^{59} an overall efficiency of 23 percent of gamma ray counting has been achieved. Construction of "directional, in vivo" gamma crystal counters is also discussed. The second report described a novel counting rate recording system, that enables one to continuously record counting rate on a linear scale without the customary lag and fluctuations inherent in circuits utilizing C.R. circuit elements. (UCRL-885)

Progress on Lipoproteins. Sufficiently large samples of the isolated lipoproteins of various classes have now been obtained in order to determine some features of the chemical composition of individual lipoproteins. Some basic features of structure have emerged as a result of these studies.

1. The lipoptroeins of 30 S_f and higher are fifty percent or more glycerol esters. The percentage of glycerol esters is much lower, or glycerol esters are absent in those lipoproteins of the 20 S_f class and lower. The percentage of protein per molecule decreases steadily from the high density lipoproteins, from a value of approximately sixty percent down to about twenty-five percent in the S_f 4 and 6 classes, and down further to less than 10 percent in those of the 30 S_f and higher class. The phospholipid cholesterol ratio is in the neighborhood of two for the higher density lipoproteins, whereas it is in the neighborhood of 0.8 for all the lipoproteins from S_f 3 to S_f 100. The percentage of cholesterol within each lipoprotein which is in the esterified state decreases steadily from the S_f 3 lipoproteins up to the S_f 100.

These characterization studies will prove helpful in analyzing the turnover studies with labeled sterol and labeled fatty acid as well as in determining the real nature of the phenomena involved in the lipoprotein changes which follow irradiation.

Special Hazards. The extent to which certain special health hazards such as carbon tetrachloride and benzene are used in the laboratory is being studied and controlled as closely as possible. Arrangements have been made for the measurement of air concentrations of beryllium in the special shop during the handling of beryllium and its compounds.

Beryllium Poisoning. A case of chronic delayed pneumonitis presumably caused by beryllium has been studied for the last five years. The disease, which has been progressive, has shown a questionable response to ACTH therapy during the last six months.

In the hope that chemical evidence of the etiological agent might be found, a bit of cervical lymph node removed in biopsy from the patient in 1946, and which shown histologically the characteristic granuloma, has been sent to Dr. Steadman at Rochester for spectroscopic analysis.

A more complete report of this case has just been prepared--UCRL-996.

Double Nucleated Lymphocyte Problem. Whereas certain experiments in the past have indicated a rise in peripheral double nucleated lymphocytes in Strain A mice after irradiation with high energy protons or deuterons, studies which are in progress now seem to show no such effect following x-irradiation. This possible difference is being examined in more detail.

11. Health Physics and Chemistry

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Instrumentation. High Energy Neutron Survey Counter. Some experiments are under way attempting to devise a liquid phosphor type scintillation counter containing a solution of bismuth. The aim is to detect scintillation pulses from the fission of bismuth by the high energy neutrons produced by the 184-inch cyclotron.

The development of the increased efficiency bismuth fission chamber referred to in previous reports has proceeded satisfactorily and the instrument is now operating, but its overall efficiency for detecting high energy neutrons is still only of the order of 10^{-5}, and for survey work outside the shielding it is desirable to increase this efficiency considerably further.

Development of Portable Linear Amplifier. The recoil proton proportional counters and the bismuth fission counters utilized in neutron survey work require linear amplifiers to render the pulses countable. Thus far the amplifier has been transported by dolly or cart. It has been felt wise to develop a battery operated portable linear amplifier of sufficient gain to render such survey measurements more feasible in regions inaccessible to the present amplifier equipment.

Research and Development Group Activities. Principal items in progress are listed below:

1. Equipment for the proton bombardment of uranium has been completed.

2. Equipment for certain phases of Hanford dissolver solution processing has been redesigned.

3. Furnace and auxiliary equipment for transuranic metal production has been completed and is in operation.

4. Equipment for Hanford-bombarded animal ash has been completed and the material processed.

5. Plutonium "cows" have been readied for shipment.

6. Seven Berkeley boxes for chemistry work in enclosed areas have been made and seven centrifuges have been reconditioned and reassembled.

Forty-seven drums of active waste in cement were dumped at sea. A Navy tugboat was used, as the Army minesweeper formerly used is no longer available. Other changes in the dumping operation included the use of a crane truck instead of the forklift for loading. A dynamometer on the boom hook enabled weighing and loading the drums simultaneously. Wire cable was used for the sling. An improved method for slinging the drums is being developed.

12. Plant and Equipment

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Bevatron Building. The Bevatron Building is complete as of October 31, 1950. The lower yokes and legs have been installed in Quadrant 1 and the lower yokes have been installed in Quadrant 4. Installation of switchgear is approximately 60 percent complete. The west motor generator set is in place. All components of the east motor generator set have been delivered to the building site and are being set in place. The Portland Cement Concrete portion of the Bevatron paving work is 90 percent complete. Paving operation has been delayed 10 days

by early rains. Slope stabilization above the Bevatron Building is about 30 percent complete. Retaining walls have been poured and stripped and work on the cooling tower basins and treated water tank supports will be initiated next week.

Construction of Cafeteria. The landscaping design has been completed and extent of work to be performed is still under consideration.

Construction of Animal House. Working drawings and mechanical drawings are complete in draft form. Budgetary factors have made necessary the deferment of this project.

Construction of Sheetmetal and Insulator Shop. Bids were opened on November 14, 1950. Contracts are being prepared.

Radiological Laboratory at the University of California Medical School. The excavation is 85 percent complete; reinforcing steel is 65 percent complete; form work is 60 percent complete; and the concrete is 51 percent complete.

M.T.A. Project. Development and design continuing.

Measurements Project. Development and design continuing.

Accelerator Design Building. Preliminary specifications and drawings have been submitted and approved by the A.E.C. and the Regents of the University. Final plans are in preparation.

Miscellaneous Construction. Fire Protection. The high pressure water line - Section D, to the south end of Warehouse No. 46, is 100 percent complete.

Alterations to Synchrotron Building. Construction of the counting room in the synchrotron building is 100 percent complete.

Rehabilitation of Usable Sections of Building No. 8. Work in connection with the rehabilitation of sections of Building No. 8 not seriously damaged by the fire is 90 percent complete.

Miscellaneous Utilities. The communications, gas and sewer extensions to the area north of the Bevatron Building are 100 percent complete. It was necessary to make these extensions before installation of the concrete paving in this area.

Old Radiation Laboratory. Alterations to Rooms 208 an 209 in the Old Radiation Laboratory (for North American Aviation) are 90 percent complete.

Alterations to Rooms 106 and 107, Building No. 4. These alterations are 50 percent complete.

Fire Equipment Building. Construction of the Fire Equipment Building is approximately 75 percent complete.

LMB/11-30-50
Information Division

MAN-MONTHS EFFORT REPORT

Scientific Personnel

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PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
184-inch Cyclotron	Operation	9.8	
Synchrotron	Operation	7.8	
Linear Accelerator	Linear Accelerator - General	6.3	
	Van de Graaff - General	6.3	
	Development	-	
Bevatron	Building	-	
	Magnet	.3	
Experimental Physics	Cloud Chamber	6.6	
	Film Program	13.8	
	General Physics Research	26.3	
	Meson Experiments with Synchrotron	2.0	
	Scintillation Counters - Research Experiments	1.3	
	Instruments for General Use	2.9	
	Special Development	17.6	
	Magnetic Measuring Equipment	1.4	
	Short Time Measurement	.6	
Theoretical Physics	Bevatron	1.9	
	General Physics Research	12.0	
Isotope Separation	Nier Spectrometer	.6	
Radioactivity Physics	General	1.3	
	Crystal Program	.6	
Chemistry, Part A	Chemistry of Transuranic Elements	5.0	
	Nuclear Properties of Heavy Element Isotopes	9.2	
	Transmutations with the 184" and 60" Cyclotrons	8.0	
	Analytical and Services	14.8	
	Process Chemistry	13.0	
	Special Chemistry Development	3.0	
	Mass Spectroscopy, Beta Ray Spectroscopy	1.4	
	Instrument Development and Services	3.5	
	X-Ray Crystallographic Measurements	3.3	
Chemistry, Part B	Synthetic and Experimental Chemistry	4.9	
	Biological Chemistry	7.6	
	Photosynthesis Chemistry	3.9	

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PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
Chemistry, Part C	Metals and High Temperature Thermodynamics	2.5	
	Basic Chemistry, including Metal Chelates	2.5	
	General	2.5	
Biology and Medicine Part A	Metabolism of Plutonium and Allied Materials	11.0	
	Radiochemistry	4.0	
	Radioautography	2.0	
Biology and Medicine Part B	Tumor Metabolism	.8	1.9 Consultant Man-Months
	Special X-Ray Studies, Radioactive Measurements, etc.	6.1	2.2
	Radioactive Carbon Studies	1.6	.3
	Fundamental Medical Research	6.9	3.4
	Hematology	.4	.2
	Medical Work with the 184" Cyclotron	.9	.5
	Fly Genetics	1.8	-
	60" Cyclotron Bombardments	.5	-
	Physical Chemistry	7.1	2.8
	Specific Irradiation	4.6	.8
	Donner Animal Colony Expense	1.3	1.9
	Large Molecule Program	6.7	11.1
	Radioactive Iron Studies	2.6	1.2
Biology and Medicine Part C	Synthetic and Experimental Organic Chemistry	17.6	
Health Chemistry, Physics	Monitoring and Disposal	11.1	
	Research and Development	12.2	
	Film Badge Program	5.7	
	Medical Examination Time	1.5	
Measurements Project Development	General	12.8	
M.T.A. Project	Design and Development	31.5	

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