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RADIATION LABORATORY

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UNIVERSITY OF CALIFORNIA  
Radiation Laboratory

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MONTHLY PROGRESS REPORT  
No. 88

July 15 to August 15, 1950

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Classification changed to **DECLASSIFIED**  
by authority of *D. D. Plummer & E. J. Thurn, LRL*  
on *April 1961* *B. Bobett*  
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Berkeley, California

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UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

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1. Bevatron

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Building. The foundation walls for the magnet are complete and the magnet room floor is being poured. The wiring raceway around the magnet room and through the generator room is being installed.

Magnet. Leg slab assembly is complete and yoke assembly is 93 percent complete. Assembling work is now on one shift only in anticipation of closing the shop in September. Eighteen percent of the yoke slabs have been delivered to the building. Fifty percent of the cable is now in the bay area. Production of cable spacers is expected to start in a few weeks. Close contact is being maintained with the spacer suppliers in an effort to insure compliance with the specifications.

The bed plate for the west motor generator is being installed. One fly-wheel and one generator stator are on the site. One rectifier unit has been received and a considerable amount, perhaps one-third, of the auxiliary equipment has been received.

Magnet Tests. It has been decided that if necessary, equipment to provide a reverse current pulse can be installed at a cost of the order of \$20,000. No attempt will be made to obtain Armco iron for the poles as this would require further magnet testing for evaluation and could not be expected to reduce the residual field by more than a factor of 2. No more model tests are now required for magnet design.

2. 184-in. Cyclotron Operation

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The cyclotron crew was on duty 442 hours during this month. Operating statistics for the period are:

Operation for customers (oscillator-on time 56%)	411-1/2 hours	93.1 percent
Filament change	2 hours	0.5 percent
Electrical trouble	10-1/2 hours	2.4 percent
Mechanical trouble	18 hours	4.0

Operation was restored to the seven day week during this month.

3. 60-inch Cyclotron OperationUNCLASSIFIED

Despite repeated adjustments, the deflector still has high drain which limits the alpha beam. However, operation reached a level of about 60 percent efficiency during this period.

4. Synchrotron OperationUNCLASSIFIED

The synchrotron has been operated for physics research during this report period. A new peak beam intensity of 500 R/min was recorded and maintained for several days during investigation of an additional orbit contractor.

Investigation of the field pattern in the gap is continuing.

Some trouble was experienced with high voltage breakdown in the r.f. accelerating system. The cause has been determined and corrected.

Following are operating statistics for the period:

Research operating time	141.9 hours	39.3 percent
Test of synchrotron	119.5 hours	33.2 percent
Maintenance	98.6 hours	27.5 percent

5. Linear Accelerator and Van de Graaff OperationUNCLASSIFIED

The scheduled installation of new oscillators has begun. Old oscillator accessories have been removed and new construction is progressing.

The Van de Graaff is awaiting shell wiring which will provide enhanced reliability.

6. Experimental PhysicsUNCLASSIFIED

Film Program. The study of the grain density of particle tracks has been extended both to very light and very heavy particles. Grain counts versus energy on electron tracks have been made, and also on tracks of  $C^{12}$  nuclei. The parameters governing the grain density are sought.

Work on the design of a solenoid-type coil for meson focusing has progressed, and a magnet has been converted for testing the spirorbit spectrometer principle for mesons.

Work is practically completed on a study of the cross section for star production by protons in the emulsion as a function of proton energy.

Cloud Chamber. Data from the n-d experiment continues to be read. About 1000 events have been examined and tabulated. Electronic equipment for the  $\mu$  decay experiment has been constructed. The facilities in Bldg. 25-B have been placed

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in improved order and the building cleaned. A cloud chamber control rack to replace the one destroyed by fire has been delivered by the shop and inter-connecting wiring is in progress. Counters for the  $\gamma$ -D disintegration experiment have been completed. Portions of the cloud chamber for this experiment have been received from the shops. A temperature controlled top for the "continuous cloud chamber" investigations is under construction. Designs for the 10 atmosphere chamber for neutron experiments continue to be investigated. A precision chamber for measurement of pair energies,  $\pi^-$  capture in  $H^+$ , is in final design. Work with the pantograph chamber for  $\phi_2$  stars induced by neutrons has been continued.

Neutral Meson Program on the 184-in. Cyclotron. Efforts during the past month on the neutral meson program have been directed toward improvements in the measurement of yield from proton bombardment of hydrogen and deuterium, and also to the refinement of data on yield versus energy and versus angle.

Cerenkov Radiation. A measurement of the Cerenkov radiation angle for the electrostatically deflected beam using achromatic equipment showed this equipment to have a standard deviation of its resolution pattern of about 3 Mev and indicated a beam energy of  $346 \pm 10$  Mev. The standard deviation of the energy spread in the beam itself must be less than 2 Mev. The accuracy of the absolute energy is to be improved and some improvement in resolution is possible by redesign of the equipment.

Production of a  $\pi^+$  Meson Beam Using the Deflected Proton Beam of the 184-inch Cyclotron. The peak in the meson production cross section in the reaction of protons on protons has been utilized to produce a beam of mesons. A 5 cm polyethylene target was used in the external beam and a meson beam of 7000 mesons per sec. was obtained in an area 2 in. x 2-1/2 in. The mesons have an energy of 53 Mev with a half-width of 6 Mev.

Synchrotron Studies. The performance of the synchrotron has been somewhat erratic during the past month and consequently the experimental progress has not been so great as expected.

Meson counting has given results on the efficiency for counting  $\pi^+$  mesons. These results are given in detail in UCRL-874 by A. S. Bishop. The particular value of the efficiency is that it permits the calculation of a cross section for  $\pi^+$  meson production.

Work has started on the angular spread of  $\gamma$ -radiation in a shower. Further work on showers in lead, as detected by different radioactivities, is being started.

Work on the  $\gamma$ -radiation from neutral mesons produced by the synchrotron  $\gamma$ -radiation is progressing. Difficulties with the liquid scintillation counters have consumed some time, but informative runs should be obtained in the next month.

Work on the production of neutrons by the synchrotron  $\gamma$ -radiation has also been done. The yield seems to increase about as the square of the atomic number. The yields also seem to be of the same order of magnitude as found in other work.

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Apparatus for the measurement of photo-protons with scintillation counters operates satisfactorily. It is hoped to use this with a neutron counter to detect the photo-disintegration of the deuteron.

### 7. Theoretical Physics

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The principal effort in meson theory has been in attempt to understand the experiments on  $\pi^-$  capture in hydrogen and deuterium. An understanding is sought in the case of hydrogen of the strong competition of single gamma emission with  $\pi^0$  emission. Pseudoscalar theory with pseudovector coupling does indeed predict a small rate of  $\pi^0$  emission because it makes the rate of capture of the  $\pi^-$  meson proportional to its velocity; however, one does not obtain any quantitative understanding of the experimental results. In the case of capture in deuterium the fact that the two neutrons do compete with single gamma emission proves that the  $\pi^-$  meson is not a scalar provided the capture takes place in the K state. The probability of the capture from the L shell has been estimated from the observed rate of the inverse process  $p + p \rightarrow D + \pi^+$  (with the assumption that the  $n + n$  and  $p + p$  cross sections are equal). It turns out that radiation from the L to the K shell should be about 20 times more probable than capture in the L shell. This conclusion could be invalidated if there were large enough interaction energy between the meson and the nucleus to radically alter the coulomb wave function.

Another attempt is being made to understand the high energy neutron cross section in terms of the transparent nucleus model.

The question of polarization of bremsstrahlung is being investigated in the hope that synchrotron experiments might be possible with polarized x-rays.

The design of the Mark I accelerator has been based on calculated fields using the relaxation method. Model drift tubes based on these calculations have been made for the first four drift tubes. Field measurements with these model tubes indicated that the calculated fields agreed well with the measured field.

The orbits of electrons emitted from the surfaces of the drift tubes in the r.f. electric field and in the fields of the magnetic lenses are being calculated to determine how these lenses should be made in order to trap the electrons.

Further studies are being made of the final beam intensity in connection with the target design of the long MTA.

### 8. M. T. A. Program

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Field Emission. Tests indicate that from 2 to 20 megawatts may be absorbed by field emission between the drift tubes in the Mark I accelerator. This power loss is very sensitive to the voltage gradient which may make it desirable to go to a lower voltage gradient in Mark II.

The use of "flux leaders" to extend the flux from the focussing magnets to the ends of the drift tubes has been suggested as a solution to the problem

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of stopping an electron current from originating on the drift tube surfaces by providing a tangential magnetic field along the end faces of the drift tubes. Model experiments are being done to determine the suitability of this method of suppressing field emission.

Oscillator Tube Design. The reports submitted by various tube manufacturers with regard to the development of high power r.f. tubes have been examined and a tentative decision reached to use a 4-6 megawatt tube on Mark II. This seems feasible within the time limits set for Mark II. Contracts for the development of such tubes are being negotiated. Also, design studies looking toward the development of a 25 megawatt resonator tube oscillator tube are being made. The tube would be about four feet in diameter and five feet high and would employ a scaled up calutron type ion source as an electron source. A 1/4 scale model is under construction which will be used to study the electron optics and structural characteristics for the proper frequency. Following this the internal structure will be refined and the full scale tube designed for 12.2 mc operation.

Drift Tube Magnets. Previous calculations of the power requirements for the drift tube magnets are high by a factor of two. The calculations also indicate that some or all of the iron at the ends of the drift tube magnets may be left off. Tests are being made to determine the final optimum amount of iron. The order for the power supplies are being held up pending a decision on possible changes in the specifications.

Drift Tube Supports. Further work has been done on the experimental determinations of the positioning of the drift tube supports. The present agreement between calculated and measured electric fields in the accelerator is now so good that it is unlikely that there will be any further changes in drift tube positions.

Vacuum Tank. The present Mark I vacuum tank design provides for four banks of oscillators with nine to each bank. Since only 18 oscillators will be used to power Mark I and the extra oscillator positions provided for the possible physical extension of Mark I are no longer needed for this purpose, the number of tank ports can be reduced from 36 to 27.

Tank Viewing System. Arrangements for viewing the inside of the Mark I tank are being considered. Since the viewing will be done with the r.f. power on, both with and without the beam, the observer must be outside the shielding. This makes the use of an optical system necessary. Twenty periscopes will be necessary to see all parts of the cavity. Those would be placed in four rows of four each along the sides and four in each end wall. Because of the high cost it was suggested that only the four periscopes necessary to view the coupling loops be installed initially with additional openings provided to which they could be moved should it be necessary to view other areas. It was decided that the requirements for viewing the interior of the tank be reviewed.

Ion Source. Design work is proceeding on a full-scale ion source that could be used on Mark I. It will give a basis of experience for improvements that may be discovered before Mark I is put into operation.

Test Cavity. The decision was made to build at Livermore a duplicate of the Laboratory's test cavity. It was also decided to build there a cylindrical test

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cavity approximately 35 feet high and 20-25 feet in diameter if funds are approved. It would serve a number of purposes including that of giving experience in constructing a large cavity of copper clad steel.

Electron Model. Assembly of the electron accelerator model is awaiting the drilling and painting of the tank. The drift tube magnets and shells are partially completed and the final source is under construction. Part of the instrumentation is ready for release from the shops.

Mark II Accelerator, General. In response to the request of Pitzer an estimate of 2 months was made for the delay that would result in the change from deuteron to proton acceleration in the Mark II accelerator design. It was pointed out that a major consideration in the change is that if the machine were designed to accelerate deuterons and serious difficulties were encountered, the field gradient could be cut in half and protons accelerated to half the deuteron energy. On the other hand, if the machine were designed for protons and could not be made to operate properly at full potential gradient, it could not be made to operate at all.

Mark II Frequency. The decision to operate the Mark II machine at 20 mc is considered to be firm until some operating experience is obtained with Mark I. Some of the difficulties that had led to the earlier decision to operate at a longer wave length have now been resolved to a considerable extent.

Mark II Power. Drift tube magnet power for a 500 foot accelerator with a gradient of .5 Mev/ft operating at 20 mc has been calculated to be 8 megawatts.

Mark II Target. The present thinking on the Mark II target is to combine plutonium and tritium production since one can obtain large Pu production without any large sacrifice of H<sup>3</sup> production. Such a target would utilize a secondary target in which additional neutron multiplication would occur that would consist of a subcritical lattice of uranium and normal water with enough Li incorporated to produce the desired amount of H<sup>3</sup>. The amount of uranium required is determined by the amount of heat that must be dissipated. Depleted uranium could also be used.

## 9. Chemistry

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### Part A

Radioactivity of Np<sup>241</sup>. A new neptunium beta-activity, with half-life 55 minutes and 0.8 Mev beta-energy has been observed in uranium irradiated with 38 Mev helium ions. It is best explained as Np<sup>241</sup>, produced by the (α,p) reaction.

Ranges of Fission Fragments. The ranges in aluminum of Ba<sup>140</sup> and Sr<sup>91</sup> recoil fragments from the fission of uranium with 350 Mev protons have been measured in the 184-in. cyclotron. The first results are in close agreement with the values obtained with slow neutron fission, showing that not much, if any, of the increased excitation is transferred to kinetic energy of the recoil fragments.

Alpha-energy Measurements with Photographic Plates. Nuclear emulsions are being used to study the energies of alpha-particles. This technique supplements

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the pulse analyzer by being more suitable for very weak samples. Preliminary results indicate that the precision and resolution will compare favorably with the pulse analyzer.

Mass Assignment of Terbium Alpha-emitter. The 4-hr. terbium alpha-activity has been assigned to mass 149 with the mass spectrograph. Natural samarium was used as a mass scale. A transfer plate showed 80 alpha tracks at mass 149; the background was about 4 to 5 tracks for a similar area elsewhere on the transfer plate.

Mass Assignment of Natural Alpha-Activity of Samarium. Pure  $\text{Sm}^{147}$  has been obtained from the decay of  $\text{Pm}^{147}$ . Mass analysis showed it to be substantially pure. Pulse analysis showed it to have alpha-particles of the correct energy and in about the right abundance to account for the known alpha activity of natural samarium.

New Mass Spectrograph. The magnet and part of the vacuum tank of the new mass spectrograph have been finished and are now mounted.

Crystal Structures at Low Temperatures. We have constructed an x-ray powder camera in which the sample is cooled with cold nitrogen, obtained by controlled evaporation of the liquid. A study of sodium superoxide has shown that the structure changes to a lower symmetry at about  $-75^{\circ}\text{C}$ . Cyclobutane has been shown to have two different crystal structures at low temperatures, but these structures have not been worked out.

## Chemistry

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### Part B

Synthetic and Experimental Chemistry. The developmental work on the reduction of cadmium-nickel salts of the fatty acids for the normal and branched chain  $\text{C}_1\text{-C}_5$  compounds has been completed and shown to give good to excellent yields. Thus, formic, acetic and propionic acids can be reduced in 80-95 percent yields to the corresponding alcohol and the higher molecules in 60-70 percent yields. This method has proved satisfactory for preparing methyl iodide in high purity.

High specific activity preparations of the following compounds have been carried out in the past month. Yields based on  $\text{CO}_2$  and quantity of radioactivity handled are indicated in parentheses: sodium propionate- $2\text{-C}^{14}$  (30 mc., 42.7 percent); sodium butyrate- $2\text{-C}^{14}$  (40 mc., 57.2 percent); sodium formate- $\text{C}^{14}$  (128 mc., 85-91 percent); methyl iodide- $\text{C}^{14}$  (28 mc., 68 percent); sodium isobutyrate- $1\text{-C}^{14}$  (15 mc., 95 percent). As intermediates in these preparations, high specific activity preparations have been made of propyl iodide- $1\text{-C}^{14}$  and ethyl iodide- $1\text{-C}^{14}$ . Other compounds whose syntheses have been studied include: cyclohexanone- $2\text{-C}^{14}$ , valine- $1\text{-C}^{14}$ , succinic acid- $1$  or  $2\text{-C}^{14}$ , aspartic acid- $1$  or  $2\text{-C}^{14}$ , ethylene glycol- $1,2\text{-C}^{14}$ , ethyl chloroacetate- $1$  or  $2\text{-C}^{14}$ , and vinyl acetic acid- $1\text{-C}^{14}$ .

Work was continued on the purification of labeled glucose and mannose made by the cyanhydrin method. By the use of a recording refractometer, elution

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curves are being analyzed from various absorbing substances. Employing this same equipment, tentative separations have been made of co-enzymes on ion exchange resins using displacement with citric acid.

In the studies on the isotope effects involved in the use of  $C^{14}$ , the decomposition of oxalic acid has been carried out at  $100^{\circ}$ ,  $80^{\circ}$ ,  $60^{\circ}$  and  $40^{\circ}C$ . Labeled naphthalene and malonic esters have been prepared to study the magnitude of the decarboxylation isotope effect on the free acids.

Biological Chemistry. Procedures have been worked out for the paper chromatography of the steroids, cholesterol and cholestenone. These compounds can now be separated on Quilon impregnated paper using as the elution solvent, simple primary alcohols with or without water. In cooperation with the Medical Physics Department, the feeding of octadecyl alcohol and cholesterol in rabbits has continued. It has been found that these compounds are capable of giving an increase in the  $S_{F}^{13}$  factor of blood. Other feeding experiments are being contemplated.

The separation of the components of egg yolks is being studied in preparation for the isolation of the various labeled products from radioactive eggs obtained by feeding labeled sodium acetate to a hen.

Work on the metabolism of labeled purines has continued. Adenine-4,6- $C^{14}$  and 8-aza-adenine-4,6- $C^{14}$  have been injected in mice and after 24 to 48 hours the animals were sacrificed and dissected. The organs were examined for total activity and identity of radioactive compounds. The liver, spleen and intestines were extracted to obtain the nucleo-protein fraction and these are being analyzed by paper chromatography. It has been found that for adenine the radioactive products are different from the injected compound.

It has been found (Medical Physics Division) that when stilbamidine- $C^{14}$  is injected in normal and tumor-bearing mice there is a marked difference in the liver uptake of radioactivity and fecal and urinary excretion of the radioactivity. In particular, the  $C^{14}$  is concentrated and retained in the liver of cancerous mice. Experiments have been undertaken to identify the nature of the stable radiocarbon containing molecules present in the liver of these tumor-bearing mice. It is suspected that it may be a complex of the stilbamidine and certain of the nucleo-proteins.

Photosynthesis Chemistry. The chemical processes comprising those of  $CO_2$  reduction in all plants appear to have similar initial steps and intermediates. The more complex products vary considerably in the various higher plants and micro-organisms. The work of this laboratory is directed towards elucidation of these primary processes common to all photosynthetic organisms.

The phosphorylated compounds, precursors to sucrose on polysaccharide synthesis, are being separated and identified in several ways. Improved methods with pre-washed papers are being developed to allow separation of compounds which had not been resolved previously by paper chromatography. Enzymatic hydrolysis of these compounds is in progress and should allow their identification with known compounds. It is known that these are phosphates of glucose, fructose, trioses and an unknown dimeric low-molecular weight hydroxy carboxyl compound.

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Ion exchange separations are being continued with phosphatase hydrolysis, phosphate analysis, fructose analysis and two-dimensional chromatography as aids to identification of the observed peaks.  $C^{14}$ -labeled photosynthetic phosphates have been successfully separated. A small amount of carrier compounds is essential to prevent adsorption. Several unknown compounds isolated from classical preparations are being studied.

Since experiments with soy bean leaves have been reported at variance with results of this laboratory, they have been repeated here. We have found soy leaves similar to other leaves in that they form little alanine in steady state photosynthesis, form malic and aspartic acids and have a higher specific activity in the fructose than in the glucose moiety of sucrose.

Short steady state experiments with Scenedesmus have been performed to determine the prime relationships of phosphoglyceric acid and phosphopyruvate.

It has been found that serine and glycine are the major products of dark labeled glycolate assimilation by Scenedesmus. The serine/glycine ratio has been observed to increase markedly in the light. This serine is being purified prior to its chemical degradation.

Phosphoglycerate from  $C^{14}$  formate fed Scenedesmus has been degraded and found labeled similar to that observed in  $C^{14}O_2$  assimilation in similar times by the same organism.

The assimilation of formaldehyde, ethanol and acetate by plants is under investigation.

### Chemistry

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#### Part C

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

1. Liquid metal systems and heats of formation of intermetallic compounds.
2. Theory of refractory behavior.
3. Thermal conductivity of gases.
4. Measure and study of heat transfer coefficients in forced convection film boiling.

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

1. The chelate complex of lanthanum with TTA work has been completed.
2. Thermodynamic studies on rhenium.
3.  $Fe^{3+}$ - $Fe^{2+}$  electron exchange rate.
4. The thermochemistry of germanium (II).

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10. Medical Physics

## Part A

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Tracer Studies. Exposure of rats to tantalum aerosols are being continued. The fate of carrier-free tantalum solutions are being studied in rats following intramuscular administration.

Metabolic studies upon the fate of terbium are being continued in rats. Alteration of sodium space following irradiation has been measured in rats for 1 to 9 days.

Decontamination and Bone Metabolism Studies. (a) Effect of low phosphorus diet on removal of radiocalcium and radiostrontium. Young 21 day old rats were injected with radiocalcium intraperitoneally. The controls, fed a complete diet from this time of weaning, showed an initial retention of over 95 percent of the dose in the skeleton. At the end of six weeks, 5.9 percent of the dose had been excreted in urine, and the biological half-life of the radiocalcium (determined on semilog paper) was 680 days. However, when the rats were fed a phosphorus deficient diet (0.015 percent P) from the time of injection of radiocalcium, the urinary excretion of the isotope was 10-20 times as great as in the controls, with over 58 percent of the dose eliminated in the first 6 weeks. The biological half-life of the radiocalcium in these animals was only 41 days, and the skeleton contained only 21.9 percent of the dose compared to 72.0 percent in the controls. These experiments indicate that the most recently deposited calcium is removed first during the negative calcium balance associated with developing rickets in these animals.

Similar results were obtained with radiostrontium, although the differences were not so great. At 2 weeks, the urinary excretion of radiostrontium in the animals on the low phosphorus diet was over 5 times that in the controls.

These experiments suggest a practical procedure for decontamination of these radioisotopes.

(b) Radiofluorine experiments. Experiments with  $F^{18}$  show that this isotope is rapidly absorbed from the gut (over 70 percent in the first hour) in the rat, and is distributed in soft tissues and skeleton. Radioautographs show a concentration of the  $F^{18}$  in the growing epiphyses of young rats, and in the growing roots of the incisor teeth. These experiments indicate that fluorine is normally deposited with new bone mineral.

Chelating Studies. Studies on the effect of chelating agents on the excretion of  $Pu^{239}$  in rats have reached the assay stage. An increase in the urinary excretion of  $Pu^{239}$  by the use of ethylenediamine tetracetic acid by a factor of 60 over the controls in the first 3 days after the administration of the  $Pu^{239}$ , was noted. At 50 days, Fe-3 administered to the animals resulted in a 15 fold increase in urinary excretion over the control animals.

Further in vitro screening tests for complexing agents for beryllium have turned up another good complexing agent, namely saccharic acid. In vivo studies to determine the effect of various chelating agents on urinary excretion of Fe and Mn are being set up.

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Histology and Radioautography. In collaboration with C. A. Tobias and John Beukema, a gross and microscopic study of biological effects of roentgen and deuteron irradiation of the epiphyses of the skeleton of growing rats is nearing completion. Among the findings, a noteworthy one is that following arrest of bony growth at an irradiated epiphyseal cartilage plate, this plate remains inactive for long periods and becomes walled off by bone; a new, additional epiphyseal plate may then be established and growth then becomes resurgent through active bone formation in the new area. The bones are thus abnormal in their possession of two epiphyseal plates.

In collaboration with C. H. Li, D. H. Copp, and Frank Ulrich, a study was made of the growth inhibition attendant upon injection of adrenocorticotrophic hormone in normal and hypophysectomized male rats. A tracer dose of  $\text{Ca}^{45}$  was injected 1 hour before autopsy and its distribution in blood, bone and excreta is being determined and correlated with data on retarded growth, the x-ray evidence of osteoporosis, radioautographs of bone, and histologic evidences of inactive osteogenesis in these same animals.

Radiochemistry. Carrier-free procedures have been developed for the isolation of  $\text{Ti}^{51}$  and  $\text{Cr}^{51}$  from deuteron bombarded vanadium.  $\text{Ta}^{176,177}$  has been isolated in the carrier-free state from a hafnium target using a previously reported procedure. A radio colloidal procedure has been worked out for the isolation of carrier-free radio-scandium produced by deuteron bombardment of titanium. Astatine production has continued.

Medical PhysicsUNCLASSIFIED

## Part B

Metabolism of Carbon<sup>14</sup> Labeled Glycine. Analysis of the breath excretion of Carbon<sup>14</sup> of the first three patients shows: 84 - 92 percent excretion in the breath, approximately 5 percent in the urine, and a small amount in the feces. The red cell life of Patient 1 is found to be approximately 115 days; of Patient 2 about 110 days. Patient 3 will probably show a short red cell life of about 80 days.

Carbon<sup>14</sup> Labeled Stilbamidine. Further results have been analyzed in the experiment in which carbon<sup>14</sup> labeled stilbamidine was given to a patient with multiple myeloma. Twenty percent of the amount injected was excreted by the urine during his three months of life following administration, and 10 - 12 percent was excreted by the feces. Several more tissues are yet to be analyzed.

More results have been obtained which further substantiate the observation that the carbon<sup>14</sup> labeled stilbamidine concentrates in larger amounts in the livers of mice with neoplasms than in the livers of normal mice. It now appears that mice implanted with melanomas develop smaller liver concentrations than mice with certain other neoplasms. More controls are being obtained since the present control series is not adequate.

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Endocrine Influence on Iron Turnover. Investigations are being started on the endocrine influence on iron turnover. Four groups of forty rats have been started on a special regime. Group I serves as controls; Group 2 is hypophysectomized; Group 3, hypophysectomized, receives twice daily injections of adrenocorticotrophic hormone; Group 4, normal, receives the same dose of adrenocorticotrophic hormone. The rats have been on this schedule for 2 weeks. At approximately 3 weeks the iron turnover studies will be carried out. Half of all the groups will be studied for several months from the standpoint of excretion of iron.

Regional Circulation. Work has been started with the Department of Experimental Surgery on a problem to test the effect of portal-caval anastomoses on the liver circulation.

In these experiments the portal vein has been joined to the inferior vena cava by a side to side anastomosis. The section of the portal vein located between the anastomosis and the liver has been subjected to varying degrees of constriction in an effort to divert varying quantities of blood away from the liver.

Preliminary results indicate that the liver usually gets more blood than would be anticipated by the degree of constriction applied. Normal liver blood flows vary considerably, so that conclusions must await complete compilation of the data.

A problem has been started in conjunction with Dr. S. W. Hoobler at the University of Michigan. Hepatic vein catheterizations are performed to measure the efficiency of the human liver for chromic phosphate phagocytosis.

Preliminary results indicate that the efficiency varies from about 60 percent to 98 percent, or almost complete clearance.

Bacteriology. When *E. Coli* is irradiated with deuterons and with alpha particles of high and low energy, the apparent target size for lethality increases with decrease in energy of the bombarding particles. This result is in conflict with the simple target theory which predicts greater efficiency for the high energy particles, and necessitates a modification in the picture of the mechanisms of lethal action. A spread of effect of an ionization; i.e., an energy transfer from the site of ionization, which increases with the ion density and which kills the cell according to conceptions of target hypothesis, seems to explain the phenomenon.

Hematology. Double nucleated lymphocytes. The incidence of double nucleated blood cells in Strain A mice given 250 rep total body doses of 190 Mev deuterons, is lower than the incidence previously found with 100 rep doses of deuterons and protons. These studies as well as parallel studies with x-rays are continuing. Three Curtiss-Dunning rats have been kept in the 184-in. cyclotron building for a period of six months. Smears have been made to determine the incidence of double nucleated lymphocytes in their peripheral blood during normal operation times, and after reversal of the beam put them in an area of relatively high flux of neutrons. Only one double nucleated cell was found out of 21,000 leucocytes counted. This is suggestive evidence that low dose rate of neutrons does not produce double nucleated lymphocytes in this strain of laboratory rat.

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11. Health Physics and ChemistryFOR OFFICIAL  
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Shielding for the 184-inch Cyclotron. The construction and installation of the new and larger deflected beam "cave" for the 184-in. cyclotron presented a variation in the radiation field. It was found that upon operation of a maximum sized deflected beam in the cave in the absence of roof blocks that the fast neutron field in the south end of the building reached above tolerance levels. This was particularly so if measurements were made at elevations above ground floor levels such as in the mezzanine floor offices and roofs thereof. Fast neutron intensities in these latter regions were particularly high reaching to four and five times tolerance levels. Installation of the roof blocks over the cave area, however, was found to satisfactorily depress the neutron intensity to values within the permissible range. These measurements were made with the hydrogen recoil proportional counter system.

Projects completed by the Research and Development Group. The activities of the Research and Development Group are summarized as follows:

1. The sample from the Chalk River reactor was received and successfully processed in a lead-shielded, remotely operated cutting box, a two-inch lead cave containing dissolving, centrifuging, heating and column units, an automatic sampler, etc., and auxiliary gloved boxes.
2. Equipment was readied for use in the Chalk River run (see No.1 above) for use in October. This is partially complete.
3. Further improvements were made on equipment for the dissolver-solution processing group. Some units were completed.
4. Equipment for the magnetic susceptibility measurement experiments was completed.
5. Drawings for boxes for proton bombardment of uranium are being done.
6. An improved small sampler for use with columns in gloved boxes and lead caves is complete.
7. Four Berkeley boxes, including three special types, have been completed.

Sixty-seven drums, two gloved boxes, 5 packages, fifteen old gas cylinders and two kilograms of sodium-potassium alloys were disposed of at sea during this period.

12. Plant and EquipmentFOR OFFICIAL  
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Bevatron. The building is approximately 96 percent complete. The electrical fixtures are being hung in the magnet room; the heating plant for the shop and office wing has been installed; the painter has about three more weeks work; and the paving in the upper parking lot is complete. Magnet steel is being delivered to the building and stored between the magnet foundation walls. The

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switchgear is being connected in the switchgear room by the erection contractor. About 30 percent of the wiring raceway gallery steel has been delivered and set in place in the building. Motor generator bed plate on the west foundation is being installed.

Construction of Cafeteria. The cafeteria is complete and in operation. Design and landscaping is in progress.

Construction of Animal House. Architects' working drawings are almost complete. Mechanical design is in progress.

Construction of Sheetmetal and Salvage Shop. Cost estimates have been prepared and approval of site by the University is pending.

Radiological Laboratory at the University of California Medical School. The excavation is about 85 percent complete.

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

Measurements Project. Development and Design continuing.

Miscellaneous Construction. Power Distribution. Work on the associated power extensions is continuing.

Fire Protection. All work contemplated in the F. Y. 1950 budget has been completed. Work reported in the future will be new items provided in the F. Y. 1951 budget.

Security Fence. The security fencing presently scheduled for the Bevatron area has been completed.

Alterations to Synchrotron Building. Construction of the counting room in the synchrotron building is approximately 85 percent complete.

Cyclotron Improvements. Motor generator house for the increased magnet excitation is 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 getting under way.

Roads and Parking Areas. Paving of the open storage area has been completed.

## MAN-MONTHS EFFORT REPORT

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PROGRAM	SUBDIVISION	Scientific Personnel	
		MAN-MONTHS EFFORT	COMMENTS
184-inch Cyclotron	Operation	13.9	
Synchrotron	Operation	8.3	
Linear Accelerator	Linear Accelerator - General	8.9	
	Van de Graaff - General	8.6	
	Development	--	
Bevatron	Building	--	
	Injector	--	
	Magnet	2.2	
	Vacuum System	--	
	Miscellaneous	.1	
Experimental Physics	Cloud Chamber	11.0	
	Film Program	20.5	
	Neutron-proton Scattering	--	
	Proton-proton Scattering	.5	
	Absolute Cross Section Measurements	.3	
	General Physics Research	7.7	
	Meson Experiments with Synchrotron	.5	
	Scintillation Counters - Research Experiments	1.6	
	Pair Counter Experiments	10.1	
	Particle Momentum and Energy Analysis	1.5	
	Proton Elastic Scattering	.8	
	Meson Counting at the Synchrotron	1.9	
	Preparation of Liquid Targets	1.4	
	Instruments for General Use	1.9	
Special Development	11.9		
Theoretical Physics	Bevatron	.9	
	General Physics Research	16.6	
Isotope Separation	Nier Spectrometer	.5	
Radioactivity Physics	General	3.6	
	Crystal Program	.4	
Chemistry, Part A	Chemistry of Transuranic Elements	8.9	
	Nuclear Properties of Transuranium Elements	9.0	
	Transmutations with the 184-in. Cyclotron	21.2	
	Analytical and Service	16.3	
	Process Chemistry	12.2	
	Special Chemistry Development	1.0	

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PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
Chemistry, Part B	Experimental and Synthetic Chemistry	5.4	
	Biological Chemistry	5.9	
	Photosynthesis Chemistry	6.1	
Chemistry, Part C	Metals and High Temperature Thermodynamics	2.5	
	Basic Chemistry, including Metal Chelates	6.0	
	General	2.5	
Biology and Medicine, Part A	Metabolism of Plutonium and Allied Materials	10.0	
	Decontamination Studies	6.0	
	Radiochemistry	4.0	
	Radioautography	2.0	
Biology and Medicine, Part B	Tumor Metabolism	.9	1.0 Consultant Man-Months
	Special X-Ray Studies, Radioactive Measurements, etc.	7.0	3.4
	Radioactive Carbon Studies	2.6	.3
	Fundamental Medical Research	8.7	2.8
	Hematology	.3	.2
	Medical Work with the 184-in. Cyclotron	1.3	-
	Fly Genetics	3.2	-
	60-in. Cyclotron Bombardments	.3	-
	Chemistry, Physical	5.6	1.0
	Specific Irradiation	4.0	-
	Donner Animal Colony Expense	2.1	1.5
Atherosclerosis Program	14.3	8.9	
Radioactive Iron Studies	2.8	.4	
Biology and Medicine, Part C	Synthetic and Experimental Organic Chemistry	19.6	
Health Chemistry, Physics	Monitoring and Disposal	8.2	
	Research and Development	19.3	
	Film Badge Program	4.8	
	Medical Examination Time	1.5	
Measurements Project Development	General	6.7	
M.T.A. Project	Design and Development	25.9	

FOR THE YEAR  
1950

GENERAL INFORMATION  
PERSONAL INFORMATION  
FINANCIAL INFORMATION

1. Name (Last, First, Middle)  
 2. Date of Birth  
 3. Social Security Number  
 4. Present Address  
 5. Previous Addresses  
 6. Education  
 7. Employment History  
 8. Income  
 9. Assets  
 10. Liabilities  
 11. Other Information

**DECLASSIFIED**  
**CR1**

1. Name  
2. Date of Birth  
3. Social Security Number  
4. Present Address  
5. Previous Addresses  
6. Education  
7. Employment History  
8. Income  
9. Assets  
10. Liabilities  
11. Other Information

12. Signature  
 13. Date  
 14. Remarks  
 15. Other Information