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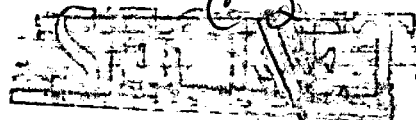
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Radiation Laboratory

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MONTHLY PROGRESS REPORT

No. 92

November 15 to December 15, 1950

January 3, 1951

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RADIATION LABORATORY, UNIVERSITY OF CALIFORNIA

MONTHLY PROGRESS REPORT, No. 92

November 15 to December 15, 1950

January 3, 1951

1. BevatronUNCLASSIFIED

Magnet. Erection of the steel preparatory to coil winding has been proceeding. The bottom yoke and leg slabs of three quadrants are in place and winding is expected to start about the first of the year. A tentative schedule has been set up based on winding one quadrant every eight weeks.

Magnet Power Supply. All the equipment has been received. A second MG set is being installed and wiring and buss work is proceeding.

Other Work. Assembly of the sample vacuum tank section is proceeding slowly preparatory to vacuum testing. The cooling tower is being erected and the linear accelerator vacuum tank has been received.

2. 184-inch Cyclotron OperationUNCLASSIFIED

The cyclotron was used for research experiments approximately 92 percent of the 470 hours that the crew was on duty. The time distribution was as follows:

	Hours	Percent
Operation for customers	432-3/4	91.8
Filament change	2-3/4	0.6
Electrical trouble	2-3/4	0.6
Mechanical trouble	5-1/2	1.2
Miscellaneous	4	0.9
Installation of new equipment	23	4.9
Total	470-3/4	100.0

The north concrete door of the main shielding was moved and the new door block and its associated blocks were installed. This provides fifteen feet of concrete shielding around the north door.

3. 60-inch Cyclotron OperationUNCLASSIFIED

A record alpha beam of 47.5 microamperes was recorded during this period. The instrument ran smoothly all month.

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4. Synchrotron OperationUNCLASSIFIED

Consistent and high intensity output characterized synchrotron operation during the first half of this report period. Continuous use of the beam for physics research and studies left little time for further development of the machine.

During the last two weeks of this period, overhaul of the vacuum chamber was necessary. This was due to severe deterioration of the rubber vacuum seals. Steps were taken on reassembly to exclude the air from contact with the rubber, as it is thought that ozone production by radiation might be the major factor resulting in the failure of the rubber.

Following are operating statistics for the period:

	Hours	Percent
Research operating time	281.40	72.8
Tests with synchrotron	28.00	7.3
Maintenance and installation	76.40	19.9
Total	385.80	100.0

5. Linear Accelerator and Van de Graaff OperationUNCLASSIFIED

The linear accelerator is in operating condition. The new oscillators are operating in a satisfactory manner at the usual beam voltage. The Van de Graaff moving is not completed and it appears that another two weeks will be required to finish the job.

6. Experimental PhysicsUNCLASSIFIED

Film Program. Progress was made on the following projects:

High Energy Electron Processes. Further work has failed to reveal any important source of experimental error, so that at present in both the positron-electron and electron-electron scattering distributions, one does not find as many high energy transfers as predicted by theory. However, when the knock-on energy is non-relativistic the predicted absolute cross section is found.

Meson Scattering. By accepting a greater energy interval (40-60 Mev) of mesons and using poorer geometry than in previous experiments, the flux of negative π mesons has been raised to a point where pure element scattering experiments are feasible. An experiment has been made with an aluminum scatterer and thus far ten mesons have been found meeting the requirements for having been scattered by the aluminum. While all the checks have not yet been made, these results are encouraging.

Positive μ Mesons. About one hundred μ^+ decay mesons which remain in the emulsion for their entire path have been found, and are being measured

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along with π mesons of known momentum (for emulsion calibration). A better value of the decay energy, and improved knowledge of the range straggling and the geometrical range straggling will be the results of this experiment.

Grain Density. The grain density study has continued over a variety of particle tracks in various emulsions. At present the best statement of the empirical grain density law is the following: The particle is assumed to thread an average number d_0 of grains per unit path in the emulsion. Of these a certain number d become developable and a number $d_0 - d$ remain undeveloped. The ratio of the number developed to the number undeveloped is found to be equal to a constant of the emulsion (the sensitivity) times the rate of energy loss of the charged particle traversing the emulsion.

Positron Spectrum of μ^+ Meson. Using the spirorbit spectrometer, electrons arising from the decay of the μ^+ meson have been counted with scintillation counters. Thus far it has not been found possible to analyze the spectrum reliably, however.

Meson Production Functions. A program of cyclotron runs has been completed for a collaborative effort with a number of Japanese universities to determine the meson production spectra and positive to negative ratios as a function of atomic number. The mesons are detected by plates placed so as to record mesons leaving the target at 90 degrees. The program included runs on Be, C, Al, Cu, Ag and Pb.

Cloud Chamber. The 22-inch Wilson Cloud Chamber in a steady magnetic field of 8250 gauss was placed next to the cave where there is a beam of 350 Mev protons coming from the 184-inch cyclotron. The protons struck a polyethylene target 4 inches thick placed in a large pair spectrometer magnet giving a field of 15,000 gauss. This technique results in a beam of positive mesons which was directed at right angles to the proton beam so that the mesons came out through a slit in the cave wall and entered the 22-inch cloud chamber.

Over a thousand pictures were taken in one day. A 1/4 inch thick lead plate across the center of the chamber permitted identification of the particles and it was found that about one out of three particles were protons and the rest mesons. The distance between the target and the cloud chamber was 14.5 feet which resulted in the decay in flight on the way to the cloud chamber of half of the π mesons. The π mesons traversing the chamber decayed in flight inside the chamber, 105 times and on 7 occasions a μ meson decayed in the gas of the chamber. About 15 mesons traversed the chamber in one picture, but this number varied markedly and on some occasions the chamber was filled with 40 or more mesons. One picture was obtained showing a π meson decaying into a μ meson which stopped and decayed into a positron. However all the other decaying μ mesons came out of the top glass or bottom of the chamber and into the lighted region.

Twice a π meson decayed at rest into a μ meson and the energy of the μ meson was that which would be expected for a zero mass neutrino. However, the accuracy is poor because of the scattering of the μ meson in the gas of the chamber which gives a probable error of 2 percent in magnetic rigidity or 4 percent in energy.

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The data for the neutron-deuteron scattering experiment has been completed.

The new meson beam has made possible scattering experiments with mesons in a cloud chamber. The new continuous cloud chamber developed by Anderson's Group at California Institute of Technology will be used for this if the experimental chamber now under construction is successful. It has been tested with a pulsed x-ray machine and produced thousands of tracks over a one inch height with a single pulse of the x-ray machine. It remains to be seen how well it will behave when the sensitive region is increased to two or three inches, either of which would be very acceptable since the chamber at present can be blasted with x-rays once every six seconds without exhausting the vapor.

Work is proceeding on the μ decay experiment at the synchrotron and the new rectangular chamber for studying the photodisintegration of the deuteron is operating very well.

A new experiment with the high energy carbon beam from the 60-inch cyclotron has been started. The beam will be sent into a Wilson cloud-chamber and the stars produced by collisions with argon and heavier gases will be observed. The snout bringing the beam to the cloud chamber and the cloud chamber are both completed.

Analysis of π^- Absorption in Deuterium. An additional run was made improving the accuracy and statistics of the gamma ray spectrum resulting from π^- absorption in deuterium. The resultant curves are now of sufficient accuracy to permit detailed comparison with theory. It turns out that the shape of the gamma ray spectrum resulting from the process $\pi^- + d = 2n + \gamma$ is very sensitive to the interaction of the two out-going neutrons. In a crude sense, analysis of this experiment is thus equivalent to obtaining the result from an n-n scattering process. Curves have been computed for the expected spectrum using various values of the n-n scattering length. These curves have been "folded" into the resolving power of the pair spectrometer and the resultant curves compared with the experimental data. This process is considered to be a reliable one since the resolving power of the instrument has been well verified by the π^- absorption spectrum in hydrogen. As a result of the analysis it is shown that the curves are fully compatible with the assumption assuming equality between neutron-neutron and proton-proton forces. In particular the results give an upper limit to the energy of stability of an hypothetical di-neutron. The limit binding energy, as permitted by this experiment, is of the order of 250 kv.

Electronics for Precision Measurement of the π^- Mass from the Hydrogen Gamma Ray Line. The number of channels of the pair spectrometer is being increased from 30 to 60. At the same time, trajectories are being determined using the stretched wire technique to determine the focus of the multiple scattered electrons made by the incident gamma rays in the converter. As a result of these measurements it will be possible to locate the Geiger counters on a curve for which radiation straggling will be the only principal cause of finite resolution.

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Electronic Detection of Positive and Negative Photo Mesons. An experiment has been started attempting to separate positive and negative mesons produced by the synchrotron beam by means of the 350 Mev pair spectrometer magnet. Preliminary experiments have shown that mesons can be counted in this geometry. This experiment is principally designed to improve the reliability of the plus-minus ratio of the measurements beyond the reliability now obtainable with photographic plates.

Neutron and Proton Elastic Scattering. In view of the "quasi-elastic" scattering results of Cladis et al, the detection threshold is being re-examined in order to evaluate the effect of the quasi-elastic particles upon previous results, and correct for it.

N-d Scattering. Runs have been made using a proportional counter telescope to measure the ratio of the total number of high energy protons produced in deuterium by a 270 Mev neutron beam to the number of those produced by n-p scattering in the same beam. In addition, the energy spectrum of the protons from deuterium has been measured at an angle of 35° to the neutron beam.

A set of 18 coincidence circuits has been added to the geiger tube amplifiers used in this experiment, and has produced an appreciable gain in useful counting rates, and in energy resolution.

High Energy Proton Spectra. The energy resolution of the 35 channel magnetic particle spectrometer has been improved by a factor of 3 by including coincidence circuits in the overlap channels. This equipment has been used in the neutron beam and in the cave during the last month. In the neutron beam, the energy spectrum of protons from n-d collisions was observed. In the cave, quasi-elastically scattered proton energy spectra were obtained at $12-1/2^\circ$ from H, D, C, O, Al, and Cu.

Development of Pair Counter. Preliminary tests on the finished form of the 200 Mev pair spectrometer are now being made.

Neutral Meson Program. The problem of an undesirably long dead time in the scintillation counter coincidence system referred to in the last monthly report has been solved by the use of short clipping lines terminated in a suitably chosen resistance located at the output of the photomultiplier tube. The electronics for studying the angular distribution of the coincident gamma photons seems now to be in satisfactory condition.

These same electronic developments are being applied to the new pair spectrometer employing scintillation detectors which will be used in a detailed study of the spectrum of the gamma radiation from neutral meson decay.

Meson Production. The experimental work on the production of π^+ mesons by 340 Mev protons on protons has been completed. Both the shape of the meson spectrum and the position of the peak in the spectrum strongly indicate that a deuteron is formed in the reaction. The work on meson production at 60° is progressing. The scattering of π^+ mesons has been attempted once more with photographic emulsions, utilizing the external meson beam. With improved geometry,

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plates containing a reasonable meson to background ratio have been obtained. These are in the process of being scanned.

Synchrotron Studies. A long run for the study of the photomesons produced in deuterium by the γ -ray beam of the synchrotron was completed. In this run, π^+ mesons were detected by the crystal counter technique and both π^+ and π^- are being studied in photographic emulsions. Since similar data for hydrogen is well known, this comparative data should prove very interesting.

For the study of positron-electron and electron-electron collisions, a run was made with the pair spectrometer magnet. A preliminary report of the study was given at the Los Angeles meeting of the American Physical Society.

The pair spectrometer magnet is also in use for tests on methods of counting π^+ and π^- mesons and for tests on the electron-positron counting equipment. Short synchrotron runs have been made for the study of scattered high energy quanta, for the study of angular spread of shower gammas (also reported at the Los Angeles meeting), and for studies of Li^8 activities.

7. Theoretical Physics

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MTA. Studies for injection with a large initial aperture have continued. This involves first the calculation of the yields between the drift tubes. The approximate theoretical fields have shown good agreement with fields determined from a model. However, an attempt will be made to obtain better theoretical fields by solving Laplace's equation for the actual geometries by relaxation methods using IBM or other calculating machines. The calculation of the orbits for the coupled longitudinal and radial motion is going to be investigated using a differential analysis built by Professor Arne Nordesieck at the University of Illinois.

Other Studies. Work on the following projects is being continued: angular spread of cosmic ray showers, analysis of photo yields on complex nuclei using various models of nuclear structure, transmission of fast neutron through nuclear matter, and analysis of π^- meson absorption in deuterium to obtain information concerning the neutron-neutron force. Comparison of the results of the last analysis with experiment gives promise that the n-n scattering can be measured in this manner.

8. M.T.A. Program

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Mark I Electron Model. The difficulty in the Mark I electron accelerating model with multipactoring has been solved by the use of a more powerful oscillator and by machining closely spaced grooves in the end face of the No. 1 drift tube. The electric field strength within the grooves is low enough to prevent the escape of the electrons which enter them. The number of electrons trapped at the drift tube surface can thus be made to exceed the number of new secondaries produced. Measured values of the ratio of beam output to injector current as high as 0.4 have been obtained and the beam is better focussed than the earlier one.

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The injector is provided with an adjustable iris by the use of which it has been discovered that the beam output per unit area of the iris is essentially independent of the diameter of the iris opening except for very small openings. A program has been started to measure accurately the magnetic fields within the drift tubes and to adjust these field strengths to the design values. Measurements scheduled to be made with the electron model include a determination of the beam shape and angular diversion as the beam leaves the accelerator.

1/10th Scale Model. The fifteen percent discrepancy between the measured and calculated values of Q for the 1/10 scale model of Mark I was studied further. The drift tubes were removed from the models and the Q was measured directly and also calculations were made of the field. As a result of this work it seemed evident that unexplained losses in the cavity were associated with drift tube structures. The drift tube was replated and the Q remeasured. This time a discrepancy of only 7 percent was found between the measured and calculated values. Further investigation of the discrepancy between these measured and calculated Q 's although still outside the probable error is not considered worthwhile.

Injector. Recent experiments on the injector have produced a beam of 2.5 amperes at 60 kilovolts, with which beam the limit of the power supply available in Building 16 has been reached. Spiral wolfram filaments have been tried with excellent results. Filament life has varied between 5 and 50 hours depending on experimental conditions, the most important being filament temperature.

B-1 Test Cavity. The B-1 test cavity has been successfully operated in a full voltage of two million volts on the sphere. This gives a field gradient of 1.8 million volts per foot at the sphere. This field gradient is a substantial fraction of the operating gradient for Mark I, which will be 3.2 million volts per foot. A study of the x-ray production as a function of the voltage in the load showed an increase after a short conditioning period of only a factor of two in going from a voltage of 1.25 million volts to 2 million volts. This indicates that the x-ray production from Mark I will be well within reasonable limits. The critical pressure for the B-1 tank is 9×10^{-6} millimeters at which pressure the tank will no longer hold voltage. To minimize x-ray intensity at the control panel the duty factor of the load is being maintained at about 1/60th. With this factor the x-ray level at the control table with full voltage on the sphere is about 1/3 R/hr at a distance of from 15 to 20 feet from the cavity. The ion locking problem has been overcome by the use of a pre-exciter.

L-1 Test Cavity. The decision has been reached to abandon construction of the L-1 test cavity because of its excessive cost and unfavorable completion date. The principal purpose of the L-1 cavity was to test the geometry of the high energy end of the Mark II accelerator. This was to be done at 20 megacycles. It is now planned to make this test in the Mark I cavity at 12 megacycles after Mark I has achieved initial operation with deuterons. The deuteron drift tubes will be removed and 1 and 1/2 drift tubes of the design for use in high energy and of Mark II will be installed.

Another purpose of L-1 was to serve as a test load for new oscillators. It is now tentatively planned to construct an oscillator test station, in one of the existing buildings at Livermore. This facility will also be used to test

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resnatron oscillators at a later date.

X-ray Production in Mark I. It has been found that the calculations of x-ray production by Mark I have been made using an impedance for the machine which is too low by a factor of two. This means that the x-rays measured were produced by a higher field gradient than was previously thought. The surface of the drift tube was thought to be at 0.78 megavolts per foot whereas it was actually 1.01 megavolts per foot. This correction reduces the estimated x-ray production of Mark I by a factor of 10, placing the present best estimate of loading from this cause at about 1 megawatt.

Current Measuring Target for Mark I. The design for the current measuring target for Mark I has been proposed to consist of two closely spaced conical aluminum shields with the side walls of the cone at approximately a 60 degree angle to the beam. Clearance between the two cones is such as to vary the velocity of water between them from 30 feet per second near the center to 18 feet per second near the edges. If the beam were delivered at a constant rate, the maximum equilibrium temperature gradient through the aluminum would be 80°F. The pulsed beam will increase the maximum instantaneous thermal gradient to about 180°F. The design of the aluminum cone presents no unusual problems in supporting the load of approximately 2 atmospheres produced by the air and water pressure.

Mark I Production Target. A study of the Mark I production target has been inaugurated by California Research Corporation. The studies are being made on an assumed beam diameter between one and three feet with a ratio of maximum to average beam energy density of 50 to 1, with this latter figure reduced to 4 to 1 by the use of a beam precessor. In addition to process design work additional studies will be required on the fundamental problems of the diffusion of polonium and the radiation damage of structural materials. Attempt is now being made to narrow considerations to a target design of the simplest possible mechanical structure which will accomplish the required functions and upon which development can be completed in a reasonable time. Two types receiving major consideration are those using solid bismuth and those using circulating liquid bismuth. The target using circulating molten bismuth seemed more certain of success at the moment, and therefore is receiving the higher priority. However, the polonium production would be 12.8 curies per day with a solid aluminum clad target against 10.8 curies per day with molten bismuth circulating in stainless steel tubes. This 20 percent difference in production amounts to an economic advantage of approximately one million dollars per year in favor of the solid target.

Two units are nearing completion in which solid bismuth will be subjected to thermal cycling. Solid bismuth has been thermally cycled by resistance heating between 250 and 300°F for one week at a rate equivalent to 4 minutes of pulse operation with no thermal cycling damage discoverable. Consideration is also being given to hazards resulting from rupture of various target designs, and to methods which may prove capable of detecting an incipient rupture with solid bismuth targets.

Polonium Separation. A study is being undertaken on molecular distillation for the removal of polonium from molten bismuth. It has been found that the enrichment factors obtained are approximately 1 percent of those calculated on

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the basis of vapor pressures of bismuth and polonium. Distillation experiments indicated that the rate of diffusion of polonium will prove to be less severe by one or two orders of magnitude than present estimates indicate.

Construction at Livermore. Steel erection work at Livermore is about 35 percent complete on the accelerator itself. Building steel has been shipped by the supplier and it is hoped that its erection can begin shortly. It is hoped also that assembly of the cavity can begin about December 15. A method for the fabrication of the liner is being worked out to allow a simultaneous soldering of the full complement of cooling tubes to each section. Bids have been received on the transmission lines and the contract let for the 7 foot shielding blocks.

The south basement of the building is complete except for back-filling and the east-west tunnel of the south building is complete. Fabrication of piping for the refrigeration is underway. Work on trenches and transformer foundations for the electric distribution system is in progress and the 40,000 kva transformer has arrived. The contract has been let for the power supply building and construction will begin as soon as weather permits.

9. Chemistry

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Part A

Crystal Structure of $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$. X-ray diffraction data have shown that the unit cell of sodium thiosulfate pentahydrate is monoclinic space group $\text{C}_{2h}^5 - \text{P}_{21}/c$. The cell dimensions are: $a = 5.96 \pm 0.04$, $b = 21.66 \pm 0.04$, $c = 7.55 \pm 0.02$, $\beta = 103^\circ 58'$. The density calculated for four molecules in the unit cell is 1.744, compared to the experimental value of 1.729. Work is in progress to try to locate the atoms; it is already clear that there is not enough room for rotating thiosulfate ions.

Vapor Pressure of Neptunium Metal. During measurements of the vapor pressure of Pu and Np metals by effusion techniques, inconsistent values were obtained. A surface coating was suspected to be the cause of the deviations. Experiments with coated and uncoated mercury pellets, with and without agitation, have confirmed that surface effects can be very serious. Agitation is obtained by vibration of the crucible with a small piece of tantalum inside it. Methods for overcoming this error are being investigated.

Alpha Activity in the Rare-Earth Elements. The long-lived artificial activity in gadolinium has had its element assignment confirmed by additional chemical separations. Its alpha energy is 3.21 ± 0.03 Mev by the pulse analyzer. Decay observations for one year show the half-life to be greater than 25 years. Excitation experiments, using enriched samarium isotopes as targets, fix the isotopic assignment as Gd^{148} , which has 84 neutrons.

A small amount of alpha activity of 2.9 Mev energy has been observed in europium produced by proton bombardment of Sm^{147} . Its principal mode of decay is electron capture with about a 2-month half-life.

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Nuclear Spectroscopy. The beta ray spectrograph has been used to investigate the decay schemes of 21-hour Np^{236} and 4.4-day Np^{234} . The former has two beta groups and a highly converted gamma ray, while the latter has at least four gamma rays following electron capture.

The 90-minute Zr^{87} decays by 2.10 Mev positron emission to an isomer of Y^{87} , which decays to the ground state with a complicated gamma spectrum. The ground state decays by electron capture to an excited state of Sr^{87} , as was shown previously. The 78-hour Zr^{89} decays by 0.910 Mev positron emission, followed by gamma rays of 27, 396, 915, and 1280 Kev. The long-lived Zr^{88} decays by electron capture with a single gamma ray of 406 Kev.

The shape and limit of the beta spectrum of P^{32} have been redetermined. The value 1.685 ± 0.010 Mev is in good agreement with some of the previous work.

Ion Exchange Separations. Tartaric acid is being investigated as an eluting agent for the separation of tracer amounts of americium and curium. With 0.1M tartaric acid at pH 4.0, a 30 percent difference in distribution constants was obtained. The separation achieved was about twice as good as with the usual citrate procedure.

Experiments are continuing on the behavior of actinide and lanthanide ions on cation exchange resins when eluted with hydrochloric acid.

Radiation Chemistry. Methanol, ethanol, n-propanol, propanol-2, and 2-methyl propanol-2 have been irradiated with alpha particles in the 60-inch cyclotron and analyzed for decomposition products. The reduction products exceed the oxidation products, so some products have been missed in the analyses. Further work is in progress to search for these.

Chemistry

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Part B

Synthetic and Experimental Chemistry. During the past month the synthesis of the following compounds has been studied: Norvaline-3- C^{14} , norleucine-3- C^{14} , leucine-3- C^{14} , codeine-methyl- C^{14} , 1-naphthaleneacetic- α - C^{14} acid, methyl- C^{14} iodide, acetyl-choline-methyl- C^{14} chloride, valine-4,4'- C_2^{14} , aspartic- γ - C^{14} acid, aspartic- β - C^{14} acid, stilbamidine-amidine- C_2^{14} , n-butyl-1- C^{14} iodide, isopropyl-1,3- C_2^{14} iodide, isobutyl-1- C^{14} iodide, benadryl- C^{14} (diphenyl-methyl- C^{14} - β -dimethylaminoethyl ether), pyribenzamine- C^{14} [2- [benzyl- α - C^{14} (2-dimethyl-aminoethyl)] amino pyridine,] glycol-1,2- C_2^{14} , ethylene-1- C^{14} and sodium octanoate-1- C^{14} .

Other projects in the field of synthetic and experimental chemistry which have been studied during the past month include: the isotope effect in the decarboxylation of malonic acid and substituted malonic acid derivatives, isotope effect in the decomposition of oxalic acid, proportional counting of low activity C^{14} samples, improvement and modification in ionization chamber measurements of low activity C^{14} samples, and synthesis of simple polypeptides and

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their decomposition when exposed to radiation.

Biological Chemistry. In the study of the metabolism of labeled purines the fate of 8-azaguanine-4- C^{14} and guanine-4- C^{14} in mice and the antagonistic action of 8-azaguanine on the metabolism of guanine-4- C^{14} has been studied. The in vivo metabolism of stilbamidine-amidine- C^{14} in mice has shown that most of the stilbamidine is to be found in the heavy, or "nuclear", parts of the cells in such in vivo experiments. In the study of the in vitro metabolism of labeled sodium propionate metabolism in liver slices, attempts to identify the one remaining major unknown radioactive compound produced in such incubations have continued.

The isolation of the various labeled components from the eggs of a hen fed sodium acetate-1- C^{14} has been worked out and separation of the various components undertaken. To date, all the yolks have been extracted and the protein, phospholipid, and cholesterol obtained from each. These fractions are now being assayed for radioactivity.

The study of the application of paper chromatography to steroids has continued with success using Quilon treated papers.

Photosynthesis Chemistry. The chemical mechanism of photosynthetic carbon dioxide reduction is being investigated in this laboratory and has been found to involve several well known metabolic intermediates. The primary intermediates which are nearly all, if not all, phosphorylated are being separated by two-dimensional chromatography. Improvement and standardization of techniques for these separations is in progress.

A series of short photosynthetic experiments has been conducted for the purpose of more exact investigation of the earliest steps. Enzymatic hydrolysis of the phosphorylated compounds from a number of previous experiments demonstrated the importance of several unknown compounds in synthetic steps prior to accumulation of sucrose. The present experiments are designed to clarify the time-sequence relationships of these intermediates.

Chemical identification of unknown intermediates is in progress. Periodate oxidation of uniformly labeled unknown compounds is expected to yield information regarding their identities. The use of C^{14}/P^{32} labeled compounds from photosynthetic experiments for comparison on ion exchange resin adsorption properties is being continued.

Work with iodoacetamide shows that incorporation of carbon from $C^{14}O_2$ into sucrose cannot be prevented with this poison even after a 20 minute pretreatment of the cells. The total CO_2 uptake is inhibited by 80-90 percent. With these relatively long pretreatment times some depressing effect on the incorporation of C^{14} into sucrose is observed as compared with controls exposed to $C^{14}O_2$ for equal periods at the same saturating light intensity.

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Chemistry

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Part C

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

1. Heat transfer in forced convection film boiling.
2. Liquid metal systems.
3. Gaseous hydroxides species of Mo and W.

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

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

10. Medical PhysicsUNCLASSIFIED

Part A

Tracer Studies. Tracer studies are being performed upon radio-thulium, palladium, neptunium, astatine and bismuth in animals.

Radioautographic Studies. Autographs were completed on stripping film of the tantalum lung studies. Also, autographs are in progress on various tissues injected with thromboplastin tagged with radio-iodine.

Marked but subtotal destruction of the thyroid gland was demonstrated by radioautographs of the residual paratracheal fibrous tissue found in monkeys, 60 days after the administration of 197 microcuries of At^{211} .

Radiochemistry. Using previously reported procedures, microcurie amounts of the following radioactivities were prepared: Pd^{103} , Mc^{99} , $\text{Ta}^{177,178,179}$, Cr^{51} , and At^{211} .

Chelating Studies. An experiment is being set up to test the efficacy of Ca EDTA and Fe^{3+} in accelerating the excretion of Pu in the body when these agents are given by mouth. These experiments will also determine the effect of prolonged feeding of these agents to rats.

10. Medical PhysicsUNCLASSIFIED

Part B

Induced Activity Trace Analysis. Accumulation of data on the distribution of trace elements in human blood and mouse tissues is being continued.

UNCLASSIFIED

Mechanism of Radiation Effects on Unicellular Organisms. The distribution of defective diploid yeast cells produced by a given dose of irradiation is being studied experimentally. Based on the shape of the survival curves of the preirradiated yeast cells, it is found that a dose in which 65 percent of the normal diploid cells survive produces at least 33 percent of defective survivals. When these are grown into colonies and re-irradiated their radiation sensitivity falls above the most sensitive normal diploid cells. On the other hand when the same test is carried out with haploid cells the sensitivity of the pre-irradiated cells does not change. This is a strong indication of the nature of the defects, that is the defects must have to do with one of the two sets of genes in the diploid cells.

Radiation Effects on Mammals (184-inch Cyclotron). In cooperation with the Naval Radiological Defense Laboratory some tests have been completed on the lethal effect of local irradiation of various parts of the body of white rats. A detailed report is being prepared, giving some idea of the dose required for lethal effect when different parts of the body are irradiated as well as evidence for indirect effects of local irradiation. Experiments were carried out on radiation hypophysectomy; the dose required for inhibition of the rat pituitary with 190 Mev deuterons is of the order of 20,000 rep. A detailed program has been initiated to study the radiation effect on the pituitary and on growth of the animals.

Biological Effects Due to High Energy Carbon Ions - C⁽⁶⁺⁾. During December the first biological test was successfully carried out using 120 Mev C⁽⁶⁺⁾ ions. These particles have rate of energy loss up to ten times as high as low energy alpha particles. The organism used was haploid yeast colony, *Saccharomyces Cerevisiae* SC 7-7. A dose of approximately 1,000 rep produced about 7 percent inhibition of cell division. Although much more work will be necessary before final statements can be made it would appear that carbon ions do not have a very high relative biological effect as compared to x-rays. Since the beam intensity is only of the order of 10,000 particles per cm²/sec. and the particles are not very penetrating (Range in AC-54mg/cm²), for the present time the carbon ions will have only limited applications. However, it is interesting to note that cosmic rays at altitude above 70,000 feet have many light nuclei similar to the C⁽⁶⁺⁾ and the biological effect due to these will have to be investigated before aviators are permitted to fly at extremely high altitudes.

Iron Turnover. Two patients having an indication of excessive red cell destruction and formation have been studied by the *in vivo* iron method. There is a characteristic pattern in the iron turnover of these patients which differs markedly from the normal. The plasma iron turnover is greatly increased as is the red cell iron turnover. The counting rate over bone marrow never achieves a normal level and does not fall to the normal minimum in 7 to 15 days. The red cell level of radioactivity remains subnormal. The outstanding difference is associated with the spleen counting rates which become markedly high starting at about two days when the marrow level is falling, and the red cell concentration rising. This type of study offers certain advantages in the diagnosis and estimation of severity of anemias associated with excessive cell destruction.

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UNCLASSIFIED

Red cell determinations are being carried out on rats at intervals after adrenalectomy. At 12 days the animals showed approximately a 12 percent decrease in red cell mass.

Metabolism of Carbon 14 Labeled Glycine. Following the demonstration that at autopsy at 106 days after administration approximately 10 percent of the injected dose was still present in the tissues, studies were initiated to determine the route and rate of excretion of this fraction of the dose. Analysis of the urine of 5 patients at intervals of 2 to 9 months after administration of the glycine indicates that this is the principal route of excretion, since the specific activity of the urinary carbon 30 days after administration was higher than the breath C 14 specific activity. The data indicate that this slow component of excretion is through the urine and has a half-time of approximately 60 to 80 days. This now makes complete accountability of the injected C 14 possible.

Beryllium Poisoning. The patient with chronic pulmonary granulomatosis treated for 8 months with ACTH died on November 26, 1950. Post mortem examination showed extensive granulomatous involvement of both lungs and the hilar nodes. Many small and medium sized cavities were present in the lungs. The thyroid and adrenals were enlarged. Microscopically the lungs showed small rounded fibrosed areas, presumably old granulomas, and subacute disseminated tuberculosis. Terminal bronchopneumonia was also present. Samples of pulmonary tissue as well as muscle, liver, thyroid, and lymph nodes are being analyzed in several laboratories independently for Be content.

Double Nucleated Lymphocyte Problem. The incidence of these cells in rabbits before and after x-irradiation is being studied. It is hoped that the technique of counting the cells may be facilitated by using larger animals and separating the white blood cells from the red corpuscles by the ox albumin method.

Special Health Hazards. Because of the work with curium and other alpha emitters going on in the radiochemistry section as well as other places, it has been thought necessary that the personnel be investigated as to the extent of exposure. To this end the advisability and practicality of the setting up of a laboratory for the analysis of excreta for alpha emitters has been considered. Urine samples of several individuals working with curium have been wet ashed. Because of the relatively small number of exposed personnel and the sporadic nature of the radiochemical work, it is thought the installation of a laboratory of our own for such excreta analysis is probably impractical. Preliminary correspondence has been carried on with Dr. Hasterlik at Argonne National Laboratories in an effort to arrange for final analysis of such samples at Argonne.

11. Health Physics and Chemistry

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Shielding Problems. The chief concern of the Health Physics group during the past month has been the study of the x-radiation produced by the oscillator test

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~~CONFIDENTIAL~~

unit in Building 52. Under conditions of maximum output the yield dosage rates have been as much as two roentgens per hour at distances of forty feet.

On the basis of the known peak voltage of the oscillator and of absorption measurements of the x-radiation an arrangement of lead shielding has been designed which is to be installed as rapidly as possible. Further high intensity operation will be deferred until this shielding is completed.

The monitoring of neutron fields with a CH₂ walled proportional counter has been facilitated recently through the development of a battery operated portable linear amplifier and recorder. This will enable one to make readings in regions where 110 voltage power is not readily accessible.

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

1. A two-inch lead cave and auxiliary equipment was readied for Chalk River bombardment. An improved slug cutter and a new dissolver box setup has been constructed, which includes a laminated lead glass window, 5 inches thick, 18 inches long and 4 inches high was constructed at the same time.
2. Equipment for the proton bombardment of uranium successfully used during the last period, was reworked for use on still more active bombardments of this type.
3. An enclosure for a vacuum line system used with transuranic metal production furnace (bazooka) was completed.
4. Standardization of the gloved box drawing files has been completed.
5. New auxiliary equipment was made for use in gloved and manipulator boxes; a power supply for an electric stirrer and overhead fluorescent light improvements and a design for a swivel-arm pipettor were completed.
6. Five Berkeley boxes were assembled.

12. Plant and Equipment

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Bevatron Building. The leg slabs are being installed in quadrants 2 and 4. Installation of bus in the generator room pit is about 75 percent complete. Oil piping is being installed on the motor generator sets. Work on the paving contract has been at a standstill for almost the entire month due to unprecedented rains. Erection of the cooling tower adjacent to the bevatron building to the east and south is approximately 50 percent complete. Space heaters have been installed in the magnet room.

Construction of Cafeteria. A limited amount of landscaping work has been decided upon. Bids have just been received and are being considered.

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Construction of Animal House. Funds for the construction of the animal house have been released and preparation of contract documents is under way. The job is expected to go to bid on December 21, 1950 and bids will be due January 17, 1951.

Construction of Sheetmetal and Insulator Shop. The contract was recorded December 18, 1950. A deep rock and tile drain is being installed to the east of the site of the sheetmetal shop to cut off subsurface water. Work on the building proper will start in the next ten days.

Radiological Laboratory at the University of California Medical School. The excavation is 87 percent complete; reinforcing steel is 80 percent complete; form work is 82 percent complete; and the concrete is 76 percent complete.

MTA Project. Development and design continuing.

Measurements Project. Development and design continuing.

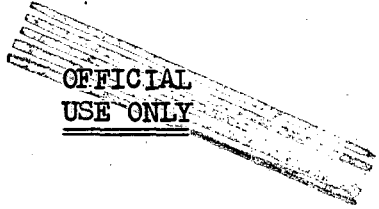
Accelerator Design Building. The bids for the fabrication and erection of the structural steel have been opened and contracts are being prepared for this phase of the work. It is expected that contracts for the general construction of the building will be ready to go to bid on January 5, 1951.

Miscellaneous Construction. Alterations to Rooms 106 and 107, Building 4. These alterations are 85 percent complete.

Rehabilitation of Usable Sections of Building 8. Work in connection with the rehabilitation of sections of Building 8 not seriously damaged by the fire is 100 percent complete.

Old Radiation Laboratory. Alterations to Rooms 208 and 209 in the Old Radiation Laboratory (for North American Aviation) are 95 percent complete.

Fire Equipment Building. Construction of the Fire Equipment Building is approximately 100 percent complete.


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MAN-MONTHS EFFORT REPORT

Scientific Personnel

PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
184-inch Cyclotron	Operation	9.0	
36-inch Cyclotron	Electron Model	7.8	
Synchrotron	Operation	7.1	
Linear Accelerator	Linear Accelerator - General	7.5	
	Van de Graaff - General	7.5	
	Development	- -	
Bevatron	Magnet	.2	
Experimental Physics	Cloud Chamber	7.4	
	Film Program	13.7	
	General Physics Research	35.6	
	Instruments for General Use	1.1	
	Special Development	18.4	
	Magnetic Measuring Equipment	2.9	
Theoretical Physics	Bevatron	2.0	
	General Physics Research	11.5	
Isotope Separation	Nier Spectrometer	.5	
Radioactivity Physics	General	1.4	
	Crystal Program	.6	
Chemistry, Part A	Chemistry of Transuranic Elements	5.0	
	Nuclear Properties of Heavy Element		
	Isotopes	8.7	
	Transmutations with the 184" and		
	60" Cyclotrons	6.9	
	Analytical and Services	14.2	
	Process Chemistry	12.4	
	Special Chemistry Development	4.0	
	Mass Spectroscopy, Beta Ray Spectroscopy	1.5	
	Instrument Development and Services	3.5	
	X-ray Crystallographic Measurements	3.1	
Chemistry, Part B	Synthetic and Experimental Chemistry	4.7	
	Biological Chemistry	7.3	
	Photosynthesis Chemistry	3.8	
Chemistry, Part C	Metals and High Temperature Thermodynamics	2.5	
	Basic Chemistry, including Metal Chelates	2.0	
	General	2.5	

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PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
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	.7	1.8 Consultant Man-Months
	Special X-Ray Studies, Radioactive Measurements, etc.	5.8	1.8
	Radioactive Carbon Studies	2.7	.3
	Fundamental Medical Research	6.1	3.6
	Hematology	2.2	.1
	Medical Work with the 184-in. Cyclotron	1.2	.5
	Fly Genetics	2.0	-
	60-in. Cyclotron Bombardments	.2	-
	Physical Chemistry	11.3	3.0
	Specific Irradiation	5.3	.8
	Donner Animal Colony Expense	.5	1.9
	Large Molecule Program	1.7	11.6
	Radioactive Iron Studies	3.0	1.6
Biology and Medicine Part C	Synthetic and Experimental Organic Chemistry	17.0	
Health Chemistry, Physics	Monitoring and Disposal	9.6	
	Research and Development	26.0	
	Film Badge Program	5.9	
	Medical Examination Time	1.6	
Measurements Project Development	General	12.8	
M.T.A. Project-Mark I	Design and Development	31.0	
M.T.A. Project-Mark II	Design and Development	1.4	