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UNIVERSITY OF CALIFORNIA

Radiation Laboratory

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MONTHLY PROGRESS REPORT
No. 90

September 15 to October 15, 1950

October 31, 1950

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Berkeley, California

UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

September 15 to October 15, 1950

MONTHLY PROGRESS REPORT No. 90

October 31, 1950

1. Bevatron UNCLASSIFIED

Magnet. All the core frame steel is now in the building. The foundation plates are installed and erection of the bottom slabs is proceeding in one quadrant.

Coil spacers and other critical parts for the coil winding are being expedited as energetically as possible but it is now apparent that winding will not start until some time after November 1.

Magnet Power Supply. The generator rotors have arrived and the mechanical erection of one of the MG sets is well along. Five of the eight rectifiers and all of the high and low voltage cubicles are in place. Practically no wiring has yet been done on the magnet power supply.

Other Parts. The injector liner and drift tube drawings have been completed sooner than expected. The vacuum system to test the internal pole construction is being tested and a small amount of time is being spent on the vacuum tank design. The pole base and tip drawings are complete but procurement has not started. The magnet cooling fans are in place. The cooling tower and water pumps are being procured.

2. 184-inch Cyclotron Operation UNCLASSIFIED

The cyclotron was used for research experiments approximately 86 percent of the 467 hours that the crew was on duty.

The time distribution was as follows:

Operation for customers	405-3/4 hours	86.4 percent
Filament change	1/2 hour	0.2 percent
Electrical trouble (oscillator)	1 hour	0.4 percent
Mechanical trouble	3-1/4 hours	0.8 percent
Visitors	1/2 hour	0.2 percent
New concrete shielding installation	56-1/4 hours	12.0 percent
	467-1/4 hours	100.0 percent

The installation of the additional five foot concrete wall of the main shielding was started this month.

3. 60-inch Cyclotron Operation UNCLASSIFIED

Continued trouble was encountered with the deflecting system but was not bothersome enough to prevent operation. Eighty-nine percent of the available time was spent doing bombardments.

4. Synchrotron Operation UNCLASSIFIED

The synchrotron has operated consistently at a high intensity output during this report period. Maximum use of the synchrotron by the experimental program left no time for the actual development tests on the machine. The majority of users of the synchrotron beam have requested a reduction in intensity from the beam intensity available. A pair spectrometer magnet and conduits for the counter room addition were installed.

Following are operating statistics for the period:

Research Operating Time	284.20 hours	78.5 percent
Tests of Synchrotron	11.75 hours	3.3 percent
Maintenance and Installations	66.05 hours	18.2 percent
Total	362.0 hours	100.0 percent

5. Linear Accelerator and Van de Graaff Operation UNCLASSIFIED

The Van de Graaff reconstruction was completed and tested and found to be satisfactory. After the completion of the test it was decided to put the Van de Graaff on wheels immediately, so that provisions for installation of a beam buncher could be made. The concrete work external to the building has been completed and the external tracks will be laid within the very near future. Final completion of the mobilization of the Van de Graaff will take approximately one month.

The linear accelerator oscillators are scheduled to be completed within two weeks. The electricians will finish the wiring shortly after this time.

6. Experimental Physics UNCLASSIFIED

Film Program. Another synchrotron run was made in order to expose electron sensitive G5 emulsions to electrons and positrons of various known energies. The plates containing electron and positron tracks of 200 Mev are under study. The positron-electron and electron-electron scattering, the nuclear scattering, and the pair production cross sections are being determined.

The spirorbit spectrometer has been successfully operated as a meson spectrometer. This instrument utilizes a very large solid angle, and is capable of making a momentum analysis of mesons up to 12.5 Mev, or of electrons to about 60 Mev.

On analysis of those meson stars from which a high energy proton is emitted, it has been found that many more charged particles are emitted in the opposite direction than would be anticipated if the nucleus as a whole participated in the momentum balance.

Tracks of carbon nuclei which have been accelerated to 120 Mev in the 60-inch cyclotron are being studied in order to evaluate the effect of charge on grain density and delta rays.

Cloud Chamber. A new rectangular chamber to be used with counter control for experiments on the photodisintegration of the deuteron was completed in the shop, and the precision chamber for the large magnet is in the shop at present. New timers and high speed coincidence circuits for the synchrotron chamber are in the testing stage. A new chamber for use in the cave for studying π^+ and π^- mesons has been designed. Also, plans are being made to photograph carbon nuclei accelerated by the 60-inch cyclotron. More data for the n-d scattering experiment have been read.

Photo Production of Neutral Mesons by Liquid Hydrogen. Liquid hydrogen was bombarded successfully in the synchrotron beam in order to study the photo production of neutral mesons. The photo production was observed by gamma-gamma coincidence between two liquid scintillator telescopes presented at various angles to the beam. The results are as follows: 1) the total cross section for photo production is approximately 1.1×10^{-28} cm^2/quantum. 2) the differential cross section per unit solid angle for photo production is approximately 7×10^{-30} cm^2 at 90° and 17×10^{-30} at 45°. 3) the angular distribution is strongly peaked forward. 4) the correlation function relative to angle between the two telescopes indicates that the excitation function for the production of neutral mesons by photons has a higher order of contact near threshold. This is in marked contrast to the production of charged mesons by photons.

Neutral Meson Program on the 184-inch Cyclotron. The past month's effort on the neutral meson program has been directed toward improving the counting of the gamma-gamma coincidences from the decay of neutral mesons produced in the deflected proton beam. Several experiments wait upon the successful completion of this technique, which is rendered difficult by the short duty cycle of the proton beam and the relatively large production of high energy neutrons. By proper use of pulse height limiters and delay line clipping, it has proven to be possible to do reliable quadruple coincidence counting with a resolution time of 2×10^{-8} seconds. This electronics development is basic to the gamma-gamma coincidence counting.

Proton Elastic Scattering. More statistics have been collected on carbon and aluminum. The differential cross-section for carbon appears to fall off exponentially with angle between 6° and 50°. The same trend is observed in aluminum, except for an indication of a dip near 16°.

Neutron Elastic Scattering. It is proposed to use our triple-coincidence scintillation counter telescope and electronics to do 270 Mev neutron elastic scattering. As a check of the equipment we did 84 Mev scattering from copper and lead. Our results check those of Bratenahl, Fernbach, Hildebrand, Leith and Moyer. The counter efficiency is extremely low for 270 Mev neutrons. More

investigation is being done in an attempt to increase the efficiency.

Cerenkov Radiation. The proton energy measuring equipment has been modified so that the angle which the Cerenkov radiation makes with the proton beam can be very accurately measured. The energy resolution remains ± 3 Mev but the position of the maximum can be read with an absolute accuracy of about ± 1 Mev. This is probably the most accurate energy measurement of protons of this energy that has been made. Some day-to-day variation in the deflected proton beam energy has been noted, all results having been within 2 Mev of 340 Mev. This energy measurement has been applied to determining the range energy curves and also the kinetics of π^+ meson production in p-p collisions. Results of these experiments might better be published under other headings but they do not contradict these energy measurements. Further improvement in resolution and absolute accuracy might be achieved by complete redesign of the instrument but this is not contemplated until the present instrument has been fully exploited.

Nucleon Bremsstrahlung. The experiments on nucleon bremsstrahlung have been stopped temporarily pending completion of the scintillation pair spectrometer which should be in the testing stage in the first week of November. It is felt that the proportional counter spectrometer method has been carried as far as is warranted.

Proton-Proton Scattering. A critical study of past proton-proton scattering data has been made and a calibration of the ionization chambers versus the Faraday cup has been repeated. The best value of the multiplication factor of A for 1 cm length at 0°C and 760 mm Hg is 166.

Range-energy Curve for Protons. Runs have been made to establish absolute values on the range-energy curve for protons using the Cerenkov radiation to find the velocity of the protons.

Electronic Meson Counting Method. The electronic meson counting method has been used based on the β^+ decay of the μ^+ meson to remeasure the energy spectrum in the meson beam produced by proton-proton collisions at the 184-inch cyclotron. The results were in substantial agreement with those previously found using photographic emulsions to detect the mesons. The counting system was much faster than the emulsions but had poorer energy resolution.

Lifetime of the π^+ Meson. Using the fast meson detection method based on the decay of the π meson, the π^+ meson lifetime has been remeasured. Approximately 251×10^{-8} sec. mean life has been found, which is in agreement with values previously measured.

Meson Studies. Scintillation counters are being used in work with the scattering of mesons and progress has been made in counting the mesons in the meson beam. In this work the meson beam is proving to be very useful. Further experiments have been made on production of π^+ mesons by protons on protons using emulsions. These plates are now being read and should establish more firmly what the angular distribution and the excitation is in the above reaction.

Synchrotron Studies. During the past month a somewhat larger than usual amount of time has been consumed by electrical and mechanical work around the machine. The wiring for the new counting racks is being done, and the tracks for the pair spectrometer have been completed. It is expected that work with the pair spectrometer may start in about a month.

Plates have been exposed to photomesons from Be and C. This was done with the "sea of copper", and examination of the plates should give information on the differences in yield, the energy and angular distribution of the yield.

Two exposures of electron sensitive emulsions, especially treated to reduce background, to fast monoenergetic electrons produced by γ-rays and bent in a magnetic field, have been made. The purpose of these experiments is to study electron-electron collisions. The plates are being scanned at present.

The survey of neutron yields from elements bombarded with γ-rays is practically completed. The yields show a Z^2 dependence for $Z > 30$ as found by Kerst and co-workers. The yields at low Z show irregular variations, probably connected with the binding energy of the last neutron and the number of γ-rays per unit energy.

Work is being done on the yield of Li^8 from several elements bombarded with synchrotron γ-rays. Be^9 shows a good yield, but the other elements (C, N, D, F, etc.) have considerably smaller yields.

A careful set of measurements has established the relations of different types of measurements of synchrotron beam intensity. In particular, comparison with the output of the 340 Mev betatron at the University of Illinois can be made. The results seem to indicate that a "good beam" here is about one-half as intense as that described by Kerst in his letter to the Physical Review. The "beam shape" has also been measured by Rose.

Several runs have been made for those doing counting experiments with mesons. One further run should establish some definite facts about yields and angular distributions in the study of neutral mesons.

7. Theoretical Physics SECRET

Preliminary investigations are underway to investigate feasibility of tackling the low energy n-d scattering problem. High energy n-d scattering is also being studied.

A study of the lateral spread in cosmic ray showers has recently been completed.

A phenomenological study of the experiments concerning meson production in nucleon-nucleon collisions is in progress. Angular momentum and parity relations are used in an attempt to relate meson production to nuclear forces and low energy scattering data.

MTA. Further studies of the beam structure and dynamics are being made in order to find a method to give the beam a proper radial distribution when it reaches the target area.

8. M. T. A. Program SECRET

Mark I Current Measuring Target. Preliminary design work has been done on the current measuring target for the Mark I accelerator. The target would be composed of two layers of 20 mil stainless steel tubes through which cooling water would be circulated. The beam would be rotated by a precessing magnet to cover a 7 foot diameter area on the target to give about 70 $\mu a/in^2$ on the target surface. The target assembly would be surrounded by a concrete shielding wall 9 feet thick. Such a target would have an activity of 10^4 curies after a one-hour bombardment.

Mark I Production Target. There have been two basic proposals for the Mark I production target. The first of these would employ pellets of bismuth flash-coated with a protective coating of such materials as nickel or aluminum. These coated pellets would be carried along in a water stream through 20 mil stainless steel tubes which form the target. The problems of this type of target are those of attrition of the pellets, erosion of the stainless steel tubing by the pellets, and corrosion of the stainless steel by water.

The second proposal is to irradiate molten bismuth which would be circulated through 20 mil stainless steel pipes. The main problems are the corrosion of the stainless steel by the molten bismuth and the prevention of solidification of the bismuth in the event of a shutdown. Both of these ideas are being extensively studied, and it is hoped within the near future to make a choice between them and thereby concentrate effort on the most favorable one.

Polonium Distillation. Tests on the distillation of polonium from bismuth have been very encouraging and a 1/5 scale pilot plant is under construction to study the distillation further. This pilot plant should be in operation in about one month.

Precessing Magnet for Mark I. The problem of precessing the beam has been discussed with representatives of Westinghouse and General Electric Corporations. There appears to be general agreement on the present approach to the problem and final specifications for the precessing magnet are now being assembled and will be ready shortly. Various solutions to the problem of obtaining a 4-foot diameter non-conducting vacuum tight cylindrical segment to fit inside the magnet are under consideration.

Calculations have been made to ascertain the feasibility of a suggestion made for the dissipation of high energy spike of the beam by means of a rotating wolfram target. The calculations indicated that the physical size of such a rotating target would probably be excessive. A suggestion had also been made to oscillate as well as rotate the target, but it seems clear at this time that the use of a precessing magnet is the cheapest and most probably successful means of equalizing the intensity of the beam.

Mark I Design Change. The AEC request that the Mark I accelerator be designed to allow for CW operation has necessitated the redesign of the liner cooling system since the amount of heat to be removed is increased by a factor of 3.5. This is the only item that is greatly affected by the change.

Ion Source. An analysis of the ion beam from the injector has been made. Through the use of collimators a 1/4 inch diameter beam was run through an analyzing magnet. By changing source conditions the ratio of H_1^+ to $H_2^+ + H_1^+$ could be varied from 0.5 to better than 0.9. The introduction of the collimators and the magnet within the source housing introduced complications of discharge and current drains not otherwise present and increased the low energy component of the beam.

Various cathode structures are being tested in the search for one that can be used in the full-scale CW ion source. Tests are being made of the Philips-type low temperature cathode in the ion source. High energy positive ions do not rapidly damage this type of cathode because of the low temperature at which it operates. The beam obtained in this test has been limited to 500 ma because of the small size of the cathode. One such source has run 40 hours with no detectable diminution of emission.

Experiments are also being carried on using low voltage acceleration employing a metal plate perforated with 1/16-in. holes near which is placed a similar plate spaced about 1/16-in. away. This apparatus has delivered 1/2 ampere of positive ions at between 10 and 15 Kev.

Oscillator Studies. Studies of the RCA 5831 tube are continuing as is also work on the XC test equipment. Steady operation at 800 kilowatts output from the B-1 resonant load has been achieved. This amounts to somewhat greater than 1 megawatt input. The operation was pulsed at eight 30 ms pulses per second. It has not been possible to go above 600 kw in the load with CW operation. This limitation on the power is the result of sparking in the load and not to difficulties with the oscillator. When loaded to 800 kw the voltage between the ball and the liner is 1.8 megavolts. Plate voltages on the oscillator tube as high as 18 kv have been obtained at which point the efficiency is estimated to be better than 80 percent. Efficiency measurements were made under CW operation with voltages as high as 15 kv. Two such measurements gave efficiencies of 75 percent at 9 kv and 78.5 percent at 15 kv.

Livermore Test Cavity. A definite decision has been made on the requirements for the test cavity to be constructed at Livermore. The drift tube will be designed to correspond to an energy of 350 Mev and for operation at 20 megacycles. The length of the cavity will be 40 feet, which is 1-1/2 times the repeat length. It is being designed to operate at a field gradient corresponding to an energy gain of 1/2 Mev per foot.

One-tenth Scale Mark I Model. Measurements of the magnetic field and the Q on the 1/10th scale model of Mark I are nearly complete and final results on the shunt impedance and power loss in the various components will soon be available. The drift tube magnets have all been designed and nearly all measurements on them have

been completed. The measurements of the magnetic force between drift tubes as a function of drift tube position are essentially complete.

Mark I Electron Model. The electron accelerating model of the Mark I has been operating very successfully. The beam current obtained is approximately 20 μa as the beam is very nearly monoenergetic at about 8 Kev. There is some astigmatism which is considered to be due either to lack of uniformity of magnetization of the thin iron covers of the drift tube magnets or to some misalignment of the drift tubes. A disk is being inserted in each of the first two gaps to further eliminate power losses caused by electron loading. The most important measurement remaining to be done with this model is the phase acceptance angle, since the injector requirements are dependent on it.

Mark II Design. It has been decided to consider only two frequencies in the design studies for the Mark II machine; namely, 12 and 20 megacycles. It has also been tentatively decided that the accelerator will be designed for 350 Mev, so that in the eventuality that the designed potential gradient of 0.5 megavolts per foot cannot be maintained, it will be possible to lower this gradient, replace the drift tubes and still have a long enough tank to get particles of at least 250 Mev. At present the design study on Mark II is underway assuming a frequency of 12 megacycles, an energy of 350 Mev, and a 700 foot tank. There are still some model tests that must be performed to get all the data necessary to complete these calculations.

A preliminary tabulation has been made of the overall length of the 29 drift tubes and the total energy gain that would be obtained if the voltage gradient is 0.5 megavolts per foot. Calculations of the magnetic focussing field of the drift tubes have been made and the highest individual magnet power requirement is about 180 kw. The power per unit length required decreases appreciably, and therefore the power per magnet increases only slightly. The combined power for magnetic focussing will be about 5 megawatts.

Mark II Target Studies. The Metallurgy Group at the Oak Ridge National Laboratory has been making studies of the Mark II target problems. They have been studying methods of coating uranium so that it can be water-cooled while under bombardment by the ion beam. The only thing thus far tested has been a silver plating on uranium. This piece was fastened to a water-cooled copper block by means of a mercury amalgam binding. Targets of this design were bombarded by a proton beam in a calutron unit and a heat flux of about 1 kilowatt per square inch was achieved. Under these conditions failure was observed between the uranium and the water-cooled copper block. One of the severest problems met in Mark II target design is the serious thermal cycling involved. Components of the Mark II target will be subjected to approximately 10^6 thermal cycles per day.

Electron Model Cyclotron. By the use of shims the magnetic field for the electron accelerating cyclotron model has been corrected to approximately the desired form and an electron beam has been accelerated satisfactorily. A beam of approximately 0.1 μa has been measured at a radius of 15 inches, which is somewhat greater than the expected maximum radius of the beam. A study of the rapid decrease of beam current with radius is being made. This effect may resut from the fact that the injector sprays electrons at a large angle and most of these are lost by collision with the dee during acceleration.

High Current Cyclotron Studies. Calculations have been made of the weight of the magnet required for a high current cyclotron for neutron production. For a 375 Mev deuteron accelerating cyclotron having a 2 foot minimum gap the weight of the magnet would be approximately 15,000 to 16,000 tons. If the deuteron energy is 250 Mev, the weight of the magnet can be reduced to about 10,000 tons.

Livermore Construction. The pilings for the buildings at Livermore are now about 75 percent complete, and the tunnels on the west side of the building have been excavated and the slabs laid. The first of the vacuum manifolds has been delivered and welded into place and some of the steel rings to support the vacuum vessel have been delivered and are being assembled.

9. Chemistry SECRET

Part A

Fission of Tin. Another example of "fission" in light elements is the production of Na^{24} from tin by irradiation with high energy protons. This product is formed with a cross section of 10^{-31} cm^2 at 100 Mev and a cross section greater than 10^{-30} at 200-335 Mev. Since the threshold for formation by spallation of alpha-particles, neutrons, and protons is about 400 Mev, the reaction must be considered as fission. Previous examples include chlorine from copper, scandium from bromine, cobalt from silver, and gallium from tin.

Ranges of Spallation Recoils. The ranges of recoil fragments from spallation of copper are being estimated by a comparison of the yields in a copper foil of known thickness and in thin nylon films placed on each side of the copper. Preliminary results for copper + 335 Mev protons are:

Activity	Range against Beam	Range with Beam
Cu^{61}, Cu^{64}	0.011 mg/cm^2	0.044 mg/cm^2
Cr^{49}	0.30	2.2

The interpretation of these ranges in terms of energies and the explanation of these energies by the mechanisms of the reactions is not complete.

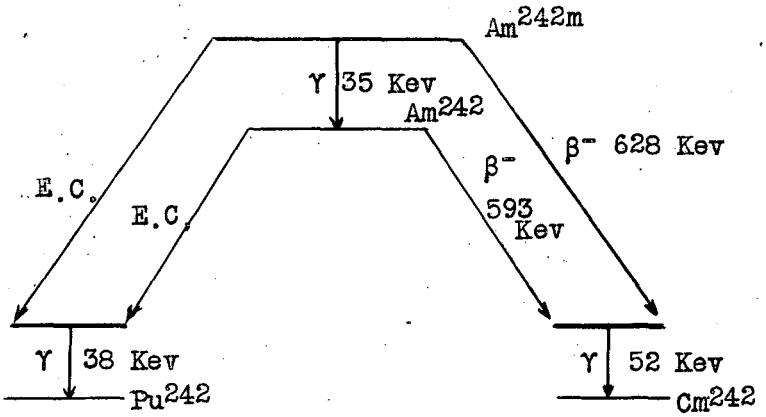
Decay of Rb^{82}. Internal conversion electrons from the decay of Rb^{82} have been observed with the beta-spectrometer. The energies of seven of the corresponding γ-rays agree very well with seven γ-rays reported by Siegbahn and Deutsch for Br^{82}, which decays to the same daughter, Kr^{82}. Some fifteen other electron lines were observed in the rubidium sample, but it is not established how many of these are due to Rb^{82} and how many to Rb^{81}.

Decay of Neptunium Isotopes. By resolution of decay curves of neptunium counted through various lead absorbers, we have estimated the energy of the γ-ray of Np^{241}, a beta-emitter, to be 0.7 Mev. The total decay energy, estimated by closing a cycle, is 1.2 Mev.

Beta-spectroscopy of a Np^{234} and Np^{236} mixture showed conversion electrons

corresponding to 0.8 and 1.5 Mev γ-rays, attributed to Np^{234}. The end point of the beta-spectrum of Np^{236} is about 0.53 Mev. An earlier estimate of the decay energy of Np^{236} from a cycle was 0.5 Mev.

Decay of Am^{242} and Am^{242m}. Work continues on the decay of the Am^{242} isomers. The best interpretation of the data is:



New Mass Spectrograph. The magnet and most of the vacuum tank of the new large mass spectrograph have been completed. After detection of some leaks, the tank seems to be vacuum tight.

Carbon Ion Transmutations. Some excitation curves for production of astatine isotopes from gold by carbon bombardment have been determined, but they are uncertain because of experimental difficulties. There seems to be a monotonous increase of yield with increasing energy, but the detailed shapes of the curves are not reproducible from one experiment to the next.

Crystal Structure of Osmium Tetroxide. Crystals of OsO_4 are monoclinic, with lattice parameters

$$a = 9.395\ A$$
$$b = 4.524$$
$$c = 4.751$$
$$\beta = 125.33^{\circ}$$

There are two molecules in the unit cell. The symmetry is C2/m, C2, or Cm. Thus, the osmium atoms must be at 000 and 1/2 1/2 0. The best arrangement of the oxygen atoms is tetrahedrally about the osmium atoms, with the symmetry C2.

Chemistry UNCLASSIFIED

Part B

Synthetic and Experimental Chemistry. During the past month the following C^{14}-

labeled compounds have been either prepared or their preparations studied: butyl-1-C^{14} iodide, isopropyl-methyl-C^{14} iodide, sodium acetate-2-C^{14} (42 mc. run), naphthoic-carboxyl-C^{14} acid, naphthylacetic-α-C^{14} acid, valine-methyl-C^{14}, norleucine-3-C^{14}, norvaline-3-C^{14}, sodium bicarbonate-C^{14} (10 mc. run), aspartic-β-C^{14} acid, aspartic-γ-C^{14} acid, choline-methyl-C^{14} chloride, acetyl-choline-methyl-C^{14} chloride and morphine derivatives.

The following list of compounds have been offered for distribution to the Isotopes Division. The approximate yields are indicated in parentheses: butyl-1-C^{14} bromide (50 percent), amyl-1-C^{14} bromide (50 percent), isoamyl-1-C^{14} bromide (60 percent), isobutyl-1-C^{14} iodide (60 percent), isocaproic-2-C^{14} acid (30 percent), isobutyric-1-C^{14} acid (95 percent), isovaleric-1-C^{14} acid (95 percent), leucine-α-C^{14} (20 percent), norleucine-3-C^{14} (40 percent), norvaline-3-C^{14} (40 percent), aspartic-γ-C^{14} acid (50 percent), and aspartic-β-C^{14} acid (30 percent).

The following compounds have been outlined for preparation in cooperation with the Division of Animal Husbandry of the University of California at Davis, for the project of Prof. Max Kleiber for the studies of metabolism of cows: sodium n-valerate-1-C^{14} (activity, 11 mc), sodium n-caproate-1-C^{14} (11 mc), sodium n-valerate-2-C^{14} (30 mc), sodium n-caproate-2-C^{14} (30 mc), sodium isobutyrate-1-C^{14} (11 mc), sodium isovalerate-1-C^{14} (11 mc), aspartic-γ-C^{14} acid (20 mc), aspartic-β-C^{14} acid (30 mc), leucine-α-C^{14} (50 mc), and norleucine-3-C^{14} (25 mc).

Work on the decomposition of labeled oxalic acid in sulfuric acid has continued with emphasis on a survey of the analysis procedures, in particular, the use of ionization chambers.

An apparatus for the experimental use of proportional counting has been obtained, and experiments are now underway with various styles and types of proportional counters. The purpose of this work will be to analyze very low specific activity material (less than 0.01 dis/min/mg $BaCO_3$) fairly accurately.

Biological Chemistry. Studies on the metabolism of purines have continued with work on the identification of the excretion products formed after the injection of adenine-4,6-C^{14}, 8-azaadenine-4,6-C^{14}, guanine-4-C^{14} and 8-azaaguanine-4-C^{14}. Tentative identification of the four radioactive compounds in the urine from mice injected with adenine has been made, as well as identification of the radioactive compound excreted after guanine injection. Work has been continued on the isolation, by the use of chromatographic methods, of the radioactive compound excreted after injection of azaadenine.

Chemical studies on the metabolism of labeled stilbamidine in mice have been made and preliminary experiments have been carried out to determine the site in which stilbamidine is present in the liver of "A" strain mice with sarcomas. A large fraction of the activity was found to be associated in the "mitochondria" fraction.

Analysis of the volatile compounds from liver slices incubated with labeled propionic acid has continued. Among the products are a group of acids and these

are being extensively studies. One of these compounds has been shown to give, on degradation, labeled propionic acid and labeled carbon dioxide. These compounds are thought to be hydroxy acids of various types and present research is directed toward proving or disproving this idea.

Chemical studies of cholesterol metabolism have continued as follows: (a) The yolk of the eggs from a hen fed labeled acetic acid is being worked up to obtain labeled cholesterol. The purification of this cholesterol, using either alumina or ion exchange columns, is being attempted. (b) Experiments on the feeding of cholesterol and alcohols to rabbits have been terminated pending the evaluation of new alcohols. Octadecyl alcohol and cholesterol when fed to rabbits raised the blood cholesterol more than any other compound tried, including the customarily used Wesson Oil.

Photosynthesis Chemistry. The products of enzymatic hydrolysis of the paper chromatographically separated phosphorylated intermediates of photosynthesis are under investigation. Triose phosphates have been identified but the free trioses are not yet completely identified. The chemical properties of three major hydrolysis products of carbohydrate nature are under investigation. The identity of P^{32} and C^{14} labeling in these unknown phosphates has been demonstrated by an experiment with both isotopes. Radiophosphate and the corresponding carbohydrate or acid were used. Diphosphorylated compounds of unknown nature are under investigation. By determination of the P^{32}/C^{14} ratio it is expected to determine the number of carbon atoms per phosphosate group.

Evidence for natural occurrence of phosphoglycolic acid is accumulating. Glycolic acid may be formed from a phosphorylated precursor during the C_2-regeneration process. Fixation of C^{14}-labeled formic acid during photosynthesis is being studied since a close relationship between the Sakami reaction and photosynthesis has been observed. Formate does not compete with CO_2 when fed simultaneously. Very short steady state photosynthesis with $C^{14}O_2$ has been repeated and evidence for continuous $C_3 + CO_2$ carboxylation reobserved. Self-absorption corrections for formaldemidon and barium formate, required for accurate degradation experiments, are being determined.

The inhibition of photosynthesis by high oxygen pressure observed in O_2 pressure measurements by Tamiya has been verified using $C^{14}O_2$ with Chlorella at pH 10.3. At high light intensity, 66 percent inhibition was observed. The CO_2-absorption inhibition is less than the O_2-production inhibition.

Glycol-1,2-C^{14} has been synthesized by lithium aluminum hydride reduction of methyloxalate-1,2-C^{14}. Methods for rapid direct counting of this volatile compound have been developed and it has been tested as a substrate during photosynthesis by Scenedesmus. Very little glycol was fixed in preliminary experiments.

Chemistry

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. Studies on the metabolism of tantalum, manganese, chromium and sodium^{24} are being continued in rats.

Radioautographic Studies. Radioautographs (NTA stripping film) of lungs of rats 64 days after inhalation of plutonium "smoke" showed clusters of tracks about the alveolar macrophages. There was some evidence that the tracks were related to carbon dust particles in the cytoplasm. Insofar as could be determined, these cells appeared either to leave the lung or, in some cases, to die and disintegrate leaving the radioactive material again free in the air spaces.

Chelating Experiments. The assay of the cerium samples in the in vivo chelating experiments described in previous progress reports have been completed, i.e., both the excreta and the tissues. The tissue sample assays on the plutonium animals have also been completed. The experiment on the effect of Fe-3 on manganese depletion studies is still in progress. In vivo studies on the use of certain chelating agents to remove beryllium have been completed.

Whole Body Radiation Studies. Analysis with the flame photometer with various tissues after acute radiation injury have been completed and are included in a report which will be released shortly. Somewhat similar studies using radioactive potassium from the cyclotron are in progress.

Radiochemistry. Carrier-free procedures were developed for the isolation of: (1) $Bi^{204,206}$ from deuteron bombarded lead and (2) Mn^{52} from deuteron bombarded chromium. Approximately 100 μc of each radioelement were prepared. Previously developed procedures were used in the isolation of microcurie amounts of carrier-free radio-scandium and radio-chromium. Fifty millicuries of Oak Ridge Tm^{170} was processed and prepared for injection.

Medical Physics

Part B

Metabolism of Carbon 14 Labeled Glycine. Studies of the red blood cell life span of the first five patients are now nearing completion. Two of the above, with leukemia, had red blood cells with shortened life span of approximately 80 days (as compared with the the norm of 120 days). Two polycythemia patients had red blood cells which were of two distinct populations. Both had red blood cells of from 5 to 10 days' life span and also red blood cells of approximately 120 days' duration. One patient with lymphatic leukemia had red blood cells of normal life span. Work is now in progress to determine the extent of the utilization of the C^{14} labeled hemoglobin.

Mechanism of Radiation Effects on Uni-cellular Organisms. Recent experiments and theoretical work concerning the mechanism of biological effects of radiations on yeast cells were described in the current Quarterly Progress Report. An interesting phase of this work, the production by radiation of recessively inherited defects in the cells is being pursued. It is hoped that these defective yeast colonies will give new information concerning the basic mechanism of cell division. At present, the properties of radiation induced, recessive genetic defects, are now under investigation.

Trace Analysis. Data is now being accumulated on the distribution of a number of trace elements in normal and cancerous mice with the technique of activation analysis.

Cyclotron and Linear Accelerator. No experimental work was done this month due to equipment change-overs.

Double Nucleated Lymphocyte Problem. Experimental work, using various strains of mice with both x and particulat-irradiation is continuing in an attempt to more thoroughly explore the relationship between double nucleated lymphocytes and radiation exposure. Double nucleated lymphocyte counts in laboratory personnel are also being continued.

Radiobiology-Bacteria. Post irradiation survival of *E. coli* as a function of temperature of incubation is being further studied. This is apparently an important phenomenon in ultra-violet experiments. However, between the ranges of 30° and 40° centigrade it does not appear to be noteworthy in the case of ionizing radiation. Certain experiments have suggested an intensity-of-radiation effect in the case of alpha-rays on *E. coli*. This is being further scrutinized.

Iron Turnover. Patients having polycythemia and some with anemia are being examined for 17-ketosteroid excretion on the basis of the definite influence of the pituitary and ACTH on iron turnover. The replacement with the higher efficiency sodium iodide crystal in the *in vivo* scintillation counter has made possible even smaller tracer doses of $iron^{59}$. The *in vivo* iron turnover studies are being continued, with some patients having blood dyscrasias and in others with rheumatoid arthritis, before and after ACTH administration. As the number of patients studied increases, there are indications that certain characteristic patterns of iron distribution are associated with myelosclerotic myeloid metaplasia , aplastic anemia, marrow hyperplasia occurring with hypersplenism, and with certain types of leukemia.

11. Health Physics and Chemistry — UNCLASSIFIED

Instrumentation. The recoil proton proportional counter method for fast neutron survey work has been further studied so as to render more valid the quantitative estimates in neutron energy flux. Extensive surveys have been made recently with this instrument upon various types of operation at the 60-inch cyclotron. Certain recognized shielding weaknesses have been quantitatively evaluated.

The high energy bismuth fission chamber to which reference has been made in previous reports has been debugged to such an extent that it now appears possible to make reliable surveys of the very high energy neutron flux with it.

The techniques of filling boron trifluoride proportional counters have been under study during the past few months and the methods for accomplishing this seem to be now well in hand.

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

1. Preparation of equipment for proton bombardment of uranium is essentially complete.

2. Improved equipment for the liquid transfer system for use in work with Hanford dissolver solution is essentially complete.

3. A bombardment from Chalk River has been processed for Los Alamos.

4. Bombarded americium from Hanford has been processed.

5. Five Berkeley boxes have been completed; the usual repairs, oilings, and replacements to box equipment have been made.

Forty-seven drums of cemented radioactive waste and one beryllium-contaminated pump were disposed of at sea during this period.

12. Plant and Equipment — FOR OFFICIAL USE ONLY

Bevatron. The building is 99 percent complete. Water has been connected to the building. Mechanical equipment has been checked and final inspection has been made. Pending the completion of a few minor items, the building will be accepted by the first of November, 1950. All the magnet steel has been delivered to the building and the first sections have been installed on the walls. Switchgear is progressing. 99 percent of the wiring raceway gallery is complete. The west generator rotor and stator are in place as is the motor. The fly wheel is being lowered into position. All the components of the east motor generator unit have been received at the site with the exception of the generator starter which is in transit. Grading and paving around the bevatron building started about four weeks ago. The rough grading is complete. The fine grading is 50 percent complete. The first two pours have been made. The job is scheduled for completion about the middle of November, 1950.

Construction of Cafeteria. The landscaping design has been completed and extent of work to be performed is 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 Salvage Shop. Final plans and specifications are substantially complete and the job is expected to go to bid October 27, 1950.

Radiological Laboratory at the University of California Medical School. The excavation is 83 percent complete; reinforcing steel is 40 percent complete; form work is 40 percent complete; and the concrete is 33 percent complete.

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

Measurements Project. Development and design continuing.

Miscellaneous Construction. Fire Protection. The high pressure water line - Section D, to the south end of Warehouse No. 46, is 95 percent complete.

Alterations to Synchrotron Building. Construction of the counting room in the synchrotron building is approximately 95 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 70 percent complete.

Miscellaneous Utilities. The communications, gas and sewer extensions to the area north of the Bevatron Building are 98 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 and 209 in the Old Radiation Laboratory (for North American Aviation) are 80 percent complete.

Alterations to Rooms 106 and 107, Building No. 4. These alterations are 40 percent complete.

Accelerator Design Building. Architects' working drawings and mechanical drawings are almost complete.

MAN-MONTHS EFFORT REPORT

Scientific Personnel

PROGRAM	SUBDIVISION	MON MONTHS EFFORT	COMMENTS
184-inch Cyclotron	Operation	11.6	
Synchrotron	Operation	6.9	
Linear Accelerator	Linear Accelerator - General	7.8	
	Van de Graaff - General	7.6	
	Development	-	
Bevatron	Building	-	
	Magnet	.3	
Experimental Physics	Cloud Chamber	8.0	
	Film Program	20.7	
	Proton-Proton Scattering	.9	
	Absolute Cross Section Measurements	-	
	General Physics Research	19.1	
	Meson Experiments with Synchrotron	1.8	
	Scintillation Counters - Research Experiments	1.0	
	Pair Counter Experiments	7.0	
	Particle Momentum and Energy Analysis	2.6	
	Proton Elastic Scattering	1.7	
	Meson Counting at the Synchrotron	2.6	
	Preparation of Liquid Targets	1.3	
	Instruments for General Use	3.2	
	Special Development	13.8	
	Magnetic Measuring Equipment	1.5	
	Short Time Measurement	.9	
Theoretical Physics	Bevatron	2.3	
	General Physics Research	13.3	
Isotope Separation	Nier Spectrometer	.5	
Radioactivity Physics	General	3.5	
	Crystal Program	-	

PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT		COMMENTS
Chemistry, Part A	Chemistry of Transuranic Elements	7.2		
	Nuclear Properties of Heavy Element Isotopes	10.3		
	Transmutations with the 184" and 60" Cyclotrons	9.0		
	Analytical and Services	15.3		
	Process Chemistry	11.8		
	Special Chemistry Development	2.7		
	Mass Spectroscopy, Beta Ray Spectroscopy	1.8		
	Instrument Development and Services	3.8		
	X-ray Crystallographic Measurements	4.5		
Chemistry, Part B	Synthetic and Experimental Chemistry	4.7		
	Biological Chemistry	7.7		
	Photosynthesis Chemistry	3.8		
Chemistry, Part C	Metals and High Temperature Thermodynamics	3.0		
	Basic Chemistry, including Metal Chelates	2.5		
	General	1.0		
Biology and Medicine Part A	Metabolism of Plutonium and Allied Materials	10.0		
	Radiochemistry	4.0		
	Radioautography	2.0		
Biology and Medicine Part B	Tumor Metabolism	1.4	1.9	Consultant Man-Months
	Special X-Ray Studies, Radioactive Measurements, etc.	6.0	1.6	
	Radioactive Carbon Studies	1.8	.2	
	Fundamental Medical Research	7.3	3.1	
	Hematology	.3	.2	
	Medical Work with the 184" Cyclotron	1.0	-	
	Fly Genetics	1.4	-	
	60" Cyclotron Bombardments	.3	-	
	Physical Chemistry	5.3	1.0	
	Specific Irradiation	3.4	-	
	Donner Animal Colony Expense	2.1	2.3	
	Aetherosclerosis Program	15.9	10.2	
	Radioactive Iron Studies	2.2	.9	
Biology and Medicine, Part C	Synthetic and Experimental Organic Chemistry	17.5		

PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
Health Chemistry, Physics	Monitoring and Disposal	7.9	
	Research and Development	23.9	
	Film Badge Program	5.5	
	Medical Examination Time	1.3	
Measurements Project Development	General	11.1	
M.T.A Project	Design and Development	29.3	