

Lawrence Berkeley National Laboratory

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PROGRESS REPORT NO. 65

August 15 - September 15, 1948

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UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

August 15 - September 15, 1948

PROGRESS REPORT NO. 65

1. 184-inch Cyclotron Program

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The cyclotron was used for research experiments eighty-nine percent of the five hundred and ten hours that the crew was on duty.

Radio-frequency tests of the proton conversion unit were started this month and are now in progress. Some modifications have already been made on the unit, based on the work thus far.

2. 60-inch Cyclotron Operation

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A major part of this period was spent in repairing the instrument due to the last shutdown. Operation was resumed on August 22, but a considerable amount of adjusting was required in order to locate the beam after the frequency shift that was made. About one-third of this period was spent on productive bombardments.

3. Synchrotron Program

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The installation of 1000 radial wires mentioned in the previous progress report has been completed and the last two weeks have been devoted to measurement and compensation of the azimuthal variations in magnetic field. At present the error has been reduced from plus or minus 8 gauss to plus or minus $1\frac{1}{2}$ gauss at full excitation. This method of compensation leaves the correcting coils on the magnetic return path available for eliminating low order harmonic variations in magnetic field, which are not easy to remove with the radial wires. This latter adjustment is the equivalent of adjusting the d.c. level of various portions of the orbit to the same value. At present the sum of the variations in the first four harmonics when weighted by the proper factor has been reduced to plus or minus 0.1 gauss. Additional tests are being conducted to determine the effect on azimuthal field variations of varying the magnet excitation, the d.c. flux bar bias, moving the peaking strip off of the medium plane, and changing the resonant frequency from 60 cycles per second to 30 cycles per second. It also is planned to investigate the radial variation of field at several positions and to determine the effective change in (n) which can be made by passing currents through circumferential wires located above and below the orbit.

The segments of the quartz donut are being prepared for final assembly and vacuum testing. Considerable difficulty has been encountered with dimensional errors on most of the segments and it has been necessary to do a large amount of grinding in order that the donut will have adequate clearance when installed in the magnet. It is planned to make the first donut assembly without an rf section since it is feared that the accelerating gap may become charged and interfere with the obtaining of a betatron beam. After such a beam is obtained the rf section will be installed to determine the necessity for shielding the accelerating gap.

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4. Linear Accelerator Operation~~RESTRICTED~~

A total of 135 hours of operation were completed during the month on p-p scattering, inelastic scattering, short half-life investigations, and carbon activation.

The chief source of Van de Graaff trouble was again with the d.c. generators. Four hundred cycle alternators are on order to replace the d.c. generators. The linear accelerator tank was open for 1½ days for repairs on the tank gasket and to fix a cooling water leak.

The 4 Mev deflecting magnet operates satisfactorily. Apparatus for the neutron half life experiment is being set up beyond the magnet, and a circuit for stabilizing the position of the deflected beam has been tested.

5. Experimental Physics~~RESTRICTED~~

Film Program. An experiment is being done to measure the ratio of masses of heavy and light mesons. A plate holder is used which has two channels arranged so that light positive mesons and heavy negatives can be received simultaneously. Uncertainties in the magnetic field, which now limit the accuracy of the meson mass measurements, do not affect the present measurement because the magnetic field cancels out in the calculation of the ratio of masses. The present experiment measures the ratio of masses of heavy negative to light positive mesons. In an earlier experiment the masses of heavy negative and heavy positive mesons were found to be the same within experimental error. One object of the present investigation is to find whether the ratio of masses of light and heavy mesons is consistent with the assumption that a light particle (e.g., a neutrino) is given off when a heavy meson decays to give a light one. The ratio of masses which fits this assumption is 1.32 ± 0.04 .

In this experiment so far only two light positive mesons have been found which stop in the emulsion. Some heavy negative mesons have been found on the same plates. In order to get a preliminary result for the ratio of the masses of heavy and light mesons we have combined measurements from the two light positive mesons with measurements of the mass of the heavy negative meson made earlier with the same magnetic field. This gives a ratio of 1.36. It is hoped that we will shortly be able to give a value of the ratio which is based on measurements of more light positive mesons.

Cloud Chamber. Work has continued on the problem of measuring the energy spectrum of the delayed neutrons from O^{17} . A long run has been made from which about 300 pictures were obtained. The analysis of them is still in progress. Also, another unsuccessful attempt has been made to detect the γ - rays that are supposed to be the decay products of the neutral meson.

Range Measurements. Measurements were continued and essentially completed on the aluminum equivalent thicknesses of elements of various atomic numbers. High sensitivity statistical values were obtained for the stopping power relative to aluminum of the following materials; sulfur, phosphorous, selenium, tellurium, silicon and polyethylene. The relative stopping powers of these "non-conductors" agree fairly well with theory, the largest differences being due, it is believed, to the inability to make more uniform absorbers of these materials.

Scintillation Counters. Further work has been done on the design and testing of the so-called "standard" photomultiplier coincidence circuit. Engineering of the photomultiplier head and of the amplifier - discriminator - coincidence chassis was completed. A "pilot" channel presently in use has a measured resolution time of .2 microseconds, which is essentially that of the

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anthracene. The tremendous advantage of coincidence arrangements for the reduction of the noise level was verified; for example, at sensitivity settings normally used for gamma counting, noise counts are reduced by a factor of 10^4 .

Preliminary design of an ultra-high speed scaler was undertaken. Tests of a drastically modified scale-of-two indicate that a reliable resolution time of 0.2 microsecond, and possibly less, is attainable.

The effect of temperature changes on the sensitivity (i.e. photon efficiency) was checked and observations in substantial agreement with those made at the Naval Radiation Laboratory were obtained. Changes of 30 percent in pulse height for 10°C temperature shifts are observed. This renders the use of anthracene for accurate proportional counting quite difficult in the case of gamma and beta radiations.

Fast recoil protons show the presence of an effective plateau in the sensitivity characteristic, as predicted, so that the temperature effect is of no consequence for the measurement of penetrating particles.

P-P Scattering. Both forms of apparatus worked satisfactorily, and some data on angular distribution was obtained. More runs are needed. The neutron background is still high in the counter method. The alignment of the apparatus is the chief problem in the photographic plate method.

Inelastic Scattering. Inelastic scattering runs were made on carbon at 32 and 18 Mev, and on Al at 32 Mev. Preliminary analysis of the 18 Mev carbon run showed tracks of range corresponding to the ground level and to one excited level. The energy resolution was 0.4 Mev half width.

Short Half-Life Investigations. The 20 second activity of C^{10} was confirmed by bombarding separated B^{10} . Absorption measurements indicated roughly a 2 Mev positron from C^{10} . The 3 second activity from Ni was found in separated Ni^{58} , and has a threshold of 5 to 8 Mev; hence, it is probably Cu^{58} .

Activation Curves. Activation curves of C^{11} from boron carbide gave a threshold for the $\text{B}^{11}(\text{p},\text{n})\text{C}^{11}$ reaction of 3.0 ± 0.5 Mev.

Preliminary runs were made with foils to obtain U and Th fission activation curves under proton bombardment. Counting rates and backgrounds appear to be satisfactory.

An attempt was made to detect high energy neutrons from the linear accelerator by placing a graphite plate near the machine and later counting the C^{11} activity induced in the carbon. Counts were obtained, but the activity was too small to permit a check on half life to be sure the counts were not from impurities.

Several plates were exposed for film program measurements of the 32 Mev proton range in emulsions.

Study of Protons emitted by Targets in High Energy Neutron Beam. This program was begun during this month, and has used three cyclotron runs. A neutron energy distribution determination was made and gave agreement with previous determinations. Preliminary angle and energy distributions of protons from C, Cu, and Pb were measured.

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Search for High Energy Gamma Radiation from Cyclotron Target in Alpha Bombardment. On the supposition that neutral meson decay might exist, or that μ meson decay might yield γ photons, or that high energy photons from other sources (such as brehstrahlung) might originate in the target, a pair counter with magnetic field and coincidence counting tubes has been prepared. An initial run gave results which encourage further work.

Neutron Scattering Studies with Proton Recoil Proportional Counters. Measurement of the angular distribution of neutrons scattered from Be, C, Al, Cu, Ag, and Pb has been completed and a final summary of the results is in progress.

Apparatus is being designed for the measurement of the total cross sections and small angle differential cross sections of a large number of elements. The new detector will be a set of three, aluminum-walled proportional counters in coincidence. The new tubes are designed for a higher energy cut-off; hence a narrower energy range, lower background and better small angle geometry.

Neutron Cross Section Studies with Bi Fission Chambers. A third determination of the hydrogen total cross section was made, using pentane and carbon and the same technique as in previous runs. The results were $\sigma_H = .071 \pm .002$ b and $\sigma_C = .494 \pm .004$ b. The previous runs gave for hydrogen:

$$\begin{array}{ll} \sigma_H = .074 \pm .002 & 1) \\ \sigma_H = .073 \pm .003 & 2) \end{array}$$

Total, elastic and inelastic cross sections were measured for lead:

$$\begin{array}{l} \sigma_t = 4.46 \pm .06 \\ \sigma_e = 1.77 \pm .05 \\ \sigma_i = 2.68 \pm .05 \\ \frac{\sigma_i}{\sigma_t} = .40 \pm .01 \end{array}$$

In these measurements an "inelastic" process is by definition one in which the neutron is degraded below detection energy for the Bi fission chambers. The ratio of σ_i/σ_t is higher with fission chamber detection than with the carbon disc detectors. The production of moderately high energy neutrons by various nuclear processes would decrease the σ_i/σ_t ratio for the lower threshold carbon detectors.

A fission chamber with gold-plated electrodes has been built that presumably has a higher fission threshold than bismuth. Tests indicated the chamber would work satisfactorily at usable counting rates in the neutron beam.

6. Theoretical Physics

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Work has been started on calculations of p-p scattering at 32 Mev. The data on scattering and absorption of 90 Mev neutrons by nuclei has been interpreted in terms of a model in which nuclear matter is described by an absorption coefficient and an index of refraction. This leads to quite satisfactory account of the observed phenomena. Calculations of meson yield as a function of α -particle energy agree well with the latest observations. The reduction in the heavy meson mass to 286 electron masses is a considerable help in obtaining this agreement. Studies of beam dynamics and injection problem for the bevatron are in progress.

7. Isotope Separation Program**SECRET**

Calutron. During the period covered by this report the JA and XC program has continued development of an isotope separator using a 360° energy modulated beam. The JA equipment has been utilized to determine the principles of ion optics involved. The XC magnet and associated equipment has been nearly completed and a proto-type unit for TCl_4 designed. It is expected that operation of the XC equipment will begin late in September.

Nier Spectrometer. This instrument has been employed a portion of the time on classified work. A considerable amount of time was spent in correcting a slow recovery feature of the amplifier-recorder system. The trouble was finally found to lie in polarizability of the electrometer input resistor (10^8 ohms). Replacement of this by a resistor of different manufacture gave the proper time constant in recovery.

A germanium crystal (Hall effect) method for continuous measure of the magnetic field has been satisfactorily developed and is being installed.

8. Chemistry

Part A

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Chemistry of Transuranium and Allied Elements

Melting Point of PuF_3 . Earlier values based on discontinuity in the PuF_3 vapor pressure curve and that from direct determination gave conflicting values for the melting point of PuF_3 . This problem has been reinvestigated by observing the arrest point on the cooling curve using a 400 mg sample of pure PuF_3 in a tantalum crucible. The melting point so obtained was $1435 \pm 5^\circ\text{C}$ in agreement with one of the earlier direct determinations.

Properties of Americium Metal. Several samples of americium metal were made by reducing the trifluoride with barium. One good specimen of 355 μg gave a picnometer density of 11.9 g/cm^3 which falls in the range of values previously reported. A small pellet was flattened between steel surfaces and the metal appears to be much more malleable than plutonium as judged by the breaks along the edges. This sample of americium metal became wrinkled on standing at room temperature which is indicative of a phase transition accompanied by large volume change similar to that which is encountered with plutonium. The work on the physical properties of americium metal were done in an inert atmosphere. Upon placing the sample in air at room temperature the surface appeared to darken gradually but over a one day period there was no visible flaking or pitting.

Separation of Hafnium from Zirconium. A mixture of hafnium and zirconium in 1-2 M HClO_4 was placed on a Dowex 50 column and eluted with 6 M HCl . Columbium was also present and came off the column first, followed by the hafnium and then zirconium. The separation between hafnium and zirconium was about three times as good as the average obtained for adjacent rare earth elements under similar conditions. In this particular experiment 50 μg of each element with radioactive tracer were separated in a column 1 mm diameter by 10 cm long.

Nuclear Reactions With High Energy Particles

Light Polonium and Bismuth Isotopes. Polonium isotopes down to Po^{206} have been identified and their alpha decay energies measured. Two new isotopes with half lives 4 hours and 40

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minutes, respectively, were identified following the bombardment of lead with 380 Mev helium ions. The alpha particle energies were 5.56 ± 0.10 Mev for the 40 minute period and 5.35 ± 0.10 for the 4 hour period. Since these isotopes both have mass numbers lower than 206, these findings definitely confirm the rise in alpha decay energy with decreasing mass number suspected on the basis of the Po^{206} energy being slightly higher than that of Po^{207} . These latter two activities have alpha decay energies 5.26 ± 0.05 and 5.1 ± 0.1 , respectively. All alpha energies were obtained with the alpha particle pulse analyzer.

Better values have been obtained for the alpha energies of the short lived bismuth alpha emitters which are thought to be of mass number < 203 . The energies of these activities previously reported by mica absorption methods have been measured more accurately with the alpha particle pulse analyzer after making some changes which allowed it to tolerate a higher background of electrons. The new values obtained for the three periods are as follows:

9 minute - 5.83 Mev
 27 minute - 5.47 Mev
 1 hour - 5.15 Mev

These values also illustrate the trend toward higher alpha decay energies with decreasing mass number for the highly neutron deficient isotopes.

Collateral Decay Series Starting with Pa^{226} . A new collateral branch of the uranium series starting with Pa^{226} has been prepared by irradiating thorium with 80 Mev deuterons. The longest lived member is Pa^{226} with a 1.5 minute half life. Three other alpha groups tentatively assigned to Pa^{226} , Ac^{222} , Fr^{218} and At^{214} have been observed. It is of interest that the activity attributed to At^{214} has an alpha energy 8.74 Mev which is very close to that of the most energetic alpha transition, namely that of the decay of ThC' (Po^{212}). The four alpha emitters and their energies are as follows:

| | |
|------------|------|
| Pa^{226} | 6.54 |
| Ac^{222} | 6.94 |
| Fr^{218} | 7.81 |
| At^{214} | 8.74 |

Chemistry

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Part B

Synthetic and Experimental Chemistry. The synthesis of low-activity stilbamidine from cyanide has been completed. An overall yield of about 25 percent based on potassium cyanide was obtained with the product material having an activity of about 100,000 d/min./mg. A high-activity preparation is in progress which will produce stilbamidine with a specific activity of about 6 mc/mmole.

The synthesis of synthetic C^{14} labeled D-glucose and D-mannose has been completed.

A sample of this glucose was converted to lactic acid by *Lactobacillus casei* and the lactic acid degraded; 4.5 percent of the activity was found in the carboxyl group and the remainder in the methyl group of the lactic acid. D-mannose- $l-C^{14}$ gave lactic acid on fermentation with 3.7 percent of the activity in the carboxyl group. In an attempt to check the degradation procedure for the lactic acid, synthetic pyruvic acid labeled with C^{14} in the methyl position was degraded in a similar manner. Presumably due to over-oxidation one percent of the methyl carbon activity was found in the carboxyl group of the pyruvic acid. Thus, about 3 percent of the C-1 carbons of the glucose apparently appear in the carboxyl group of the lactic acid.

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A practical method for the synthesis of ring-labeled compounds has occupied the attention of this group for some time. A series of experiments have been recently carried out in which the possibility of a preparation using the Diels-Alder condensation was studied. Attempts to prepare acetylenedicarboxylic acid were unsuccessful although a large number of different conditions were tried. The possible formation of calcium acetylenedicarboxylate by the high temperature and high pressure carbonation of calcium carbide was also investigated, but no reaction was observed between the calcium carbide and carbon dioxide even at a temperature of 335°C and a carbon dioxide pressure of 5700 psi.

Biological Chemistry. Studies on the metabolism of C¹⁴ labeled tyrosine, dihydroxyphenylalanine (Dopa), and stilbamidine are continuing.

Photosynthetic Chemistry. A series of photosynthetic experiments with the green algae Scenedesmus have been performed with C¹⁴O₂. The experiments are conducted with algae suspensions first photosynthesizing ordinary carbon dioxide in air. After 30-60 minutes of photosynthesis to insure passage of an induction period, an aliquot of NaHC¹⁴O₃ solution is injected into the suspension and it is shaken for 5-second, 15-second, 30-second, 90-second, and 5-minute periods after which the algae are killed rapidly with acetic acid and the water soluble products which contain the radioactivity are separated by paper chromatography. In the 5-minute experiment, 35-50 percent of the fixed C¹⁴ is found in water soluble material and assumed to be protein; the other major products are fructose, glucose, and alanine. Sugar appeared in detectable quantities only after 30 seconds photosynthesis. With exposures to C¹⁴O₂ for periods of five seconds, only one major radioactive area is apparent on the chromatogram. This compound, while not yet identified, has properties similar to a P³² active compound observed earlier. Its chemical properties on ion exchange resins are similar to those of 3-phosphoglyceric acid. Further experiments, therefore, to identify the phosphorylated compounds are underway. Since a number of these compounds are apparently labile, efforts are being made to prevent their decomposition.

A series of experiments are in progress to determine the path taken by C¹⁴ which is given to photosynthesizing algae in the form of methyl-labeled pyruvate. In 5 minutes, 1 ml. of cells in 100 ml. of solution will fix approximately 80 percent of the activity given to them in the form of pyruvic acid (0.7 mmoles containing 3 μc.). About 80-90 percent of the fixed activity is water insoluble but is extractable from the cells by alcohol. Partition experiments and paper chromatographs indicate that this activity is present in fatty acids. The possible presence of sugars and amino acids in the water soluble material has been investigated, and it is found that less than 1 percent of the water soluble activity is in the form of sugar.

Chemistry

Part C. Subproject 48B

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

1. Papers for the Plutonium Project Record.
2. Thermodynamics of CN and CH.
3. Thermodynamics of gaseous molybdenum and copper halides.
4. Low melting metal alloys.
5. Refractory studies.
6. Construction of 4000° furnace.
7. Structure of solids.
8. Vapor pressure of metals.
9. Absorption coefficients of species in sun
10. Gaseous oxides and hydroxides.

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

1. Polymerization of zirconium in aqueous solution.
2. Chemistry of ruthenium.
3. Solvent extraction of lanthanum with TTA
4. Dimerization of iodic acid.

Engineering Development of Plutonium Separation. Under this heading work is being done on the following problems:

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

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9. Medical Physics

Part A. Project 48A-I

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For the past two months, Doctor C. D. Van Cleave was at this Laboratory learning radioautographic methods, at the request of the Atomic Energy Commission. He did some preliminary studies of the deposition of radio-europium in liver. The studies are not yet completed and will be reported at some later date. Ansco has recently supplied us with uncoated superay "A" emulsion for use in preparing overlaid radioautographs. This type of autograph using undecalcified bones involved many technical difficulties. Up to the present, it has not been possible to obtain satisfactory results with bone using this method. Radioautographic studies with strontium, protoactinium, and europium are being continued.

The 1 day tracer studies on samarium with carrier have been completed and a major portion of this lanthanide earth is not absorbed from the injection site. Studies involving the fate of radio-arsenic in rats with and without carrier have been completed up to 16 days. As was previously reported, the major part of the radio-arsenic administered was incorporated in the hemoglobin of the rat red blood cells. Studies involving the metabolism of protoactinium in rats are being continued. The deposition of Cb^{95} in animals in 1, 4, 16, 32, and 64 days have been completed when this radio-element is complexed with citrate. Complexing with citrate increases the relative amount of columbium absorbed from the injection site. However, the metabolism of the absorbed material is similar to that observed with uncomplexed columbium. Studies with the 254 day U^{230} following intramuscular injection have been completed. Three percent of the material administered still remains in the animals, a major portion of this being in the skeleton.

Decontamination and bone metabolism studies have been continuing. Prompt treatment with sodium citrate or zirconium citrate failed to produce the striking effects on the metabolism of radiocerium which had been observed in the case of yttrium and plutonium. Rats were given 5.5 microcuries of Ce^{144} intravenously, and immediately thereafter received 40 mg. zirconium citrate or an equivalent amount of sodium citrate intraperitoneally. Both treated groups showed a 2-4 fold increase in urinary excretion, little or no change in fecal elimination, and no significant reduction in bone retention. The effect of zirconium citrate and massive doses of parathormone on radioyttrium was also investigated. The increased urinary excretion following prompt treatment with zirconium citrate was confirmed. A smaller, but definite, increase in urinary elimination was observed when the zirconium was given 48 hours after the radio-yttrium, but this effect was not enhanced by massive doses of parathormone (500 units/rat). A parallel experiment with plutonium is now being analyzed.

No new targets have been received from the cyclotron during the past month. Work is progressing on a method for obtaining millicurie quantities of carrier-free columbium by

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remote control methods from an Oak Ridge solution of columbium and zirconium. The solution has hard beta and alpha contaminants. The alpha activity can be removed by extractions with a benzene solution of TTA. The hard beta is probably due to Ru^{106} with its Rh^{106} daughter, as reported by Oak Ridge (CNL-37, Page 97). An Oak Ridge Shipment of Y^{91} has a hard beta contaminant which has tentatively been identified as 275 day Ce^{144} with its 17 minute daughter Pr^{144} . Using Ce carrier, some activity can be separated from the yttrium. If this is allowed to stand for an hour and Pr carrier is added and separated, an activity is obtained with a half-life of approximately 16 minutes. The activity which is carried with the Ce is about 15 percent, by counts of the total activity.

Medical Physics

Part B. Project 48A-II

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Use of the High Energy Deuteron and Alpha Beams for Biological Studies. One phase of the study of chromosomal aberrations produced by the particle beams has now been finished and the data are being analyzed.

Radiation resistant (B/r) and radiation susceptible (B) strains of Escherichia coli have been irradiated by fast deuterons to study the nature of the mutations of these bacteria. Exponential survival curves were obtained.

Some simple experiments using mice were undertaken as a preliminary study of radiation effects from local irradiation. Qualitatively one might state the following preliminary results:

- a. The LD 50 (4 weeks) for mice when the beam is passed through only the abdomen is the same as the LD 50 (4 weeks) for total body radiation. The symptoms of radiation sickness remain. The blood picture, however, does not change as abruptly as with total body irradiation.
- b. The LD 50 (4 weeks) for a beam that is directed through the chest region of the mice is several times higher than to total body LD 50. The diarrhea and rapid weight loss are absent. There is, however, gradual weight loss, and the cause of the lethal effect often appears to be pulmonary hemorrhage. The blood picture changes are not as profound as with total body irradiation.

Further efforts were made for localizing the effect of the cyclotron beam in animal tumors. At the present time rats are being used. Also a survey is being made of methods of diagnostic localization of various types of tumors since it appears more and more likely that localized radiation treatment of many types of tumors would be possible if exact physical means of localization of the extent and location of the tumor were possible.

Radiation Effects on Hemoglobin Synthesis. The effect of radiations on the hemopoietic system, in particular the synthesis of hemoglobin, is being studied. Radioactive Fe^{59} is used for these studies, and white rats are the test animals. After X-irradiation of 200 r the radioactive iron appears in the newly synthesized hemoglobin at a much lower rate than in normal unirradiated controls.

Blood Conductivity Measurements. An apparatus has been perfected to study the resistance changes during blood clotting and clot retraction. Significant data as compared to normals were obtained on the subjects who had polycythemia vera and leukemia. By the use of this method, studies are being carried out to determine the effects of radiation on blood coagulation and the hemopoietic system in rabbits.

10. Health Chemistry and physics

Studies of the fast neutron content of the radiation field outside the cyclotron shielding

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are in progress. A proton recoil counter has given indication of approximately 10 neutrons/cm²sec in an energy range to which the counter is sensitive (approximately 0.5-4 mev).

BF₃ counter studies of slow neutrons have given results approximately in agreement with previously-reported measurements with indium foils, i.e., and attenuation of 10,000-50,000 in the 10 ft. shielding, and a minimum flux at about 1 ft. from the external surface.

Design is in hand for a proton recoil counter which will give a rough energy distribution of the neutrons outside the shielding.

Below are described the activities currently in progress in the Research and Development Section of the Health Chemistry Group.

- a. A specially equipped box for Dr. Gofman for processing yttrium and strontium with minimum exposure: approximately 75 percent completed.
- b. A controlled atmosphere arc stand for Dr. Conway's spectrum analysis of radioactive isotopes: parts and assembly completed, tests in progress.
- c. The decontamination chamber: tests completed on model electric motorized dolly; mockup chamber under construction.
- d. S. G. Thompson's interceptor run: the Webb 60-inch cyclotron target assembly is ready for a trial run. The actual bombardment is expected to begin within the month. Lead shielded beta-gamma gloved box is being put in final readiness.
- e. The 1-inch lead shield for the portable 1-inch lead manipulator panel is in the shop; the lead glass viewing window for the panel is completed.
- f. Strip coating study: aging tests are being continued.
- g. Conversion of Filter Queens to air testing equipment is under way.
- h. Ventilated surgeon's gloves are being improved by the insertion of a system of veins made of 3/32-inch tubing into which air is fed, resulting in much more satisfactory usage than previous models.
- i. An alarm counter for alpha-contaminated air is being built.
- j. Plywood gloved hoods: two specially equipped boxes have been assembled; five regular-type boxes readied; one box partially complete; three boxes awaiting parts previous to assembly; one existing box fitted with special equipment.

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APPROXIMATE DISTRIBUTION OF EFFORT

| PROGRAM | SUBDIVISION | MAN-MONTHS EFFORT | COMMENTS |
|-------------------------|--|-------------------|-------------|
| 1. 184-inch Cyclotron | Operation | 121.6 | |
| 2. 60-inch Cyclotron | - - - | - - | Non-Project |
| 3. Synchrotron | R.f. System | 2.6 | |
| | General | .5 | |
| | Injection | 1.8 | |
| | Miscellaneous Equipment | - | |
| | Magnet Tests and Operation | 4.7 | |
| | Vacuum Chamber | 1.0 | |
| 4. Linear Accelerator | Linear Accelerator - General | 5.8 | |
| | Van de Graaff - General | 6.0 | |
| | General, Development, etc. | 1.0 | |
| 5. Experimental Physics | Cloud Chamber | 4.3 | |
| | Film Program | 6.1 | |
| | Ionization Chamber and Crystal Counter | 5.9 | |
| | Neutron-proton Scattering | .6 | |
| | Proton-proton Scattering | 3.5 | |
| | Neutron Diffraction | .7 | |
| | Meson Range and Decay Measurement | 3.3 | |
| | Absolute Cross Section Measurements | 2.1 | |
| | Neutron Half Life | 1.0 | |
| | Cyclodrome Design Studies | .5 | |
| | General Physics Research | 11.3 | |
| | Magnetic Measuring Equipment | 1.3 | |
| | Cyclodrome Magnet | 5.9 | |
| 6. Theoretical Physics | Synchrotron | .8 | |
| | Cyclodrome | 1.2 | |
| | General Physics Research | 13.9 | |
| 7. Isotope Separation | JA Conversion | 4.4 | |
| | Nier Spectrometer | 1.6 | |



| PROGRAM | SUBDIVISION | MAN-MONTHS EFFORT | COMMENTS |
|-------------------------------------|---|-------------------|--------------------------|
| 8. Chemistry, Part A | Chemistry of Transuranium and Related Elements | 12.5 | |
| | Nuclear Properties of the Transuranium Elements | 4.0 | |
| | Transmutations with the 184 inch Cyclotron | 13.0 | |
| | Transmutations with the 60 inch Cyclotron | 1.0 | |
| | Analytical and Service | 14.0 | |
| Chemistry, Part B | Synthetic and Experimental Organic Chemistry | 6.3 | |
| | Biological Chemistry | 4.4 | |
| | Photosynthetic Chemistry | 6.0 | |
| Chemistry, Part C Project 48B | Metals and High Temperature Thermodynamics | 6.0 | |
| | Basic Chemistry, including Metal Chelates | 6.0 | |
| | Engineering Development of Plutonium Separation | 3.5 | |
| | General | 4.0 | |
| 9. Medical Physics, Part A-Div I | Metabolism of Fission Products | 10.0 | |
| | Decontamination Studies | 7.0 | |
| | Radio autography | 1.0 | |
| | Radio chemistry | 2.0 | |
| Medical Physics, Part B-Div II | Uranium Research | 4.7 | 3.0 Consultant Man-Month |
| | Tumor Metabolism | 1.3 | .5 |
| | Special x-ray studies, Radioactive Measurements, etc. | .5 | - |
| | Radioactive Carbon Studies | 2.3 | - |
| | Fundamental Medical Research | 3.4 | 1.0 |
| | Hematology | .2 | - |
| | Medical Work with 184-inch Cyclotron | 2.5 | 1.0 |
| | Fly Genetics | 4.1 | - |
| 10. Health Physics and Chemistry | Monitoring and Special Problems | 8.3 | |
| | Salvage, Decontamination, Disposal, etc. | 6.1 | |
| | Research and Development | 6.9 | |

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