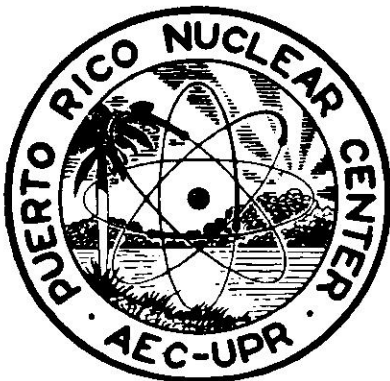


PUERTO RICO NUCLEAR CENTER

RESEARCH ACTIVITIES

AT

PUERTO RICO NUCLEAR CENTER



OPERATED BY UNIVERSITY OF PUERTO RICO UNDER CONTRACT
NO. AT (40-1)-1833 FOR U. S. ATOMIC ENERGY COMMISSION

PUERTO RICO NUCLEAR CENTER

Dr. John C. Bugher
Director

Dr. Henry J. Gomberg
Deputy Director

The Puerto Rico Nuclear Center was established in October 1957, and is operated by the University of Puerto Rico for the U. S. Atomic Energy Commission. The purpose of the Center is to offer comprehensive programs for research and advanced training in nuclear science and engineering and in the peaceful applications of nuclear energy in medicine, agriculture and industry. The Puerto Rico Nuclear Center in support of formal education assists in the Professional and Master's degree programs of the University of Puerto Rico and offers to qualified students from all areas opportunities for research at the master's, doctorate and post doctorate levels.

The main Reactor Building of the Center is located at Mayaguez, where a one megawatt swimming-pool type reactor is operated. The power level is to be increased to 2 megawatts by September 1963 and later to 5 megawatts. The reactor is equipped with two eight-inch and four six-inch beam tubes, with a present neutron flux of nearly 10^{13} neutrons /cm²/sec. Four of these beam tubes are at present in use. The thermal column has recently been modified to give a more uniform thermal neutron flux of 10^8 neutrons /cm²/sec.

The Center at Mayaguez also possesses a natural uranium graphite moderated pile and an L-77 aqueous uranyl sulfate reactor with a beam tube flux of 10^8 neutrons /cm²/sec. A gamma room, using activated fuel elements is adjacent to the reactor pool, as are two interconnecting hotcells with mechanical manipulators. A gamma pool is equipped with twelve, twelve inch cobalt-60 capsules with a total activity of 2,000 curies. The associated facilities include laboratories, greenhouse and workshops.

In Río Piedras the Bio-Medical Building of PRNC is located in the new Medical Center adjacent to the Dr. I. González Martínez Oncologic Hospital. Its proximity to the other medical facilities located in this area facilitates extensive research and training activities in the Medical and Biological fields. A well rounded program of chemical research is also conducted here.

Facilities include an 8,000 curie Co-60 therapy unit, X-ray units, a 3,000 curie Co-60 source in a shielded underground room, smaller plutonium-beryllium neutron sources, photochemistry laboratories, organic chemistry laboratories, a radiochemistry laboratory and counting room, an agricultural laboratory, an autoradiography dark room, a clinical radioisotopes laboratory, and an animal house.

In addition to the facilities located in Río Piedras and Mayaguez, the Nuclear Center operates a 100 ton oceanographic research vessel and conducts an extensive terrestrial ecology program in the El Yunque Tropical Rain Forest.

The following pages contain summaries of the more important research programs being carried out at the Puerto Rico Nuclear Center. Requests for additional information on any one program should be sent to:

Dr. John C. Bugher, Director
Puerto Rico Nuclear Center
Bio-Medical Building
Caparra Heights Station
San Juan, Puerto Rico

RESEARCH AT MAYAGUEZ

BIOLOGY

MARINE BIOLOGY PROGRAM - Frank G. Lowman (Ph. D., Univ. Washington)

This research program is designed to determine the movements of selected trace elements from a land mass into sea water, marine organisms, and bottom sediments and to investigate the cycling of these elements in the food webs and in the open sea environment. The movements of the trace elements are being correlated with measurements of biological productivity, movement of organic compounds through the food webs, and physical and chemical oceanographic measurements.

For the work at sea a 100 ton ship, the Shimada, is equipped with three research laboratories, over-side work platforms, an oceanographic A-frame and associated equipment.

Methods have been and are being developed for the determination of tracers of stable isotopes by activation analysis. Scandium, antimony and phosphorus can be determined to 5×10^{-9} gms, 5×10^{-9} gms., and 5×10^{-8} gms. respectively. The methods are applicable to marine samples, sea and river water, bottom sediments, sands, rocks, and minerals. Other methods have been developed for the analysis of silver 110, vanadium 52, manganese 56, cobalt 60, selenium 75, and iodine 128. The uptake of radioactive scandium and ruthenium by marine algae and tunicates is being investigated. It is intended to study the uptake of carbon 14 through photosynthetic processes in marine phytoplankton.

In order to provide background information upon the rate of addition of world-wide fallout to the land mass and marine environment of Puerto Rico, samples of rain water have been analyzed for cerium 144 and 137, praseodymium 144, ruthenium 106, zirconium 95, niobium 95, and barium 137 in relation to studies of world wide fallout. No cesium 137 was detected in terrestrial plants and this is contrary to expectation. In marine algae only zirconium 95, niobium 95, ruthenium 106, rhodium 106, and potassium 40 were found. No cerium 144, praseodymium 144, cobalt 57 and 60, and zinc 65 were detected, although these have been found in tests at the Pacific proving grounds.

Fluorescent dyes are being used to study the flow of water offshore from the BONUS Reactor site, in relation to the distribution of trace elements in this area.

MECHANISM OF BACK MUTATION - F. K. S. Koo (Ph. D., Univ. of Minnesota)

On the assumption that repeats exist at different levels in the genetic material, a mutation may be induced by impairment or loss of one of the members in the repeat and a back mutation by adding an identical member back through interchanges between homologous chromosomes or sister chromatids. This working hypothesis is to be tested by using yellow-green mutants of Oryza sativa in

which normal green stripes representing back mutation events are expected to be detected in leaves following seed irradiation. Since back mutation in this test system presumably involves interchanges between sister chromatids, chromosomes must first be induced into a bipartite condition before being irradiated. The first phase of the program, i.e., induction of mutations, is being carried out with the aid of gamma and neutron irradiation. This study may also shed light on the nature of gene structure in higher plants.

RADIATION AND CHEMICAL EFFECTS ON PLANT CHROMOSOMES AND CELLS - F. K. S. Koo
(Ph. D., Univ. of Minnesota)

The main objective of the program is to investigate the effects of radiation of low and high linear energy transfer on plant chromosomes and cells with particular reference to modification of the effects by chemicals such as radiosensitizing and protective agents. At present experiments are being limited to the studies of the effects of the halogenated thymidine analogues on chromosomes and especially their combined effects with radiation. The inhibitory effects of various chemicals on mitosis have also been explored with tropical plant materials.

PARAMUTATION RESEARCH - Duane B. Linden (Ph. D., Univ. of Minnesota)

Genetics regulatory systems which control gene mutation are being investigated with major emphasis being given to the paramutation system as it occurs in maize. The nature of the regulator and its product as well as the type of alteration that is produced are the problems to be solved. Radiation treatments of the components of the system have indicated that the type of change which occurs in this system is an inactivation process rather than a true mutational event.

Experiments are in progress or contemplated at the present time in several areas. Radiosensitivity curves of the regulator responsible for the paramutation change are being obtained. The site of action of the regulator is radiosensitive and dose response at this point is being studied. The efficiency of densely ionizing radiation from neutrons is being compared with sparsely ionizing gamma rays as an aid in determining the nature of the mechanism in this system. Biochemical studies include separation of DNA and RNA components by ultracentrifugation to characterize the regulator or its product.

INSECT CONTROL BY INDUCED STERILITY - David W. Walker (Ph. D., Washington State Univ.)

The sterility of *Diatraea saccharalis*, the lesser sugar cane moth borer, is being studied by gamma irradiation and by feeding radioactive isotopes. The study is being carried out jointly with the Federal Agricultural Experimental Station in Mayaguez and the Commonwealth Experiment Station in Rio Piedras.

Male pupae one to three days of age were irradiated at dose levels between 1000 and 12,000 rads and were mated with nonirradiated females. Males irradiated at dosage levels higher than 12,000 rads emerged but did not mate. A lower dosage level seems to act as a stimulant for mating in the irradiated males. The isotope tagging work will make use of phosphorus 32, sulphur 35, calcium 45, strontium 89, iron 59, and boron 10.

CHEMISTRY

THERMAL AROMATIC REARRANGEMENTS - Owen H. Wheeler (Ph. D., London)

The postulated intra-molecular nature of the Chapman rearrangement of phenylbenzimidazole ethers is being checked using carbon 14 labelled compounds.

The allied rearrangements of corresponding allyl ethers will be studied using tritium labelled compounds. It has been found that these rearrangements can be conveniently carried out using tetraglyme (tetra-ethylene glycol dimethyl ether) as solvent. Extensions of this work will include the investigation of the rearrangements of amidines and triazines.

GAMMA RADIOLYSIS OF ORGANIC COMPOUNDS - Owen H. Wheeler (Ph. D., London)

The mechanism of the gamma-induced hydroxylation of estrone and its derivations in aqueous and acetic acid solution is being compared with chemically induced hydroxylations, including that of Fenton's reagent.

The mechanism of the gamma photolysis of cyclic ketones is also being studied in relation to the mechanisms of ultraviolet photolysis.

CHEMICAL DOSIMETRY - Fausto Muñoz Ribadeneira (B.S.C.E. Polytech. Inst., Quito, Ecuador)

Cupric ion at concentrations of 10^{-3} - 10^{-1} M. has been found to stabilize the ceric dosimetry system so that ordinary distilled water can be used. A small reduction of the G (Ce^{+4}) value occurs from 2.50 ± 0.05 to 2.33 ± 0.01 . An empirical relation exists between the decrease in ceric G-value and the concentration of copper. The effects of other cations on this system are being studied.

ULTRASONICS AND MASS TRANSFER - Fausto Muñoz Ribadeneira (B.S.C.E. Polytech. Inst., Quito, Ecuador) and Rafael Muñoz Candelario (Ph. D., Brooklyn Polytech. Inst.)

Ultrasonics are being applied to the leaching of Uranium ores and liquid-liquid extraction of uranium concentrates. Dissolution and mass transmission rates will be determined under different conditions, and the "hot-spot" chemistry of the solutions investigated.

SZILARD-CHALMERS REACTION IN ORGANIC COMPOUNDS - Juan F. Facetti (Ph. D., Asunción)

The distribution of radioactive antimony 122 and antimony 124 between the tri and pentavalent oxidation states on irradiating antimony oxides with neutrons was studied. A linear relation between the composition of the oxide and the percentage of radioactive antimony V was found, and this is similar to results found with arsenic oxides. The thermal and gamma ray annealing of these compounds is being studied. The equipment used includes a NaI (Tl) crystal coupled to a multichannel pulse height analyzer. This work is being extended to other

isotopes of antimony formed by activation of tin and tellurium compounds. Neutron activations are carried out in the swimming pool reactor and gamma annealing with the cobalt 60 source.

SEARCH FOR NEW NUCLIDES - Juan F. Facetti (Ph. D., Asunción)

A number of gaps exist in the table of nuclides and the disintegration schemes of many known radioisotopes have not been fully investigated.

A new isotope of platinum, Pt^{201} , has been identified in the (H, α) reaction with Hg^{204} . The isotope has a half-life of 2.3 ± 0.2 min. and decays to Au^{201} . A search for other new isotopes formed from moderately heavy atoms through (n, α) reactions is being carried out.

HOT ATOM CHEMISTRY OF ORGANIC SULFUR AND PHOSPHORUS COMPOUNDS - Owen H. Wheeler (Ph. D., London) and Juan F. Facetti (Ph. D., Asunción)

The neutron activation of aromatic sulfur and phosphorus compounds is being studied with the sulfur and phosphorus in various valency states, in order to determine the mechanism of hot-atom reactions in such compounds.

The organic and inorganic radioactive fractions formed will be separated by gas-chromatography coupled to an ionization chamber (Cary Loenco) and by electrophoresis.

SULFUR DERIVATIVES OF STEROIDS - Owen H. Wheeler (Ph. D., London)

A number of derivatives of steroids incorporating mercaptoethylamine and cysteine in the side chain, at positions 17 and 20, and in sulfur rings A and B are being synthesized as possible radiation protecting compounds.

ENGINEERING

EFFECT OF RADIATION ON THE THERMAL EMISSIVITY OF GRAPHITE - K. Kenneth Soderstrom (M. S., Univ. Florida)

The effect of prolonged reactor irradiation of graphite on its thermal emissivity is being studied, using an assembly mounted in one of the 8" beam tubes.

THERMAL NEUTRON SHUTTER - Carlos V. Wheeler (B.S.M.E. - Chase Inst. of Tech.)

Two systems are being designed which will allow experimental animals and other materials to be irradiated with thermal neutrons, relatively free from fast neutrons and gamma rays.

One of these consists of an evacuated diffusion tube inserted into the reactor pool, and the other utilizes reflections from a highly polished curved metal surface.

PHYSICS

FERROELECTRIC PROPERTIES OF CRYSTALS - Julio Gonzalo González (Ph. D., Madrid)

Low temperature measurements of ferroelectric characteristics are made and radiation damage in ferro- and antiferro electric materials is being studied. The ferroelectric hysteresis behavior of crystals of tri-glycine sulfate has been studied over a range of frequencies and temperatures. A statistical model was applied to this compound which is in fairly good agreement with the experimental data.

Extension of these experiments will study radiation damage caused with X-rays and gamma rays as well as with fast neutrons. It is also planned to study the Mossbauer effect in ferroelectric crystals, with the object of determining a theoretical interpretation of the coercive field in ferroelectrics.

The equipment available includes a Sawyer and Tower circuit for displaying hysteresis loops and measuring their characteristics, as well as a General Radio bridge for accurate measurements of the electric constant.

PHOTOMULTIPLIER FATIGUE - Rev. Ignacio Cantarell (Lic. Physics, Madrid)

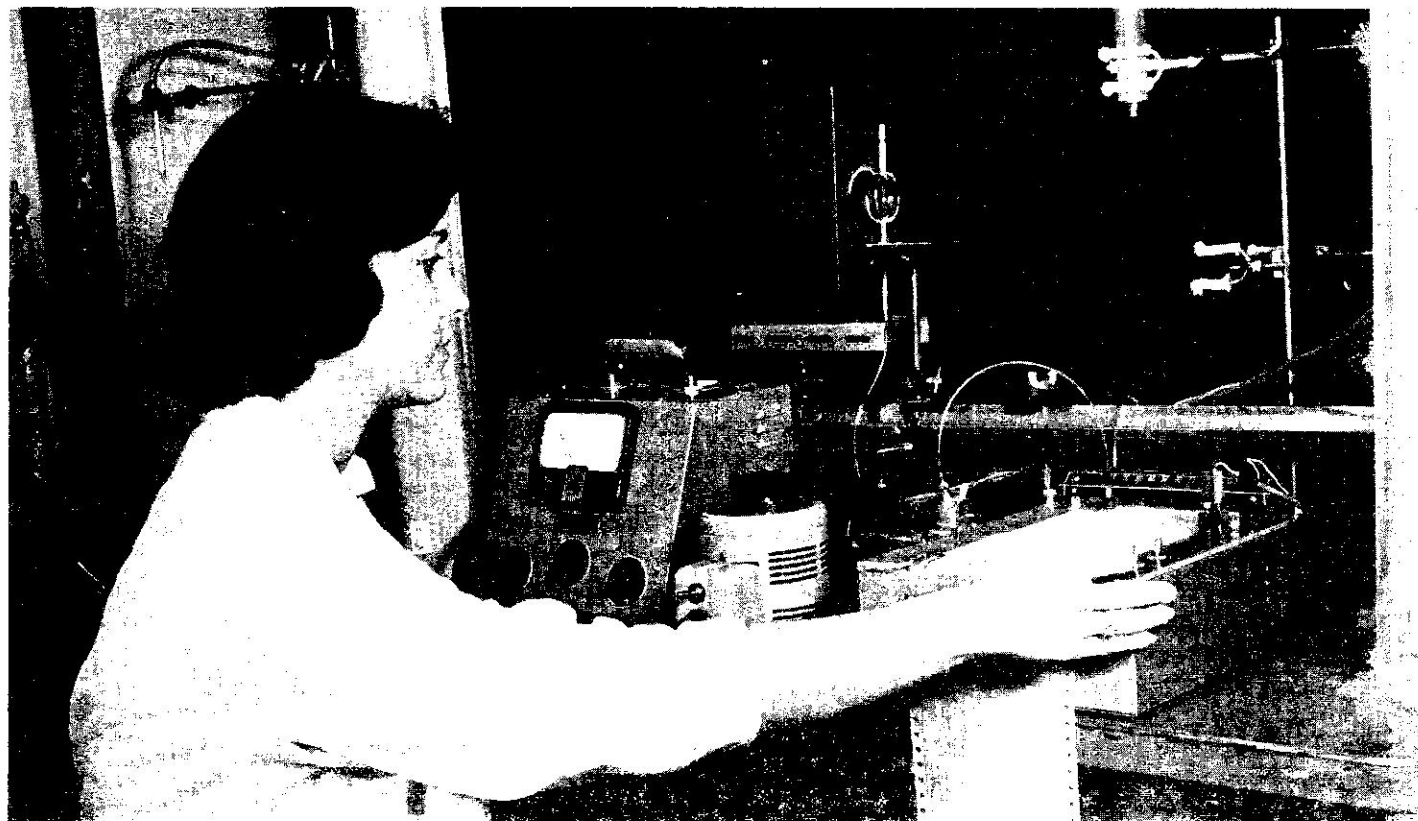
A theoretical and practical study of fatigue in photomultiplier tubes has been carried out. The various physical factors determining fatigue have been investigated and means of correcting for it studied. A number of mechanical and electrical devices have been developed for automatically eliminating fatigue for extended periods.

RESONANCE IN RADIATION EFFECTS IN CRYSTALS - Henry J. Gomberg (Ph. D., Univ. Michigan) and Florencio Vázquez Martínez (Ph. D., Madrid)

The effect of monochromatic x-rays on the crystal lattice spacing of alkali halides is being studied and this work will be extended to the study of the effect of monochromatic x-rays on other crystal properties. An x-ray spectrometer is being adapted for very low energy work and another high intensity spectrometer is being constructed.

NEUTRON SPECTROMETER RESEARCH - Ismael Almodóvar (Ph. D., Carnegie Inst. Tech.), Helmut Bielen (Ph. D., Bonn) and Kenkichi Okada (Ph. D., Kyoto), in cooperation with Dr. B. Chalmer Frazer and Dr. Walter Hamilton of the Brookhaven National Laboratory.

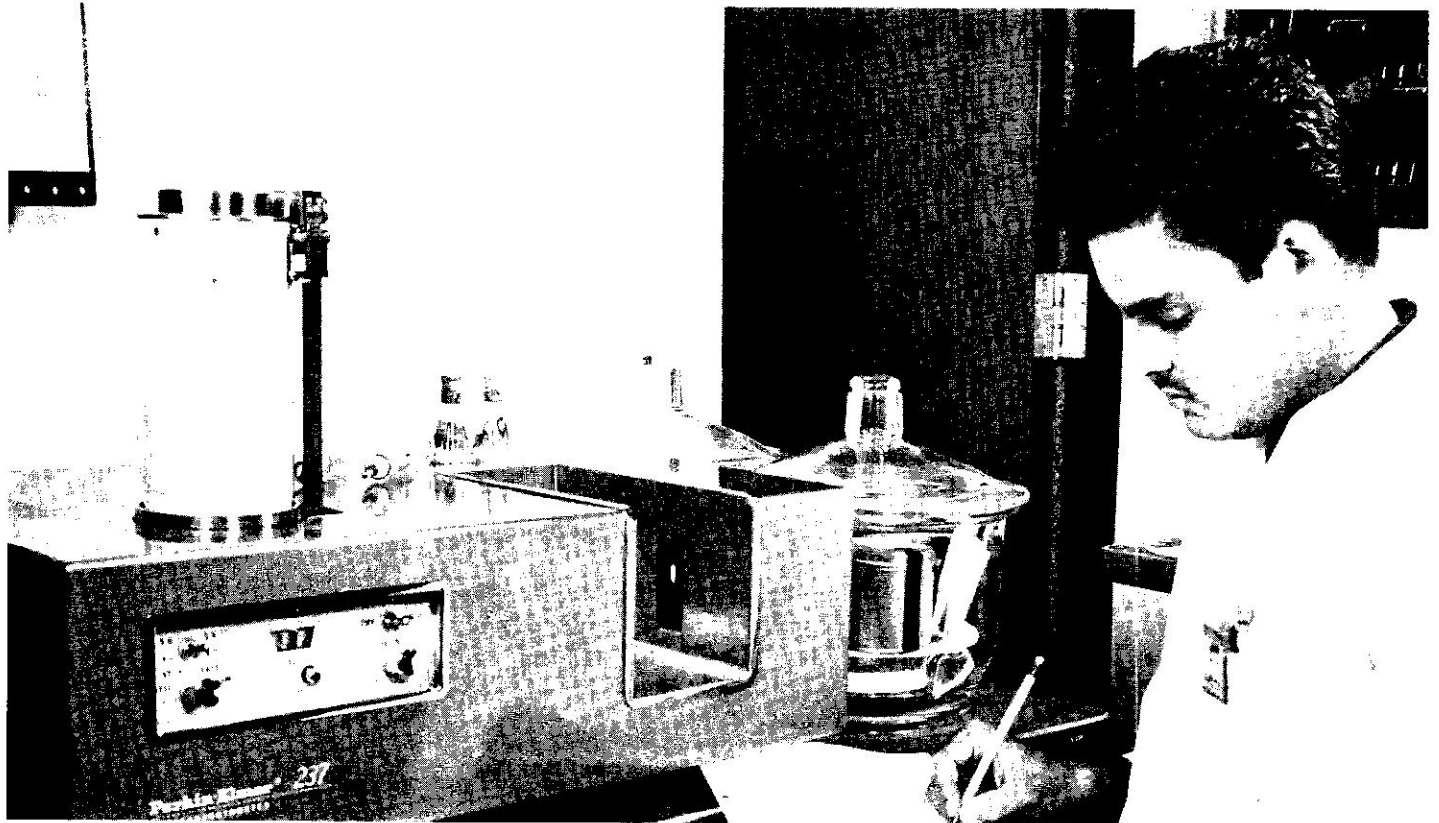
Two double-crystal type neutron spectrometers have been installed at the beam tubes of the PRNC swimming pool reactor. The first crystal selects the thermal spectrum by Bragg reflection and the second crystal is the sample under study. The scattering or diffraction pattern is recorded semi-automatically using electronic counting equipment. Studies have been carried out on calcium tungstate (scheelite) and this has led to a refinement of the X-ray diffraction data. Present studies include low temperature magnetic structure measurements on barium nickelate and iron silicate (fayalite). It is also intended to



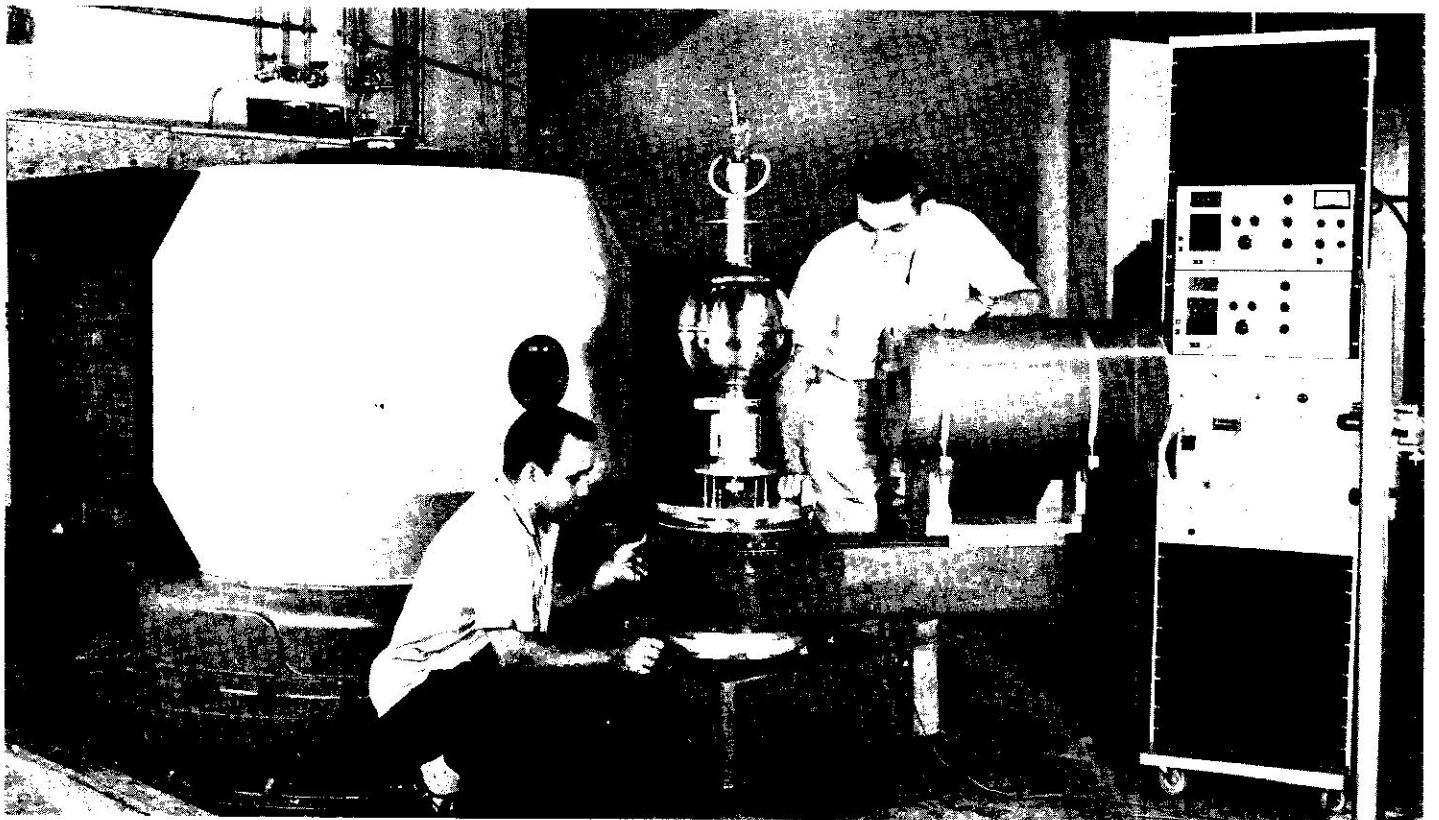
RECORDING AND MONITORING SYSTEM FOR CONTINUOUS IRRADIATION
PHOTOOLYS*



APPARATUS USED FOR MEASURING THE PHOTOCONDUCTIVITY OF SINGLE
CRYSTALS OF ANTHRACENE



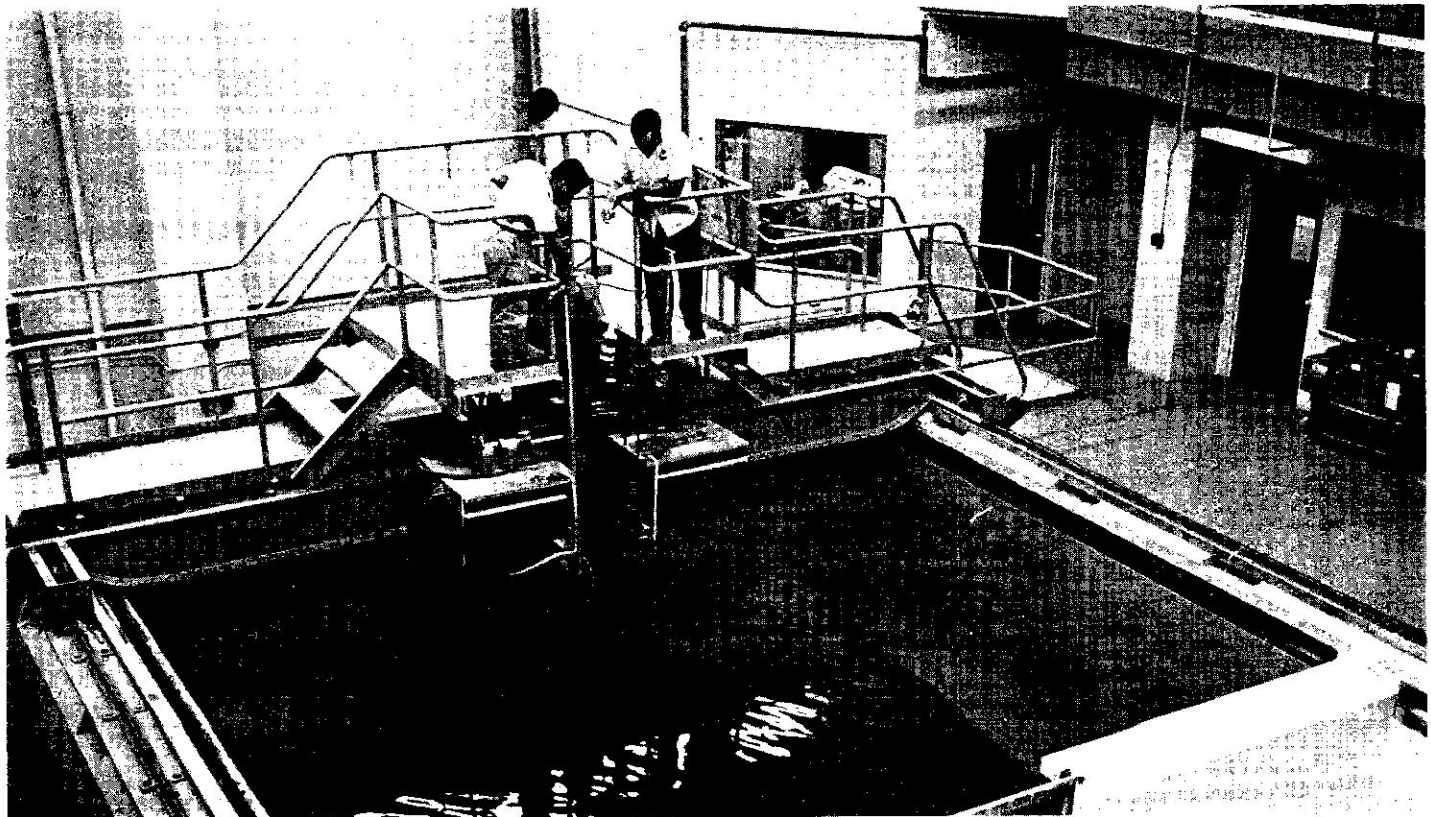
INFRARED SPECTROPHOTOMETER BEING USED IN THE DETERMINATION OF EQUILIBRIUM CONSTANTS



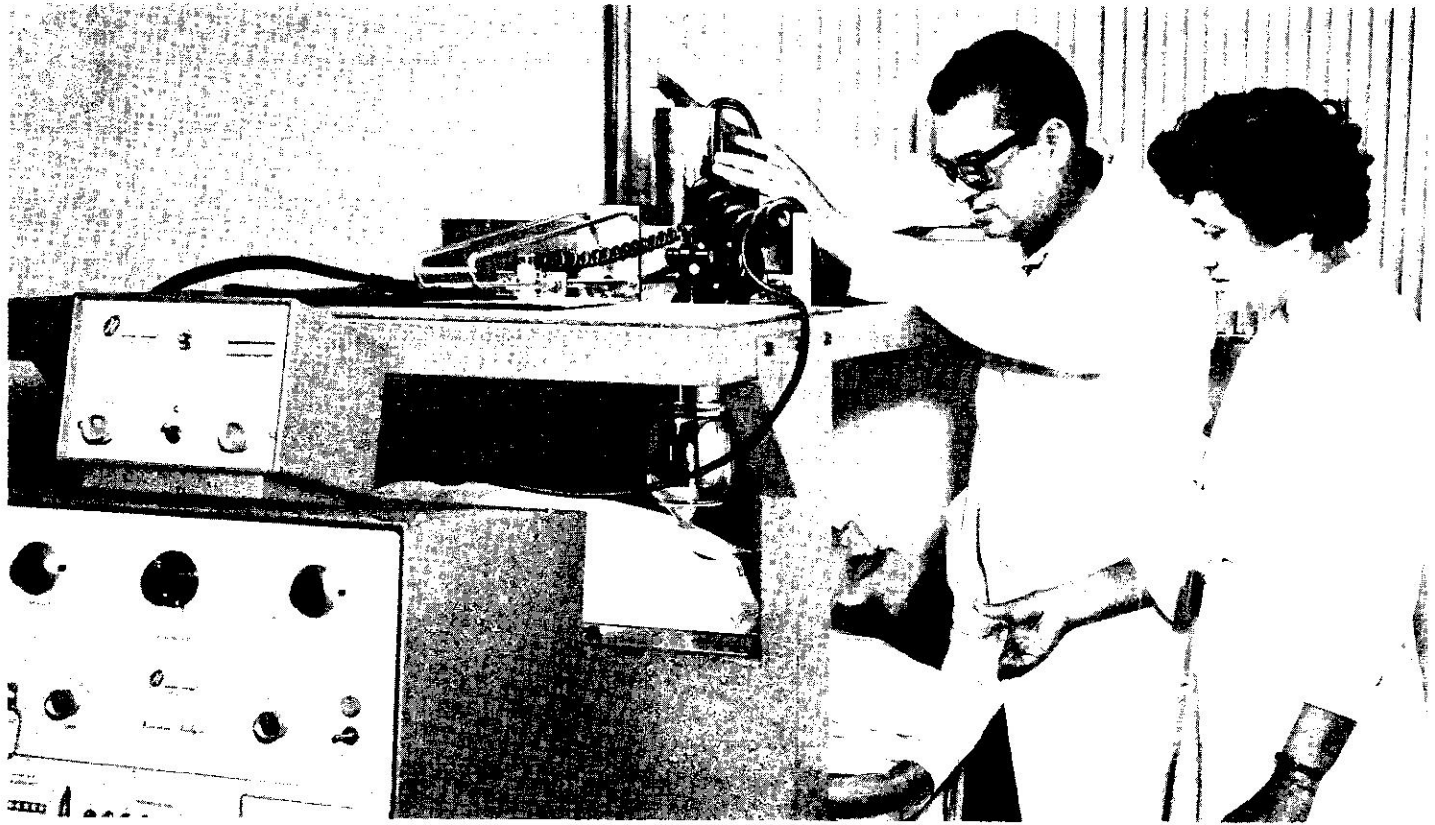
LARGE NEUTRON SPECTROMETER CONSTRUCTED AT BROOKHAVEN NATIONAL LABORATORY FOR P.R.N.C.



CONTROL ROOM FOR P.R.N.C. POOL TYPE RESEARCH REACTOR DESIGNED FOR OPERATION AT A 5 MEGAWATT POWER LEVEL



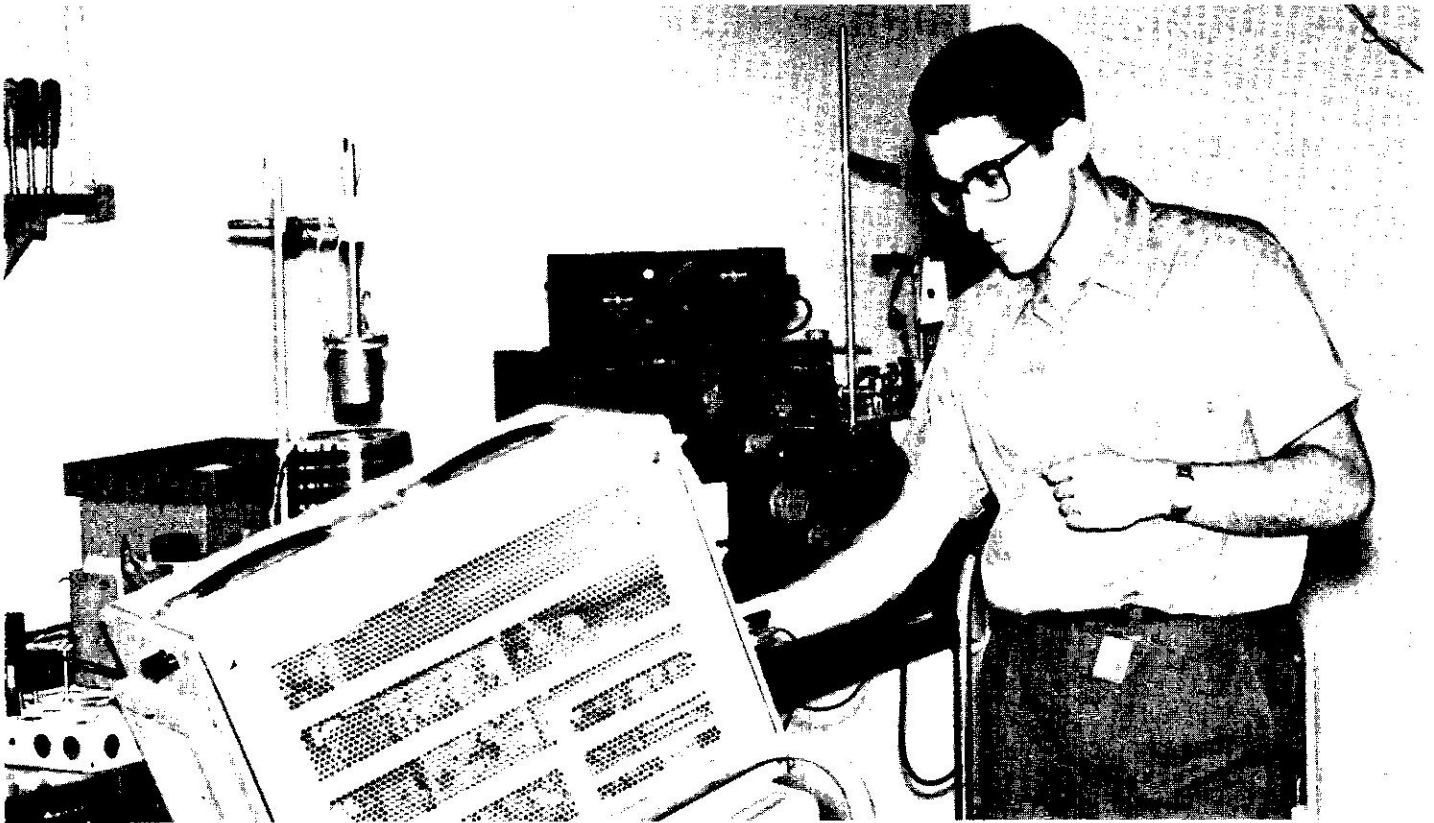
VIEW OF P.R.N.C. POOL REACTOR LOOKING TOWARD BRIDGE WITH CONTROL ROOM VISIBLE IN THE REAR



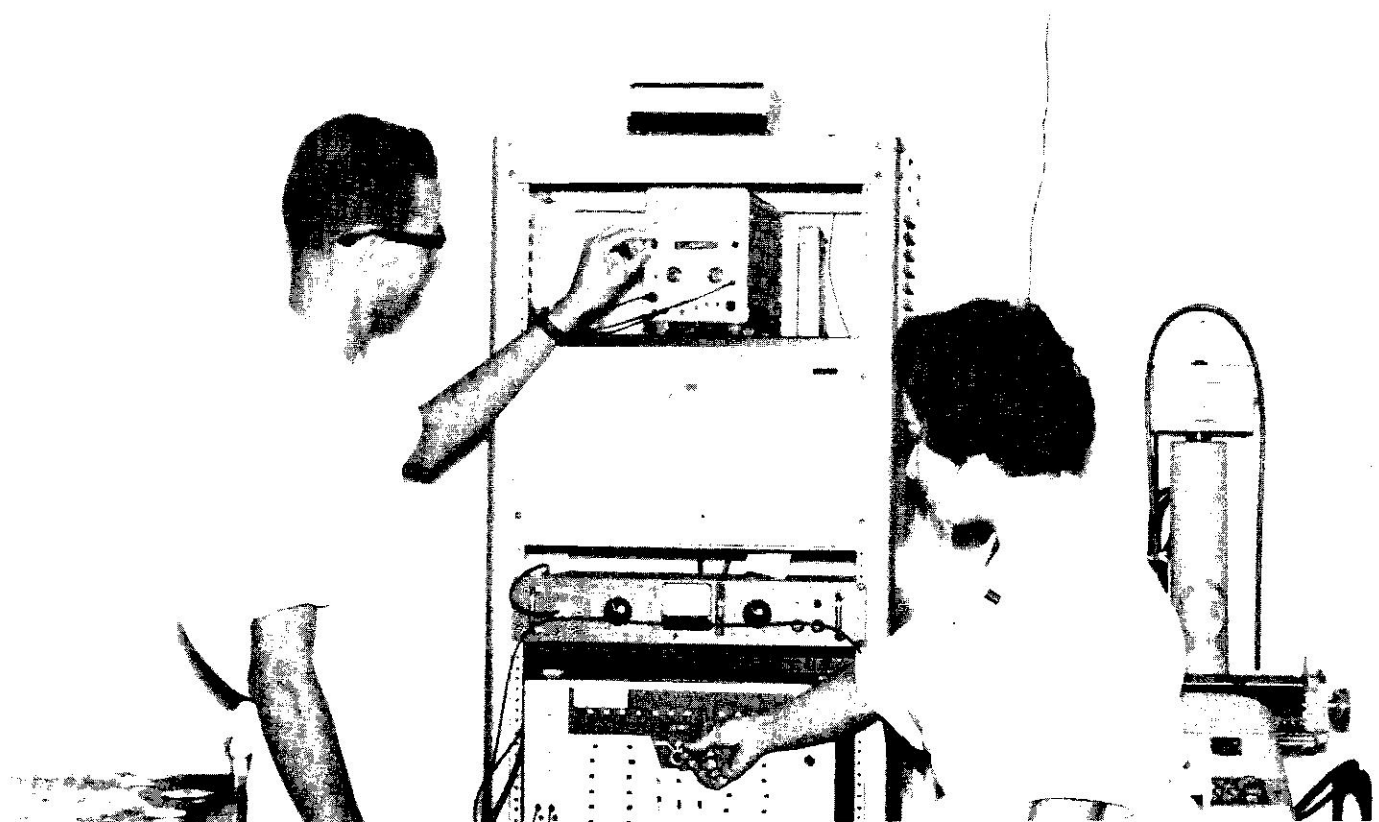
VIEW OF SCANNING EQUIPMENT USED IN TUMOR LOCALIZATION



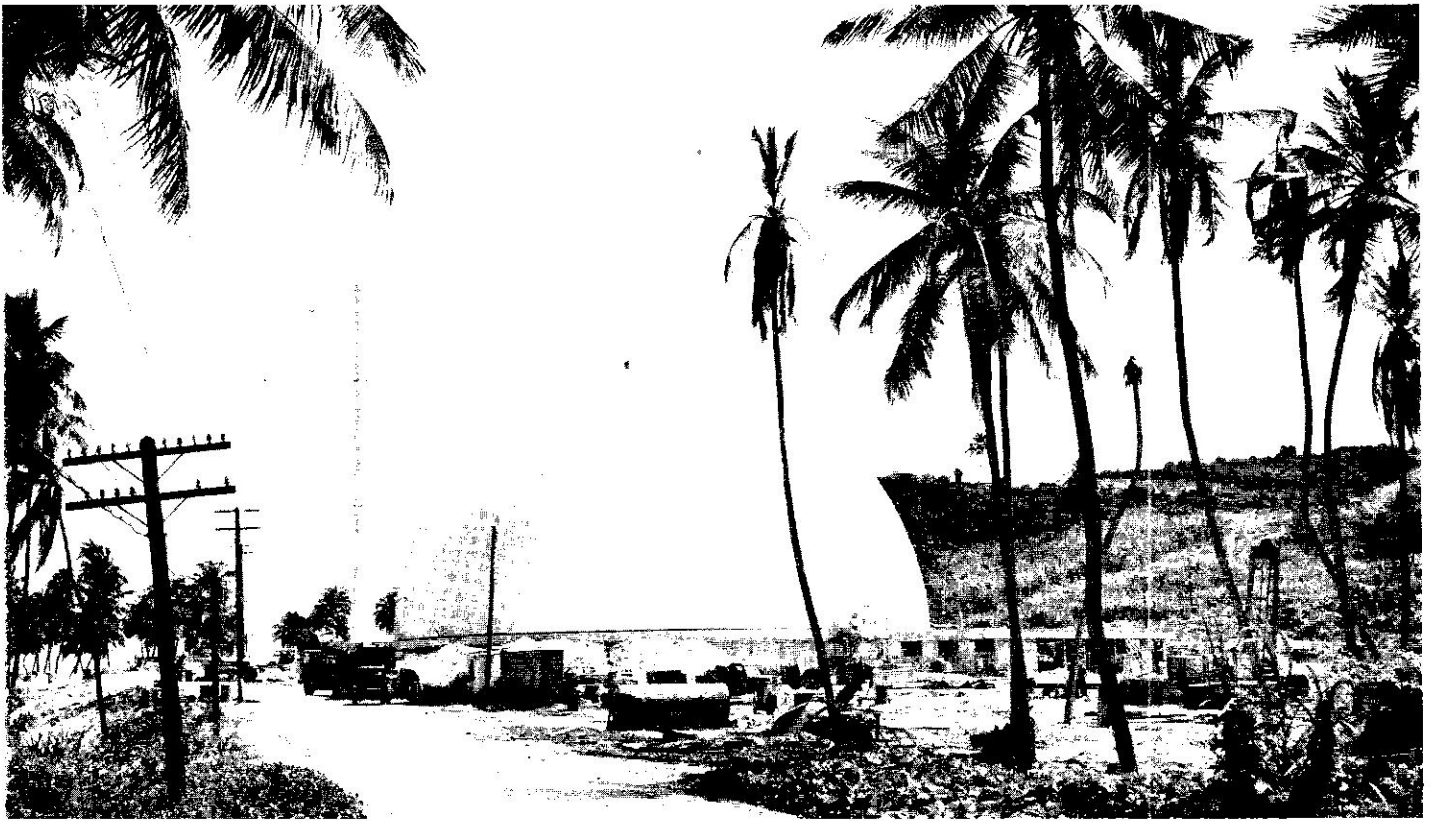
SCANNING UNIT USED FOR THE DETECTION OF RADIO-IODINE IN THYROID GLAND STUDIES



VIEW OF EQUIPMENT USED IN FERROELECTRIC CRYSTAL STUDIES



MULTICHANNEL ANALYZER USED FOR THE DETERMINATION OF TRACE ELEMENTS IN THE MARINE ENVIRONMENT



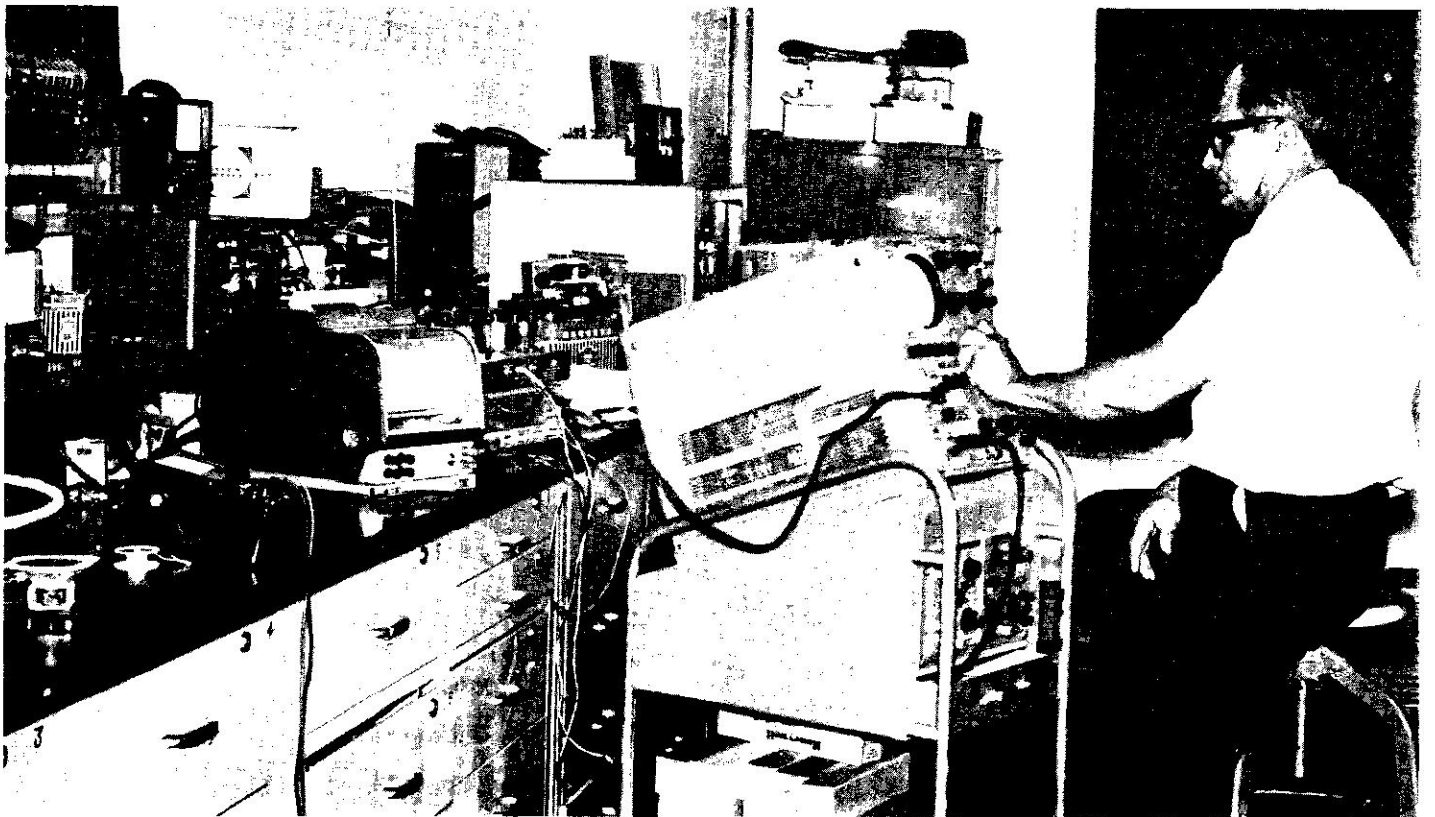
VIEW OF BONUS REACTOR WHERE
ENVIRONMENTAL STUDIES ARE BEING CONDUCTED



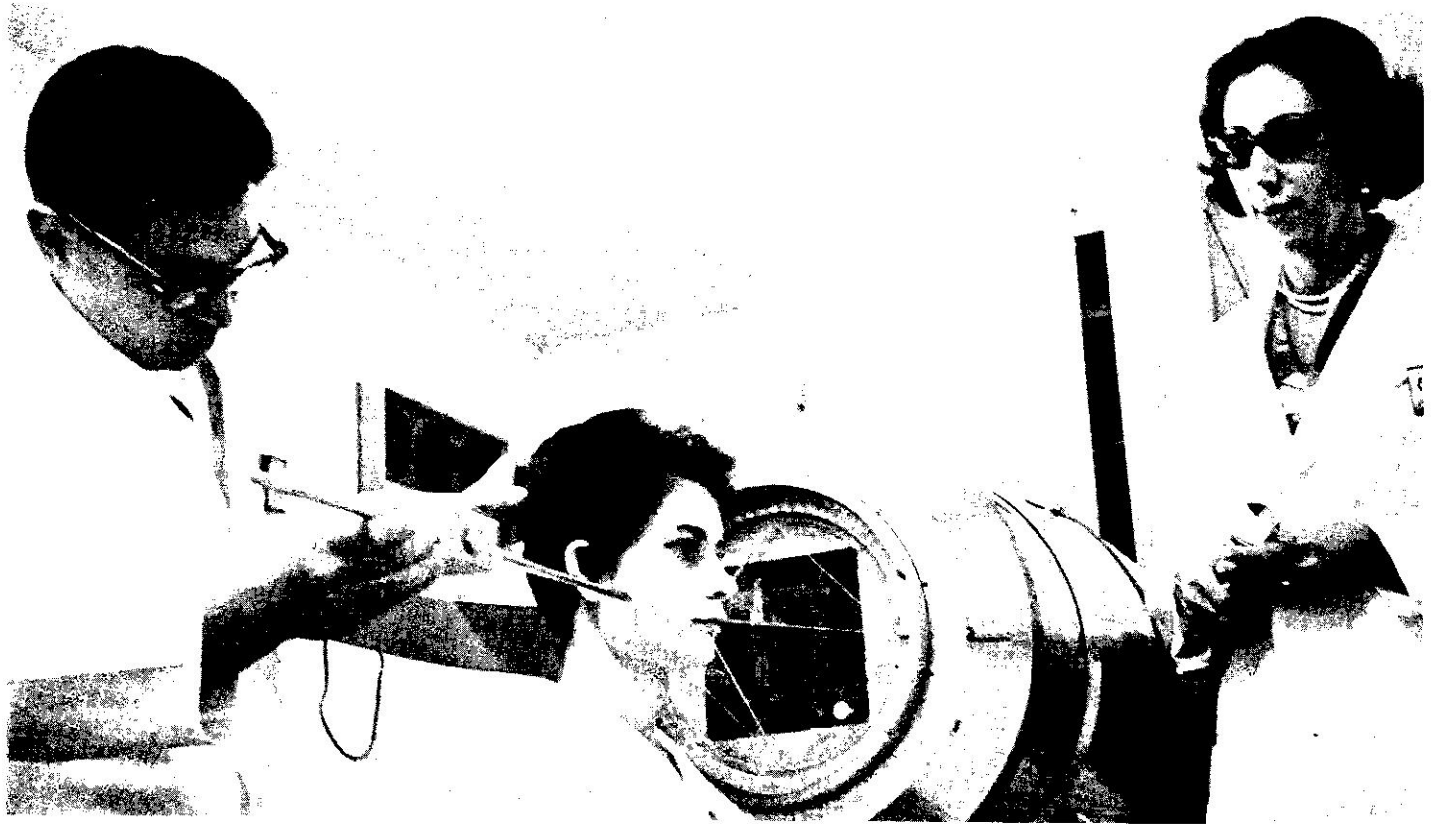
SELECTING INDIGOFERA PLANTS IN THE P.R.N.C. GREENHOUSE



SCIENTIFIC GLASS BLOWING SHOP



ELECTRONIC SHOP



PREPARATION OF PATIENT FOR RADIOTHERAPY TREATMENT WITH
COBALT-60 8,000 CURIES UNIT



COBALT-60 8,000 CURIES TELETERAPY UNIT

investigate the structure of organic crystals in relation to hydrogen-bonding in these compounds. Other work will include the study of inorganic amines and magnetic spin measurements with thiospinels.

The larger of the two spectrometers is equipped with a magnet for studying changes in magnetic diffraction patterns under a field, and for possible later use in polarized neutron studies. X-ray diffraction equipment is also available for crystallographic measurements. Other equipment includes furnaces and ovens for preparing compounds at high temperature and for growing crystals.

COMPTON SCATTERING - Eddie Ortiz (Ph. D., Texas A. and M.)

The cross-section of the H^2 reaction will be measured from the energy degradation of the Compton effect in a dispersing medium and determining the cross-section using a gamma deuterium threshold counter recently developed in this laboratories.

RESEARCH AT RIO PIEDRAS

BIOLOGY

TERRESTRIAL ECOLOGY - Howard T. Odum (Ph. D., Yale)

A study of the radioecology of a typical tropical rain forest at El Verde in the high lands at the eastern end of Puerto Rico has been initiated. Cesium 137 sources will be installed in this area and the effect of known doses of gamma radiation on the lethality, growth rate, etc. of tropical trees will be determined. More subtle biological effects of radiation such as the shifts in plant population and the relationships between them will also be investigated. The balance between plant viruses and their hosts and vectors may also be significantly altered. No similar study has been carried out in tropical areas in the world and there may emerge concepts of value to forestry and agriculture.

RESONANCE IN RADIATION EFFECTS IN BIOLOGICAL MATERIALS - Henry J. Gomberg (Ph. D., Univ. Michigan), Robert A. Luse (Ph. D., Univ. California) and Florencio Vázquez Martínez (Ph. D., Madrid)

Experiments using monochromatic X-radiation in the energy range of 6.4 to 8.5 kev have shown increased inactivation of the metallo-enzyme catalase at or near the K-absorption edge of iron (7.11 kev). This work is being extended to the investigation of X-ray deactivation of other metallo-enzymes, bacteria, and cells.

The physics of the x-ray beam was studied by double diffraction by a second crystal analyzer for the photon energy distribution. An estimate of the extent of second harmonic energies was made from absorption measurements relying on the different mass absorption coefficients at the first and second

harmonic wavelengths and from the double diffraction measurements in which photons from second harmonic energies were analyzed separately. Contamination by higher harmonics was found when the tube was operated at higher voltages. The monochromating system permits irradiation with photons of uniform energy distribution (± 50 ev in 6-9 kev).

CHEMISTRY

RADIATION CHEMISTRY AND PHOTOCHEMISTRY - Malcolm Daniels (Ph. D., Durham)

The research activities of the Radiation Chemistry and Photochemistry group are directed towards the interrelationship of these disciplines in two major areas of interest.

1. Reactions of Oxyanions - Malcolm Daniels (Ph. D., Durham)

The photochemistry of oxyanion solutions is being investigated with particular emphasis on characterising the various transitions ($n \rightarrow \pi^*$, $\pi \rightarrow \pi^*$, charge-transfer) and the nature and reactivities of the primary species. Work is currently in progress on the nitrate and periodate ions.

Radiation chemical studies include the investigation of pH intensity and concentration effects, with particular interest in the relative roles of excited states, free radicals and molecular dissociation processes.

2. Radiation Effects on DNA - Malcolm Daniels (Ph. D., Durham) and Alec Grimison (Ph. D., London)

Photochemical reactions of pyrimidine bases in aqueous solutions are being studied over the wavelength range 2537 Å - 1849 Å, with particular interest in (a) the nature of the reactions occurring at 2537 Å (which are fundamental to understanding of photobiological effects) and (b) the threshold for photooxidation processes.

The nature of the excited states involved in these reactions is being investigated by fluorescence and phosphorescence studies under appropriate conditions, and correlating work is being carried out with DNA solutions using viscosimetric, optical, and sensitizing methods. Incidental to this work is a study of salt effects, hydrogen bonding, and aggregation in denatured and undenatured DNA solutions. Radiation chemical studies on DNA and pyrimidines are aimed at elucidating the role of free radical reactions and excited states.

Irradiation techniques are common to both programs and include low and high pressure Hg lamps and Xenon lamps for continuous irradiation, and a 2700 curie Co⁶⁰ gamma ray source. Apparatus for flash photolysis is under construction. Spectrophotometric studies are carried out with the following instruments: thermostated Beckman DU, Zeiss PMQIII, Bausch and Lomb Recording 505, and Beckman Far UV DK 1A with polarized optics. Fluorescence and phosphorescence work is carried out with Aminco-Bowman and Farrand instruments, and viscosities are determined on a Couette-type rotating cylinder viscometer.

ORGANIC BORON COMPOUNDS - H. Harry Szmant (Ph. D., Purdue)

The research is oriented, in part, toward the development of structures suitable for use in the neutron activation therapy of malignant tissues. There are being synthesized internally coordinated orthoborates derived from a variety of glycols or catechols, and aminoalcohols or aminophenols, and the mechanism of the formation of these compounds is being investigated. In view of the desirability to encounter compounds which are relatively resistant to hydrolysis, it is proposed to investigate the dependence of the rates of hydrolysis on the structural features of the internally coordinated orthoborates. The synthesis of compounds of special interest to neutron activation therapy will be repeated utilizing B¹⁰ enriched reagents.

There are being investigated new derivatives of diboron, that is, compounds containing a boron-boron bond. The structures of the derivatives of glycols and diboron are being investigated in order to determine whether the rings include one or both boron atoms, and for this purpose there are being developed new boron-boron cleavage reactions, studied by infrared spectroscopy.

SUBSTITUTION OF HYDROXYL GROUPS IN POLYFUNCTIONAL ALCOHOLS - H. Harry Szmant (Ph. D., Purdue)

The aim of this program is to develop synthetic methods which are suitable for the selective replacement of one hydroxyl group of polyfunctional alcohols (including carbohydrates) by another functional group, and in this fashion arrive at potential antimetabolites. Successful synthetic methods will also be utilized to prepare compounds containing radioactive atoms in the substituents replacing the hydroxyl group.

There is being completed the study of formation of imidates derived from simple and polyfunctional alcohols and from the isomeric cyanopyridines. These imidates are now being subjected to nucleophilic substitution reactions reminiscent of the Pinner cleavage of imidates.

Another approach under study is the reaction of polyfunctional alcohols with activated dichlorocompounds such as, for example, 1, 3-dicyclohexyl-2, 2-dichloro-imidazolidino-4, 5-dione.

ORGANIC SULFUR COMPOUNDS - H. Harry Szmant (Ph. D., Purdue) and (in part) Edwin Roig (Ph. D., Pennsylvania)

This program is limited primarily to the study of the chemistry of sulfoxides and to the potential use of these compounds as radiation protective agents.

The oxidative addition of thiols to activated olefins is being investigated from the viewpoint of the structure of the resulting isomeric hydroxy sulfoxides. The formation of intramolecular hydrogen bonds is being studied by infrared spectroscopy in the case of the hydroxy sulfoxides derived from styrene and indene.

There are being determined the structural factors that affect the magnitude of the equilibrium constants for the association between sulfoxides and phenols, and these intermolecular hydrogen bonds are being studied using infrared spectroscopy.

Sulfoxides were found to be reduced to sulfides by means of triphenylphosphine. The mechanism of this reaction is of interest since it is acid catalyzed and favored by electron-withdrawing substituents. A technique to follow the rates by means of ultraviolet spectroscopy is being developed.

The reaction between sulfoxides and carbene-like species is being investigated and the structure of the product of the reaction of dimethyl sulfoxide and sulfocarbene (CH_2SO_2) is under study.

A project investigating the association of sulfoxides is being initiated and involves the synthesis of homologous sulfoxides containing O^{18} . The exchange of oxygen atoms between different sulfoxides (one of which is labelled) will be studied and the separations of the reaction mixtures will be carried out by gas chromatography.

CHROMIC ACID OXIDATION OF HYDROCARBONS - H. Harry Szmant (Ph. D., Purdue) and Edwin Roig (Ph. D., Pennsylvania)

This project is a continuation of previous work and its aim is to ascertain if the mechanism of the oxidation of 1, 1-diarylethanes includes a rearrangement of an intermediate radical. There will be synthesized 1, 1-diarylethanes containing C^{14} in the 2-position, and these labelled compounds will then be subjected to oxidative degradation. The presence of the C^{14} label in the degradation products (carbon dioxide, substituted benzoic acids and benzophenones) should permit us to establish the presence of rearrangements during the oxidation reaction.

MECHANISM OF THE WOLFF-KISHNER REACTION - H. Harry Szmant (Ph. D., Purdue)

In continuation of previous work on the mechanism of the base-catalyzed reaction of hydrazones of diaryl ketones, there is being studied the relative importance of the bond-breaking and bond-forming steps in order to clarify the reasons for the nonlinearity of the Hammett plot given by this reaction. There is being determined the dependence of the reaction rates on dimethyl sulfoxide concentration, and it is also planned to employ deuterium- or tritium-labelled compounds for the purpose of studying the kinetic isotope effects.

ACEROLA METABOLISM - Andrew Maretzki (Ph. D., Penn. State)

The metabolism of carbon 14 and phosphorus 32 labelled compounds in the acerola plant is being investigated, using autoradiography on two dimensional paper chromatograms made from extracts of the plant tissue. Injection of uniformly labelled carbon-14 glucose or sucrose in acerola fruit during the earliest stages of development resulted in no detectible uptake of radioactivity by ascorbic acid. Similar results were found with the injection into the stem of the excised fruit, branches of the tree, and excised leaves. Conversion to ascorbic acid was not found in fruit slices incubated with the above precursors for periods of five minutes to three hours, nor with acetate labelled precursors, in either the carboxyl or the methyl carbon group. A remarkably high rate of formation of a labelled substance similar to ascorbic acid was found. This appears to be a poly-carboxylic acid with a neutralization equivalent of 90 and is apparently different from any of the organic acids commonly found in plants.

BIOCHEMISTRY OF SUGAR CANE - Robert A. Luse (Ph. D., Univ. California)

A quantitative measure of the sucrose content of sugarcane using isotope dilution method and employing carbon-14 labelled sucrose has been developed. The sucrose is separated as a borate complex by ion exchange chromatography and the specific activity of the isolated sucrose is determined by proportional counting and bio-chemical means. Another technique uses thin layer chromatography of sugars, a method which is more sensitive than paper chromatography. This method also is being tested for the analysis of sugar phosphates. Neutron activation of paper chromatograms has also proved to be a very sensitive method of biochemical analysis. In these experiments, paper chromatograms of sugarcane extracts were irradiated with neutrons to transmute non-radioactive phosphorus-31 to radioactive phosphorus-32. Autoradiography of the activated chromatograms was then carried out.

Conditions for the incorporation of carbon-14 into sugarcane leaf discs have also been developed. Studies with phosphorus-32 applied to the leaf of native sugarcane have shown that phosphorus is rapidly distributed throughout the plant stem and other leaves. An automatic method of analysis of the sucrose content of sugarcane mutants has been developed using a Technicon autoanalyzer. This allows nearly 500 samples to be analyzed in one day with a minimum of operator attention. The production of sugarcane mutants by the neutron irradiation of sugarcane seeds is being studied with the object of preparing mutants with high sucrose content.

MEDICAL SCIENCE

STUDIES ON SCHISTOSOMIASIS - M. Paul Weinbren (M. D., Witwatersrand), John B. Villella (Ph. D., Univ. Michigan) and H. J. Gomberg (Ph. D., Univ. Michigan)

Experiments on the Puerto Rican strain of Schistosoma mansoni are being carried out to determine the maximum degree of immunity that can be produced in experimental animals and the conditions for obtaining this immunity, and to throw light upon the mechanism involved in the production of immunity against schistosomiasis. The effect of radiation levels of 1000 r., 2000 r., and 2500 r., or the critical dose level, is being investigated on the infectivity of mice.

RADIATION INDUCED VARIABILITY IN INDIGENOUS ARTHROPOD BORNE ANIMAL VIRUSES OF PUERTO RICO - M. Paul Weinbren (M. D., Witwatersrand)

The type and degree of arthropod borne animal virus activity in the El Yunque Rain Forest area will be investigated. The program is designed specifically to study any changes in population or behavior which may result following the proposed exposure to a 10 kilocurie cesium 137 source. Attempts will also be made to isolate viruses from arthropod animals, birds and reptiles. A program of serum collections to follow changes in antibody status among the vertebrate populations is also planned. A further objective is the testing of the hypothesis that ionizing radiation may be used to activate latent arbor virus infections in wild caught arthropods.

EVALUATION OF RADIATION RESPONSE IN CASES WITH CANCER OF THE CERVIX UTERI TREATED WITH RADIOTHERAPY BY MEANS OF EXFOLIATIVE CYTOLOGY - Víctor A. Marcial (M. D., Harvard)

The aim of the project is to determine the validity of exfoliative cytology as a prognostic tool in cases with cancer of the cervix uteri treated with radiation. This is a long term project that will require a minimum of two years observation of each case. As an initial step in the analysis of the data collected, a study of the significance of persistent tumor cells in the vaginal smear at the end of external radiation therapy is being conducted. The purpose of this initial analysis is to determine if the presence of persistent tumor cells at the end of external radiation is related to poor prognosis. Cases with at least two years follow-up will be used for this sub-study.

USE OF FLUORODS FOR RADIATION DOSIMETRY - Margaret P. Lozano (M. S., Univ. Rochester)

The objective of this study is to test the usefulness of fluorods (silver activated phosphate glass rods) in clinical radiation dosimetry. Plans are under way to test the fluorods as a possible dosimeter for isodose curve plotting with the 300KVP X-ray unit. Isodose curves in water have already been determined using Victoreen r-chambers. The fluorods will be tested against such chambers for the possibility of a more simple and reliable method for plotting isodose curves. Positive results would also justify the use of fluorods with patients treated routinely with the above x-ray unit. Photographic films will also be used to provide qualitative information.

LEUKEMIA STUDY - Víctor A. Marcial (M. D., Harvard)

This study is in collaboration with the Department of Epidemiology of the School of Public Health of Harvard University in an international survey of the possible increase of leukemia in patients treated with high doses of radiation directed to the pelvis for carcinoma of the cervix.

STUDY OF THE EFFECT OF RADIOTHERAPY ON INTESTINAL ABSORPTION IN HUMANS - Sergio Irizarry (M. D., Buffalo) and Víctor Marcial (M. D., Harvard)

The gastrointestinal tract is known to be highly sensitive to ionizing radiation. The purpose of this investigation is to study the absorptive function of the patient with abdominal cancer while undergoing radiotherapy. In addition to acute effects of therapy it is planned to study any long term changes (if any) that may occur. Specifically the absorption of radio-oleic acid and vitamin A will be studied.

TUMOR LOCALIZATION - Sergio Irizarry (M. D., Buffalo)

Developmental work has been done on the regular scanning equipment by introducing a modification which allows the placement of a photorecording unit underneath the examining table. The cassette of the photorecording unit has also been modified so that it may function like a regular x-ray cassette. With these modifications of the photorecording unit and the cassette, it is possible

to obtain a simultaneous consecutive double exposure in the same x-ray film; one being produced by light activation from the photorecording apparatus and the other by an x-ray tube. In this way the final record is a combination of a photoscanning and a radiograph of the organ or area being examined. This technique has been applied successfully to the study of organ and tumor localization in the thyroid, lungs, kidney, and liver.

THE STUDY OF THYROID GLAND FUNCTION UNDER THE INFLUENCE OF A COMBINATION OF ESTROGENIC AND PROGESTATIONAL SUBSTANCES IN PUERTO RICAN WOMEN - Sergio Irizarry (M. D., Buffalo), Dr. Gregory Pincus (Director of Research, Worcester Foundation for Experimental Biology), Dr. Manuel E. Paniagua (Puerto Rico Family Planning Association) and Mr. José L. Janer (Biostatistics Division, School of Public Health, School of Medicine)

The objective of this investigation is to study the possible effects of cyclic administration of a mixture of progestational and estrogenic substances on the thyroid gland function of iodine accumulation in a population of Puerto Rican women who are using these substances for contraceptive purposes. Specifically observations will be limited to studying the effects of the drug known as Enovid and the drug known as Sc 11800 under different dosage and time schedules using the 24 hour radioiodine uptake measurement.

PHYSICS

STUDY OF RADIATION DAMAGE IN ORGANIC CRYSTALS USING ELECTRICAL CONDUCTIVITY - Amador Cobas, (Ph. D., Columbia) and H. Harry Szmant (Ph. D., Purdue)

The effect of neutron, gamma, and x-ray irradiation on the electrical conductivity of anthracene crystals is being measured. The initial experiments have measured the changes in dark and photoconductivity in anthracene crystals after neutron bombardment. In extensions of this work trap densities and depths of penetration will be measured by studying the mobility and conductivity as a function of temperature. This work will be extended to other organic crystals. The presence of reaction products from the anthracene crystal after repeated irradiation will be studied spectroscopically and by vapor phase chromatography.

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