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MONTHLY PROGRESS REPORT NO. 126

September 15, 1953 to October 15, 1953

November 5, 1953

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UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

September 15, 1953 to October 15, 1953

MONTHLY PROGRESS REPORT NO. 126*

November 5, 1953

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

Fast Deuterons from 340 Mev Protons on Nuclei

In order to improve the problem of the accidental coincidence counting rate encountered whenever the magnetic particle spectrometer is used, new electronic units have been built to use with the 35 channel scintillation counters. The old units were built to use with GM counters, not scintillation counters, and therefore these units consisted of amplifiers which were fed from the 35 channel counters and gated on by a second signal. The input pulse was about 1×10^{-6} seconds long at the point where it was mixed with the gating signal. This time was long enough to allow accidental counts to be recorded due to the background counting rate of the 35 channel counters. New electronic units have been built to correct this situation. These new units consist of first a mixing circuit where six inputs are combined to give a single output pulse whenever one of the inputs has a pulse. Then the output from this mixer is fed into a double coincidence circuit of the Garwin type. The other input into the coincidence circuit was used previously as the gating signal. The output from the coincidence circuit is fed into an EFP-60 amplifier where it is lengthened to about 1 microsecond and then it can be fed through a conventional linear amplifier and scaler. The input pulses into the coincidence circuit are both about 4×10^{-8} sec. long. This decrease in mixing time should cut down the accidental counting rate by a factor of about 25. Of course, combining inputs will increase the accidentals again, but even with five inputs the accidentals should be less by a factor of five.

Range-Energy Calculations

The calculations have been completed, and the Information Division is processing the material which will be issued as report number UCRL-2301.

Comparison of H^3 and He^3 in High Energy Deuteron-Deuteron Collisions

This experiment has been successfully concluded. The ratio of H^3 to He^3 was found to be 0.86 ± 0.14 at one production angle. The fact that the ratio is close to unity provides evidence that charge symmetry of nuclear forces exists at high energy. The complete results will be written up in a forthcoming UCRL report.

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* Previous report UCRL-2358 (No. 125).

CONFIDENTIAL

Cerenkov Radiation Counter

A run was made with the Cerenkov counter using π^0 gammas from protons on carbon. For the higher energy photo pulses, having voltages of around 0.15^o, the counting rate ratio for the angles 0° and 180° was several hundred. Counting rate attenuation by lead in the beam indicated that gammas were the cause of the coincidences.

Experimentation with magnetic toroids, as pertaining to coincidence networks, was continued.

Gamma Ray Spectroscopy

A run was made at the linear accelerator in an attempt to measure the excitation function for a gamma line of approximately 15 Mev, excited by proton bombardment of carbon. This gamma line has previously been reported in connection with pair spectrometer work at the 184-inch cyclotron at various bombarding energies from 30 Mev to 340 Mev. This experiment was performed using a NaI(Tl) crystal two-inches in diameter by two inches long and pulse height analysis with photographic recording. Background difficulties prevented obtaining the excitation function, but it was possible to establish the existence of this gamma line at 32 Mev bombarding energy. Further work on the excitation function and the angular distribution of the gamma line are planned. A more accurate determination of the gamma ray energy is to be made using the 180° focussing pair spectrometer at the 184-inch cyclotron.

Delayed Heavy Particle Emitters

Another attempt to measure the excitation curve of Al^{24} accurately was unsuccessful because of the very low yield of Mg^{24*} at 4×10^{-8} amperes and the non-linearity of the neon integrating counter above this level. It is expected that the non-linearity of the integrating counter can be overcome by reducing the total pressure in the counter.

Neutron Polarization

A one day run on the 184-inch cyclotron was made to determine the polarization of neutrons produced by bombarding lead with 340 Mev protons. Owing to the inability to get the iron collimator in the neutron port, collimation was made by means of the igloo. As a consequence, the background ratios were high and the results were inconclusive. A future run is planned with better collimation and better monitoring.

Elastic Proton Double Scattering

On Oct. 12 and 13 the second run on the elastic proton double scattering experiment on the linear accelerator was made. Four new counters were used in two double telescopes. The front counter in each telescope had a 50 mil plastic scintillator while the rear counter in each telescope had a 1-1/2 inch plastic scintillator. These scintillators were viewed by 5819 photomultipliers. Fast electronics with 10^{-8} sec. coincidence circuits were used to assure that only charged particles were counted. A 70 mil calcium target was placed in the steering magnet in a position where it would scatter protons into the 20° port when the magnet was off, but was clear of the protons when the magnet was deflecting the protons into the 20° port. A second 70 mil calcium target was placed in the scattering chamber to give the second scattering.

It was intended that the beam be magnetically deflected into the target in the scattering chamber and the counters adjusted to positions on either side of the beam to give equal counting rates. The magnet was then to be turned off and the beam allowed to hit the target in the deflecting magnet. The counters would then give an unequal count if a spin dependent effect is present. It was necessary to run with the beam current very low when the beam was magnetically deflected and at its maximum value when the beam was scattered into the 20° port. When the run was made it became apparent that one counter telescope was much more sensitive than the other to background when the beam was maximized on the straight through port. It is hoped that this difficulty will be corrected in the next run.

Liquid Hydrogen Bubble Chamber

A liquid hydrogen bubble chamber similar to the one designed at Chicago by Hildebrand and Nagle has been built. A preliminary test using liquid nitrogen has indicated a need for better control and measurement of temperatures. A test with liquid hydrogen will be made in the near future.

Proton-Proton Scattering and Proton Polarization

A run has been made on p-p scattering in order to measure the attenuation of the proton beam in liquid H_2. This measurement will give a completely independent set of data on the absolute value of the p-p scattering cross section, on which there are conflicting measurements. The run at 340 and 250 Mev seems to be satisfactory but the results have not yet been analyzed. This will take more time.

An experiment on the polarization of protons by scattering on carbon has been performed. The result seems to indicate a substantial polarization of the beam. Much more work will be needed to study exhaustively this important phenomenon.

Film Program

During this report period accelerator time was used for the following experiments: (a) high energy spallation products at 0° from a carbon target under alpha particle bombardment; (b) spallation products in the backward direction from Ag targets under proton and alpha bombardment; and (c) angular distribution of 4 Mev $\pi^{\pm}$ mesons produced in carbon when bombarded by 300 Mev protons.

Work is continuing on the high energy disintegration processes in light elements. In particular, the Li^8 fragments from the reaction

$$_1H^2 + {}_3Li^7 \longrightarrow {}_1H^1 + {}_3Li^8$$

are being analyzed for their angular distribution. Other researches under progress are (a) γ-ray spectrum from Pb and C under 320 Mev bremsstrahlung bombardment; (b) π^+ and π^- production cross sections as a function of atomic number, Z, and neutron number, N, by protons; (c) interactions of 380 Mev alpha particles in G5 emulsions; and (d) high energy β-ray spectra.

Cloud Chamber Studies

Pion Production in Deuterium. A three day run was made with the 10 atmosphere cloud chamber in the neutron beam of the 184-inch cyclotron. Among the new equipment used were a pressure control panel, a nitrogen cylinder rack and manifold, and a temperature control water bath.

The new pressure panel served its dual purpose of saving time in setting up, and adding to convenience during operation. The cylinder rack was also mainly for convenience, but it also helps to save cyclotron time.

The water bath was the most important change in the system. Its purpose was to keep all parts of the cloud chamber at the same constant temperature and it did an excellent job except when the main refrigerating unit failed.

Twelve copper-constantin thermocouples were put in various places to check on the temperature control and the results were as good as could be expected.

Because of the changes, less difficulty was experienced in obtaining excellent pictures of minimum ionization tracks.

Scanning of the film has been started but no measurements have been made to date.

32 Mev Protons in Oxygen. Another run has been made and the analysis of events from previous runs has been started.

35 Atmosphere Diffusion Chamber. The expansion unit has been built and operated with the chamber. The depth of the sensitive region is increased, but excessive turbulence is introduced. This problem is being worked on.

A more adequate system for supplying alcohol vapor is being investigated, since the chamber loses sensitivity whenever too much radiation is present.

32 Mev Protons in Methane. A one day run was made, but very little data was obtained because most of the time was spent in re-adjusting the position of the magnet at the end of the linear accelerator.

90 Mev Neutrons in Hydrogen. Analysis of the film is continuing and another run is being scheduled.

Scattering of Positive Pions in Lead. Film reading and analysis of events is continuing.

Interactions of 32 Mev Protons with He^4. One fifth of the inelastic events have been analyzed, giving the following results:

Type	Number
$p + He^4 \longrightarrow H^2 + He^3$ ("pickup"):	33
$p + He^4 \longrightarrow 2p + H^3$:	19
$p + He^4 \longrightarrow p + n + He^3$:	10
$p + He^4 \longrightarrow 2H^2 + p$:	0
From the H_2O contaminant;	
$p + p \longrightarrow p + p$ (elastic):	6
Inelastic oxygen events:	11
Not analyzable:	3
Total	82

These preliminary results do not include solid angle corrections.

Synchrotron Studies

Because of a large leak in one of the rubber boots on the rf section of the vacuum system, the synchrotron was disassembled, starting on October 6. Since the machine has been in operation since September 1952, it was well worthwhile to make a complete overhaul.

In the period before the shutdown runs were completed on the excitation function of photofission in uranium, thorium and bismuth. The counting rate with bismuth was so small at lower energies as to make the statistics very poor, but the results with U and Th should be good.

A week-long run was made to determine the cross sections for 300 Mev quanta of C_6H_6 and C_6H_{12}. Unfortunately the beam was not as intense or steady as in some previous runs so the accuracy was not sufficient to get much information about the triplet cross section.

A short run was made with the high pressure hydrogen target to measure π^+ mesons. Part of the run was spent exposing plates at 0° to the beam since those exposed previously have been entirely scanned. The magnet was then turned around to look at 180°, and it was decided that the cross section is not great enough at this angle to use the geometry that was set up. The π-μ detection method was used. A geometry with larger solid angles will have to be used.

2. THEORETICAL PHYSICS UNCLASSIFIED
(A. E. C. Program No. 5211)

Attempts to treat the divergencies of the relativistic two body equation by Riesz's method are being made.

Work was started on an extension of Fermi's method of high energy processes based on the idea of the grand canonical ensemble.

The calculations of the meson nucleon scattering for the charged scalar field in the intermediate coupling region have been completed and a paper describing the procedure has been submitted to the Physical Review. An effort is now being made to test the validity of the assumptions used for intermediate values of g.

Work on the deuteron is continuing. The second and fourth order adiabatic potentials and the first non-adiabatic correction to the second order potential have been calculated.

An estimate is being made of meson and nucleon production cross sections by high energy nucleons. A statistical model is being employed which is based on a generalization of Fermi's treatment.

The Milne problem for the infinite slab (i. e., elastic isotropic scattering inside a slab of finite thickness) has been formulated as a Fredholm equation by integrating the transport equation. The Neumann expansion, appearing as an expansion in number of collisions, seems applicable as a complementary approximation to age theory.

Maxwell's equation are being studied in general coordinate systems in order to examine the transformation properties of classical radiation. The field of a charge at rest in an arbitrarily moving (i.e., non-inertial) system has been obtained; when transformed to an inertial system, in which the charge's motion is arbitrary, the conventional velocity and radiation field is obtained.

Work is continuing on the theory of the energy spectrum of the high-energy neutrons produced by proton bombardment in the cyclotron.

In the strong coupling treatment of Bohr and Mottelson (in the coupled single particle--collective mode model of the nucleus) only axially symmetric deformations have been considered. The question of whether in certain cases the nucleus is asymmetrically deformed (i.e., is a three axis ellipse) has been investigated, and preliminary considerations have indicated an affirmative answer.

An investigation of eddy current distribution in the 184-inch cyclotron dees resulting from rapid changes in the magnetic field is being made to aid in determining the structural strength required of the new dees.

3. MTA TARGET PHYSICS PROGRAM (A.E.C. Program No. 4900) CONFIDENTIAL

During the past month the analysis of the results of the 320 Mev deuteron orbit profile studies inside the cyclotron tank was completed, and the preliminary indications were borne out as to the difficulty of increasing the fraction of the beam brought out of the cyclotron. It appears that by displacing the whole deuteron tube laterally about 18 inches an increase of perhaps a factor of two might be effected, but short of this major operation the present target arrangement is essentially optimized. No further attempts to increase the beam are being made.

The large liquid scintillator tank is awaiting the results of some tests on porcelainization of different weld types; i.e., arc, heliarc and gas, to determine just how much grinding will have to be done on the welds of the photomultiplier tube light seals in the tank walls.

The proton-recoil telescope has been operated in the neutron beam, and all the electronics performed quite satisfactorily. No neutron energy spectra were measured, but this is planned for the next run or two. The proton-recoil neutron telescope will subsequently be used in conjunction with the manganese sulphate tank to determine the external yield of neutrons per incident high energy neutron with thick targets and the value of σ_{1n} for thin targets.

4. ACCELERATOR CONSTRUCTION AND OPERATION UNCLASSIFIED

Bevatron Construction. (Program No. 9001)

Magnet. During the period the assembly of the magnet was completed and the first pulsed operation began on the night of October 2. The magnet is operated at night in order to reduce the maximum power demand on the University system to avoid an increase in power costs. Prior to October 2 the move of the power supply controls from the mezzanine to the first floor of the generator room was completed and the motor generator sets were checked out. Between October 2 and the end of the period the magnet received about 2,000 pulses at full current and voltage. No difficulties occurred with the magnet structure. Some of the insulated joints inside the vacuum tank have shorted out but since there are many points still insulated in all the possible eddy current circuits no trouble is expected. The operation during the first week of pulsing was for the purpose of adjusting the magnet power supply. A considerable number of faults occurred during this period but these have been eliminated by proper adjustments.

On October 13 the magnet test crew took charge of the magnet operation and the remainder of the period was spent checking out their apparatus prior to making field measurements.

The cooling fans were run for a short time to check the electrical circuits with the air ducts and shrouding still incomplete. The duct work will be finished during the week of October 19 which will permit operation near full output. At present about 300 pulses can be used before the magnet temperature reaches the maximum permitted of 45° C. A higher temperature will be possible when cooling is available. Without cooling, the temperature distribution through the coil is uneven and trouble might be experienced with differential expansion if the final maximum temperature were permitted.

Vacuum System. The tank was kept under vacuum until October 5 in order to permit testing the accelerating system with both a vacuum and the magnetic field. There was no effect of the magnetic field on the tightness of the vacuum tank. The minimum pressure reached during the vacuum testing period was 1×10^{-5} millimeter untrapped and 2×10^{-7} millimeter on a trapped ionization gauge. In each pumpdown a minimum of 16 hours has been required to reduce the pressure to the point at which the diffusion pumps can be opened. This is apparently due to water absorbed on the surfaces or in the materials inside the tank. A study is being made of various means of reducing this time.

Accelerator. RF voltage has been applied to the accelerating electrode with the power amplifier tube and saturable reactors installed. The power amplifier was used as an oscillator in these tests. With the vacuum obtained it was necessary to use a d-c bias to enable the oscillator to build up. Frequency was controlled through the operating range by manually adjusting the reactor saturating current. One of the peaking transformers which produces 30 pulses as the magnet current rises has been installed with its associated electrical equipment and operates satisfactorily. Componenets for controlling the frequency from the magnet current are being installed.

Schedule. Magnetic measurements are expected to require four weeks after the cooling is available for continuous pulsing. They should be complete by November 18. About four weeks more will be required to install the inflector and complete the pole face winding, move the injector into position, and install probes and other miscellaneous equipment required for startup. First operation might then be expected December 16 if no delays occur.

184-inch Cyclotron Operation. (Program No. 5741)

The cyclotron was used for research experiments approximately 94 percent of the 491 hours that the crew was on duty. The time distribution was as follows:

Operation for customers	459.75 hours	93.6 percent
Electrical troubles	7.75	1.6
Mechanical troubles	3.00	0.6
Magnet measurements (for conversion)	6.50	1.3
Vacuum troubles (oil leak)	7.25	1.5
Miscellaneous	7.00	1.4
Totals	491.25 hours	100.0 percent

184-inch Cyclotron Modification. (Program No. 4900.02)

Magnet. The auxiliary coil tanks have been completed at Mare Island. One tank has been delivered to Westinghouse and the other is stored at Mare Island pending the need for it for the winding of the second coil. Westinghouse is preparing to mount the first tank on the winding fixture and should start the winding operation during the next month.

The adhesive coated tape for the auxiliary coil has proven unsatisfactory and negotiations are in process with the supplier to furnish this tape without the adhesive and with the Westinghouse Co. to apply the adhesive to the conductor.

The pole disc blank has been shipped to the machining contractor and the machining is in process.

Radiofrequency Design. The location of the oscillator and the characteristics of the transmission lines connecting it to the resonance system have been tentatively agreed upon. Detailed design of these parts is in process and the agreed-upon dimensions are being confirmed on the half-scale model. Tests are also in process on the magnetic shielding required to reduce the field at the oscillator tube to the allowable 150 gauss.

Vibrating Condenser. The blade forgings are complete and inspection of these parts by ultrasonic means will be made at the vendor's plant in the immediate future. The previously encountered difficulty with the test blades of peeling of the copper plating was apparently due to improper cleaning and should not be a problem in the finished parts. The capacitor vacuum tank is in the process of construction and it has been decided to have all critical welds x-rayed by laboratory personnel, in an attempt to eliminate the difficulties encountered with the auxiliary tanks.

Deflector. The theoretical work is continuing on the deflector design prior to building any additional models. It is tentatively planned to use either the scattering foil or the electrostatic deflector to displace particles into the pulsed magnetic channel.

60-inch Cyclotron Operation. (Operated by the University of California)

The work on heavy ion acceleration, reported last month, has been extended, time being made available for this work by a continued decrease in demand for bombardment time. During this period 160 hours out of the available 340 were used for bombardment purposes.

In addition to heavy ion work, experiments were conducted with various deflector, exit strip and feeler designs. Rewarding findings were made in both the heavy ion and machine geometry areas.

Synchrotron Operation. (Program No. 5731)

Deterioration of the vacuum segment vacuum gaskets forced the synchrotron to be disassembled after thirteenmonths of highly successful operation. It was felt that the resonator section of the vacuum donut should be replaced with a spare one at this time. The original resonator after more than four years of service had become marginal in operation due to erosion of the copper straps at the accelerating gap.

At the end of this report period the synchrotron reassembly was under way.

Linear Accelerator and Van de Graaff Operation. (Program No. 5751)

The linear accelerator operated on a routine basis during the entire period of Sept. 15 to Oct. 15, except for three shifts. One of these was used to install a new concrete shielding wall on the south side. The other two were for scheduled maintenance on the Van de Graaff generator.

The installation of the concrete shielding is part of a program designed to assure compliance with presently accepted stray neutron fluxes. Surveys to establish the neutron reduction provided by the wall have been made and the data are being analyzed. It appears that additional shielding will be required between the end of the tank and the bombardment area.

The program to develop a pre-exciter based on the Eimac 4W20000 tube is continuing.

Following are the operating statistics for the period.

Repairs	22 hours	6 percent
Running time	320	91
Maintenance	10	3
Totals	352 hours	100 percent

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

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Gamma-Gamma Coincidence Apparatus

An apparatus has been set up in which a radioactive sample is placed between two gamma ray scintillation counters. The pulses from one counter, if they are of appropriate size to pass a one channel analyzer, trigger a gate which allows the coincident pulses from the second counter to pass to a 50-channel pulse height analyzer. Thus the spectrum of gamma rays in either instantaneous or delayed coincidence with a given gamma ray can be observed. The apparatus has been used to confirm the cascade relationship of the 146 kev and 100 kev gamma rays in the decay of Pu^{238}.

New Rhodium Fission Product

In the study of products of fission from tantalum induced by 340 Mev protons a new rhodium beta emitter of 2.2-hour half-life has been observed. The mass assignment was attempted with the time-of-flight isotope separator but failed because of insufficient activity. The absence of this activity in the fission product mixtures resulting from thermal neutron induced fission is explained by calling it an isomer which is not a decay product in significant yield of the corresponding ruthenium isotope.

Crystal Structures of Rare Earth Trichlorides

Some time ago it was reported that the trichlorides of the rare earths from dysprosium to lutetium have the YCl_3 type structure, but the lattice constants reported changed discontinuously in an unexpected way between $TmCl_3$ and $YbCl_3$. Recent calculations based on patterns taken with chromium X-rays, which give a higher dispersion, lead to results which show no anomaly.

Crystal Structure of TmOF

A sample of TmOF has been observed to have the tetragonal structure like that of LaOF, YOF and PuOF. The lattice dimensions are:

$$a = 3.878 \pm 0.003\ \text{Å}$$
$$c = 5.359 \pm 0.003\ \text{Å}.$$

Process Chemistry

Work is in progress on the following problems: preparation of titanium metal, film boiling from subcooled liquids, the thermal conductivity of gases at high temperatures, the agitation of liquid-liquid systems, solubility studies, thermal diffusion in liquids, the capacity of perforated plate liquid-vapor contacting columns, gas-phase mass transfer studies, and vacuum flow through annular sections.

Metals and High Temperature Thermodynamics

Work is in progress on the following problems: heats of formation and absolute absorption coefficients of high temperature molecules, the reflection coefficients of molecular beams, magnesium oxide gas, refractory silicides, sodium carbonate vapor, and high temperature halide molecules.

Basic Chemistry

In view of the graduation of all our men this last year, a new group of graduate students is starting new problems in the field, but it will be some little time before their research programs are under way.

Health Chemistry

The Equipment Development Group and the Airborne Activities Control Group are continuing to spend essentially full time of preparation of equipment and testing operations of same for a highly active irradiation to be received from the MTR at Idaho Falls late in October. The processing of this material will take place at Livermore. Maintenance and repair, modification, etc., continues to be done on local equipment.

The Berkeley Box Group assembled and delivered eleven gloved boxes on request to researchers; this group also spent considerable time on the Livermore project described above.

Five special radioactive sources were completed and delivered on request.

Fifteen commercial coatings and coverings were tested for corrosion, heat resistance, etc., for ascertaining the possibility of their use on surfaces desired to be protected from the physical and chemical effects of radioactive materials which they contact during processing.

6. BIOLOGY AND MEDICINE UNCLASSIFIED
(A.E.C. Program Nos. 6300-6500)

Biological Studies with the 184-inch Cyclotron

In collaboration with Columbia University a series of experiments was concluded concerning the relative biological effectiveness of low energy alpha particles and high energy deuterons in producing cataracts in the lens of the rabbit eye.

Activation Analysis

Initial pilot experiments were made on radioautography of deuteron, proton and alpha particle irradiated tissue sections. Gross differences in structural P-32 could be detected in the mouse ovary and in the salivary gland; in the latter the epithelial tissue contains more phosphorus than connective tissue.

Instrumentation

The gamma ray pinhole camera with image amplifier is undergoing performance tests. So far an overall amplification of 200 image intensity was achieved as compared to the gamma ray pinhole camera using a fluorescent crystal but not an image amplifier.

Effect of Radiation on Liver Blood Flow

Entermann and coworkers have observed an increase in the size of the liver of rats given 2500 roentgens total body x-rays. This has suggested to us the investigation of possible changes in liver blood flow in irradiated animals using a method for the indirect measurement of liver circulation which was developed in this laboratory and is based on the rate of phagocytosis of intravenously injected colloidal chromic phosphate. Liver blood flow measurements were carried out on fifteen male rats weighing approximately 170 grams each. They were fasted for 24 hours and remeasured. A significant depression of liver blood flow was observed with fasting. Ten of these rats were given 2500 roentgens and five were retained as controls. The fasted controls showed a continued marked fall in blood flow with time while the irradiated animals showed little or no further decrease in blood flow after irradiation.

Since the spleen is extremely sensitive to irradiation and following irradiation promptly decreases in size, an experiment was designed to measure the effect of irradiation on the spleen blood. This can be ascertained by sacrificing the animal after measuring the liver blood flow and determining the spleen liver distribution quotient for the phagocytized colloid. This experiment is still in progress.

Hematological Studies on Persons Undergoing Dental X-rays

A group of ten individuals received doses of x-ray to the head and neck region during dental radio-graphic procedures varying from forty to three hundred twenty roentgens. Hourly blood counts were done on each of these persons during a control period before irradiation and during the day of irradiation - the doses having been delivered in the morning. A statistical comparison was made between lymphocyte counts before x-ray and after x-ray and demonstrated significant depression.

Tracer Studies

The deposition of aerosols in the lungs of primates on a long term basis and long and short term thullium, cerium, radium and iron tracer studies are continuing.

Experiments on the relative biological effects of alpha and beta emitters using astatine and X-rays to determine LD_{50} in rats and long term effects on monkeys are progressing as planned.

Radiation Chemistry

Methods have been developed for the determination of glycolic acid and glyoxalic acid in aqueous acetic acid solutions. These procedures are being employed in studies of radiation production in oxygen aerated solutions of acetic acid. Mechanics for the observed kinetics in both oxygen-free and aerated solutions are being worked out. Radiation chemical studies of oxalic acid and formic acid are under way. The work on glycine is being continued.

Histology

Tissues taken from a large series of At^{211} rats, some with KI pre-treatment, others without, have been prepared and read. A number of normal rats have been autopsied to obtain a better record of the normal tissues of the Sprague-Dawley strain.

Bio-Organic Chemistry

The following listing of subjects indicates most of the research projects which have been actively investigated during the period of time indicated above. This research program includes projects in organic chemistry, plant and animal biochemistry, and associated instrumentation.

1. Studies of irradiation effects in organic compounds have included the following subjects:
   a. Radiation decomposition of glycine, methanol, choline and choline derivatives; and quaternary ammonium compounds.
   b. Studies of the field strength in the Co^{60} source with small ion chambers.
   c. Dosimetry of the Co^{60} source.

d. Construction of a vacuum Toepler pump system for analysis of gases produced by irradiation.

2. Radioactive assays for compounds of C^{14}, S^{35} and T include work with:

   a. A scintillation counter using a triple coincidence-single anticoincidence circuit.

   b. Scanner circuits for automatic analysis of chromatograms.

   c. Routine low level C^{14} ionization chamber assays.

3. The synthesis of the following compounds has been studied:

   a. Uric-8-C^{14} acid.

   b. Leucyl alanine-2-C^{14}.

   c. Thioctic-1-C^{14} acid.

   d. Dimercapto-isobutyric acid and intermediate compounds.

   e. Sodium butyrate-2-C^{14}.

4. Studies of the effect of Δ^7-cholestenol on atherosclerosis and as a precursor in biogenesis of cholesterol.

5. Fatty acid metabolism in rats, mice and rabbits in normal and pantothenic acid-deficient animals with and without the addition of other compounds, such as heparin and Coenzyme A.

6. Irradiation of mice and the study of the resulting Coenzyme A liver levels.

7. Effect upon photosynthetic reservoir sizes by changing light intensity, pH and CO_2 pressure.

8. Biosynthesis of sedoheptulose, mannoheptulose and ribulose diphosphate and their use as intermediates in photosynthetic conversions.

9. Kinetic and thermodynamic analyses of biological systems such as animal radioactivity breath curves or photosynthetic reactions.

10. Investigation of chemistry and possible occurrence of thioctic acidthiamin conjugates in the biological systems.

11. Influence of thioctic acid in photosynthesis by algae.

12. Metabolism and excretion of S^{35}-labeled thioctic acid by the rat.

13. Metabolism and excretion of morhpine and codeine by mammals.

14. The degradation of sedoheptulose by conversion to mannoheptulose to obtain an assay of the number 6 carbon.

7. PLANT AND EQUIPMENT REPORT

Bevatron. (Account No. 5-271-9001)

The vacuum tank is tight, and the magnet core is complete except for minor adjustments. The injector is operating but will have to be moved into its final position before the Bevatron can operate. Bids have been received but not let for the shielding. This work should be completed about March 1, 1954.

Chemical Laboratory, Building 70. (Account No. 5-271-1002)

The walls are being formed and poured by the general contractor. The sewer and drain line work has been completed except for that portion outside the south side of the building, and the plumbing contractor is fabricating pipe sections in his shop at present. The electrical contractor has placed the conduits at foundation level and is presently placing receptacle circuits in the walls. The entire project is approximately 22 percent complete.

Electronics Research Building 80. (Account No. 5-271-2002)

An architect is to be recommended to the Regents at their next meeting.

Miscellaneous Construction. (Account No. 5-271-2001)

The Gamma House foundations are 90 percent complete and bids have been received for the erection of the building. The destructor contract has been let to Morse Boulger Destructor Co. and work is expected to start in the near future. Alterations to Building 50 are 98 percent complete. Work has been started to prepare the east parking lot for paving.

MAN-MONTHS EFFORT REPORT

SCIENTIFIC PERSONNEL

Program No.	Subdivision	Man Months Effort	Vac. and Sick Leave
Operations			
3000 Weapon's Research	General	274.94	14.77
4000 Reactor Development - MTA	Design and Development	21.52	0.57
5000 Physical Research			
5200 Basic Physics Research	General Physics Research	60.10	18.90
	Theoretical Studies	15.45	2.16
	Film Detection	12.33	3.57
	Cloud Chamber	11.90	1.44
	Magnetic Measurements	1.01	1.55
	Sub-Total	100.79	27.62
5311 Basic Chemistry Research	Chemistry of Heavy Elements	6.76)	
	Nuclear Properties of Heavy Element Isotopes	14.29)	
	Transmutations with 184-in. and 60-in. Cyclotrons	7.49)	
	Analytical and Services	14.70)	
	Mass Spectroscopy, Beta Ray Spectroscopy	2.11)--	7.93
	Instrument Development and Services	4.82)	
	X-Ray Crystallographic Measurements	2.00)	
	Radiation Chemistry	0.72)	
	Office and Travel	7.85)	
	High Temperature and Special Chemistry	4.35	
	Health Chemistry Research	6.67	
	Sub-Total	71.76	
5361 Applied Chemistry Research	Process Chemistry	8.37	
5731 Electron Synchrotron	Operations	4.15	
5741 Synchro Cyclotron (184-in.)	Operations	8.71	
5751 Linear Accelerator	Operations	8.77	
5761 Proton Synchrotron-Bevatron	Operations	10.65	
TOTAL PHYSICAL RESEARCH		213.20	35.55

MAN-MONTHS EFFORT REPORT

SCIENTIFIC PERSONNEL

Program No.	Subdivision	Man Months Effort	Vac. & Sick Leave	Com-ments	Vac. & Sick Leave
6000 Biology and Medicine Research					
6300 Medical Research	Health Medicine	1.16			
	Internal Irradiation	6.77			
	Sub-Total	7.93		1.37 Consultant Man-Months	
6400 Biological Research	Miscellaneous	3.07)		1.75)	
	Instrumentation	2.00)		-)	
	C_{14} Metabolism	2.18)		0.58)	
	Use of Radioactive Material in Human Physiology	12.32)		4.56)	
	Trace Elements	3.47)		0.60)	
	Physical Biochemistry	12.32)--	9.68	2.73)--	2.02
	Biochemical Response to Radiation	4.61)		1.06)	
	Metabolism of Lipo-proteins	5.67)		9.35)	
	Iron Metabolism Hematopoiesis	2.73)		-)	
	Biological Effects of Cosmic Radiation	1.96)		-)	
	Radiation and Mutation Rate	1.45)		0.48)	
	Bio-organic Chemistry	27.49	2.44		
	Metabolism of Fission Products	17.79	1.12		
	Animal Colony	1.40	0.60	3.25	
	Sub-Total	98.46	13.84	24.36	2.02
6500 Biophysics Research	Health Physics	4.30			
	Irradiation Studies	4.08		1.08	
	Sub-Total	8.38			
TOTAL BIOLOGY AND MEDICINE RESEARCH		114.77	13.84	26.81	2.02
	GRAND TOTAL - OPERATIONS	624.43	64.73	26.81	2.02

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