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UNIVERSITY OF CALIFORNIA

Radiation Laboratory

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MONTHLY PROGRESS REPORT NO. 115

October 15, 1952 to November 15, 1952

December 2, 1952

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UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

October 15, 1952 to November 15, 1952

MONTHLY PROGRESS REPORT NO. 115*

December 2, 1952

1. BEVATRON
(A. E. C. Program No. 9500)

UNCLASSIFIED

Magnet

Magnet and magnet power supply tests were concluded on November 7. Operation of the power supply with the generators connected in series was satisfactory up to the required current of 8333 amperes and the repetition rate of 10 pulses per minute. Only a few pulses could be made at the maximum repetition rate to avoid exceeding the existing maximum demand on the University power system. Operation with the generators in parallel under the supervision of the Westinghouse engineers was not satisfactory. Westinghouse is preparing recommendations for changes that will either permit satisfactory parallel operation or make the series installation permanent. The tests of the series connection was made with temporary wiring. Tests of the magnet current measuring shunt and peaking transformer which had been modified following tests of the original design were completed.

One carload of magnet pole base plates has been received and the assembly line for cleaning the plates is ready for production. Some changes have been made in the assembly of the plate clamping fixture to provide more uniform clamping. Assembly of slabs will start when at least one of each type of plate required has been received. This date is estimated as December 10 since two more carloads of steel must be received before slab assembly can start. The top yokes will be removed from all sectors of the magnet and the completed pole base slab installed in random positions. This assembly of the magnet started on November 10.

The 1/7th scale magnet model was being tested at the end of the period. Indications were that the slope of the pole tips should be increased slightly. However, calibration runs were still to be made before this could be positively settled. The shop work on part of the pole tip die has been held up pending a decision on the final shape.

Vacuum System

The first tangent tank was received on November 7 and pump baffles and other parts were being attached at the end of the period. The top and bottom of the first quadrant tank have been assembled and attachment of the sides was to start at the end of the period. The double gasket joints are being tested by pumping between the gaskets using a helium probe on the inside edges of the joint. No great difficulty has been experienced getting tight joints.

* Previous report UCRL-2000 (No. 114).

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Injector

The new ion gun tube and high voltage assembly has been installed in the metal protecting house. The linear accelerator drift tubes have been lined up and the vacuum system is ready to start pumping with a single temporary mercury pump. The ion gun and linear accelerator will be tested in line at some distance from their final location. Installation of the power supply equipment and control wiring is proceeding but completion is not expected before the end of the year.

Controls and Instruments

The general plan of the control system has been agreed on and wiring diagrams are being prepared for most of the equipment. There will be secondary control rooms at the injector and the accelerating electrodes and in the motor generator room in addition to the main control room. The use of a PAX automatic telephone system for the building is being considered.

2. 184-INCH CYCLOTRON OPERATION UNCLASSIFIED
(A. E. C. Program No. 5741)

The cyclotron was used for research experiments approximately 92 percent of the 534 hours that the crew was on duty. The time distribution was as follows:

Operation for customers	495.25 hours	92.7 percent
Electrical troubles	4.50	0.8
Mechanical troubles	27.00	5.1
Other	7.75	1.4
Totals	<u>534.50</u>	<u>100.0</u>

3. 60-INCH CYCLOTRON OPERATION UNCLASSIFIED
(Operated by the University of California)

The operation efficiency of the 60-inch cyclotron was 75 percent during the past month. The newly installed vertical grid feelers remained in the machine during this time and performed well with proton, deuteron and alpha-particle. Difficulty was experienced with the acceleration of C⁺⁶, nonetheless. Only about one-fifth of the C⁺⁶ beam current realized with the former feelers was obtained.

4. SYNCHROTRON OPERATION UNCLASSIFIED
(A. E. C. Program No. 5731)

The synchrotron operated at high intensities this report period. The beam intensity was increased by modifying the injector geometry and optics. Tests have shown that output of individual injectors can be predicted by tests on the injectors before they are installed in the machine.

The 5 Mev linear accelerator development program has continued and beam intensity has been improved. Some physics research is planned with this 5 Mev beam during December.

5. LINEAR ACCELERATOR AND VAN DE GRAAFF OPERATION
(A. E. C. Program No. 5751) UNCLASSIFIED

A system of four electrostatic lenses employing Brookhaven strong focusing was arranged convergent-divergent, divergent-convergent to a particle in the horizontal plane, and divergent-convergent, convergent-divergent in the vertical plane. The 4 Mev Van de Graaff proton beam was sent through the unexcited 40-foot linear accelerator, and filled the 3/4 inch aperture of the lens system. Mathematical analysis had previously indicated that with 44 kv between electrodes, parallel particles in both vertical and horizontal planes should cross the axis at the same point at the end of the 20 inch long lens system. When the voltage was adjusted to 44 kv, the 3/4 inch Van de Graaff beam focussed on a disc of quartz to a point less than 1/2 mm diameter. 85 percent of the beam was being accepted and focussed as measured by a Faraday cup. Mathematical analysis shows that 100 percent of the beam in the horizontal components and 63 percent in the vertical components, or a total of 79 percent, should be accepted and focussed. The electrodes are sections of hyperbolic cylinders milled to a few mils accuracy, and spaced accurately to ± 15 mils. The axial spacing between electrodes equaled the electrode length. The copper electrodes are supported from copper cylinders by 3/4 inch long, 3/8 inch diameter steatite insulators and connected by RG-58/U cable.

Following are the operating statistics for these machines:

Running time	320 hours	75 percent
Maintenance	16	4
Repair	86	21
Totals	<u>424</u> hours	<u>100</u> percent

6. EXPERIMENTAL PHYSICS
(A. E. C. Program No. 5211) UNCLASSIFIED

Film Program

Work has continued during this period on the following projects without, in any case, obtaining final results:

- (a) π^- meson scattering in Al, Cu and Pb.
- (b) Meson mass measurements and the energy balance in pi-meson decay.
- (c) High energy electron processes in traversing matter.
- (d) Physical analysis of high energy disintegration products.
- (e) Meson spectra and plus/minus production ratios.

- (f) Measurement of high energy beta decay spectra.
- (g) Comparison of mirror disintegration of B^8 and Li^8 .
- (h) Development of meson spectrometer magnets.

Cloud Chamber

A run was made at the 184-inch cyclotron using the meson cloud chamber in the high-energy external proton beam. Two targets, aluminum and beryllium, were used to produce π -minus mesons. About 550 pictures were taken, and the film is now being read and analyzed.

A one-day run was made at the cyclotron using the ten-atmosphere cloud chamber in the 270 Mev neutron beam for the study of n-d scattering. The chamber was filled with deuterium, and a lithium-deuteride target was used. About 500 pictures were taken.

Another run was made using the same experimental setup as in the n-d scattering run, for the study of mesons produced in deuterium. Because of the long sensitive period characteristic of the ten-atmosphere chamber, up to nine beam pulses could be used in a single picture; this increased the data rate by a substantial factor. The film (about 1500 pictures) has been scanned in the stereoscopic viewer, and approximately 120 π -minus mesons have been found. They are now being reprojected and measured.

The Gamma-Gamma Coincidence Detection of Neutral Pions Produced by Protons on Beryllium

Previous work on this experiment was done with 2×10^{-8} second dead time and resolution time counting equipment. Background from the target prevented running at a beam intensity that would give reasonable counting rates. A run was made this last month with 3×10^{-9} second dead time and resolution time counting equipment. The shorter dead time equipment reduced the background from the two-inch beryllium target. For the first time the quadruple coincidence counting rate (per integrator volt) was on a plateau with respect to beam intensity. Background from the target still limits the beam intensity that can be used. The difference in the counting rates with one-fourth inch lead and five-fourths inch carbon converters is about 1.5 counts per minute at a beam intensity just below the knee of the plateau region. Considerable background reduction was obtained by using 11.3 gms/cm² of copper between the stilbene scintillation phosphors of each telescope. For photomultiplier high voltages of 1900 volts, the detection efficiency for electrons is better than that for 1700 volts by a factor of roughly three. The detection efficiency is not a violent function of the discriminator bias over a factor of about six above the feed-through bias.

Production of Tritons in Deuteron-Deuteron Collisions

The reaction $D + D \rightarrow H^3 + p$ was studied using 190 Mev deuterons in the cave. Fast pulses from stilbene scintillation counter telescopes were employed to get coincidence counts between the two outgoing particles. Range and time-of-flight methods were used to reduce the effective background. It was found quite feasible to run at full beam strength. The process was first identified by: (1) moving the triton telescope in azimuth and elevation; (2) inserting a delay of 5×10^{-9} sec. between coincidences; and (3) inserting enough absorber to just stop the postulated particle. In all cases the net counting rate substantially disappeared. Values of the differential cross section at 45° , 60° , and 90° (center-of-mass) were obtained. The cross section at 90° is approximately 10μ barns and is rising very steeply at 45° . This behavior is not unexpected if one postulates a strong pick-up process to dominate the cross section mechanism.

Further Study π Meson Orbits at the 184-inch Cyclotron

In the last Monthly Report the detection of an available flux of negative π mesons just outside the tank wall of the 184-inch cyclotron was described. The orbits observed appeared to be in rough agreement with those calculated by Barkas and Rankin at an earlier date. Before certain experiments could be performed, however, it was deemed necessary to explore the meson trajectories for various energies and various angles of emission by means of the flexible wire technique. The results of this exploration indicated that the present features of the target support and the thin window for emergence of the mesons allow an energy region extending from about 60 Mev up to the upper energy limit of the mesons created to emerge. In the region of 70 Mev there is a quasi-focusing of the trajectories so as to yield a fairly well defined parallel flux of mesons of this energy in a beam whose cross sectional area is roughly four square inches. A few modifications of the meson target support and of the thin window frame will allow mesons of lower energies to emerge into the accessible region of the platform.

Proton Scattering

The investigation of the range spectrum of particles scattered when Be^9 is bombarded with 32 Mev protons has progressed. The existence of a level at about 7.0 Mev has been confirmed by observing the scattered spectrum at several different angles. It has been determined that our earlier judgement of the data as "inconclusive" was due to the fact that at 15° (the original observation angle) this level does not stand out appreciably over the background level. At 60° , for example, the level is quite prominent.

A study of the angular dependence of the observed levels of both Be^8 and Be^9 will continue, and cross sections will be reported as data is collected and treated.

Proton-Proton Scattering at Reduced Energies (160 and 250 Mev)

Magnetic analysis of the beam after energy attenuation has been of considerable help in obtaining a more monochromatic beam of better-known energy. In this arrangement the 345 Mev proton beam enters in the cave where it passes through a suitable beryllium absorber. Following the beryllium absorber the beam passes through collimators, and a magnetic field of about 11,000 and 14,000 gauss for 160 and 250 Mev respectively, which bends the trajectory about 28° , and a last fixed collimator.

The beam emerging from the last collimator appears quite monoenergetic in the analysis of a Bragg curve. Study of a Bragg curve does not determine the number of low energy protons with great precision. However, the Bragg curve indicates that the energy homogeneity is very much better than that of other reduced energy beams we have used, and certainly indicates less than five percent of the protons can have a significantly lower energy than the protons desired. Approximate analysis of the scattering from the collimator slits indicates that the beam is very probably purer than the five percent figure would indicate. The beam current before energy attenuation is approximately 10^{-10} amperes, while that obtainable after the magnetic energy analysis is about 1×10^{-13} and 5×10^{-13} amperes.

The present scattering measurements are not fully complete, and some recalibration of the ionization chambers using the Faraday cup is essential before final absolute cross sections can be given. Results so far, down to 11° , c. m. system, seem to agree quite well with those measurements made here in earlier years, and still seem to be in disagreement with those at other locations (Harwell and Rochester).

Total Proton-Proton Scattering Cross Section (345 Mev)

The large liquid hydrogen target has been completed and tested. (The hydrogen container is a cylinder eight inches in diameter and 20 inches long. The beam will pass along the axis of the cylinder.)

The electronic arrangements for a first run on this problem are well advanced, and a run is anticipated during the coming month.

The method involves counting the protons as they enter the target through a scintillation counter and counting them with a large scintillation counter as they leave the target, providing they are not scattered by more than eight degrees. A proton scattered by more than eight degrees will fail to appear in the last counter. It is an event of this last variety that we wish to count. This means that our counting scheme is in effect an anticoincidence arrangement, although no anticoincidence circuits are actually used.

As a check on the electronic counting arrangements the pulses from part of the run are to be photographed on moving film. It is hoped that an analysis of this film may show (by study of pulse heights) whether or not any low energy protons are arriving at the target, and whether or not protons are arriving in pairs to a significant extent. Also the pulse height distributions may help to decide whether or not the last counter is detecting all the particles it is expected to detect, and whether or not the electronics is behaving as it should, that is, giving results in agreement with those shown by the film.

Elastic Proton-Deuteron Scattering (using 345 Mev Protons)

Complete success in this problem has hinged on a positive identification of some of the scattered particles as deuterons. Two slightly different arrangements were to be used. Both methods involved measurement of specific ionization and total energy by pulse height measurements based on a thin and a thick counter.

It was hoped that low energy deuterons might be detected using a proportional counter in connection with a liquid scintillation counter. However, it has been found that the arrangement as originally conceived is inadequate because of the fluctuations in energy loss as the deuterons pass through the 1.5 cm thick proportional counter that was to be used. The fluctuations referred to are those calculated by Landau and also by Simons.

The same method has been successful in the region of higher energies. Liquid scintillation counters 1.5 gr/cm² thick and 13 gr/cm² thick have been used to measure specific ionization and residual energy respectively. Protons and deuterons have been separated fairly well.

On the basis of this separation of protons from deuterons it is hoped that this work will go ahead reasonably rapidly. The technique is also being studied in connection with some other problems to which it may be applied.

Synchrotron Studies

In this period the synchrotron delivered some very intense beams. Some further calibration was done with Victoreen thimble chambers surrounded with 1/8 in. of lead. These tests showed about 60 r at 1 meter corresponds to 1 Nunan. Unfortunately this does not agree with results of about 1-1/2 years ago, which gave about 100 r/Nunan. The result is in the same direction as that of the Blocker, Kenney, Panofsky type test which showed fewer equivalent quanta per Nunan than previously.

Some measurements of the beam structure in time have been made. They show the radio frequency structure previously found. Measurements will be made of the effect of operating parameters of the synchrotron on this fine structure. The results were obtained by photographing on the screen of a fast scope the pulses from a fast counter. A trace of the radio-frequency can also be put on the scope.

Some time has been spent in preparing the high pressure hydrogen or deuterium target for a run. Plates will be used in this run to detect the π mesons. The run was under way at the end of the report period. A run was also made exposing plates to the direct beam to see whether the short mean free path star particles which produce further stars, such as have been observed at the California Institute of Technology could be observed here at 320 Mev.

Some injector tests were made with excellent results. An electrode arrangement has been developed which gives large steady beams of more than 1000 r/min. at one meter.

Preliminary measurements have been made on this development time of a shower by placing a counter directly in the beam, followed by a lead converter and a large block of paraffin, plus another counter, which could be moved around. The delay of this second counter relative to the first was measured. In the direct beam there is no delay, but in the part of the shower scattered out, there is definite delay. This work will be continued.

7. THEORETICAL PHYSICS
(A. E. C. Program No. 5211)

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Pion Studies

The implications of the plus-minus meson ratio in recent p-d pion production experiments are being examined. In particular, information is sought about the variation with energy of the contribution from the state with isotopic spin $3/2$.

A study of negative pion production from neutrons on deuterium has been initiated for comparison with experiments now underway.

Meson production from neutrons on complex nuclei is being calculated as an extension of earlier work on protons on nuclei. It is hoped to include the effects of deuteron formation in the final state, and to investigate the isotopic spin and energy dependence of the matrix elements.

The calculation of the probability of the neutral meson decaying into two pairs is being continued.

The study of the internal conversion of negative pions in hydrogen has indicated that about 1 percent of the gamma rays convert into pairs, independently of the form of meson theory employed. However, a detailed experimental investigation of this is regarded as unprofitable.

Field Theory

The study of the classical equations of motion of the meson spin is continuing.

The application of the Tomonaga intermediate coupling scheme to the pseudoscalar charged meson theory continues. Numerical calculations are being carried out for the neutral and charged pseudoscalar cases.

A brief study is being made of the possibility of a field theoretical treatment of isobars.

An investigation of the scattering of mesons by nucleons according to the theory of radiation damping, including that of virtual transitions, is being initiated.

Accelerator Calculations and Other Studies

The beam dynamics of the strong focussing accelerator proposed by Brookhaven is under investigation using the differential analyzer. Particular attention is being devoted to problems connected with the loss of phase stability at the phase transition point.

Some of the problems of beam extraction in synchrocyclotrons are being studied. Alternatives to the regenerative peeler-deflector system are under examination. Catching efficiencies are being estimated, and a proposal to produce transient local magnetic field variations by means of very large pulsed currents is under consideration.

The calculation of quantum corrections to the radiation from charged particles in circular orbits continues. It has been found possible to formulate the quantum problem in such a way as to parallel the classical calculation exactly.

Theoretical estimates have been made of some problems of free molecular streaming and of geometrical effects in connection with the laboratory's ion pump development program.

8. THE M. T. A. PROGRAM (A. E. C. Program No. 9200)

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Target Physics Research

In the previous report measurements of the charged particle beam transmitted through beryllium and uranium targets bombarded by He^{3++} particles of 510 Mev from the 184-inch cyclotron were described. These measurements clearly showed an appreciable current of longer range stripped deuterons and protons resulting from break-up of the He^3 particles extending beyond the range of the bombarding particles. Analysis of the beam attenuation curves is complicated by superposition of stripped protons and deuterons. However, the best rough analysis of the data indicates that the cross section for production of stripped deuterons may be as high as 0.08 barn for beryllium and 0.24 barn for uranium.

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An external beam of stripped deuterons with an approximate average energy of 320 Mev has been obtained by placing a beryllium target in the external beam at such a position azimuthally as to maximize the high energy deuteron beam out through the steering magnet. Using helium containing 4 percent He^3 , an external beam of about 5×10^{-14} ampere of 320 Mev deuterons has been obtained. Experiments to determine the neutron yield and angular distribution from a 12 in. x 12 in. x 10 in. uranium target utilizing the high energy stripped deuteron beam are now in progress.

Sparking Studies

The experiments on XC to determine the behaviour of various metals under high energy sparking conditions continue. Briefly the results are that phosphorous bearing coppers are variable, only best being nearly equal to OFHC copper. Inconel is appreciably better than the best of the coppers.

An inconel facing has been provided on drift tube one of Mk. I and has provided by far the best operation to date. The level of improvement is about 3 to 5 mv. A completely new all inconel drift tube is now about ready to go in.

Dynamical Properties of the Mark I Accelerator

The r. f. regulator equipment has been installed at Livermore and adjustments made with the entire accelerator in CW operation. There remains only a final adjustment of the r. f. input level, which will determine the range in r. f. level over which the accelerator can be controlled under closed-loop conditions. Before the system can be operated under pulsed conditions, there are certain "debugging" troubles to be worked out in the matter of enabling Power Supply No. 1 by means of the r. f. regulator units. There exists at present a mutual disagreement between the r. f. regulator unit and Power Supply No. 1 in the matter of enabling. This problem is not thought to be serious and should require only a day or two of engineering effort for its solution.

Transient response of the Mark I system under closed loop conditions was adjusted to have the shortest attainable rise-time consistent with reliable operation of the ignitron firing networks in Power Supply No. 1. Rise-time is limited by misfiring of the ignitrons, which occurs when a sufficiently rapid signal is applied to the firing networks, and illustrates a basic limitation on peaking-transformer type firing networks, as well as on most electronic-type firing networks. A type of electronic firing-signal generator has been developed which does not have the shortcomings mentioned above. This design is available whenever it may be decided that a faster response-time must be achieved in Mark I than the now available rise-time minimum of 5×10^{-3} seconds. Experiments on the test cavity model have indicated that a rise time of 2×10^{-3} sec. or less is attainable.

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Work is progressing apace on the compilation of research reports. The final report of this work will consist of a series of four reports or papers on the various aspects of the work and their inter-relationship. The first three of these papers will be unclassified, and will be published as UCRL reports. Work at present is under way on the first of these, a paper dealing with Time Quantization in Feedback Systems, which will be published. The other two papers will cover dynamical properties of a system of one or more electronic oscillators having a common resonant load, and a summary and interpretation of feedback theory, with special attention to phase-correction techniques. The classified report will deal with application of the foregoing to the dynamical stabilization of particle accelerators, in particular to the Mark I machine.

Time-Quantization in a Feedback System

Effects observed in an otherwise linear feedback system wherein time is quantized have been studied. The physical process of time-quantization in a feedback system have been analyzed and complications resulting therefrom have been investigated. The spectral composition of the output of a clamped type of time-quantizer has been developed in a manner applicable to time-quantizers having any output pulse shape. On the basis of the spectral analysis, a transfer function was developed which is applicable to signals of all frequencies. Linear passive approximations to the transfer function were developed, including one which is physically realizable, which are applicable to signals having periods longer than two quanta of time. The results of the analysis have been applied in a new criterion for stability of a time-quantized feedback system. Experimental verification of the theoretical results is demonstrated.

9. CHEMISTRY

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Part A

(A. E. C. Program No. 5311)

Alpha Decay of Am²⁴³

A sample containing 1 percent Am²⁴³ in Am²⁴¹ has been studied with the magnetic alpha spectrograph. The main group of alpha particles is at 5.267 ± 0.005 Mev, and a new group of about 10 percent abundance was found at 5.226 Mev. A gamma ray of 75 kev energy, measured with a scintillation spectrometer, follows the emission of the 5.267 Mev alpha particles.

Spallation of Silver

The yields of products from the spallation of silver induced by 340 Mev protons have now been measured in enough cases to permit a rough contour map of the yield distribution to be drawn. The result is similar to the maps for-corresponding reactions on elements in the region of copper, except that the yields drop sharply when more than about 40 nucleons are emitted from silver. For copper, a rather broad plateau in yield for such reactions is one of the evidences for fission. Thus fission seems to be much more rare in silver than in copper, as might be expected from the greater coulomb barrier.

Spontaneous Fission of Cf²⁴⁶

Fission counting on a sample of Cf²⁴⁶ revealed spontaneous fissions which decayed with the proper half-life (35 hours) to be due to Cf²⁴⁶. The rate observed corresponds to a half-life for spontaneous fission of 2100 ± 200 years, in excellent agreement with a prediction made empirically from other known spontaneous fission rates. As Z increases, the rate of spontaneous fission also increases so rapidly that this technique may be very valuable for the observation and especially for the identification of isotopes of new elements.

Observation of Cf²⁴⁸

Alpha particles of 6.3 Mev have been observed from decay of a new long-lived californium isotope produced by alpha particle irradiation of curium rich in heavy isotopes, resulting from long neutron irradiation. This new californium isotope is believed to be Cf²⁴⁸, which if correct makes it the heaviest isotope yet observed. The (very weak) activity has not decayed significantly in one month.

Identification of TbF₄

TbF₄ was prepared some time ago by the reaction of F₂ with TbF₃. It was identified by its x-ray diffraction pattern which is analogous to that of ThF₄. In order to verify its composition, measurements were made of the weight loss when the material was converted to TbF₃, TbOF, and Tb₂O₃ when heated at various temperatures in air. The final products were also identified by x-ray diffraction. The results indicate that the TbF₄ was better than 90 percent pure and may have been much purer than that. The calculations are made on the assumption that the impurity is TbF₃.

CHEMISTRY
Part B

(A. E. C. Program No. 5311)

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Metals and High Temperature Thermodynamics

Work is in progress on the following problems:

1. Determination of the vapor pressure of tin.
2. Thermal conductivity of gases.
3. Gaseous molecules.
4. Gaseous oxides.
5. Refractories.

Basic Chemistry

The following problems are under investigation:

1. The hydrolytic polymerization of zirconium.
2. Thermodynamics of indium.
3. Heats of complexing.
4. Studies in non-aqueous solvents.
5. Thermodynamics of $S_2O_3^{=}$.
6. Rare earth fluorides.
7. Potential of the RuO_4^- - RuO_4 couple.

CHEMISTRY
Part C

(A. E. C. Program No. 6400)

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Plant Biochemistry

The principal research effort in this field continues to involve studies of the metabolic pathways of carbon and phosphorus in plant photosynthesis. However, some of our research activity is now also being directed towards finding out something about the nature of the primary conversion act of photosynthesis; that is, the conversion of electromagnetic energy into chemical bond energy. We are investigating the possibility that the different metabolic pathways of carbon in the light and in the dark may be explained by whether or not there is a transfer of electronic excitation energy from chlorophyll to thioctic acid.

Animal Biochemistry

Research in the field of animal biochemistry continues to involve studies on (1) the role of Δ^7 -cholestenol in atherosclerosis, (2) the effect of heparin on fatty acid metabolism, and (3) the metabolism of adenine in mouse liver slices.

Organic Chemistry

Work in this field has included (1) research leading to the syntheses of morphine-7- C^{14} , codeine-7- C^{14} , cholic acid-23- C^{14} , and heptanoic acid-7- C^{14} , (2) studies leading toward the chemical degradation of ribulose and sedoheptulose, and (3) studies on the isotope effect involved in the rearrangement of methyl-labeled pinacol.

10. MEDICAL PHYSICS
Part A

(A. E. C. Program No. 6400)

UNCLASSIFIED

Tracer Studies

Studies upon the relative biological effects of beta and alpha emitters is being continued. Work upon the deposition of aerosols in the lungs of primates is under way.

Radioautography

Work was completed on experimental astatine monkeys. In progress at present, are autographs on excised thyroid material from two patients (human) who were presurgically injected with I^{131} .

Radiation Chemistry

Work is continuing on the effects of heavy particle radiation on aqueous solutions of organic substances. A study is being made of the effect of specific ionization on radiation yields in evacuated acetic acid solutions. Radiation products formed in aqueous solutions of formic, oxalic and amino-acetic acid are being identified. The mechanism of radiation induced amination reactions is being investigated.

MEDICAL PHYSICS

UNCLASSIFIED

Part B

(A. E. C. Program No. 6400)

Nucleic Acid Studies

The incorporation of P^{32} into the desoxyribose nucleic acid (DNA) of various tissues is being studied as a function of time after total body irradiation. From preliminary results it appears that there is a different interval from the time of irradiation to the point of maximum depression of DNA formation in different tissues and a large difference in the rate of recovery toward normal DNA formation after irradiation.

The effect of estrogen on nucleic acid formation is under investigation with a view to elucidating the mechanism of estrogen irradiation protection.

Activation Analysis

Progress was made in the ion exchange separation of calcium and strontium in the neutron-irradiated tissue ash samples. Previously the induced Ca^{45} and Sr^{89} activities were not completely resolved from each other. The newly developed technique allows separate quantitative estimation of these elements. An ion exchange separation of Fe^{59} and Co^{60} has been perfected by means of Dowex-1 resin. By this method satisfactory separations of these two important induced activities are obtained. The capacity of Dowex-1 for iron was measured as 153 mg. Fe/gm. dry resin. Some data are available for the Dowex-1 on the dependence of the distribution coefficient of iron in hydrochloric acid of different concentrations. Analysis of tissue ash samples of the distribution of various elements in tissue and blood ash samples is being continued.

Biological Effects of Radiation Studied with the 184-inch Cyclotron

Localized irradiation of the pituitary region of young male rats was continued. Two new experiments were initiated during the past month. A small group of rats, having alloxan diabetes, was irradiated in the pituitary with the aim of studying the modification of the diabetes by the depression of pituitary activity resulting from radiation. In the second experiment rats were exposed in such a way that the beam intercepted the pituitary stalk. If the dose is sufficient to seriously impair the nerve fibers in the stalk, the animals should show vastly increased water turnover due to the imbalance in the posterior pituitary function. This study was initiated with the aim of understanding radiation factors connected to water metabolism.

Experiments concerning activation dosimetry using the 190 Mev deuterons are being continued. It is found that 21 minute C^{11} isotope induced by deuteron irradiation of chiefly carbon in tissue gives satisfactory activity for dosimetry in some special instances. After exposing a single *Drosophila* to 1000 Rep, the induced C^{11} activity amounted to about 220 disintegrations per minute, a quantity which is well measurable in the scintillation counter. The *Drosophila* weighs 1 mg. The C^{11} activation of polyethylene foils were used to obtain the correction of the dose rate dependence of the ionization chambers used for routine dosimetry. The corrections obtained were independently checked with the Faraday cage. The activation dosimetry is also a convenient method when one wishes to make certain that the dose delivered to a specific region of the animal body actually reaches the site to which the beam is aimed. In the pituitary irradiation experiments a number of checks were conducted in this fashion.

Iron Turnover Studies

In the normal subject the predominance of the plasma to marrow pathway for iron and the fact that most of the iron leaves marrow in cells from which it can return to plasma only after a relatively long time makes it impossible for tracer iron used to label the plasma compartment to become even partially homogeneously distributed in both red cell iron and non-red cell iron until many red cell lives have passed. It is not established whether the non-erythrocyte iron soon becomes of the same specific activity as plasma. However, it seems highly probable that the turnover through the cells may constitute the longest time-constant linkage. The other pools of the non-erythrocyte iron probably have half-times sufficiently short so that by fifteen to sixty days after a single intravenous injection the specific activity of all non-red cell iron is approximately that of the plasma. If such an assumption can be made the total non-erythrocyte iron is estimable.

If the specific activity is uniform throughout all non-erythrocyte iron, then an extrapolation to zero time of the proper one of the slow components in the graph of plasma Fe^{59} (percent of that injected versus time) should give a zero time percentage of Fe^{59} which when divided into the percentage of Fe^{59} in all non-erythrocyte iron results in a ratio of the total non-erythrocyte iron to the total circulating plasma iron. Since the latter is known, the following relation has been used for calculation:

$$\text{Total Non-Erythrocyte Iron} = \left[\begin{array}{c} \text{Total} \\ \text{Circulating} \\ \text{Plasma Iron} \end{array} \right] \left[\frac{100\% \text{ Fe}^{59} \text{ inj.} - \% \text{ Fe}^{59} \text{ in all cells}}{\% \text{ Fe}^{59} \text{ in all Plasma}} \right]$$

11. HEALTH CHEMISTRY
(A. E. C. Program No. 5311)

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The Equipment Development Group has been engaged in work on the following items:

1. Equipment was completed for use by UCRL chemists at Idaho Falls in processing the first UCRL bombardment to be made there. Included in the equipment are a shielded box for active column work, a box for the subsequent chemistry work, and auxiliary equipment for use with these boxes. Counting equipment will be assembled there by the chemists.
2. Equipment was completed for use in absorption curve work on Fr^{223} . In this experiment it was necessary to heat the material to 400-500°C. in sealed glass tubes in the vicinity of the spectrograph window.
3. Additional equipment for use in processing neptunium-containing material from Hanford.
4. Work continues on equipment being readied for use in the 6-in. and 2-in. lead caves, in which bombardments from Idaho Falls will be processed.
5. Sixteen gloved boxes were assembled, fitted and delivered as per requests. A member of the Health Chemistry group has been moved to Livermore for full time work on Project Whitney, while three or four others are contributing part time effort there. In the immediate future additional full time employees will be stationed at the new site.

The Pit Room in Bldg. 5, where the Central Storage Facilities for radioactive materials is located, has been renovated by repainting, and the doors to the pit have been modified for easier movement. To afford more room in this area, the milling machine assigned for milling radioactive materials, heretofore located in the Pit Room, has been moved to Health Chemistry's new storage facilities in the Basement of Bldg. 29.

12. PLANT AND EQUIPMENT

Chemistry Laboratory Building. (Project No. 9500. 5-271-1002)

Plans are now expected by mid-December.

Synchrotron Research Building. (Project No. 9500. 5-271-2001)

Exterior work is complete and work on the interior is progressing. The building is now 75 percent complete.

Electronics Research Laboratory. (Project No. 9500. 5-271-2002)

Preliminary programming work has been started by the Plant Engineering Department.

Bevatron Instrument. (Project No. 9500. 5-271-9001)

The magnet core is being disassembled preparatory to the installation of the curved vacuum tanks. One curved tank is nearly completed and work on another is beginning. The framework and housing for the ion gun have been completed and its fabrication is continuing. The first tangent tank has been received from Mare Island.

Miscellaneous Construction. (Project No. 9300. 3-271-3001)

Block House. The shell is complete. Work on the interior and on the alarm system is continuing.

Computer Building. Work has just begun.

Pits in and around Building 153. Bids have been received and opened and recommendation made to the Regents. Their answer is being awaited.

MAN-MONTHS EFFORT REPORT
SCIENTIFIC PERSONNEL

Program No.	Subdivision	Man-Months Effort
9500 Bevatron	Miscellaneous	12.72
<u>Operations</u>		
2000 M. T. A.	Design and Development	37.44
3000 Weapons Research	General	77.07
5211 Physics Research Experimental Physics	Cloud Chamber	11.51
	General Physics Research	45.25
	Instrument for General Use	3.55
	Magnetic Measuring	4.88
Theoretical Physics	General	15.81
Photographic Film Detectors	General	13.78
5261 Applied Physics Research		
Mark III Cyclotron	Electron and XC Models	3.40
<u>Chemistry Research</u>		
5311 Basic Chemistry Research, Part A	Chemistry of Heavy Elements	2.83
	Nuclear properties of Heavy Element Isotopes	8.14
	Transmutations with 184" and 60" Cyclotrons	4.88
	Analytical and Services	19.66
	Special Chemistry Development	1.00
	Mass Spectroscopy, Beta Ray Spectroscopy	1.33
	Instrument Development and Services	3.25
	X-Ray Crystallographic Measurements	3.12
Health Chemistry Research	6.88	

MAN-MONTHS EFFORT REPORT
SCIENTIFIC PERSONNEL

Program No.	Subdivision	Man-Months Effort	Comments
5311 Basic Chemistry Research Part B	Metals and High Temperature Thermodynamics) Basic Chemistry, including Metal Chelates) General	6.31	
5361 Applied Chemistry Research	Process Chemistry	4.96	
<u>Reactor and Accelerator Operation</u>			
5731 Electron Synchrotron	Operation	9.49	
5741 184-inch Cyclotron	Operation	9.10	
5751 Linear Accelerator	Operation	12.89	
<u>Biological Research</u>			
6300 Biology and Medicine	Internal Irradiation and Hematological Response Health Medicine	6.90 .50	1.35 Consultant Man-Months
6400 Biological Research	Instrumentation for Quantitative Measurements of Radiation	2.15	0.40
	C ¹⁴ Metabolism	3.81	0.25
	Use of Radioactive Materials in Human Physi- ology and Experimental Medicine	12.11	3.99
	Trace Elements and Irradiation Studies	7.03	1.05
	Radiation and Mutation Rate	1.60	0.13
	Physical Biochemistry	13.73	3.50
	Biochemical Response to Irradiation	4.28	0.50
	Miscellaneous	3.44	4.82
	Metabolism of Lipo Protein and Lipids	5.77	12.99
	Iron Metabolism Hematopoiesis	2.99	0.50
	Synthetic and Experimental Organic Chemistry	22.58	-
	Metabolism of Fission Products	16.98	-
6500 Biophysics Research	Biological Effects of Cosmic Radiation Health Physics	2.80 1.87	0.12 -

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