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MONTHLY PROGRESS REPORT NO. 121

April 15, 1953 to May 15, 1953

June 2, 1953

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UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

April 15, 1953 to May 15, 1953

MONTHLY PROGRESS REPORT NO. 121*

June 2, 1953

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

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Fast Deuterons from 340 Mev Protons on Nuclei

The yield of deuterons from 340 Mev protons bombarding carbon at 40° to the beam has been measured by using the magnetic particle spectrometer previously described in these reports. The deuterons were separated from protons by momentum and range. Wedge shaped absorbers of 0.3, 0.6, 0.8, 1.2 and 2.0 deuterons ranges thickness were used. The yield of charged particles using these absorbers was essentially flat from 0 to $0.6R_D$. From $0.6R_D$ to $1.2R_D$ the yield dropped 5.8 ± 1.4 percent. From $1.2R_D$ to $2.0R_D$ the yield dropped very slightly. Since no appreciable decrease in yield from 1.2 to $2.0R_D$ is seen, the effect of nuclear attenuation of protons in the absorber is small. Tritons and alpha particles would be absorbed in the region 0 to $0.6R_D$. The results indicate that the yield of tritons and alpha particles is essentially zero. The drop in yield from 0.6 to $1.2R_D$ must result from deuterons being absorbed. This corresponds to a differential cross section for deuterons of about 4 millibarns per steradian.

The energy spectrum of these deuterons showed a peak at about 60 Mev, was down to zero at 110 Mev, and had fallen somewhat at 40 Mev. It is hoped that shortly a determination can be made of the variation of this yield with atomic number. This would help show whether these deuterons could result from a pick up process.

Detection Efficiency of Three Millimicrosecond Counting Equipment

A calibration run was made to measure the efficiency of the fast counting equipment for the detection of protons that lose about 8 Mev in stilbene phosphors. Four stilbene phosphors, each 2.4 gm/cm^2 thick, were placed in the 340 Mev scattered deflected external proton beam of the 184-inch synchrocyclotron. The protons were collimated both fore and aft of the steering magnet. The jaws of the pre-magnet collimator were closed down to 0.10 inch by 0.10 inch. The 40 inch long brass collimating tube was one-fourth inch in diameter. Photographs were taken to ascertain that the beam passed through the centers of the 3.25 square inch phosphors. The proton beam intensity was reduced to about five protons per second by operating the source at reduced arc voltage, reduced tank filament current, and reduced filament voltage.

* Previous report UCRL-2200 (No. 120)

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Alternate counters were connected in double coincidence through similar pulse shaping circuits. The output of each crystal diode coincidence circuit was fed through a pulse lengthening amplifier and a linear amplifier to a discriminator circuit. The output of each discriminator circuit was recorded on a scaler. In addition, if the discriminator circuit is tripped by the output pulse from a fast coincidence circuit, a shaped pulse of constant amplitude and duration is generated.

These shaped pulses are fed into a slow double coincidence circuit D_3 . The efficiency of this slow double coincidence circuit D_3 is assumed to be 100 percent for the detection of these shaped pulses. If ϵ_1 and ϵ_2 are the detection efficiencies of channels one and two respectively, then $D_1 = \epsilon_1 N$, $D_2 = \epsilon_2 N$, and $D_3 = \epsilon_1 \epsilon_2 N$, where D_1 and D_2 are the number of fast double coincidences recorded in channels one and two, D_3 is the number of slow double coincidences, and N is the number of true coincidence counts. D_1 , D_2 and D_3 are measured and the equations solved for the three unknowns ϵ_1 , ϵ_2 and N .

The results of this calibration run are expressed in a curve of the absolute detection efficiency for protons losing 8 Mev in each stilbene phosphor against the length of delay line. The detection efficiency is nearly 100 percent around the peak of this resolution function. The resolving time τ , defined as one-half the full width at half maximum, is just about three millimicroseconds. The resolving time can be shortened at the expense of detection efficiency. The detection efficiency of the quadruple coincidence circuit is the same as that for the double coincidence circuit.

The Elastic Photoproduction of Neutral Pions from Deuterium

The design of the magnetic channel used to help identify the protons and deuterons is being improved. A larger and more efficient photon telescope is under construction. Further runs will be scheduled upon the completion of the deuterium liquifier and the special deuterium chamber required for this experiment.

Photoproduction of Negative Pions from Deuterium

Some of the calculations have been completed, and the results have been compared with experiment. A more detailed report appears in the Physics Quarterly Report.

Inelastic Scattering

The activities of the past month centered around a one week run on the linear accelerator. The results of this run were very favorable; it provided the bulk of the data required for two theses. One more short run to check a few points should bring the heavy element inelastic scattering experiment to a successful conclusion.

Time of Flight Neutron Spectroscopy

The time of flight techniques described in previous reports has been investigated more thoroughly, especially with regard to charged particle distributions in the region of the probe used to establish the reference time. Using a thin (1/16 inch) copper probe, it has been found possible to obtain a single clear pulse of incident deuterons. The distribution of charge pulses in the deflected region is complicated, but under all cases of parameter settings it is possible to find a probe radius such that the probe intercepts only one charge pulse.

Using the new probe, an attempt to measure the cross sections of U, Bi, Sb, and C has been made. The data film is now being analyzed.

Ether Bubble Chamber

An ether bubble chamber similar to the one described by Donald Glaser [(Phys. Rev. 87, 665 (1952); Bull Am. Phys. Soc. 28, 72 (1953)], has been constructed and operated with moderate success. Bubbles have been shown to be formed by ionizing particles. At present, attempts are being made to obtain photographs of charged particle tracks in the chamber.

The liquid in the chamber is maintained at a constant temperature, T, by means of a heat reservoir. This temperature (approx. 120° C) is 88° higher than the boiling point at atmospheric pressure. The chamber is maintained in a liquid state by about 20 atmospheres pressure. The chamber is then expanded to a final pressure of one atmosphere, where it is a pure liquid in a superheated state.

The surface tension of the liquid suppresses formation of vapor bubbles. If there were no impurities and no ionization, the system would remain in the superheated state indefinitely. The effect of ionization is to give clusters of electric charge that compensate the effect of surface tension and hence, allows bubbles to form. With bubble formation, the pressure rises to the vapor pressure at the temperature T.

Work is in progress to construct a chamber that will operate first with liquid nitrogen, and later, with liquid hydrogen.

Film Program

Experiments performed during this period were (a) momentum distribution of disintegration products from Ni under 340 Mev proton bombardment and (b) interactions of 386 Mev α -particles and 341 Mev protons in G-5 nuclear emulsion. The plates are now being processed for scanning.

Progress has been made on the following researches: (a) γ -ray energy spectrum from C when bombarded by 160 Mev and 330 Mev bremsstrahlung beams; (b) γ -ray energy spectrum from Be under 340 Mev proton bombardment; (c) meson mass and energetics of meson decay; (d) spallation products from various targets under proton, deuteron, and alpha bombardment; (e) high energy β -ray spectra; (f) nuclear scattering of high energy electrons; and (g) 90° photomeson production from hydrogen using the spiral orbit spectrometer.

Cloud Chamber Studies

The 35 atmosphere diffusion chamber has been operated at 29 atmospheres using helium gas. The tracks observed at this pressure are satisfactory and modifications are being made to increase the vapor supply and deepen the sensitive region.

Measurements have been made to determine the magnetic field inside the 35 atmosphere chamber, with the chamber in place in the cloud chamber magnet in Bldg. 6. Maximum field is approximately 22,000 gauss with pulsed operation of the generator, and the field varies about 10 percent over the sensitive region of the chamber.

A vacuum positioning system for the film in the new stereoscopic camera has been constructed. This system improves the focus since the whole surface of the film is now held against a flat plate, where the former system supported it only at the edges and some sagging occurred.

A camera mount and shutter have been built to allow the use of a cloud chamber camera in recording magnetic measurements for the bevatron. One lens of the camera records an oscilloscope trace and the other records information about the position of the measurement.

Analysis of events produced by 270 Mev neutrons on helium is being continued. More than 500 events have been measured and calculations are being made on these events.

Analysis of the data obtained in the linac run using 32 Mev protons on helium is under way.

Synchrotron Studies

Some experimental running on the synchrotron was done to find conditions suitable to running counter experiments at reduced energy. At full energy the beam comes out over a time of 2500-3000 μ sec. At three-fourths energy (reducing the magnetic field to 75 percent), somewhat similar conditions to those used at full energy give a 50 μ sec beam. However, by adjusting the rf voltage somewhat higher and carrying a good

fraction of the beam into the deceleration region, it is possible to obtain about one-tenth the intensity spread out to 3000 μ sec. At still lower energy, about 150 Mev, a beam of 150-200 μ sec length, was obtained. This should be useful for some kinds of counting experiments.

The main running during the month was for the low energy photo-meson experiment. The spiral orbit spectrometer was used in the beam to detect photomesons from C and CH₂ in nuclear emulsions. By using both directions in the plate position in the magnetic field, both π^- and π^+ mesons were measured. Plates are being examined at the present time.

Some valuable experience in correcting for external magnets was also obtained, in order to get large synchrotron beams with spiral orbit spectrometer. The stray field is large and an excellent arrangement of shielding has been worked out. This should help materially when the larger spiral orbit spectrometer is used.

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

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Meson Production and Scattering

The effect of the meson-nucleon interaction in the final state of the reactions $p + p \rightarrow \pi^+ + n + p$ has been investigated. The proton energy distribution has been found to be much more sensitive to the interaction than that of the meson.

The angular distribution for the reaction $n + d \rightarrow \pi^- + p + d$ is being calculated, phenomenologically, assuming charge symmetry.

Field Theory

The examination of the relativistic bound state formalism, in particular the definition of the energy of the system, is being continued.

The work on the high energy Compton scattering on nucleons, using the classical extended source model has been written up.

The investigation of the meson-nucleon scattering in the radiation damping theory continues.

Work on the meson-nucleon equation in the adiabatic limit is continuing. By returning the equation to co-ordinate space (approximately) and replacing the Yukawa functions by square wells, a rigorous equation for the large component was obtained. It was found that the V_1^0 lifetime could be obtained assuming that the particle is in an $\ell = 5$ ($j = 11/2$) virtual state of the $p - \pi^-$ system.

A study of the one nucleon Green's function in the absence of an external field has been started. Attempts are being made to take account of the non-linearities in the equation.

A consistent method of treating meson scattering in the Tomonaga approximation has been developed and numerical calculations of scattering cross sections are being carried out. New methods have been discovered for obtaining precise information about the ground state meson wave functions.

A study of the theory of particles of half integral spin is being made in an attempt to construct a relativistic description of heavy particles (nucleons) which does not involve the negative proton.

Nuclear Reactions

A study of the statistical theory of nuclear reactions is being undertaken with a view to resolving some of the disagreements of theory with experiment.

The inelastic scattering of medium energy protons by nuclei has been reexamined in an attempt to improve previous calculations which correlated the angular distribution with the change in the angular momentum between the initial and final nuclear states. The agreement with experiment is still unsatisfactory.

The cross section and angular distribution for the reaction $d + d \rightarrow H_3 + p$ are being calculated.

Miscellaneous

A calculation of the bremsstrahlung spectrum from 300-500 Mev electrons, including target corrections, is in progress.

The phase variations of particles in a cyclotron operated with two 90° dees driven in phase have been studied in connection with projected modifications of the 60-inch cyclotron. The proposed use of an approximately square r. f. wave form is equivalent to an increase of $\pi/2$ in dee voltage.

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

In the past month the first cyclotron run was made with the deuterons from stripping of the 95 percent He^3 . The maximum beam obtained was 5×10^{-13} amperes, which agrees very well with the maximum of 2×10^{-14} amperes usually obtained with the 4 percent He^3 . In view of the apparent success of the experiments reported two months ago in sharpening the energy-

distribution in the beam by means of internal collimators, it was thought desirable to re-run the attenuation curve for the emergent deuterons with the internal collimators in place. The internal collimators, however, reduced the intensity of the beam by a factor of 20, which, combined with an abnormally high grid current in the Faraday cup electrometer tube, rendered these attenuation measurements very uncertain.

A cyclotron run was made using the 320 Mev deuteron beam in the water tank, and a yield of 8.4 neutrons per incident deuteron was obtained. This figure is certainly minimal, since the average energy of the beam is uncertain and corresponds, by extrapolation of known yield data, to a deuteron energy of around 300 Mev, which seems quite reasonable.

An exploration of the beam pattern is being prepared by means of small ion chambers placed inside the cyclotron before the focus magnet, in an attempt to gain more beam intensity. On two occasions beams of 2×10^{-13} amperes, or about ten times higher than normally obtained, were observed with the 4 percent He^3 , and the source of the high beams is not clear.

The loss of the 95 percent He^3 in about 20 hours of actual running time has been too small to be measurable (certainly less than 1 percent), and the new shaft seals on the Kinney pump seem to be working perfectly.

Work is continuing on the neutron time-of-flight experiment, and some success has been made in developing a fast limiter circuit, which is at present the main obstacle in completion of the equipment.

The liquid scintillator tank has worked quite well in the detection of artificial sources, such as the β -rays from P^{32} and the α -rays from plutonium, and tests are now being made to find suitable neutron-sensitive solutes, such as compounds of cadmium, boron, or mercury which do not affect the scintillator solution.

4. ACCELERATOR CONSTRUCTION AND OPERATION UNCLASSIFIED

Bevatron Construction (Program No. 9001)

Magnet. The last pole tip plates were shipped on May 13. This completes the delivery from the Verson Manufacturing Company of the approximately 1500 tons of steel used for the magnet pole bases and tips. Approximately 70 percent of the pole tips have been assembled but none are yet installed. Delivery of insulating material required for attaching the supporting conduits for the pole face winding is expected the first week in June.

Vacuum System. After three of the quadrant tanks had been completed, it was decided to make tests on the insulation of the gasket joints at a higher voltage than had been previously used. This was due to the realization that these joints would be subjected to approximately 12 volts in operation and the failure of enough joints to complete a current loop around the poles of one quadrant would undoubtedly result in a damaging arc. It was found that voltage breakdown occurred in several places at voltages between 100 and 300 volts. Examination of these joints, as well as some which still exhibited short circuits when tested with a low voltage meter, showed the presence of metal chips and burrs around the hole which could lead to shorts in the future. Accordingly it was decided that a thorough job of deburring and cleaning these insulated joints should be undertaken and that the two quadrant tanks installed should be removed for this purpose. In addition, a coating of paint is to be applied to the metal surfaces where it will improve the insulation, and splices now existing in the bars which run the length of the quadrant tank are to be insulated.

Preliminary estimate is that this additional work will add about a month to the completion time of the bevatron. Tests are being made of the ability of the typical joints to hold voltage and the mechanism of failure. Circuits will be installed to permit checking the resistance of the important joints after the magnet is assembled.

Injector. Testing of the pre-exciter oscillators of the linear accelerator has started. Operation of the main oscillator is expected to begin the week of May 18.

Accelerator. The accelerating electrode has been installed to the point at which its capacity to ground could be measured. This was found to be somewhat smaller than expected, which will reduce the exciting power slightly. Installation work in progress at the end of the period was primarily piping for the water cooling of the power amplifier and oil cooling of the saturable reactors. Testing of the frequency control and driver system is continuing.

184-inch Cyclotron Operation (Program No. 5741)

The cyclotron was used for research experiments approximately 97.3 percent of the 515.25 hours that the crew was on duty. The time distribution was as follows:

Operation for customers	501.25 hours	97.28 percent
Electrical troubles	5.50	1.07
Mechanical troubles	2.75	0.53
Miscellaneous	<u>5.75</u>	<u>1.12</u>
Total	515.25 hours	100.00 percent

184-inch Cyclotron Conversion (Program No. 4900.02)

The design of the auxiliary magnet coils for the conversion was completed during this period and requests for quotations were sent to three possible fabricators. Schedules for delivery of the coil copper and insulation indicate that it will be possible to obtain the completed coils by the end of the calendar year.

The design work on the revised one-half scale rf model has been completed and shop orders issued. Experimental work on the vibrating condenser blades has continued, and it is hoped that it will be possible to arrive at a firm design during the next quarter.

Theoretical and preliminary experimental work is still in process on the various proposed deflectors. The electron model of the 184-inch cyclotron is nearly ready for the operation to test some of these methods.

Studies are under way on the shielding requirement which will result from the increased energy and on certain revisions to the experimental facilities, such as "the meson cave", revisions to the proton probe and an internal target in which the mesons will be produced.

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

Continued good operation with alphas, protons, and deuterons have resulted from the removable feeler structure mentioned in previous reports. The flexibility of removing it during C^{+6} operation has also enhanced the performance with this particle. The overall operating efficiency has exceeded 80 percent.

Synchrotron Operation (Program No. 5731)

The synchrotron has continued its high performance operation during this report period.

The electron linear accelerator has been put back in operation. It is now producing a high current beam at 3-4 Mev. The average current is 2.4 microamperes produced with 7.5 pulses per second, 2 microseconds per pulse. This current is 0.160 amperes peak during the pulse.

A program to increase the electron linear accelerator beam is under way. This program is investigating injector optics, emitters and strong focusing.

A number of physics bombardments for various groups has been made using the electron beam from the electron linear accelerator.

The inflector program for getting this linear accelerator beam into the synchrotron is continuing. Tests are being made on the inflector assembly mounted in the 120° mockup of the synchrotron magnetic field.

Operating statistics are as follows:

Operation for customers	161.3 hours	45.8 percent
Tests with the synchrotron	65.5	18.6
Maintenance	<u>125.3</u>	<u>35.6</u>
Totals	352.1 hours	100.0 percent

Linear Accelerator Operation (Program No. 5751)

The total operating time of 480 hours was distributed as follows:

Running time (physics research)	370 hours	78 percent
Repairs	100	20
Maintenance	<u>10</u>	<u>2</u>
Totals	480 hours	100 percent

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

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Radioactivity of Sm¹⁴⁶

Previous work by ordinary counting methods in this laboratory failed to detect the alpha activity of Sm¹⁴⁶ produced by cyclotron transmutation. Recent experiments by the nuclear emulsion technique have detected a few tracks in the energy range 2.5-2.6 Mev in an abundance which corresponds to a half-life of the order of 10⁸ years.

Radioactivity of Astatine

The electron capture decay of At²¹¹ is a simple transition to the ground state of Po²¹¹.

The decay of At²¹⁰ by electron capture is followed by at least five gamma rays with energies 44.1, 190, 239, 1180, and 1450 kev. The decay scheme is not yet determined.

Thallium Isotopes

The time of flight isotope separator has been used to separate Tl¹⁹⁸, Tl¹⁹⁹, and Tl²⁰⁰. The latter two were found with half-lives of 7.4 hours and 28 hours, in good agreement with the accepted values of 7 and 27 hours. The Tl¹⁹⁸ showed a 5.3 hour activity which must be an isomer of the 1.8 hour activity also assigned to this isotope. The new activity is formed in lower

activity than the 7 hour Tl^{199} , and therefore escaped detection in the earlier experiments without isotope separation. The gamma spectrum of the new Tl^{198} is simpler than that of Tl^{199} , and therefore the activity cannot be attributed to defective separation of the isotopes.

Crystal Structure of Lithium Amide

A powder diffraction pattern of lithium amide can be explained by a tetragonal unit cell with $a = 5.04 \text{ \AA}$, $c = 10.26 \text{ \AA}$. The stronger lines of the pattern all correspond to a pseudocubic cell with c half as large and have intensities corresponding to a ZnS type structure. Thus the correct structure is probably closely related to the ZnS structure.

Autoreduction of Americium

Some observations on the autoreduction of americium solutions have been explained by the following mechanism. The reducing agent is hydrogen peroxide, formed from water by the alpha particles. The reduction of AmO_2^+ to Am^{3+} by hydrogen peroxide is slow, so that there is an induction period during which the concentration of hydrogen peroxide is building up. The reduction of AmO_2^{++} to AmO_2^+ is fast, with no induction period, and no AmO_2^+ is reduced until all the AmO_2^{++} is gone. Addition of Zr^{+4} , which forms a peroxide complex, inhibits the reduction of AmO_2^+ .

Metals and High Temperature Thermodynamics

Work is in progress on the following problems: refractory silicides, molybdenum chlorides, alkaline earth oxide gases, carbon fluorides, and the thermal conductivity of gases at high temperatures.

Basic Chemistry

The following problems are under investigation: studies involving liquid ammonia as a solvent, the thermodynamics of indium (See UCRL-2202), ferric fluoride complex ions, the hydrolytic polymerization of zirconium, the thermodynamics of sulfide ion (See UCRL-2108), the oxidation-reduction chemistry of RuO_4^- , RuO_4^- and RuO_4 (Work completed. Results to be published shortly.), a study of hydrates, the thermodynamics of thiosulfate, and bromate thermodynamics.

Process Chemistry

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

Health Chemistry

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

1. The equipment to be used in processing large quantities of special soil was completed, including 2-in. lead shields for the chemistry boxes. Equipment for opening slugs, consisting of material from this operation bombarded in the Idaho Falls reactor was completed as was the quartz capsule crusher. One such irradiated capsule has been processed and a second slug is now in the reactor and the equipment is being readied for its return.
2. Equipment for the low geometry counter to be used in the Cave Room (Room 107) of Bldg. 5, described in the February 15-March 15 progress report, is almost complete.
3. A 160-curie Co^{60} source, from Oak Ridge, was transferred from its shipping container to its permanent housing. This source is for use in Livermore.
4. The largest part of the time spent by this group has been used in designing and fabricating boxes and auxiliary equipment for processes at Livermore.
5. The vacuum line box for C^{14} work has been redesigned and completed.
6. The electronic welder for fabricating plastic tank liners, cable sheathes in active boxes, ball-sockets and tong shafts and other remote control devices in two-inch lead caves, etc., has been improved in design and completed.
7. Ten Berkeley Boxes have been assembled, fitted and delivered on requests from researchers.

The number of targets from the various accelerators handled by the Health Chemistry Transportation group was 107; the average handled during the previous months for the past three or more years has been approximately 60. During the present period over one-third of the 107 targets were handled during off-hours.

6. BIOLOGY AND MEDICINE
(A. E. C. Program No. 6300-6500)

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Biological Effects of Radiation

Studies with the 184-inch Cyclotron. Dosimetry. Cadmium sulphide crystals are presently being used with a. c. amplifiers on the pulsed deuteron beam and it is hoped that this method will shorten the time lag inherent in the cadmium sulphide crystals when they are used for dose distribution measurements.

In collaboration with Professor Chaikoff, a group of thyroidectomized rats were irradiated in the pituitary to elucidate the role of radiation in the etiology of pituitary tumors.

Studies with the 60-inch Cyclotron. Physical measurements of the rate of energy loss of six times ionized carbon particles and their dosimetry have been sufficiently advanced to obtain reliable measurements of the lethal effect of carbon ions on haploid yeast cells. This was done at two different regions of energy loss, both above that available with alpha particles. It was found that carbon ions become biologically less effective as their rate of energy loss increases and it would appear that the biological effectiveness decreases in agreement with the simple hit theory. The complete RBE curve available for the haploid yeast cells shows an RBE of one at low specific ionization, an increase in the alpha particle region and a sharp decrease in the carbon particle region. A detailed report is being prepared.

Scintillation Counter Scanner. The scanner previously reported has been rebuilt with new photo tubes smaller in size than the ones used previously and with a larger lead shield to cut down background. The thicker shield will permit the use of isotopes with higher gamma ray than was possible previously.

Head to toe scanner pictures have been taken of patients injected with fifty microcuries of Fe⁵⁹. The images obtained are faint, but show localization in the spine and pelvic regions. In one patient localization is shown in the regions of the liver and spleen.

Liver and spleen pictures are being taken of various patients injected with fifty microcuries of colloidal Au¹⁹⁸. So far only a few of the pictures have shown the spleen due apparently to the low amount of activity present in the organ. More pictures will be taken, probably with a higher dose.

Colloidal Gold Studies

Studies have been initiated of the rate of disappearance from the blood of colloidal gold and its rate of appearance in the liver. This has been done in cooperation with Dr. Strajman and Mr. Hal Anger who has made gamma-ray photographs of the gold in the spleen and the liver of these patients.

Nucleic Acid Metabolism

The testing of tissue extracts that stimulate nucleic acid (DNA) formation is continued. Additional confirmation has been achieved for partial protection of mice after irradiation using extracts of homologous tissues.

The search for the isolation of the active principal is continuing both in homologous and heterologous tissues.

Fat Metabolism

Lipoprotein disturbances in the irradiated animal is being investigated for the rat, the mouse, and the dog. Some clinical studies have been done in man at relatively low irradiation dosage.

The nature of the action of heparin in clearing the blood of high molecular weight lipoproteins has recently been shown to be a specific hydrolysis of the neutral fat of lipoproteins by a serum lipase (heparin active factor). Lipoprotein interconversions have been accomplished in vitro in which high S_f lipoproteins are converted into lower S_f lipoproteins with a lowering of glycerol ester and a release of fatty acids. This conversion appears to be the same as the normal process in vitro of lipoprotein interconversion.

Tracer Studies

The studies on the removal of curium from rats by the use of the chelating agent versene have been completed.

Experiments on a means of deposition of aerosols in the lungs of primates have been completed and the deposition of these aerosols is in progress.

The relative biological effects of beta emitters and therapeutic doses of astatine on rats and primates including the application of histological and radioautographic investigations are currently under way.

Radiation Chemistry

Studies of radiation effects in aquo-organic systems are continuing. Acetone has been tentatively identified as a product from irradiated acetic acid solutions. Other organic acids of known purity are being prepared for further radiation studies. The irradiation assembly has been modified for proton bombardments.

Plant Biochemistry

Studies on the fundamental nature of plant photosynthesis are continuing. This research is designed (1) to determine the metabolic pathways of carbon in plants during the processes by which carbon dioxide is transformed into the plant's carbohydrates, proteins and fats, and (2) to determine the method by which sunlight (ultraviolet radiation) is transformed into chemical energy in the plant. The main projects which are now underway and which are directed towards these ends are:

1. The role of 6-thioctic acid in the transfer of light energy to chemical energy in photosynthesizing plants is under investigation. Syntheses of S^{35} -labeled thioctic acid are being made by means of an exchange reaction of the unlabeled compound with radioactive sulfur.
2. A flow system is being used to determine the compounds into which radiocarbon is incorporated during very short periods (5 seconds and less) of photosynthesis.
3. A search is continuing for the important sulfur- and phosphorus-containing metabolites of plant photosynthesis.
4. The "steady-state" reservoir sizes of important algae metabolites are being determined.
5. A study is being made of the Hill reaction and of the effect of thioctic acid upon the rate of this reaction.

Animal Biochemistry

Research in animal biochemistry is in progress on the following topics:

1. C^{14} -labeled adenine is being used to determine the turnover rates of nucleotides and nucleic acids in mice. Attempts are being made to find differences in these rates between normal and tumor-bearing mice.
2. Attempts are being made to find differences in the rates of appearance of atherosclerosis in cholesterol-fed and lathosterol-fed rabbits.

3. C^{14} -labeled glucose is being used to determine the "glucose-space" in the dog. These studies have an important bearing on the problem of diabetes.
4. The sodium acetate metabolism of pantothenic acid deficient rats is being studied.

Organic Chemistry

Research in organic chemistry is taking place on these subjects:

1. A program is underway to determine the effects of high energy beta and gamma irradiation on various organic compounds. Determinations will be made of the influence of various organic functional groups on the susceptibility of organic molecules to radiation decomposition.
2. Methods for the syntheses of C^{14} -labeled diethyl malonate, morphine and various peptides, and of S^{35} -labeled thiocetic acid are being investigated.
3. A synthesis of C^{14} -labeled tripalmitin is underway.
4. Chemical degradations of ribulose and sedoheptulose are under investigation.

7. PLANT AND EQUIPMENT REPORT UNCLASSIFIED

Bevatron (Account No. 5-271-9001)

Three curved tanks have now been completed and at present two are in place in the magnet. Approximately 80 percent of the steel for the pole tips has been delivered and 75 percent of the pole tips have been assembled. The fourth tangent tank has now been installed. The accelerator electrode and the house for housing the oscillator have been installed. The injector is approximately 90 percent complete.

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

Swinerton and Walberg, the general contractors, are now working and their grading subcontractor, Ariss-Knapp, is moving earth and preparing the site for construction. The heating, ventilating and air conditioning contract, which was awarded to Coast Heating and Air Conditioning Company, was recorded on May 6, 1953. The other contracts on Building 70 are in various offices for approval.

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

The building is presently being reconsidered by the Bureau of the Budget.

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

Drawings and specifications have been completed for the Gamma House and Destructor and will be sent out for bid in the near future when a formal site approval has been given by the Chancellor.

Bids on a Sprinkler System in Building 14 have been received and an award made. Work will start in the near future.

Plans and specifications for alterations to the Director's Office, Building 50, are now being completed.

MAN-MONTHS EFFORT REPORT
SCIENTIFIC PERSONNEL

Program No.	Subdivision	Man-Months Effort	Comments
<u>Operations</u>			
4000 M. T. A.	Design and Development	18.01	
5211 Basic Physics Research	General Physics Research	55.11	
	Theoretical Studies	13.82	
	Film Detection	15.54	
	Cloud Chamber	9.67	
	Magnetic Measurements	2.34	
	General Instrument Design	4.77	
		<u>101.25</u>	
5311 Basic Chemistry Research	Chemistry of Heavy Elements	5.10	
	Nuclear Properties of Heavy Element Isotopes	7.51	
	Transmutations with 184-inch and 60-inch Cyclotrons	3.48	
	Analytical and Services	18.05	
	Mass Spectroscopy, Beta Ray Spectroscopy	1.50	
	Instrument Development and Services	3.67	
	X-ray Crystallographic Measurements	2.83	
	Radiation Chemistry	1.00	
	High Temperature and Special Chemistry	6.00	
	Health Chemistry Research	9.26	
		<u>58.40</u>	
5361 Applied Chemistry Research	Process Chemistry	5.18	
5731 Electron Synchrotron	Operations	10.52	
5741 184-inch Cyclotron	Operations	10.73	
5751 Linear Accelerator	Operations	18.65	
5761 Bevatron	Operations	8.54	

MAN-MONTHS EFFORT REPORT
SCIENTIFIC PERSONNEL

Program No.	Subdivision	Man - Months Effort	Comments
6300 Biology and Medicine	Health Medicine	1.99	-
	Metabolic Ward	-	-
	Internal Irradiation	6.27	1.75 Consultant
		8.26	Man-Months
6400 Biological Research	Miscellaneous	2.67	2.73
	Instrumentation	2.26	-
	C ₁₄ Metabolism	5.25	0.25
	Use of Radioactive Material In Human		
	Physiology	10.88	4.39
	Trace Elements	3.64	0.49
	Physical Biochemistry	13.20	3.65
	Biochemical Response to Radiation	4.07	0.50
	Metabolism of Lipoproteins	5.35	8.85
	Iron Metabolism Hematopoiesis	3.96	0.50
	Biological Effects of Cosmic Radiation	2.35	0.12
	Radiation and Mutation Rate	2.00	0.25
	Bio-organic Chemistry	26.74	-
	Metabolism of Fission Products	16.58	-
	Animal Colony	3.00	2.93
6500 Biophysics Research	Health Physics	3.03	-
	Irradiation Studies	4.32	0.63

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