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# Radiation Laboratory

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PROGRESS REPORT No.68

November 15 to December 15, 1948

Special Review of Declassified Reports
Authorized by USDOE JK Bratton
Unclassified TWX P182206Z May 79

REPORT PROPERLY DECLASSIFIED

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Berkeley, California

UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

November 15 to December 15, 1948

PROGRESS REPORT NO. 68

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## 1. 184-inch Cyclotron Operation

The cyclotron was in operation through November 21. During this time, the crew was on duty 337 hours; approximately ninety-eight percent of this time was used for research experiments.

The cyclotron was shut down on November 22 and the installation of the new proton unit was started.

## 2. 60-inch Cyclotron Operation

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The performance of the 60-inch cyclotron has been above average during this period. Operating efficiency of about 80 percent was achieved, despite the scheduling of a number of small bombardments necessitated by the shutdown of the 184-inch machine. A new ion source has increased the average alpha particle output from about 3 to 6 microamperes. A peak performance of 14 microamperes has been noted.

## 3. Synchrotron Program

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The quartz doughnut was put in place in the magnet and evacuated. Some trouble was experienced with leaks under and through the rubber boots forming the joints between doughnut sections, but these were stopped by proper choice of the kind of rubber and the sealing technique. After a good vacuum (about 0.03 microampere) was obtained, the top poles and magnet yoke were assembled. At this stage an accident occurred (lucite rod slipped in Wilson seal) which broke a quartz section; a new section was installed and the magnet reassembled.

On November 23 the first betatron beam was seen on the anthracene detector, with the magnet running at 200 volts peak and using a contractor coil. The compensation at this time consisted of the slab coils, the radial compensating wires described in the preceding report, and a set of 8 manually adjustable quadrant coils made by using properly chosen groups of the radial wires. The manual adjustments were used to maximize the beam, and the magnet voltage was raised gradually. At about 1 kilovolt the contractor coil became unnecessary. Later the voltage was raised to 16 kv without loss of the beam. The slab coil corrections and the special radial wire corrections were found to be superfluous, since the manually adjustable coils seemed able to do the whole job, and therefore they were disconnected. Adjustments of the n-coils (turns in gap parallel to orbit) were useful but not critical.

The next step was to put in the rf cavity section. Then on December 14 the first synchrotron beam was seen on the anthracene detector, using a short rf pulse. The magnetic effect of the cavity could be compensated equally well by specially applied leading current over the cavity or lagging current over the opposite side of the doughnut, or by the manually adjusted coils alone; the latter method is now used. Finally, to anticipate by a day the next report, 120 Mev x-rays from the synchrotron were seen on December 16; details will be given in a later report.

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## 4. Linear Accelerator and Van de Graaff Operation

Van de Graaff Generator. Following the disassembly and cleaning of the Van de Graaff accelerating tube mentioned in previous reports, the voltage was worked up very gradually in order to avoid any danger of damage to the tube. A Zeus meter monitoring radiation from the tube served to indicate the safe operating level. On November 30, a 4-million-volt beam was attained again, although it was somewhat smaller then the best beams obtained previously due to "softness" of the accelerating tube and poor alignment of the ion source and accelerating tube system. A beam was available from November 30 to December 10, when better alignment of the overall system was undertaken.

Linear Accelerator. The linear accelerator was used for 32 Mev bombardments during the period December 1 to December 10. Most of the beam time was devoted to p-p scattering.

## 5. Experimental Physics

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Film Program. A study of the energy distribution of mesons at the full energy of the bombarding alpha particles has been begun. Photographic plates have been simultaneously exposed within the cyclotron at the following distances from the carbon target: 1 to 4, 4 to 7, 7 to 10, and 10 to 13 inches, corresponding respectively to meson energies (at normal incidence to the plates) of 0.7 to 2, 2 to 5, 5 to 9, and 9 to 14 Mev. To date the plates in the 4 to 7 inch position and in the 7 to 10 inch position have been studied.

An experiment is underway to determine the range-energy relationship of protons from the linear accelerator in Ilford C-2 emulsions. This information is desired in order to verify the theoretically-extrapolated relationship that has been used thus far in determining meson masses.

Cloud Chamber. The cloud chamber group has been measuring the proton and deuteron tracks from the run made last month before the cyclotron was shut down. A third and improved projector has been set up for making measurements. The Helmholtz coils and auxiliary equipment have been moved to the synchrotron building and a cloud chamber is operating there in anticipation of the high energy x-ray beam that is expected soon.

Application of Scintillation Counting to $\gamma$ Detection. The coincidence scintillation counter using anthracene was tested at Donner Laboratory using Co60 and I 131 gamma sources and it was found that with a given sample the scintillation counter gave from 8 to 10 times as many counts as could be obtained with a thick walled geiger counter. Efforts are being made to further reduce the background counts produced by the photo-multipliers and thus increase the sensitivity of the instrument so that it can be used to detect low energy beta rays. Among the possibilities considered were operating the photo-multiplier tubes in a weak magnetic field, use of various types of coincidence circuits, and cooling to dry ice temperature. Measures which are thought most likely to produce immediate good results are the use of an improved coincidence circuit of a conventional vacuum tube type with provision for cooling to dry ice temperature if necessary. A piece of equipment incorporating these features is nearing completion.

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High Energy $\gamma$ Rays. The cyclotron shut-down has limited this program to the necessary jobs of careful evaluation of the effects of electron scattering in the radiator, absorber, and counter walls.

Designs have been developed and construction begun on a more elaborate pair counter involving five energy intervals, eight proportional counters, and a coincidence circuit with nine four-channel mixers.

Scattering of High Energy Neutrons. The results of a number of measurements of angular distributions and total cross sections have been calculated together with their errors and the material has been summarized in tabular and graphical form. Estimates of the elastic scattering cross sections of Al, Cu, Ag, and Pb made by integration of the angular distribution curves give surprisingly high values. For both the carbon detector and the recoil counter measurements, the elastic scattering cross sections appear to be about 85 percent of the total cross sections.

Scintillation Counter Research. The most interesting development centers around the successful test of a new coincidence arrangement between photomultiplier tubes, in which the pulse from one tube is used directly to gate the second tube. One stage of the second tube is operated at reduced voltage, just below the multiplication threshold. A relatively small pulse from the first tube will then "trigger" the second, so that if a pulse is passing through it the pulse can reach the signal electrode and be counted.

The noise level of this arrangement is exceptionally low even at room temperature. Estimates of resolution time are in the range $10^{-8}$ to $10^{-9}$ sec, which permits very high sensitivity. In fact, with a test gamma source it was possible to show a "plateau", in which essentially every Compton scattering event in a crystal being observed by the photomultipliers was being counted.

An effort was also made to measure the emission time of trans-stilbene. It was established that this figure is less than .004 microseconds, the limit of the method employed. The use of the above coincidence method with this material augurs well for a practical transit-time measuring device.

Instrumentation. A 10 channel pulse analyser is now under construction. It is planned to use it mainly for scattering experiments on the 184-inch cyclotron but it will have considerable flexibility and be adaptable to other uses.

A differential chamber for studying fission in a deuteron or proton beam has also been designed and is under construction.

## 6. Theoretical Physics

On a model which takes into account collisions between nucleons in the nucleus, and thus gives higher momenta than the Fermi-Thomas model, it is possible to explain the deuteron production under neutron bombardment in terms of the picking up of a proton by the passing neutron. The total scattering cross section measurements have been explained in terms of a mean free path of $5 \times 10^{-13}$cm for 110 Mev neutrons in the nucleus (a value deduced from the n-p scattering cross section) and a nuclear radius $R = 1.4A^{1/3} \times 10^{-13}$ cm. Considerable progress has been made in developing the theory of scattering at low energies. The effects of resonances in the dynamics of particles in the bevatron are being investigated.

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## 7. Isotope Separation and Analysis Programs

Cyclorator Development. The development of the cyclorator employing Z-component modulation has continued. Preliminary work was concerned with spot focussing the beam at the receiver, the beam spot being, of course, sufficiently focussed across the magnetic field while efforts were made to decrease the length of the beam parallel to the field. This Z-focussing was attempted by appropriate curvature of the source slits. Results indicated some focussing. If, however, straight slits were used, and baffles were placed in the C slit so that the emergent beam was 1-1/2 inches long in the Z direction, about 2/3 of the beam could be collected on a 1-1/2 inch receiver. Using this arrangement a d.c. voltage was then applied between the halves of the G-slit and the observed Z-deflection was determined to be in good agreement with that computed.

Radio frequency voltage was then applied to the G slit. It was anticipated that in this case the use of a split G slit would introduce undesirable energy modulation of the beam along with Z-modulation. The system has been designed to minimize such energy modulation and it is believed that a separation run can be made with approximately the present design. Since the effect of energy modulation is to increase the effective energy width of the beam, defocuss the beam as a function of deflection, and to introduce undesirable phase discrepancies at the receiver, it is considered that it will be necessary to use a different system of Z-modulation ultimately.

Curves of collected beam current versus voltage bias were taken with no rf, with rf on the G only, and finally with rf on both G slit and receiver. By this means the energy modulation of the beam was determined and was considerably less than anticipated. The modulation of the beam was observed on an oscilloscope connected to the receiver with rf only on the G slit. The modulation could be made very good by adjusting the various controls and as very rough computation indicated that the modulation was nearly 100 percent. With rf applied to both G slit and receiver, curves of collected current versus magnetic field and frequency were obtained. Although the modulated beams have been small to date the evidence is very good that it is possible to Z modulate the beam in the manner described. The best data to date show a 90 percent modulation for a beam of 1 ma. It is planned to attempt to increase the modulated current by several fold and then try a separation run.

Nier Spectrometer. A new divider network, incorporating wire wound elements throughout, was constructed and installed. In conjunction with the new magnetic sweep circuit greater stability of operation has been obtained. A magnetic field control has been designed and tested which introduces greater flexibility and stability than the former controls. Features of the design are a 50 to 1 variation in the speed control, reversible direction of sweep, and extremely fine steps in varying the magnet current.

To facilitate adjustment of the mass spectrograph for optimum resolution, tests have been carried out on a high speed sweep of the high voltage circuit. A continuous pattern of a mass peak may thus be maintained on the screen of the oscillograph and thereby no effect of any adjustment be immediately ascertained. Due to the inherent long time constants in the high voltage circuit, a 60 cycle sweep did not prove satisfactory but a sweep of 1 cycle per second produced a usable pattern on the screen. Further tests are being made to improve this circuit.

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A vernier circuit has been designed for detecting fluctuations in the high voltage and the magnet current. A potentiometer circuit is utilized to compare the voltage drop across a resistor in the high voltage circuit, or magnet current circuit, with that of a standard, the difference in voltage being measured with a 10 millivolt Leeds and Northrop Speedomax recorder. A sensitivity of 1 millivolt per volt over a range of 0 to 3000 volts is obtained in the high voltage vernier, while a sensitivity of 5 millivolts per milliampere over a range of 0 to 400 milliamperes is obtained in the magnet current vernier.

Samples of $UF_6$ were analyzed to determine the best method of handling such samples in the mass spectrograph. No satisfactory data was obtained due to poor resolution in the mass spectrograph and impurities in the samples available.

## 8. Chemistry

### Part A

Collateral Decay Series. Some new data have been obtained on the radioactive properties of the short-lived members of the several new collateral radioactive series. Certain revisions and new measurements on half lives are as follows: $Ac^{224}$ 2.9 ± 0.2 hr, $At^{216} \sim 3 \times 10^{-4}$ sec, $Ac^{223}$ 2.2 ± 0.1 min, $Fr^{219}$ 0.02 sec, $Ra^{221}$ 31 ± 1.5 sec, $Em^{217} \sim 10^{-3}$ sec, $U^{228}$ 9.3 min. Most of the isotopes in these series are on the neutron deficient side of beta stability and presumably decay by electron capture as well as by alpha-emission. The electron capture-alpha decay branching has been determined for a few of these as follows: $Ac^{223}$ $K/\alpha = 0.001$, $U^{229}$ $K/\alpha = 5$, $Th^{225}$ $K/\alpha = 0.1$. The electron capture branching of $Ac^{223}$ was obtained from the growth of $AcX^{223}$, that of $U^{229}$ by the growth of $Pa^{229}$ and that of $Th^{225}$ by the growth of $Ac^{225}$.

Neutron Deficient Isotopes in the Region of Bismuth and Lead. Four new alpha emitting isotopes of bismuth have been previously reported. Little was known regarding their mass numbers other than that they were below mass number 203. An attempt has been made to locate their mass numbers by observing the lead and thallium daughters which arise through the electron capture branching of these activities. A series of experiments have been carried out in which successive removal of lead and thallium from the bismuth fraction permits tentative assignments as shown in the following table. Since these activities cannot be prepared singly, the various fractions obtained are quite complex and resolution is difficult.

| | 197 | 198 | 199 | 200 | 201 | 202 | 203 |
|---|---|---|---|---|---|---|---|
| Bi | α,K(?) 1.7 min | K,α 9 min | K,α 25 min | K,α 62 min | ? | ? | ? |
| Pb | ? | K <30 min | K 70-100 min | K 18 hrs | K 8 hrs | ? long | 52 hrs |
| Tl | ? | K 1.8 hr | K 7 hrs | K 27 hrs | ? 75 hrs | ? 12 days | stable |

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Fission Cross Section with High Energy Particles. A special series of irradiations was carried out using the deflected beam of 190 Mev deuterons in such a way that the beam intensity could be accurately measured. For uranium the cross section for fission was obtained as 1.5 barns based upon the measured yield of $Ba^{140}$, assuming that its fission yield is 2 percent. This latter value was obtained from the fission of uranium with 380 Mev helium ions and a different distribution of fission products in the two cases might introduce considerable error in this assumed fission yield. The fission cross section of bismuth was found to be 0.2 barns based upon the analysis of $Mo^{99}$ with its known fission yield. This fission cross section agrees fairly closely with a value of 0.16 barns obtained by integrating the whole fission yield curve and from estimated intensity of the internal circulating deuteron beam.

Neutron Deficient Transuranium Isotopes. By irradiating plutonium with 80 Mev helium ions a very small amount of a 2.5 hour curium alpha emitter was prepared. This alpha activity has an energy of 6.50 mev and has been tentatively assigned to $Cm^{238}$.

Following the irradiation of $U^{233}$ with 15 Mev deuterons a 30 minute period in the neptunium fraction has been noted. This activity is characterized by K and L x-rays of this region, $\gamma$ rays and conversion electrons. It is possible that there is also an alpha particle of 5.5 Mev with this half life. The isotope has been tentatively assigned to $Np^{233}$ based principally upon the mode of formation and alpha decay systematics.

Absorption Spectrum of Am(III) in Solution. The absorption spectrum of americium in perchloric acid solution has been obtained using the Baird grating spectrograph. The most intense lines at about 5100 A have been previously reported.

## Chemistry

### Part B

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Synthetic and Experimental Chemistry. The synthesis of 5-20 mc. batches of eighteen $C^{14}$ labeled compounds has been undertaken. The compounds will be distributed by the Isotopes Division of the Atomic Energy Commission. Additional compounds will be added to the list from time to time as procedures for their preparation are developed in the laboratory.

Oxalacetic acid-$C^{14}$ and malic acid-$C^{14}$ have been prepared via the Claisen condensation between ethyl acetate-1-$C^{14}$ and ethyl oxalate.

Among the compounds being studied at present are alanine-3-$C^{14}$, codeine-$C^{14}$, Demerol-$C^{14}$, fumaric acid-$C^{14}$, succinic acid-$C^{14}$ (by two methods), morphine-$C^{14}$, butyric acid-1-$C^{14}$, valeric acid-1-$C^{14}$, hexanoic acid-1-$C^{14}$, propionic acid-3-$C^{14}$, (via malonic ester) and diiodo$^{131}$tyrosine.

Kharasch and Gladstone (1943) reported that the decomposition of acetyl peroxide in glacial acetic acid at 85-95° C resulted in the formation of succinic acid, methane, carbon dioxide and some methyl acetate. In order to study this mechanism, unlabeled acetyl peroxide was decomposed in glacial acetic acid labeled with $C^{14}$ in the methyl group. The preliminary results indicate that succinic acid

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comes from two molecules of acetic acid while methane, and probably carbon dioxide, come from the acetyl peroxide. The mechanism of Kharasch and Gladstone when applied to this reaction would give the same distribution of activity as were found.

Biological Chemistry. Work has continued on preliminary experiments using high specific activity stilbamidine in mice. The data indicate that the activity is excreted through the feces and urine without extensive metabolic changes as very little $C^{14}O_2$ appears in the breath. There is a high kidney uptake. The uptake of the heart is striking, being high (a factor of 5-10) not only with respect to the other body tissues but with respect to ordinary striated muscles. As the number of labeled compounds studied increases, the greater metabolic activity of the heart shows up more clearly.

A report will shortly be issued describing the work done on the fate of $C^{14}$ injected as methyl labeled glycine in "A" strain mice. It is felt that this work will serve as a basis for work on humans with $C^{14}$. The data indicate that the slow component of the turnover rate of the $C^{14}$ is the same in all tissues of the mouse, including bone and brain.

Since ~~copper~~ is a component of the enzyme responsible for the production of melanin in melanoma, an attempt was made to give radiocopper to determine the possible localization of the radiation. There was no significant difference observed in uptake of the normal and neoplastic tissue.

Photosynthetic Chemistry. Isotope Effect in Photosynthesis: In the course of kinetic studies on photosynthesizing barley seedlings it has been found that plants utilize $C^{12}O_2$ faster than $C^{14}O_2$. The concentrations of the $C^{12}O_2$ and $C^{14}O_2$ were measured by continuous reading instruments.

As a further check, a 200 mg. "Isotope Farm" was grown from a 2 mg. inoculum in a large quantity of dilute $C^{14}O_2$. When 70 percent of the carbon dioxide was used up and several phases were converted to barium carbonate, the resultant specific activities were: air phase, 99 cts/min/mg; water phase, 106 cts/min/mg; algae, 81 cts/min/mg. The large difference between the organic and inorganic phase confirms the reality of the isotope effect.

Work is continuing on characterization of the carbon dioxide-acceptor molecule, the first carbon dioxide addition compound in photosynthesis, plant respiration process, and the sugars synthesized in photosynthesis. Progress has been made on the fate of labeled pyruvate fed to plants.

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## Chemistry

### Part C. Subproject 48B

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

1. Thermodynamics of CN and $N_2$.
2. Absorption coefficients of CN and $C_2$.
3. Thermodynamics of molybdenum halides and oxides.
4. Thermodynamics of gaseous aluminum oxides.

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5. Low melting metal systems.
6. Structure of solids and gas-solid surface interactions.

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

1. The exchange of iodine atoms between iodate ion and iodine.
2. The chelate complex of lanthanum with TTA.

Engineering Development of Plutonium Separation. The following subjects are being investigated:

1. Solvent extraction using chelate process.
2. Pilot-scale synthesis of TTA.

Ore Reduction. A mictro titration method for U(VI) is being developed.

## 9. Medical Physics

Part A. Project 48A -I- RESTRICTED

The metabolism of carrier-free copper and gallium has been worked out in rats. Tracer studies on radio-yttrium, arsenic, tin, and europium are being continued. The possibilities of adapting crystal counting to biological problems are being explored.

A series of radioautograph experiments have been initiated using the costochondral junction of the rat. At this junction, calcified bone, calcified cartilage, as well as their respective coverings, periosteum, and perichondrium are present in one small section of tissue. Experiments using $Sr^{89}$ have demonstrated strontium uptake both in calcified cartilage and bone. From the degree of blackening of the autographs, it appears that calcified cartilage takes up less strontium than the bone does. The costochondral junction of phosphorus deficient rats took up very little strontium and these sections have required a much longer exposure time than the control rats, described above. The phosphorus deficient rat experiments will be completed shortly. A radioautograph experiment has been set up using element 61. The costochondral junction will be studied and at the same time callus formation on the tibia will also be studied. In the near future similar experiments will be set up with plutonium and zirconium.

Experimental studies are being conducted in the study of the effects of growth hormone upon phosphorus-deficient and/or rachitic animals, injected with radiostrontium. Calcium, phosphorus, and nitrogen balances, comparative bone uptake of strontium, and total fat and protein tissue assays are being made upon the treated animals. Decontamination studies of plutonium and yttrium by the use of zirconium citrate are continuing. Studies of blood level changes and kinetics of deposition in both osseous and soft tissues as a function of time of zirconium and yttrium are included. The assay of parathormone-treated animals previously injected with +6 plutonium and zirconium citrate is proceeding.

$At^{210}$ was separated from alpha bombarded bismuth. An isotonic solution containing approximately 25 microcuries was prepared. Decay curves show that

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long-life alpha activity contributed less than 1/40,000 of the total alpha disintegrations at the time of bombardment. Approximately two millicuries of $Cu^{64}$ and 10 millicuries of $Ga^{67}$ were isolated carrier-free from deuteron bombarded copper. Isotonic saline solutions of each were prepared for injection. About 2 microcuries of $Ta^{182}$ were separated from alpha bombarded hafnium oxide ( $\sim$ 100 $\mu$a hr).

## Medical Physics

Part B

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Laboratory investigations are being made in a number of fields. As representative of the scope of work presently carried on, there are listed below some of the various problem groups:

### Biological Effect of Cyclotron Radiations Using 190 Mev Deuterons and 380 Mev Alpha Particles.

1. Study of the specific ionization, straggling and scattering of the particles.
2. Dosimetry for protons, deuterons, and alpha particles.
3. Biological effects studied as a function of the specific ionization.
   a. Chromosomal effects studied as a function of the specific ionization.
   b. Lethal effects on B and $\frac{B}{r}$ strains of Escherichia coli.
4. Effect of deuterons and alpha particles on water.
5. Lethal effects on mice.
6. Therapeutic irradiation of mouse tumors.

### Study of Hematopoiesis.

1. The mechanism of hemoglobin synthesis using radioactive iron.
2. The effects of X-radiation on hemoglobin synthesis.
3. Transplantation of bone marrow in rats, both normal and anemic with radiation, benzene poisoning and bleeding.

### Studies of Blood Coagulation.

1. Electric resistance studies of human blood during blood clotting and clot retraction.
2. Radiation effects on blood clotting.
3. The role of calcium in blood clotting using radioactive calcium.
4. The role of cobalt in the etiology of polycythemia.

### Basic Studies on the Metabolism of $C^{14}$ Labelled Compounds.

1. Methyl labelled acetate.
2. Carboxyl labelled acetate.
3. Pyruvate methyl and carboxyl labelled.
4. Formate methyl and carboxyl labelled.
5. Propionic acid methyl and carboxyl labelled.
6. Glycine methyl and carboxyl labelled.

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7. Phenylalanine 3rd and carboxyl labelled each separately.
8. Tyrosine.
9. Glucose.
10. Carboxyl labelled lactate.

Distribution of Various Radioactive Colloids and the Physiology of Deposition.

1. Colloids concentrating in liver and spleen.
2. Colloids concentrating in bone marrow.
3. Methods of infusing colloids into the lymphatic tissues.

Neutron Activation Analysis of Tissues.

1. Methods and techniques.
2. Trace elements in human blood.
3. Trace elements in nuclear matter vs. cytoplasm in normal and neoplastic tissues.

Radiation Effects on Bacteria. Correlation of radiation sensitivity with morphology, age, strain, and conditions of irradiation using ultraviolet lights, x-rays, and deuterons (also see above).

Health Radiation Protection.

1. Systematic study on project personnel and hematological data.
2. Clinical study of patient suspected of Be poisoning.
3. Planning of the study of radiation effects on the eye.

Study of Long Range Effects of Radiation on Human Beings Treated with Radioactive Isotopes.

Studies on the Effect of Hormones on Radiation Sensitivity of Animals.

## 10. Health Physics and Chemistry

Further study of the fast-neutron component of the radiation field outside the shielding (see previous reports) has involved attempts to evaluate the effective energy of the fast neutrons. A pair of coincidence proportional counters, divided by a very thin septum of adjustable thickness, are ready to be used when the cyclotron is again operated. Preliminary estimates have been obtained by studying the counting rate of a $BF_3$ proportional counter vs. thickness of paraffin jacket - the whole enclosed by a Cd envelope. By this means the effective energy has been estimated between values of 0.5 to 2 mev in various locations.

In the past month we have extended our film badge program to cover about 30 percent more people. We are now covering 825 people with film badges. We have had reason to calibrate and run various tests on 250 I.D.L. pocket chambers model 3340. We have found that these chambers do not measure up to the manufacturer's specifications. Over a period of 8 hours all showed leakage. The majority of the chambers leak more than 30 percent of their full-scale value, and some as high as 60 percent.

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The projects currently in progress in the Research and Development Section of the Health Chemistry Division are listed below.

1. S. G. Thompson interceptor run. Two weeks of successful bombardment have been completed on the curium sample on the 60-inch cyclotron and the third week has been started. Average beam to the back plate for the first two weeks was slightly less than 5 microamperes, with a ratio of about 20:1 between back plate and interceptor.

2. Specially equipped box for Dr. Gofman's yttrium and strontium processing. The box is complete; a dry run is scheduled for December 17. The hood is to be delivered to 113 Donner December 21. The first serum preparations are to be made in it December 27.

3. Controlled atmosphere arc stand for Dr. John Conway's spectrum analysis of radioisotopes. The table for the stand is completed; the hood is about one week from completion.

4. Dr. Gofman's slow discharge syringe. A syringe for injecting around 200 lambda of yttrium 90 serum, with suitable shielding, at a constant rate, in a period to vary from 1-1/2 to 12-1/2 minutes for the total volume, is being made. The mechanical and electrical equipment is nearly complete.

5. Electronics and meter work. A second model of the new probe with a preamplifier for an alpha survey meter is being built. Experiments are under way with a coil winder to find the most efficient coil construction for use on an air sampler. The winder will also be for general use. The 250-volt regulated power supply for the air sampler is complete. Three new wooden boxes have been made to replace more of the old canvas bags holding the Mark 1 Model 40 alpha survey meters. Evaporating furnace for production of aluminum leaf tungsten foils for use in cyclotron bombardment completed and foils have been produced.

6. Stock equipment additions. Available now are 12 ball and socket finger-type manipulators, 6 double-ended-type and 3 panograph pipettors.

7. Gloved boxes. Dry box, shortened from 37" to 24", with lucite front was delivered to the XC Laboratory, and one spare of the same type was delivered to stock. Gloved boxes were equipped, delivered, and installed; one each, to Messrs. Thompson, Fink and Meinke, Bldg 5. A box for Dr. John Conway was completed and made ready for assembly. A vacuum port dry box was delivered to L. Eyring. Five automatic samplers are being assembled, while five standard centrifuges have been assembled and plastic painted.

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## APPROXIMATE DISTRIBUTION OF EFFORT

| PROGRAM | SUBDIVISION | MAN-MONTHS EFFORT | COMMENTS |
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| 2. 60-inch Cyclotron | -- | -- | Non-Project |
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| | Injection | 2.0 | |
| | Magnet Tests and Operation | 5.5 | |
| | Vacuum Chamber | -- | |
| 4. Linear Accelerator | Linear Accelerator - General | 6.5 | |
| | Van de Graaff - General | 6.1 | |
| 5. Experimental Physics | Cloud Chamber | 3.6 | |
| | Film Program | 10.5 | |
| | Ionization Chamber and Crystal Counter | 3.9 | |
| | Neutron-Proton Scattering | 1.6 | |
| | Proton-proton Scattering | 2.2 | |
| | Neutron Diffraction | -- | |
| | Meson Range and Decay Measurement | 1.6 | |
| | Absolute Cross Section Measurements | 2.2 | |
| | Neutron Half Life | 1.0 | |
| | Bevatron Design Studies | -- | |
| | General Physics Research | 6.1 | |
| | Magnetic Measuring Equipment | -- | |
| | Bevatron Magnet | -- | |
| | Bevatron 1/4 Scale Model | -- | |
| 6. Theoretical Physics | Synchrotron | -- | |
| | Bevatron | 2.6 | |
| | Cyclotron | -- | |
| | Linear Accelerator | -- | |
| | General Physics Research | 11.6 | |
| 7. Isotope Separation | Nier Spectrometer | 2.2 | |
| | Low Mass Spectrograph | .6 | |
| | XC Isotope Separation Program | 5.6 | |

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| PROGRAM | SUBDIVISION | MAN MONTHS EFFORT | COMMENTS |
|---|---|---|---|
| 8. Chemistry, Part A | Chemistry of Transuranic Elements | 6.6 | |
| | Nuclear Properties of Transuranium Elements | 3.0 | |
| | Transmutations with the 184" Cyclotron | 6.8 | |
| | Transmutations with the 60" Cyclotron | 1.0 | |
| | Analytical and Service | 14.5 | |
| Chemistry, Part B | Synthetic and Experimental Organic Chemistry | 7.8 | |
| | Biological Chemistry | 5.3 | |
| | Photosynthetic Chemistry | 5.2 | |
| Chemistry, Part C | Metals and High Temperature Thermodynamics | 3.0 | |
| | Basic Chemistry, including Metal Chelates | 1.0 | |
| | Engineering Development of Plutonium Separation | 1.5 | |
| | Ore Reduction | 1.0 | |
| | General | 3.5 | |
| 9. Medical Physics, Part A, Div. I | Metabolism of Fission Products | 11.0 | |
| | Decontamination Studies | 7.0 | |
| | Radio-Chemistry | 2.0 | |
| | Radioautography | 2.0 | |
| Medical Physics, Part B, Div. II | Uranium Research | 1.0 | .2 Consultant |
| | Tumor Metabolism | 1.3 | 1.5 Man-Months |
| | Special x-ray Studies, Radioactive Measurements, etc. | 3.6 | 3.1 |
| | Radioactive Carbon Studies | 3.1 | .7 |
| | Fundamental Medical Research | 4.2 | 2.0 |
| | Hematology | .6 | 1.1 |
| | Medical Work with 184" Cyclotron | 2.9 | 1.1 |
| | Fly Genetics | 1.0 | .3 |
| | 60" Cyclotron Bombardments | .4 | - |
| 10. Health Physics and Chemistry | Monitoring and Special Problems | 6.3 | |
| | Salvage, Decontamination, Disposal, etc. | 5.1 | |
| | Research and Development | 7.8 | |

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